McGraw-Hill Rural Activities Series
W. A. Ross, Consulting Editor

Machines for the Farm, Ranch, and Plantation
McGraw-Hill

RURAL ACTIVITIES SERIES

W. A. Ross, Consulting Editor

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According to the 1940 census, 30,475,206 persons were living on 6,096,799 farms in the United States, but eight years later this figure had dropped to approximately 25,000,000 persons. Farms averaged 174 acres each in 1940; this represented an increase of 17 acres per farm since the preceding census. No doubt, this farm size growth can be attributed largely to the increased mechanization of agriculture; during this same period, the horse and mule population, 27 months old and over, dropped nearly 26 percent to a new low of 13,028,863 head. From 1940 to 1948, the average expenditure per farm for farm power and machines, not including motor fuel, increased over 150 percent.

It is estimated that in 1940 slightly more than 11,000,000 farm people, 14 years old and older, were doing productive farm work, not including chores. Five years later this farm group had dropped 20 to 25 percent as a result of farm people’s accepting industrial employment and entering military service. Despite this decrease in the number of productive farm workers, our agricultural production continued to rise. From 1941 to 1946, while this nation was conducting a two-front war, our achievement in agriculture was unparalleled. In 1945, nearly one-quarter of the farm output went direct to the armed forces and to our allies. At the same time, however, total food supplies to civilians exceeded slightly the 1935–1939 average. This was not only a tribute to our farmers, who worked so untiringly but also a credit to our modern and efficient farm machines, including tractors, farm trucks, grain drills, gang plows, combines, cultivators, and other agricultural machines.

If starvation is avoided over vast areas of the world, it will be due largely to modern farm machines in the hands of capable farmers. Contrasting the farmers of today using modern machinery with those of a century ago using the methods of that time, one finds that the present-day crops could not have been harvested by our entire population, using century-old methods. A well-known farm leader
recently stated that a wheat farmer adequately equipped with modern farm machinery can plow, seed, harvest, and market more wheat than 40 farmers with as many teams of horses could 40 years ago.

Concurrent with the significant advances in farming methods are new demands on farmers; one of these is the demand for ability to keep pace with the proper care, operation, and maintenance of their farm machines. For centuries, information was passed on from father to son on the care and use of the rather simple farm tools. Such instruction, however, does not meet the requirements of agriculture as it becomes increasingly mechanized.

When this country was in swaddling clothes during the Revolutionary War period, it took 19 farmers to produce enough food and fiber surplus to take care of one city dweller. Today each farmer not only takes care of his own requirements, but is also able to supply these essentials to five other families engaged in other lines of work. American farmers need only the signal of an emergency in production and their machinery and equipment are put to greater use in an effort to meet that demand. Farmers in 1941 doubled their peanut, soybean, and other essential oil crops. The extra use made of the machinery during the war years greatly increased the necessity for proper care, operation, and service of farm power and machines. This is often referred to as "preventive maintenance."

Maintenance or preventive maintenance means taking care of a machine or tractor so it is in good operating condition at all times. This includes proper adjustment and alignment of all parts and replacement of those worn or broken—all to the end that power is saved or utilized to advantage, delays are minimized, and the work done in an efficient manner. Having the appropriate machine for the work and operating it properly, however, precede maintenance.

The importance of organized, systematic instruction on the selection, operation, care, and storage of farm machines is apparent. The purpose of this book is to provide information, suggested procedures, and methods that will be of value to students and teachers of farm mechanics, dealers, servicemen, and those already established on farms, ranches, and plantations.
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Arthur W. Turner
Elmer J. Johnson
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Editor's Foreword

AMERICA'S development in agriculture, from the early efforts of the colonists down to the present, has been characterized by ingenuity and resourcefulness. Had the situation been otherwise, the machines and implements with which the American farmer does his work today would not be available. While history reveals several distinct eras in which agricultural machinery developed very rapidly, the upswing was rather steady when compared to the curve of national growth.

The speed and efficiency with which American farmers plant, cultivate, harvest, process, market, and store crops has long held the respect and admiration of peoples in other countries. The answer is largely in the machines used. They are efficient, save time and labor, and multiply individual manpower. Up-to-date machines are synonymous with progress, and it should be remembered that the American farmer, rancher, and plantation operator has more equipment available to him than any other such worker in the world.

Shortly after the attack on Pearl Harbor, the production of farm machinery was curtailed sharply as the war imposed exacting demands on the nation's steel output. Landowners and operators were unable to purchase new machinery and equipment to offset the increasing shortage of labor. But the rapidly accelerated demands for food made it necessary to increase the allotments of certain essential materials, vital in the manufacture of agricultural machines. More replacement parts were required, also, with the expanded cooperative use of available machines during the war years.

Events of World War II greatly accelerated agricultural mechanization. The further development of farm machines stimulated interest in the improvement of crop varieties. More important than ever before is systematic instruction on the selection, operation, care, maintenance, repair, and storage of agricultural machines. To assist in keeping pace with a rapidly moving mechanical age, this book has been prepared by authors who are eminently qualified.
Arthur W. Turner, a native of Minnesota, spent much of his youth on farms in that state and in Canada. Accepting the challenge of agricultural engineering, Mr. Turner enrolled at Iowa State College, where, following graduation and service in World War I, he became a member of the faculty. In addition to his teaching, Mr. Turner conducted tractor schools and soil-conservation demonstrations. Later, he was employed by the International Harvester Company to do advertising and promotional work and was also educational adviser for that concern. In 1944, Mr. Turner was appointed Assistant Chief, Bureau of Plant Industry, Soils, and Agricultural Engineering, U.S. Department of Agriculture, where he has charge of agricultural engineering research. He is the author of numerous technical publications and is a past president of the American Society of Agricultural Engineers.

Elmer J. Johnson was reared on a Kansas farm, farmed with his father, and then operated farms in his home locality. Prior to World War I, he attended Kansas State College. Returning from service in the armed forces, he enrolled at Colorado A. & M. College from which he was graduated with honors. As teacher of vocational agriculture and Assistant State Supervisor for Agricultural Education in Colorado, Mr. Johnson conducted and supervised many adult evening schools in farm mechanics. In 1940 he was employed by the U.S. Office of Education to develop National Defense Training and Food Production War Training programs in agriculture. He served as Federal Agent for Agricultural Education in the Pacific Region, and later as program-planning specialist.

*Machines for the Farm, Ranch, and Plantation* is unique in its organization of subject matter and is a real contribution to agricultural literature. Complete and well illustrated, this book is logically divided into jobs and activities as they occur naturally in the life of the man on the soil. Various late and improved machines are discussed. The manuscript was reviewed by a number of farm-machinery experts and agriculturalists. It is the hope of the editor and authors that this publication will meet a long-felt need on the part of prospective and present farmers, students, teachers, extension workers, soil conservationists, agricultural specialists, implement dealers, and others interested in the subject.
MACHINES FOR THE FARM, RANCH, AND PLANTATION
FIG. 1. The goal of a year's work—a profitable crop well harvested.
Introduction: The Development of Farm Machines and the Principles on Which They Operate

The Development of Farm Machines

For centuries, the size of a farm was governed primarily by the amount of man labor available and was influenced only slightly by other factors, because nearly all of the farm work was done by hand. The main tools consisted of an ax to clear the land, a spade to turn the soil, a hoe and a rake for seedbed preparation and cultivation, and a sickle for harvesting. Under such conditions, there was very little food and fiber produced beyond home needs, and this took most of the year-around time of an entire family.

Before the 18th century, horsepower was mainly used for transportation and warfare. The first mention of the horse in the Bible occurs in Genesis, 47:17. It was about 1715 B.C., during the time of Joseph, that the Egyptians used the horse in warfare. Although the horse was, no doubt, tamed during the Stone Age, not many horse-drawn farm machines were developed until the 18th century. Following the industrial revolution of about 1760, an advance was made in the development of farm machinery utilizing the horse as a means of field power.

The initial invention and manufacture of horse-powered farm equipment came just when our new republic was ready for its surge westward to develop the potential agricultural resources of this country. During the 19th century, the inventive powers of American geniuses transferred a large amount of farm work from hand to horsepower. It was not until the 20th century that any appreciable amount of farm work was done by motor power; the increased demand
for food production during World War I and World War II accelerated the widespread use of motor power on the farm.

Farm machines constitute the key to the productive ability of American farmers and the nation's food-production program; in fact, to the nation's entire economic and social structure. Labor that is required to produce food, our first requirement, will not be available to industry and commerce. Increasing industry—the designing and making of goods—heightens the standard of living. Such has been the picture of American progress, progress that has given America the highest standard of living in the world. Thus, it

seems logical that if farm labor can be made more efficient, if it continues to increase the production of each worker, industry will continue to develop and expand. As industry expands, standards of living, for farm and urban residents alike, will continue to rise. Just as farm machines constitute the key to the productive ability of American farmers as a whole, mechanical power constitutes the key to the individual farmer's production.

Tractor power has greatly increased the speed of performing field work. Greater acreage has been gained largely by increasing the size of farm power units on large farms. Small machines operated with animal power have been replaced with much larger machines operated with tractor power. For example, the sulky plow and the two-horse walking plow are being replaced with tractor plows, and
the one-row riding cultivator is being replaced with tractor cultivators of two-row size and larger. It is, of course, impossible to picture the saving in labor thus effected on a particular farm, as there is a wide variation in the kinds of animal-drawn equipment originally used and in the size and speed of tractor-operated machines replacing them.

There is also a wide variation in machine performance in different parts of the country. In the more level areas where farms are large, the acreage covered or work done per day per machine is much greater than the national average. Most of this difference is due to the use of larger machines. Because of the size of machines used, more work has been performed in the Great Plains areas than in other sections. This is because (1) the first tractors were built primarily to pull large machines and (2) the Great Plains areas are grain-farming areas. Such machines were costly and had to be used where the work done would justify the expense. Plowing, seedbed preparation, planting, and harvesting were the main operations, all of which were pulled-machine jobs for which tractors replaced horses.

The row-crop areas of corn in the Middle West and of cotton in the South presented more difficult problems. However, as the grain crops were mechanized, the progress of inventive work resulted in the development of row-crop tractors with accompanying machines
such as tractor planters and tractor cultivators. This development placed these operations on a tractor basis and in a few years it was not uncommon to see one man and a four-row planter or a four-row cultivator working as much as 25 acres in one day.

From that time on there has been rapid development in all farm machines, those for haying and harvesting as well as seedbed preparation, and planting and cultivating machines designed for tractors. Today, the value of tractors and machines on the basis of each acre of cropland varies widely throughout the United States, reflecting the influence of the row-crop tractor system of farming.

It is more than a coincidence that states with the greatest investment in farm machinery also rank near the top in per capita farm income. California, Iowa, and Illinois rank first, second, and third; they hold practically the same position in the value of modern machines and laborsaving equipment per farm. Florida, Texas, and Oklahoma, among the 13 Southern states, have the greatest investment in machinery per farm; they also have the largest per capita agricultural income in the South.

The mechanization of the row crops of the Corn Belt ushered in a new day in farm equipment. Up to that time farm machines had been designed to accommodate the horse. Rows were spaced for horses; machines were planned to use the power of one, two, or more horses. This limited development and kept tractors from the small and unevenly dimensioned farms.

The reorganization of the efficiency and convenience of mechanical power has placed the tractor ahead of the horse as a source of farm power. Tractors and machines are now designed for small farms, formerly considered one- and two-horse or mule farms. Conveniences, attachments, and adaptations of the larger row-crop tractors are now available to small operators on the farm, ranch, and plantation.

This new development holds the greatest promise for the South. In 1920, there were 246,000 tractors on farms in the United States. Twenty years later this number had increased over sixfold. Every region of the nation participated in this increase; however, the North Central states and the Corn Belt were in the lead. More than 40 percent of the farms in that section were tractor operated, while fewer than 5 percent of the farmers and plantation operators in the South Central states owned tractors at the opening of World War II.
A significant development is that of a small, flexible, row-crop tractor with light machines that can be attached to and detached quickly from the tractor. In this manner they make one-man units; that is, the tractor operator is also the machine operator. These small tractors and small machines are relatively low in cost. This new development will enable each operator to be independent in so far as his field work is concerned. He can prepare the seedbed, plant, and harvest at the time that will give him the greatest return from each of the crops he produces. He will also have a power plant, readily maneuvered on smooth or uneven terrain, for many power jobs—pulling, pushing, operating by belt or through the power take-off.

The machines discussed in this book are treated in three stages: (1) selection, (2) operation and servicing, and (3) reconditioning and storage. There are several factors influencing selection that apply to all types of farm machines. They are factors that will enable a person to judge and select a machine better. They will direct his attention to points that are important in selecting one particular machine over another. These factors are (1) reliability of the manufacturer, (2) design and workmanship, (3) adaptability, (4) safety features, (5) ease of operation, and (6) ease of service and adjustment.

The Reliability of the Manufacturer. Manufacturers spend many years and considerable money in building a reputation for machines and establishing their trade-marks. After a manufacturer has established his reputation, an identifying trade-mark, and a trade name, he is likely to continue to maintain and protect them.

It is seldom possible to judge a machine by its appearance and determine whether the best materials have been used in its construction. Thus, if a machine is the product of a reliable firm, the manufacturer will do his part in correcting defects that may appear. The reliability of the manufacturer is, therefore, a fundamental factor to consider in purchasing a machine.

Design and Workmanship. These two factors are definitely interrelated. Manufacturers may build the same type of machine, but the arrangement and relationship of component parts may differ. It is possible after studying machines and understanding the functions of the various members to decide whether or not the means of attachment, bracing, and operation are adequate. The number and types of anti-friction bearings and the protection given them are items to
consider also. Workmanship is reflected in the general over-all design, assembly, and finish. Well-machined gears, good bearings, and an adequate system of lubrication, as well as over-all stability, should be considered.

**Adaptability.** It is very important, in selecting a machine, to determine whether it will do the desired work satisfactorily. Machines should be adapted to the power available and vice versa. Agricultural conditions, climate, soils, and crops vary so widely that a machine that functions satisfactorily under one set of conditions may be a disappointment under other conditions. (For Safety, see page 24.)

**Ease of Operation.** Convenience and comfort of the operator are desirable features, since quality of work depends a great deal on the operator. Levers, shifting mechanisms, and other means of adjustment that tire the operator are not desirable. Machines are now moved about on hard-surfaced highways and the ease with which a machine can be converted to transport for the highway is to be taken into consideration.

**Ease of Service and Adjustment.** All mechanical devices wear and must, in time, be adjusted; some items must be replaced. Find out whether essential parts are readily available and the extent to which service on the machine is available. Also determine whether lubrication can be taken care of without undue effort. The dealer is an important factor in machine operation. His service should be readily available. A good servicing dealer is like a reliable manufacturer; he stands behind the equipment he merchandises. His service consists of instructing in operation, supplying replacement parts, advising the owner on maintenance, providing periodic maintenance, and reconditioning machines in certain instances.

**New Types of Machines.** The recent rapid developments in farm machines indicate that farmers are eager for more laborsaving machines. Thus, in turn, farm operators will continue to cooperate with manufacturers in developing and adapting machines to specific farm jobs.

There are five places where a farm operator may purchase new farm machines: (1) factory, (2) branch house of factory, (3) local dealer representing the manufacturer, (4) a jobber, and (5) a mail-order house. Usually the full-line manufacturer and most of the others have no provision for retail sales at the factory. This may not be true of the small and specialty manufacturer producing machines.
INTRODUCTION

for a given locality. Factories produce machines for many sections of the country, and the machines are shipped to the proper branch house for distribution and sale to farmers of that area. The branch house, like the factory, sells through the local dealer. A display of the machines used locally can generally be seen more often at branch houses than at the dealers.

The local dealer should be in a position to render the service of a specialist or expert on machines for his community. Like the manufacturer, he remains in business because of reliable dealing and service to farm operators. He is acquainted with the machines, models, and types best suited to the locality. He can advise as to the proper size of machine. He also provides service and carries certain stock replacement parts.

After a farm machine has been placed in service, the need for intelligent operation is evident, if desired results are to continue year after year. It behooves every farmer to study carefully the operation of each of his implements and then put into action practices that will ensure long, efficient, and effective service at a minimum cost. It is such sound operation and care that frequently make one farmer more successful than another even though both are operating on a similar scale and under conditions alike in nearly every respect. Many farmers take great pride in their machinery and refer with enthusiasm to the number of years it has been in operation and the acreage it has covered each year. Generally speaking, such farmers are the stable, financially sound, and respected citizens of their communities. Others may well profit by their example.

Principles on Which Farm Machines Operate

The intellectual and physical welfare of man is primarily dependent on what the earth yields. This means that a progressive society cannot be created and maintained in a framework of unproductive, backward agriculture. The satisfaction and comforts resulting from abundance make possible a people operating on a basic foundation of peace and stability. Improved agriculture reflects the progress that makes the modern world different from previous periods. Farm machines play a major role in such progress.

Machines Defined. A machine is generally defined as a combination of two or more mechanical parts, such as levers, gears,
sprockets, pulleys, and shafts, designed to act upon materials so as to
modify and change them in a desired manner.

Farm machines, in general, are used to substitute low-cost energy
supplied by motive power for the more expensive muscular effort of
man. Since they can be made in a variety of types and sizes to
modify or transmit the energy of animals or motors, farm machines
are commonly referred to as “labor-saving devices.”

It is advisable that owners and operators have an understanding
of the function of machines in general and of some of the underlying
mechanical principles. Such understanding will simplify work and
should improve the performance of the machines.

Six Simple Machines. Farm machines, like other machines, are
combinations of one or more of the six simple or elementary machine
principles. The six simple machines follow.

1. The lever is a simple, rigid bar turning about a fixed point called the
   “fulcrum.” The mechanical advantage of the lever is the ratio
   of the length of the lever arm of the applied force to the length
   of the arm of the resistance force. The three classes of levers are
   illustrated.

2. The wheel and axle is sometimes called a “continuous” lever. A
   rolling wheel assists the force in moving an object.

3. The inclined plane is illustrated by rolling a load upon an incline.

4. The screw is a continuous and circular inclined plane, whereby a
   small force working through a great distance can raise a heavy load.

5. The wedge can be considered a modification of the inclined plane
   since force applied on the wedge separates the objects on both sides
   of the wedge.

6. The pulley is of two kinds: the fixed and the movable. The fixed
   pulley merely changes the direction of travel and gives no mechan-
   ical advantage. The movable pulley increases the effective force
   at a sacrifice of speed or mechanical advantage. Combinations
   of fixed and movable pulleys give any desired effective increase of
   force, or mechanical advantage.

Common hand tools such as the shovel, the hoe, or the hammer
are simple, convenient devices for applying force. Machines, on
the other hand, such as a mower or a cultivator, have two or more
working parts and serve one of the following purposes—(1) to apply
forces in such a way as to make labor more effective, (2) to replace
human labor with the energy of motive power, and (3) to change the
character of labor, making it less irksome and difficult.
A lever is a rigid member that revolves about a fixed point known as the fulcrum (F). Force (F) is applied at the lever to move or tend to move a weight (W) attached elsewhere to the lever. Levers are divided into three classes, according to the positions of the force, weight, and fulcrum. In a lever of the first class, the fulcrum is between the force and the weight (Fig. A). In a lever of the second class, the weight is attached between the force and the fulcrum (Fig. B). In a lever of the third class, the force is applied between the weight and the fulcrum (Fig. C). In all classes of levers, the equation for figuring the efficiency of the lever is as follows: the length of the force arm (AB) multiplied by the force is equal to the weight arm (OC) multiplied by the weight, or $F \times AB = W \times BC$.

The inclined plane assists in raising a force upward, whether it rolls or slides (Fig. D). Use of the inclined plane, like the lever and other simple machines, reduces the physical effort or strain; however, it requires increased travel.

The wedge may be considered as two inclined planes attached at their bases. Applying force to the head of the wedge spreads or tends to spread the object penetrated (Fig. E). The screw is in reality a cylindrical inclined plane. As the screw is turned the weight is lifted (Fig. F).

Pulleys and blocks are of two types: fixed pulleys (Fig. G) and movable pulleys (Fig. H). In describing the action of the pulleys, W indicates the weight to be lifted or the load, and if $F = W$, then W is attached to a movable pulley. The travel distance of F will be twice that of W; thus we say we have a mechanical advantage of two. Fig. I combines the pulley arrangements of Figs. G and H, which merely changes the direction of travel of F over Fig. J, so the mechanical advantage remains two. In Fig. J, we have 2 blocks with 3 pulleys or sheaves in each. Those in the block to which load W is attached are movable, there being 6 strands supporting load W. In order for load W to move up, the force F will have to travel 6 ft., giving a mechanical advantage of six.

The wheel and axle, the sixth simple machine, is illustrated by the differential pulley (Fig. K). In this case the fixed block has two pulleys or sheaves for a chain rope. The two pulleys have different radii, yet operate as a unit. The movable pulley is connected to the fixed pulley by an endless chain. As the chain is pulled down as F, the load W is raised at a speed of the ratio between the two pulleys on the fixed block.

---

**Fig. 4. Principles involved in the six simple machines.**

(A-C) Levers. 

(D) An inclined plane. 

(E) Wedge. 

(F) Screw. 

(G-J) Pulleys. 

(K and D) Wheel and axle. 

All farm machines make use of one or more of these principles.
**Force, Work, and Power.** Any applied effort or force that overcomes a resistance or results in objects being lifted or moved is *work*. Thus, in turning a crank, lifting a chair, or sliding a table across the floor, work is done. *The time it takes to move an object* is also involved in work. The shorter the time required for accomplishing a given amount of work, the greater the ability to do work.

Work is done when a man exerts force through distance, as in turning a wrench to tighten a nut on a bolt. The bicycle rider exerts a force downward against the pedal, making the sprocket turn which moves the chain and revolves the rear wheel. The work done by the rider is used or consumed in overcoming the resistance of the bicycle to motion, in keeping it moving, or in overcoming gravity as he goes uphill.

Turning effort or *torque*, when considered in the tractor engine, produces work when it causes motion. When a force is applied to the crank, it acts through the leverage of the crank arm and develops a torque or turning effort in the crankshaft. This turning effort does work in propelling the tractor by overcoming its resistance. When a greater amount of torque is required, more cylinders are provided to the crankshaft and their combined effort is used.

*Mechanics* is the science of applied mathematics that treats of the action and effect of forces on bodies.

*Force* is defined as any cause tending to produce or modify motion. The units by which a force is usually measured are *pounds* or *tons*. Besides force, there are two other elementary quantities in mechanics from which numerous compound quantities are derived. These are *distance*, which is measured in linear units such as inches or feet, and *time*, which is expressed in hours, minutes, or seconds.
Work, in mechanics, is the product of force by distance, and is expressed by a combination of units of weight (force), and of distance, such as inch-pounds, foot-pounds, and foot-tons.

Power, in mechanics, is the product of force by distance, divided by time, or the performance of a given amount of work in a given time, and is expressed as inch-pounds per minute and foot-pounds per minute or second. The term “power” is frequently used by writers on mechanics to designate a “force.” In connection with the so-called “mechanical power” involving the simple machines, we speak of the applied force as the “power.” This is not strictly correct, however. In mechanics, “power” should always be used in accordance with the definition given above.

Horsepower (abbreviated hp.) is the unit of power adopted for engineering work. One horsepower is equal to 33,000 foot-pounds per minute, or 550 foot-pounds per second.

Power is ordinarily measured in foot-pounds per second. As this unit is often too small for practical purposes, the larger unit of horsepower is used. Figure 7 illustrates the principle of horsepower. In this example, the horse walks at the rate of 66 ft. per min. and lifts a 500-lb. weight. When these figures are multiplied, it is seen that 33,000 ft.-lb. per min. is the rate at which the horse is doing work. This rate is known as the “horsepower.”

The horsepower of an engine indicates the rate at which it is able to do work. The belt horsepower and the drawbar horsepower are measured on a device known as a “dynamometer,” which determines the actual power developed.
Some Facts about Tractor Horsepower. The drawbar power required to pull two 14-in. plows under certain soil conditions may be 1,200 lb. at 3 m.p.h., or 1,320 lb. at 4 m.p.h. Let us see how much drawbar horsepower it will take to pull such a plow 3 m.p.h.

There are 5,280 ft. in a mile.

\[
\frac{3 \times 5,280 \text{ (feet in mile)}}{60 \text{ (minutes in hour)}} = 264 \text{ ft. per min.}
\]

and

\[
264 \times 1,200 \text{ (pounds pull)} = 316,800 \text{ foot-pounds}
\]

\[
\frac{316,800}{33,000} = 9.6 \text{ drawbar horsepower.}
\]

Or

\[
\frac{3 \times 5,280 \times 1,200}{60 \times 33,000} = 9.6 \text{ hp.}
\]

To pull these two plows at 4 m.p.h., the horsepower required is

\[
\frac{4 \times 5,280 \times 1,320}{60 \times 33,000} = 14.08 \text{ hp.}
\]

To these horsepower figures must be added the power required to move the tractor and overcome frictional losses. The average wheel tractor delivers about 70 percent of its engine horsepower to the drawbar. Therefore, the 9.6 hp. required to pull this plow 3 m.p.h. must be taken as 70 percent of the engine horsepower. This would mean an engine horsepower of 13.70 in the average tractor.

\[
\frac{9.6 \times 100}{70} = 13.7 \text{ hp.}
\]

Cycle. Applied to the internal-combustion four-cycle engine, a cycle comprises four strokes for each piston (1, intake; 2, compression; 3, explosion; 4, exhaust) performed during two revolutions of the crankshaft. An interval, or period, of time occupied by one round or course of events, recurs in the same order in a series. In a two-cycle (two-stroke cycle), the four operations are performed in one revolution. On the upstroke, the piston exhausts burned gases.
Near the end of the stroke, the intake enters under pressure and com­
pletes compression for the explosion.

B.t.u. This is the abbreviation for British thermal unit, which
represents the amount of heat required to raise the temperature of
one pound of water one degree Fahrenheit at or near 37°F. There
are 778 ft.-lb. of energy in 1 B.t.u., and 42.4 B.t.u. to 1 hp.

Transmission of Power. All machines, except engines and
motors, require for their operation the application of energy, that is,
power from an outside and independent source. Machines requiring
power in the form of rotary motion by means of belt or rotating shaft

Fig. 8. Steps in the operation of a simple four-stroke cycle internal-combustion engine.
FIG. 9. Some common methods of transmitting power. (A) Spur gears, bevel gears, and cone gears. (B) Flat belts. (C) V-type belts. (D) Link belt or chain. (E) Hydraulic. (F) Straight shaft or power take-off shaft. (Note knuckle or universal joint.) (G) Triangle.
are generally called "power machines," as distinguished from "field machines," pulled by animals or tractors.

Various methods are used to transmit power or motion from one machine to another, or among parts of the machine itself. In many machines, a combination of several methods is employed to obtain the results desired.

One of the most common ways of transmitting power is by belt. A wide range of speed ratios is possible and, when necessary, the speed ratio can be easily changed. Belts are desirable to cushion shock and, moreover, frequently serve as an automatic means of emergency protection against extreme overload.

Leather, rubber, and canvas belts are in common use. Thickness of rubber and canvas belts is referred to as "so many ply," in accordance with the number of layers of material used in the construction. Likewise, thickness of leather belting is referred to as "single" or "double."

Where small-diameter ordinary pulleys must be used, selection of the proper belt is of paramount importance. A stiff belt will not hug a small pulley closely and may, therefore, cause excessive slippage. Moreover, a belt that has a rough contact surface fails to obtain a grip over the full possible area of contact.

Information as to material and ply of belt most suited to particular installations can readily be obtained from belt manufacturers.

Belt Speed. In feet per minute (ft. per min.), this is the circumference of the pulley in feet, multiplied by its revolutions per minute (r.p.m.). The pulley circumference in feet equals the diameter in inches multiplied by 0.262. The limiting speed depends on the type of drive and kind of pulley used. Speeds as high as 6,000 r.p.m. have been found practicable. Limit of safety for cast-iron pulleys, however, is generally specified as 5,000 r.p.m. with best results being had at 4,500 r.p.m. or less. The standard tractor-belt speed is 3,100 ft. per min.¹ Link belts or sprocket and chain are used where power is transmitted at low speed. There is no slipping when a hook-link belt or chain is used. This type is used for transmitting power over short distances, as on binders and planters. The smoothness and efficiency of the V belt is replacing the chain belt in many places. Chain belts and some flat belts can transmit power over several pulleys and in both directions, while V belts generally function between two pulleys only.

¹ Standard of American Society of Agricultural Engineers.
Gears. Gears are often used to transmit power in compact machines, and where shafts are close together. Gears and also chain belts are used for synchronization between shafts, as in connection with the snapping rolls on corn pickers. Gears may be of several types: spur, bevel, cone, or helical. It will be noted from the illustrations that gears can transmit power at various angles. Gears constitute a more expensive form of power transmission than belts, but have advantages in certain applications, which will be noted throughout the text.

Triangles. These are used to transmit power some distance from the point where generated, as on some windmill installations. The triangles can be of a variety of designs as illustrated by the "walking sticks" used in oil fields.

Universal Joints. Such joints are employed where power is transmitted between two machines, or on the same machine, by a continuous shaft. The universal joint permits independent travel between the units as between a tractor and a pulled, or tractor-operated, machine. Universal joints are used to change slightly the direction of power.

Electrical Transmission. This is a convenient, simple, and flexible way to transmit power between a source of electrical generation and an electric motor. Power lines, as well as the wiring around farm yards and buildings, are examples. Electrical transmission also has other potential uses in tractor-powered generators. It can be used to operate parts of the pulled machine if a generating source is on the tractor.

Air Transmissions. Air is being used in some so-called "power lifts." Compressed air, either through operated pumps or engine exhaust and storage tanks, operates parts of machines. Compressed air has many safety-feature advantages in controlling machine manipulation.

Hydraulic Transmission. This is similar in operation to air transmission. Oil, or other liquid, is forced into a cylinder to raise and lower a machine or parts of machines. The pressure is maintained by the tractor engine in field machines and by electrical motors in others.

Clutches. A clutch serves as a means of temporarily disconnecting the line of power from where the power is developed or obtained to where it is used. In the automobile and truck (see Fig. 10a).
the clutch permits starting the engine first and then connecting that power to the transmission and, in turn, to the rear or drive wheels. Clutches are used on all power-operated machines, planters, mowers, harvesting units, manure spreaders, and belt-driven machines. Without a clutch the cutter bar of a mower would operate all the time the mower was in motion; the same would be true of planters and other machines used on the farm, ranch, and plantation.

**Fig. 10a.** Clutches are a convenient means of disconnecting the line of transmitted power. Above, friction clutch.

Clutches are of several types: (1) friction, (2) gear, (3) grab, (4) slip, and (5) dog or ratchet. Friction clutches are employed in tractors, motor trucks, crawler tractor tracks, and similar places where a large power unit must have the power applied gradually to the load. In this type of clutch, two flat surfaces covered with appropriate facing are pressed firmly together by means of spring pressure. When the clutch plates are fully compressed, they turn as a unit, actually becoming one continuous shaft.

Gear or Grab Clutches. Such clutches are used on mowers and binders to connect the power from the ground wheels, or other source, to the operating parts. These clutches are made of iron or alloy steel and are thrown in and out while the machine is not in operation.
the clutch were thrown in while the machine were moving, some of the members might break.

Fig. 10a. Grab clutch.

Fig. 10c. Safety clutch (A); note universal joint (B).

Slip Clutches. These are safety devices, similar in principle to the friction clutch except that they are always in gear. This means that the two plates are pressed together by springs having a predetermined tension or compression force. Should an overload occur, as in feeding a thresher or corn picker, or should a hard object get in the working parts of the operating mechanism and stop it, the clutch would slip and thus prevent further damages.

Dog or Ratchet Clutches. These are composed of a set of teeth or gears engaged by tapered spring teeth in "dogs." This type of clutch operates only in one direction. If the machine backs up, the tapered side of the dogs and spring action permit the dogs to slide in and out of the teeth without imparting motion.

Ratchet clutches in drive wheels also act as a differential in enabling both wheels to supply motion or power while revolving at different speeds. They are commonly used in mower wheels.

Rules for Figuring Size and Speed of Pulleys or Gears. The driving pulley (or gear) is referred to as the "driver" and the driven
pulley (or gear) is called "driven." The term "revolutions per minute" is abbreviated r.p.m.

To Find Diameter of Driver.  R.p.m. of driver, r.p.m. of driven, and diameter of driven being known.

Diameter of driver = \( \frac{\text{r.p.m. of driven} \times \text{diam. of driven}}{\text{r.p.m. of driver}} \)

For example, assume machine with 50-in. flywheel pulley is to run at 250 r.p.m. Engine pulley runs at 1,250 r.p.m. To find diameter of pulley required.

Diameter engine pulley = \( \frac{250 \times 50}{1,250} = 10 \text{ in.} \) Ans.

For mating gears or sprockets, the number of teeth is proportional to diameter and generally more accurate and convenient to use. If number of teeth is used instead of diameter, the number of teeth must be substituted in the calculations wherever diameter occurs.

To Find Diameter of Driven.  R.p.m. of driver, r.p.m. of driven, and diameter of driver being known.

Diameter of driven = \( \frac{\text{r.p.m. of driver} \times \text{diam. of driver}}{\text{r.p.m. of driven}} \)

For example, assume that an engine pulley runs at 1,200 r.p.m. and is 11 in. in diameter. Driven shaft is to run 400 r.p.m. Find the diameter of the driven pulley required.

Diameter of driven = \( \frac{1,200 \times 11}{400} = 33 \text{ in.} \)Ans.

To Find R.p.m. of Driver.  R.p.m. of driven, diameter of driven, and diameter of driver being known.

R.p.m. of driver = \( \frac{\text{diam. of driven} \times \text{r.p.m. of driven}}{\text{diam. of driver}} \)

For example, assume that a hammer mill runs at 2,000 r.p.m. and has 8-in. pulley. Engine has 11-in. pulley. Find engine pulley r.p.m.

R.p.m. of engine pulley = \( \frac{8 \times 2,000}{11} = 1,454 \text{ r.p.m.} \) Ans.

To Find R.p.m. of Driven.  R.p.m. of driver, diameter of driver, and diameter of driven being known.

R.p.m. of driven = \( \frac{\text{diam. of driver} \times \text{r.p.m. of driver}}{\text{diam. of driven}} \)
Fig. 11. A chart showing work capacity of field machines at different speeds per hour.

How to Use: In the left-hand column, find the line that represents the working width of your equipment. Follow this line to the right until it touches the diagonal line representing the speed of travel. Follow vertical line to the bottom of chart and estimate hourly acreage from nearest figure. In figuring acreage for implements wider than 100 in. figure as above for half the width and multiply the result by two.

Example: (Using a three-bottom, 16-in. offset plow cutting 48 in., traveling at 3 3/4 m.p.h.) Follow the line numbered 48 to a point midway between the diagonal lines marked 3 3/4 m.p.h. and 4 m.p.h., which represents the speed at which you are traveling. From this point, drop down to the bottom of the chart. Acreage covered is just a trifle less than 1 3/4 acres per hour.
For example, assume that an engine with 13-tooth pinion runs at 1,800 r.p.m. Driven gear has 36 teeth. Find r.p.m. of driven shaft.

\[
\text{R.p.m. of driven} = \frac{13 \text{ teeth} \times 1,800 \text{ r.p.m.}}{36 \text{ teeth}} = 650 \text{ r.p.m. Ans.}
\]

**Methods of Figuring Daily Capacity of Farm Implements.** A strip of land 99 in. wide and 1 mile long is 1 acre. The following methods for figuring the daily capacity of farm implements are based on these dimensions.

**First Method.** Width in inches times miles per hour of travel times 10 (hours in day) divided by 100 (100 substituted for 99 for easy figuring) equals acreage for 10-hr. day.

**Example:** A disk harrow 8 ft. (96 in.) wide is pulled by a tractor at a speed of 4 m.p.h. What is the daily capacity in acres?

**Solution:**

\[
96 \times 4 \times 10 = 38.4 \text{ acres}
\]

This method allows nothing for turning or service stops. Turning and field servicing generally consume 15 percent of operating time.

**Note:** A short cut for this method is to multiply the width in inches by the rate of travel, and point off one place. Thus, 96 \times 4 = 384, pointed off one place equals 38.4 acres.

**Second Method.** Width in feet times rate of travel. Taking the same outfit as for the first method, 8 \times 4 = 32 acres.

This method cancels out 12 above the line and 10 below the line in the above solution, and the result is only five-sixths of that obtained by the first method. In other words, this method allows 16\% percent for stops, which in most cases is a little too much. However, either method is close enough for practical purposes.

**Examples:** A one-row cultivator is being pulled by 2 horses at the rate of 2 m.p.h., the rows being 3\(\frac{1}{2}\) ft. (42 in.) wide. How many acres will be covered in a 10-hr. day?

**Solution:**

\[
\frac{42 \times 2 \times 10}{100} = 8.4 \text{ acres}
\]

A two-row cultivator is being pulled by a tractor at the rate of 4 m.p.h., the rows being 3\(\frac{1}{2}\) ft. wide, making the cultivating width 7 ft. or 84 in. What is the daily capacity?

**Solution:**

\[
\frac{84 \times 4 \times 10}{100} = 33.6 \text{ acres}
\]
Safety. The growing need for safety education on the farm and especially in using farm-operating equipment is given consideration throughout this book. An analysis of farm accidents shows some 26 percent credited to farm machinery. A further analysis shows that, of this large portion of the accidents, 96 percent are the result of personal actions and only 4 percent of the 26 percent, or 1 percent of the entire number of farm accidents, are the result of machine failure. Thus it is apparent that rural America is in need of an intensive educational program on the intelligent use and careful operation of farm machines.

First, all must recognize that, in order for machines to operate, it is necessary to have some functionally dangerous working parts where observance of rules against danger is necessary for safe operation. Some of these parts are knives, cutters, chains and sprockets, gears, rotating shafts with protruding couplings and keys, vibrating parts, and flywheels. Explosive fuels are also to be considered.

Further, farm equipment is involved with functional dangers as it is used by the operator; weather conditions, jobs, crop conditions, terrain, mechanical condition of the machines, and age of the machines must be considered.

Mechanical guards and devices are provided in many cases to protect the operator from these dangerous parts. However, cutter bars cannot be completely protected and still cut grass or grain. Corn-picker and snapper rolls are safe if the operator uses judgment; however, the picker rolls cannot distinguish between an ear of corn and a man's arm, if the man lets his hand ride the elevator along with the corn. Even at that, there are instances of persons operating a machine without the regular protective device in place. It should be understood by any person permitted to use or operate a farm machine that every protective device or shield is to be in place, and well secured. The operator contributes to the safety program by wearing proper clothing, including gloves or mittens. However, mechanical guards and devices around machines will never take the place of intelligent and diligent precaution and sensible manipulation on the part of the worker. Only persons who have been instructed—not told—how to operate a machine should be permitted to operate one. The pages that follow incorporate safety instructions and cautions with the individual machines wherever possible. This cannot be considered complete safety education, however.
PART I
SEEDBED-PREPARATION MACHINES
1. Selecting Seedbed-preparation Machines

The accepted purpose of using farm machines is to increase crop production and to lower production costs. Seedbed preparation is the first and most important operation in crop production. Thus, it is obvious that care should be used in selecting the proper seedbed-preparation machines for the crop and soil.

The soil is the farmer's "working capital." It is necessary that this capital be used in the wisest possible manner to earn the profit that justly belongs to him. Careless handling of the soil results in a loss just as surely as the mishandling of working capital results in loss to a manufacturer or a businessman. Selecting seedbed-preparation machines will be discussed in this chapter under the following headings:
1. Selecting Moldboard Plows
2. Selecting Disk Plows
3. Selecting Harrow Plows or One-way Plows
4. Selecting Listers, Middlebreakers, and Damming Listers
5. Selecting Secondary Seedbed-preparation Machines
   - Disk Harrows
   - Peg-tooth Harrows
   - Spring-tooth Harrows
   - Blade Harrows
   - Field Cultivators
   - Orchard Cultivators
   - Chisels or Sub-soilers
   - Rotary Rod Weeder
   - Rotary Plows
   - Land Rollers and Packers
   - Drags and Levelers

To make a comparison between the mode of life of the plant and that of a human being, the soil around the plant may be regarded as the dining room in which the plant eats, the kitchen in which its food is prepared, the storehouse where the food elements are kept in reserve, a reservoir for water, and a ventilating system. The importance of conserving the farmer’s “working capital” and obtaining good annual returns emphasizes the necessity for proper soil management.

When we understand that plant growth, in the form either of regular crops or of weeds, consumes plant food or fertility and the water that is contained in the soil, we see why it is necessary to replenish the fertility and change the condition in the soil before new development of plant food will take place. The moldboard plow is the most common and generally used implement to turn the soil in the preparation of seedbeds. It will continue to be the most common implement until, through further research and tried experience, some other device or practice proves more efficient in producing and increasing yields.

Many factors affect the selection and operation of implements in the several steps necessary in the preparation of seedbeds for crops. Some of these are (1) type of soil, (2) kind of crop to be grown, (3) moisture conditions, (4) soil erosion from wind and water, (5) season of the year, (6) power available, (7) residue, (8) insect pests, and (9) previous crops grown on the land.
SELECTING SEEDBED-PREPARATION MACHINES

Under most conditions, the seedbed should be of adequate depth, the soil well pulverized and then made firm. Large air spaces, trash, and clods in the subsurface are undesirable because they break contact with the untilled subsoil, preventing the capillary rise of moisture. This, in turn, tends to retard root growth; in fact, this condition may even prevent seed germination. However, under dryland conditions where winds erode the land, it is desirable to have a rough, trashy, cloddy, or uneven surface to prevent soil blowing. This is essential to prevent water runoff and drifting of snow, as well as erosion, in these areas. A rough surface will aid in preventing the drifting of snow and will readily take in the dashing type of rain which prevails on the so-called “dryland” plains. From these statements, it can be seen that the many operations necessary in preparing a seedbed vary widely to meet local conditions and to achieve the desired final results.

There are many types of plows and other implements used in preparing land for crops; included are listers, middlebreakers, disk plows, field cultivators, subsurface cultivators, rotary rod weeder, one-way tillers, harrows, packers, and levelers. All are used for the general purpose of turning and pulverizing the soil preparatory to planting. These machines, particularly the disk harrow, the rotary rod weeder, and the field cultivator, may either replace or supplement the work done by the plow. The plow, however, can be considered the first and basic implement in seedbed preparation.

The plow is usually the first field implement selected by a farmer, as plowing is generally the first job in crop production. Since it is the primary implement, farm operators need be fully acquainted with its importance in seedbed preparation, the results desired from its use, and the crops to be grown. The purposes of plowing or turning soil, regardless of the implements used, are numerous. The following are some of the results that should accrue from this phase of seedbed preparation:

1. Put the surface in condition to receive moisture rapidly.
2. Increase the moisture-holding capacity of the soil.
3. Prevent erosion from wind and water.
4. Incorporate vegetation and fertilizers in the soil so as to increase humus and improve fertility. This is partly a result of increasing the bacterial life in the soil that feeds largely upon vegetable and animal matter incorporated into the seedbed.
5. Destroy weeds and prevent weed growth.
6. Destroy insect pests and prevent insect damage.
7. Improve soil aeration.
8. Break up the soil for a mellow seedbed.
9. Change soil texture and consequently improve the seedbed.
10. Increase the crop-yielding capacity of the soil.
11. Facilitate later soil-manipulation operations.
12. Promote greater root development.

When selecting any machine for plowing the land or for any of the other operations in seedbed preparation, it is essential that the machine selected be the proper one for the particular farm, and one that will utilize satisfactorily the power available.

1. Selecting Moldboard Plows

The walking plow is the basic unit of all moldboard plows, whether pulled by animals or by a tractor. When the walking plow is made up of the proper members and appropriate materials, adjusted with the proper landside, bottom suction, and wing bearing, and has the correct hitch, it will move through the soil without any manipulation or guidance through the plow handles. When these same conditions prevail in a horse- or tractor-pulled gang plow, ideal plowing results with slight effort on the part of the operator and little wear on the plow. This means that efficient use is made of the power.

A brief description of the plow bottom will aid in selecting the proper unit and serve as a guide for correct operation. The plow bottom is nothing more or less than a three-sided wedge. The cutting edge of the share and landside form one side of the wedge. The mold-
and upper portion of the share are curved and made to invert the earth. The curvature and length of the moldboard have to do with the pulverization of the soil. These three members are rigidly attached to the "frog," a comparatively heavy steel member that serves as the frame for the plow bottom. Plows are referred to as right-hand and left-hand bottoms, depending on which way the furrow is turned. (Unless otherwise specified, all discussions here will deal with the right-hand type.) Bolted to the left-hand side of the "frog" is the landside, which keeps the plow in a straight line and also transfers the side pressure of cutting and turning the slice to the furrow wall. The curved "mold," or turning surface of the bottom, is bolted to the right-hand side of the frog, carried at an angle of approximately 45 degrees to the landside. The left-hand edge of the mold, which cuts the soil away from the land, is called the "shin." The "share," or blade of the plow bottom, is held against the lower edge of the mold and to the forward end of the landside by means of close-fitting pins and a lock-bolt device inside the frog. The moldboard receives the furrow slice from the share and partially pulverizes or turns it over, placing it in the previous furrow. The "brace" keeps the rear of the moldboard and landside in proper relationship. The plow beam fits rigidly in the inner side of the frog and pushes the plow bottom.

Selecting Types of Plow Bottoms. The selection of the plow bottom, regardless of the type of plow—walking, gang, riding, or tractor—is determined by the type of soil, moisture content, and whether fall or spring plowing is the practice. Different types of soils require bottoms of different shapes to accomplish the results desired in plowing. The texture of the soil and the amount of moisture it contains determine whether it should be pulverized thoroughly or merely turned over to be further pulverized later on with other implements. For a mellow-loam soil and soils of similar texture, select a plow with a bottom that will pulverize well. For a sticky, wet-clay soil, select a plow with a bottom that will break it as little as possible, leaving the pulverizing to be done later.

The soil breaks two ways under action of the plow bottom. It breaks on surface or horizontal angles of approximately 45 degrees, as shown in Fig. 14A. One of the purposes of the "colter," and other accessories to be discussed later, is to assist the shin in cutting the furrow slice and also cutting rather than tearing a rough, uneven furrow wall. The soil also breaks vertically, that is, perpendicular
FIG. 14. The soil-breaking action of a properly selected plow. (A) Horizontal action, approximately a 45 degree angle with forward motion. (B) Vertical action, causing a wedge-like break.

FIG. 15. The principal types of plow bottoms. (A) Breaker. (B) Stubble. (C) General-purpose. (D) Blackland. (E) Slat. (F) High-speed. (G) Five-member or replace-
ment point. (H) Dual-purpose bottom.
SELECTING SEEDBED-PREPARATION MACHINES

Manufacturers have designed hundreds of shapes in attempting to provide the most satisfactory bottom for a variety of plowing conditions. These can be grouped into nine main classifications: (1) the breaker bottom, (2) the stubble bottom, (3) the general-purpose bottom, (4) the blackland or gumbo bottom, (5) the slat moldboard, (6) the hi-speed bottom, (7) the deep-tillage bottom, (8) the general-purpose hi-speed five-member bottom, and (9) the dual-purpose bottom.

The Breaker Bottom. The breaker bottom turns thickly sodded soils over completely, disturbing their composition very little. This keeps air and light away from the leaves and stems of the grass. This moldboard is long and narrow with a gradual slope. Use this bottom for turning virgin sod and land being returned to cultivation after years of idleness.

The Stubble Bottom. The stubble bottom has an abrupt mold that rises steeply from the back of the share. It gives the soil a pitching action, barely turning the furrow slice before the soil falls into the furrow, well broken and level. Use such a bottom where the loam and sandy-loam soils pulverize readily and where surface vegetation, such as corn and small grain stubble, covers easily.

The General-purpose Bottom. This bottom slopes back more gradually than the stubble bottom and turns a more ribbon-like furrow slice. It scours in a great many soils, and does satisfactory work in both stubble and tame-grass sods. It gives best results in sandy and clay-loam soils.

The Blackland or Gumbo Bottom. This type of bottom is particularly designed for heavy, tough, and sticky soils, some of which are common to Texas, that cause scouring troubles. Such moldboards have a long, gradual slope. Because of the increased draft in such soils, blackland plows come in smaller sizes, particularly where power is a problem.

The Slat Moldboard. The slat moldboard is designed for soils so sticky by nature that the ordinary plow bottom will not scour. The slat moldboard eliminates part of the regular moldboard, so that there is less surface for the soil on which to stick, thus improving the scouring. Use these bottoms also for plowing black, waxy, and clay soils where an ordinary bottom fails to scour.
The Hi-speed General-purpose Bottom. This bottom is designed for use with modern tractors. It will plow efficiently at speeds up to 6 m.p.h., yet turn a full furrow when field conditions call for lower speed.

The Deep-tillage Bottom. This is one of the special bottoms and is designed for heavy-duty plows turning furrows 10 and 12 in. deep.

The Five-member Bottom. The five-member plow bottom, a hi-speed general-purpose bottom, has five parts instead of the conventional three. The plowshare is divided with a “point” and a “lay.” The point fastens on with two bolts. One size of point will fit all sizes of bottoms. The point is sharpened readily by grinding instead of forging. After the point has been sharpened once or twice, it must be replaced with a new one; the cost is very small, less than repointing a soft-center share. The lay under average plowing conditions should outlast two or three points.

The moldboard is divided into two parts, the “shin” and the “mold.” Most moldboards wear on that portion just off the shin. This part can be replaced readily and at a low cost. This eliminates the necessity of obtaining complete new moldboards which are rather expensive.

The Dual-purpose Bottom. This implement has an additional beam and a small base plow for stirring the sub-soil. It is often referred to as a two-base or “double deck” plow.

These are the main types of bottoms. Consult the state extension agricultural engineer or department of agricultural engineering at the state college regarding plow bottoms to meet peculiar local soil conditions.

Selecting Plow Bottoms as to Material. Moving soil under pressure, over metal surfaces such as the share, moldboard, and landside of a plow, is a difficult job. Soil is heavy and is an abrasive material that tends to scratch and wear the plow bottom. Soils vary in amount of sand and gravel present, in stickiness, and in other characteristics, so that it is necessary to select and fabricate materials to meet different soil conditions.

Selecting Shares. Shares come in a variety of patterns to meet all conditions. The bottom can be adapted to a variety of special conditions. For example, the cobblestone share has a “clipped” wing; it is popular for dodging large boulders in stony ground where pulverization is not difficult and a full-cut share is not necessary. The
alfalfa share has an extra-wide blade and extended wing for cutting thickly matted roots. The rice, or black-root share has a much greater cutting angle for better shearing action. Other types include the blackland, breaker, and peatland share.

Cast-iron Shares. These are made for the low-cost walking plows. Handle them carefully at all times. Avoid a sharp blow or a shock that will break the share, for it cannot be repaired but must be replaced with a new one.

Chilled Cast-iron Shares. These shares provide a very hard and wear-resistant surface for gravelly soils. Being hard, they are also brittle and subject to breaking and chipping; however, they are most practical for the gravelly, abrasive soils. Such shares are low in cost, so replacement expense is not an important item.

Cast-steel Shares. Such shares are generally used for work in sandy and gravelly soils, which cause a great deal of abrasive wear and, at the same time, do not require the high polish of soft-center shares for proper scouring. Chilled steel is made by pouring hot metal into molds where rapid cooling on the outside produces a very hard and close-grained working surface.

Solid-steel Shares. These shares, also called “crucible-steel shares,” are used where scouring is no problem. The material is the same throughout. Since this share wears rapidly, it is not satisfactory in sandy and gravelly soils.

Soft-center Steel Shares. These are made from three-layer steel, the outside layers being high-carbon steel capable of taking a very hard finish that resists wear. The center layer is low-carbon steel and, being softer, absorbs shocks to prevent breakage. When sharpening
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a soft-center steel share, use care to see that the outer, hard-steel layers are properly welded together. A wear plate of high-carbon steel is welded on the top side of the point of the share for increased wear. Most of the plow bottoms have quick-detachable shares. A pin in the gunnel of the share fits in the frog while one quick-detachable link reduces the time required to replace and secure it properly.

Selecting the Moldboard as to Material. Moldboards are of three main materials or alloys—soft-center steel, solid steel or crucible steel, and chilled cast iron. Cast-iron moldboards are found on the very low-cost plows. Soft-center steel moldboards are the best under most scouring conditions, owing to the fact that this material scours better. The solid-steel moldboard seems to give satisfactory performance where scouring is not a problem. Chilled cast-iron moldboards are better for the sandy, gritty, and gravelly soils. The hardness of the cast steel gives them splendid wear-resistant qualities. Chilled plows are adaptable to all parts of the South where there is sandy land and especially in the yellow pine districts.

Selecting the Landside as to Material. Landside materials are either solid steel or chilled iron, the selection depending on the soil conditions. Landsides are often constructed with a detachable heel. This is desirable. Moldboards, depending on the plow, have one of three kinds of landsides: Up to 4 in. are considered low, from 4 to 6 in., medium, and from 6 to 8 in. in height are designated as high. Use low landsides on plows equipped with rear wheels to take the side draft. Plows without rear wheels need higher and longer landsides depending upon the size and type of bottom. Special types of landsides are designed for particular plows. Always use the landside with its specific type of moldboard.

Selecting Plow Accessories. The parts of a plow, other than the bottom itself, are generally considered accessories but are quite necessary to obtain best results. Included in this list are the gage wheel on

Fig. 17. Soft-center plow-bottom construction. Above, section of the moldboard. Below, section from an reinforced share point. (A) Layers of high-carbon hard steel. (1 and 3) Layers of hard steel. (2 and 4) Layers of soft steel.
SELECTING SEEDBED-PREPARATION MACHINES

FIG. 18. Plow-bottom accessories aid plowing under special conditions. (A) Knife colter. (B) Combination rolling colter and jointer. (C) Notched colter, combination jointer, covering wire. (D) Notched colter with trash guard to facilitate cutting. (E) Weed hooks.
walking plows, stationary knife colter, rolling colter, jointer, such covering devices as chain, wires, and weed hook, and moldboard extension.

The Gage Wheel or Beam Wheel. Such a device is necessary where the operator desires an even depth of plowing throughout a field having a variety of soil conditions, or hard and soft spots. The gage wheel is advantageous also where a rolling colter is used on walking plows.

Stationary or Knife Colters. Colters are used to cut the furrow slice loose from the wall instead of having the plow shin tear it away and leave a rough, uneven furrow wall. The colter also reduces the pull or draft of the plow. The various types of stationary colters or cutters are attached to the beam and hang down ahead of the plow shin. Some, attached to both the beam and plow shin, are known as "double enders." Provide "double enders" where the strain is unusually heavy, as in plowing stump land or doing road work.

The Rolling Colter. The rolling colter, often referred to as a "rolling cutter" by farmers, is so effective in long or heavy trash, and so valuable in obtaining complete corn-debris coverage, that manufacturers are now supplying light rolling colters for walking plows, as well as large and sturdier colters for riding and tractor plows.

The rolling colter performs three important functions: (1) It cuts the furrow-slice edge leaving a clean furrow wall, and usually lessening draft; (2) it cuts through trash that might otherwise drag on the shin and beam; and (3) it cuts the trash in short lengths for better covering by the furrow slice. Most rolling colters are 14 to 18 in. in diameter. Select the larger size for most conditions, particularly when plowing deep, covering trash deeply, and for plowing tough-rooted crops such as alfalfa. For exceptionally heavy and tough trash, a rolling colter having a notched or serrated edge is preferred.

The Jointer. This is a small, one-way shovel, plow-like in appearance, that cuts a small, triangular "ribbon" off the main furrow turning it toward the furrow in such a manner that the trash is buried in the bottom of the furrow. In heavy soil or dense sod, where there is little pulverization, it is particularly important to level the furrow slice in this manner in order to obtain a smooth fit against the sloping surface of the last furrow slice.

Jointers are of two types: (1) the stationary or independent, and (2) the combination jointer and rolling colter. The stationary jointer
does not work well alone in loose and bulky trash because of poor coverage. For both hard and stony soil with occasional heavy trash, equip plows with a stationary jointer and rolling colter.

Covering Chain. The log chain as a covering device is probably the most common auxiliary device used on walking plows. Select a moderately heavy chain that is long enough to form a loop and drag on the surface of the turning slice. Fasten one end of the chain to the double tree at the furrow horse’s clevis. Fasten the other end to the plow beam at the jointer shank, or at a point on the beam about 10 in. back of a vertical line through the point of the share. The chain loop keeps the trash from pitching, straightens it, and folds it under as the slice is inverted.

Covering Wire. The covering wire, usually 6 or 8 ft. of No. 9 wire for walking plows and 9 to 10 ft. for wheeled plows, can be used alone or in combination with a chain, jointer, or colter. To use, fasten one end to the beam ahead of the plow bottom so the wire drags across the surface of the furrow slice just as the slice is being turned by the plow bottom. Allow the other end to drag under the newly turned slice. It holds the trash and assists in obtaining complete coverage. Determine the length of wire needed by the resistance of the material to be covered.

Weed Hook. The weed hook is clamped to the beam so that it draws the trash ahead slightly and folds it under just as the furrow slice lays over. Select a weed hook heavy enough to turn the trash without being bent.

Moldboard Extension. A moldboard extension or “flipper” is a wheeled-plow accessory, although some are used on walking plows. In contour, the moldboard extension curves and under some conditions is very valuable in laying the furrow slice over further to bury trash deeper in the creases. The extension can best be used on bottoms designed for that purpose.

Select and use the covering device or combination of such devices best suited to the plowing condition. The plowman who familiarizes himself with the possibilities of each covering device is in a position to do a superior plowing job. The table on page 40 shows the comparative value of several covering devices; they are listed in a descending order of importance under the conditions indicated.

Fertilizer Attachment. Studies made by the National Joint Committee on Fertilizer Application show that one of the most
In short stubble | In high stubble | In whole stalks
---|---|---
1. Combination rolling colter, chain, and jointer | 1. Combination rolling colter, chain, and jointer | 1. Combination rolling colter, chain, and jointer
2. Combination rolling colter and jointer | 2. Jointer and chain | 2. Rolling colter and chain
5. Rolling colter and chain | 5. Chain | 5. Rolling colter

effective ways of using larger quantities of fertilizer is to place a band of it on the plow sole. This means placing the fertilizer in the bottom of the furrow and having it covered by the following furrow slice. This is not the only place for fertilizer, but rather one of the placements. Farm-machine manufacturers have these attachments for every make and model of wheel-type moldboard plow. The fertilizer is carried in a hopper above the plows. Tubes deliver the fertilizer under the moldboard. The feeding mechanism is driven from the land wheel of the plow (see Fig. 19).

Fig. 19. Plow-sole fertilizer-placement attachment places a band of fertilizer in the bottom of the furrow.
Selecting Walking Plows for Size. After selecting the proper type of plow bottom, plow-bottom material, and the necessary accessories, next consider the size appropriate for the animal power available. Plows come in 7-, 8-, 9-, 10-, 12-, and 14-in. bottoms, with beams designed for one, two, or three horses or mules. The 16-in. bottoms are beamed for three horses. The term “beamed” will be understood better after studying methods of hitching found on pages 85 to 88. Walking plows are available with both right-hand and left-hand bottoms.

Selecting Riding Moldboard Plows. The walking plow maintains its position in the ground by sliding on three bearing points: (1) the toe, under the point, (2) the wing bearing, under the share, and (3) the heel, under the landside. In order to assure the plow’s staying in the ground, it is given “suction”—landside and bottom suction. These five important features need be in proper relationship to obtain a uniform furrow slice. It is obvious that the plow bottom requires a lot of power to slide it over the bottom of the furrow. This is the reason for the “sulky” or one-bottom wheel-type plow carriage coming into use. The purpose behind its development was to transfer part of the sliding friction of the plow-bearing points to rolling friction on the wheels, and maintain a more uniform plowing depth. In all
wheel-type and self-mounted tractor plows, the plow bottom is carried partially and does not slide through the soil. It is still necessary, however, to provide the proper landside and bottom suction. This information will clarify the purpose, the design, and operation of the wheel-type and tractor-mounted plows.

The sulky plow then does three things: (1) It transfers some of the sliding friction of the plow bottom to rolling friction, as has just been pointed out, (2) it permits the driver to ride instead of walk, and (3) it eliminates hand guiding. These three changes made it necessary to provide means to keep the plow level in the ground and to turn a full furrow. A frame was required to support the rider and to attach the wheels. The wheels must be adjustable to carry the plow both while plowing and with the bottom out of the ground. This was accomplished with a furrow wheel or gang wheel from a directional standpoint; a land wheel, opposite the furrow wheel; and a rear furrow wheel to assist in guiding the plow to cut a full furrow. All these adjustments made plowing easier than manipulating a walking plow with the two handles.

Wheel-type plows are designated by frame, method of raising and lowering the plows in the ground, number of bottoms, and whether horse-drawn or tractor-drawn. In all cases means must be provided to guide the plow, keep the bottoms all in the ground uniformly, and provide adjustment for different depths and widths of plowing.

The Sulky or One-bottom Plow. The sulky or one-bottom plow is built in frameless and frame types. There are several variations of the frame type.
The frameless plow has the axles of the land wheel and furrow wheel mounted in bearings attached to the plow beam. Hand levers on the land and front furrow-wheel axles raise or lower the point of the plow. The frameless type is sometimes referred to as the "square-turn plow." This is because it will turn a square corner on the inside of the plowed ground, plowing full depth as it pivots on the point. The furrow-wheel direction is released so that it "casters" as the plow turns. The frameless plow is used mainly in the New England and Middle Eastern states. A rear furrow wheel, located close behind the landside, absorbs some of the landside pressure and helps in keeping the plow in a straight line. This is sometimes called a "rolling landside."

![Frame sulky plow - high lift.](image)

This type of plow will accommodate 10-, 12-, 14-, and 16-in. plow bottoms.

The frame or high-lift sulky plow is a single-bottom riding plow in which a special frame forms the backbone. The frame plows are available with two- and three-wheel types. All three wheels (land wheel, front furrow wheel, and rear furrow wheel) on the three-wheel types attach directly to the frame, instead of to the plow beam. By means of a foot lift and bails, the plow bottom and its beam are raised and lowered within the frame. The frame feature permits the plow bottom to be raised in respect to the rear furrow wheel. Some plows are constructed with one bail and are known as "single bail," and some, made with two bails are called "double-bail" plows. This type of plow can be set to "float," that is, it will come out of the ground automatically if the bottom strikes an obstruction. It can be locked, however, so as not to float but to respond to the action of the levers.
A tongue is used and aids in guiding and turning the plow. Some models have an automatic rear-wheel control that holds the rear wheel rigidly in line while plowing, but that is automatically released and allowed to caster under control of the tongue when turning. This tends to eliminate any effect the bearing of the team has on the direction of the plow movement. This type of plow can be equipped with 12-, 14-, or 16-in. bottoms of any shape. It is understood that any or all of the plow accessories as discussed in this chapter can be used with any type and style of plow. The "two-wheel frame" plow has the wheels directly opposite each other. They are mounted on stub axles secured to a crosstie that also supports the seat. The plow is raised and lowered through a ratchet and dog device located in the hub of one wheel. This is described in Fig. 84, page 97. It is possible to obtain a rear wheel that is attached to the beam or frog. This plow is popular on land where there is an unusual number of stones or roots, and where the fields are rough, uneven, or rolling. Some models have a lever to adjust the tongue to prevent it from rubbing the horse's sides.

The Two-way Plow. This plow throws all of the furrows one way. There are many situations in which this is desired. It eliminates the dead furrows, which is an advantage for hillsides, terraced fields, irrigated lands, and small, irregular fields. The result is a uniformly smooth field free of ridges and dead furrows. It is a frame, high-lift type of plow constructed the same as the two-wheel frame plow, except that it has two bottoms, a left-hand and a right-hand bottom. Only one bottom is used at a time. One bottom of the plow is used in going across the field in one direction, and the other is used on the return trip. The plows are raised and lowered by means of a ratchet.
and dog device. The hitch automatically shifts to accommodate the bottom plowing at the time. The two-way plow can be equipped with 12-, 14-, and 16-in. bottoms.

The Gang or Multiple-bottom Plow. Horse-pulled gang plows are of one general type—a frame plow with all three wheels attached to the frame, none to the beam. The beams are rigidly secured to each other to assure proper distance, or landside clearance between them. Foot lifts or foot levers and the bail mounting of the beam enable raising and lowering the plow bottoms and their beams as a unit. Lifting springs are generally provided to assist in lifting and to help hold the plows when being lowered.

The depths of the plows are adjusted by levers on the land wheel and front furrow wheel, also an adjustment on the standard of the rear furrow wheel. These adjustments should be convenient for the operator. Gang plows naturally require more horses to pull them than do sulky plows. This increases the problem of hitching to avoid side draft. (See Part I, Chap. 2.) Gang plows are constructed with two plows, both of which are either 10-, 12-, or 14-in. bottoms. Various types of bottoms can be used but no change in size can be made. Make the selection as to size to meet such factors as topography of the farm, soil conditions, and number of horses to be used.

Selecting Tractor-operated Plows. The size and type of tractor are additional factors in selecting tractor plows. If the farm does not have the proper size and type of tractor, it is advisable to secure such a tractor and then the machines to match it. This is the basis for the discussion that follows. Until such time as the proper tractor is
obtained, horse-gang plows can be pulled behind tractors by changing the hitch, although such a method can only be considered temporary.

Tractor plows are divided into two general classes, (1) "trail-behind" plows (wheel type) and (2) "direct-connected," which are carried by, as well as pulled by, the tractor. There are several types in each class calling for different fore and aft clearances and different clearances between the underside of the beam and the point of the share. Deeper plowing and heavy soils call for heavier construction and bracing, and specific designs for specialized crop and soil conditions.

Tractor plows are on the market with from one to five bottoms, to suit the power of the farmer's tractor and his plowing conditions.

Orchard plows and special plows for other work will be discussed briefly later in this part.

Tractor plows are available (1) with three wheels, (2) with two wheels, and (3) direct-connected without wheels. The general construction differs considerably from the horse-drawn riding plows. The three-wheel tractor plow is designed to be pulled behind the power unit and it has a hitch enabling it to be used behind any make of tractor. The lifting and leveling levers are equipped with counterbalancing springs that make it adjustable for use with various types of tractors. The plow lifts on all three wheels by means of a clutch, located on the land wheel, that is operated by a trip rope from the tractor seat. The three-wheel tractor plows do not have a rear wheel and the lift is on the land wheel, although a third wheel is available as a rolling landside to absorb the side draft and relieve landside pressure. By means of a stiff hitch to the tractor drawbar, the plow bottoms are raised clear of the ground. The direct-connected plows attach direct to the tractor and the depth of plowing may be
gaged by the tractor wheels or by special gage wheels. A power lift that is a part of the tractor lifts the plow clear of the ground.

On some of the three-wheel-type plows, especially the multiple-bottom sizes, the customary land and furrow levers are replaced by cranks and screws for adjusting the depth and leveling the plow. A spring-release hitch is a desirable safety feature, for trail-behind plows, when solid objects are likely to be encountered in the soil.

These plows are available with 12-, 14-, 16-, and, in some cases, 18-in. bottoms. All are available with adjustable hitches, rolling colters, and jointers. Pneumatic-tire equipment is desirable where plows are transported frequently over surfaced roads. This eliminates the necessity of loading on trucks or trailers. Levers that have adjustable lengths for the operator’s convenience are also desirable.

Two-wheel tractor plows are available with one or two bottoms. These plows are compact, turn easily in small fields, and back up nicely for work in tight spots. The two-bottom plows have rigid connections between the beams in front and rear. Large, replaceable bushings and wheel axles that are protected against entrance of dust are desirable.

Tractor Two-way Plows. These are available in two types, the one-plow-at-a-time bottom and the two-plow-at-a-time type. Select the size and type best suited to meet such factors as topography of the farm, size of power unit, soil condition, and depth of plowing. Like
all desirable tractor plows, it has an easily tripped power lift on each wheel for raising and lowering the plow. The plow pulls from the center of the tractor.

The two-bottom, two-way plow is often called the “roll-over” plow. It is designed for the operator who has power and need for a two-bottom plow. The plow lift is on a cycle, with the first pull on the rope lowering the plow into plowing position. The second pull on the rope trips the frame of the plow, which rolls over, at the same time lifting the plow, and the hitch swings over to lock on the other side. The plow is then ready for the return trip throwing the soil in the same direction as on the previous trip across the field.

**Direct-connected Tractor Plows.** These are invariably made by the same manufacturer that made the tractor. They are available in sizes to match the power of the tractor. They come either as two-way plows or regular one-way plows. Direct-connected plows attach well forward under the general-purpose tractors. Power raises and lowers the bottoms; in fact, some manufacturers have devices for maintaining a uniform depth of plowing. It is obvious that tractor-mounted plows can be maneuvered any place because they are lifted by the tractor, and in reality are an integral part of the tractor. They are readily attached and detached.
Depth-control Tractor Plow. This is a recent development. A frame, flexible and adjustable, is constructed integrally with the tractor. This frame carries many specially designed implements. The frame is secured to a drawbar pulling from under and near the center of the tractor. By use of linkage and additional rock shafts, the frame can be extended so as to attach a number of different types of machines.

This adjustable frame is controlled in position, up and down, by a hydraulic pump, reservoir, and hydraulic cylinder constructed integrally with the tractor. This hydraulic system is under a simple lever control that raises and lowers the implement frame, including the drawbar, in horizontal planes parallel to the ground. Single, gang, and two-way plows are each mounted on a short rectangular tool bar and quickly attached to two brackets on the frame at the rear and below the tractor seat. The plows consist of a short beam and a forward extension for attaching the colter and jointer. There are no levers or “gadgets” of any kind. When the plow is mounted on its rectangular tool bar, it is adjusted for suction. From then on the depth is controlled by the lever on the hydraulic cylinder or other automatic control.
Selecting Special Moldboard Plows. Such plows are designed for uncommon purposes and conditions; for example, (1) deep plowing in Palmetto ground and heavy growths, (2) powerful plowing in hazel, blackberry, cranberry, and other heavy underbrush, (3) doing road work, (4) doing orchard and other work. These are so special that it seems advisable for them to be studied with equipment as used locally. Of course, features in the design, convenience, service, and other factors common to plows already discussed are equally applicable in the selection of special plows.

2. Selecting Disk Plows

Selecting Riding Disk Plows. Animal-drawn disk plows are available with one, two, and three disks. Under most conditions three horses pull the sulky, four horses the two-furrow, and six horses the three-furrow gang. The disks are 24 or 26 in. in diameter and are equipped with wheel scrapers for cleaning them. It is obvious that by increasing the width of cut, more power will be required. The single-furrow is adjustable to cut from 10 to 14 in. The two-furrow is set to cut 9 in., and the three-furrow 7 in., but the two-furrow can be adjusted to 7-, 8-, 10-, or 11-in. furrows and the three-furrow plow to 8- or 9-in. furrows. This makes it possible to select a disk plow of desirable size and with adjustments to utilize the power available. The number of disks and angle of cut of each can be changed readily on most disk plows. This permits the operator to adjust the width of cut to the soil conditions and the power. Some plows permit respacing the disks to change the width of cut; on others this is done by changing the angle of the frame. Select a disk plow that has provision for making adjustments conveniently.

Select a disk plow when the soil is too dry, hard, stony, or rooty for moldboard plows to penetrate, and for sticky, gumbo, hardpan, mucky, and waxy soils where moldboard plows often fail to scour satisfactorily, if at all. Extremely loose soils are also plowed to advantage with disk plows. Usually disk plows do not turn the soil so well as moldboard plows. This may result in vegetation and trash being covered less effectively, which may permit the soil to dry out more rapidly in limited-moisture areas; however, disk plowing does leave a rough surface that is receptive to rainfall and reduces wind erosion. Disk plows are being used successfully in building and maintaining terraces for the prevention of soil erosion.
Nearly all disk plows are of the gang type. In order to do a uniform job, operate the disks at the same soil-depth level. When selecting a disk plow, determine whether or not it is equipped with an eccentric, or lever, to raise or lower the frame easily on the rear wheel and adjust the level at which the disks operate.

The three furrow wheels control the depth of plowing and offset the large amount of side draft created by the disks. The two furrow wheels are necessarily angled against the disk; that is, they “canter,” or lean out from the furrow wall. The angle of the furrow wheel should be adjustable, generally by collars on the shafts. The furrow wheels are connected by an adjustable rod for varying the lead of the wheels. This rod also aids in turning the plow quickly at ends of the field. Three levers, one on each wheel, are required to level the plow.

Selecting Reversible-disk Sulky Plows. Select such a plow for hillside terraces and for eliminating dead furrows. The reversible-disk sulky plow turns a right-hand furrow going one way and the same disk turns a left-hand furrow returning. By means of half-circle gear wheels connecting the beam and plow, the direction of the disk is changed when the team turns on the unplowed ground. This procedure changes the lead on the furrow wheels as they alternate front and rear. The seat turns with the beam. As with the other disk plows, each wheel has an adjusting lever. Counterbalancing springs are desirable features. Make sure the furrow axle brackets
have a series of holes to set the furrow wheels in or out for different widths of cut.

**Selecting Tractor-operated Disk Plows.** Tractor-operated plows are constructed in many sizes, both in number and diameter of disks. They range from one medium-size disk for the small row-crop tractor up to many furrows with large disks for the heavy-duty track-type tractors. Select these large disk plows for terracing, hard ground, heavy stalk ground, and deep plowing in sugar land and other places calling for a heavy-duty plow. Tractor-operated plows are designed on the same principle as those drawn by animals but are constructed of much stronger members. Disks are 26, 28, 30, or 32 in. in diameter and are adjustable to a 7-, 8-, and 9-in. cut. This adjustment is made either by changing position of the disks on the tool bar, or by changing the angle of the disks. The wheel depths are adjusted by either levers or cranks and screws. A heavy-duty power lift, generally gear type, operated by a trip rope, raises and lowers the plow at the end of the field. The power lift is actuated by the land wheel, preferably equipped with lugs to avoid slippage. Select a plow that provides means for adding weights to the furrow wheels. Flanges on the wheels aid in keeping the plow in line. The heavy-duty plows have anti-friction bearings on the disks. These bearings must be protected with dust seals and call for pressure lubrication.
More lightly constructed plows for wheel tractors have disks 24,
26, or 28 in. in diameter. Plows are available with different-length
beams; three- and four-furrow, and five-, six-, and seven-furrow. On
these plows the number of furrows can be increased or decreased by
adding or removing disk beams. Extra beams generally include
disks, stub beams, disk bearings, and scrapers. Check the plow to be
satisfied that there is sufficient clearance between the overhead beam
for the passage of earth, trash growth, and heavy cover crops. A
depth adjustment on the rear wheels is made by a screw-type crank,
and the front end is raised by a lever and ratchet. An adequate
helper spring is desirable. The rear furrow wheel similar to the
heavier plows should be designed for wheel weights.

Selecting Direct-connected Disk Plows. Such disk plows are of
two- and three-furrow sizes for use with the row-crop type tractors. All
are close-coupled to the tractor, or under the tractor, so the operator
can readily reach the levers for controlling depth of penetration.
Direct-connected plows have only one wheel, the rear furrow wheel,
the drawbar mounting replacing the front furrow wheel and the land
wheel. A gage wheel holds the plow steady in uneven soils, “sand-
blow,” and similar conditions. Being direct-connected to the
tractor, the entire unit can be backed close to the fence corner, or
otherwise maneuvered to eliminate turn areas. Direct-connected
plows operated in connection with tractors having hydraulic, pneu-
matic, or mechanical “lifts” are raised and lowered by such mecha-
nism. These plows generally have anti-friction bearings in the
disks and furrow wheel. Select a plow with bearings that are pro-
ected with efficient dust and oil seals and pressure lubrication. Convenient lever adjustments with helper springs are desirable. The disks should have adjustable angles so the width of cut can be adjusted to the power and soil conditions.

Selecting Power-controlled Disk Plows. The frameless disk plow has a short beam and its own tool bar fits in the clamps of the power-controlled frame. The plow is regulated by a finger-control lever on the tractor in front of the operator. These plows, like the direct-connected, have a rear furrow wheel to assist in keeping the plow straight and to absorb side draft.

3. Selecting Harrow Plows or One-way Plows

Selecting a Horse-drawn Harrow Plow. This is available in two models, one having three or four disks, 20, 22, 24, or 26 in. in diameter and cutting from 15 to 28 in., the disks being spaced 10 to 12 in. apart. The other model has five or six of the smaller disks spaced 8 in. apart and cuts 24 to 28 in. The working angle of the disks can be set for 35, 40, or 45 degrees. This angling affects the width of cut, thereby helping to adjust the machine to the soil condition and power. Some harrow plows also allow for the removal of disks to adjust for plowing condition and power.

Selecting a Heavy-tractor Harrow Plow. This is also known by such names as the "wheatland plow," "wheatland disk," "disk tiller," "one-way disk," and "gold dig." It is used extensively in the construction of terraces and the preparation of soil for wheat. It
differs in construction from the regular disk plows in that it does not penetrate so deep or pulverize the seedbed so thoroughly. Because of these facts, it requires less power and, consequently, is usually found in larger units than standard disk plows. Surface trash is cut up fairly well but it is not covered so thoroughly as with other types of plows. This trash aids in preventing wind and water erosion of soil. The disks are 20, 22, 24, or 26 in. in diameter and are spaced 8 or 10 in. apart. The larger disks and wider spacings are recommended where trash or vegetation growth is comparatively heavy. The plowing will not be so deep but the coverage will be better.

It is most often used as a summer fallow tool for the semi-arid and short-season sections in the control of weeds. Where soil is inclined to blow easily or where there is no stubble covering, it has not proven so effective in preventing erosion as the field cultivator, which leaves a rougher surface when the soil is tilled while slightly wet.

The one-way disk is available in many sizes that vary from less than 2 to 10 ft. in width, penetrating the soil from 2½ to 5 or 6 in. deep. As the name indicates, it throws the soil in one direction as does the disk plow, but the disks are in a gang and revolve together as do disk harrows. By varying the angle of the disk gang, the width of cut can be changed to meet practically any soil or power conditions. Some permit the removal of disks to adjust to available power.
Select a plow on which the angle of the disk is conveniently adjustable in two or more positions, having convenient means for regulating penetration, leveling the plow, and adjusting the rear end. Special features that are often essential include grain boxes, which convert the harrow plows into seeders, and eccentric disks for “pit plowing” to retain moisture. In this type, the alternate disks are larger and set 2 in. off center. In revolving, these larger disks cut deeper and form pits. See that harrow plows are provided with disk scrapers. The “light-tractor harrow plow,” similar to the horse-drawn models, is available in two models having 8- or 10-in. spacing.

4. Selecting Listers, Middlebreakers, and Damming Listers

These machines are in reality an adaptation of the moldboard plow. They have a plow with two shares and two moldboards, one for turning the soil to the right, the other for turning it to the left. The share is double-winged and takes care of both moldboards. There is no landside to this plow because each bottom throws the soil two ways leaving a small ditch or V-type furrow.

Often land is blank listed and the ridges are later “busted” open when the grain is planted. This method of double listing the ground for a crop is from one-third to one-half again as fast as where the ground is plowed in preparing the seedbed. Where crops are listed in, which is a common practice in the semi-arid plains area, this implement is called a “lister.” In the South, it is used to break out
the middles between rows or throw up beds and it is referred to as a "middlebreaker" or "middlebuster." In the irrigated areas, its use is largely that of making small lateral ditches and may be referred to locally as a "ditch" plow. Listers for ditching are often remade to provide very wide and deep moldboards.

Selecting for Type and Size. The lister is available in several types such as the single-bottom walking lister, sulky, or gang. Sulkies or gangs can be secured in either horse- or tractor-drawn types, although most of the gangs with over three bottoms are tractor drawn. Some of the tractor types are direct-connected to the tractor, being wheelless and frameless, and are operated through a power-lift device.

Listers may be had in different sizes and styles to suit almost any crop or soil need and power available. Nearly all of the gang types are adjustable as to width of rows. When purchasing any lister, find out how quickly and easily this and other adjustments are made.

Selecting Accessories. The walking lister has a rudder blade or a sub-soiler that cuts into the soil, preventing the lister from dodging to the side. Select a sub-soiler large enough to loosen sufficient soil in the base of the furrow for the planting of grain. The sulky and gang types use the sub-soiler if they carry planting attachments. Planting crops in the furrow bottom is a common practice in limited-
rainfall areas. This places the grain in moist soil and the ridges break the wind, thus reducing evaporation as well as checking soil erosion. Rainfall is directed to the seeded grain by the furrow walls; during the season, the furrow is filled through cultivation, keeping the plant roots deep. This is a good method of covering up weeds and grass that come up in a crop row.

When the ground is trashy, use a rolling colter in order to cut the trash, cover it better, and prevent it from dragging on the lister beam where it increases the draft and prevents the job from being done in a satisfactory manner. The rolling-colter attachment is made on the
lister in a manner similar to that on the moldboard plow, except that it is set to cut at the exact center of the bottom.

The "damming lister," sometimes referred to as a "basin lister," is available as a sulky or gang with two or more bottoms. This machine opens up trenches like a regular lister. In fact, the damming unit can be secured as an attachment to regular listers. These trenches are from 6 in. to 1 ft. deep. Penetrating below the surface, the shovels leave the sub-soil in an ideal condition to absorb rain. Different mechanical methods are employed to form the dams, but one kind is a three-bladed revolving unit, operating behind each shovel, that follows the trenches and breaks up the earth to dam them at short intervals. The machine not only builds the dams but presses them into place and packs them. The operation repeated across the field makes a pattern of shallow basins to hold snow and collect water. It insures the retention of snow so likely to blow in plains areas, and retains the dashing type of rain, which prevails in these same areas, until absorbed. This storage of soil moisture during the winter and spring will carry many crops past early drought danger. Such a method of preparing seedbeds not only conserves moisture for crops but prevents soil erosion by wind and water; therefore, it is a soil-conservation practice. For drilled crops, select a damming lister with shovels about 20 in. apart, but, for cultivated row crops, select larger lister shovels spaced at the regular row width of 40 to 46 in.

5. Selecting Secondary Seedbed-preparation Machines

Secondary seedbed-preparation machines include those machines designed to pulverize further the soil and to complete the work of fi-
ting further the seedbed. They include the disk harrow, peg-tooth harrow, spring-tooth harrow, soil pulverizer, field cultivators of various types, rotary rod weeder, land packers, rollers, drags, and levelers. Each tool has its features and advantages that meet particular soil, climatic, and crop conditions. Some are used alone and others in combination. Certain conditions call for more machines than do others. Consequently, this part of the book, dealing with the selection of secondary seedbed-preparation machines, will show applications, features, and advantages of the various tools for certain conditions. It will be up to the user to select the particular tool in the size and model to meet his farming needs and conditions.

Selecting the Disk Harrow. The disk harrow in both horse- and tractor-pulled types has been described as the universal tool for preparing seedbeds. Its many functions—cutting, turning, pulverizing sub-soil, packing, and mixing soil with trash—make it a highly desirable machine for the many different crops and soil-management practices.

In addition to preparing plowed land for planting, its most common use, the disk harrow serves in many other capacities. Examples are

1. Preparing seedbeds following plowing. One or more diskings are commonly used, depending on the needs of the soil. Sod conditions may require several diskings.

2. Preparing seedbeds without an initial moldboard or disk-plowing operation. Farmers in some areas omit the plowing operation entirely, owing to existing loose-soil conditions from previously grown crops, such as soybeans. This practice has recently become popular in parts of the Corn Belt and in other areas of the country.

3. Preparing fields covered with crop residues of previously grown crops such as cotton and corn stalks or heavy growths of grain stubble. This results in more mixing of the trash and incorporating valuable organic materials with the soil.

4. Cultivating orchards and wide-row crops to keep weeds under control.

5. Summer fallowing. Follow local soil-management practices to avoid overpulverization of soil to induce soil blowing or puddling and washing of the soil when heavy downpouring rains occur.
6. Cutting up brushy lands. Large disk harrows have been successfully used in this capacity.

7. Before plowing. Heavy crop residues, such as cover crops, can be cut up satisfactorily with the standard disk harrow. This results in soil improvement by adding valuable organic matter to the soil.

8. Seedbed preparation for small grains. The disk harrow instead of the plow is popular in some areas.

Sizes and Types. Disk harrows are available in sizes suitable for all horse units and in sizes ranging from 4-ft. single disks direct-connected for small row-crop tractors to the large “squadron type” cutting 20 ft. for track-type tractors. Disks vary in sizes from 16- to 24-in. diameter in 2-in. variations. Most disks are round, although cutout disks are available for special cases. The spacings between disks range from 6 to 9 in. in light and medium duty, while extra-heavy tractor disk harrows may have 10-in. spacings. The wider spacing permits greater penetration in the soil. It is, therefore, preferable for use in gumbo, bottom land, where cornstalks are to be cut, or where the combine leaves a high grain stubble. Heavily manured lands, trash, weeds, cotton land, and cover crops, as well as western orchard and truck-crop areas, usually respond better to disking when the disks are far apart.

All disk harrows are constructed along the same general design. A number of disks are assembled on an arbor bolt and kept in proper relationship to each other by means of a spacer known as a “spool.” The center shaft, or “arbor,” is secured to an overhead frame by
means of two supports with bearings. The complete assembly is called a “gang.” Two of these gangs, with the disks concave out and connections to the drawbar, form the single disk. Most tractor disks are the double-disk type; that is, two other sections, but with the disks reversed, trail immediately behind the front section. In a properly adjusted double-disk harrow, the rear disks should cut midway between the ridges of the front disks. Some double disks are formed by two gangs only, one in front and one trailing.

Angling. Increasing the angle of the disks increases the pulverization and penetration. Changing the angle can be accomplished by one of three means. The method, however, is an integral part of the harrow: (1) The “manual-angling” method uses levers or cranks to adjust the position of the front sections. Lever linkage or cross-beam attachments cause the rear sections to trail the respective front section; (2) “hydraulic angling” is accomplished by means of a hydraulic cylinder on the disk, actuated from a pump and reservoir mounted on and operated by the tractor engine; (3) “automatic angling” uses crossed-draft connections between the front and rear gangs to angle or de-angle the disks by merely moving ahead or backing the tractor. This gang-angling mechanism locks firmly in place after the gangs are at any one of the several angles for which the device can be set.
Select a harrow having individual adjustments, if possible, because such a feature is very desirable.

Frame Construction. Select a frame that, in addition to being well constructed, provides a wide range of flexibility. Have gangs that can be tilted separately at sharp angles and also follow the contour of ditches and levees. Gangs should also ride over good-sized stones, stumps, and similar obstructions without harmful strain on the frame.

Fig. 44. Offset tractor disk with orchard shield working close to citrus trees.

Fig. 45. Offset tractor disk operating in a southwestern date orchard.

There are several types of special disks. "Orchard disk harrows" are often constructed with the frames below the top of the disks so they can operate in orchards and vineyards. They do a good job of disking under such cover crops as burr clover, vetch, horse beans, peas, and similar crops. Weight boxes are to the rear of the disks so weights will not damage shrubs or trees. Have guards for harrows operating close to trees. Others are offset to work near the tree trunks and the tractors near middle of the row. "Reversible-disk harrows" serve
as tools for general purposes, including cultivating row crops. The reversible disks are suited to cultivating row crops whether they are planted level, on beds, or in furrows. The disks can be reversed for “out-throw” or “in-throw,” or they can be set to straddle the rows.

Disk harrows are also used in bedding cane and other crops. This is discussed under cultivators in Part III.

Selecting Peg-tooth Harrows. The main use of peg-tooth harrows is to work down the seedbed after the soil has been turned by another implement, although they are often used to cultivate crops such as potatoes before they come up, or to work down ridges to cover grass and weeds in the furrow. Like all tools of secondary tillage, the main purpose is to finish the seedbed by leveling it off, crushing clods, firming the soil, and killing small weeds.

The peg-tooth harrow is available in sizes to fit nearly any horse or tractor power available. Most horse-drawn harrows are either
two or three sections, whereas when tractor drawn many sections are
often grouped together as a unit, or as a series of units. There are
several kinds of peg-tooth harrows. These are determined by the
way the teeth are set in the frame. Some have the teeth clamped
to the side of the cross-frame bars, which may be round, square, or
U-shaped. Other types have the teeth passing through the frame and
held in place by a nut and lock washer on the upper end of the tooth.
These teeth have a shoulder that is drawn against the lower side
of the cross frame as the nut is tightened. This type is not adjustable

as to setting the tooth depth, and the teeth are usually harder to
remove than those held in place by a clamp or clip, although they are
less likely to be lost. The angle of set for the teeth of these harrows is
adjustable.

For stumpy land and orchards, farmers often construct peg
harrow in an A-shape, using either wooden or metal frames. The
pegs are usually set vertically in the side and cross members of the
frame. Such harrows, because of the shape, slide around stumps,
rocks, or other solid obstructions. The angle set of the teeth for such
harrow cannot be adjusted.

Shape of Harrow Teeth. Teeth are available in many shapes such
as oval, round, square, triangular, and diamond. The diamond
shape is the most popular, because it seems to cut exceedingly well
and, when the tooth becomes dull, it can be reversed to present a new cutting edge. Pegs or teeth with heads held in place by nuts, clamps, or clips have less chance of being lost than those in “A” harrows. Select a harrow having corner teeth with a runner extension that will carry the harrow off the ground when in transport. This prevents wear on the teeth when the harrow is pulled from field to field or along roadways. Select a harrow with a good range of adjustment for setting the teeth at different angles.

Shape of Cross Members. Peg-tooth harrows usually have five cross members or tooth bars to which the teeth are secured. These are U-shaped, pipe (round), or angle iron for metal and square wood bar on others. The majority are open end; that is, the five tooth bars arranged so the teeth do not follow in the tracks of one another to make a ragged pattern. In the open-end, three strengthening bars on top of the cross bars keep the latter in proper relationship. Diagonal braces are desirable to assist in distributing the strains over the entire harrow when one tooth strikes a stone. The closed-end is similar to the open-end except that the outside strengthening bars or cross bars are at the ends of the tooth bars, where they serve as guards to prevent the ends of the tooth bars from damaging trees or vines. Select this type for orchard or vineyard work.

Most harrows are rigid rectangles, the only flexibility being between the sections. However, “flexible harrows” are available. They are used primarily in the stubble land of the Northwest and in stony ground. Each tooth bar is free to raise and lower independent of the others. This flexibility, permitting the teeth to conform to the surface of the ground, is especially advantageous on rough ground. The harrow can be rolled up like a carpet for easy transport in wagon or truck. The southern harrow is somewhat lighter in weight than the
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regular harrow. It is well adapted to Southern farming for both regular field work and for harrowing and smoothing off the tops of beds.

Selecting Spring-tooth Harrows. Select the spring-tooth harrow for deep tillage. The spring-tooth harrow is somewhat similar to the peg-tooth except that the teeth are long, curved spring teeth instead of pegs. They will work at a depth of five, six, or more inches, thoroughly stirring the soil and bringing the large clods to the surface where they can be pulverized. They are sometimes used to hasten the warming of the soil in the spring. The spring-tooth harrow is also suited for use in stony soil or that infested with pest grasses.

Fig. 50. A trail-behind spring-tooth harrow for summer fallowing and other field cultivation.

The frame of a spring-tooth harrow usually gages the depth of the teeth. Select a harrow with runners having removable shoes that can be replaced at small cost when worn. Have the levers located at the back of the harrow when using horses and at the front when using a tractor.

When the teeth are mounted on pipe, they are attached with a strong spanner hitch that transmits the strain on the pipe and not on the bolt. In channel-bar construction the teeth are mounted with U bolts and nuts. This permits respacing and also moving the teeth in or out to compensate for wear.

The horse-drawn and medium-sized tractor harrows generally have three tooth bars while the heavier tractor units, particularly for the West Coast regions, often have four tooth bars and larger teeth arms. The harrows are adjustable to penetration by means of an
adjustable hand lever. Tractor-pulled harrows are generally constructed with a latch or "trip rope" from the tractor seat for raising the teeth either for clearing trash or for transport.

Spring-tooth harrows can be equipped with single-point teeth, reversible-point teeth, alfalfa teeth, or special quack-grass teeth and furrows. Teeth with a large coil or other construction features reduce clogging and breakage. Teeth can be changed on most harrows. Select a spring-tooth harrow with the features best suited to your work and of the size to match the power available. Spring-tooth harrows, like peg-tooth harrows, can be grouped into as many units as the power can handle.

Selecting Blade Harrows. This type of harrow consists of a series of blades or knives attached to the frame. These blades can
be had in the straight- or curved-blade style. They are excellent for killing small weeds, leveling land, and cutting up clods. The blade harrow can be secured with or without a riding cart or truck to support the front part and in sizes to match either horsepower or tractor power. This harrow does not penetrate deeply nor does it pack the soil at the depths possible with other harrow types. Select this harrow to make a surface mulch and surface cultivate where there is danger of damaging roots.

Tractor-pulled knife-tooth harrows or knife weeders are used for keeping down weeds after rains or following irrigation in orchards, and also in bean, beet, grain, or summer-fallow fields.

Selecting Field Cultivators. Field cultivators equipped with teeth or sweeps working below the surface serve several purposes. They bring clods to the surface where they can be pulverized, shear off weeds below the surface, dig up roots of noxious weeds such as quack grass, Johnson grass, creeping Jenny, and leafy spurge. They are an excellent machine for mulch culture when equipped with subsurface gangs.

Select the field cultivator as a summer-fallow tool for “roughing” stubble land. For this purpose it is often referred to as a “duckfoot” cultivator. The subsurface tillage gangs and sweeps enable the user to cultivate the soil thoroughly without turning it over or burying any of the crop residues. Select this machine to obtain a rough, cloddy surface and to keep the trash on the surface; this will prevent soil blowing and water runoff. Absorption and storage of water are
thereby greatly increased and the surface trash or crop residue reduces evaporation. Subsurface gangs are spaced 18 in. apart in two ranks, with 20-in. sweeps on the forward gangs and 24-in. on the rear. The lighter weight cultivators have two ranks, that is, cross members for attaching shovel shanks, while for heavy work and in especially trashy ground, three-rank machines are used. In addition to contributing added strength, the three-rank construction clears trash more readily. A variety of tooth equipment can be used on the same frame; light spring teeth with reversible shovels, heavy spring teeth, and subsurface sweeps.

Field cultivators for tractor operation come in 5½-, 7-, 8½-, 10-, and 12-ft. single section and 14-ft. duplex, and are regularly equipped
with depth regulator and power lift. The 10-ft. can also be had with double power lift and two depth regulators. Horse-drawn machines are supplied in 5½, 7, 8½, 10, and 12 ft. and are regularly supplied with hand lift and seat; either with or without tongue truck, the power lift and depth regulator are available. Select a size to match the power and with the teeth or sweeps best suited for the purpose used.

Selecting Orchard Cultivators. This type is a modified field cultivator in construction and operation. It is primarily a rugged tractor-pulled carrier onto which a variety of shovels and tooth equipment can be attached. It is designed for deep tillage work.

Fig. 56. A three-rank direct-connected hydraulic-controlled tractor-drawn orchard or field cultivator.

Fig. 57. An orchard-type cultivator with dual spring control on shovels.

Tool equipment includes heavy coil-spring shanks with reversible points, wing furrows, lister heads and rigid shank teeth. These units are built for the heavy track-type tractors giving up to 16-in. penetration with rigid shanks, through a range to the small row-crop tractors, where the units attach direct to the tractor and the penetration is controlled by the tractor hydraulic system. The heavy-duty units are designed more for the West Coast and other irrigated areas. The width of head varies from 5 ft. with 6-in. penetration up to 11 ft. with 16-in. penetration. A power lift raises and lowers the teeth in the ground.

Selecting Chisels or Sub-soilers. Such machines cut or chisel their way far below the surface. They are used for breaking up hardpan, digging drainage ditches, lifting bed-planted sugar beets, and preparing ground for plowing. The unit must be well con-
constructed to withstand the extreme pulls or strains on the members. Chisels or sub-soilers are available in sizes corresponding to the depth of penetration desired. The lightest has a maximum penetration of 22 in. Select the larger model for deeper penetration up to 32 in. Some sub-soilers have two or more standards that can be equipped with beet pullers, chisels, listers, cultivators, and ditchers.

![Fig. 58. Another type of heavy-duty field cultivator.](image)

![Fig. 59. Single-standard sub-soiler frame (A) with sub-soiler; (B) with ditcher attachment.](image)

**Selecting Rotary Rod Weeder.** This type of weeder, as a summer-fallow implement, has met with favor in many areas where the soil is free of stones or other obstructions. It is best suited to loose soil where depressions and ridges are not too abrupt. Although the rod weeder leaves a cloddy surface, it has a tendency to pack the fine soils, making them somewhat impervious to rain. Therefore, it is not advisable to use a rod weeder exclusively year after year on fine-type soils. The rod weeder turns slowly with an upward motion.
to the front part of the rod and operates two or more inches below the surface. It is effective in weed control and works quite well on land with heavy vegetative growth. The weeder is about 12 ft. wide with four teeth that hold the rod in the ground. The rod, 1 in. in diameter, round or square, revolves in the opposite direction of travel under the soil surface by a chain and clutch mechanism driven from the left wheel. Connect units in multiple for large tractors.

**Selecting Rotary Plows.** These machines loosen, pulverize, and mix the soil in one operation, making it ready for planting or seeding. This same operation also chops up and mixes any organic matter or
surface mulch uniformly throughout the depth of the seedbed. One type does its work with a rapidly revolving cylinder set with heavy spring teeth. The cylinder revolves in the reverse direction of travel.

**Fig. 62.** A special shovel attachment on a rod weeder for subsurface tillage in mulch-culture practice.

**Fig. 63.** A self-propelled garden-size rotary or cylinder tiller plow for turning the soil and preparing the seedbed in one operation. Other implements can be attached to this same power unit.

The width of the cylinder is the width of the strip plowed and pulverized. The cylinder either is driven through the power take-off of a tractor or is self-propelled. When it is self-propelled, the operator walks and controls the machine through the handle guides. The depth of tilth is adjustable to a maximum of about 9 in. under favor-
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The self-propelled type can be had that will cut a width up to 24 in. Another type is similar to this tiller, although it is available with either revolving spring teeth or dual spiral blades.

They are designed in sizes from 14 in. up to 10 ft.; therefore, they are available in sizes suited to the soil condition and tractor power. Both of these machines are adapted best to comparatively clean soils free of stones, large roots, and excessive debris. A shear pin serves as a safety device.

**Selecting Land Rollers and Packers.** There are two definite classes of rollers or packers determined by the kind of work they do; the subsurface packer and the surface packer. There are several types of packers in each class.

**Subsurface Packers.** These can be had in the crowfoot-roller style, and the V-shaped or wedge-shaped wheel rims. The V-shaped type is used extensively in sugar-beet farming to eliminate air pockets deep in the soil. It consists of a number of open-type wheels with V-shaped rims spaced several inches apart on an axle.
with an overhead frame. Select this packer with weight boxes as it is relatively light in weight and often has to be weighted to do effective subsurface packing. The crowfoot packer or roller has serrated-edged wheels spaced much closer together than on the open-wheel type packer but it also does a good job of subsurface packing to eliminate deep air pockets if sufficiently weighted. The subsurface packers not only eliminate air pockets but crush many covered clods. They are available in sizes from 9 to 19 ft. and for trailing two-, three-, and four-bottom plows.

Surface Packers. These can be had in many different styles, but the most common are the V-shaped soil pulverizers, tube roller, and drum roller. The main uses of surface rollers are to crush surface clods, to press down the soil so that it will firmly contact the sub-soil, and to pulverize the surface for a fine seedbed. The most common type is the “soil pulverizer” which consists of a number of 16-in. diameter wheels with V-shaped edges that are placed on an axle to form a corrugated roller; that well describes the appearance of the land surface following its use. The soil pulverizer is more than a clod crusher. It helps pack loose soil, eliminates air spaces, reduces soil blowing, and prevents winter killing. It is also used to cultivate wheat, alfalfa, and other crops. These rollers, 15 in. in diameter, are often used in gangs with the second gang having 12-in. rollers splitting the corrugated ridges formed by the first gang. This corrugated surface prevents wind erosion to a small extent. Select a gang roller on which the rear gang, complete with the rollers, is removable so the packer can be used as a single roller. It is desirable to have the rollers removable, leaving open centers to straddle corn or other row crops. Another roller or pulverizer consists of 15- and 16-in. diameter sprocket-type wheels arranged similarly to the soil pulverizer. They are available in single gang, double hook-up, or arranged in large tractor units. Sizes are 44 in. to 10 ft. in length and 140 lb. per ft. in length.

The “tube roller” looks much the same as a drum roller except that it does not have a smooth surface. This is because it consists of a series of U-shaped bars bolted to the cast-iron heads or ends of the roller sections. It does a fair job of surface packing and clod crushing. The drum roller is well explained by its name; it looks like a smooth drum with an axle passing through it to which is attached an overhead frame for the seat and weight boxes, similar to the tube
Drum rollers do a good job of leaving a smooth surface where soil pulverizes readily. Such a surface condition encourages wind erosion. Where hard clods exist they are often forced into the seedbed.

Practically all rollers and packers can be had in sizes to meet any power available from one horse to heavy-duty tractors. For tractor use they are often assembled in gangs or attached behind other implements operating in the field to prepare seedbeds.
Some farmers construct their own surface rollers by pouring concrete into a smooth or corrugated drum or by stringing mower wheels on a shaft of the desired length; or they may use a smooth log of the proper length and diameter.

Selecting Drags and Levelers. Drags are often an excellent aid in the preparation of a good seedbed through the crushing of clods, leveling of the land, and breaking up of corn stalk or other coarse stubble that has been turned up by other implements tilling the soil. Nearly all drags are homemade or are the product of local mechanics. Materials used include a number of planks, split logs of desired length, or heavier objects such as a railroad rail section.

Although drags do a certain amount of leveling, other types of tools are also used to smooth off land and level it for terraces or irrigation purposes. These levelers either push or carry soil from high places and deposit it in low places, and while doing this they also pulverize the soil and pack it for the seedbed (see Figs. 67 and 68).

**SUMMARY**

1. The soil is the farmer's "working capital"; therefore, exercise care in selecting seedbed-preparation machines.
2. Some factors affecting the selection and operation of seedbed-preparation machines are type of soil, crops to be grown, moisture conditions, soil erosion, seasonal conditions, power available, residue, insects, pests, and previous crops grown.
3. Since the plow is the primary implement, select a type that is suited to the soil and climatic conditions.
4. The principal plow-bottom types include: the breaker, stubble, general-purpose, blackland or gumbo, orat moldboard, hi-speed general-purpose, deep-tillage, five-member, and dual type.
5. Materials of which shares are made include cast-iron, chilled cast iron, cast steel, solid steel, and soft-center steel.
6. Some common plow accessories that improve the quality of plowing are gage wheel, knife and rolling colters, jointers, covering devices, weed hooks, and moldboard extension.
7. Walking plows are made in sizes 7 to 16 in. and designed for one, two, or three horses.
8. Riding plows are available in sulky or gang types and either one- or two-way.
9. Tractor-operated plows are divided into two general classes: trail- behind and direct-connected.
10. Special plows are available for turning under various kinds of growth and loosening soil for easier handling as in road construction and terrace building.

11. Disk plows are either horse drawn or tractor operated and range in cut from 7 to 14 in.

12. Disk plows negotiate soils and soil conditions that are difficult for moldboard plows.

13. The reversible-disk plow works well on hillside terraces and eliminates dead furrows.

14. Anti-friction bearings with dust seals, lubricated under pressure, are well suited to heavy-duty plows.

15. Direct-connected plows plow out fence corners and work in other close places more effectively than trail-behind plows.

16. The harrow plow can be quickly angled to affect width of cut, a feature that adjusts the machine to the power and soil conditions.

17. The disks of a harrow plow revolve around a common shaft as do disk harrows. Disks may be removed to adjust to power and soil conditions.

18. The lister or middlebreaker is often used for preparing crop beds in humid areas and for reducing wind erosion in windy, arid areas.

19. A sub-soiler attached to a lister loosens the soil in the base of the furrow for covering the planted crop and also aids in guiding a walking lister.

20. The rolling colter on the beam of either the moldboard plow or lister reduces the draft and cuts the trash to obtain a smoother slice and better coverage of residue.

21. The damming or basin lister builds dams in the furrow to hold snow and rain as a moisture- and soil-conservation measure.

22. The disk harrow is the universal seedbed-preparation machine and it is available in many sizes, either single- or tandem-type, to meet any soil or power requirements.

23. Through angling and the use of weight boxes, the disk harrow is readily adjustable to soil and crop residue conditions.

24. Increase the angle of disk-harrow gangs to increase penetration and pulverization of soil.

25. Peg-tooth harrows are available from one- to multi-section units, and with oval, round, square, triangular, and diamond-shaped teeth that are fastened to round, square, or U-shaped frame bars.

26. Many spring-tooth harrows can be equipped with the type of teeth best suited for the job, such as single-point, reversible-point, alfalfa, quackgrass, and furrower.

27. The blade harrow, with either straight or curved blades, is excellent for killing small weeds, cutting up clods, and leveling land.
28. The field cultivator, with either two or three ranks, can be had in widths varying from 5½ to 14 ft.

29. The field cultivator can be fitted with many kinds of subsurface tillage shovels and sweeps, which maintain a cloddy surface. Plant residue is not turned under which, for summer fallowing, gives a surface receptive to moisture and able to control water runoff and wind erosion.

30. The orchard cultivator, which is similar to the field cultivator, can be fitted with shovels for penetrating the soil from 6 to 16 in. deep.

31. Chisels and sub-soilers will penetrate the soil up to 32 in. and are well suited to breaking up hardpan, digging ditches, and lifting bed-planted root crops.

32. The rotary rod weeder is a good machine to destroy unwanted plant growth for summer fallowing.

33. The rotary plow, either self-propelled or operated through the power take-off, loosens, pulverizes, and mixes the soil in one operation, making it ready for seeding.

34. The rotary plow or tiller can be had in widths from 14 in. to 10 ft. for working clean soils to a depth of 9 in.

35. Surface packers or rollers are excellent for crushing surface clods, whereas subsurface packers compact the seedbed base and eliminate air pockets.

36. The larger sizes of levelers are suited for most jobs in leveling for irrigation in order to obtain uniform movement and distribution of applied water.
2. Operating and Field-servicing Seedbed-preparation Machines

AFTER selecting a machine, assemble and adjust it correctly to do the best work. Properly adjusted machines save power, increase the working life of the machine by reducing need for replacement parts and reconditioning, and are easier to operate. The purchaser of a new machine needs to make sure that adjustments can be made conveniently and that it is a machine that will advance sound soil-conservation practice.

New machines as received by the purchaser are (1) assembled and delivered by established dealers or (2) received unassembled ("knocked down") from the manufacturer or agent. In the latter case, the purchaser must depend largely on the owner’s manual for instructions on assembling and adjusting for use.
Instruction books and owners' manuals are provided by manufacturers or dealers with all standard makes of implements. These publications provide essential information regarding the adjustment of each implement. Study carefully such instructions and check the implement before it is operated. Manufacturers and implement dealers usually have field men who deliver assembled machines and assist in getting them into operation. With booklets available for each implement, and with the possible assistance of machinery servicemen, there is little excuse for anyone to put a machine into service that has not been carefully checked and the necessary adjustments actually made. The following activities are discussed in this chapter:

1. Operating Walking Plows
2. Operating the One-way and Two-way Low-lift or Frameless Sulky Plows
3. Operating High-lift Sulky and Gang Plows
4. Operating Tractor Plows
5. Operating Listers and Middlebreakers
6. Operating Disk Plows
7. Operating Harrow Plows or One-way Plows
8. Operating Secondary Seedbed-preparation Machines
   - Harrows
   - Field Cultivators
   - Rotary Rod Weeders
   - Rotary Plows
   - Rollers and Packers
   - Drags and Levelers

1. Operating Walking Plows

Before starting either a used or new plow in the field, remove any rust, varnish, or anti-rust material from its moldboard, colters, and jointers with varnish remover or mild lye solution; then polish. Apply a light coat of oil to all parts contacted by a removal agent.

When the walking plow is in good condition and properly adjusted, it will run with very little guiding by the operator unless he is plowing in stony, stumpy, or trashy ground, or where soil conditions vary considerably. A satisfactory "set" is possible in all serviceable and undamaged walking plows. Provide a sharp share and maintain the
proper bottom suction, land suction, wing bearing, and hitch. Check gage wheel, jointer, colter, and special covering devices for proper set and condition.

![Image](image1.jpg)

**FIG. 70.** An early type crude soil-stirring implement that is heavy of draft and difficult to guide and merely scratches the surface.

**Checking Bottom Suction and Land Suction.** The points of all walking-plow shares dip down slightly below the plane of the underside of the share; this is known as "bottom suction." The "land suction" is the distance the point of the share extends in the unplowed ground beyond the plane of the land face of the landside. These "suck" features have a decided influence in holding the plow steadily to a satisfactory depth and width. They also influence draft, quality of work, and effort necessary on the part of the plowman.

![Image](image2.jpg)

**Fig. 71.** Providing proper bottom suck under the gunnel keeps the walking plow in the ground.

**Fig. 72.** The walking plow is held to the land by the maintenance of proper side suck.

![Image](image3.jpg)

**Approximate Center of Draft**
Cast shares cannot be forged; therefore, they must be replaced when the bottom suction and land suction are worn away. When new shares are needed, obtain those of the right kind, shape, and size for the particular plow used. The bottom or down suction and land suction of new steel shares are correct if of the right kind and size. Take care when sharpening and in repointing steel shares by forging to maintain the proper suction, in so far as these features are built into the share itself.

Lay the finished steel share on a smooth surface as shown in Fig. 73 and check on the down suck at points A, Fig. 71, and B, Fig. 73. Ordinarily, the clearance at each of these points should be very close to $\frac{1}{8}$ in. Sometimes for plowing ground that is very hard, and particularly when using wide-cut shares, these clearances are increased slightly. See that the share has the bend well back from the point, as in A and B in Figs. 71 and 73 instead of having just the tip of the share keeps the plow in the ground. Do not allow too much down suck. If these two precautions are not heeded, the plow will "bob"; that is, it will jump, weave, and even fail to hold its depth. After a steel share has been forged sharp or repointed, check also on what land suck the share itself carries by holding a straight edge along its land face. Ordinarily, the share should show from $\frac{1}{16}$ to $\frac{1}{8}$-in. clearance.

The measurements for bottom suction and land suction vary slightly in plows of different makes and widths. Suction measurements for any particular share can be obtained from the local dealer merchandising that line of implements. Proper running of the plow depends also upon a perfect fit of the share and landside, so draw them down tight when replacing. Excessive wear in both share and landside tends to destroy the proper down-suck and land-suck features.

**Determining the Wing and Landside Bearing.** The first and most important point to remember is that shares must be sharp and properly set to do a good job of plowing. A blunt point, a dull cutting edge, or a badly worn wing will not only affect the proper running of the plow but will also increase draft. Usually all three of these undesirable conditions exist in the share at the same time. Inspect the plow bottom frequently. The action of the plow in plowing will indicate what service or adjustments are necessary.
The bottom, or base, of the walking plow is carried on two bearing surfaces. Part of the downthrust of the plow is carried by the heel of the landside, and part is carried by the flattened portion of the outside corner of the share or wing. Hold a straightedge across the bottom of plow, so that it rests on the heel of landside and on the wing of share. (See Fig. 21, page 41.) This feature in walking plows is extremely important and often not well understood. If the plow has too much wing bearing, it will not suck in properly on the wing side, and is said to “wing up.” The plow then tends to run narrow or “out.” If the plow has too little wing bearing, it “wings down” or tends to run “wide.” Provide for more wing bearing when the soil is mellow than when the ground is hard and compact. It is possible that a plow with the proper amount of wing bearing for fall plowing may “wing down” in spring work, or a plow that worked perfectly in the spring may perform unsatisfactorily when the same share is used in the fall. If a plow tends to wing up or wing down, and if the operator attempts to overcome the difficulty by setting the hitch over, or if he overcomes the tendency to run wide or narrow by “fighting the plow” through the handles, then it becomes difficult to keep the plow bottom level and in proper relation to the furrow slice.

For average plowing conditions, see that regular steel shares carry wing bearing approximately as follows: for 12-in. bottom, ¾ in.; for 14-in. bottom, 1¾ in.; for 16-in. bottom, 1½ in. The wing bearing on cast shares cannot be changed, except that it can be lessened by grinding away a little of the wing. Increase or decrease wing bearing on steel shares by forging, or by carefully bending the wing slightly up or down using a heavy, well-closed, adjustable wrench when the share is cold.

Providing Proper Hitch and Draft. Horse-drawn plows have a vertical and a horizontal clevis on the end of the beam to adjust for the desired width and depth of the furrow slice. Set and attach these to the evener clevis in such a way as to avoid side draft and gouging into the furrow wall or furrow bottom. Vary in length the eveners for different sizes of plows, or have different sets of holes made in the ends of the eveners to meet the needs of varying sizes of plows used. The distance between evener holes for two horses on a 14-in. plow is 38 in.; for a 12-in. plow, 33 in.; and for a 16-in. plow, 43 in. With three horses, use a “landed” beam plow (Fig. 20) which has a beam that is angled ¾ to 4 in. to the land and, therefore, is not parallel.
to the land furrow wall as is the case with the two-horse plow. Some plows have an adjustment to convert them from a two-horse to a three-horse plow. This is done by using a wedge between the beam and frog of the plow and is known as "beaming" the plow.

Making the Vertical or Up-and-down Hitch. The proper adjustment of the vertical hitch is another important factor in the successful operation of the plow. The kind of work a walking plow does, its draft, and its handling qualities depend to a great extent upon the relation of power to load. The center of the load or center of resistance for a plow in operation is, for all practical purposes, an imaginary point 2 in. from the shin of the plow and just below the surface of the ground. The line of hitch is an imaginary line, straight or broken, extending from the center of load to a point approximately 3 in. above the hame hook of the furrow horse and passing through the clevis. To run properly under good plowing conditions, this line of hitch should be in a straight line. If the clevis is set too high it will "break" the line of hitch upward and, when the team pulls, the front of the beam will tip downward because the line of hitch always
tends to straighten. When the beam tips downward, the plow point tips downward. The plowman then has to push down on the handles in an attempt to keep the plow bottom level. This causes the plow to "teeter" over the heel and wing; the plow pulls harder, the plowing is poor, and the plowman becomes exhausted. When the clevis is set too low on the plow, the line of hitch is broken downward. The team pulls the front of the beam upward which, in turn, destroys the "sucking-in action" and the plow works at a shallower depth than desired. The plowman, endeavoring to overcome this, has to lift up on the handles, and carry some of the weight intended to be carried by the wing and heel.

As the share becomes dull, the plow tends to ride out, and the operator raises the hitch in order to force the plow downward. The plow then tends to "teeter" over the point, the weight on the heel and wing is reduced, and the plow will probably weave because it is not held steady by natural forces. This condition calls for more guiding by the plowman through the handles than should be necessary.

Hitch a small team to the plow at a lower point than that used for a large team. A close hitch requires a higher clevis adjustment than when the traces are lengthened considerably.

Making the Horizontal or Sideways Hitch. The hitch line between the horses and the center of load on the plow should be a straight line. When two horses are used, this line of pull is considered as a point midway between the horses' collars; for three horses it is the middle of the center horse's collar.

When the hitch on the plow is too far toward the unplowed ground, the "broken" line of hitch will tend to straighten and the plow will not cut a full furrow, unless the operator can hold it to its width by pressing down on the right handle and lifting on the left or land handle. Just the opposite situation will be noted if the hitch is
toward the plowed ground. A plow bottom that does not have enough land suck, or that has too much wing bearing, will tend to run narrow. On the other hand, if there is too much land suck, or not enough wing bearing, the plow will tend to make too wide a furrow. These undesirable tendencies can be overcome, temporarily, by the hitch. However, if the hitch is used to make up for a poor condition of land suction, bottom suction, or wing bearing, the plow will not do a good job; it will not run steady, pull will be increased, and the plowman will tire more quickly. Correct the plow bottom by making the proper adjustments as soon as possible.

It can be seen that the size of horses, number of horses, length of traces, and length of eveners are also factors to be considered when hitching to a plow. Equalize the load according to horse size and pulling ability by having two or three pinholes in each end of the evener, and the same number of draft holes at the center of the evener. Place the largest horse in the furrow; this makes it easier to maintain a straight line of draft or pull, and gives better footing to the smaller horse. As the number of horses is increased, the tendency to produce side draft increases. In such cases, hitch the teams in tandem rather than abreast. Working too many horses abreast is a common cause of overheating them, especially during hot weather, and one or more of the horses must walk in the soft plowed ground.

The factors of height and position of hitch, amount of suction, and wing bearing have the same effect with both riding and tractor plows. In view of this fact, they have been discussed fully here under walking plows.

A few principles to follow when opening a field with a walking plow are:

1. First, look over the field and mark those places where the soil surface needs to be lowered or raised.
2. Mark the lands in such a manner that, when the field is plowed, future field operations will be satisfactory and soil erosion prevented. Often land ridges are so located as to fill the dead furrows made at the previous plowing.
3. Turn furrows toward areas where the land level is to be raised and away from areas to be lowered.
4. Assuming that lands are 60 ft. wide, the resulting number of land ridges and dead furrows can be held to a minimum by the following practice:
   - Set first land-ridge stake 30 ft. from the side of field, and then continue
setting land-ridge stakes every 120 ft. Set stakes in a similar manner on the other side of the field. Plow out 60-ft. lands at each place marked by a stake. This leaves a 60-ft. unplowed land between each plowed land. Plow out these lands turning the soil toward the previously plowed lands. This procedure will space dead furrows 120 ft. apart and provide the same distance for ridge furrows.

2. Operating the One-way and Two-way Low-lift or Frameless Sulky Plows

The proper operation of the low-lift sulky depends largely on providing and maintaining the proper bottom suction, land suction, wing fullness, sharpness, levelness, hitch, and angle of front furrow wheel. It also depends on the adjustment of lifting springs, as well as the set and condition of jointer, cotter, and special covering devices.

The first important requirement in all satisfactory plow performance is that shares be of the right type, sharp, and correctly set. Keep the entire plow bottom polished to assure good scouring. Always keep rolling colters and jointers sharp and in correct position.

Adjusting Width of Cut. The front furrow wheel is supposed to run in the angle between the furrow wall and bottom of the open furrow. It may also serve as a guide to help the plow maintain its width.

The method for setting the plow for desired width of cut is shown in Fig. 77. The steps are (1) lower the plow bottom to the floor or ground, (2) level the plow, and (3) set the front furrow wheel to lead straight. Place a straightedge tight against the point of the share and against the rear furrow wheel. The distance from the rims of the front furrow wheel to the straightedge should be approximately \( \frac{3}{4} \) in. less than the width the plow will take when plowing.

To plow wider, move the wheel farther away from the beam (see
W, Fig. 77). The set of the front furrow wheel is primarily to hold the plow straight, and not to control the width of cut.

Checking Bottom Suction and Land Suction. The down thrust of a riding plow bottom is carried on the wheels instead of on the heel of the landside and the wing of the share. Varying the rear of the plow bottom up or down tips the point and regulates the suction. Riding-plow bottoms have some bottom and land suction built into them. This is maintained by proper shaping when sharpening or replacing a worn share.

Adjusting for Levelness. In one-way riding plows, the front furrow-wheel lever is known as the depth lever, and the land-wheel lever as the leveling lever. Place the plow on a level spot in the yard, or on the machine shed floor, and adjust and set it before taking to the field. This will serve as a guide for field adjustment after the first round. The yard or floor method is as follows: Place a 6-in. block (if plowing 6 in. deep) under the land wheel (see Fig. 77, page 89) and adjust the height of the rear furrow wheel so that the heel of the landside just clears the floor, with the point of the share just touching the floor. This adjustment is made by raising or lowering the axle in the axle bracket. Adjust the rear-wheel guide rod, on plows so equipped, with the plow bottoms on the floor and the block under the land wheel. The rear wheel should lead (toe out) slightly toward the moldboard (away from furrow wall). The harder the plowing, the greater the side draft, requiring more lead. The proper amount of lead under average soil conditions, for any moldboard plow when all side draft is to be absorbed by the plow, is as follows: for single-bottom, \( \frac{3}{8} \) in.; for two-bottom, \( \frac{1}{2} \) in.; for three-bottom, \( \frac{3}{8} \) in.; for four-bottom, \( \frac{1}{2} \) in.; and for five-bottom, \( \frac{3}{8} \) in. The desired settings can be marked for quick adjustment after the back furrow has been thrown.

Next, take the plow to the field. After throwing the back furrow, set the plow as previously marked. The front furrow wheel must run on the same plane as the point of the share. The rear-wheel adjustment should keep the bottom level. Some minor adjustments may also be necessary to compensate for soil and field conditions. When the plow is not level, furrows may be ragged, turning difficult, the soil left cloddy, draft increased, and trash and weeds left uncovered.

Adjusting the Hitch. The same principle of up-and-down hitch or clevis adjustment applies to the riding plow as to the walking plow. This means a straight line of draft from the hames to the center of load.
on the plow bottom. When this line is not straight, excess weight is thrust on either the front furrow wheel (when the hitch is too high) or on the rear furrow wheel (when the hitch is too low). The first case tends to throw the plow "on its nose" causing it to weave. A good way to check the line of hitch is to stop the plow with the plow bottom at its desired depth. With the team forward enough to keep the traces taut, stand in front of the furrow team and sight from the hame hooks to the center point of pull. The point of attaching to the plow clevis is in this line of sight if the line of hitch is in straight line. If not, move the position of the clevis up or down, whichever is necessary, until the line of pull is straight.

The cross, or horizontal hitch, is readily adjustable to accommodate the position of the horses and various sizes of eveners. Maintain here, as discussed previously in connection with walking plows, a straight line from the center line of pull of the horses to the center point of load, and parallel to the furrow wall.

Angling the Front Furrow Wheel. When three horses are used abreast, side draft will occur because the center of pull (middle of the center horse) is further from the open furrow than the center of pull on the plow.

In order to keep the line of hitch as straight as possible, attach the clevis to the plow on the unplowed side of the beam. The result is that the land horses pull toward the open furrow at a slight angle and the plow tends to lead toward the open furrow. This is overcome by angling the front furrow wheel toward the furrow wall just enough to offset the plow's tendency to lead out. Avoid angling the wheel so much that it tends to climb the furrow wall.

Adjusting the Lifting Springs. The lifting springs, on sulky and gangplows, which are of the coil type and usually two in number, are to counterbalance the weight of the plows so that the levers can be operated more easily, especially with the foot lift.
The foot lift on a riding plow serves as both a lift and a lock. The plow can be locked down when in plowing position by pushing forward on the upper pedal until it goes over center. In plowing stony land, the setscrew on the lock can be screwed down so the plow will float, not being locked in place. The plow then raises automatically when striking a stone or similar object and no damage is done. Always set the lifting spring sufficiently loose to prevent the bottoms from lifting except when they strike an obstruction. Adjust the springs with the plows in a raised position. Set the spring take-up bolts on the end of the spring so as to leave a slight tension on each spring. Too much spring tension retards the plows in entering the ground, and insufficient tension makes it difficult to adjust the control levers while plowing.

Adjusting Plow Accessories.
The rolling colter and a jointer, used independently or together, help to obtain clean plowing and proper coverage of weeds, grass, sod, or other material to be turned under as a fertilizer.

The colter and jointer are usually attached to the plow beam so that they may be satisfactorily aligned with the plow bottom. When both the colter and jointers are used, set the colter hub from \( \frac{3}{4} \) to \( 1\frac{1}{2} \) in. back of the plow point and the blade just deep enough to cut the trash or roots. Under most conditions, this adjustment is one-half of the plowing depth, although if there are many tough roots, the colter must be set deeper. Adjust so the colter cuts \( \frac{1}{4} \) to \( \frac{3}{4} \) in. toward the land. The jointer is set slightly shallower than the colter blade and about \( \frac{3}{4} \) in. to the furrow side from the colter. Set the jointer so that the point is nearest the colter and nearly touching it.

When used alone, the rolling colter is set from \( \frac{1}{2} \) to \( \frac{3}{4} \) in. to the land, as when used with the jointer. In soil that does not scour well,
this distance may have to be increased in order to put more pressure on the moldboard. However, this adjustment should not be increased so much that the furrow wall crumbles. The colter hub is set 3 to 4 in. back of the share point with the blade set just deep enough to cut the trash. If the colter is too small or set too deep, it may push the trash, rather than mounting and cutting it. Never set a colter to cut
more than one-fourth of its diameter. A sharp colter blade will help to prevent the pushing of trash. When plowing sod such as alfalfa, set the blade deep enough to cut roots below the surface, but always at least 1 in. shallower than the furrow-slice depth.

The rolling colter often needs field adjustment to meet changed conditions in soil or vegetative matter. Use a colter of sufficient diameter to cut through all vegetation, roots, and the like. The colter saves power because it is easier to cut sod with a colter blade than to tear it apart at the landside.

When the jointer is used alone, a soil depth set of 1½ to 2 in. is generally satisfactory with the jointer point directly over that of the plow. See that the jointer is set at an angle to turn smoothly a small furrow and not push the soil. When adjusting the jointer and colter, clamp them firmly to the beam in order to avoid any slippage that may change the adjustment during the field operation that follows. The bearings of many colters are adjustable. Check and set them carefully so that the blade will turn freely and yet not show side play. Sharpen jointer share and colter blade before placing them in operation. This is a part of the adjustment.

The same adjustments for colter and jointer apply to the two-way plow as to the low-lift sulky plows. Always follow instructions in the manual on operation provided with the plow.

3. Operating High-lift Sulky and Gang Plows

The operation of the high-lift sulky plow is dependent on the same factors as previously listed for the low-lift sulky plow with the following additional items to be considered: Heel clearance, landside clearance, and the angle of front and rear furrow wheels. In gang plows, the width and cut of the first plow bottom and the levelness of the two bottoms must also be considered.

Adjusting for Heel Clearance. The rear furrow wheel has several purposes in plowing: (1) to assist in keeping the plow running straight ahead, (2) to control the depth of the rear plow for plows having more than one bottom, (3) to reduce landside pressure, and (4) to replace the heel bearing. The rear furrow wheel in reality controls bottom suction and land suction.

Set the rear furrow wheel to run straight in the corner and deep enough so that the landside heel is off the bottom of the furrow and
one finger can be placed between the end of the heel and the furrow bottom. At no time should the landside heel leave a pronounced groove in the furrow bottom. In such cases draft is increased through sliding heel friction and the plow does a poor job because of lack of proper down suction. Likewise, lowering the rear furrow wheel increases the suction by raising the back of the plow bottom.

Specific instructions for making the rear furrow-wheel adjustments are usually found in the owner's manual. Adjustments vary with the make of plow.

**Adjusting for Landside Clearance.** Set the rear furrow wheel to prevent the landside heel from pressing against the furrow wall. When the furrow wheel is properly angled into the corner of the furrow, a little space, approximately \( \frac{1}{2} \) in., is maintained between the landside heel and the furrow wall.

**Angling the Furrow Wheels.** The angling of the furrow wheels, front and rear, is dependent on the amount of side draft in the plow resulting primarily from team arrangement. When the line of pull is on the unplowed side of the line of load, set the wheels so that the front furrow wheel leads toward the furrow wall and the rear furrow wheel leads away. If, on the other hand, the line of pull is toward the plowed ground side (more common in gang and multiple-bottom plows), set the front furrow wheel to lead away from the furrow wall and the rear wheel to lead into the furrow wall. Here again, follow the owner's manual for specific instructions on "lead."

**Adjusting Gang Plows.** All furrows, whether turned by a one-bottom or by a multiple-bottom plow, should be uniform. When those turned by a gang or other multi-bottom plow do not look alike, the discrepancy is generally caused by the furrow slices not being the same width. This can result from (1) the bottoms not being set the same depth or not being level, or (2) the front bottom turning too
wide or too narrow a slice. Proper setting of the wheel-control levers will eliminate the first situation, while the angle of the front wheel or distance of the front furrow wheel from the front plow beam will correct the second situation. Set the furrow wheel so that the center of the wheel rim is 3 to 4 in. from the furrow wall. The set of the rolling colter is an important factor in width of furrow slice as well as a clean furrow wall.

4. Operating Tractor Plows

Opening a Field with a Tractor Plow. Remove any protecting covering on the moldboard, colters, and jointers as outlined under walking plows in this chapter. With the plow hitched to center of the drawbar, open the land with a furrow. On the next round, drive ahead until the first bottom is cutting a full furrow and the plow beams are exactly parallel with the furrow wall; then stop. Disconnect the tractor from the plow, maneuvering it until the right drive wheel is lined up in its proper track in the furrow. Then, keeping the drive wheel in its proper track, back the tractor to the

![Diagram of land layout and plowing process](image-url)
plow. Hook the plow as close to the center of the drawbar as possible, while still maintaining that same relative position of tractor and plow.

When plow and hitch are in proper adjustment, a reasonable amount of weight should be carried on all wheels. Adjust the rear wheel down so that the landside runs lightly on the floor of the furrow. Too low a hitch on the plow takes the weight off the wheels, while too high a hitch puts too much weight on the wheels. Adjust the lifting springs to raise or lower the bottoms equally.

![Diagram of plow mechanism](image)

**FIG. 84.** One type of power for raising and lowering the plows and beams. Pulling trip rope \( A \) releases cam roller \( B \) so that drum \( C \) makes one-half revolution with the land wheel. The drum is attached by linkage to the plow beams. Spring \( D \) holds the cam roller \( B \) in contact with the drum.

Use a rolling colter of sufficient size and adjust to give a clean furrow bank. A 15-in. rolling colter should not cut more than 3\( \frac{1}{2} \) in. deep in any kind of plowing, and an 18-in. colter not over 4\( \frac{3}{4} \) in. deep. Then set the jointer to meet the plowing condition. Check to see that the front bottom cuts no more than the other bottoms.

When the plow is properly adjusted and correctly hitched, it will run right and with little, if any, effort on the tractor driver’s part. This will depend, of course, on how much, if any, of the side draft is absorbed by the plow.

**Operating Tractor Trail-behind Plows.** In general, the same principles apply to tractor trail-behind plows as to horse-drawn gang plows. These include such things as land suction, bottom suction, levelness of the plow, “set” of furrow wheels, proper vertical and
horizontal hitch, and the "set" and condition of the colters and jointers. These plows, naturally, include some automatic features to facilitate faster operation. The power-lift unit, a dog and ratchet arrangement in the land wheel operated through a rope trip from the operator (see Fig. 84), raises the plows vertically at the end of the field and again lowers them in the ground after the turn is made. This lift must be kept clean and well lubricated with light oil. The "depth" or "master" lever is used only for obtaining the depth. After the proper adjustment for depth is obtained, level the plow with the leveling lever. Then only the trip rope is used in raising the plows out of

the ground and again lowering them. The same applies to cranks or screws when they replace levers.

Hitching Trail-behind Plows. In order to hitch a plow properly on a horizontal basis to a tractor, it is necessary to understand the principles of draft and the importance of the center of draft. To illustrate, take a flat board on which five nails at one end provide five different points of attachment, one nail in the center. Fasten a string to the center nail and the board can be pulled in approximately a straight line, with some tendency to waver due to irregularities on the surface. Fasten the string to the nail at the right and the rear end of the board swings to the right. Fasten to the nail at the left and the rear end swings to the left. If you fasten just a little to the left of the center nail, the rear end swings only slightly to the left.
Now apply this principle to a plow. If the center line of the plow is directly behind the center of the tractor drawbar, there may be some tendency for the plow to waver. By setting the plow hitch a little to the left of the center of draft, you cause a little landward pressure to be thrown on the rear wheel, or the rear landside, or both, with the result that the tendency to waver is eliminated and the plow runs steady.

It is, therefore, necessary to know the procedure for determining the center of load of a plow. On a single-bottom 14-in. plow under average plowing conditions, the center of load is 2 in. from the shin (new furrow wall) and not far above the joint between the moldboard and the share, which places the center of load 12 in. from the last furrow wall.

If another 14-in. bottom is added, the center of load shifts one-half the width of the cut of the second bottom, or 7 in. This must be
added to the determined 12-in. center of load on the single bottom, giving a 19-in. distance from the last furrow wall as the center of load on a two-furrow, 14-in. plow. For each additional bottom, add one-half the cutting width of the bottom with these results:

Center of load on a three-furrow 14-in. plow is:

$$12 + 7 + 7 = 26 \text{ in.}$$

Center of load on a three-furrow 16-in. plow is:

$$14 + 8 + 8 = 30 \text{ in.}$$

Center of load on a four-furrow 16-in. plow is:

$$14 + 8 + 8 + 8 = 38 \text{ in.}$$

For a plow to be pulled with minimum draft at a given depth, the center of load of the plow must be in line with the center of the tractor drawbar, or nearly so. This sometimes presents difficulties, especially with a row-crop tractor. When using such a tractor, always set the wheels “in” for plowing, as this will provide economy of work and longer life for the equipment. The center of pull is midway between the rear wheels (or tracks), so with the row-crop wheels set “out,” the center of pull is a greater distance from the furrow. However, most row-crop tractors are built with adjustable wheels to reduce or eliminate side draft.

**Distributing Side Draft.** When the tractor was first introduced, the plowman endeavored to throw the side draft into the tractor while the tractor man wanted to throw it into the plow. As a compromise, side draft was divided equally between tractor and plow. Such a compromise has its drawbacks, especially when we are accustomed to convenience and ease of work. Whenever any appreciable amount of side draft is absorbed by the tractor, it makes steering more difficult for the tractor operator. If steering is tiring, and it is by the end of the day, the operator often blames the tractor. To offset this, most of the side draft (when any exists) on moldboard plows equipped with rear wheels should be absorbed by the plow. The result will be the satisfaction that goes with the ease of tractor operation. Keep a small percentage of side draft in the tractor and the plow will hug the furrow wall and prevent it from weaving back and forth. For these reasons it is desirable to absorb practically all of the side draft in the plow, especially when it affects tractor steering.
Making the Vertical Hitch. The up-and-down or vertical hitch for trail-behind tractor plows is similar to that for the walking plow; that is, it should be a straight line from the center of load of the plows to the tractor drawbar. Make this observation when the tractor is pulling the plows at the desired depth because then the tractor is lower down. The soil crushes under the tractor wheels and, in pneumatic-tired tractors, the tires flatten a little or "squat" when pulling under load. All of these factors are affected by the height of clearance or throat of the beam and in turn the height or size of the plow wheels. The height of hitch is very important. If the tractor hitch is too low and the plow hitch too high, the plow is pulled on its "nose" and the shares will wear off on the underside, increasing draft and making it hard to keep the plow in the ground at the desired depth.

Checking Landside and Heel Clearance. The landside of the rear plow on three-wheel plows absorbs some of the side pressure and some of the heel pressure. The "set" of the rear wheel varies for different makes and sizes of plow bottoms. These plows have another adjustment. A connecting or lifting rod connects the rear furrow-wheel assembly with the lifting mechanism. This rod raises the rear of the plow and, in many cases, releases the rear wheel so it casters when the plow is turned at the end of the field. The rod (according to specific instructions) is shortened for deep plowing and lengthened for shallow plowing. A short connecting rod speeds the raising of the plows.

On two-wheel plows, the rear landside absorbs all the heel and landside pressure that is not taken care of by the drawbar hitch.

Adjusting Spring-release Hitch. All tractor-pulled plows have a spring-release hitch to protect the plow; in case a bottom strikes a rock, root, or other obstruction, the plow is released or unhitched.
from the tractor. Following the action of this safety feature, it is a simple matter to back the tractor, rehitch, raise the plow, pass over the obstruction, and then lower the plow. Adjust tension of the trip spring so as to release easily or not, as desired (see Figs. 89 and 90).

![Fig. 89. Operation of a revolving-hook hitch. (A) Hitch in operation position. (B) Plow strikes a heavy object and is released from the tractor.](image)

![Fig. 90. Adjusting the hitch-release-spring nut to obtain the desired tension for release.](image)

**Operating Tractor-mounted Plows.** These direct-connected plows for the medium and small tractors have no wheels other than a gage wheel for controlling the depth. Such plows are suspended by linkage from a hydraulic power lift. One lever controls the adjustable gage wheel, the rest being done by the power lift.

**Using the Touch Control.** The direct-connected frameless type of tractor-operated equipment includes plows of all types. The plow, like all other machines, is adjusted and secured to the rectangular tool bar. When this tool bar is fastened to the tractor implement frame and is adjusted, the plow is ready for work. The spring-loaded drawbar is part of the implement frame. The colter and jointer are adjusted as for other moldboard plows. There are no wheels other than an optional gage wheel for depth control. There are no levers
or linkage mechanisms with the implements. All operating adjustments are made by means of a small touch-control lever on the tractor. The lever controls the mechanism, which, in turn, provides accurate depth control for the plow.

5. Operating Listers and Middlebreakers

Where more than one bottom is employed, check the distance between each bottom and set securely at the correct spacing. Frame holes on most models are provided to set the bottoms at the desired distance apart. Check the depth of the set for each bottom in order that all bottoms will operate uniformly as to depth. This adjustment can be made by lever, or frame adjustments, or both. Set the sub-soiler on the walking lister, particularly if loose ground is being listed, deep enough to penetrate firm soil in order to prevent side slipping of the implement. Set the sub-soiler to operate in the direct center of the lister bottom in order to permit a smooth, straight, and even operation of the machine.

Space the wheels to meet the desired width of row and fit into furrows; this will ensure an even width of rows. Wheel axles may be slipped out or in and set at the desired place by a set clamp or other locking device. When planters operate in connection with the multiple-bottom lister, it is essential that all rows are evenly spaced, particularly if multi-row cultivation machines are to be employed. When possible, use a lister-planter with as many bottoms as there are rows covered by the multi-row cultivator.

The damming or basin lister must form dams that are firm and large enough to prevent them from washing out when heavy rains occur. This necessitates dams of furrow-wall height and spaced somewhat closer on rolling land than where the land is flat. Adjust the damming unit so that it will not trip until enough soil has been collected to provide a strong dam.

6. Operating Disk Plows

Operating Animal-drawn Disk Plows. Check carefully both the new disk plow and the one that has been idle before placing them in field service. This is to determine whether or not they are adjusted properly and in condition to do desirable work. Operate disks at the same level to do an even job of plowing. Keep the disks sharp, polished, and adjusted properly so they will cut and turn furrow slices
with the least draft. Some items to check on the horse-drawn sulky or gang disk plow are the rear furrow-wheel lever, the rear furrow-wheel locking device, the front furrow-wheel lever, the landing lever, the disk scraper, the hitch, and the bearings for wheels and disk.

First check each lever. Determine whether the levers will permit the plow to be adjusted for any of the desired field-operating levels. Set the landing lever so that it will control the front wheel to provide

Fig. 91. The disk plow calls for accurate adjustments such as equal spacing of disks. Depth set for front and rear ends is the same. Set oscillating scrapers with proper clearance between disks without undue friction. Inset shows adjusted rotary-type scrapers.

the desired lead to or from the furrow wall. Set the scraper to work lightly against the disk, near the center, but with the wing 1/4 to 3/4 in. from the blade which will, under normal conditions, scrape off adhering soil. Avoid too much tension, as this increases draft and causes unnecessary wear on both the scraper and the disk blade. Examine all bearings of wheels and disk blades to see if too tight or loose and then adjust if necessary. Set up these bearings as snug as is possible to keep out dirt and hold the lubricant without interfering with the free turning of the wheels or disk blade. Grasp opposite edges of a free wheel or disk blade and, by pushing or pulling with the hands in opposite directions, it can be determined whether there is
sufficient play in the bearings to warrant their being adjusted. Properly lubricate these bearings, protect with dust seals, and good service will be assured. Replace the worn parts without delay.

**Operating Tractor-powered Disk Plows.** The tractor disk-plow adjustments are similar to those for horse-drawn disk plows, except that some special adjustments may have to be made on the hitch to avoid a lifting tendency on the front wheel. This lifting tendency will occur if the tractor hitch is too high. Avoid a high hitch because *disk plows depend upon weight for soil penetration* and not suction as with moldboard plows. If the disk plow does not have a power-lift device operated by a rope, adjust lever lengths so that they can be readily reached and operated by the tractor driver. A depth crank replaces separate wheel levers as used on horse-drawn disk plows. Check this crank to see that it operates freely and that all bottoms can be set at the same depth to get a uniform plow job.

The usual steps in making the proper hitch between a tractor and a disk plow are as follows:

1. Place right drive wheel of tractor in furrow at correct operating position.
2. Locate distance between center of pull of tractor and the furrow bank.
3. Locate center of draft of plow and its distance from the furrow bank.
4. Attach plow to tractor at its midpoint with center of pull as near the center of draft as possible.
5. Start plowing and, if side draft affects steering of tractor, shift some of the side draft to the plow by hitching nearer the center of the pull on the tractor.
6. Set clevis on the vertical adjustment so as to get on the line of hitch.
7. Operate plow, adjust hitch, and angle furrow wheels until the furrows are alike and turn uniformly.

Adjust the cut per disk and retain the number of disks to fit the power available, since nearly all disk plows permit such adjustments. It is...
essential that the farmer know the land that he is going to turn and the crop for which it is being prepared.

Operating Tractor-mounted Disk Plows. Those disk plows that are designed and adapted to specific tractors do not have the framework and front wheel of the conventional type of disk plow. These specially adapted disk plows, as with the moldboard plow of the same design, do not call for so many adjustments as do other disk plows. All adjustments should be checked, however, before field operations begin.

7. Operating Harrow Plows or One-way Plows

Good performance from the harrow plow, "one-way," "gold dig," or disk tiller is dependent on sharp disks, maintained bearings, proper weight, and correct hitch adjustments. The rear wheel of the heavier tractors and pulled plows are designed for wheel weights. Add sufficient weight to obtain the desired plowing job.

Adjusting Hitch. The correct hitch is a straight line from the center of load to the center of the tractor. Maintain such a hitch because varying from this may result in uneven plowing and severe compensating furrow-wheel adjustments.

Adjusting Depth. The harrow plow has many adjustments similar to the disk plow. Since the plow will open new lands, check the auxiliary crank, which supplements the long lever at front in controlling the depth of the front wheel, to see that it provides sufficient range of control. Set the screw crank that adjusts the plow depth set, through action upon the land and rear furrow wheels, to insure a level depth of field operation. The angle at which the disks operate to meet plowing conditions is controlled by a bolster adjustment at the rear of the plow. Set this according to definite soil markings on the plow frame.
8. Operating Secondary Seedbed-preparation Machines

Soil is broken so that it can give the plant an adequate supply of water, air, and light, and to provide the seed and the growing roots with a proper foothold or anchorage. The soil must be porous enough for water to penetrate the surface readily and percolate freely into both root bed and sub-soil. At the same time it needs to be uniform and crumbly in structure so that all parts of the root bed are kept well supplied with moisture. Several machines are designed for this purpose.

Operating Disk Harrows. The disk harrow has many adjustments similar to the harrow plow. The scrapers, for example, although different in type, operate on one lever for each section. Check and adjust all scrapers to determine whether they work the same on each disk. The set is the same as for scrapers on disk plows. Check the lever for each section of a gang and adjust so that they have the same action upon their respective sections.

The disk harrow is possibly the most abused tool on the farm. It is often left unsharpened or unhoused, pulled over unsuited surfaces, unpainted, unprotected from rust, and seldom properly lubricated. The disk harrow rolls on its blades; they act as wheels, with the result that there is strong temptation to transport the disk harrow from field to field over all kinds of roads without protecting the cutting edges. Avoid such practices, as damage to the sharpened edges is likely to occur.
Making Field Adjustments. Disk harrows often need field adjustments, some of which are:

1. The proper height of hitch to the tractor will keep the disk gangs running level. In many machines this is approximately 12 in. For exact height for the machine, consult the operating instructions. When the hitch of the harrow are too high, the inner ends of the gangs will cut shallow, while a hitch too low will cause the inner ends of the rear gangs to cut deeper.

![Diagram of disk harrow](image)

**FIG. 95.** Overhead and side view of automatic adjusting angling of one type of disk. The straight and full angle are shown.

2. The gangs must run level to leave the ground uniformly smooth. All machines have such adjusting devices. Consult the owner's manual on these leveling adjustments because the different makes and types are sufficiently different to require specific directions.

3. Weight partially determines the depth of penetration and the draft. Sharpen disks rather than use weight to overcome the disadvantage of dull disks. Most disk harrows are provided with weight pans so that the added weight may be adjusted for the type of work and soil. As an efficient operator of the disk harrow, know when and how much weight to add. Experience is the best source of information. Adjust these weights on the disk harrow to be centered in each box or equally distributed throughout the length of each box. Usually the front gang is weighted more heavily than the rear gang on tandem disks.
4. Adjust the snubbing blocks to force the center ends to penetrate as deeply as the outer-end disks. Angle the disk gangs to secure the desired penetration. The best penetration is secured when the angle is set at 20 to 21 degrees. At this angle a line drawn parallel with the line of travel touches the front edge of one disk and the back side of the adjacent disk.

There are many factors within a harrow itself that affect the depth at which it will operate. Some of these depth factors are (1) the weight of the harrow, (2) the size of the disk blades, (3) the angle of the disk gangs, (4) the sharpness of the disk blades, (5) the angle of the hitch, (6) the type of disk blades—round, spading or cutaway, (7) the dish or concavity of the disk blades, and (8) the general working conditions of the harrow.

Because of the abuse, lack of protection, and extreme service to which disk harrows are accustomed, it is expected that many troubles will occur during operation. Some of these common troubles with causes and suggested corrections are:


2. Ridging. Gangs need leveling. Hitch too high or too low. Rear gangs of tandem disks need moving in or out to cover cut of the front gangs.

Fig. 96. Always straighten the gangs when crossing vegetative waterways (see Fig. 43).

![Diagram of disk-harrow multiple-flange bearing](image1)

**Fig. 97.** Section of a disk-harrow multiple-flange bearing. Equipped for pressure lubrication and having dust flanges, it requires little attention other than keeping it tight and lubricated.

![Diagram of oil-soaked disk-harrow wood bearing](image2)

**Fig. 98.** Oil-soaked disk-harrow wood bearing.

4. Parts break or disk blades break. Usually due to abnormal operation. May require larger diameter, heavier blades, and heavy harrow units. Faulty sharpening as pointed out on pages 131 to 132. Buried stones or roots.
5. Frames twisted or bent. Using too much weight with dull disks to obtain penetration. Short turns when angled and bogged down in heavy soils.


9. Heavy draft. Bearings not fitted or replaced if badly worn. Lubrication inadequate.

Operating Peg-tooth Harrows. Peg-tooth harrows have a lever to adjust the angle set of teeth for each section. Frequently the same
notch does not give the same tooth angle to all of the sections; determine this for both old and new harrows. Check the clamp or locking device that holds each tooth to make sure that the locking adjustment is firmly fastened and the teeth set at the depth desired.

Operating Spring-tooth Harrows. Several kinds of teeth are available for these harrows. After selecting the kind of teeth wanted, adjust all to the same depth and equalize all control springs and levers for holding the teeth in the ground. Many of the points are reversible; thus, when points are dull, merely loosen the nut, reverse the point, and then tighten properly. This provides a new set of sharp points. Adjust the spring tension on the spring trips for the soil and depth.

Operating Field Cultivators. This summer fallowing tool can be fitted with several different types of shovels so that it may be adjusted for various jobs. For trashy summer fallow, set the rear gang back far enough to avoid raking the trash. Common stubble rarely causes trouble, but such weeds as Russian thistles may be a problem. Adjust the pressure springs and rods individually by a nut on the end of each rod. Make this tension uniform and correct for the conditions under which it operates. Adjust the lever for each gang, where they are separately controlled, to ensure an even depth of operation by each gang.

Operating Rotary Rod Weeders. The rod that is usually 3/4-in. square or 1 in. round operates from 1 to 5 in. deep and in units from 9 to 12 ft. wide. Where more than one unit is operating in the same field, adjust all to work at the same depth whether pulled by the
same or by different power units. Check the new machine carefully to see that the levers are set to get the uniform results desired.

Operating Rotary Plows. The engine not only propels the plow, but also operates or revolves the cylinder and teeth. With the engine running at recommended speed and the machine moving ahead, the cylinder with either teeth or blades is lowered to pulverize the desired depth. The speed of travel is influenced by the depth of operation, the power, and the condition of the soil. Free-running, well-lubricated bearings are essential service items. Keep the dust seals in sound condition to guard against any soil, grit, and moisture in the bearings. Keep the spiral blades and teeth sharp, well secured, and in true condition. Clean and protect the cutting parts at end of each day’s work.

Operating Rollers and Packers. The main adjustment to check on rollers is to see that the weights are equalized throughout the weight boxes, if weighted, and, when using corrugated rollers, that the rear gang splits the corrugations made by the first gang. This latter adjustment can only be attained by making the second gang or rear gang secure in the position desired and this is usually taken care of by rigid framework. Keep all bolts snug and lubricate moving parts.
Operating Drags and Levelers. The main adjustments on these machines are the cross members that move the soil from high spots into low spots. This is controllable only where levers or bolting devices are provided with which to make this adjustment. Check these adjustments to see that a uniform set is made at both ends of the drag or leveler. Keep all cutting edges sharp. Use a large, flat file for sharpening in the field.

![Leveling land requires matching rows in order to give the finished land a smooth carpet effect with the slope necessary for irrigation.](image)

9. Field-Servicing and Lubricating Seedbed-preparation Machines

A desirable habit in a good power-plant engineer is a workman-like inspection of his equipment at frequent intervals throughout the day. With cleaning waste in hand, he removes dirt and dirt-collecting material; he inspects the lubrication; he checks moving parts for needed adjustment; and his trained ear detects any unusual sounds or noises. Preventive maintenance is continuous. As a result, the equipment performs at peak efficiency year after year. Work delays are few and of short duration.

In a like manner, the farm operator can keep his machines in good operating condition season after season. Each machine does the job for which it was designed in an efficient manner, is economical in power, and performs without undue machine delay. This calls for a periodic check in the field to tighten loose parts and replace lost or
broken parts. These include nuts, set screws, bolts, clamps, screws, cotter keys, and other locking devices. Field service is a daily “must” with operating implements. It will prevent many major reconditioning jobs that might otherwise be urgent and constitute a hazard to satisfactory production.

**Providing a Field Kit.** Many tractor farmers have developed a field servicing kit of convenient size and style as a part of their tractor equipment. This kit contains the few necessary hand tools and a small assortment of cotter keys, washers, lock nuts, bolts, screws, lubrication fittings, nuts, and other desired items. A similar kit will prove equally valuable as a time, equipment, and crop saver to those using animal power.

**Field Servicing.** Make the service in a workman-like manner. It must be safe to the crop, operator, and machine. There is always a hazard in connection with temporary or makeshift repairs because they frequently cause more than normal wear on other parts or may even endanger the operator. Regardless of what the service job might be, it is essential to determine its cause, which may be abuse, poor lubrication, neglect, overstrain, or lack of adjustment. Remove the cause or causes in so far as is possible before placing the machine in operation again.

Since dull cutting parts waste power, replace them with reconditioned or new parts. To overcome the tendency of a dull part failing to penetrate the soil easily, it may be necessary to adjust levers and hitch to force penetration to the desired depth or add weight to the implement. These temporary adjustments should not be tolerated for more than the remaining part of the day.

One of the most common field-service jobs is the replacement of dull cutting parts such as shares, colter blades, and disk blades, with new or sharpened parts. Save time by having extra units of these parts on hand to avoid delays in field work. Make these field replacements before power is wasted. Before putting the machine into operation after replacing a part in the field, make sure that the new part is properly secured and adjusted.

Many of the machines used to prepare the seedbed have moving parts with bushings of various kinds to reduce the wear on shafts, journals, and axles. Adjust or replace worn bushings before other damage occurs. Wherever there are bushings, there is wear; however, proper adjustment, lubrication, and replacement reduce the
extent of wear on the journal or axle. Many of these bushings are "plain bearings" of the slow-speed type; therefore, they are easily lubricated and fairly easy to replace. The adjustments of collars to keep the bearings properly fitted is a common field-service job. When adjustments can no longer take up the wear and new bushing parts are necessary, it is essential to get the proper replacement through ordering the exact part by number. When the old part is being replaced with a new part, even though in the field, the bearing must be thoroughly cleaned and lubricated before the machine is used again.

**Lubricating Plows.** Farm machines operate in and through dust, mud, and soil; abrasive materials that speed up wear and destruction of those parts. This emphasizes the need for regular clean lubrication. Lubrication is one of the most neglected services to farm machinery; consequently, many implements—some costly—are rendered useless or are relegated to the scrap heap long before they have served their normal life. Nearly all land-breaking and
seedbed-preparation implements are lubricated by means of pressure fittings and grease cups. Screw down grease cups and service pressure fittings periodically to force needed grease into the bearings. This aids in excluding dirt. Clean grease fittings before new grease is forced into the bearings. Keep all grease containers clean and covered.

Inspect the bearings, wheels, rolling colters, disks, plow bails, and other moving parts subject to wear, keeping them snug to retain the lubricant and exclude dirt. Take up undue play in wheel or disk bearings by adjusting or replacing the cone or collar. Make certain that such adjustments do not bind the wheel or disk. For plows, check the depth of furrows and levelness of all furrows frequently, with proper knowledge of plow behavior and the machine’s instruction book or owner’s manual. The proper adjustment, whether of lever, hitch, wheel setting, or accessories, can be made. A measuring stick is a desirable item in the toolbox.

Protecting Polished Surfaces. Plow bottoms, colters, jointers, and polished parts of other machines such as middlebreakers, cultivators, and disks, are readily attacked by rust and other corrosive agents. Corrosion impairs the efficiency of the seedbed-preparation machine, bringing about poor scouring, increased draft, and a resultant unsatisfactory job. Avoid this corrosion of all polished surfaces by lifting them out of the soil when they are not in use and removing all dirt. Cover polished surfaces with oil or grease to prevent moisture from coming in contact with them when it is necessary to leave machines in the field overnight or when work is interfered with by rain or for other reasons. Protection of polished surfaces is covered more completely in Chap. 3.

Correcting Scouring Troubles. Keeping all polished parts of a plow from corrosion is a “must” if nonscouring difficulties are to be avoided. When polished parts do not scour, there is a definite cause which, in most cases, could have been prevented through proper care, operation, selection, or adjustment of the plow and its accessories. There are many causes for plows not scouring and a few of these with corrective measures are:

1. Rust. Remove rust from moldboard with a soft, wet brick frequently dipped in water, but be careful not to scratch the moldboard. Kerosene-soaked rags and other rust-removing agents are sometimes satisfactory. After removing the rust, use the plow in a sandy-type scouring soil, when
available, until a full land polish is secured. Apply rust preventive to moldboard when not in use after securing land polish.

2. Varnish, Paint, and other Rust Preventive Agents. Remove with varnish remover or a mild solution of lye and water. If using lye solution, it must be washed off very soon unless plowing starts immediately. Use plow in a scouring soil for at least a short time after removing the moldboard coating.

3. Shape. Select a moldboard of the shape suited to the soil and soil condition. Seek advice of plow specialists.

4. Metal. Select a metal suited to the soil and soil condition. Seek advice of plow specialists.

5. Uneven Surface. These high and low spots can be noted by running fingers lightly but rapidly over entire surface of the moldboard and in both directions. If plow has a "land polish," the low spots appear dull. A new moldboard is the only remedy when either high or low spots cause nonscouring.

6. Suction. Correct landside and bottom suction to that recommended by the manufacturer. See page 83, on "Checking Bottom Suction and Land Suction.

7. Clearance. Set landside and heel clearance of high-lift plows as recommended by manufacturer (see pages 94 and 95).

8. Joints. Fit share until it makes a smooth and even joint with the moldboard. Select proper share for the plow and tighten snugly all bolts. This may necessitate tapping them lightly, using a wood block and lead hammer.

9. Level. Adjust for levelness as recommended by manufacturer (see page 90).

10. Side Draft. Adjust angle of furrow wheels and hitch team to overcome pronounced side draft.

11. Polish. A bright-appearing moldboard does not always indicate a land polish. Use plow in a drier and sandier soil until a land polish is secured. Increasing the operating speed will often start a plow scouring and in time a land polish will be secured. Reduce furrow depth and width if necessary to acquire needed speed.

12. Adjustments. First check the previous 11 points in an effort to remove nonscouring troubles. Then, if necessary, resort to a temporary adjustment until the real trouble can be removed or there is a favorable soil condition. Keep in mind that any adjustment that increases soil pressure on the moldboard is a rule that usually aids in promoting scouring, although the reverse is sometimes true. Try only one adjustment at a time and, if it does not give relief, return the plow to the original set and...
then try another adjustment. Try the temporary adjustments in the order given:

a. Set colter slightly more “to land.”
b. Plow a little deeper.
c. Plow a little wider—on single-bottom plows.
d. Plow a little narrower—on single-bottom plows.
e. Increase plowing speed.
f. “Wing down” plow slightly more—on wheeled plow.
g. “Wing up” plow slightly more—on wheeled plow.
h. Increase landside clearance—on high-lift plows.
i. Decrease landside clearance—on high-lift plows.
j. Set colter less “to land.”
k. Remove colter.
l. Increase heel clearance—on high-lift plows.
m. Decrease heel clearance—on high-lift plows.
n. Set weedhook higher.
o. Set weedhook lower.

SUMMARY

1. A walking plow in proper condition and adjustment will turn a smooth furrow slice and require very little guiding.

2. The land suction and bottom suction of a share have a decided influence in holding a plow steadily to its depth and width of cut.

3. The wing bearing of a 12-in. walking plow is $\frac{3}{4}$ in., and under average conditions about $\frac{1}{2}$ in. is correct for a 16-in. bottom.

4. The use of horizontal and vertical hitches on a plow to overcome undesirable land suction, bottom suction, or wing bearing is an evidence of poor plowmanship.

5. Riding plows have some bottom and land suction built into them; however, varying the rear of the plow bottom up or down through levers regulates suction.

6. Adjust a sulky plow for levelness by placing it on a level floor. Put a block under the land wheel of a height equal to the plowing depth. Adjust rear furrow wheel so that the heel of the landside just clears the floor with the share point touching the floor.

7. A hitch that is too high increases the weight on the front furrow wheel causing the plow to weave, and a hitch that is too low places undue weight on rear furrow wheel.

8. When using both a jointer and colter, set the colter hub $\frac{3}{4}$ to $\frac{1}{2}$ in. back of the plow joint and just deep enough to cut the trash or roots.

9. Set the colter $\frac{1}{2}$ to $\frac{3}{4}$ in. to the land. When used alone, the hub
is set 3 in. to 4 in. back of the plow point. Set rolling colters to cut one-half of its radius or less.

10. Set the rear furrow wheel to run straight in the furrow corner, lifting the heel of the landside about \( \frac{1}{2} \) in. and holding it the same distance from the furrow wall.

11. To hold draft to a minimum, the center of the plow load needs to be in line with the center of the tractor drawbar.

12. Set tractor wheels "in" for plowing, as this makes for economy of work and longer life for equipment.

13. If side draft affects steering of tractor, have the hitch changed to put most of the side draft in the plow.

14. As a safety feature, the spring-release hitch is adjusted at a tension to trip without endangering the implement or operator.

15. When listing in loose soil and the implement side slips, a sub-soiler set deep enough to penetrate firm soil will overcome this difficulty.

16. Keep all disks sharp, clean, polished, and operating at the same depth.

17. Set disk scrapers to work lightly against the disk near the center but about \( \frac{1}{2} \) in. from the blade at the disk edge.

18. Disk harrows with disks of small circumference penetrate the soil more readily than larger disks, but the draft may be greater.

19. Disk harrows make the best penetration when the angle of the gangs is set at 20 to 21 degrees.

20. The field cultivator equipped with duckfoot shovels leaves a cloddy, rough surface that is receptive to moisture and ideal for summer fallow in many areas.

21. The skilled workman keeps his equipment clean, protected from the weather, with cutting edges sharp and properly adjusted, and all moving parts lubricated as recommended by the manufacturer.
3. Reconditioning and Storing

Seedbed-preparation

Machines

We look forward to the day when every person using any mechanical device will be mechanically minded enough to check the machine periodically, make the provided adjustments, lubricate the machine, and be able to detect any unusual performance or noise. When that time is reached, machines will operate more efficiently and run longer, and the operator will be in better condition to handle a machine.

Many machines are prepared for a more satisfactory inspection and reconditioning that follows by a thorough washing, with water under pressure, if available. An elevated stand or wash rack is helpful when washing a farm machine. Some dirt can be removed by tapping with a mallet. Use a wire brush to loosen and remove dirt except on polished surfaces, and a wooden paddle to remove corroded material. Use a safe solvent for loose grease. Such a cleaning also prepares a machine for painting. If lye water is used to remove grease and corroded material, rinse it off completely without delay. Protect the operator, livestock, and poultry from contact with the lye water. Dry the machine immediately after washing and rinsing to prevent corrosion of the metal by rust, and any damage by water to the other materials of which the machine is constructed.

Farm machines are constructed primarily of metal—iron and steel alloys, aluminum, brass, bronze, and magnesium. Other materials include wood, plastics, canvas, rubber, and beltings of all types. Wood, canvas, and rubber all wear, and they lose their efficiency through weathering. The metal parts of a machine often operate in contact with each other. Whenever surfaces operate one over the other, wear takes place and in time the worn parts have to be replaced.
This condition is normal, but wear is more pronounced in farm machines such as those used in seedbed preparation, which operate in and through large amounts of soil and dust having an abrasive action. The following activities are discussed in this chapter:

1. Reconditioning Walking Plows
2. Reconditioning Riding Plows, Listers, and Middlebreakers
3. Reconditioning Tractor Plows
4. Reconditioning Disk Plows and Harrow Plows
5. Reconditioning Secondary Seedbed-preparation Machines:
   - Disk Harrows
   - Peg-tooth Harrows
   - Spring-tooth Harrows
   - Field Cultivators
   - Rod Weeder
   - Rotary Plows
   - Rollers, Packers, and Levelers
6. Painting Farm Machines
7. Protecting and Storing Seedbed-preparation Machines

1. Reconditioning Walking Plows

**Inspection.** Clean thoroughly in order to be able to see all parts satisfactorily. Inspect the plow very carefully while the performance...
of the machine is fresh in the operator's mind. Inspection forms are available from most state agricultural extension departments and from many machinery dealers and manufacturers. The use of such forms simplifies inspection and helps to ensure a thorough job.

Every farmer should keep owners' manuals for all his machines in a convenient and accessible place. These can help him in making inspections and adjustments, and provide needed information for identifying replacement parts. The inspection determines in detail the parts, adjustments, and service required. Obtain new parts needed from the dealer on the next trip to town. The proper source for genuine new parts is the local implement dealer merchandising and servicing that particular make of machine. By this procedure, standard replacement parts are obtained from the factory.
The following advice, given in Farmers' Bulletin 1761, U.S. Department of Agriculture, may well be followed: "When ordering replacement parts, the make, model, size and number (if any) of the machine, as well as the description, parts' number, and the quantity desired, should be given as the parts on different sizes and models are not always interchangeable. It is a good practice to give the date when the machine was purchased new, as this will help to identify the model."

Make the annual post-season inspection on clean ground or floor, preferably with the machine under cover.

**Putting the Walking Plow in Working Condition.** In order to do a thorough job of reconditioning, the farm operator should follow a definite plan and procedure. By following the steps in the procedure suggested below, the operator can return any walking plow to service in satisfactory condition:

1. Remove shares, check them, sharpen, and set suction. (Some plow bolts have left-hand threads.)
2. Replace shares and the landside.
3. Recheck suction in landside and throat of plowshare after assembling.
4. Inspect for smooth joints between share, moldboard, and landside. Then tighten all bolts.
5. Tighten all other parts of the plow, replacing any parts that are lost or broken.
6. Inspect beam to see if sprung upward or sideways. If sprung, replace.
7. Sharpen jointer and colter, or roll the colter edge.
8. Clean colter bearing and adjust sleeves. Lubricate with fresh lubricant.
9. Adjust colter and jointer on the plow for a field job.
10. Inspect, repair, and adjust eveners, hitch, and handles.
11. Protect share, moldboard, jointer, and colter from corrosion.
12. Paint all parts, except polished surfaces, of the plow, including eveners and handles.
Each step listed on the preceding page can be broken down further for farm mechanics’ instruction purposes.

2. Reconditioning Riding Plows, Listers, and Middlebreakers

Riding plows present different problems in inspection since the frame, bails, wheels, axles, adjusting levers, power lifts, and lubrication devices are items not found on the walking plow.

**Putting the Riding Plow in Working Condition.** The following steps in reconditioning riding plows are generally applicable to all horse-drawn sulky, gang, or two-way moldboard plows:

1. Clean the plow, using the method described in the second paragraph of this chapter (see page 121).
2. Inspect the plow and plow members. Go over the machine systematically to determine the adjustments and repairs necessary and the new parts to be purchased. Make a record of this on a farm-machine inspection sheet or in a notebook (see Figs. 106 and 107).
3. Check bottom suction, land suction, and heel clearance. Note wear on share at underside of point and compare it with a new share. Do the same for land suction. Measure the heel clearance. It will vary from 1/4 to 1/2 in., on a correctly set three-wheeled plow, or approximately the thickness of the finger tips. Heel clearance is changed when the rear furrow-wheel support is bent. A two-wheeled plow has no heel clearance.
4. Look for bolts and other assembling items that are loose or missing.
5. Check the shares, moldboards, and landsides for wear.
6. Check the wheel bearings and axles for wear. Support the plow to...
remove weight from the wheels and then determine the amount of wear by rocking the wheels on their axles.

7. Check the colters and jointers for wear and sharpness.

8. Inspect the power lift and lifting springs for action and tension.

9. Check the control levers to see that they operate freely and that detents engage and disengage properly with the quadrant.

10. Remove the old shares. Clean the frogs. Attach new or reconditioned shares, holding down on points while tightening.

11. Check the frogs and beams. A bent frog, like a sprung beam, will throw the bottoms out of alinement. Examine the joint between the share and the moldboard. If it fits perfectly, any misalignment is probably due to sprung beams. If the share does not fit smoothly at the moldboard and is higher at the wing side than near the shin, it indicates a frog sprung downward. Replace sprung frogs.

Plow beams are seldom “sprung” or bent. If one is bent, the dealer can probably replace it. Modern factory methods of controlled beam tempering cannot be duplicated locally. Replace sprung beams.

Place the plow on a level floor and lower the bottoms to plowing position. Place a 6-in. block under the land wheel to substitute for that depth of plowing (Fig. 77). Adjust the depth and leveling levers until the plow bottoms rest evenly on the floor. Failure of the plow to rest on all of the base points indicates a sprung beam or frog. The vertical measurement from the point of the plow to the beam must be the same for all beams on multiple-bottom plows. Any variation indicates a sprung beam. If the measurements are different, the one with the larger measurement is sprung. The measurement between share points, share-heal points, and points of moldboard wings should be equal. If not, a sprung beam or frog is indicated.

Replace badly worn moldboards and landsides. Make sure that the bolt heads fit down closely and present a smooth surface.

Tighten all bolts and loose rivets. When bolt holes have become worn, ream them out and replace bolts with a size to fit. Tap heads of the bolts with a hammer as the nuts are tightened to bring them up snug. Recondition, lubricate, and adjust the wheel bearings. Disassemble the wheel bearings. Clean bearings and axle with a safe solvent. Where welding outfit is available, worn parts of axle may be built up and then dressed down to fit wheel bearings, or new parts may be ordered and installed. Coat bearing parts with grease, assemble, lubricate, and adjust to turn freely. Avoid looseness.
If the rear furrow wheel cannot be adjusted to give the correct base landside heel clearance of \( \frac{3}{4} \) to \( \frac{3}{4} \) in. and a lead of about \( \frac{3}{4} \) in. on the front edge of the wheel for land clearance, it is out of alignment.

**Sharpen Shares.** A cast-iron share in which the suction has not been destroyed can be sharpened by grinding on the top side. Cast-iron shares are identified by their rough appearance and raised pattern numbers. Sharpen dull crucible-steel shares by grinding or forging.

![Image](image.jpg)

**Fig. 111.** Replace badly worn plow-bottom members. Be sure all members fit closely, leaving an over-all smooth surface.

When badly worn, the point can be rebuilt by welding. Steel shares have the numbers stamped in. Sharpen soft-center steel shares by forging. Sharp plow bottoms are so essential to good plowing that reconditioning of soft-center steel shares should be done by a competent mechanic. These shares are identified by three layers that show on the moldboard edge.

**Sharpen the Disk Colter and Jointer.** To recondition, lubricate, and adjust the colter bearings, proceed thus: Disassemble colter; clean colter bearings with a safe solvent; tighten rivets in colter hub; sharpen colter by grinding lightly and equally on both sides of the cutting edge or roll the edge; assemble and lubricate colter bearings, using new parts where needed; adjust bearing to turn freely but
without play or "wobble"; and set jointer to cut 1 1/4 to 2 in. deep with the point 1/8 in. from the colter disk and with about 1/8-in. opening at the top.

Recondition the Power Lift. Disassemble power-lift clutch and clean with a safe solvent. Replace badly worn or broken parts. Lubricate with a light oil and reassemble. Adjust the tension in the lifting springs. Set the plow for average plowing depth and tighten the

![Diagram of a plow with labeled parts: Rear wheel adjusting mechanism, Axle stem, Wheel bearing, Colter bearing, Power lift bearing, Power lift spring, Collar bearing, Front wheel bearings, both sides, Power lift keep filled to proper level.]

springs until there is a slight tension on them while the plow is in a raised position.

Inspect and Adjust the Control Levers. Straighten bent levers and adjust until they operate freely. If detents do not disengage easily from quadrants when hand latch is closed, shorten the rod connecting the hand latch and detent plunger.

Lubricate the Plow. Clean pressure fittings and force in the recommended lubricant until it oozes from end of bearings. Do this each time the bearings are lubricated to push out the old lubricant and accumulated dirt. Clean all oil holes, and lubricate with the proper grade and quality of machine oil.

The procedure just outlined also applies to the reconditioning of listers and middle breakers.
3. Reconditioning Tractor Plows

This discussion is divided between (1) the trail-behind plows and (2) direct-connected plows. Additional parts of trail-behind plows requiring service over horse-drawn wheel plows are (1) the spring-release hitch, (2) the rope-trip mechanism for lifting plows out of the ground, and (3) the connecting rod between front and rear furrow wheels in three-wheel plows. Inspect the spring-release hitch, cleaning and checking to see that none of the members are bent or otherwise damaged. With all these members in good condition, lubricate the catch sparingly. When this has been done, adjust the spring to desired tension for the soil. The rope trip is merely linkage operating the power lift. Inspect and clean the lift; then, put in proper condition and repack with clean lubricant. The adjustment and operation of the rear furrow-wheel connecting rod was discussed in Chap. 2.

The members of direct-connected plows are few and adjustments and service requirements are minor, other than the maintenance of the power controls. The power controls will be discussed with the tractors (Part V) inasmuch as they are constructed as an integral unit with the tractor.

4. Reconditioning Disk Plows and Harrow Plows

The general procedure outlined for reconditioning the moldboard plow is recommended for the disk plow and all other seedbed-preparation machines.

Inspecting. After having thoroughly cleaned the machine, use a systematic procedure for checking each part. Then make a record, on a farm-machine inspection sheet, of all requirements for restoring the machine to satisfactory service. This would include such things as replacement parts, repairs, adjustments, and such servicing jobs as sharpening. Among the things to check when making the inspection are bearings for looseness, disks for sharpness, scrapers for adjustment, lift springs for tension, frame and other parts for distortion, and the set of the wheels. When making the inspection, apply penetrating oil or other effective penetrating agents to nuts which are to be removed when reconditioning. Now place the order for needed replacement parts and outline a reconditioning plan.
Putting the Disk Plow in Working Condition. Mark each major part as removed in order to facilitate reassembly; keep all small, loose parts in a container if they cannot be safely attached to the major part. As these parts are removed, clean them carefully in a safe solvent so they may be checked for reconditioning needs such as replacement parts, repairs, and adjustments. Determine the causes of breaks and undue wear as a guide to safeguard the operator in preventing a recurrence of the trouble. Necessary replacement parts should be added to the inspection sheet for ordering. The following is procedure for reconditioning the disk plow:

1. Straighten bent parts of frame and weight boxes either on the machine, by use of a hammer with a sledge or other heavy metal object on the opposite side, or removed from the machine, for straightening on an anvil face. Some parts can be straightened in a vise. When possible, straighten these parts cold. Replace any broken or lost items with new or satisfactory used parts. If more economical, some broken parts can be either brazed or welded, but an angle iron brazed across the break on
one or opposite sides further ensures the strength of such a repair. Hold broken parts securely in position when brazing.

2. Inspect all bearings for looseness, replacing those which are worn too much for adjustment. If the bearings are worn sufficiently to have permitted damage to the bearing caps or shell, replace. Bearing journals worn beyond adjustment must either be replaced or built up and dressed down smooth to the original size. The disk bearing of the roller type has an adjustment inside the rear cap. Keep these bearings snug, but not tight enough to bind. When the adjustment is used up, replace bushings. Check all lubrication fittings and replace any damaged parts. Make sure that all of these fittings are snug and do not lose lubricant. When bushings or bearings are replaced, make sure that they do not close off the lubricant entrance.

3. Sharpen disk blades that are dull. The draft of a disk plow with sharp blades is much less than that of a plow with dull blades. There are several methods in use for restoring the cutting edges to disk blades. Since manufacturers of heat-treated steels are using high carbon in the composition with a resultant greater ruggedness in the disk blades, it is not advisable to generalize here on sharpening recommendations. Always follow the manufacturer’s instructions and the owner’s manual.

The following methods are in common use:

a. Grinding the vertical edge is the recommended practice for sharpening disks. Such a method of grinding the inside or vertical edge is simple and is gaining in favor among disk operators, as it gives a straight downcut that increases penetration. Grind the disks to restore the original true round or cutaway shape, regardless of the sharpening method used.

b. Grinding the rear edge is a method that has been in use longer but now seems to be losing favor. It results in a thinner edge that may, when used in stony or brushy soils, tend to chip and bend at the edges. Since the result of this method lacks the fullness of the vertical-ground edge, it is doubtful that it will remain sharp as long under most conditions.

c. Turning edges. Some machinery service shops are equipped to remove metal from the disk edge by scraping or turning it off, thus restoring the cutting edge. This is usually done on the convex side of the blade.

d. Rolling edges. Some machinery service shops are equipped for rolling the edges of disk blades. This method was satisfactory for the older disk blades having lower carbon in the steel, but it is not satisfactory on heat-treated, high-carbon steels. A few machinery
service shop operators using rolling equipment have resorted to heating the disk blades so that the edges will roll out easier. This is fatal to a heat-treated disk blade, for the hardness will be drawn out and cannot be restored in a local shop. Only the manufacturers have the equipment and the necessary information to do this heat-treating job in a satisfactory manner.

4. Adjust the lift springs so it is easy to operate the depth levers. The proper tension will balance the plow when being raised and will prevent the wheel from slipping. Replace any weak or broken springs. Straighten, without heating, any bent parts of the lever assembly, including the quadrant, plunger rod, and lever handle. Adjust the plunger rod to release the plunger from the detent in the quadrant when closing the hand latch. Frequently the plunger rod has to be shortened by the formation of a new eye. Oil the plunger to improve its action. If plunger spring is weak, broken, or lost, replace it.

5. Adjust the wheels to overcome any difficulty encountered when turning, cantering, or following the furrow. This may necessitate a careful check on the hitch, hitch bar, or levers. Straighten, if any, of the parts that are bent and then adjust. Check the wheel bearings and vertical shafts. Recondition the bearings as stated under 2 above and straighten any distorted shafts. Recondition the power lift by following the instructions provided in the owner's manual for the specific plow.

6. Straighten bent parts of coulters and repair or replace those that are broken.
or otherwise damaged. When making new eveners, use the old evener as a model. Adjust any control rods or devices in connection with the hitch that affect the proper function of the plow.

7. Reassemble all reconditioned and replaced parts in the order indicated in the owner's manual provided with the machine. Assemble the parts, as a rule, in the reverse order of removal. Marking the parts as removed will facilitate the assembling job and the replacing of each part to its original position. Adjust and set control levers and other adjusting devices with the machine in the usual working position.

8. Recheck bolts, nuts, setscrews, and other locking devices to make sure that they are set firmly and are of the correct size. See, too, that all cotter keys are in place, fully opened, and pressed smooth around the shaft. Check the stub-beam clamps for snuggest. Replace any lost locking parts and those that cannot be repaired economically. Worn bolt holes must be reamed out and fitted with a bolt of the exact size. Reset all loose rivets and replace those that cannot be swelled to fit the hole.


10. Lubricate all moving parts with the recommended lubricant. Clean all fittings and force the lubricant into the bearings until it oozes from the end of the bearing. For places lubricated with oil, clean the oil pipes and other parts of the assembly, and then fill the oil reservoir with the recommended oil. Lubricate all bearings upon completion of the reconditioning of the machine and before painting. Before placing the machine in service, clean bearings and renew the lubricant again.
Keep lubricants in tight and clean containers at all times and always wipe off fittings when applying or adding lubricants.

11. Test and recheck all repairs and adjustments on the job, making any corrections and changes found necessary. Particularly, check all locking devices.

**Reconditioning Harrow Plows.** The instructions for disk plows apply here. Many of the parts are smaller proportionally, yet they require the same thorough inspection and diagnosing of damage, breakage, and undue wear. Recondition all parts of each machine during the idle season.

5. **Reconditioning Secondary Seedbed-preparation Machines**

**Reconditioning the Disk Harrow.** The same thorough inspection and diagnosing is required to locate the cause of damage, breakage, or undue wear as for the disk plow. Recondition all parts of the machine before it is needed for use in the field. The following is a fairly complete procedure for reconditioning a disk harrow for those items not covered sufficiently under the preceding machines.

Further, to facilitate the inspection, place the machine, after it is cleaned, on an even, dry, and tidy floor with the gangs set straight. In cold weather provide a warm room for the inspection and reconditioning. Use a systematic procedure when inspecting the machine to avoid missing any part in need of attention and make a record of all parts requiring reconditioning to put the machine in efficient working
RECONDITIONING AND STORING SEEDBED-PREPARATION MACHINES

FIG. 117A. Farmer delivering a disk harrow in doubtful condition to a vocational agriculture shop. The owner will recondition this machine in the evening adult classes.

FIG. 117B. The same disk harrow after reconditioning.

condition. This inspection will include the bearings, lubrication system, disks, scrapers, gang bolts, spools, frame, bumpers, bearing standards, angling mechanism, tongue truck, transport trucks, hitch, weight boxes, and all fasteners.
1. Number and remove bearing caps, lubrication fittings, bearings, disks, and gang-bolt assembly. Clean bearings and other removed parts with a safe solvent. Install new bearings as needed, but be sure they do not cover lubricant opening in shell. It is often impossible to keep foreign material out of the bearings of disk harrows. Bushings are either wood or chilled iron. The wood bearings have been hardened by treatment in hot oil. They wear well, are easy to replace, and are not costly. Replace the bearings before damage is done to the journal or to the bearing assembly that holds the bushings. Also replace the bearing assembly if it has become worn as a result of delay in replacing the bushings. The savings of a timely repair here are evident. Some tractor-operated and a few horse-drawn disk harrows have chilled-iron bearings that must be adjusted as needed and replaced before the housing of the bearing is damaged. More durable bearings are made of hard white iron with double-thrust flanges. These flanges carry the weight of the disk and reduce side play.

2. Number the disks and spools as removed to assure the proper order of reassembly. Clean rust and corroded material from the meeting surfaces of disks, spools, and bumpers to permit a snug fit when reassembled. Straighten the gang bolt and other parts, if bent. This can be done cold, in most cases, on an anvil face or in a vise.

3. Straighten levers and other parts of the angling mechanism that may be bent and that control the angle of the harrow. This is necessary to assure ready

Fig. 118. A farmer replaces a disk-harrow bearing during the idle season.
angling and proper cutting of ridges. Adjust rear gangs so they trail uniformly and correctly. Then adjust the leveling device or mounding blocks to assure an even penetration over entire harrow width.

4. Repair, replace, or make new parts as needed for the tongue, eveners, and neckyoke. Straighten, tighten, and repair the hitch if worn, broken, or loose. Replace or repair all worn, loose, damaged, or bent parts of the tongue trucks and transport trucks.

![Replacing a broken disk with a new one.](image)

**Fig. 119.** Replacing a broken disk with a new one. Observe that the disks in the foreground have had the recommended vertical edges ground.

**Reconditioning the Peg-tooth Harrow.** Though simple in construction and containing no moving parts, this machine is nevertheless subject to wear, breakage, and other damage. It is probably second to the disk harrow in lack of service received. It requires timely care and attention if it is to give the life and service for which it was designed.

Here is a rather complete procedure for reconditioning a peg-tooth harrow including items not covered sufficiently under the preceding machines:

1. Remove dull, damaged, and short teeth and loosen those in need of adjustment. Discard teeth that are too short for an even depth adjustment. Sharpen
the teeth to maintain their original angle. Have the points sharp for efficient weed control and effective penetration. Most harrow teeth are diamond-shaped in cross section. Avoid overheating when grinding the teeth. Overheating can be noted by a color change and may destroy the temper. As the teeth are ground, place them in a water or oil bath to assure no further loss of temper or hardness. Sometimes the teeth need only be turned in order to provide a sharp edge.

2. **Straighten bent tooth bars** by hammering them out cold or placing them in a vice, and bending to the original shape. Replace broken tooth bars if not advisable to braze or weld. Do likewise with any frame parts that are bent or broken. Nearly all harrow-tooth bars and frame parts are made of metal and are of various shapes such as round, flat, channel, and U-shaped.

3. **Straighten levers, plunger rods, handles, ratchets or detents, and quadrants of the angling mechanism**, if bent. Replace or repair by brazing or welding any broken parts of lever assembly. Shorten or lengthen the plunger rod, if necessary, in order to assure that the plunger seats properly and raises clear of the detents in the quadrant. Oil the plunger and replace plunger spring if weak, lost or broken.

4. **Reassemble all frame parts, tooth bars, and angling mechanisms** in their original position. This necessitates having marked these parts as they were removed. Place the teeth in the clamps, but leave them loose enough for adjustment of length if they are of the adjustable type. Place the harrow on a level floor with the angling lever set to hold the teeth in a perpendicular position. Now block up all corners of the harrow sections to an even height of approximately 4½ in. below the tooth bars. Adjust all corner or runner teeth to this depth and firmly bolt in position. Space all teeth evenly for those types of harrows that have no fixed position for the teeth. For those types of harrows that do have fixed location of teeth, this is no problem. With each tooth in proper position, adjust them to the depth of the corner runner teeth and firmly bolt in place.

**Reconditioning the Spring-tooth Harrow.** This machine is not so simple in construction as the peg-tooth harrow. Neither is it used so extensively on most farms. Some farmers have several kinds of points for their spring-tooth harrows and these are often reversible. This may delay the need for sharpening when reconditioning.

After cleaning the machine, place it in working position on an even floor. Systematically determine the replacements to purchase, adjustments to be made, and general repairs to recondition the harrow. Proceed to do this by raising the teeth and observing their
condition and adjustment. Follow the operator's instruction book for removing, reconditioning, and adjusting all members.

There follows a fairly complete procedure on reconditioning a spring-tooth harrow for those items not covered sufficiently under preceding machines.

1. Remove all dull teeth for sharpening, reversing, or replacement. Stubborn nuts not loosened by the use of penetrating oil may have to be heated with a blowtorch, hammered from opposite sides, or split with a cold chisel. This requires a heavy metal object back of the nut such as a sledge hammer. Always use a wrench with sufficient leverage and one that fits the nut snugly. Sharpen the dull teeth by grinding on the underside or forging and grinding the badly worn teeth to the original angle, which is about 45 degrees. Avoid overheating when grinding. Some new points are available that can be either bolted or clamped on, but when a cutting torch is available, many farmers cut new points from discarded auto-spring leaves. These points are then welded to the old tooth ends, forged, and ground to the proper shape and sharpness. Replace all sprung teeth.

2. Straighten bent levers, quadrants, plunger rods, and other damaged parts of the lever assembly. Replace or braze any broken parts.

Reconditioning the Field Cultivator. The inspection and reconditioning of this machine is quite similar to that of the spring-
Tooth harrow and particularly the teeth and levers. The wheels and wheel bearings demand the same service for reconditioning as that provided for similar bearings on other machines.

Reconditioning the Rod Weeder. Proceed with the inspection and reconditioning as has been discussed in connection with harrows in this chapter. Check the points for distortion and sharpness and inspect the rod-drive mechanism, clutch, chain, and other parts for wear, breakage, and other damage. Replace, recondition, and adjust all items as found necessary by a systematic inspection.

Reconditioning Rotary Plows. Inspect the teeth and spiral blades frequently to be sure they are sharp and in satisfactory condition. If badly worn or damaged beyond repair, they must be replaced, because the efficiency of the machine is dependent on the ability of every tooth to dig out its share of soil.

Reconditioning Rollers, Packers, and Levelers. Follow the same systematic inspection, ordering of replacement parts, and reconditioning as discussed relative to harrows in this chapter. These machines require less attention than many machines and for that reason are often unnecessarily neglected. Keep all bearings adjusted, moving parts clean and lubricated, loose parts tightened,
lost and broken parts replaced, and any cutting parts, as found on some levelers, sharp.

6. Painting Farm Machines

One of the greatest needs for rust-inhibitive paint on metal is in the protection of farm machinery. Such paint is to be applied to the cleaned metal, except polished surfaces. In addition to its anti-corrosive qualities, it provides the proper base for second coats and decorative paints. Machinery so protected on the metal and wood members has its life prolonged materially, is attractive, invites regular maintenance, and has better resale or trade-in value. Establish a farm-machinery paint program regardless of whether the machines are stored inside or outside. Coat polished surfaces with a good rust-preventive (see Figs. 211, 212, and 213). The following analysis will be helpful in painting all farm machines, both wood and metal.

<table>
<thead>
<tr>
<th>STEPS</th>
<th>KEY POINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Assemble equipment and supplies.</td>
<td>Wire brush, Whisk broom, Steel wool, Scraper, Sandpaper, Soft brick, Lye, Paintbrushes, Putty knife, Paint buckets, Paddles, Rags, Mixing pail with Solvent, tight lid</td>
</tr>
<tr>
<td>2. Make necessary repairs.</td>
<td>Place the machinery on blocks, sawhorses, or jacks in a well-lighted, dry, warm place. The various parts should be readily accessible. Replace all broken castings and parts and tighten loose bolts, nuts, and screws. Repair or replace all broken wooden parts.</td>
</tr>
<tr>
<td>3. Prepare surfaces.</td>
<td>Remove all the rust possible by wire brushing, sanding, scraping, or rubbing with a soft brick and water. Wash off all grease with rags soaked in a safe solvent. Old caked grease and some paints may require use of lye water. Caution: Do not use gasoline. Lye water must be thoroughly rinsed off if used. Scrape loose paint from the tongue and other woodwork. Complete preparation of surface just before painting so that rust will not accumulate again before the metal is primed.</td>
</tr>
<tr>
<td>4. Secure and mix the primer.</td>
<td>To make red lead primer or first coat used to inhibit formation of rust and to provide a foundation for finish coats, proceed as follows: To make one quart of this primer, purchase from a paint store 5 lb. of dry red lead, a small can of liquid drier, and about one quart each of gum turpentine and raw linseed oil.</td>
</tr>
</tbody>
</table>

end
1. Apply cobalt blue.
2. Apply red lead primer of brushing consistency.
3. Strain the priming paint through a fine screen. With a long-handled brush, apply the paint thoroughly. Work the paint into all joints and crevices and around bolts and nuts. Apply to the large flat surfaces and wheel last. Rub the primer paint into the old painted rust spots especially well. Deep rust spots should have two coats of metal primer.
4. Cover the wood parts of the machinery with the same red lead primer used for metal, since it will seal the wood against water and provide a very good foundation for finish coats of paint to be applied later.
5. For a finish coat, the metal primer can be tinted to dark green, maroon, or black but cannot be tinted to any light color.
6. Exterior floor paint, house paint, or truck and tractor enamel in various colors can also be used for the finish coat on both the wood and metal parts.
7. Avoid using the newly painted machinery for several days, until the paint applied has dried to a hard finish.

7. Protecting and Storing Seedbed-preparation Machines

Protecting Seedbed-preparation Machines during the Work Season. Rust is the most common cause of scoring troubles. Fortunately, it is easy to prevent. Many farmers keep a can of used motor oil in the field and, with a swab or old brush, oil the plow bottom at night when the job is finished. This affords necessary rust protection for a short period of time. Give this same protection to the lead-polished surfaces of other seedbed-preparation machines such as colter blades, jointers, lister bottoms, middle cutter bottoms, harrow disk blades, field-cultivator shovels, and sub-soilers.

If satisfactory storage space is close at hand, it is more economical and desirable to place farm machines under cover each night or after each job is finished during the work season. The delay of field work due to inclement weather, other urgent work, and unforeseen delays
may keep an idle machine in the field longer than anticipated. Prevent damage to machines from weathering by taking advantage of satisfactory coverings or housing during the work season. The wear caused by pulling or hauling the implement to and from storage is far less than that experienced through weathering in the field for a long time between work periods.

Wooden tongues or poles have a tendency to sway downward in the middle. This is especially true if they are exposed to moisture or weather. Overcome this by holding up the tongue with the neckyoke or other suitable object. A straight tongue is less likely to drop off the neckyoke while in use than one badly swayed. A straight tongue is necessary to secure proper hitch and levelness of machines not having tongue trucks.

**Protecting Seedbed-preparation Machines during the Idle Season.** The useful life and service of many farm machines is shortened through the lack of proper protection and safe storage. Most machines are used only a few weeks each season, so their total period of annual service is rather short. However, the chief enemies of machines—decay, rust, and corrosion—are active the year around.
FIG. 123. Store the tongue and other wood members so that they will not warp.

FIG. 124. Machines that are left exposed to the weather deteriorate rapidly.
A small amount of time, effort, and expense, given to the protection of farm implements against destructive moisture and barnyard acids, will return dividends in the form of improved performance, longer service, higher resale and trade-in value, ease of operation, and lower operating costs.

Give adequate protection to farm implements during the idle season as well as during the work period by protecting the surfaces and by providing suitable weatherproof shelter. Protecting and storing farm machines include preparing them for storage at the close of their work season and again when they are taken out of storage and made ready for service. In Chap. 2, information was given on starting a machine in the field, whether a new one or one that had been used before.

**SUMMARY**

1. Thoroughly wash, using water under pressure; clean and dry machine before reconditioning, painting, or storing.
2. Keep the owner's manual for each machine in a convenient, accessible, and protected place.
3. Inspect and adjust machines during the idle season and well in advance of the work season; take note of needed replacement parts.
4. When ordering replacement parts, provide information as to make, model, size, and number of the machine, as well as description and number of each part.
5. Follow a definite procedure in removing parts when reconditioning a machine and mark the parts to facilitate reassembly.

![Image](image_url1)

**Fig. 126.** The good owner protects all hand-polished surfaces with a rust preventive when the machine is not in use.

6. Replace sprung beams and frogs.

7. Place wheel-type plows on a level floor when making adjustments of the bottoms.
8. After reconditioning a machine and again when placing in service, clean all pressure fittings and force in the proper lubricant until it oozes from end of bearings.

9. Grinding the vertical edge is the recommended practice for sharpening most disks.

10. Follow a systematic plan for painting farm machines, applying a rust-inhibitive paint to all metal parts, except polished surfaces which are to be covered with a rust preventive.

11. Gasoline and other highly inflammable products endanger life and property when used for cleaning machines and machine parts; therefore, use such solvents as naphtha and those recommended by the service dealer.

12. When storage space is limited, remove wooden members, polished parts, and mechanical items; store in a dry, protected place after covering metal parts with a rust preventive.

13. Shield the cutting and pointed edges of machines when stored under cover or in the open, and store wooden members in a manner to prevent warping.

14. Even though a machine was cleaned, reconditioned, and lubricated when placed in storage it needs to be cleaned again and thoroughly lubricated when removed from storage and restored to service.

Fig. 128. Preparing a disk for safe storage. Note two types of guards to protect people, as well as animals, from injury.
PART II
CROP-PLANTING MACHINES
4. Selecting Crop-planting Machines

Fig. 129. After preparing a good seedbed, the next important step in assuring a maximum yield is the skillful planting of good seed with efficient equipment.

In Part I, the soil was referred to as the farmer's "working capital," and the importance of using it in the wisest manner possible was emphasized. After preparing a seedbed to support the crop production desired, it is essential that high-quality graded seed be properly placed or planted so as to utilize efficiently the well-prepared seedbed. Always practice sound soil-conservation methods.

To the household of the plant—"kitchen," "dining room," and
“storehouse”—now has been added the “bedroom,” where the seeds or plants are nursed and fed in order that they can spread their roots to obtain the food from the “dining room” where nature is prepared to serve it. Of course, through the applications of humus and fertilizer, man assists in keeping the “pantry” well stocked.

Before man emerged from the forest in primeval days, he was not concerned with planting seeds or with other methods of propagating plants. His livelihood came from the fruits of the forest, which spread and multiplied without the purposeful assistance of mankind. Many plants still multiply or continue their existence in this same manner. Some plants are seeded or spread in the natural or wild state by means of wind, water, birds, and animals. The seeds of some plants have a sticky or bur-like covering that aids in their distribution, while others have a wing-like shape to help them in being carried by wind. Still other seeds have fruity coverings that are responsible for their distribution by animals, birds, and man.

To protect his existence when he emerged from the forest, man found it essential to plant certain crops in order to assure a constant food supply. This led to the slow but sure process of improving methods of planting to meet soil, climatic, and plant conditions. In this age of mechanization, great strides are being made in improving methods of seeding plants. Present research, directed toward precision planting of seed and seed stock, is developing this method to a high standard, with the result that farmers are obtaining greatly increased yields and productivity.

There are several operations or steps in planting most crops. Broadcasting the seed on top of the soil requires separate follow-up operations to assure maximum germination. The grain drill combines all of these operations into one machine. Larger seeds such as corn and cotton are planted with special machines, while still other devices are used to plant potatoes and bulbs and to reset plants.

The size of fields, terrain, soil type, and many other factors affect the size of machine used, which is also determined by the power available. For the large fields in the open plains area, large tractors are generally available. The medium-sized farms common to the Middle West and other areas have medium-sized and coordinated crop-planting machines. For the same crops, in fields that are still smaller or are irregular in shape, the use of the small tractor, animal power, or even hand power may be more suitable. Special power and
special machines are sometimes used; for example, rice is seeded in California from an airplane. Soil and climatic conditions often determine the design of the covering mechanism while the seeding mechanism remains the same for all soil variations. The selection of crop-planting machines will be discussed under these headings:

1. Selecting Broadcast Seeders
2. Selecting Grain Drills
3. Selecting Corn Planters
4. Selecting Cotton Planters
5. Selecting Beet-, Bean-, and Vegetable-seed Planters
6. Selecting Potato Planters
7. Selecting Plant-setting Machines

1. Selecting Broadcast Seeders

Grain-seeding machines that merely spread the seed over the ground surface are known as "broadcast seeders." Another operation may be necessary to cover most of the seed. This feature distinguishes them from such seeders as grain drills, which place the seed in furrows or rows and cover it with soil. There are certain crops, soil conditions, and terrain that favor broadcast seeding. Some of them are small fields; irregularly shaped, rocky, stumpy, trashy, and wet fields; or sloping land being returned to grass as a part of a soil-conservation program.

The small initial cost of most broadcast seeders, the rapidity of their sowing, and the small storage space they require are features in their favor. Windy weather and certain seed mixtures are not conducive to satisfactory broadcast seeding. Wind tends to disturb the even spread of seed and, in a mixture, the heavier seeds are thrown out farther than the lighter seeds. This often results in uneven stands and reduced yields. Other types of seeding machines, even with higher initial cost, insure yields generally sufficient to pay amply for the difference in cost.

Selecting Hand Broadcasters. Broadcasting seed with the hands can be done rather easily, although there is an art in doing the job efficiently. Use a suitable cloth sack with a shoulder strap and a ring 8 to 10 in. in diameter sewed into the sack opening. The ring permits the hand to enter the sack and withdraw the seed without interference.
A sack seeder with a shoulder strap and a tube having a regulating device to control the seed flow is desirable. Some knapsack seeders are available with a shoulder strap, a valve controlling the seed flow, and a rotary mechanical device for seed distribution. Select a seeder having a gear ratio high enough so the distributor wheel spreads the seeds over the desired swath, and one that can be cleaned easily at the end of each day's work.

Selecting Wheelbarrow Seeders. This type of seeder serves for small fields and conditions not suited to machines pulled by animals or tractors. These are available with round holes in the seedbox for such seeds as alfalfa and clover, or with elongated holes for bulky grass seeds such as bluegrass and orchardgrass. The hoppers in some models provide both kinds of holes. The hoppers for wheelbarrow seeders vary in length from 10 to 16 ft. and hold from 1½ to 2½ bu. The entire weight when empty varies from 50 to 100 lb. Such seeders
are equipped with an agitating rod, rope, or chain which oscillates over the seed openings. Power to operate the agitator is taken from the single wheel. Select a wheelbarrow seeder with the proper holes for the seeds being sown. The stroke or movement of the agitating device needs to be adjustable for changing the seeding rate.

Selecting Endgate Seeders. The endgate seeder provides a quick, inexpensive method of seeding oats. It can also be used for certain other grains and grasses. Although the grain drill is preferred and shows increased yields through more uniform distribution and seeding depth, the endgate seeder will dispose of some seeding jobs in short order. Endgate seeding necessitates a harrowing job to cover most of the seed, thus lengthening the complete operation. Estimated seeding rate without covering is 12 acres per hour. The width of distribution for spring-oats seed is from 36 to 46 ft.; wheat, 42 to 52 ft.; flax, 20 to 26 ft.; timothy, 20 to 24 ft.; and clover, 24 to 28 ft.

The endgate seeder fits into the back of the farm-type wagon box, replacing the endgate. The seeder has a small hopper, which is kept filled by a person shoveling grain into it from the wagon. Rotating distributors or star wheels, single or double, operated by a chain from a sprocket bolted to a rear wagon wheel, distribute the seed. These
seeder may be had with either a force feed or seedbox agitator, and supplementary grass-seed hopper. Essential features are a slip clutch for safety and bevel gearing having either straight or helical teeth for driving the distributors to reduce noise. Drives are available for wood or steel wagon wheels as well as for tractor trailers.

Selecting Wheeled Broadcast Seeders. These two-wheel seeders, most of which cover 11-ft. strips, are available in either wide track or narrow track. The latter is lighter in draft and does not “whip” the horses so much when pulled over rough, rocky, stumpy, or cornstalk ground. Seeding is influenced less by wind with the wide-track seeder because it is closer to the ground. The wide track has the wheels at the end of the seedbox; this permits the use of larger wheels. Wheel marks serve as guides for the operator to prevent overlapping or slipping. Furthermore, each wheel operates half the seeder. On the narrow track, one chain in the center operates the entire seeder.

In selecting a narrow-track seeder, obtain one with a marking device at each end of the seedbox. Select seeders having agitating devices over the holes similar to those on wheeled seeders. The seeders employ force feeds, of the type used with drills, which drop the seed from the seed cup into a spout having a deflector at the bottom, or a scattering spout to distribute the seed more evenly.

The hoe broadcast seeder is a wide-track broadcast seeder with a
"hoe attachment" to stir the soil and cover the seed. This attachment consists of hoes set 6 or 7 in. apart. These seeders are particularly suited to stony or stumpy ground because a spring trip permits each hoe or shovel to respond to obstructions by swinging backward to pass over them and then returning to its original working position. The seeder is constructed with fluted force feeds (see Selecting Grain Drills below) which handle seeds in size from flax to stock peas. The hoe seeder is available in three sizes: 12, 16, and 22 bar. A grass-seed attachment can be obtained for use with the hoe broadcast seeder.

2. Selecting Grain Drills

A grain drill is a machine for placing seed in the soil in rows evenly spaced. It was designed primarily for the seeding of small grain, but it is also used for the planting of many other crops including soybeans, peas, flax, and sorghums. Seeding with a drill differs from broadcast seeding in that it places the seed in the soil in rows at a predetermined depth and width while the broadcast seeder scatters the seeds on the surface. Drilled grain gets a better start, particularly under dry conditions, because the seed is planted in furrows deep enough to
Fig. 155. A composite grain drill for instruction purposes. The left half of the drill shows double-run feed, single-disk furrow openers, and two-hand lifts. The right half of the drill is equipped with fluted feed, double-disk openers, and power lifter.
contact moisture needed for germination and root development. Other advantages of drills over broadcast seeders are that (1) seed is distributed more evenly, (2) seed is covered more uniformly and at a controlled depth, (3) soil can be firmed about the seed, if desired, (4) less seed is required, and (5) mixtures of seeds can usually be sown more uniformly.

The principal parts of a grain drill are (1) a main frame and hitch, (2) combination transport and drive wheels, (3) a hopper with a seeding device adjustable for quantity and size of seed, (4) furrow openers for depositing the seed in the ground, and (5) a power-controlled lift, on some models. Its size is ordinarily designated by the number of furrow openers and width of spacing. For example, a "20-6" grain drill has 20 furrow openers seeding in 6-in. spaced rows. Drills are available with spacings 6, 7, 8, 10, 12, and 14 in. apart. Some special drills have 4- and 5-in. spacings. Drills are available in sizes varying from the five-row, one-horse size for seeding between cultivated row crops to combination units pulled by a tractor and covering a broad space of many feet. Grain drills are also tractor mounted.

The frame is the backbone of the grain drill and serves two purposes. It must be designed and constructed strong enough to support the grain hopper and mechanism while operating over field surfaces, and permit limited flexing so the drill will conform to uneven ground yet keep the feeds in accurate alignment. Select a drill with wheel axles mounted in self-alining, anti-friction bearings to prevent binding and to give long service with proper care.

The several kinds of drills are distinguished by the type of feed or kind of furrow opener used. Further identifying features are the
power, row spacing, number of furrow openers, and covering device. Usually the farmers in a particular locality are partial to a certain type of drill. Even so, it is helpful to know the main grain-drill types in use and the operating features and peculiarities of each. Styles not commonly used may be especially desirable for certain crops and soil conditions.

There are two major classifications of grain drills: plain drills and fertilizer drills. Plain grain drills are used for planting seed alone. Fertilizer grain drills are used for planting when both seed and fertilizer are deposited in a single operation. Fertilizer grain drills are really two drills in one, in that the seed grain and the fertilizer are carried in separate divisions of the hopper or in separate hoppers and have their separate feeding mechanisms. In some cases, the fertilizer is fed into the grain tubes with the seed and is deposited with it in the furrow. Some kinds of seed, especially peas, are harmed by direct contact with fertilizer. This necessitates the use of separate tubes and boots in order to deposit the fertilizer in the furrow at a safe distance from the seed. Both plain and fertilizer grain drills are further classified according to their method of feeding the seed grain as fluted-force feed and double-run feed.

Selecting the Type of Feed. Fluted force-feed drills are used commonly in territories where drills handle only small seeds such as wheat, oats, barley, rye, and flax. The fluted force feed consists of a series of cups, attached to the bottom of the hopper, and rotating fluted feed rolls that measure out the desired quantities of seed. The quantity of seed is varied by sliding the fluted feed rolls in or out of the cups. The more roll exposed to the seed, the greater the quantity planted. The fluted feed roll shaft turns in long bearings, one in each cup, so that the entire shaft is kept in accurate alignment. The shaft is driven by a chain or gear. Each cup has an adjustable discharge.
gate which may be set in three different positions for the planting of different sizes of seed.

The double-run feed drill is usually preferred in territories where soybeans, peas, beans, and, in some places, corn for silage are planted by the same drill as that used for small grains. The double-run feed consists of a series of divided feed cups, each of which has a shaft-driven, ribbed-center feed wheel and is attached to the bottom of the hopper. One side of the cup is for small seeds and the other is for large seeds. In seeding, it is always necessary to cover the sides of the cups not being used. Feed-quantity changes are obtained by shifting to any of the 10 gear ratios provided in the driving mechanism or by interchanging driving sprockets. Twenty speeds are thus available with regular equipment.

Selecting the Fertilizer Feed. The separate fertilizer compartment of the hopper or fertilizer grain drills differs radically from the seed grain-feeding mechanism. The fertilizer is fed through adjustable gate outlets, one for each furrow or row, in the forward side of the hopper and is forced through these openings by shaft-driven, star-shaped feed wheels, the speed of which is controlled by a lever on the outside of the hopper. See that the fertilizer feed is strong enough and adjustable to conditions under which fertilizer must be deposited.

Selecting the Type of Furrow Opener. Five distinct types of furrow openers, with variations in several of them, enable the operator
to select openers to meet all soil conditions. Each with its advantages and disadvantages is described here.

The single-disk openers are available with four different deliveries. The single-disk openers with open delivery have standard 13-in. single disks with closed boots, which provide a complete passageway for the seed to the bottom of the furrow, independent of the disk. They are preferred for sticky soils and heavy gumbo. The single-disk semi-deep furrow openers have 14-in. single disks and are regular for semi-deep furrow drills. They are also available for 7-, 8-, and 10-in. spacing.

![Fig. 139. Close-up of the star feed mechanism for fertilizer.](image)

These are used in areas where moisture is limited and deeper-than-ordinary seeding is desired.

The double-disk openers are available with two types of disks. Saw-blade double-disk openers are designed to place seed in the ground with the downward movement of the disks and provide uniform covering of seed at tractor speeds. They are very efficient in all types of cornstalk land, seeding at an even depth and giving little trouble from clogging. They are, in effect, rolling shoes. The curved-blade double-disk openers have seed delivery to the rear of the disk bearing. On this type of opener, one blade is 12 in. in diameter and the other is 13 in.

The hoe furrow openers are available with two types of release. The
pin-hoe furrow openers have a pin break that releases the hoe when in contact with an unyielding object, thus avoiding injury to the hoe. The spring-hoe furrow openers have a spring release that allows the hoe to pass an obstruction and come back automatically to its normal position. Shoe furrow openers are used where deep penetration is not required. They have high-carbon steel blades that scour effectively in sticky soils and do good work in other soils.

Furrow openers are available in straight rank or zigzag rank. Straight-rank furrow openers are all set in the same line, while zigzag furrow openers are staggered by means of long and short drawbars. Shoe furrow openers are an exception, being supplied in zigzag rank only. Select zigzag rank for seeding on trashy fields.

The deep-furrow drill, largely used in arid or semi-arid regions where
soil is likely to blow, has a large shovel disk or disks on the face or front of the seed tube for forcing out soil to form a furrow similar to a small lister row. This furrow, because of its depth, requires rows to be further apart than do the more common types of drills.

Selecting Covering Devices. Although the furrow openers help in covering seed, chains and press wheels are also used frequently. The press wheels may be attachments or they may be somewhat larger and carry the main drill weight, thus obviating the need of the end wheels common to most drills. The press wheels firm the soil about the seed driving out air pockets and aid in the prevention of wind erosion. The regular press drills firm the soil more than do attachment press wheels. Covering chains are most common in the more humid areas as they do not pack the soil. Packing the soil often promotes crust formation. The gang press wheels used in semi-arid sections in place of chains to cover the seed and firm the soil are available in two types: the single-wheel type, which is available for 7-, 8-, and 10-in. drills, and the double-wheel type, which is supplied for all drills (except semi-deep furrow) having an even number of furrow openers. Single beet-type press wheels are available as attachments for all single disks and hoe and shoe furrow openers. This type of press wheel packs the soil firmly over the seed to promote germination and serves to some extent as a depth gage in drilling beets, beans, and other crops planted in wide rows.

Selecting Special Drills. In order to handle some kinds of seed and meet seeding conditions peculiar to certain areas, various special
SELECTING CROP-PLANTING MACHINES

Fig. 142. Some of the seed-covering devices, each suited to certain soil and climate conditions. (A) Chain. (B) Press wheels for semi-arid sections. The buffer strip of grass on the contour is a soil-conservation measure. (C) Gang-press-wheel attachment for packing soil around the seeds.
drills are required. These special drills, which are modifications of the commonly used types, include press drills and plow-press drills designed for use in especially light soil and semi-arid areas. These are equipped with large press wheels that carry the weight of the drill and follow each opener to firm down the soil over the seed as it is deposited. Plow-press drills are used in areas where plowing and seeding are customarily accomplished in one operation. Semi-deep furrow drills are regularly supplied in 12-10 and 16-10 sizes with a special type of 14-in. single-disk opener for seeding in deep trenches. Chains or press wheels are used for covering the seed. Power-lift tractor grain drills which have two built-in power lifts and a tractor hitch are supplied as plain drills in 28-6, 24-7, 20-8, 16-7, and other sizes. The five-disk drill (one-horse wheat drill), is supplied only in districts where custom and topography make it desirable. Regular-type grain drills can be used for drilling rice; however, the metal should be rust resistant to withstand the moist conditions. Special grass-seed drills with 4-in. spacings provide a more uniform covering so desirable for small seeds. The narrow rows reduce the weed hazard that may result from wider rows, and more evenly cover all of the land with grass.

Selecting Seed Hoppers. These are either metal or wood, but the metal hopper holds considerably more grain. Select metal hoppers that are rust resistant. Wood hoppers may warp or split. Hoppers may be separate for grass, grain, and fertilizer or an integral part of the machine. An agitator, consisting of a rod inside the seedbox, with fingers over each seed outlet is desirable to pick up threads, string, and other objects when bearded grains and uncleaned seed are used. In well-constructed grain hoppers, all or most bolts, nuts, screws, and other locking devices are on the outside to prevent their getting into and damaging the feed devices in case they become loosened.

Levers are available for operation at the rear, end, or front of the hopper. Select the rear location if levers are operated from the seat or footboard. Select the end position if the operator stands, walks, or sits at the end of the drill, as is common in hilly areas. The front location is convenient for one-man tractor operation. Some drills have a small auxiliary quadrant that aids the operator in setting for maximum depth of seeding and in lifting the openers when the drill is being transported.
Selecting Grain-drill Accessories. A careful grain grower not only selects the type of drill and type of furrow opener most suitable for his conditions, but usually selects some item or items of special equipment as attachments. Select attachments that make for greater convenience and efficiency in seeding operations.

Horse-hitch Attachments are still available for tractor drills and to meet the needs of horse drills of different sizes. Horse-hitch attachments are for one-pole drills in two-, three-, and four-horse sizes, and for two-pole drills in three-, four-, six-, and eight-horse sizes.

Grass-seed Attachments are available for all sizes of plain and fertilizer drills. The grass-seed hopper, when not an integral part of the grain hopper, is secured by brackets to the regular grain hopper and is always ready for use. The attachment has a fluted-force feed similar to a fluted-force grain feed, but with smaller sized cups, rolls, and ribbon tubes. It is driven by a chain from the main axle, and the quantity of grass seed sown is regulated by a separate lever that controls the grass-seed mechanism. The grass-seed attachment may be operated separately or with the grain seeder, as when sowing a small-grain nurse crop with the grass. The seed can be sown through grain tubes or broadcast ahead of or behind the furrow openers. When the seed is broadcast, use hooks to hold the lower ends of any tubes that interfere with the grain and grass-seed drive mechanism, and with the power lift if drill is so equipped. When the seed is to be broadcast behind the furrow openers, special long tubes are required. Some drills have separate hoppers or divisions of the hopper for grass, grain,
and fertilizer, which can be sown in one operation, separately, or in any combination desired. Grass-seed attachments for soil pulverizers are very practical under certain soil conditions where a firm soil is particularly necessary.

**Marker Attachments.** These attachments, which make the guide lines by means of which the operator can eliminate uneven “guess” rows, are available in either automatic bar markers or disk-marker attachments (single and double) for 16-8 as well as other sizes of grain drills.

![Fig. 144. Grain drill with full-length footboard permits the driver to follow previous wheel mark.](image)

**Footboard Attachments.** These are available in three types: (1) end footboards, for plain and fertilizer drills, 12-opener and larger, (2) center footboard, supplied for 11-opener and smaller sizes, and (3) full-length footboard, available for plain and most fertilizer drills.

**Grain Agitators.** Such agitators can be supplied for use in the seed hopper to aid in the more even feeding of seeds that have a tendency to bridge over the feed cups.

**Attachments for Fluted Feed.** These include (1) grain feed shutoffs which are covers used to close off feed cups when wider rows are desired, (2) a fast oat sprocket (16-tooth), that can be supplied to clamp over the regular 8-tooth sprocket, in order to double the rate of seeding for light oats and similar seed, and (3) a speed-reducing unit, used to sow one-half the quantity of seed shown by the indicator on the drill.

**Attachments for Double-row Feed.** These include (1) alfalfa and flax reducers supplied in either wire or cast types, used also for sorghum...
and other small seed when sown in small quantities, (2) two sizes of sprockets for lower rate of seeding, and (3) a speed-reducing unit similar to the unit for the fluted feed.

Attachments for Fertilizer-feed Grain Drills. These include (1) a fertilizer-agitator attachment used with types of fertilizer having a tendency to bridge over the outlets, (2) a fertilizer feed wheel with thick fingers, (3) a low-quantity fertilizer feed wheel, (4) a 12-tooth clutch sprocket to increase the quantities of fertilizer sown, and (5) a special delivery attachment which keeps the fertilizer away from the grain when the grain and fertilizer are delivered through separate tubes. “Baffle plates” are installed in the grain hopper of drills used in hilly country to prevent the excessive shifting of seed in the hopper. For some soils and grains a “depth gage” on shoe furrow openers is essential to regulate the depth of seeding (see Fig. 140D).

3. Selecting Corn Planters

A checkrow planter automatically counts out and plants kernels or seeds of corn, cotton, and similar seed, when equipped with suitable seed plates. The check wire with knots or buttons on it, when stretched across the field, makes it possible for the planter to deposit the seed in hills at uniform distances apart; thus the field can be cultivated lengthwise and crosswise. Select a checkrow planter if cross cultivation is necessary to control weeds. Much corn that is checked might be drilled to advantage. Drilling corn is faster.
Corn that has been drilled cultivates easily with shovels or flame and is easier to harvest, especially with a corn picker. When corn is on contoured ground, drilling is necessary.

Selecting Animal-drawn Corn Planters. These are available in sizes to meet almost any power used on the farm, and in different types or combinations to suit varied conditions. Regardless of what kind of planter is selected, it should have the following important features: It should (1) be mechanically dependable, (2) plant a variety of crops, (3) be easily operated, and (4) operate on comparatively light draft. Probably the most important of all features is the assurance of reliable and accurate planting; this is necessary if maximum yields are to be obtained.

For convenience in study and discussion, the planter can be divided into two major units:

1. The front frame, which includes the feeding mechanism composed of (a) seed hopper and seed plates, (b) seed-plate drive shaft, (c) clutch, (d) check heads with forks, (e) boots with valves, and (f) furrow openers.

2. The rear frame, which includes (a) main axle and wheels or driving unit and (b) axle for reeling or unreeling wire.

Selecting Hoppers or Seed Cans. Seed hoppers, or cans, are really the sides and top of the seed containers. The bottom is the seed-selection plate. Most planters are operated with a single hopper for each row known as the "single type." Select a hopper that can
be tilted and that is hinged at the front. This type eliminates the necessity of removing the seed when changing plates and, furthermore, simplifies the job of removing the seed when necessary.

Combination corn, pea, and bean hoppers, or double-deck hoppers, can be obtained for most planters. Both hopper decks of the combination type are of the same diameter and use plates interchangeably. The upper deck can be removed when only corn is being planted.

Selecting the Type of Drop or Plate. The seed plates are seed-metering devices that revolve in the bottom of the seed hopper, or boxes, with cells usually on the outer edge for accurate selection or chambering one or more seeds according to the shape and size of the cells. Select a planter with a power-hill drop so the planter can be set to drop hills automatically with each revolution of the seed-plate shaft, the spacing depending on the size of the sprockets used. Select a checkrow planter that can also be used to drill seed in rows, that is, drop singly similar to a grain drill, at a predetermined spacing and according to the type of sprocket and setting of the variable drop lever.

Accurate planting is essential if maximum yield is to be obtained. To ensure a high degree of accuracy, it is important to select the proper plate. Select one suitable to the size and shape of the seed. The wide use of hybrid seed corn, which varies considerably in size and shape, necessitates the manufacture of a large number of plates.
This large selection is advantageous to the corn grower, provided he selects a suitable one for the year's seed.

Fortunately all types of seed plates—edge-drop, flat-drop, and full-hill-drop—interchange in the hoppers with cells of different sizes and shapes and number of cells per plate. Thus the plate best adapted to the seed can be used in the planter. “ Accumulative drop” is the name given plates that mete out one seed at a time. When the cell of the accumulative-drop plate is shaped to receive the kernel on the edge, it is called an “edge-drop plate.” Select edge-drop plates for planting all graded seed, whether hybrid or open-pollinated.
Naturally, the variation of thickness of a kernel is much less than the variation in the width. “Flat-plate drop” is the name given those plates shaped to receive the kernel on its flat side. Select this type of plate for ungraded open-pollinated corn and some shapes of hybrid corn.

Accumulative drop is an essential device in checkrowing or driving fairly rapidly, because the seeds are deposited where wanted without being scattered in the row. In this method, the seeds are picked up by the seed-plate cells and the desired number wanted per hill is counted out. The seeds are held in turn by a valve or valves in the boot that opens and drops them at the proper time. A shift lever on some planters changes the number of kernels per hill to meet the operator’s wish.

The action of the seed-plate driving mechanism is such that the plate is momentarily halted at the instant the seed cell is directly over the discharge opening. A “shake-down” motion, which assists in filling the cells on the plates, gives the seed ample time to be discharged and get away and gives the seeds in the other cells time to settle snugly into their places before approaching the cutoff.

Checkrow planters have a seed-plate drive and clutch. The buttons on the wire pass through the check fork on the check head. This trips the clutch, which engages the check shaft as it is operated by the chain drive from the main
axle. The seed-plate drive executes one revolution each time engaged. This revolves pinions mounted on each end of the shaft, each pinion having three rows of teeth with two, three, or four teeth per row. Thus, whichever row is engaged determines whether two, three, or four seeds or kernels are accumulated on the upper valve of the boot.

Select a planter in which a convenient foot lever is provided to vary the number of kernels per hill. Thus, in passing from a better piece of the field to a poorer place, the number of seeds per hill can be reduced, and in going the other way the number can be increased. In order to plant satisfactorily, the clutch must operate with unfailing accuracy every time the check fork is tripped. Select clutch rollers that are case hardened and that run on large, hard, steel pins so as to minimize wear.

Select a planter having seed-boot valves that will keep hills separate and also deposit all the kernels in a compact hill. (See Figs. 152, 153, and 154.) The boot construction, including valve action, is the same regardless of the type of furrow opener used. This positive
action is obtained from planters having one hill on a valve near the point of planting and another already accumulated below the selecting plate. Thus the rate of travel has little effect on the accuracy of planting. Triple action of seed selection and planting is obtained by a mechanism, when the wire buttons trip the seed-plate drive clutch, as follows (see Figs. 150 to 154).

FIG. 154. (A) Valves closed, holding seeds at upper and lower levels in the boot. (B) Valves opened at both levels. This planter has a horizontal divider that prevents corn in the upper valve from dropping out with the corn in the lower valve.

1. Seed above the lower valve is injected as a hill into the furrow.
2. Seed from the upper valve is dropped into position above the lower valve.
3. Seed for the third hill is accumulated on the upper valve by the seed-plate travel.

Selecting Furrow Openers. Full-runner openers meet average soil conditions, so they are generally supplied with checkrow planters unless otherwise specified. The special types include stubrunners, single-disk openers, and double-disk openers. Some prefer the stub-runners for trashy ground or where quack grass is encountered. Single-disk furrow openers are recommended for hard or stony soils
and also in soddy or trashy ground. Double-disk openers can be used for the same conditions as the single-disk and in fields where the weeds are permitted to get a start. The full-runner furrow opener is more likely to collect and carry trash that tends to string the seed.

Selecting Planter Accessories. These accessories are used with the furrow openers to promote germination. Gage-shoe attachments make it possible for runner openers to “float” and thus to follow the ground contour closely. Blade-furrowing attachments make it possible to plant the seed in shallow furrows next to moist soil. Subsequent cultivations fill in the furrows and kill small weeds. Disk-furrowing attachments are available for planting the seed in a shallow trench. Where planters are attached to listers, it is desirable to use sub-soilers to provide sufficient loose soil for the shoe or other opener to cover the grain properly. For all walking-lister planters, this helps to guide the implement, particularly if the soil is not firm. (See Chap. 1 for lister-planter equipment.)

The rear frame consists of the rear axle, wheels, scrapers, seat, row markers, reel with axle for holding the check wire, and depth-control
mechanism. The open-type wheels not only carry the planter but firm the soil around the seed. They not only assist germination, but minimize the danger of soil blowing. Solid wheels may form a crust over the seed in some soils. Scrapers keep the face of press wheels clean and smooth. Select a horse-drawn planter with a seat that can be easily adjusted forward or backward on the bracket to balance the weight of the operator against that of the front frame to ease neckyoke weight.

Except where planting is done in furrows made by a previous operation, it is well to use a marker in order to have all rows spaced equidistant. This may be of the shovel, disk, or spike type, and attached in a manner to permit the operator to shift it to the other side at the end of each row without getting off the planter. Automatic markers are more convenient. One marker in the ground on each side of the
planter pulls the opposite marker up to the frame. Markers are adjustable to the desired row width.

**Selecting Combination Planters.** Where peas or beans are planted with a crop such as corn, both jobs can be done at one time by using a planter with either a separate or a horizontally divided seed-box. In the latter case, the same drive shaft runs the planting mechanism for the corn and peas or beans. Special plates are used for the peas or beans, but they can be dropped through separate tubes or the same tube as the corn on some planters, and may be dropped either with the corn hills or between corn hills.

*Fig. 157.* Corn planter with disk-furrow opener and stubrunner planting through heavy corn stalk residue—a soil-conservation practice.

*Fig. 158.* A lister planter in operation. Note sit-right rows and clean field.
Selecting Fertilizer Attachment. This may be used in addition to the planting of one or two grains. In fact, many plant corn and peas or beans and sow fertilizer in one operation. When used with the checkrow planter, the fertilizer can be placed in checks or continuous bands that are adjacent to the rows as well as above or below the seed but do not touch the seed. The fertilizer usually drops through a separate tube or a separate division of the tube through which the grain passes, in order to prevent “firing” the grain. This firing may occur if fertilizer and grain are planted together. Many planters are equipped with a split boot that places a band of fertilizer on each side of the grain. A star feed measures out the fertilizer at practically any rate desired by adjusting the feeding device, or speed at which it is turned, or both. Select a fertilizer boot adjustable for depth.

Selecting Tractor-operated Corn Planters. There are many things common to animal-drawn and tractor-operated planters. It is unnecessary to discuss them again at this point. Tractor-operated
corn planters are being used more and more. In fact, it is recommended that owners of the row-crop type of tractor plant their corn with tractor power. Tractors speed up the work. It is possible to plant at a speed of 4 to 5 m.p.h., covering 18 to 25 acres a day with a two-row tractor planter, and up to twice that acreage with a four-row planter. Tractor-operated corn planters are of two main types: trail-behind and direct-connected. The direct-connected are again divided into mounted at the rear and mounted ahead of the rear wheels.

![Fig. 160. A two-row trail-behind tractor planter with the marker in position.](image)

Some of the advantages of the tractor-operated planter over the animal-drawn planter are that it (1) generally obtains a more uniform planting, (2) ensures straighter rows on rolling or hilly land (planter direct-connected to tractor), (3) achieves more uniform coverage through elimination of horse tracks, and is (4) faster, saving time and labor.

The trail-behind corn planters, either two- or four-row, can be operated behind any tractor. The four-row consists of two units similar in principle to, but sturdier than, the regular horse-drawn planters. The check shafts of each planter are connected by a universal joint that gives all the flexibility of a two-row planter and assures all four boot valves operating in unison for accurate checking.
The direct-connected planters, whether mounted at the rear or ahead of the rear wheels, lift free of the ground for quick turning and lining up at the end of the row. They can be backed to the fence to plant all of the field in regular rows. Planters ahead of the rear wheels are

![Figure 161: A four-row trail-behind tractor planter showing a variable hitch.](image)

![Figure 162: A direct-connected tractor planter with a mechanical lift is especially convenient for getting into corners. This four-row broadcaster fertilizer planter with press wheels has a shovel marker in position.](image)

secured to a tool bar back of the front wheels and are readily adjusted by the operator with convenient levers. These planters are either single planters, one on each side of the tractor, or two-row planters, one on each side.

Tractor-operated planters have the same seed mechanism as
horse-drawn planters. On the rear of direct-connected types, the seed-plate drive is from a sprocket on the tractor axle. The planter has press wheels smaller in diameter than those on horse planters (normally 16 in.). These wheels close the furrows and may regulate the depth of planting. The wheels are connected to the main lever, convenient to the operator.

![Image](image_url)

**FIG. 163.** The hydraulic lift is actuated by the tractor and controlled by a convenient lever. It eliminates the manual effort in lifting the planters out of the ground.

The planters can be equipped with either a hand or a power lift. The hand lift is of the ratchet type. The power lift is operated by means of a tractor-mounted hydraulic pump or mechanical lift.

4. Selecting Cotton Planters

The cotton grower requires a machine that will plant cotton, corn, sorghum, peanuts, kafir corn, and other row crops with accuracy. This means a planter with readily interchangeable plates. Its general construction features are different from those of the corn planter. Cotton is usually planted on a ridge or bed except in the subhumid and irrigated areas where it is planted on the level or in furrows. Cotton planters vary in size from one-row walking planters, through one- and two-row riding planters pulled by mules, up to
FIG. 164. A multi-purpose planter for planting row crops without appreciably disturbing the surface as a soil-conservation measure. A 38-in. V sweep with seven tiller points prepares the seedbed below the surface. Each sweep carries a fertilizer boot for deep-row application. Two-disc furring openers follow each sweep, one for seed, one for row application of starter fertilizer.

FIG. 165. A tractor-mounted cotton planter that forms the beds, plants cotton, and distributes fertilizer all in the same operation.
four-row tractor-operated planters. The tractor-operated cotton planters are available in the same patterns as tractor-operated corn planters; namely, two-row direct-connected, two-row and four-row mounted on rear of tractor, two-row mounted ahead of the rear wheels, and varied sizes of trail-behind planters. The selection of tractor-mounted planters is controlled by the make and size of tractor.

Selecting the Type of Seed Drop. The success of combination cotton and corn planters, the same as corn planters, is determined by the accuracy of the drop and its adjustment. The corn drop is the same as that discussed under corn planters, and one important feature is the selection of seed plates to accommodate the particular seed being used. Gin-run cotton seed is used most commonly for planting. This seed, with the lint adhering to it, is one of the most difficult seeds to plant accurately. Extreme accuracy, however, is not a requirement, as quantities planted are always much greater than the quantity required for a satisfactory stand, and it is thinned later. The thick planting is usually to reduce the hazard of soil crusting and losses from germination. Some growers checkrow their cotton mainly for better control of grass and weed growth. Others accomplish similar results by drilling the seed as usual, and cross-blocking with the cultivator or chopper.

The cell-drop plate (Fig. 166) has cells on the outer edge. Agitators stir the seeds, assisting them off a sloping collar into the cells. Feed springs gently force more or less seed into the cells, after which a cutoff pushes the surplus back. The cells next pass over an opening to the feed spout, where a spring-controlled knockout partially enters the cells, assisting in the seed ejection. The picker-wheel drop is a saw-tooth type which picks out the cotton seeds, one or more at a time, taking

![Fig. 166. Cross-sectional view of the cell-drop cotton-planter mechanism.](image-url)
lint and trash with it. The action can be understood by referring to Fig. 167. A horizontal rotating agitator plate \( A \), with fins or fingers \( B \) radiating outwardly from the body of the plate, and with fingers pressing the cotton seed downward on the saw-tooth picker wheel \( C \), revolves in an opposite direction and at right angles to the movement of the agitators. This picker wheel in reality picks the seed from the mass of seed and lint pressed down on it. A sliding gate shutter adjusts more or less of the picker wheel in contact with the seed. Full-hill drop can be obtained with either type of seed selection, although some types of planters require a hill-drop attachment. In that case, the seed, as it leaves the hopper, drops through to a valve located in the bottom of the boot. The valve may be the gate type, which opens at predetermined distances, or the rotary-valve type, which has large cells in the periphery and deposits the seed in hills at intervals determined by the drive sprocket used.

The seed plates are operated from planter-axle sprockets by chain and gears. The rate of seeding is increased or decreased by a movable pinion meshing with one of three rows of teeth. There are no valves in the boots for checking cotton. There are checkrow planters, however, which have a mechanism similar to that of the checkrow corn planter previously described.

**Selecting Furrow Openers.** Furrow openers, almost directly below the axle at the end of the perpendicular seed tube, are of either the double-pointed reversible-shovel type or the master-shoe type. Shields are generally used with the shovel type to prevent soil from falling into the furrow. A large sweep or ridger is generally used ahead

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**Fig. 167.** Construction and operation of the picker-wheel drop. (Left) Picker-wheel drop. (Right) Cell drop.
of the furrow opener where cotton is to be planted in beds. The sweep, which is adjustable, takes off the tops of the ridges in a leveling operation, destroys weeds over a large area, and exposes moist soil for the seed. A middlebreaker bottom or a lister bottom can be used in place of the sweep for planting in deeper furrows.

Providing a Variable Depth Attachment. The purpose of unchecked cotton is to obtain germination of sufficiently strong plants
to assure a maximum yield. Inasmuch as weather conditions affect germination and growth, a variable depth attachment is available for planting the seed from shallow to deep continuously. Thus, in a dry season, the deeper planted seeds succeed and in wet seasons the more shallow succeed. Since this variation in planting is continuous, a uniform stand is obtained.

5. Selecting Beet-, Bean-, and Vegetable-seed Planters

Nearly all these planters are of the four- and six-row type with either shoe or disk opener. They have various types of feeds as fluted, double-run, and plate. Although the double-run type similar to that on grain drills is the most common, the plate feeds are replacing the other feeds, largely because of the introduction of segmented seed. The sugar-beet seed is not a true seed, as is the kernel of corn, but is a seed ball having from one to five germs. There are machines to segment these seed balls, and, as this practice continues to grow, further use will be made of plate feeds for greater accuracy and to obtain more even distribution in the row. Segmented or sheared beet seed, as it is often referred to, is gaining in popularity. In addition, planters designed for planting segmented seed are doing such a fine job of spacing that the need for thinning is almost eliminated.
Another experimental method of planting beet seed is by making pellets. The segmented seed is encased in a spherical mold about \( \frac{1}{4} \) in. in diameter. Pellets lend themselves to selective plate planters.

Beet-, bean-, and vegetable-seed planters are available for both tractor and animal power. The main differences are the hitch and size. The vegetable-seed planter is also available in hand styles. Select a type adapted to the size of fields, type of soil crops to be planted, and power available. Select a planter with adjustments for spacing rows as desired. Tractor-operated planters are usually of the tractor-pulled and tractor-mounted types, depending in most cases on the make and type of tractor. Planters for some tractors are under the tractor, and ahead of the rear wheels on other tractors so the operator can observe the planting process. This type is power controlled in lifting and depth.

Vegetable seeds are usually quite small. Therefore, when selecting a planter to handle them, make certain that the seeding mechanism is well suited for handling all the seeds that are to be planted. Select a vegetable-seed planter that is of a size suited to the acreage planted, having furrow openers, press wheels, covering devices, seed hoppers, and markers to perform the jobs to be done (see Figs. 137, 138, 140, and 142). Most vegetable-seed planters can be combined into units to fit any horse or tractor power desired.
Selecting Furrow Openers. The disk openers have proved to be more satisfactory in the semi-arid areas under irrigation. When the disk opener is used with a depth-band attachment, it is easier to secure a uniform depth of planting. Shoe-type furrow openers plant the seed at less even depths and, in slightly moist soil, may cause a smooth surface in the opened furrow that may not be closed by the press wheels. Depth bands and clean press wheels are necessary if a uniform depth of planting is to be maintained. Clean press wheels are difficult to maintain in some soils unless moisture conditions are ideal. Select planters with scrapers to remedy this situation.

Providing Markers. These are essential because, with multi-row planters, it is customary to use multi-row cultivators, which require all rows to be evenly spaced. In fact, the distance between the four or six rows planted at a time must be equal. This is assured by a bar that maintains the space for which the rows have been set on the planter. When beds are being planted, the use of markers is not essential.

6. Selecting Potato Planters

Selecting the Type of Planter. Potato planting, until the turn of the century, was a hand job. It was slow, laborious, and costly. Today, this practice is followed only where the acreage grown is small and hand labor is inexpensive. Most of our market potatoes are
grown on quite a large commercial scale in relatively few areas. In order to reduce costs, mechanical planters are used.

Mechanical planting is more accurate than hand planting in all respects. This can be understood when we review the various operations in planting potatoes. The planter (1) opens a furrow of proper depth for the seed, (2) selects the seed for planting, (3) drops the seed to the bottom of the furrow at regular intervals, (4) covers the seed uniformly for good germination. It is frequently equipped for sowing fertilizer at the same time. The farm operator should select a planter constructed to do all these things.

Planters are of the one-, two-, and four-row sizes and, except for the four-row size, can be pulled by animals or tractors, although nearly all the two-row planters are pulled by mechanical power.
Whether it is pulled by horses or by tractors, it is customary for two persons to operate the outfit, one on the planter and one for the power. The two-row type may require three persons with two on the planter and one on the tractor.

There are three main types of planters: picker pin, picker finger, and cup. Some manufacturers offer a fourth type, the corrective, which is a combination of a disk cup and a manual method. The picker type consists of a wheel that has up to 12 arms, each of which has points to pick up seed pieces. The picker wheel revolves on an axle and, as the arms pass through the picking chamber, the two or three pins on each arm pick up a single seed piece. As these arms, each with a seed piece, pass downward, the seed piece is forced off to fall into the opening made by the furrow opener. These pieces are then covered by the disks at the rear. In order to get accurate planting, the seed chamber through which the picker arms pass should be kept filled with seed at a uniform level. On some planters this level is maintained by automatic control of the gravity feed from the seed hopper to the seed-picking chamber.

During recent years, potato growers have expressed a desire to plant large seed pieces and whole potatoes. The added amount of seed piece tends to assure the sprouts plenty of nourishment during the first and important weeks of growth. This practice necessitates various sizes of picker heads. As a result, some manufacturers provide three or more sets of interchangeable picker heads for
SELECTING CROP-PLANTING MACHINES

Fig. 175. The principles of selecting seed pieces in potato planters.
(A) Picker-pin type. (B) Corrective-cup type. (C) Picker-finger type.
different-size seed pieces as follows: large picker heads for seed pieces averaging 3 or 4 oz., medium picker heads for seed pieces averaging 2 to 3 oz. and mixed uneven sizes, and small picker heads for seed pieces averaging less than 2 oz.

The picker finger operates similar to the picker pin. A finger-type arrangement picks the seed pieces from an automatic feed roll below the hopper. As the seed piece is selected, a finger grasps the seed piece and holds it while the finger arm revolves to the seed tube where it is dropped into the furrow.

The cup type consists of a series of cup-like receptacles. Each cup is filled with a seed piece as it passes through the seed hopper. These are delivered to a revolving selector plate where a person may make corrections by filling in any skips. The seed is then dropped into a seed tube that leads directly to the furrow. This type does not penetrate the seed piece, but the operator must be careful to prevent seed pieces from becoming wedged in the cups. There are various sizes of selector-seed plates for different sizes of seed pieces.

Selecting Furrow Openers. The furrow openers are usually of the disk or colter type and are available in different sizes to meet any specific need. These disks can be adjusted to make almost any size furrow or ridge desired. Under certain conditions, shovels are used instead of disks but this practice is an exception rather than the rule. Levers control the furrow openers and seed coverers and as these are let down the planter goes into gear. Spacing can be controlled through the use of varied size of sprocket wheels.
Providing Fertilizer Attachments. Fertilizer attachments are available on all standard potato planters. They place commercial fertilizer through separate tubes above, below, or on one or both sides of the potato row. This permits the fertilizer to be placed in distinct bands and yet not come in direct contact with the potato seed piece.

7. Selecting Plant-setting Machines

These machines, used to set such plants as tobacco, guayule, tomatoes, cabbage, peppers, sweet potatoes, cauliflower, mint, broccoli, bulbs, eggplant, horse-radish, strawberries, flowering plants, and nursery stock, are often of local design and manufacture. However, transplanters are on the market which are well suited for the job to be performed. An operator with two helpers can set three to eight acres per day with a one-row machine. Such machines do not have such widespread use as do other planting and seeding machines.

Selecting Size and Type. Two-row transplanting machines are common in some areas; however, four-row tractor-pulled machines are used in California and other large field areas. Select a transplanting machine having (1) a device to open a furrow, (2) a tank for a supply of water, and (3) blades or disks for firming the soil around the plants. It is highly desirable to have comfortable and convenient arrangements for those who work on these planters. Other desirable features in plant-setting machines are
1. It is adjustable for planting on either level ground or ridges
2. Plants can be set equidistant but spaced to meet the need of various crops
3. Row width adjustable if more than one row planted at a time
4. Furrowing shovel or shoe that can be set for different depths and widths of furrow
5. Packer wheels or press plates, or both, to firm the soil about the plants
6. Watering device that controls the amount of water used for each plant and places water where wanted

Fig. 178. The details of a semi-automatic transplanter. The plants are placed in holders, which, in turn, set the plants.

7. Adjustable marker for spacing of rows
8. Wheels adjustable as to width to accommodate all row centers
9. Provision made for a fertilizer attachment
10. Water-supply tank large enough to avoid frequent filling
11. Wide-rimmed wheels to prevent undue sinking into sandy soil or soft seedbeds
12. Plant boxes large enough to avoid the necessity of frequent replenishing
13. Ease of guiding and following rows
14. Frame sufficiently strong to handle the heavy loads to which it is subjected
15. Plants set at a uniform depth allowing ample room for the roots

When selecting a transplanter, the purchaser should make sure that the machine has features essential for the crops to be planted, and
SELECTING CROP-PLANTING MACHINES

applicable to the conditions under which these crops are planted. Since transplanters are used for only short periods each year by most operators, the acreage covered by one planter does not always justify the cost of such a machine. Transplanting is a slow and tedious hand job; therefore, groups of farmers can often cooperate profitably in the selection, purchase, and use of a transplanter. Timeliness of planting must be considered when several farmers own a machine cooperatively.

Selecting Fertilizer Attachments. The same study is being given to sowing fertilizer with the various plants as to seed crops. Each type of plant being set and the soil used call for specific placement of fertilizer. Select a transplanting machine that is equipped to place the fertilizer as required for the soil type and for the different crops to be planted. This may call for fertilizer with the plants in the rows, and to one or both sides of the plants set.

SUMMARY

1. Man is steward of the soil, and thereby is charged with passing on its productive ability undiminished. He must, therefore, use crops and soil-handling practices that are approved by recognized conservation specialists.

2. Broadcast seeding is often preferred on fields that are small, irregularly shaped, rocky, stumpy, wet, and trashy.

3. The drill has many advantages such as distributing seed uniformly, covering it at a controlled depth, firming soil about the seed, requiring less seed for a given acreage, and sowing many mixtures uniformly.

4. A 20-6 grain drill has 20 furrow openers spaced 6 in. apart.

5. Fertilizer drills deposit both seed and fertilizer in a single operation, but they are fed from different boxes and by separate mechanism; some also have grass-seed attachments.

6. Drills have either double-run or force feeds and these have many types of furrow openers such as single disk, double disk, hoe, shoe, and lister; each type has many variations.

7. Where weeds are difficult to control and cross cultivation is required, select a checkrow planter.

8. Combination or double-deck hoppers permit the planting of two kinds of grains such as corn and peas in one operation; fertilizer attachments can also be had with these planters.

9. The edge-drop plate is suitable for planting graded seed, but the flat plate is preferred for most ungraded seed.

10. The accumulative drop with seed-boot valves deposits seeds in a compact hill, even when it is moving at a rapid speed of planting.
11. Planters are available with full-runner, stub-runner, single-disk, and double-disk openers. The stub and disk openers are preferred for trashy soil, and the disk openers for hard, stony, or soddy soils.

12. Plant or lister plant the same number of rows as will be covered by the cultivating equipment which follows, to facilitate further that operation.

13. Tractor planters are either trail behind or tractor mounted, with the latter being ahead of or behind the rear wheels, having either hand or power lift.

14. Cotton planters are available in the same patterns as corn planters; as with corn planters, use the tractor-mounted type when it is desired to plant close to fences and in other tight places.

15. The beet-, bean-, and vegetable-seed planters use double-run, fluted, and plate feeds, with the plate feed gaining favor for planting segmented beet seed.

16. The potato planter has four kinds of feeds, picker finger, picker pin, cup, and corrective. The latter is a combination disk-cup and manual method.
5. Operating and Field-servicing Crop-planting Machines

Crop-planting machines, used only a few days each year, are vastly more important machines than their short annual period of operation might indicate. Their operating condition and adjustment are of vital importance, because the success of an entire year’s crop is dependent on the efficiency of the planting job.

The practices of uniformly distributing the correct amount of good seed for the soil conditions, and planting at the proper depth, are well known to all who have successfully grown products of the soil. When seed is planted too thick, too thin, too deep, too shallow, and when a drill leaves unplanted strips or a planter skips hills, the yield will be unsatisfactory. However, the work, time, and money spent in planting, cultivating, and harvesting are just as great as, or greater than, those expended for proper planting that gives maximum production. Accurate planting probably has at least as much influence over yields as any other operation. Therefore, measure accurately the quantity of seed per acre, or kernels per hill, and plant uniformly to meet moisture conditions, fertility, and other factors influencing the productive possibilities of the soil.

The farmer who understands and gives careful thought to the adjustment and operation of his planting equipment and soil-conservation practices will profit greatly. The servicing and operation of local planting equipment should be studied carefully and participated in by agricultural students, farm-shop instructors, farmers, and farm-machinery service men. Planting seasons are usually very short and, in order for the farmer to plant most of the crop during the optimum period, his equipment must be in proper condition to render the best service possible.

“Operation” means the actual use of the machine in performing the work for which it was designed. The success of operation is determined in large measure by the inspection and servicing program...
regularly maintained. The old adage, "A stitch in time saves nine," can be appropriately applied to machine efficiency.

Field servicing does not include reconditioning, but it does include taking care of, in a timely manner, such things as lubricating, adjusting, sharpening, making emergency repairs, and replacing and keeping tight bolts, nuts, screws, setscrews, cotter keys, and the like. "Servicing" a machine means taking care of it so that it will continue to function properly. This is referred to as "preventive maintenance," which is stopping trouble before it has begun. The following major activities will be discussed in this chapter:

1. Operating Broadcast Seeders
2. Operating, Adjusting, and Servicing Grain Drills
3. Operating, Adjusting, and Servicing Corn Planters
4. Operating Cotton Planters
5. Operating and Adjusting Bean, Beet, and Vegetable Planters
6. Operating and Adjusting Potato Planters
7. Operating Plant-setting Machines

1. Operating Broadcast Seeders

Satisfactory broadcast seeding by hand requires a skilled and conscientious worker. Many factors affect this method of seeding that do not concern the operator of drills. Mechanical devices have
been developed to do the job and are very accurate. Broadcast seed by hand only when wind will not affect seeding. Broadcast seedings are either cultivated or harrowed for covering. Going over the field in both directions assures better covering. A spike-tooth harrow laid rather flat to avoid covering too deeply is usually preferred for light seed such as grass.

**Hand Seeding.** This is the oldest and simplest method of seeding by man and is mentioned many times in the Bible. To accomplish hand seeding, the operator places a marker or range-pole flag to guide him straight across the field in order to reduce skips and overlaps. As the sower reaches each end of the field, he sets the pole over two widths so that it will be in proper line to guide him on the next trip toward it. Some operators spread seed with both hands, grasping seed with one hand and then the other from the sack carried over the shoulder. Others seed with only one hand and grasp seed in coordination with the step. The size and weight of the seed as well as the arm swing of the operator determine the width seeded each time across the field.

Another method of hand seeding small seeds such as lespedeza is to use a cardboard tube attached to the lower end of the sack containing the seed. The flow of the seed from the sack through the tube is controlled by a valve in the tube. The tube is rotated from right to left as the operator crosses the field. This simple scattering device is more accurate for the average person than straight hand seeding.

The knapsack seeder, suspended by a shoulder strap, has either a sliding gate or a valve that is adjustable, to allow the desired amount of seed to flow into an opening from which it is spread by one or two wheels with several radial ribs. Where two wheels are used, they turn in opposite directions. The crank is turned at the correct uniform speed, which spins the wheels for an even spread or cast of the seed. Coordinate the pace used with the flow at the seed gate, or valve opening, for the job being done.

**Operating a Wheelbarrow Seeder.** First check the wheel to see that it is in alinement and turns true without excessive side movement. The device that rotates the feeding chain or rod in the seed hopper will then be moved the same amount. Set the chain or other device to operate directly over the holes, thus assuring a uniform feed at each opening. Walk a uniform rate and avoid hitting large pockets, clods, or other objects, any of which may prevent uniform
seeding. If a marker is not used on each end of the seed box, then set flags as for hand broadcasting. Keep the seed box on an even keel or horizontal plane at all times, so the seed will not shift to one end of the hopper away from the openings at the other end. Keep the box fairly well filled. Only clean seed will feed uniformly. Remove all seed from the seeder at the end of each day’s work.

**Operating Pulled Broadcast Seeders.** The endgate seeder is usually driven from a sprocket on the left rear wheel of a wagon. Keep the sprocket on the wagon wheel in line with the sprocket on the endgate seeder. Place the sprocket chain, known as a “flat hook-link chain,” on the sprocket wheels with the hooks leading in the direction of the pull and with the openings toward the outside. Lubricate frequently the hook-link chain bearings, as well as other points of wear. The tension of the hook-link chains is very important. Have them loose enough to avoid undue strain on the bearings of the sprocket wheels with the tightener on the loose, or idle, side of the chain. These chain belts are often operated too snugly. Some points the operator should bear in mind are (1) the smaller the wagon wheel to which the sprocket is attached, the more rapidly the distributing wheel or wheels turn, (2) the higher the box, the greater the effect of wind on seed distribution, (3) the cleaner the seed, the more even the flow through the feeding device, (4) the steadier the driving speed, the more even the seeding, (5) range-pole flags or marker poles should...
be set over two seeding spaces when the end of the field is reached unless marks such as old corn rows are being followed, and (6) all seed should be removed from the mechanism when the day's work is finished unless the seeder is housed overnight.

Operate the two-wheeled seeders, both narrow and wide track, as near level as possible, so the seed will not shift end to end. Check the fluted feeds to see that all are feeding the same. If not, set the fluted feed wheels the same on the driving shaft in relation to the feed cups. The narrow-track type has no wheel marks to follow, so attach a marker to each end of the grain hopper to avoid overlaps or skips. If the seeder is not equipped with a revolving shaft, known as an "agitator," the operator should clean out the openings to each feed cup at intervals. Where such a cleaning device is not used and where the seed is trashy, drop the gates occasionally, open the flutes completely, jack up the drive wheel, and turn it until all the seed in the box has been removed. Lubricate according to manufacturer's directions. Check to see that the feed gate at each feed is properly set for the grain being seeded. (See Calibrating a Grain Drill, page 208.)

In operating hoe broadcast seeders, check the feeds to see that all are clean and feeding uniformly. All the fluted feed rolls are held rigidly to a steel shaft that is moved in or out to increase or diminish the rate of seeding. Check the spring trips on the hoes to see that they are free and operating properly.

2. Operating, Adjusting, and Servicing Grain Drills

As a rule, a grain drill is used for only a short time each year; consequently, it is idle and supposedly in storage during most of the 12-month period. The drill will give satisfactory service if inspected and put in first-class condition before being placed in operation and then checked periodically while in use. Lack of proper attention may result in persistent trouble. Therefore, it is well for the owner or operator to know how to prepare the drill for service and then observe preventive-maintenance practices to keep the machine in good operating condition.

There are certain "key" parts in any machine to which the experienced operator gives special attention at the time the machine is first started in the field. In the case of a grain drill, inspect and closely check (1) the hopper, to see that objects that could cause breakage
are not in the feed cup, (2) the feed shaft, to see that it is turning, (also the fertilizer feed shaft on a fertilizer grain drill, and the grass feed shaft on drills having a grass-seed attachment), (3) the disks, single or double, making sure that they are all in alinement and turning (also the disk markers if present), (4) the covering chains, to keep them from being tangled, and (5) the land measurer to see that the worm drive is engaged. Have disks and all other moving parts properly lubricated.

At the end of the first trip across the field and back, make a further check on (1) the amount of seed left in the hopper, in order to compare the rate of seeding, as shown by the indicator, with the acreage covered, as shown by the land measure, (2) the various driving and driven parts, to see that they are functioning properly, and (3) all bolts, screws, and locking devices, to see that they are holding tight.

**Lubricating.** The final assembly of a new drill should include complete lubrication. Likewise, any drill that has stood for a time should be lubricated before it is moved.

The importance of daily lubrication while the drill is in operation is something that the dealer should strongly impress on the drill user at the time the drill is delivered. The owner’s attention should be called to the lubrication directions in the instruction pamphlet, and to the various lubrication points on the drill. Daily lubrication during the drilling season is essential to satisfactory operation, light draft, and long life.

Grain drills require three types of lubricant—grease, oil, and light oil—depending upon the parts to be lubricated. Apply grease with a pressure gun through pressure lubrication fittings if they are provided. Use only a good grade of pressure gun grease. In connection with application of grease, give particular attention to the pressure lubrication fittings in axle boxes, grain-drive gear yoke, fertilizer
countershaft hangers, disk bearings, ratchet-wheel hubs, and power-lift bearings. Use soft grease for double disks. Grease the lid hinge the full length of the lid.

On parts not equipped with lubrication fittings, apply a good grade of machine oil, using an ordinary oilcan. These parts include the rockshaft bearings, lifting mechanism, sprocket bearings where no fittings are used, pressure-rod pitmans and swivels, and lid-spring plungers.

Apply kerosene only to the grain feed cups every day; such lubrication is particularly necessary after the cups have become rusted. Apply to the feed cups twice daily when the seed has been treated or when the drill is being operated under dusty conditions.

Obtaining Desired Rate of Seeding. Uneven seeding is wasteful of time, equipment, seed, land, and money. It should, therefore, be avoided by every grower of crops.

The method of setting the feed mechanism to seed different quantities per acre depends on whether the drill has a fluted feed or a double-run feed. The fertilizer drill has the fertilizer feed in addition to the grain feed, and is set separately. Grass-seed attachments, available for all drills, are also set separately to give the desired rate of feeding.

Setting the Fluted Grain Feed. When setting the two pointers on the larger drills on the grain-indicator plate, place both of them exactly on the mark denoting the desired quantity per acre, according to the instruction book.

On fluted feed drills, the grain feed cup-adjusting gates can be set in different positions. The quantities marked on the grain-indicator plate are obtained with the cup-adjusting gates set in the top position. Make this adjustment the same on all cups and tap the latch on the bottom firmly into the retaining notch.

Most grain drills will seed the per-acre quantities for which the grain-indicator pointers are set, provided the seed is the same size and weight as that which was used in calibrating the drill at the factory. Seed varies in weight and in kernel size from one section of the country to another, from one farm to another, and from one season to another on the same farm. Consequently, no factory calibration of the feed can be expected to apply universally and at all seasons. The heavier the seed, the faster it will go through the drill; the larger the kernels, the fewer will be seeded per acre. It is, therefore, neces-
sary for the drill user to check the per-acre quantity himself and establish the rate of seeding for the particular size and weight of seed he is using. He can do so by establishing the ratio between what the land measurer shows and the amount of seed going through the hopper.

In territories where this per-acre quantity, or "rate of seeding," is expressed in quarts, it will be necessary to convert the quarts to pecks, inasmuch as the grain-indicator plate is calibrated in pecks. If, for example, it is desired to convert "60 qts. of wheat per acre," divide 60 by 8 (8 qt. = 1 peck), getting the result of 71/2 pecks. Then set the indicator pointer between the 7- and the 8-peck marks. Always set the land measurer back to zero when starting a new plot or field. When setting the grain-indicator pointer, always push the pointer past the desired figure, then back to its proper setting. This action will clear the cups of any trash or foreign material and make for an even setting.

Setting the Double-run Grain Feed. Changes in the rate of seeding or per-acre quantity sown by double-run feed are made by shifting gears on the speed device (two devices on 12-opener and larger drills) and by interchanging driving sprockets. It is possible to make ten changes by shifting the speed-device gears. When the driving
sprockets are changed, the speed of the feed shaft and, therefore, the rate of seeding are increased or decreased proportionally. Drills are regularly supplied with both 8- and 16-tooth driving sprockets. If the rate of seeding obtained with the 8-tooth sprocket is too high, the user can obtain, as special equipment, 5- and 6-tooth sprockets which seed, respectively, five-eighths and six-eighths of the amount sown with the 8-tooth sprocket.

FIG. 183. The grain tables inside the hopper lid aid in obtaining the desired rate of seeding.

Note that the grain-sowing table supplied in the instruction pamphlet, and also on the hopper, gives seeding rates "with reducers" and "without reducers." These reducers, which decrease the size of the cup outlet, come regularly with the drill. Special wire reducers and cast reducers are available for use with flax, alfalfa, and sorghum seed.

Because of the variation in size and weight of seed from section to section, it is advisable to check the amount of seed used against the land measurer and calculate the allowance necessary to obtain an accurate setting on the grain indicator. For example, to set the drill to seed 60 qt. of wheat per acre, proceed as follows:
1. Refer to the "wheat" division of the grain-sowing table printed on the inside of the hopper lid (also given in the instruction pamphlet) and find the figure of 60 qts., noting that this rate of seeding is obtained with the 16-tooth sprocket A and the left half E of the grain cup covered.

2. Place covers over the left side of all feed cups and install the 16-tooth driving sprocket on the grain-drive countershaft.

3. Set the speed device B in the sixth notch, as indicated in the column at the extreme left of the table, remembering to set both sides if the drill is 12-opener size or larger.

Calibrating a Grain Drill. Seeding-rate indicators may become inaccurate through abuse or damage. Thus at times it is desirable to check and calibrate a grain drill even though this has already been done by the manufacturer. When calibrating, check the grain delivered by each seed spout to correct any variation between spouts that might exist. The steps in calibrating a grain drill are:

1. Find the strip width in feet and inches that the drill will sow. This is the distance between each spout, multiplied by the number of spouts or openers.

2. Divide the drill width, as determined above, into the square feet in an acre (43,560). The result will be the distance the drill travels to sow an acre.

3. Determine the circumference of the drive wheel and divide this into the distance to be traveled when seeding an acre. The result will be the number of times the wheel has to be turned to sow an acre.

4. Jack up the drill, place a canvas under it, and place a pan under each spout.

5. Set the dial indicator at the amount desired per acre. Fill the hopper with grain, engage the clutch, and turn the wheel at normal field-working speed until the number of turns required for an acre, or known fraction thereof, has been made.

6. Weigh and record the amount of seed delivered at each feed spout; then weigh the entire amount of seed that has gone through the drill, and check against the dial.

7. Determine the percentage of error and set the dial thereafter to compensate for the error. If any feed cups are not feeding like the others, correct by moving the flute feed wheel on the shaft to the proper position, or by other corrective means recommended for the particular make of drill. Continue the checking process and adjust the feeds until all spouts feed alike.

8. Make a written record of the variation between the seed dropped and the amount indicated on the dial so that the dial can be accurately set for
the amount of seed desired per acre. When making this check to calibrate the drill, set the land measurer at zero and thus determine its accuracy at the same time.

**Setting the Fertilizer Feed.** Regulate the per-acre quantity, pounds per acre, deposited through the fertilizer feed by adjusting (1) the feed-gate openings and (2) the speed of the feed wheels.

The size of these feed-gate openings in the back plates over the feed wheels is controlled by the “quantity” lever on the end of the hopper. This lever can be set in 30 notch positions. Adjust this lever so that when it is in notch 30 the gates are fully open, and when it is at the bottom of the quadrant, the gates are fully closed.

Two drive gears, controlled by the “speed” lever on the rear of the hopper, permit driving the feed wheels in the hopper at “slow” or “fast” speed as required to sow the quantity desired. Special attachments are available that permit still further variation in the quantity sown. When the speed lever is in the middle or neutral position, the drive is inoperative.

Refer to the fertilizer-sowing table on the inside of the fertilizer-hopper lid and set the feed to sow at the desired rate. For example, if the drill has 7-in. spacing and the desired sowing rate is 200 lb. of fertilizer per acre,

1. Find the figure 200 under the 7-in. heading in the sowing tables, noting that the figure 200 is in Table 2, “fast speed.” (If the drill has 8-in. spacing, the nearest figure to 200 would be used, that is, 195.)
2. Set the speed lever in the “fast” position.
3. Follow the line across to the “notch” column to find the number of the notch in which to set the quantity lever.
4. Set the quantity lever in notch 4. The quantity lever should never be pushed below notch 5 unless the fertilizer mechanism is in operation, or unless the fertilizer beneath the feed gates is first cleaned out. Otherwise, efforts to push the lever below notch 5 are likely to result in damage to the lever or gate mechanism. To avoid the loss of free-running or granular-type fertilizer when moving the drill to or from the field, close the feed gates completely.

The quantities shown in the fertilizer-sowing table are based upon the use of standard free-running fertilizer weighing a little over two pounds per quart.

Check the feeding mechanism daily and clean out all material each day. Fertilizer not removed may harden or “set” in a manner
similar to cement and damage the drill mechanism when put in operation again.

**Setting the Grass-seed Attachment.** Grass seed, like other seed, is sown on a volume basis—so much to the acre. The feed control is graduated in quarts, but grass seed is usually purchased and handled by the pound. Consequently, the drill user, in order to calculate his requirements (so many acres at so many quarts to the acre), needs a conversion table like this one:

- 1 qt. of timothy seed weighs \( \frac{5}{2} \) lb.
- 1 qt. of bluegrass seed weighs \( \frac{1}{2} \) lb.
- 1 qt. of alfalfa or clover seed weighs 2 lb.

Suppose the crop grower has decided he will sow a mixture of alfalfa, clover, and timothy at the rate of 10 lb. of alfalfa, 6 lb. of clover, and 3 lb. of timothy per acre. As the feed indicator on the grass seed box is set in quarts, this mixture must be turned into quarts, as follows:

- 10 lb. of alfalfa .................. 5 qt.
- 6 lb. of clover .................. 3 qt.
- 3 lb. of timothy ................. 2 qt.
- Total .................. 10 qt.

The feed indicator would then be set at 10 qt.

**Adjusting the Hitch.** Inasmuch as (1) a grain drill must be level to do good work, (2) the level of the drill (as indicated by the level of the hopper) depends on the height of the hitch, and (3) tractor drawbar and team sizes vary widely, it is obvious that the height of the hitch must always be adjusted in order to keep the drill at the proper level. Too low a hitch on the drill tilts the hopper toward the rear and results in furrows too deep, too much soil over the seed, and increased draft. Too high a hitch on the drill tilts the hopper forward, results in seed being improperly covered, and may even result in spilling seed from the hopper. For horse hitches, adjust the hitch at the rear end of the poles to the height of the team.

**Adjusting the Levers.** Where more than one lifting lever is on the drill, as is the case with large drills, they are to be checked against each other because a notch for one lever may not maintain the same depth as the same notch does for another lever. This is to be observed and checked in the field. Check and maintain the parts of power lifts where these are used in place of levers, giving particular attention to the clutch. Also have the lift and trip-control ropes handy for the
reach of the tractor operator. Have the levers within easy reach of the operator. When operated from the tractor, they should be adjustable for length. Set the helper-lift springs to balance the furrow openers and thus assist both in raising the furrow openers and in applying pressure. If there is a small auxiliary quadrant, it should be set for greatest depth of seeding, and set for maximum lift when transporting.

Servicing the Seed Tubes. Through rough handling, these are often damaged so that they do not function properly. Before starting the season's work, clean out these spouts so that the seed will not clog in them; for the hose-tube type, a stiff wire or small stick with a hook to hold onto the top of the tube will keep the tube open and the grain flowing. Replace all damaged tubes that cannot be repaired and that hamper the grain passing through them.

Servicing the Furrow Openers. Keep all shovel- and hoe-type openers sharp; shoe-type should have the shoe blades replaced when worn enough to affect the quality of work being done. Some drills have deflectors at the lower end of seed spouts. Have these in the proper position and check the retaining bolt for snugness. Lift the furrow-opener gangs when turning at the end of a field or backing up. If they are not lifted, soil is forced into the lower end of feed spouts with any backward movement. This, of course, clogs the openings and prevents seed from dropping into the seed furrow. Keep disk openers, either single or double, sharp; scrapers, if used, are adjusted to fit just up to, but not tight against, the disks which might
keep them from turning freely. Set the disk at the angle recom-
mended by the manufacturer and at the same time inspect the bear-
ings and set them to exclude dirt as well as to retain lubricant used.
This checking is to be done periodically, as disks not properly set or
serviced cause excess wear and draft and do not perform satisfactory
work. A disk drill may clog the seed tube where these tubes use the
disk to serve as one side of the tube near the ground. If such seed
spouts are used in seeding wet
ground, check the spout ends fre-
quently. Where spring tensions
are used on each furrow opener,
they are to be set alike so that they all operate under similar
tension. Adjust pressure-spring
“keeps” and cotter keys to allow
play between the cotter and the
pressure arm swivel thus per-
mitting furrow openers to follow
the contour of the ground. To
plant shallow in loose soil, place
the cotter pin in a lower hole at
the top of the pressure-spring rod
to prevent furrow openers from
going too deep.

Servicing Press Wheels and
Covering Chains. Have press wheels in direct line behind each
furrow opener and the bearings for each wheel set to keep them in line.
If chains are used, the links must be watched so that none opens up to
drop part of the chain. The two chains at each end should be tied to
the footboard or some other drill member so they will not catch under
the wheels when turning. If this is not done, the furrow gang or chain
may be broken. Tie up chains when transporting.

Driving Animal-drawn Grain Drills. When footboards are
used, the operator stands at the end of the drill next to the seeded
portion of the field in order to follow the last wheel mark as the guide
to prevent skips or overlaps. If no footboard is used, the operator
either walks behind the drill or rides the seedbox at the end next to
the seeded portion of the field for the same purpose. Should the soil
be very loose, it is sometimes desirable to set the depth lever one hole
shallower for the end at which the operator rides. This is to be checked by the operator while on the job. Markers are not regular equipment on a drill because the wheel mark is considered the best guide, but, when the operator rides a center seat or stands at center of footboard, a disk or shovel marker is sometimes used to guide the operator who lines up the drill tongue with the field mark. When doing this, the operator must occasionally stop the drill and make a check in order to avoid skips and overlaps. Check the marker to see that it is centered with the drill if only one is used; if two are used, see

![Fig. 186. Missing plants in one spot show the effect of inaccurate field planting.](image)

that they mark equal widths from their respective ends of the drill. Always be sure the marker is in first-class condition and not making an indistinct or wobbling line. Drill crosswise to the harrowing or other last field operation prior to seeding in order to ascertain more easily the portion drilled. When seeding hillsides and driving at right angles to the slope, it is best to start seeding from the higher side of the field. If the operator rides one end of the machine, it will in this case be the higher end.

3. Operating, Adjusting, and Servicing Corn Planters

**Obtaining an Accurate Drop.** Lack of accuracy in planting is probably the leading factor, from a mechanical standpoint, for losses in yield. The losses may not always be evident if they are distributed throughout the entire field. The two fields in Fig. 186 illustrate this situation.
Another way of showing the effect of varying stands of corn is by means of the figures below. These tests were conducted in 39 Iowa county-demonstration plots over a seven-year period; three stalks to a hill were considered a perfect stand.

<table>
<thead>
<tr>
<th>Percent of Stand</th>
<th>Percent of Crop Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>63.3</td>
</tr>
<tr>
<td>75</td>
<td>88.3</td>
</tr>
<tr>
<td>90</td>
<td>97</td>
</tr>
<tr>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

In order to obtain a full yield, it is first necessary that the full number of seeds be counted out and properly planted in the hill space. It is then the operator's responsibility to see that his planter, whether or not it is new as of that year, has all parts in good, clean condition—

the land-polished areas bright and free of corrosive spots. This is not a difficult assignment if a new machine has been properly assembled and adjusted to the seed and field conditions. It is likewise a fairly simple job if the machine was cleaned, serviced, and protected at the close of the preceding year's service.

Grade the seed corn carefully to simplify the selection of the plate and assist in assuring a good stand. Seed corn, and particularly hybrid seed corn, comes in a wide variety of kernel shapes and sizes.

**Supplying the Seed Plate.** This particular assignment is a part of the operation, as it is a yearly job. The implement dealer should have the selector plates for the current year's seed. The first step is to try several seeds from a sample until the cell in the selector plate is located that seems to fit the sample best. The number opposite this cell is the number of the plate to be obtained that will probably plant this type of seed most accurately.

After obtaining the plates decided upon, make a further test, this in the planter itself. Block up the planter so that the drive wheels can...
be turned by hand. Set the planter for power-hill drop and turn the drive wheel so the planter drops approximately 75 times a minute. The speed of the plate affects the accuracy of the drop. Make a test run of 100 or so drops. Incidentally, if the seed is to be inoculated with insecticide, this should be done before the plate is selected.

When seed is not graded, the plate selects kernels that it can plant. Consequently, the number of off-shaped kernels accumulates in the hopper and necessitates a periodical cleaning out of all seed from the box. Cases have been known in which the seed hopper was nearly full of these off-shaped kernels after a few days of planting and a poor planting job naturally resulted through no fault of the planter. This emphasizes the need for using graded seed. When using edge drops and the kernels are very wide, the plate retainer (false plate) should be reversed so that the grooved side is up; this has the effect of deepening the seed cell.

**Checking and Servicing the Planting Mechanism.** Keep all moving members of the planting mechanism free of foreign material and lubricated. Do not apply oil or lubrication to any of the parts inside the seed hoppers, as none is required, and it might interfere with the chambering and discharge of the seed. Likewise, do not allow any oil to get inside the planter boots. The seed-shaft clutch on checkrow planters should be oiled with kerosene only, or with thin machine oil mixed with kerosene. Heavy oils retain an accumulation of dust and grit and prevent the proper functioning of the clutch.
Setting Openers. Check the depth of planting frequently, because narrow furrows may permit considerable soil to roll down on the planted seed, covering it too deeply, even if depth shoes are used. The openers can be set at different widths and to meet practically any row spacing desired. Set the wheels to follow properly any width of row for which the openers have been set. When changing any set for width of row, check all locking devices. The furrow marker is to be set to meet any change of row width or else the "guess" row each time will not be equidistant with the planter rows. The guess row is the space between any two pairs or sets of rows planted by the planter. Keep shoe of furrow opener clean and scouring in order to insure an even depth of planting. When depth-gage shoes are attached to the planter runner, set them the same for each runner. Never back up or turn with furrow opener in ground, because soil may be forced into the seed tube and clog it. Set all openers at just the depth needed to cover the grain correctly. Any depth beyond this is power consuming and may adversely affect germination. Check sub-soilers at frequent intervals when machines are equipped with them to see that they are at the right depth, sufficiently sharp, and not dragging trash. When trash collects on a sub-soiler or if the subsoiler is not scouring, the depth of planting is disturbed. Set press wheels in line with openers and use scrapers if dirt sticks to wheel face. Set the width of the openers for checkrowing to coincide with the buttons on the checkrow wire.

Operating Checkrow Attachment. First, lay out wire by driving planter to edge of field and place in position to drive across field where the first two rows are to be planted. Put red in place. Hook wire on anchor stake, leaving a few extra links back of hook, then set anchor stake to the rear of planter in line with outside check head—the one nearest edge of field. Adjust spring tension on the reel so that sufficient resistance is secured to straighten out the kinks as wire is...
being unwound. Now drive carefully straight across the field so that the wheel marks can be used as a guide on the return trip when planting the first two rows. At the end of the row, uncouple the wire or remove reel, and turn into position for planting first two rows, driving planter far enough into the field to allow for about four links of wire to the rear of planter and then set stake in rear of center of planter. II, owing to the shape of the field, the rows increase in length, leave enough additional wire at one end or both ends to reach the longest row.

In setting anchor stakes, the farmer must take care to pull the wire each time so that the stake is always a uniform distance in back of the last hill planted. The force applied to pulling the wire is not always an indication that it is being pulled the same distance, as ridges, clods, and other objects throughout the field sometimes cause a resistance that is deceptive.

As an aid to correct setting of stakes, it is recommended that a line be stretched across the end of the field so that the stake each time can be set even with the line. Another valuable aid is to place straight wooden sticks in the first anchor-stake hole and then in every third or fourth hole thereafter so that, in subsequent settings, the anchor stake can be lined up with the row of sticks marking previous positions of the stake.

Second, *begin to plant* with everything in proper adjustment and in good running order on the planter. Lower marker on the side toward the field, taking care that it is adjusted properly to conform with the width of planter. Place wire through fork and pulleys and close pulley holder. Set lifting lever to allow runners to go into
ground at the desired level of depth and drive a steady gait to opposite end of field, using wheel marks as a guide.

Do not try to plant nearer than four buttons from the end of the row before tripping pulley holder and releasing wire, unless in an open field where the anchor stake can be set some distance beyond the edge of the planted field. This plan will leave room for planting one round or four head rows across the end of the field and will relieve much unnecessary strain on the wire. Furthermore, this will help when turning in the cultivation that follows.

When as near the end of the field as just indicated, release wire, raise runners out of the ground and turn into position for starting on next row. In driving across the field, keep the planter tongue directly over the furrow made by the marker. Then continue planting, observing these points:

1. Drive at a steady gait or speed.
2. Do not drive planter nearer than four links of wire from the end of the field. This will leave room for four end rows and will avoid straining the wire.
3. Release the wire from the check head before making a turn at the end of the field.
4. Fill the hoppers often enough so that the seed plates are completely covered at all times.
5. Empty the hoppers twice daily to remove odd-shaped kernels.
Third, to secure a good check when planting an average-length field of 60 to 80 rods, it will be found that carrying the front frame level with the runners in the ground at operating position will deposit the hill far enough back of the button on check wire (about 1½ in.) to get a perfect check.
Should the hills show out of check, the distance of this offset is twice the amount of adjustment required at heel of post or runner to correct the error. For example, if the hills are 2 in. out of check, an adjustment of one inch at heel of runner will throw them in line. If it is found that the hills are dropping too soon, throw heel of runner forward by raising front of planter, using adjustment at rear of pole. If the hills are carried too far before dropping, throw heel of runner to the rear by lowering front by means of tongue adjustment. This correction, if not too great, can also be made by raising or lowering the end of the pole with breast straps, but breast straps must always be hooked up short enough to prevent the pole swaying, which would affect the alinement of the hills.

Fourth, to take up wire of a center reel with the reel in position, pass the wire through the wire guide under front end of tongue and attach...
to under side of reel drum. If all the wire has not been unreeled, be careful to put the reel in so that the wire winds on from the bottom when the reel turns ahead.

To guide or distribute the wire evenly on the reel, use the oscillating wire guide which is attached to seat support, being careful to move slowly back and forth as wire is being wound.

Tighten up tension on the friction clutch so that the wire will be wound snugly on reel, but do not apply enough tension to prevent the clutch from slipping sufficiently to compensate for difference in speed of reel and ground wheels. Do not put oil or grease on clutch faces. With the side reel in position, pass the wire through rollers in the check head, but not through the fork, and attach to reel so that it will feed from the front and over top of reel.

Using Hoppers. Individual or combination hoppers are used for peas and beans when planted with corn. For narrow rows, under 38 in., these hoppers on most machines, if separate, are placed outside the corn hoppers, but on wide rows they are placed to the inside of the grain hoppers. Securely clamp sprocket to planter feed shaft and carefully line up sprockets to operate the pea and bean attachment. Bolt the feed tube securely in position, making sure that the tube is properly placed with end of tube in opening and inside of post. If each kind of seed planted is dropped through a separate channel, be sure that the diverting gate functions properly. When using a fertilizer attachment, the first and most important instruction is to empty
the hopper every night, remove all moving parts, clean, and coat with kerosene. Fertilizer has many of the characteristics of cement and will harden into rock consistency when combined with very little moisture. Removing hardened or "set" fertilizer injures the mechanism and may even cause breakage.

**Operating Tractor-mounted Planters.** The operation and servicing of a tractor-mounted planter, with or without attachments and combination units, is similar to the operation and servicing of the
horse-drawn planters. The main thing to watch is not to operate at a speed beyond that recommended by the manufacturer because of the danger of scattering the seed, even if there are valves that lower the seed to reduce the distance of the final drop. Few planters, even with these valves, operate efficiently if over 85 or 90 hills are dropped per minute. In order to prevent stretching the checkrow wire in fenced fields with a four-row planter, stop when four or eight hills from the end of the field instead of two or four hills as with horse-drawn

![A tractor-mounted cotton planter using depth gage wheels.](image)

planters. This eliminates undue strain that would be placed upon the wire if the operator were endeavoring to plant as near the ends of the field as with a two-row planter.

With a tractor-mounted planter, the attaching devices should be checked frequently to make certain that all remain snug.

4. Operating Cotton Planters

The same general instructions apply to the cotton planters, both drill and checkrow, as to corn planters, except those regarding the care to be taken in selecting seed plates. Keep all parts of the planter mechanism cleaned and polished, including the seed spouts and openers. Cotton planters need agitators in the seedboxes when seed is used from which the lint has not been removed. When planting
on beds, lower the caster wheel to permit it to run down in the furrow and carry the planter frame.

5. Operating and Adjusting Bean, Beet, and Vegetable Planters

In semi-arid areas where irrigation is practiced, it is generally advisable to attach furrowers on the planter to form furrows or corrugations for the irrigating water and also to prevent the soil blowing so prevalent in these areas. Soil blowing may cut off the newly sprouted plants. These furrows or ditches also permit irrigating up

Fig. 199. Furrowing accurately for vegetables, as for most other crops in irrigated areas, avoids erodable grades and yet ensures ease of irrigation.

the crop if necessary and are helpful guides in cultivating the crop while small, or even before the seed has germinated. Clean the hopper before filling with seed and check the accuracy of planting in the same manner as for a grain drill.

Use the same care in selecting seed plates for the vegetable seed as that outlined for corn planters. Here, however, there is no dealer's selector plate as a guide.

Adjusting Openers. If disk openers are used, adjust them to turn freely and yet to retain bearing lubricants. Set scrapers just snug enough to clean off any soil that has a tendency to adhere. Adjust depth band to assure covering as suited to the soil and moisture conditions.

Setting Markers. Since row widths are sometimes varied in order better to meet irrigation requirements, set the marker accurately,
making sure it is held firmly in position. The harrowing that precedes planting should be at right angles to the planting plan.

**Adjusting for Depth.** Set levers at the depth desired, being sure that this works in harmony with the depth bands. The press wheels aid in covering and firming the soil about the seed. Always keep the press wheels clean. This is done most satisfactorily by stretching cross sections of an inner tube over each press wheel. To do this, it is necessary to remove each press wheel but it is well worth the effort as soil does not adhere to the rubber which thereby aids in maintaining an even depth of planting.

6. Operating and Adjusting Potato Planters

Seed pieces vary in size and shape. Planting potatoes is thus more tedious than planting most grain crops. Operators having planters with different picker heads for the various sizes of seed select and install the head best adapted to the seed being planted.

Before operating the planter, check all the planter parts carefully to see that they are in proper working condition and adjustment.
Checking Depth. Regardless of the type used, set at a depth consistent with the soil and moisture conditions. Potatoes are ridged more under irrigation than when grown under normal rainfall conditions and the planting depth should be set accordingly. Check all these adjustments and properly set in the field, because the firmness of soil varies greatly and the weight of the persons on the planters, as well as the amount of fertilizer and seed in the hoppers, affects the sets made.

Checking Pickers. Observe the pickers frequently to make certain the seed pieces are properly dropped off, that only one piece is picked at a time, and that this is accomplished without undue injury to the seed piece. With the cup- and wheel-corrective types there are likely to be excess seed pieces in many of the cups, if the pieces are small. The operator must be on the alert to correct the seed in each cup by removing or adding pieces as needed.
**Setting the Spacing.** The width of row and space between hills in the row should be set according to fertility of the soil, moisture available, and tools to be used for cultivation. Set the row width by carefully setting the marking disk or shovel.

![The plant setter must be as accurate in his spacing in the rows as between rows.](image)

**7. Operating Plant-setting Machines**

The team or tractor that pulls a transplanter is to be operated at a rather slow speed so the persons setting the plants can perform their job satisfactorily. Each plant, even under irrigated conditions, is usually watered as it is set. Whether this phase of the job is done manually or by an automatic device, it can be done better if adequate time is given for all operations. The moisture condition of the soil should be ideal for the plants being set. For most plants, it is best to reset them on a cloudy and cool day. If the job is done toward evening, the plants have the benefit of the night in which to revive. The soil should be as fine as possible and fairly firm, because a loose or cloddy seedbed is not conducive to survival of the plants.

Select and set the furrow opener to make the desired depth and width of furrow for the plants being set out, allowing sufficient room for the roots. Adjust the watering device to drop the correct amount of water at the desired spacing for the plants. Set the pressing wheels or pressing plates to firm the soil about the plant and, if possible, make a
slight trench at each side of the plant row to hold future water for use of the plants. Closely observe the water tank to assure a sufficient amount of water for each plant set. If there are enough plants in the plant box on the machine to work for a considerable length of time, it is often desirable to protect them by a cover, damp soil, or moisture to increase their chances of survival when set in the field.

In order to facilitate cultivation, exercise care when setting the marker to ensure all rows being equidistant. Set the marker shovel firmly on the arm to which it is attached and set the supporting chains on either side at the same length. The operator must always be alert to follow carefully the mark made for the row and, when a team is used, have a snug hitch. Some machines lock the tongue in position when it is planting, but when the frame or subframe is raised with the furrow opener at the end of the row, the tongue is released and the machine may be turned. Give careful periodical attention to the adjustment of all springs, water-valve controls, lubrication, meshing of gears, and alignment of sprockets or gears. 

Clean the transplanter at the close of each day's work. Protect the polished surfaces with oil or grease so they will function satisfactorily the next day. Remove any fertilizer from the hopper and clean and coat the fertilizer members.

SUMMARY

1. Field servicing is not reconditioning, but includes lubricating, adjusting, sharpening, replacing, and keeping tight the many kinds of locking devices. This preventive maintenance stops trouble before it begins in order to keep the machine functioning properly.

2. Broadcast seeding requires a second operation to cover the seed and unless there are rows, wheel marks, or marker lines to follow, it is well for the operator to use marker flags to avoid overlaps and skips in seeding.

3. When backing or turning short with a grain drill, lift the gangs, or soil may be forced into the lower end of some feed spouts and shut off furrow seeding.

4. Set the feeding indicator securely at the rate of seeding desired and periodically check the amount of seed used against the acreage indicated on the land measurer, which was set at zero when starting the job.

5. A stiff wire or small stick with a hook to hold onto the top of the seed tube will keep the tube open and the seed flowing.

6. Drill crosswise of the last field operation prior to seeding, to facilitate following wheel or marker line.
7. Try several seeds from a sample in the cells of a selector plate, and then select a plate having the number opposite the desired cell.

8. If ungraded seed is used, the plate may not select off-shaped kernels, therefore permitting such kernels to accumulate. Clean them out of the grain box periodically.

9. To have rows the same width in both directions of checkrowed fields, the furrow openers of the planter must be the same distance apart as the buttons on the checkrow wire.

10. With valves in the boot, some tractor-type checkrow planters can drop as many as 90 hills per minute without scattering the seed.

11. When planting cotton seed from which the lint has not been removed, an agitator in the box assists in assuring accurate planting.

12. In the Plains area, where winds are prevalent and irrigation is practiced, it is often desirable to place ditches on the planter to guide cultivations prior to seed germination and permit irrigating up the crop. The ditches also break up drifting soil particles that might otherwise cut off the tender young plants.

13. Vegetable- and beet-seed planters having small press wheels may have the wheels covered with cross sections of old inner tubes that provide a smooth surface to which soil does not adhere.

14. Have a snug hitch when using animal-drawn planters, to facilitate making straighter rows.

15. Thoroughly clean all fertilizer out of the drill box each evening, because it may harden like cement, and corrode metal parts.
6. Reconditioning and Storing
Crop-planting Machines

It is good farm management to check carefully all machines after the work season. Note the adjustments and repairs needed, and then make definite plans to recondition these machines well in advance of the next work season. This will eliminate hurried reconditioning the following year, when time is such an important factor. It also assures the work being done, reduces the number of field breakdowns, and increases the economy and efficiency of production. The need for service on crop-planting machines is largely the result of natural wear, breakage, poor lubrication, inadequate inspection, and failure of badly deteriorated parts.

The first step in the reconditioning of a farm machine is to determine, in detail, needed replacement parts, adjustments, and service. Then mark with tags, or record the needs in a book or on a farm-machine inspection sheet. Some badly worn or broken parts may be repaired or built up in the farm shop by an experienced workman, if replacement parts are not available. Order new parts early and correctly when it is not practical to repair the old parts. Used parts may be satisfactory when new parts are not available. The most acceptable source for new parts is the local implement dealer who handles the particular make of machine involved.

A maintenance form was illustrated in Chap. 3 for inspecting a machine and recording the condition of parts. Another good method is to use a metal-covered book or a surveyor's leather-covered field book. Tie the book to a shelf in the machine shed and keep in it a record of service requirements on all machines.

With heavier machines, take into the shop or farm-machine service station only those parts requiring attention. Identify all removed parts from each machine; place small parts in separate containers and number them in the order of removal. Follow the manufacturer's instructions when taking apart and reassembling any machine. The following activities will be discussed in this chapter:
1. Reconditioning Broadcast Seeders

2. Reconditioning Grain Drills

3. Reconditioning Corn Planters

4. Reconditioning Cotton Planters

5. Reconditioning Bean-, Beet-, and Vegetable-seed Planters

6. Reconditioning Potato Planters

7. Reconditioning Plant-setting Machines

8. Storing Crop-planting Machines

1. Reconditioning Broadcast Seeders

Before the actual reconditioning is begun, it is a good plan to have on hand all the needed parts, as determined by the inspection, as well as the essential shop tools. Proceed in this manner to save time and expense and be ready for the important job of seeding and planting next season.

Repairing Knapsack Seeders. Repair slightly worn or torn canvas bags by double-sewing a piece of similar material over the damaged place. Fit the new piece and stitch close enough to prevent any seed loss at the point of repair. Replace badly damaged bags by riveting or bolting new ones to the mechanism. Replace unsatisfactory or worn gears and scattering wheels. They are inexpensive and the job is quite simple.

Reconditioning Wheelbarrow Seeders. If the metal wheel is not true, remove it and straighten spokes by placing them on a flat metal surface such as an anvil face, lightly tapping the bent spokes into a straight line. The rim is brought into proper shape by tapping the bent part with a hammer as it is held over the anvil horn. Should any spokes be loose, they can be either spot-welded or riveted. If riveted, the loose spoke should be held in a vise with the wheel rim against the vise so that it is held firmly when riveted. Inspect the chain or other rotating device in the grain box that operates over the feed openings and bring this into proper adjustment or tension. Inspect the grain box or hopper carefully to see that it is tight. Replace missing nails, screws, or bolts with the proper size so as not to damage the hopper further.

Repairing Endgate Seeders. Since this seeder does not have many parts, it is easily and quickly reconditioned and no particular instruction is needed. All parts are easily removed and replaced. The sprocket wheels and hook-link chain are the parts most likely to be worn or damaged and in need of repair or replacement.
Reconditioning Two-wheeled Seeders. Flute feeds, when damaged, usually need to be replaced. Remove the gear or sprocket on the end of the shaft that operates the feeds and loosen all flutes; then remove the shaft. As the shaft is being removed, grasp each flute feed and mark as removed so that it will be replaced in the same feed cup from which it came. Reset flutes the same on the shaft with respect to the feed cups. If seeder has hoes or shovels, sharpen as needed and adjust the trip springs or replace if broken. Some wide-track seeders have reversible axles. These are supported on the inner side of the hopper by means of a strong bracket. If the axle is worn, turn it end for end.

2. Reconditioning Grain Drills

Chapter 5 outlined grain-drill maintenance requirements and called attention to the consequences likely to attend failure to follow such a procedure. Inspection may reveal four separate kinds of work to be done in reconditioning the drill; they are (1) replacing
parts that are missing, (2) replacing broken parts or those worn beyond repair, (3) repairing parts that may be put into usable condition, and (4) tightening and adjusting the drill.

Remove all seed and fertilizer from the hopper and then thoroughly clean the drill, removing surface soil and grease. This is generally done with brushes and noninflammable cleaning fluids. Dealer service stations are frequently equipped with pressure hot-water cleaners.

The following is a recommended procedure for inspecting and reconditioning a grain drill:

1. Inspect feed shafts and lubricate.
2. Replace badly worn hook-link chains, align, and then adjust tension.
3. Replace gears that are worn to the extent of damaging other gears.
4. Replace weak and broken springs. Adjust pressure springs so that all have equal tension. Adjust balance springs in a similar manner.
5. Inspect and adjust furrow-opener parts. Replace any furrow-opener parts that are worn beyond repair or that cannot give efficient service.
6. Remove disks. Clean, lubricate, and adjust or replace disk bearings. Sharpen disks as needed.
7. Adjust scrapers.
8. Inspect wheel bearings. Clean and adjust, or replace.
9. Straighten wheels and spokes, if bent. Reset tires on wooden wheels.
10. Examine all brace irons and supports. Replace or repair as necessary.
11. Tighten bolts, nuts, rivets, and screws. Replace those that are lost or broken.
12. Examine grain hopper and tighten parts. Repair any broken, loose, or damaged parts. Replace any lost parts or those damaged beyond repair.
13. Inspect hitch—tractor or horse types. Repair or replace parts as necessary to put in good order.
14. Lubricate.
15. Calibrate (see page 208, Chap. 5).
16. Repaint (see page 141, Chap. 3).
17. Cover mechanism as well as soil- and grain-polished surfaces with rust preventive.

It is essential to follow a systematic plan in reconditioning the various parts of drills so that they can be reassembled properly for easy adjustment and efficient operation.

When a worn or damaged fluted feed cup is replaced, the procedure depends on whether the cup is nearer the middle or the outer end of the feed shaft. If the cup is fairly close to the outer end of the
shaft, it is advisable to detach all cups up to and including the one to be replaced and slide them off the shaft.

Removal of the cups is accomplished by (1) removing the bolts holding the cups to the hopper bottom, (2) removing the cotter keys holding the feed roll in place on the shaft, and (3) sliding the cups with the feed rolls, springs, and washers along to and off the end of the shaft.

If, however, the cup to be replaced is toward the middle of the drill, remove cotter keys from the feed shaft and slide the shaft along for whatever distance is necessary to release the cup to be replaced. Keep detached feed rolls, washers, and other parts in the same relative position and order as they were on the shaft.

Under either method of replacement, the end of the feed roll in each cup must be so placed on the shaft as to be even or flush with the fluted washer in the cup when the indicator pointer is set at zero. The positioning of the feed roll with respect to the fluted washer is accomplished by adding or removing the slotted-hole washers that serve as shims holding the feed roll in place between the cotter pins.

To replace a double-run feed cup, (1) remove cotter keys from the shaft, (2) slide the shaft toward the outer end of the drill until the end passes the cup to be removed, and (3) remove the bolts securing the cup to the hopper bottom, thus freeing the cup. Installation of the
new cup and reassembly of the shaft are accomplished by reversing that procedure. Caution: Be sure, when the cotter keys are put back, that the ends are spread and smooth against the shaft; otherwise they constitute hazards.

Replacing a Vertical Countershaft and Pinions on Speed Device. Throw the speed device out of gear by raising the furrow openers, loosen the cap screw, and turn the dust cap on the top end of the vertical countershaft at right angles. Then slide the shaft up and out, releasing at the same time the sliding pinion and the stationary pinion. This procedure is reversed when the new gear is installed and the shaft reassembled.

Replacing a Multiple Gear on Speed Device. Lower the furrow openers to the ground and jack up the drill, blocking it securely. If the drill is a through-axle type, one wheel must be removed; if of stub-axle type, this may not be necessary. Then loosen the setscrews on the driving parts on the axle. If a through-axle drill, with one wheel remaining on the axle, grasp the wheel below center and pull the axle out. If a stub-axle drill, grasp the wheel and pull the axle out in the same manner. Before sliding the axle all the way out, however, and releasing the multiple gear, note carefully all assembly details of the cam and washer between the multiple gear and speed-device yoke, so that no difficulty will be experienced in reassembling. Reassemble by reversing the disassembly procedure.

Reconditioning Double-disk Furrow Openers. Remove the furrow opener, complete with drawbar, from the drill before begin-
ning to disassemble. With an open-end or monkey wrench, remove the outer plug in the disk hub. Then use the special L-shaped wrench to unscrew the bearing-block plug inside the hub. The plug in the right-hand disk has a right-hand thread; that in the left-hand disk has a left-hand thread.

With this inside plug unscrewed, the entire assembly of disk, bearing, bearing-block plug, bearing case, and bearing seal can be lifted off the furrow-opener housing. To get at the bearing, it is necessary to cut the rivets holding the bearing case to the disk.

After thoroughly washing all parts with a safe solvent, reassemble by putting the new bearing in place, then the plug, then the case, and bolt the case to the disk. This permits checking the bearing for proper clearance before riveting.

If the bolted bearing does not turn freely in the bearing case, grind until adequate clearance is obtained. Then rivet to the disk and reassemble to the furrow-opener housing. Make sure that the seal is in place and that both the bearing-block plug and the outer plug are properly "snugged."

Replacing Inside Scrapers. It is necessary to pay particular attention to the assembly of the scrapers, the scraper hinge, and the spring spreader. Be sure to get these parts assembled correctly.

Reconditioning Single-disk Furrow Openers. When it is necessary to replace a bearing or a seal, or to clean a bearing, use a hammer and chisel to straighten out the washer-type nut lock, then unscrew the nut. Remove the disk assembly, consisting of bearing case, bearing, and disk, from the hanger, as well as the seal. To get at the bearing, it is necessary to cut the rivets holding the bearing case to the disk, as explained for double disk.

When reassembling with new bearing installed, thoroughly wash all parts with a safe solvent, making sure that oil seals are in place and that the steel-sealing washer is properly located between the hub and the hanger. Make sure that the flattened portion of the washer-type lock nut lines up with the flat surface of the hanger. Snug up the nut and bend the washer-type nut lock up against the nut.

Reconditioning a Power Lift. When the mechanism is not raising the furrow openers satisfactorily, the first thing to check is the power-lift clutch to see that paint, grease, dirt, or other material is not interfering with its efficient operation. Then check the adjustment of the helper spring, if it is present. Also, check the setscrews that
hold the clutch in position on the axle. Usually the source of the trouble can be located among these three places. Check wheels for alignment and straighten parts as needed. Look for contributing causes such as bent or broken axles, spokes, and rims. Braze, weld, or replace broken parts.

3. Reconditioning Corn Planters

The corn planter, similar to the grain drill, is used for only a few days each year, yet those days determine to a considerable extent, from a mechanical standpoint, the corn harvest. The corn planter should have an off-season check and reconditioning to leave it in first-class shape for the following season. It is assumed that the polished parts, fertilizer members, and furrow openers have been removed, cleaned, protected against corrosion, and stored in a dry place away from poultry and livestock.

Reconditioning Horse-drawn Planters. Make an annual inspection during a slack work period and perform the following jobs:

1. Clean planter so that it can be more satisfactorily inspected and reconditioned.
2. Remove, clean, and replace badly worn or broken links in hook-link chains. Replace chain according to direction of pull and then adjust the tension.
3. Inspect feed-shaft bearings and service or replace if badly worn.
4. Inspect clutch and variable drop gears. Service, adjust, and replace as needed.
5. Check oil in clutch and variable-drop gear case. At start of season, clean clutch-gear case and refill with oil of correct grade. Check oil level.
6. Clean out seed hoppers and runner-shank seed tubes.
7. Examine seed plates, false plates, and dropping mechanism. Replace as needed.
8. Inspect furrow openers. Sharpen and adjust.
9. Inspect runner openers and replace if badly worn.
10. Inspect fertilizer attachments for needed service and replacements.
11. Inspect check fork, checking mechanism, and check wire. Service and replace as needed.
12. Inspect drill shaft. Service, straighten, or replace.
13. Inspect disk or other type of marker used. Tighten and repair.
15. Inspect levers for needed adjustment and service.
Fig. 208. Student reconditioning a corn planter in the school vocational-agriculture shop. (A) Before, (B) After.
16. Examine and tighten bolts, nuts, studs, rivets, and cotter keys. Replace with the correct size any that are badly worn, broken, or missing.

17. Inspect the following for service, renewal, needed adjustment, and lubrication:
   a. Main axle bearings
   b. Feed-shaft bearings
   c. Clutch and variable drop device
   d. Drive wheels
   e. Bearings of disk-type furrow opener
   f. Rollers on checking head
   g. Bearings of reel hanger

18. Inspect, repair, and adjust hitch, eveners, and pole.

19. Cover surface of disks or shovels of furrow openers, runner openers, disk marker, and grain-polished parts with a rust preventive, grease or paint, if machine is not to be put into immediate use. Paint all wood and metal parts that are not protected.

20. Recheck all adjustments and repairs on the job.
Reconditioning Tractor-operated Planters. Proceed in a manner similar to that for the horse-drawn planters just described. Also inspect and service the hitch or attaching mechanism. Inasmuch as the tractor governs the travel and consequently the uniformness of planting, the mounting of planter to the tractor must be in first-class condition. This includes brackets, hitches, and power-operated mechanisms. Clean these items to be sure that all operate freely and are in proper order.

The "pay-out" stake mechanism is checked easily, as are the shaft and the universal connection between the 2 two-row planter units.

Reconditioning Combination Planters. The same instructions apply here as those discussed under Corn Planters.

4. Reconditioning Cotton Planters

In general, the corn-planter instructions apply here. The cotton-seed picker wheels need to run true and be in proper mesh with the driving mechanism. Likewise, the boots must be clean and smooth to permit unrestricted seed drop. The fertilizer attachments, whether on corn, cotton, vegetable, or potato planters, are treated the same. They should be cleaned out at the close of each day's work. If not, the fertilizer sets, corrodes metal parts, and may cause damage to the machine when it is next operated. Remove all parts in need of reconditioning at the close of the working season and make definite plans to make or secure the necessary repairs.

5. Reconditioning Bean-, Beet-, and Vegetable-seed Planters

The same instructions apply here as to the corn planters and grain drills, for parts that are similar.

Recondition such parts on any planter or drill with exacting care. When wood parts are being replaced, a suitable kind of wood must be selected and accurately fitted. This is usually done by using the discarded part as a pattern to determine the correct size and proper location for holes and fittings. Holes that are too small induce splitting, while those that are too large result in play; both efficiency and safety are to be considered.
6. Reconditioning Potato Planters

Many of the same instructions that were listed for corn planters and grain drills apply here. After thoroughly cleaning the machine, include the following steps in the reconditioning procedure:

1. Jack up planter. Turn drive wheel with machine in gear to observe working parts. Replace or repair worn and broken parts. Replace lost parts; adjust.
2. Tighten loose bolts, rivets, and other fasteners.
3. Clean oil holes of old grease and foreign material.
4. Remove and clean grease cups. Clean bearings. Replace any grease cups or other grease fittings that are lost or broken.
5. Remove and clean potato tubes.
6. Inspect braces and supports. Repair or replace.
7. Inspect potato hopper. Repair as needed.
8. Examine and then repair, adjust, align, sharpen, tighten, or replace the following parts:
   a. Pawls and pawl springs
   b. Main axle bearings
   c. Clutch, clutch springs, and clutch sprockets
   d. Chains, sprockets, and gears
   e. Picker shafts and bearings
   f. Picker arms or cups
   g. Picker spears and picker springs
   h. Seed-hopper agitator or belt
   i. Furrow openers and bearings of covering device
   j. Marker blade or disk and all marker parts
   k. Bolts attaching pole to main frame or tractor hitch
9. Lubricate thoroughly.
10. Clean again and paint (see page 141).

7. Reconditioning Plant-setting Machines

These machines do not have many parts in common with other crop-planting machines; therefore, a rather complete reconditioning may well include the following jobs:

1. Clean the machine.
2. Examine tank and weld or solder any leaks.
3. Inspect water pipes and water valve at heel of furrow opener. Tighten, replace, or adjust parts as needed. Set water regulator at amount
desired. Check valve and springs controlling the water and water trip.

4. Inspect timing that spaces plants and releases water at desired distances. Adjust for timing. Replace or repair parts of timing device in need of attention. Tighten parts and set gears for a full mesh.

5. Examine frame. Straighten bent parts, tighten loose parts, and weld or replace broken parts.

6. Inspect lever that controls subframe and depth of furrow. Bolt packing wheels or press plates into the proper position. Check springs on subframe to assure uniform packing pressure.


8. Repair plant boxes if broken or damaged. Bolt firmly into position.

9. Inspect seats for needed repairs and replacement of parts.

10. Check foot and hand trips. Tighten, repair, and adjust.

11. Inspect all springs. Replace weak and broken springs. Adjust tension.


13. Inspect front and rear frame wheels and packer wheels. Clean and adjust bearings. Adjust wheels.


15. Clean lubrication fittings and apply recommended lubricant.

16. Paint.


8. Storing Crop-planting Machines

Crop-planting machines have many grain- and soil-polished members that are readily subject to corrosion and deterioration if not well protected and stored. Adequate protection and storage require a relatively small amount of time. Lack of attention to these machines may result in uneven seeding, increased draft, breakage, and operation difficulties during the next and succeeding years.

Studies show that proper housing frequently doubles the life of farm machinery. See Chap. 3 for more complete information on protecting and storing machinery, particularly for in-use and idle season storage. Store crop-planting machines in dry places protected from the weather and livestock. Remove all grain and fertilizer from machines. Grain left in a planter collects and holds moisture and invites damage from rodents. Depending on the climate, the grain will sprout, mold, or rot, causing deterioration of cloth and wood as well as rust and corrosion of metal.
Where dry and protected inside storage space is limited, it may be necessary to remove hoppers and operating mechanism to such storage, leaving the drill framework and wheels outside. Keep pneumatic tires from contact with the ground and away from oil and grease.

**Storing Broadcast Seeders.** After removing the grain from the knapsack seeder, clean and cover the wheels and gears with a rust preventive. Hang the seeder in a place protected from weather, rodents, birds, and insects. *The endgate seeder* is comparatively small, so, after cleaning it, store in an elevated position so it cannot fall.

Support long hoppers of seeders in such a manner that they will not warp or sag. Avoid using them as shelves or tables. Clean out seeders and protect metal surfaces with a good rust preventive. Avoid having these machines in open storage.

**Storing Drills.** Prepare for storage at the close of the work season. A little care at this time will save hours, if not days, of work the following season and will save money in service and parts. Unless drill parts receive the right kind of attention, they will deteriorate from rust and acid corrosion.

Reference was made in Chap. 5 to the necessity of removing all seed and fertilizer from the drill at the close of each working day. Even after following that precaution, the owner should again examine the drill as it goes into storage. Any grain or fertilizer left in the hopper will collect and hold moisture. This, in turn, will rot wood.
and corrode metal. Remove the back plates and feed wheels, coat them with a protective film of oil, and store them on shelves.

Store grain drills in the dry, setting them level and under cover. Improper storage may bend or deflect the hopper so the working parts will not function properly. Place boards under the grain drill when it is necessary to store it on a dirt or cinder floor.

Clean the grain tubes thoroughly and apply kerosene liberally to the feed mechanism. Cover the furrow openers, whether disks, hoes, or shoes, with a rust preventive. Lower the furrow openers to the floor so as to relieve lifting mechanism of unnecessary strain. If the storage space has a dirt floor, place the furrow openers on a plank. This provides a uniformly smooth surface for the openers and gives added protection against rust. Close and secure the lids to the seed and fertilizer hoppers.

Storing Corn, Cotton, and Combination Planters. Much of the accuracy of the corn and cotton planters depends on the out-of-season care given them. To protect these machines from corrosion and damage, store them in weatherproof buildings away from poultry and livestock. Where this is impractical, remove the planting mechanism, including hoppers, plates, boots, and furrow openers. Label
each piece, indicating where it is to go on reassembly. Then clean, coat with a rust preventive, and place inside.

Follow these steps in storing such planters:

1. Empty hoppers.
2. Clean valve mechanism in boot and clutch with a safe solvent and coat with oil for protection. This should be washed off with a solvent before use the following season.

3. Grease the furrow opener or cover with other rust preventive.
4. Place board under the openers and rest the weight of the planter on them.
5. Remove tongue and place a wooden block between tongue braces. Store the tongue in a dry location, well supported throughout its entire length to avoid warping, or place it in an upright position.

Storing Potato Planters and Plant-setting Machines. The same general instructions apply here as for other planters and drills. Remove all seed, fertilizer, and fertilizer members; clean and coat with rust preventive. Clean and protect all plant- and soil-polished surfaces, and store in a weathertight building.
Removing Crop-planting Machines from Storage. Clean new or reconditioned machines that have been in storage. Again examine bearings, bushings, and working parts. Lubricate machines before using them. Such locking devices as bolts, nuts, screws, cotter keys, and setscrews should be checked again even though this was done when the machine was placed in storage. Adjust or calibrate, as needed, all devices having to do with accuracy of planting. Remove grease, paint, or other rust preventive previously placed on polished surfaces by means of scraping, hot water, and safe solvents, and by use in the soil.

SUMMARY

1. When replacement parts are not available or are costly, it may be possible to braze or build up the worn or damaged part to make it serviceable.
2. The most satisfactory source of new parts is the dealer who handles the particular make of machines.
3. When disassembling a machine for reconditioning, keep all small items for each unit in separate containers and mark all larger items for identification when assembling.
4. When replacing wooden members, use the old part as a pattern, carefully mark the places where holes are to be bored, and make these the exact size of the bolts because an undersized hole may induce splitting and a hole too large will permit play to impair the machine.
5. When bolts holding metal parts become too small, a new bolt is to be used or the hole reamed out and a new bolt snugly fitted.
6. Many metal parts that are bent or distorted can best be straightened without heating; heat might weaken the part by destroying the temper.
7. A vise or press can often be used to straighten any bent or distorted members while they are cold. Whether a vise or sledge is used, it is well to protect the member from further damage with wood or other material.
8. Thoroughly clean all planters and drills; remove the grain and fertilizer before placing in storage.
9. Nearly all seed-planting machines are used for only a few days each year. Therefore, to ensure long, economical, and satisfactory service, provide satisfactory storage during the working and idle seasons.
10. A good rule with any machine is to keep it clean, dry, and serviced.
11. Store grain drills in the dry, keeping them level where they will not serve as a rack or shelf, and away from livestock, poultry, and birds.
12. Where the storage room has a dirt floor, keep all members free of the ground by setting them on planks or other objects.
13. Protect all polished surfaces and other metal parts that may corrode with a rust preventive after they have been cleaned and dried.

14. A few minutes spent in storing machines or vital parts in a dry and protected place for the time not in active use may save hours of time when again placing them in service and may also improve the quality of service rendered.
PART III

CROP-TILLAGE MACHINES
7. Selecting Crop-tillage Machines

In the two preceding parts, the importance of the soil, seedbed preparation, seeding, and the use of high-quality, graded seed were emphasized as the basis of the farmer's annual production of crops. After good seed has been carefully planted in a well-prepared seedbed, the growing plant must make use of plant food, moisture, and sunshine.

Also, in the previous parts, the soil and seedbed were compared to a present-day house with its several functional rooms. This comparison was made to supply a better picture of the requirements of the seed and, later, the plants in their germination and initial growth. An occupied house is stocked with food and other provisions. After the soil is provisioned with humus and fertilizer and the seeds are planted, it is necessary to protect the crops from weeds endeavoring to
steal the plant food and moisture. Thus, one of the primary reasons for cultivating crops is to guard against the robbers of plant food. Cultivation requires the use of machines best fitted for the work. The selection of them is discussed under the following activities:

1. Selecting Walking and Riding Cultivators
2. Selecting Tractor Cultivators
3. Selecting Lister Cultivators
4. Selecting Beet and Bean Cultivators
5. Selecting Field-cultivating Machines
   - Rotary Hoes
   - Harrows and Drags
   - Weeders—Pencil-point, Rod, Flame, and Chemical
6. Selecting Plant Blockers and Rotary Choppers
7. Selecting Orchard-cultivating Machines
8. Selecting Truck-garden Tillage Machines

It is a far cry from the crooked stick, as first used by man for cultivating crops, to the present-day tractor-powered cultivator that tills several rows at a time. Down through the ages, the machines for cultivating crops have kept pace with soil-preparation and planting machines, although there has been great misuse of some tillage machines. This misuse is most serious where plant feeder roots are cut by deep cultivation when they fan out, and again where the soil surface is left in a condition not receptive to moisture and conducive to erosion.

The main purpose of cultivating is to promote the growth of certain plants by destroying competitive plants. This and some of the other means for stimulating plant growth through cultivation are

1. Retention of moisture by
   a. Killing weeds and other competitive plants
   b. Development of a soil surface receptive to moisture
   c. Development of a soil surface preventing too much aeration
   d. Development of a soil structure increasing water-holding capacity, and preventing runoff
2. Breaking up of wind currents by a rough soil surface, thus preventing soil and sand from either shearing off plants or blowing away to leave them without anchorage.
3. Incorporating fertilizers into the soil.
5. Increasing oxygen in soil through aeration.
6. Reducing danger of lodging through moving soil up to plants.
7. Directing moisture to or from the plants as desired.

Soil, climate, crops, size and shape of fields, terrain, power, and man power influence the type and size of tillage machines used. Large fields can be cultivated quickly and often on a high daily-
acreage basis with row-crop tractors and multi-row cultivators. Smaller row-crop tractors with mounted cultivators are economical on small and sometimes irregularly shaped fields. On the other hand, some crops may demand the slow and careful tillage of smaller cultivator units.

Multi-row hi-speed tractor cultivators reduce labor and make possible early and late cultivation.

1. Selecting Walking and Riding Cultivators

When the hoe is the only means of tillage, the crop production per farm worker is materially restricted. One of the most significant results of larger farm machines is the reduction of time and cost to produce a bushel of wheat, a bushel of corn, or a bale of cotton.

The cultivating machine can be expanded in size rather easily as compared with some others. There are few moving parts and complicated mechanisms. The main problem when increasing the size of the units is to retain maneuverability, which is necessary for dodging plants in crooked rows and which makes the machine easier to handle in irregularly shaped fields, at point-row ends, and on land farmed on the contour.

Selecting Cultivating Shovels or Ground Equipment. Present-day cultivators usually have several small, pointed plows commonly referred to as shovels, sweeps, and blades. They are moved through the soil parallel to the rows to kill weeds and mulch the soil between the rows. A variety of interchangeable soil-working members is
available for use with most cultivators to meet different crop requirements, soils, and seasons of the year. The more common are the bull tongue, spring tooth, spike tooth, deer tongue, duckfoot, horse hoe, sweeps, and potato hillers or long moldboards.

The **bull tongue**, in blade widths up to 6 in., throws the soil both ways. Select this type for loose, loamy soils free from clods. **Spring teeth** are similar to the spring teeth of field cultivators (Part I) and are used in heavier soils than the bull tongue. The **spike tooth** or **deer tongue** is a double or reversible shovel. It is available in widths varying from 1 to 4 in. in \(\frac{1}{4}\)-in. variations. Provide it for early cultivation and next to the rows in later cultivations. The **duckfoot**
is a spearhead type of shovel with only slight angle to the ground. It undercuts close to the surface. Thus it is used especially in late cultivations. The horse hoe is sometimes referred to as right- and left-hand moldboards or wing hillers. It throws soil into or away from the row. Sweeps are arrowhead or V-shaped shovels from 5 to 18 in. or more in width. Also available in left-hand and right-hand are half-sweeps 8 to 10 in. or more in width for working next to the row. Use sweeps in mulch culture and late cultivations to prevent crop-root injury. Potato hillers or long moldboards are used for throwing up ridges in the crop row. Other soil-working members are straight shovels, ranging from 2 by 9 in. to 5 by 11 in., and several sizes of twisted shovels, spearhead shovels, detachable-point sweeps and shovels, winged furrows, and other special sweeps and shovels. Select shovels adjustable on the shank, as to pitch and the amount of soil they throw.

Selecting Walking Cultivators. Those of the half-row type are usually pulled by one horse or mule and have from one to seven or more shovels. As one round trip at least is required to cultivate each row, these cultivators are suited only to small fields, stumpy and rocky land, and for crops that are extremely tedious to cultivate. The one-row walking cultivator, as the name implies, covers one row each time across the field, its two gangs, each equipped with soil-working members, straddling the row. These gangs can be maneue-
vered or guided independently of each other for working as close to the row as desired. The operator walks, using offset handles to guide the cultivator gangs.

**Selecting Gang Types.** There is a choice of several gang types—steel or pipe beam, round or shaped shank, accommodating two to four or more shovels on each half-gang. Shank breaks and trip releases prevent bending, breaking, and twisting of the shanks, beams, or other parts of the cultivator, when the shovels encounter solid objects. Trips are of three main types—spring, pin-break (wooden), and friction.

![Fig. 219. Three types of shank releases. (A) Spring. (B) Pin-break. (C) Friction.](image)

The spring trips employ one or more springs per shovel, which allow a shovel to pivot backward to pass over a solid object encountered. The shovel may then return to its working position automatically, although usually the machine is either backed or stopped and the gang elevated, to permit the shovel to snap back into working position. Select spring trips on which the spring tension is adjustable. The pin-break is a wooden pin or peg serving as the lower of two pins to hold the shovel shank in place. When it encounters an unyielding object, the pin breaks, permitting the shovel to swing back and pass over the object, thus avoiding damage to the cultivator. The pin, when broken, must be replaced. The friction type, which is rarely used, works on the principle implied by its name.

Provide shields, especially for cultivating small plants. Four types are available: rotating, solid, wire, and hooded. The wire type is used after the first cultivation; the hooded shields are for small listed plants.
Select shields that can be adjusted to regulate the amount of soil rolling into the row.

**Selecting Riding Cultivators.** These have either shovels or disks and most are of the single-row type, although two- or more-row models are available. *Disk cultivators are particularly suited for listed ground* and for use where quack grass, vines, and trash in the field collect on the shanks of shovel cultivators. The disk gangs can be set at many angles to throw soil to or from the row and to meet varied ground contours. It is often desirable to change the number of disks in a gang, for example, when throwing dirt away from small plants in narrow rows. For such conditions, select a disk cultivator from which a disk on each gang can be easily removed.

**Selecting Gangs.** Gangs are guided by seat, lever, or foot controls, although they may be set rigid if desired for field use or travel.
Fig. 221. Disk cultivators are adjustable to many cultivating requirements. This cultivator has the disks set to throw soil to the row. Note solid shield.

Fig. 222. A shovel cultivator guided by means of a foot control.
Fig. 223. Combined hand and foot control of the shovel gangs.

Separate levers control the working depth for the shovels or disks on each gang; however, a single master lever for raising and lowering both gangs is desirable and usually provided. Some provision for adjusting the height of the hitch is also desirable.
Wheels are somewhat larger and stronger than for walking cultivators in order to carry the extra weight of the operator. Tires are available in various shapes. Provide the concave tire for sand and loose soils, and the flat, oval, and convex types for the heavier soils. The bearings in the wheel boxings are lubricated by means of hub-caps, pressure fittings, or grease cups. To meet varied row widths, the axles are in two pieces, divided in the middle so that they can be adjusted in the frame to space the wheels.

A spacing lever is often provided to control the distance between gangs. On some cultivators, the distance between gangs is controlled by spacing the gangs on an arch or rod. Most cultivators are adjustable for rows 28 to 42 in. wide, while others can be set for rows as wide as 60 in.

A tilting lever at the rear end of the pole is helpful for cultivating on side hills and when using horses of different sizes.

It is desirable to have a frame that balances on the wheels when the shovels are either in or out of the soil and that can be adjusted to balance with operators of different weights.

**Providing a Fertilizer Attachment.** Fertilizer applied at the time of cultivation reduces the danger of fertilizer being washed away by spring rains before and during the planting season. Such application also supplies plant food at a very desirable time. Fertilizer attachments are available for most cultivators. They clamp to the frame arch. Agitators driven by independent sprockets from the
wheels assure a steady flow of fertilizer through the distributor tubes to be deposited directly behind the front shovel of each gang.

2. Selecting Tractor Cultivators

The tractor cultivator is part of the equipment comprising the completely mechanized farm. Tractor cultivators are of the trail-behind and tractor-mounted types. The latter is practical, simple, and efficient. Several methods of mounting are in use. Tractor-mounted cultivators are designed for each make and model of tractor, thus providing a cultivator suitable for large and small farms. They range in size from one- to four-row for corn and cotton; even more rows are possible for beets, beans, and some other vegetables. Mounted cultivators, like other machines for row-crop tractors, are readily attachable and detachable.

For successful operation, a tractor-mounted cultivator must follow rows planted with a planter covering the same number of rows. This is essential because the space between shovel gangs is not flexible. The shovels operate as a unit.

Choosing Mounting Arrangement. Tractor cultivators for field crops, including beets and beans, are mounted in one of three positions, or in a combination of them.

**Front Mounted.** This means a tool bar even with or perhaps extending ahead of the front axle. These cultivators may have all the shovels
in front; however, a better method is to have the shovels next to the rows in front, where the operator can do a good job of dodging crop plants. The remaining shovels are in a rear section behind the tractor. These rear shovels cultivate the spaces between the rows and also loosen the soil in the wheel tracks. There are two methods of front mounting, one with the steering-wheel gang shift, described later under Guiding the Cultivator, and the other employing a rigid tool bar secured to the tractor chassis. Both methods are satisfactory.

Side or Center Mounted. In this type, the cultivator gangs are between the front and the rear wheels. These are mounted either to a rigid bar through the tractor chassis or to a forward drawbar. The actual cultivating takes place close to and just in front of the operator. Here again, the soil-working equipment for the center of the rows is often attached to a tool bar at the rear of the tractor. This is another satisfactory arrangement.

Rear Mounted. A rear tool bar and mounting linkage are available for cultivating equipment mounted on the rear of the tractor. This is especially true for bedding and cultivating crops like sugar cane and even corn in some sections. Both regular and cutaway disks are used for this purpose. These machines have two or three disks on each gang that are reversible and adjustable for tilt and angle of cut. Middlebreakers that may or may not use colters and gage wheels attach to the same common basic frame bar and are sometimes employed to make beds and to cultivate.

Checking the Guiding of the Cultivator. In some cultivators, the gangs are shifted by being pulled or pushed to one side or the other by the tractor itself to dodge the rows, especially when cross-cultivating checked rows. The front-mounted tractor cultivators of some manufacturers are shifted while the tractor is being steered. This is accomplished by linkage controlled from the tractor-steering mechanism.
Checking Raising and Lowering Gangs. Most cultivators are available in either hand or power lift. In the hand or manual lift, levers convenient to the operator enable him to raise the gang on either side independent of the other. This necessitates the operator’s raising the gangs at the end of the rows and guiding the tractor. Nearly all cultivators are equipped with a spring-assisted master lever, which lifts all of the gangs. Gage wheels, especially on four-row cultivators, keep the gangs at proper depth. The power-lift cultivator is preferred in the multi-row models. A convenient control raises and lowers the cultivators mechanically. Various methods are employed for this—hydraulic, mechanical, and pneumatic. The delayed-action lift is desirable for cultivator gangs in front and at the rear. This is a power lift that raises the front gangs first and then, after the tractor has traveled a few feet, lifts the rear gangs. The same procedure lowers the gangs.

At least one new-type tractor has a quick-attachable cultivator with a part of the shovels on the sides of the tractor and the rest at the rear. The raising and lowering is through a touch-control system that also controls the depth of cultivation.

Selecting Soil-working Equipment. The pneumatic-tired tractors, with their increased speed in cultivation, have brought about radical changes in the design of sweeps and shovels. Some of the most common types are
1. The general-purpose or "mixed-land" sweep having a rather broad angle and medium crown. Like most sweeps, they are \( \frac{3}{16} \) to \( \frac{3}{4} \) in. in thickness. This type is 6 to 18 in. in size, and 6 to 10 in. for either right or left half-sweeps. This style of sweep is well suited to shallow or deep cultivation at a moderate speed without throwing an excessive amount of soil.

2. The blackland sweep, having a sharp angle and high crown, throws considerable soil even at slow speeds.

3. The so-called "high-speed" sweep has a broad angle and medium low crown, well suited for shallow cultivation which throws a moderate amount of soil at high speeds.

4. The very low crown and sharp-angled sweep, sometimes referred to as the "Texas" sweep, can be had in widths from 4 in. to over 3 ft. This sweep can be operated at speeds in excess of 5 m.p.h. with only a small amount of soil being thrown to the row, and is admirably suited to shallow cultivation. Where flame cultivation is a part of the mechanized farming equipment, it is one of the best types to use in conjunction with the shovels.

Tractor-operated cultivators can be equipped with other types of shovels, shanks, and shields described previously (see page 254). In addition, the same tool bars will often accommodate rotary-hoe attachments (described later), bean-harvester attachments, peanut-digger attachments, beet-puller attachments, and furrowing attachments.

3. Selecting Lister Cultivators

Lister cultivators are for cultivating crops planted in lister furrows. Many of these function best in cultivating crops during their early stages of growth. There are several types of lister cultivators, the main two being sled and wheel. The former takes one row at a time and is rather heavy in draft, whereas the latter takes from two to five or more rows and is mounted on wheels.

The sled lister, sometimes referred to as a "go-devil," usually has three disks of varying size in each gang. These disk gangs can be adjusted as to position and to throw soil to or from the row. In some cases, the disks can be removed and replaced with shovels. On most sled listers, large side blades can be attached near the front end of the runners to shear off weeds and grass and to level the ridges. Wings or crusher boards attached to each side of the runners help to balance the machine in the row as well as to crush clods. Select a machine having a hooded or solid shield that can be adjusted as to
position and a lever to control the depth to which the disk gangs penetrate.

The wheel lister may or may not use shovels with disks located on both sides of a row, these to be set to throw soil to or away from the row, and for bedding. A main lever for each gang controls the disks, shovels, and shield as a unit while a secondary lever on some models controls shield and shovels. The two-row horse models take alternate rows. Models covering more than two rows usually do not alternate on rows and may be pulled by horse or tractor power. Select a

machine having gangs that are flexible or pivoted, permitting them to follow unevenly spaced rows.

4. Selecting Beet and Bean Cultivators

These machines are not limited in their use to the cultivating of sugar beets and field beans. However, they are designed to cultivate low-growing crops planted in narrow rows, such as sugar beets and beans, although they can be adjusted to meet almost any row width. These machines are of the multi-row type with the four-row designs being most common in the irrigated sugar-beet areas. They are also available for tractors in trail-behind and mounted types, covering up to six rows, as previously described in this chapter. Always select a size and type best suited to the power and crop and to the conditions under which it is to be operated.
Mulch culture is gaining in prominence in the Great Plains and other semi-arid regions. The procedure involves stirring the soil below the surface, leaving a mulch or crop residue on the surface. (A) One type of mulch-culture cultivator. Disks throw the soil away from the rows, while the spring-mounted subsurface sweeps destroy the weeds. (B) Another type with single disks and rigid shanks for the subsurface sweeps.

Fig. 231. A multi-row beet and bean cultivator working in sugar beets.
Other essential features to consider when selecting these cultivators are ease of guiding through frame or wheel control so as to follow the rows accurately; easily changeable shovels and blades; easily set ground-working equipment to meet row width and cultivation depth; suitability for row ditching in irrigated areas; adaptability to a variety of shovels; and lightness of draft.

Since sweeps or duckfoot-type shovels are commonly used on this cultivator, it is often called a "duckfoot" cultivator. This misnomer is also frequently applied to the field cultivator discussed in Part I. Seedbed-preparation Machines.

5. Selecting Field-cultivating Machines

Selecting a Rotary Hoe. This machine is not a cultivator of the usual type, but it does perform an essential function by breaking soil crust, destroying small weeds, and making a surface mulch for some row crops while they are in the early stages of growth. It is efficient, also, for breaking crust and aerating the soil for small-grain crops. The gangs are flexible so that they will cover
surface variations between rows. This flexibility also permits safe crossing of small depressions and gullies. Select this machine to cultivate right in the rows around the young and tender plants before other machines can be safely used.

The single-row or double-row rotary hoe is, in reality, a number of curved points or fingers spaced about 5½ in. apart; these may be combined with shovel equipment. Hoes having front and rear gangs are staggered so the rear hoes work the soil left between the front hoes. The one- or two-row sizes are used for horsepower while the larger four- to six-row combined units are often preferred for tractor power. Select a hoe with a platform to hold additional weight when deeper penetration is desired and transport wheels for moving over hard-surface roads.

Selecting Harrows and Drags. Although harrows and drags are primarily seedbed-preparation machines, they often serve as valuable cultivating equipment. Select these machines for weeding, when the plants are small, or to break crust before they have come through the soil surface, if deep penetration is not required. They will break soil crust, level ridges, and kill many small weeds. These machines were discussed in Part I.

Selecting Weeder. The pencil-point type of weeder is composed of two or three rows of spring teeth with round or pencil points. The teeth operate directly over the rows, the light teeth flipping out the weeds while they are “still in the white”—without injuring the more deeply-rooted, planted crop plants. Weeder attachments are available for horse-drawn cultivators as well as in complete units.
They are also available for rear mounting to the row-crop tractor’s drawbar.

Flame Weeders. Hoeing weeds by hand or by mechanical means with shovel-type cultivators to destroy them requires considerable labor. Working the soil, even for cultivating, is dependent on the dryness of the field. Flame weeders or weed burners, as well as chemicals, have been used for years by irrigation-ditch companies and railroads. Flame is being used to clean drainage ditches, fence rows, and road banks of unwanted vegetation, and for controlling weeds in row crops. This practice is most promising with the semi-tropical crops, cotton and sugar cane, and with other row crops including corn, soybeans, and vegetables. Flame weeders, when used as flame cultivators, consist of a comparatively light frame carrying a fuel tank, two or more burners for each row, and control valves for gaseous fuels or an engine-driven compressor for liquid fuels. Being comparatively light in weight and also in draft, flame cultivators can operate as soon as the ground can support traction.

An intense heat flame forces its way around each individual crop plant, burning the tender weeds and grasses. Combination cultivators, mechanical on the front of the tractor and flame at the rear, provide a very thorough cleaning job. Prospective users of flame cultivators are urged to contact their state experiment agricultural
engineers as to flame-intensity and travel-speed requirements for their crops. Rod weeders were discussed as a seedbed-preparation machine in Part I.

Chemical Weed Killers. A new chemical, commonly referred to as “2-4-D,” is very effective on certain types of vegetation, especially the round-leaf families. The chemical is equally destructive on crop and weeds alike, so is to be used with caution and under restricted conditions. It is possible to use chemicals alone or in combination with flame- and mechanical-control methods. Chemicals can be applied by ground machine or aircraft.

6. Selecting Plant Blockers and Rotary Choppers

These machines cut out excess plants, leaving small blocks of sugar beet, cotton, and similar plants at regular intervals. Other machines perform the same function with a flame. These intervals are determined by the germination stand, width between rows, water supply, and fertility of the soil. Some beet blockers are made from duckfoot beet and bean cultivators. Other machines have blades, shovels, and disks to cut out plant spaces in the row when pulled across the field at right angle to the rows. For example, the machine might have blades that cut out 8-in. spaces 4 in. apart to leave plant blocks of that size spaced 8 in. apart. This saves consid-
erable time and expense as compared with blocking or chopping with hand labor.

Beet blockers and cotton choppers equipped with rotary knives are available. Select those having knives that are adjustable to leave blocks of the desired size at practically any spacing wanted. These machines are pulled along the rows just as a cultivator and partially till the soil while performing their primary purpose of thinning the planted crop.
7. Selecting Orchard-cultivating Machines

Orchards are cultivated with disk cultivators, field cultivators, and special tools as discussed in Part I. In irrigated areas, ditching shovels are frequently attached to the cultivator tool bar for making irrigation ditches or furrows. Sub-soilers and chisels, as discussed in Part I, apply equally well in orchards.

8. Selecting Truck-garden Tillage Machines

Some of the tillage machines used to cultivate regular field crops are adaptable to truck-garden use, particularly the one-horse, half-row cultivators with a variety of shovels and attachments discussed previously.

Small engine-drawn walking cultivators are often used for culti-
Fig. 241. Small garden-type tractor fitted with cultivating equipment.

Fig. 242. Select a garden cultivator with sufficient tool equipment.
vating onions, carrots, and other truck crops grown on a modest scale. Sizes are available to handle up to five rows of some crops. They may have either rubber tires or metal tires with lugs to meet varied soil and moisture conditions. Some of these garden tractor cultivators can be put to other uses such as pulling lawn-mower attachments and operating small sickle bars and rotary hoes. Select those with a series of travel rates and a variety of attachments to meet the many necessary uses.

The small row-crop tractors have garden crop-cultivating machines to cultivate the same number of rows as are planted by a sister machine. The cultivating equipment is attached to the same tool bar and controlled by the same mechanism as that discussed under Vegetable Planters in Part II.

**SUMMARY**

1. The losses on farms in the United States caused by weeds have been estimated at three billion dollars annually, being second only to losses from soil erosion.

2. The destroying of weeds and other vegetation competing with the crop is of more importance than the actual stirring of the soil.

3. Many feeder roots may be cut off by deep cultivation thus causing more actual damage than help to the growing crop.

4. Soil is stirred to retain moisture, break up wind currents that might prevent soil from moving and shearing off plants, incorporate fertilizer in the soil, increase soil organisms, increase soil oxygen, reduce lodging, and direct moisture toward plants.

5. The size and type of cultivating tools is affected by the soil, climate, crops, size and shape of fields, terrain, power, cultural practices, and cost and availability of manpower.

6. Walking and riding cultivators are usually selected for use in the smaller and more irregularly shaped fields, especially if the fields are stumpy or stony or the terrain is difficult, and where horsepower or mulepower is used.

7. Shovels can be had in many types to meet practically every need. They vary from the narrow bull tongs, of 1 in. or less in width, to sweeps over 18 in. wide.

8. The three main types of shovel trips are spring, friction, and pin-break.

9. The main types of shields are hooded, wire, solid, and rotating.

10. Disk cultivators are particularly well suited for cultivating listed ground and for use where grass, vines, and trash are prevalent.
11. For tractor operation, select a cultivator that covers the same number of rows at a time as were planted by the planter.

12. Many farmers prefer having the shovels next to the row attached to the front of the tractor, for dodging plants, and the mid-row shovels to the rear, to plow out wheel tracks.

13. Power lifts—hydraulic, mechanical, and pneumatic—are preferred for multi-row cultivators. The delayed action that first raises the front gang and after a few feet of travel raises the rear gang is desirable; the same procedure lowers the gangs.

14. Flame weeder are particularly useful for destroying plants competing with crops when soil or moisture conditions are not suitable for soil stirring.
8. Operating and Field-servicing Crop-tillage Machines

EVERY good farmer operates and services his farm equipment to secure the maximum years of service and efficiency. Farm-machine investments, like investments in any other business, are an expenditure of money that assists the investor in making a profit. Every additional year of efficient use of a farm machine increases its investment value to the owner. A good procedure is first to become well acquainted with the instruction book furnished with each machine and to develop operating skill.

The same general phases of operation and field service, discussed in Parts I and II of this book, apply to crop-tillage machines. Protect all land-polished surfaces; when a land-polished surface becomes rusty or corroded it will not do satisfactory work. Remove all land-polished surface parts from the soil at the end of the day. A conveniently located can of used lubricating oil and a rag or brush facilitate applying such a temporary protective coating at the end of the day's operation. The night or following day might be rainy.

Locate all oil holes and lubrication fittings and follow a systematic procedure of lubrication so that no bearing is neglected. Before applying new lubricant, wipe away all dirt from around the point of lubrication so that dirt will not get into the bearing. Exposed gears working under dusty conditions last longer if used dry. If lubricated, use a light oil or kerosene, otherwise they may gather grit and wear excessively. Operating and field servicing will be presented under the following activity headings:

1. Operating Walking and Riding Cultivators
2. Operating Tractor-mounted Cultivators
3. Operating Lister Cultivators
4. Operating Beet and Bean Cultivators
5. Operating Field-cultivating Machines
   Rotary Hoes
Harrow and Drags

6. Operating Plant Blockers and Rotary Choppers for Beets and Cotton
7. Operating Orchard-cultivating Machines
8. Operating Truck-garden Tillage Machines

1. Operating Walking and Riding Cultivators

A cultivator may be used for several crops and with many row spacings in one season. Again, one or more cultivating machines may be used for one crop in a season. Both of these circumstances may necessitate changing soil-working equipment and adjusting members of the machine. Where a crop is cultivated several times during a season, the conditions vary considerably between the first cultivations and those near the end of the cultivating period. This requires different shovels to suit the weather and variations in crop and weed growth.

Deciding on a Cultivating Procedure. Farmers are appreciating more and more how much they can speed up field work and reduce operating costs. This applies to general farm layout and building arrangement as well as to field practice. Discussion here will be limited to common methods of cultivating only. The same principles apply to all other operations. Here are some cultivating procedures:
1. Lift the gangs at the end of the row, make a sharp turn, possibly backing, so as to return on the adjoining row. After getting in proper position, the operator lowers the gangs and proceeds. This consumes considerable time; first, in stopping the team to raise the gangs so the sharp turn can be made, second, in slowing work in making the sharp turn and aligning the machine, and third, in stopping to lower the gangs.

2. Cultivate alternate rows going across the field and the remaining ones on the return. This eliminates the sharp turn and delays of the first procedure. With careful guiding of the team or tractor, it is often possible to raise and lower the gangs without stopping.

3. Cultivate on a rotation basis. Cultivate the first row or rows on first trip, then skip over two, three, or four rows on the return. The second trip takes the second row and the return is one row farther over on the uncultivated ground. This in reality divides the field into small "lands." It speeds up turning. The important thing here is to find out whether the added speed at the row ends offsets the added travel at the turn on the land.

**Choosing Soil-working Equipment.** In Chap. 7, the various soil-working tools were discussed with the adaptation of each. It is now desirable to discuss combinations of tools for the various cultivations:

*Early Cultivations.* These are usually deep cultivations, as the crop's root system is small and undeveloped. Therefore, set the gangs to cultivate the soil near the plants. Use double-pointed shovels, straight or twisted shovels, to deep-cultivate all the space between rows. Use shields to prevent the small crop plants from being covered. Use the solid shield for cloddy and rocky soil and trashy conditions. The open shields permit some of the smaller particles
to slide through, while the revolving type will help to pulverize loamy soils. A unit of rotary hoes is beneficial in breaking the crust immediately over the row. In fact, a wide two-gang rotary hoe is often used for the first two times over the crop, traveling at 4 to 5 m.p.h. This produces a mulch and effectively kills weeds.

Intermediate Cultivations. These cultivations are determined by the root growth that spreads between the rows. As the growth extends, shallower cultivation is practiced over the roots. This is accomplished by replacing the inside shovels with half sweeps and also by moving the shovels on the gangs farther from the row. Turn the outside shovels on the shanks or use twisted shovels to move or throw the soil to or from the row. The shape and size of shovels, their position on the shank, and the depth of cultivation influence the amount of soil moved to or from the plants.

Replace point-type shovels with sweeps for later cultivation. They work the surface soil only; they save the crop roots, yet shear off the weeds and leave a desirable topsoil mulch. Different soils require varying treatment. Moisture in the soil governs this to a degree and must be considered.

Lay-by or Final Cultivation. The last or "lay-by" cultivation in many cases is done by moving or throwing the soil into the row to
form a slight ridge. Use disk-hilling attachments, moldboards, wing hillers, or potato hillers. Ridging is not a common practice under so-called "dryland" farming conditions. After selecting suitable soil-working shovels for the job, set them properly for crop, soil, and moisture conditions; then the shovels will penetrate well, run at an even depth without working away from or to the row, and use a minimum of draft.

**Setting the Shovels or Sweeps.** Tests made in 1947 indicate that cultivator sweeps can best be set on a floor before taking the machine to the field. Set the sweeps flat on the floor, without angle or suction. With all tools spaced, and keeping the sweeps flat, raise those nearest the plants so that they will run somewhat shallower than the others. Sweeps set this way wear uniformly, retain their original shape, that is, angle with the point and with respect to the bottom. They do not wear so as to be wobbly and thus induce strain on the machine. Seldom will any field adjustment be required. If, in animal-pulled cultivators, the rear shovels or sweeps run too deep, the hitch may be too low. To correct, lower the pole at the neck-yoke and change the height of hitch as necessary; also, correct this situation with the leveling lever. If the front sweeps run deeper than the rear ones, reverse the hitching procedure. When using spring-trip shovels, have tension loose enough so that they operate satisfactorily.

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1 U.S.D.A. and Mississippi Agricultural Engineers at Mississippi Delta Experiment Station.
factorily. For pin-break shanks, there will be less delay caused by breaking of pins if using well-seasoned hickory or other tough wood fitted snugly into the pinholes. Never use metal pins.

**Spacing the Gangs.** Operate the gangs of riding cultivators parallel to each other. Set each gang at the same proper position on the bar and at the desired distance apart, for the condition of the crop. Make sure the gangs are firmly bolted or clamped in the desired position. When setting the gangs, have the wheels at the correct distance apart so there will be no danger of interference with the gangs or the crop row. Make certain that the axle for each wheel has been slipped into the axle sleeve the same distance and then turn setscrews down tight to hold the axle securely in position.

When cultivating is done along a hillside, it may be necessary, particularly in loose soil, to set the lever controlling the gang on the higher level one notch deeper. This necessitates a reset of the gang levers after turning at each end of the field.

**Guiding the Gangs.** The gangs follow the row by several methods: (1) foot control, (2) seat guide, (3) pivot axle, (4) parallel shift, and (5) a combination of the last two. Regardless of the method of control, hitch the team snugly with the pole strap over the neck-yoke, a straight line extending from the hames along the traces to the shovels in the soil. Then, with all parts of the cultivator in
prime condition, the gangs will respond immediately to the guiding controls. With the foot-control type, the gangs move independently of each other by foot pressure. Others have pedals that move both gangs together. On some cultivators, a hand lever in front of the operator performs the same function. Pivot control, particularly effective on hillside work, is through pedals that pivot the wheels to guide the direction of the cultivator. In this type, the wheels pivot together to remain parallel. The parallel shift is effected by foot controls that swing both gangs to right or left but do not control the direction of the tongue. The combination control swings both gangs together and also pivots the wheels. In seat-controlled cultivators, the tongue is moved by side movements of the seat while directional foot control may be placed upon the gangs at the same time.

In using two-row cultivators, always follow the two rows that were planted together. If that is not done, it will be difficult or impossible to cultivate as closely to the row as desired because allowance must be made for variation of row width.

Using Disk Cultivators. Disk cultivators follow the same principles in operation as shovel cultivators. Set the disks at the angle and depth to do the job desired with the least draft. It is customary
to remove one disk from each side for the first cultivation, leaving only two in each gang. This is particularly true if soil is to be thrown away from the row, in which case the disk gangs are set at quite an angle to each other. Keep the disk boxings, which hold the bearings, tight to exclude dirt.

![Diagram of 4-row cultivator](image)

*Fig. 250. Floor diagram for setting cultivating sweeps on a two-row cultivator before going to the field.*

2. Operating Tractor-mounted Cultivators

It is essential to mount the cultivator on the tractor so that it is responsive to the guiding of the tractor. Check to see that the lifting and lowering device responds quickly and positively. Regulate the travel of the tractor to the crop and cultivation so the cultivator does not throw the soil too far or too forcefully. Always use a travel rate that permits ready control of the cultivator. It is desirable to have a shovel follow in each wheel track and loosen the soil. Use a cultivator that covers the same number of rows as the machine that planted the crop; in cultivating, follow the same rows as were planted. Where gage wheels are used, check them each day to make certain that gangs are operating at the desired depth.

1 Mississippi and U.S.D.A. Agricultural Engineers.
The same setting and arrangement of sweeps can often be made for most field crops such as cotton, corn, soybeans, and sorgos, as well as for soil types varying from sandy loam to those that are medium heavy. A desirable procedure for making an accurate setting is to paint straight lines on a level floor to represent rows and middles (Fig. 250). A center line of 16 ft. serves as a guide for centering the tractor in the lines of rows and middles. After the tractor is lined up, the cultivator gangs are lowered to the floor, and the sweeps arranged in correct relation to the rows and middles.

A common set is to have the inside wing tips of the front sweeps 10 in. apart for 6-in. sweeps, the second set of sweeps 8 in. in size and overlapping the cut of the front sweeps with a spacing of 18 in. between wing tips. The third sweep overlaps the second pair and covers the middle of the row, being 10-in. sweeps. Such a set uses 11 sweeps for the front section of a two-row cultivator and 21 sweeps for a four-row machine. This set is ideal to use with a flame cultivator on the rear. Set all sweeps flat on the floor as the looseness in the joints of the cultivator provides sufficient “pitch.” Sweeps set as described will wear unevenly because the wings that overlap and follow other sweeps wear less. Fortunately, however, they retain the original angle. Therefore, occasionally place such sweeps on the opposite side of the row to equalize the wear on each wing.

The proper setting of sweeps and shallow cultivation speeds up cultivation and reduces strain and wear on the machine. It also gives better weed and grass control and firmer middles for improved traction, and lessens the cost of operation and upkeep.

For such crops as cotton, a rotary hoe of four wheels is often placed between the shovel gangs. The spikes on the wheels cultivate within the row of young plants. After the plants are 6 in. high, remove the two inner rotary-hoe wheels, and replace them with pipe bushings.
Continue to use the two outer wheels as shields until the crop is about 8 in. high. The plant is now large enough (3/4-in. stalk diameter), to withstand a flame cultivator across the row. The two flames across the row from opposite sides are to be slightly staggered.

Flame cultivation permits a slightly wider set of the shovels from the row, therefore less feeder roots are cut.

3. Operating Lister Cultivators

Set the side sweeps, often referred to as blades or knives, of the sled cultivator to shear the side of the furrows. Set them with sufficient angle to clear any surface trash. For the first cultivation, it is often desired to throw the soil out. In that case, the shield is usually
removed and the inner disks of each gang set very close to the row to destroy the weeds as near the crop plants as possible. On later cultivations, the shields are usually needed and the disk gangs set to throw the soil in. Use hooded shields when the plants are extremely small. It is needless to use side knives if they are not destroying any weeds.

The wheeled Lister cultivators and those fitted to tractors may be used with disks, or disks and shovels combined, although some use knives and shovels. It is easier to follow the row when using some shovels. Since these are multi-row cultivators, set the gangs accurately on the main bar to fit the row widths. There is some flexibility to most of these cultivator gangs and this, with accurately set furrow wheels, causes the tool to follow the furrows. For the first cultivation, the disks are set to throw the soil out and the shovels are set close to the row to stir the furrow walls. For later cultivations, set the disks to throw the soil in, and set the shovels wide to break up the center of the ridge. Shovels set too deep destroy many feeder roots and increase the draft. Use the least number of shovels, set as shallow as possible, to do a satisfactory job. The skilled operator watches all gangs, especially on trashy ground, to remove a cornstalk or other object lodging in front of a shield or between shovels across a row. If not removed, such obstructions or trash may push plants over so that they are easily covered.

4. Operating Beet and Bean Cultivators

Keeping all linkage, and other parts that affect accurate guiding, in good working condition is essential. This is particularly true in cultivating close to the row to destroy weeds effectively when crop plants are small. Knives, bull tongues, and duckfoot shovels, used mostly on these cultivators, must be securely set at the correct spacing to meet row widths and then set at a depth suited to the soil,
moisture, crop, and size of plants. Disks are rarely used except in trashy soil where knives will not work.

The surface soil is the richest part of the field. Excessively deep cultivation reduces the effectiveness of this surface soil in nourishing the crop, and cuts off many small side feeder roots. Repeated stirring of a dry mulch is not profitable and is an actual waste of labor. The number of cultivations required should depend upon the appear-

ance of foul growth, occurrence of rains, or irrigation, where that practice prevails. A soil that is too wet should not be cultivated, as it may puddle. Bull tongues, which are generally run in the center of the row, must be set deep enough to break any sole formed by earlier cultivations, to facilitate ditching for irrigation, and to aid in guiding the machine accurately. Duckfoot shovels are usually set to run in the center of the row, while the knives are set to operate nearer the plants. The use of these or other machines for cross blocking sugar beets also serves as an excellent cultivation.

At frequent intervals, observe the set and sharpness of all ground-
working equipment, altering the set as needed and changing any items that are dull. Lubricate all moving parts as needed with the recommended grade of lubricant.

Although crop rotation permits a more efficient use of farm machinery, such machines as beet and bean cultivators are not to be used for those tall-growing crop plants after they are large enough to be damaged by the cultivator.

![Image](image_url)

**5. Operating Field-cultivating Machines**

**Operating Rotary Hoes.** Check the wheels on the rear gang to be sure they operate midway between the wheels of the front gang. For heavy soils, it may be necessary to add weights to the weight pans to gain penetration, but rarely is it desirable to cultivate more than 3 in. deep. A greater depth is apt to injure the crop and does not increase the effectiveness of weed destruction. A speed of 3½ m.p.h. or more is essential to obtain the maximum effectiveness of weed destruction; therefore, the rotary hoe is well suited to tractor operation. Four-wheel rotary hoes are used between the gangs of regular shovel cultivators and in combination with shovels or sweeps to cultivate in the row, and serve as a shield for the soil moved toward the row by the shovels.

**Using Harrows and Drags.** The harrow is very effective in destroying grass and weeds before crop plants come up, and may be used until the plants are a few inches tall. With many crops, particularly corn and potatoes, the harrow is a fast and economical cul-
tivation machine. Set the teeth to operate as nearly vertical as possible without injuring the crop. When harrowing down ridges or using a drag for this purpose, the operator often rides on a plank that equalizes his weight across the entire machine. However, it is generally possible to angle the teeth to secure the desired penetration. When the harrow or drag is tractor drawn, it may need added weight, particularly if the crop has been listed in.

When it is necessary to force a large amount of soil into the row to cover up weeds or grass between the plants, bolt a 4-in. board or plank to the front row of teeth of each harrow section. The angle of this board is then controlled by the same lever that controls the angle of the harrow teeth. This attachment will level the ridges in one operation, if desired. Even though the plants are taller than the weeds, and a few plants may be covered, this method is effective to bring under control a bad weed situation. It may be necessary to set the teeth to slant back at 45 degrees or more under such conditions in order to avoid soil covering or other injury to the small crop plants. Caution: Never turn so short with a harrow that the outside section has a tendency to rise up or to get the inside horse or tractor wheel into the harrow. To avoid this danger lay out the field in lands for harrowing. This is often essential where the crops are planted close to the ends of the field.

Keep the harrow and drag clean at all times because, if they become fouled, there is a tendency to cover up the crop plants. Either machine may have to be raised for cleaning, but slanting the teeth of the harrow while traveling a short distance usually does the job easily without stopping.

**Operating Weeder**s. Pencil-point weeder follow the power. They have no adjustment; however, keep the individual points properly alined. Attach carefully to the power unit or other machine with which it is operated. Check the points frequently and replace any that are broken or lost. Maintain all points by keeping them sharp and straight. In using flame weeder, use a jet flame as recommended by the manufacturer and under the pressure that seems best to kill the weeds and grass and not injure the crop. The adjustment will include such things as the size of flame, jet pressure, angle of flame in relation to the row, distance of flame from the row, and staggering of the flames across the row from both sides. Operate chemical weeder according to the instructions given with the machine and chemicals used.
6. Operating Plant Blockers and Rotary Choppers for Beets and Cotton

These machines are required to thin beets when segmented- or sheared-beet seed is not drilled. The space cross blocked or left between the beets is dependent upon the stand, fertility of the soil, moisture available, and many other factors. Delay blocking until the seed has germinated well but do it as soon thereafter as possible in order to encourage the best growth of the remaining plants, which may be thinned later. The aim under most conditions is to have 100 to 120 beets evenly spaced in each 100 ft. of row. When using a cultivator for cross blocking, usually fitted with 8-in. duckfoot shovels or knives and spaced to leave 4-in. blocks of beets, set the disks straight to run at each edge of the shovel or knife. This protects the remaining small block of beets. Set the shovels and disks just deep enough to destroy the plants in the 8-in. space. Drive at right angles across the field and drive accurately so as to leave a 4-in. block next to the cross-blocked area. The rotary chopper, for either beets or cotton, does the same job as a cross-blocking cultivator, only it follows the row while blocking. Set the knives to cut out the desired spaces and leave the desired size of plant blocks. The better the stand, the
Fig. 257. Steer the knife circle on the right side of the drill row in trashy, damp, crusted, sandy, powdery, cloddy, and cultivated fields, and among plants with two to four leaves.

Fig. 258. The rotary blocker is adjustable for length of "skips." A method of adjustment for a 5-in. "skip" is shown above. See manufacturers' instruction book for varying block size.
smaller the blocks. In order to reduce the draft, set the knives to cut as shallow as possible and still destroy the plants. The use of the rotary chopper to block sugar beets is slower than the use of a beet cultivator to cross block; however, it is easier and quicker to adjust for any changes desired in the blocking and spacing of blocks. Keep the knives sharp or they will not perform a clean job of removing undesired plants.

7. Operating Orchard-cultivating Machines

Cultivate often enough and in such a manner as to control undesired vegetation and not injure the roots, limbs, or trunks of the trees and maintain the desired mulch. Move the soil back and forth during the season to retain the desired contour of the land. It is necessary to maintain ditches and blocks about the trees in irrigated areas to hold water until it can soak into the soil. On hillsides, follow recommended soil-conservation practices to prevent erosion.

Hard sole or hardpan can be broken up by a sub-soiler. This process of deep cultivation is generally done midway between the trees. Since heavy-producing trees require a large amount of moisture to produce prime fruit of maximum size, it is essential to keep the soil rough and open at all times to accept freely and hold moisture. Keep shields in place on machines when working under low-hanging limbs to prevent injury to the fruit and trees.

8. Operating Truck-garden Tillage Machines

Whether hand- or power-operated cultivators are used, exercise care to avoid deep cultivation next to the rows, which may damage feeder roots, except carrots, celery, cabbage, cauliflower, and other crops the roots of which spread little and go deep. Small shovels and shallow cultivation are the usual rule, although it may be necessary to run a shovel rather deep in the center of rows to break any hard sole that forms. Plant garden crops in a few long rows, rather than many short rows, to make the job of cultivation easier, faster, and more economical.

Since most garden crops are planted in narrow rows and the plants are relatively small, they are best cultivated at a slow travel rate. However, where possible and expedient, plant and grow garden crops in such a manner and place that regular field-cultivation tools can be used. Garden truck grown on beds needs special cultivating rigs to
be sure there is ample clearance for the plants, since the tractor wheel is usually in the trench row.

SUMMARY

1. To hold power requirements to a minimum and facilitate operation, the soil-stirring equipment must be protected so as to maintain a land polish that readily scours in difficult soils.

2. The lifting of shovel gangs when turning is a sound practice that saves power and reduces damage to the machine.

3. As the growing season advances, the cultivation is progressively shallower next to the row and may even be farther away from the row to reduce damage to feeder roots.

4. Early cultivations are usually the deep cultivations.

5. Animal-drawn cultivators respond more readily to guiding and follow the row more accurately when the team is hitched snugly and the pole strap is over the neckyoke.

6. Sweeps, blades, or knives are usually set to work next to the row and the bull tongue set to stir the soil in the row middles.

7. The rotary hoe can be set to work over the rows while the crop plants are small, where they break crust and destroy small weeds and grass.

8. Flame weeder s are often used on fibrous-stemmed plants after the plant stems are \( \frac{3}{16} \) in. in diameter. The flames are usually slightly staggered across the row.

9. Shields are used to protect small plants from being covered by the soil being moved to the row. Shields may be slightly lifted to permit some soil to work under them and thus cover weeds in the crop row.

10. The soil is usually directed away from the plants for the first cultivations and in later cultivations the gangs and shovels or disks are set to direct soil to the row to cover competing vegetation.

11. A good cultivation rule is to use the least number of shovels possible and to set as shallow as feasible to do a satisfactory job.

12. Harrows and drags are excellent machines to work down lister ridges and fill soil in and around the plants. The harrow is also used to break crust and cultivate flat-planted crops while small or before they are through the soil surface.

13. Cultivation on the contour is one method of soil conservation.

14. Use shields over machines working in orchards.

15. Bull tongues set to stir the soil deeply in the center of the row break up plow pan as does the sub-soiler on orchard cultivators.

16. Protect land-polished surfaces during the work season by coating these surfaces with grease at the end of each day's use.
9. Reconditioning and Storing Crop-tillage Machines

CROP-TILLAGE machines will perform better and longer if they are inspected and reconditioned at the end of the work season as outlined for both seedbed-preparation machines and crop-planting machines. The first step in a good workmanlike program is to record, in the previously discussed farm-machine service book, the parts, if any, that need service before the next work season. A more detailed procedure, and one that is to be used preparatory to a reconditioning job, is to fill out the farm-machine inspection sheet mentioned in Chap. 3. An off-season reconditioning schedule will spread the work out, ease rush periods, and prevent any oversight of needed service. Reconditioning and storing crop-tillage machines will be discussed under the following activity headings:

1. Reconditioning Walking and Riding Cultivators
2. Reconditioning Tractor-mounted Cultivators
3. Reconditioning Lister Cultivators
4. Reconditioning Beet and Bean Cultivators
5. Reconditioning Field-cultivating Machines
   Rotary Hoes
   Harrows and Drags
   Weeders
6. Reconditioning Plant Blockers and Rotary Choppers
7. Reconditioning Orchard-cultivating Machines
8. Reconditioning Truck-garden Tillage Machines
9. Protecting and Storing Crop-tillage Machines

1. Reconditioning Walking and Riding Cultivators

Cultivators are simpler to recondition than machines with power-driven mechanism. This does not mean that a cultivator reconditioning job can be done quickly. However, the jobs can be done readily by most persons.
The many makes and kinds of walking and riding cultivators have numerous parts in common to be inspected and reconditioned. Some of the jobs and procedures include the following:

1. Thoroughly clean the machine, including all boxings, of dust and dirt so that it may be properly inspected and made ready for reconditioning. Use a safe solvent to remove loose grease after the caked material has been scraped off.

2. Block up the machine so that the wheels turn freely. Then rock the wheels to note the wear at hub. If axle is worn and a notch can be felt near the end, replace the axle. If the wheel is still too loose on the new axle, drive out the old boxing and replace it. Examine thrust bearing at inner end of axle and replace if it is worn sufficiently to permit the hub flange to slip out. Replace wheels, fasten in place, and lubricate with the proper grade of lubricant until it oozes out at the thrust bearing.

3. Examine the steering mechanism—foot, lever, or seat. Tighten, recondition, or replace all linkage and other steering parts in need of attention.

4. With wheels on the floor and tongue at working height, adjust wheels so that at axle height the rims are \( \frac{3}{4} \) to 1 in. closer in front of the axle than at the rear.

5. Tighten and recondition all lever assemblies of riding cultivators and handles of walking cultivators. Adjust or replace, as needed, all balance and lifting springs that assist the operator in changing lever positions.

6. Examine and recondition tongue, eveners, singletrees, and neckyoke; replace if necessary. Obtain or make new parts the size and shape of the originals using the old parts as models. Bolt the removed and new parts firmly into proper position when reassembling.

7. Check shovels, disks, or blades; sharpen those that are dull; if badly worn, repoint or replace. Sharpen disks as outlined in Chap. 6. Blades for surface work are rolled or hammered to sharpen. If it is necessary to grind them, this is done on the underside at a 45-degree angle. Grinding may impair the temper so should be done carefully. Always restore the blade to the original shape. Apply rust preventive to the polished surfaces as soon as they are cleaned or sharpened.

8. With tongue at working height, place the cultivator wheels on blocks equal in thickness to cultivation depth. The following is then a typical procedure suggested for reconditioning the gangs and component parts:
   a. Set the shovels at an angle of about 135 degrees to the shanks. Adjust gangs to a level position, and then lower each shank until all shovels rest on the floor, if shovels are to operate at the same
depth. Set gangs parallel to tongue and shovel surfaces parallel to the axle. Straighten or replace gang frames or shovel shanks that are out of line. Examine the trip springs and set them at uniform tension, thus allowing them to trip without damage to the cultivator.

b. Adjust blades uniformly at a satisfactory angle, making sure the blade ends provide the proper clearance for the crop to be cultivated and that shovel tips touch the floor.

c. Examine wood boxing of disk gangs for wear. Clean and, if they are worn sufficiently, replace them. Adjust gangs so that all disks of each gang rest on the floor, when angled the same and when set at the same distance from a center line drawn through the arch. It may be necessary to set the disks at different levels, depending on the soil and crop.

9. Recheck to tighten all bolts, braces, coupling, and other fasteners. Replace any lost or damaged parts.

10. Tighten gang bolt; otherwise cracked disks may result.

11. Lubricate.

12. Paint as needed and apply rust preventive to ground-polished parts (see page 141 and Figs. 211, 212, and 213).

2. Reconditioning Tractor-mounted Cultivators

This is done in a manner quite similar to that recommended for walking and riding cultivators, but check all lifting and lowering devices. If the gangs are controlled mechanically, recondition all the control parts and lifting springs. If the hydraulic lift on the tractor does not function properly, check the gaskets and control valves of the lifting mechanism. If worn or leaky gaskets are the trouble, replace them. If a valve leaks, replace or reseat it. If there are auxiliary springs, adjust them to function with the proper speed and action. The tractor cultivator is often in several “bundles” when removed from the power unit; keep them together to expedite reassembly.

3. Reconditioning Lister Cultivators

Aline the furrow wheels to run parallel and at the proper distance apart to follow the furrows. Adjust wheels to rest evenly on the floor. Recondition all parts as previously indicated for walking and riding cultivators.

The sled or “go-devil” lister cultivators have disks of three sizes
in each gang. Sharpen, preferably by rolling the respective disks in each gang to the same relative size. Replace the sled runners when badly worn, using well-seasoned hardwood. Use the old runner as a model. Cover the new runner with a metal tire of the same width as the runner.

4. Reconditioning Beet and Bean Cultivators

This inspection and reconditioning are similar to that described for field cultivators in Chap. 3. Briefly, this procedure includes the following: straighten frame parts, shovel shanks, and other bent parts; replace, braze, or weld broken parts; replace badly worn and lost parts; take up lost motion in wheels, frame, and linkage; sharpen soil-working equipment such as shovels, knives, and duckfeet; examine clamps for needed replacements; clean lubrication parts and then lubricate; tighten locking devices; adjust and replace bearings as needed and then appropriately cover with rust preventive or paint.

5. Reconditioning Field-cultivating Machines

If the wooden boxings on the rotary hoe are worn, replace them before the housing wears on the axle. Examine wheels and straighten any bent fingers or spikes; replace if badly damaged. Adjust the
rear gang so that the wheels run midway between those in the front gang.

For a discussion of harrows and drags, see Seedbed-preparation Machines in Chap. 3.

Place a section of a weeder, or the complete machine, on a level floor. Aline the points from end to end and then adjust so that they are spaced equidistant on the tool bar. Replace or recondition any points that are damaged.

6. Reconditioning Plant Blockers and Rotary Choppers

Check the following as indicated and then recondition or replace where necessary:

1. Examine all attachments such as shovels, duckfeet, knives, and disks. Sharpen and replace as needed. Cover all land-polished surfaces with a rust preventive.
2. Take up lost or undue motion in frame, wheels, and connections to power unit.
3. Examine shanks of attachments to straighten or otherwise recondition.
4. Examine clamps and recondition if worn, or replace if beyond repair.
5. Examine wheel bearings and adjust or replace to take care of any undue wear or breakage.
6. Check bolts and other locking devices for tightness. Replace any lost parts.
7. Lubricate.
8. Paint.

Check the moving parts on the rotary chopper to remove excessive "play." Sharpen dull knives. Straighten bent knives or replace if badly worn. Adjust for the crop that is to be blocked. Cover exposed parts with paint or rust preventive.

7. Reconditioning Orchard-cultivating Machines

These machines were discussed in Chap. 3; the material will not be repeated here.

8. Reconditioning Truck-garden Tillage Machines

Check hand-operated cultivators, of all types, at frequent intervals. Since most such cultivators are lightly constructed, they are subject to damage. Some of the parts to check and adjustments to be made are
RECONDITIONING AND STORING CROP-TILLAGE MACHINES

1. Keep the wheels running true. Keep the axle bolt snug. Large washers at each end of the hub are helpful in keeping wheels snug.
2. Sharpen soil-working attachments; then cover with rust preventive.
3. Tighten bolts and nuts to keep frame rigid; replace with proper size any lost nuts or bolts.
4. Lubricate.
5. Paint.

Check the following additional parts on a motor-driven, truck-garden cultivator after it has been thoroughly cleaned:

1. Examine drive wheels to note if running true and correct as determined by the inspection.
2. Adjust chains to a tension that will prevent undue strain on the bearings.
3. Tighten and adjust levers that control the clutch, gears, and gas feed.
4. Recondition the motor and replace worn or broken parts.
5. Lubricate with the proper grade of grease and oil.

The gage wheels and linkage on tractor-mounted cultivators require regular attention. Examine and correct any wear and misadjustment of moving parts.

9. Protecting and Storing Crop-tillage Machines

Crop-tillage machines, like seedbed-preparation machines, have many land-polished surfaces that rust or corrode when exposed to weather. The same principles and details, therefore, apply to crop-tillage machines as those discussed previously for seedbed-preparation machines in Chap. 3.

Protecting and Storing Walking and Riding Cultivators. Place all cultivators under cover in dry storage and away from livestock and poultry at the close of the work season. The entire cultivator deteriorates in the weather and endangers livestock if left in the open. Even under protective cover, a coating of a good rust preventive is advisable on polished surfaces. Turn over the seat of a riding cultivator. After cleaning, pack the wheels and other lubricated parts with a fresh lubricant.

Remove shovels, sweeps, disks, and other soil-working members for sharpening and repair. Mark or tag each removed part to identify it easily when refitting it to the machine. Clean polished parts thoroughly, cover adequately with a good rust preventive, and then
store in closed bins or other suitable dry storage space. Unused overhead space in buildings can be used for such storage purposes.

**Protecting and Storing Tractor Cultivators.** At the end of the work season, drive the tractor to a machinery "mounting stall," or provide other arrangement for holding the cultivator. Remove the rear gangs, then the front cultivator members, and move the tractor out. Now follow the same procedure for the cultivator and soil-working equipment as that outlined for walking and riding cultivators.

![Image](image_url)

**FIG. 260.** Remove shovels and other land-polished members for inside protection before storing.

**Protecting and Storing Field-cultivating Machines.** Most of these were discussed in Chap. 3 and need not be discussed again here. The rotary hoe is stored similar to the disk harrow and the weeder similar to the peg-tooth harrow.

**Protecting and Storing the Rotary Chopper.** The rotary chopper can be considered in two parts. Part one includes the knives, which are treated like any other soil-working equipment. The other part is the carriage and mechanism. Clean these, remove all lubricant, repack, and protect the machine with a good rust preventive or paint, whichever is appropriate to each part.

**Protecting and Storing Garden-tillage Machines.** Here again the machine is considered in two parts: the ground equipment as for the rotary chopper, and the machine itself. Prepare and store in the same manner as the rotary chopper used for cotton or sugar beets.
Removing from Storage. Move the cultivator to the open where it can be completely assembled and rechecked. Repack bearings and housings with clean lubricant if necessary. Remove the rust preventive from the polished surfaces of soil-working equipment and assemble on the shanks. Set all soil-working equipment as previously discussed.

SUMMARY

1. Maintain tillage tools in prime working condition by following an annual reconditioning procedure that includes all parts of the machines.
2. Inspect and adjust or replace all worn bearings and then adequately lubricate.
3. Sharpen the shovels and disks when reconditioning and then cover with a rust preventive.
4. If a year-round record on each machine is kept in a bound book, the job of reconditioning will be simplified.
5. Order all needed parts well in advance of the active work season for each tool.
6. When storage space is limited, it is well to remove the soil-stirring parts, keeping attaching parts intact, and place in a dry, protected storage place away from birds, poultry, and livestock.
7. Thoroughly lubricate machines when they are placed in storage, after the bearings have been cleaned and reconditioned.
8. Clean and again lubricate machines when removing from storage.
9. Cover all cutting parts, whether stored indoors or in the open, to protect workers and livestock.
10. Securely fasten all machines and machine parts when they are stored overhead or on walls.
11. Mark all removed parts to identify them when reassembling.
PART IV
HARVEST AND HARVEST-HANDLING MACHINES
10. Selecting Harvest and Harvest-handling Machines

Farmers always look to the harvest. It is then they reap the year's work. After planting well-selected and graded seed in a properly prepared seedbed and stimulating the growth of the crop through cultivation and other means, the grower naturally wants to harvest all his crop in the best of condition. This is true whether the crop is a grain, grass, fiber, fruit, or root.

Harvesting needs to be done at a time most advantageous to the particular crop and with efficient machines that recover in good condition all the crop produced. Harvesting is accomplished for some crops in one operation, while for others it requires a series of operations and machines. The grain combine and the corn picker are examples of one-machine harvesters. Hay, on the other hand, requires several harvest-handling machines. The selection of harvest and harvest-handling machines will be presented under the following headings:
1. Selecting Hay-harvesting Machines
   - Mowers
   - Rakes
   - Loaders
   - Stackers
   - Crushers
   - Bale loaders and Bale Loaders
   - Choppers

2. Selecting Grain-harvesting Machines
   - Headers
   - Binders
   - Threshers
   - Combine Harvester-threshers
   - Conveyors and Elevators—Portable

3. Selecting Crop-harvesting Machines
   - Binders
   - Ensilage Cutters
   - Ensilage Harvesters
   - Ensilage Blowers
   - Pickers
   - Cutoff Corn Harvesters
   - Shellers
   - Field Shellers
   - Husker-shredders
   - Stalk Cutters

4. Selecting Fiber-harvesting Machines
   - Cotton Strippers
   - Cotton Pickers
   - Cotton Gins
   - Hemp Harvesters
   - Flax Harvesters

5. Selecting Root Crop-harvesting Machines
   - Potato Diggers—Irish and Sweet
   - Beet Pullers
   - Peanut Diggers
   - Bulb Diggers

6. Selecting Special Crop-harvesting Machines
   - Sugar-cane Harvesters
   - Green-crop Harvesters
   - Lettuce Harvesters
   - Grain-sorghum Harvesters
   - Clover Hullers
SELECTING HARVEST AND HARVEST-HANDLING MACHINES

Seed Strippers
Bean Cutters
Bean Hullers
Nut Harvesters

1. Selecting Hay-harvesting Machines

Hay is America’s second largest crop, being exceeded in acreage only by corn. Hay crops include alfalfa, sweet clover, timothy, lespedeza, native grasses, other grasses and grass mixtures, and grain crops grown for soilage or cured for feed. Hay crops can be harvested by following at least nine different methods. It is necessary to decide how the crop is to be harvested before selecting the machines.

Nine methods are (1) cutting, field curing, raking, and either stacking or mowing; (2) cutting, curing, loading, chopping, and blowing into the barn; (3) cutting, wilting, loading, chopping, and curing in the barn; (4) cutting, wilting, loading, and curing the whole hay in the barn; (5) cutting, field curing, and following in the field with a pickup baler; (6) cutting, wilting, windrow baling with pickup baler, and curing in the mow; (7) cutting, field curing, raking, cross raking or bunching for hand loading, or sweep raking to stack; (8) field cutting, chopping, and ensiling green; and (9) field cutting and chopping in one operation and blowing into a wagon for delivery to a silo, or to a mow for final curing.

Selecting Horse-drawn Mowers. As the mower is the first machine used, in most instances, it will be discussed first. This
machine is designed primarily to cut grass by means of a shear-like action between the sliding or reciprocating knife blades, or sections, and the stationary ledger plates. After the grass is cut, it is left in a uniform swath for partial curing and follow-up by other hay machines.

In addition to cutting grass for hay, mowers are also used to cut weeds and harvest many crops other than hay. Special equipment is available for cutting grass under unfavorable conditions, and for harvesting special crops including peas, beans, and lespedeza.

The size of the mower is indicated by the width of the swath cut. This is determined by the length of the cutter bar. Mowers are available in sizes ranging from a 3½- to a 7-ft. cutter bar. The narrow cut is found on one-horse mowers, while the wider cuts, 4½, 5, 6, and 7 ft., are available for team- and tractor-drawn mowers. Select a mower having a cutter bar of appropriate length.

Unfavorable weather conditions, rain and heavy dews, frequently interfere with successful haymaking, so it is necessary for the farmer to take full advantage of every hour of sunshine. Speed is vitally important if the crop is to be put in the mow, stack, or bale in a good, green, high-quality feed condition.

A description of the horse-drawn mower will aid in selection on the basis of construction and convenience. A mower can be divided for description into (1) frame and hitch, (2) gear drive, (3) lifting and tilting mechanism, and (4) the cutter-bar parts.

*The Main Frame.* This is the foundation of the mower and is cast in one piece. It provides rigid construction and keeps the gears,
SELECTING HARVEST AND HARVEST-HANDLING MACHINES

Fig. 266. Horse-drawn mower with parts identified.

Fig. 267. Cutaway view of transmission section of the main frame of mower. Power is transmitted from the large spur gear (1) on the axle to the counter shaft pinion (2) and bevel gear (3) on the counter shaft and to the bevel pinion (4) on the crankshaft, then to the flywheel shaft (5) and pitman (6). (7 and 8) Clutch and clutch pedal.
and shafts in true alignment. Since the mower is operated through the two wheels, the frame provides weight to give traction. Locating the gear case in back of the axle helps to balance the frame weight on the axle. A coupling bar attached to the frame, high up and ahead of the axle, minimizes its tendency to exert downward pressure on the neckyoke.

The wheels provide power, through the gear mechanism, to operate the reciprocating knife. Ratchets are located in the wheel hubs and a pawl holder with pawls and springs is keyed to each end of the main axle to transmit the forward motion of the wheels to the one-piece axle. In reality, the pawls are a type of clutch. When backing the mower, the pawls are not engaged, thus permitting the wheels to turn, but not the axle.

The Gear Drive. This takes the rotary motion from the axle (Fig. 266), changes its direction and converts it into crankshaft or reciprocating action to drive the knife. During years of development, gears have been made of cast material, some exposed when running, others enclosed and running in lubricant. The open gears were safety hazards and also exposed to dust and grit. Some mowers now have steel-cut gears of improved design, enclosed and running in lubricant. This provision, combined with anti-friction bearings, reduces draft and naturally increases the normal life of a mower. The clutch is
generally mounted on the hub of the bevel gear and revolves with this gear when in mesh with it. Increasing the number of driving members on the clutch decreases the lag in cutter-bar motion when the mower is thrown in gear.

The Lifting and Tilting Mechanism. This controls or adjusts the cutter bar for cutting and, when raised, for transport. Horse-drawn mowers are sometimes classified by lift—plain lift or vertical lift. Plain-lift mowers have a hand-lift lever that raises the cutter bar to a maximum height of about 12 in. at the inner shoe, next to the mower wheel, and 52 to 54 in. at the outer end. The knife will continue to operate in this position. It is necessary for the operator to leave the seat to raise the cutter bar into a vertical position. After the cutter bar has been raised by hand, it is secured in a vertical position by the attachment of the stay rod provided. The vertical-lift mechanism enables the cutter bar to be raised to a full vertical position without stopping the mower. The clutch is automatically controlled with the movement of the bar. It is disengaged when the bar is raised beyond a certain height and automatically engaged again when the bar is lowered. Select this type for cutting close to trees, stumps, or other obstructions. A foot lever is used on all mowers to raise the cutter bar off the ground when passing over stones or other low obstructions, and when turning. There is no latch on the foot lever, so the cutter bar drops to the ground when pressure is released. A
lifting spring assists the operator in raising the cutter bar when either the hand or foot lever is used. A tilting lever adjusts the angle of the cutter bar, tilting the front of the bar down or up or maintaining it level. It is generally operated in the level position. Where the ground is covered with dead grass or stubble from a previous crop, the guard points are tilted upward sufficiently to prevent the old stubble from catching on the guards. It is sometimes necessary to tilt the guard points down in order to get under and cut lodged and tangled crops.

**Fig. 270.** Cutter bar with the parts identified.

_The Cutter Bar._ This is the "business end" of the mower. The condition of the cutter bar and the keeping of it in proper adjustment affect the efficiency of the mower. This discussion of cutter-bar parts will assist in the selection as well as the operation of a mower. _Knife_ and _sickle_ are names commonly used to designate the moving part of the cutter bar. It is composed of a series of triangular sections, each with sharpened beveled edges, riveted to the back of the knife. As the knife moves outward, the outside edge cuts; on the return stroke, the inside edge does the cutting. Technically, the _knife_ has smooth sections as on a mower, and a _sickle_ has serrated sections as on the grain binder and combine. _Ledger plates_ are riveted to the guards and provide one-half of the shear or cutting surface. These usually have serrated edges. _Guards_ extend in the front of the knife blades for their protection and divide the grass or other material to be cut. They are ordinarily spaced 3 in. apart and provide a mounting for the ledger plates. _Inner and outer shoes_ support the cutter bar at their respective ends. Each shoe has an adjustable soles to regulate the height of cut. The pointed part of the outer shoe also...
acts as a divider to separate the cut from the standing grass. The inner shoe of the cutter bar is attached to the mower at the inner-shoe hinge with hinge pins. In properly adjusted mowers, the outer end of the cutter bar angles forward slightly and is called the “lead” of the cutter bar.

Selecting Tractor Mowers. The cutter bar with its several parts is, in general, the same for tractor mowers as the one previously explained for horse-drawn mowers. Tractor mowers are operated by power direct from the tractor engine. This is transmitted either by a direct-connected power take-off shaft, or by power take-off and belt-pulley drive. The power take-off is discussed as part of the tractor in Part V. That discussion describes how the power shaft is attached to the power take-off shaft and how it is placed in gear, the safety feature of the slip clutch, and the proper shielding of the shaft as a safety measure.

Trail-behind Tractor Mowers. These can be mounted or attached to most tractors having a standard power take-off shaft. The frame of the mower is hinged to the drawbar of the tractor while the rear end of the frame is carried on independent wheels. This construction provides good flexibility as it permits the cutter bar to float independently of the frame end of the tractor. Clean, even cutting results at all times as the mower is free to follow the ground contour. This type is especially suited for cutting over uneven ground and over borders and small ditches in irrigated fields and meadows.

The cutter bar is raised or lowered by means of a long lever.
mounted on the frame of the mower and extending to within easy reach of the operator. The usual manual lifting mechanism can be replaced by the tractor power lift.

![Diagram](image)

Fig. 272. (A) Select a tractor mower with a safety spring trip that automatically releases the cutter bar when it strikes an obstruction.

Select tractor mowers equipped with a safety spring trip that automatically releases the cutter bar if it strikes an obstruction. The bar swings back away from the obstruction and prevents damage.
The entire cutting unit, including pitman, then swings back in a normal straight-line position.

*Tractor-mounted Mowers.* These are available for specific makes and models of tractors. They are of two types; those mounted at the rear of the drive wheels and those mounted ahead of the drive wheels. The rear-mounted mowers are mounted on the tractor drawbar and driven by belt from the tractor power take-off. Similar to the trail-behind mowers, these are constructed with a safety spring trip, so they swing back when an obstruction is encountered.

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*Fig. 273.* A rear-mounted mower with a hydraulic lift controlled by a convenient lever.

*Fig. 274.* A small tractor with a direct-connected side-mounted mower controlled by a power lift.
Side-mounted Mowers. These are on the right side of the tractor, ahead of the operator. They are driven by a belt or chain from the power take-off. A safety spring trip also protects the mowers. Both types are readily attachable and detachable.

Selecting Mower Attachments. In addition to a variety of guards and special cutter bars, several attachments are available for special-crop handling. To facilitate cutting, select extension guards to lift lodged and tangled crops such as hay, grain, peas, and beans. Also select a tongue truck to remove undue weight from the necks of horses and prevent the tongue from whipping on rough land.

The Canning Pea-mower Bar. This has a long-hinged lifter guard replacing each regular third guard (see page 318). In harvesting green canning peas, the vines are lifted gently so that the pods will not be injured and then rolled into well-formed windrows. The hinged guards follow the contour of the ground.

The Windrower. This machine is for green crops, and places the cut crop in a windrow for picking up with a green-crop loader or hay loader. Select side-delivery windrowers when cutting grass-seed crops such as alfalfa in order to avoid unnecessary handling that results in shattering (see page 318 and 319).
Reaping Attachment. Designed for horse-drawn mowers, it is used in certain sections for harvesting grass-seed crops. The attachment includes an extra seat located over the right mower wheel. From this position the operator rakes the crop into the platform, retaining it until he has the proper-size bunch, and then dumps it.

Buncher Attachment. Designed for gathering short hay and seed crops that cannot be raked, it consists of a metal shield holding the cut material on a steel-fingered platform (see page 319).

High-cut Attachment. This raises the cutter bar on a wheel at the outer end and has an adjustable hook on the inner end. The cutter bar can be raised up to 12 in. above the ground for cutting weeds over the tops of young grain and alfalfa (see page 319).

Selecting Hay Rakes. Grasses cut for hay have to be loaded for hauling or further processing. Some loaders take hay direct from the swath while others load from the windrow. Thus, for the latter method, the grass or hay is placed in windrows with hay rakes, where it can be gathered or picked up later.

![Selection of guards for the material to be cut.](image)
FIG. 277 A-C. Special attachments designed for particular conditions. (A) Canning pea-mower bar. (B) Green-crop windrower. (C) Windrower attachment for tractor mowers. (See also Fig. 277 D-F.)
Fig. 277 D-F. Special attachments designed for particular conditions. (D) Another type of windrower attachment in action. (E) Buncher attachment. (F) High-cut attachment.
Dump rakes roll the mowed swath of hay into convenient rows. They are available in either one- or two-horse sizes. Select the larger size except where fields are small or when operating under close conditions. Dump rakes, often referred to as "sulky" rakes, are available with hand or foot power, or a combination of both, for lifting the teeth to dump the hay. When hay is shocked by hand, hand dumping is preferred because the rake tines engage the crop more quickly after dumping. The rake tines can be had with or without coils, but those with coils are less likely to break when the tips catch.

Side-delivery Rakes. The advent of the hay loader called for a hay rake that would put the hay in loose, fluffy, continuous windrows. This is also advantageous for pickup balers and hay choppers. Some operators rake the hay into windrows directly behind the mower. Side-delivery rake action tends not only to form loose windrows but to expose the slower drying stems. This permits the crop to cure more uniformly and reduces loss of leaves, the most nutritious part of the crop.

Some side-delivery rakes are so constructed that the cylinder can be reversed to do the work of a tedder. The purpose of a tedder is to
move heavy or wet hay. The stirring action assures more even drying of the crop. Where the amount of work justifies their use, regular tedders are preferred rather than the combination tedder.

Side-delivery rakes are of two types; fork and cylinder; both of them perform the same duty. The hay is delivered to the left so the direction of travel is the same as that of the mower. Select the fork type for working where the ground surface is rough. The individual forks tend to lift the hay out of the low spots. Side-delivery rakes and tedders are operated by the wheels, somewhat similar to the mower. Where land is corrugated for irrigation, equip the rake with dual drive wheels to prevent either end from dropping into the ditches.

Sweep Rakes. These are also known as “bunching,” “buck,” and “bull” rakes; they move hay from shock or windrow to the stack, stacker, or baler. The horse-drawn types can be had with two, three, or four wheels, and with side or rear hitches. Select the rear hitch for heavy hay and for irrigated conditions where small ditches must be crossed. A power-lifting device will relieve the operator of raising the rake with hand levers. Sweep rakes operated by tractor or special power unit are used by many hay producers. These motor buck rakes carry larger loads and move more rapidly than those operated by horses; they are, therefore, suited to move hay over greater distances and eliminate other handling operations.
FIG. 281. Overhead view of tractor-pulled side-delivery rake. Select the double caster wheel for operating over terraces, across corrugations, and in irrigated fields.

FIG. 282. Tractor-mounted sweep rakes. The caster wheels expedite carrying large loads over all surfaces.
Selecting Hay Loaders. The hay loader facilitates rapid handling of hay where it is loaded onto wagons or trucks from either the swath or the windrow. Loaders gather the hay without tearing the windrows apart. This is desirable for loading legume-hay crops, such as alfalfa and clover, the leaves of which have a tendency to shatter.

![Hay loaders pick up hay either in the windrow or swath and elevate it to wagon or truck.](image)

The two general types of hay loaders are the cylinder or carrier, and the fork or rake bar. Loaders are attached to the rear of the vehicle to be loaded. As the wagon or truck is driven forward, straddling a windrow or over swathed hay, the loader gathers up the hay and delivers it to the hayrack. The loader is operated by power from the ground wheels.

*The Cylinder Loader.* Such a machine operates much like an ordinary clothes wringer. One large cylinder in contact with the ground revolves to the rear. It gathers the hay and lifts it backward, where the small cylinder, revolving in the opposite direction, catches or holds it. This operation forces the hay between the two cylinders up onto an incline where an endless belt carries it to the wagon.
The Fork Loader. This machine can rake and load hay in one operation. Two sets of bars, the length of the loader apron, operate on a crank. These bars have a fork at the bottom with wire teeth spaced at regular intervals the full length. While one set of bars is "forking up" a bunch of hay, the others are pushing the hay upward.

Fig. 284. The combination fork or rake-bar type hay loader with parts identified.

Fig. 285. The cylinder or carrier loader with adjustable top.
This operation is continuous, moving the hay all the way to the top of the apron.

*The Combination Loader*. This combines the principles of both preceding types. A cylinder gathers the hay and places it on the apron while the rake bars do the elevating.

Select loaders that have an automatic release hitch. These can be operated from the top of the load by pulling a trip rope, thus eliminating the necessity of the driver’s climbing down to release the loader when the rack is loaded.

*Selecting Hay Stackers*. Hay stored in stacks in the field or feed lot must retain its feeding value. Losses occur through heating and absorbing rain or snow. Several different types of stackers are available for varying climatic conditions.

*The Overshot Stacker*. This type is generally used where the hay is brought in with a buck or sweep rake. Each load, after being pushed on the stacker teeth, is raised and thrown overhead onto the stack by animal, car, truck, or tractor power transmitted through pulleys and rope or cable.

*The Swing-around Stacker*. This one is loaded and raised similar to the overshot. Before dumping, however, the load of hay can be swung around and dropped on the stack where desired. This can also be done with derrick and “Mormon” stackers.

*The Buck-rake Stacker*. This is mounted on the front of, and operated by, tractors. Upon reaching the stack, the hay is shoved up the
Fig. 287. Combination buck rake and stacker, a laborsaving machine.

Fig. 288. A cable hay stacker.

incline of the rake, and dumped on the stack. Similar stackers operated by horsepower are referred to as combination stackers.

The Cable Stacker. This type employs a fork or sling similar to those used in placing hay in a mow. Any length and height of stack
can be built within the limits of the length of the poles holding the cable and length of cable.

**Selecting Hay Crushers.** These machines crush or crack the stems of freshly cut alfalfa, soybeans, and other grasses, to expedite curing of the stems. Crushed stems give up their moisture more rapidly so the leaves do not become brittle while the stems are drying to a safe moisture content for storage. The hay crusher is a combination 7-ft. mower followed by a field swath pickup, similar to that on a pickup baler. The pickup delivers the hay direct to smooth rollers that are under adjustable spring tension. The grass or hay with crushed stems is returned to the ground in a fluffed-up condition. It is then windrowed for loading or baling. The unit is pulled by a two-plow tractor and operated through the power take-off.

**Selecting Hay Balers and Bale Loaders.** Baled hay is in a convenient form for handling, especially for train or truck transport.

*Stationary Balers.* Such balers are located near a stack for stack pressing, or centrally in the field for baling from the windrow. Operated by either engine or tractor, a push-type plunger forces the hay into a reducing dimension form; thus, friction within the hay channel controls the amount of compression. Select a self-feed attachment for safety and uniform feeding.
Pickup Balers. These gather the hay in the windrows, press it, and leave it in bale form for loading. Some pickup balers use twine of a much larger size than does the grain binder. Knotters similar to those on binders tie these bales. Other pickup balers use wire ties, some requiring another operator to tie the bales. Power is supplied through either the tractor engine, the power take-off shaft, or an...
auxiliary engine on the baler. A pickup apron, similar to a hay loader or slat-type conveyor, elevates the hay to a hopper where an auger or other conveyor feeds the hay to the plunger. Some pickup balers are designed for using bale blocks and others operate without blocks. With the round baler, the windrow is flattened, compressed, and rolled up like a thick carpet, under tension by a flexible forming band. When the bales are completed, they are automatically wrapped with ordinary binder twine. The bales are of the same length, but the diameter can be varied to provide bales from 45 to 100 lb.
Several types of bales are produced by pickup balers: (1) the conventional rectangular bale, ranging from 14 by 18 in. up to 17 by 22 in., and adjustable length, (2) the round bale that rolls the hay, and (3) the "sliced" rectangular bale. Bale loaders are available mounted on tractors as trailers while others pick up and deliver bales to a wagon or truck. Some of these machines are fitted to be used at
the barn for conveying the bales to the mow. Bale loaders are usually of local manufacture. They are of several different designs: (1) a low, flat-topped trailer attached to the pickup baler and onto which the bales are dropped or placed as formed, (2) a large wheel attached to one side of a hayrack or hay truck, which picks up the bales as it passes over them in the field and hoists them onto the rack, and (3) a long, sloping elevator that literally scoops up the bales and elevates them to the hayrack. (4) The tractor-mounted loaders are on the side of the tractor. They pick up bales as the tractor moves through the field. The same loader can be used to elevate bales from wagon or truck to the mow.

Selecting Hay Choppers. Leaving hay to cure in the field is very risky in humid regions. Considerable hay is lost and much of the rest deteriorates in feeding value. In order to reduce this hazard, mow or barn curing of hay is practiced by many haymakers. Long hay, or even field-baled hay, can be cured by mechanical means in the mow. However, chopping greatly reduces hand labor and eliminates forking. There are three types of hay choppers. The field chopper cuts the crop, chops it, and loads it in a wagon, all in one operation. This machine combines the mower cutter bar, the reel of the binder, the auger and canvas conveyor of the combine,
the chopper of the feed mill, and the ensilage harvester blower. The chopped hay is blown into a light wagon. It then is blown into a silo if it is to be kept as silage, or blown into the barn for curing.

**FIG. 297.** Field hay chopper cuts the green crop, chops it, and delivers it to a trailer or truck bed.

**FIG. 298.** Windrow-chopper, operated from power take-off, takes the windrowed hay, chops it, and delivers the crop to a wagon, truck, or trailer.

The windrow chopper chops and loads hay that has wilted in the windrow. This is then blown into the barn or mow. The stationary or barn chopper receives field-wilted hay from wagon or truck, similar
to an ensilage cutter, and chops and blows the hay into the mow. Chopped hay reduces storage space requirements. Barn-curing equipment required where uncured hay is placed in the barn is discussed in Part VI, in connection with barn-mowing devices.

2. Selecting Grain-harvesting Machines

The invention of the reaper is often referred to as the beginning of mechanized crop production. As soon as farmers realized that they could harvest more grain than they could plant, a demand arose for better plows, tillage tools, and planting equipment. Inventors met these demands with a continually growing list of new and improved agricultural machines. The reaper, as originally designed, is still a common machine in many countries of the world. More than half the farming population of the world still relies on sickles and cradles; these were the harvesting tools of America until the 1830's.

**Selecting Headers.** The header is the simplest grain harvest-handling machine used in America today. It cuts the heads from the grain and elevates them into header barges. They are then stacked for threshing, a later operation. Headers are pushed ahead of the power used. The swath-cut ranges in size from 12 to 20 ft.

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1 Cyrus McCormick, Stevens Point, Va., 1831.
The wider ones are used mainly in the plains areas of large acreage where little or no attempt is made to save the straw.

Selecting Grain Binders. The binder performs three main operations: it (1) cuts the standing grain, (2) binds the grain into compact bundles, and (3) makes it possible to deposit accumulated bundles on the ground. The binder will harvest all the small-grain crops. The size of binders ranges from 6- to 8-ft. cut for horse-drawn, and 8- to 10-ft. cut for tractor-powered machines. Horse-drawn binders receive power from the one large wide drive wheel, known as the “bull wheel.” Auxiliary, independent gasoline engines are available to operate the binder mechanism. Tractor binders receive power from the tractor engine through the power take-off. A knowledge of binder units and their operation is necessary for selecting type and make. For convenience, the discussion of construction and, in turn, operation will be divided into functional parts or units.

Main Frame and Power Drive. The main frame of the horse-drawn binder, and the same is generally true of the tractor binder, is constructed around the main wheel to provide rugged construction and to keep the power-drive shafts and bearings in alignment. The other members of the frame attach to this main frame. In horse-drawn binders, the power is transmitted from the main axle by a large chain to a countershaft at the rear. The clutch is on this countershaft. The countershaft operates much like the countershaft of the mower.
It drives the crankshaft through bevel gears. A gear on the rear of the crankshaft powers a chain which, in turn, operates all other moving parts of the machine. The power take-off on tractor binders delivers its power at a similar point to that of horse-drawn binders so that the discussion from here on is similar for both horse-drawn and tractor binders. The chain drive with a roller chain is preferred to other types. It transmits power to the platform and elevator rollers and to the binding unit. The sickle pitman on tractor binders is driven directly from the power shaft.

The Cutting Unit. This part of the binder consists of the cutter bar and divider similar to the mower. In addition, the reel is included in the cutting unit. Cutting the stems of grain requires less power than that required for juicy grasses. As a result, the sections have serrated edges and the ledger plates smooth edges. The cutter bar, being a part of the strongly braced steel platform, is held firmly in place and requires no “lead” as does the mower bar. The divider, as its name implies, is a device attached to the outer end of the platform for separating the swath to be cut from the remaining standing grain. Select a divider that can be folded when the transport tongue is attached for moving the machine on the highway. The height of cut is regulated by adjusting the height of the binder in relation to the main and grain wheels. The platform can be tilted down, by a tilting lever, for cutting lodged and tangled grain. The reel plays an important part in gathering all the grain and placing the
cut grain evenly on the platform canvas. The reel is adjusted by means of two convenient levers. One lever raises and lowers the reel in relation to the cutter bar, while the other shifts the reel forward or backward.

**Conveying or Feeding Unit.** This unit consists of the platform canvas, and the upper and lower elevator canvases. The platform canvas carries the cut grain to the inner end of the platform where it is lifted to the binder deck between the **elevator canvases.** The canvases are endless when in operation and have cleats or slats evenly spaced to carry the grain. The elevator canvases move at a uniform speed. The grain is held between them as it is elevated to the deck.

**Binder Deck Unit.** This unit consists of (1) the deck roller, (2) steel deck or table, (3) deflector, (4) deck wind board, and (5) butt adjuster. The **deck roller**, located between the upper roller of the...
lower elevator canvas, rotates toward the deck and lifts or carries the grain from the elevator to the deck. The deck, usually of steel, has a steep slope so the cut grain slides down under the deflector to the trip hook. The deflector keeps the grain on the deck, while the deck wind board prevents wind from interfering with the formation of the bundles. A butt adjuster, sometimes called a “butter,” is located on the front of the deck. It evens up the straw at the butts to assist in making well-

FIG. 303. Binding unit and deck of a tractor binder. The deck is cut away to show operating parts below the deck.

shaped bundles. Butt adjusters are either a small moving canvas or an oscillating paddle.

**Binding and Tying Unit.** Such a unit ties the grain into compact bundles after which they are deposited on the sheaf or bundle carrier. This unit consists of (1) packer arms, (2) trip-hook and trip-dog assembly, (3) twine-tension roller and slack-twine spring, and (4) binding and tying assembly which includes needle, knotter, breast-plate, and discharge arms.

**Packer Arms.** Generally three in number, these are in reality long, curved fingers that compress or pack the grain against the trip hook.
These packers come up from under the platform so as not to interfere with the gravity action of the falling cut grain.

Trip-hook and Trip-dog Assembly. These regulate the size of the bundles. When sufficient grain has collected to make a bundle, the pressure against the trip hook forces it back and releases the trip dog. This action engages a clutch, which sets the binding mechanism in operation to tie the bundle.

Twine-tension Roller and Slack-twine Lever. These control the tension of the binding twine between the twine can and the needle.

The twine-tension roller is located just outside the twine opening in the can. The twine tension has no function in adjusting the tightness of the bundle. (See Binder Operation, Chap. 11.) The slack-twine lever is used on tractor binders only because of the higher speed. It holds the twine taut while the needle is in operation.

Binding and Tying Assembly. The compacted grain is tied into bundles and kicked onto the bundle carrier by the binding and tying assembly. The needle comes up from below the deck, carrying the twine over the packed grain to the knotter. Select a needle with a rotating hardened-eye surface to provide long wear. The needle places the twine in the twine holder disk. This already has the lower strand of twine, from the previous tying operation. The knotter hook or bill rotates in proper sequence moving up and under in such a manner as to form a loop in the two strands of twine. As the loop is being completed, the jaw of the hook opens, grasps the twine, and...
pulls it through the loop to complete the knot. The three discharge arms rotate behind the bundles to "kick" it out when tied. They are also part of the tying mechanism, as they pull the knot off the hook, tighten the knot, and hold the twine while the twine knife cuts the two strands of twine.

Fig. 305. Knotter mechanisms used on grain binders.

Fig. 306. Rice binders are similar in construction to other grain binders. Note lugs on bull wheel.

Carrying and Dumping Unit. This unit receives the tied bundles. It is either a wire rod carrier or a carrier with a controlled endless belt that holds six or seven bundles so they can be deposited in a windrow. This maintains open driveways in the field and facilitates shocking, or loading bundles for stacking or threshing.

Selecting Rice Binders. Although these binders are similar to the regular grain binders, they incorporate those things which will
permit them to function satisfactorily under wet and muddy conditions that cause poor traction. When power is derived from the bull wheel, it must be fitted with special mud lugs to assure traction. Select solid wheels, or those covered on the sides with sheet metal, to exclude the mud. Since rice binders are often operated under rather wet conditions, select a machine with exposed metal parts that are rust resistant. The use of an auxiliary engine on the binder or of tractor-powered binders using a power take-off has eliminated much of the traction difficulty encountered with horse-drawn rice binders.

Selecting Binder Accessories. Extension guards are essential on the binder sickle bar if there is any lodged or tangled grain to be cut. Use one of these guards for each foot of length in the cutter bar. Other accessories, usually essential, that may be regular equipment are tongue trucks and transport trucks. The former remove weight from the necks of the horses and facilitate turning while the latter permit the machine to be more satisfactorily moved on the highway, being less hazardous to other traffic.

Reel accessories include different-speed reel sprockets. Select sprockets that will enable the reel to gather the grain, and push it back on the canvas, without carrying it around on the reel. For nodding grain, select a reel having arms covered with screen or light tin. Reels with belting wipers at the outer ends of the slats will clean the divider of straw. For lodged grain, select a loop divider. Where straw hangs on the outer ends of reel slats, either select a reel having slat end guards or unite ends with an 8-in. band of light sheet metal. Reels are available with three, four, and six paddles, and vary in width to meet the needs of most any crop or crop condition.

Selecting Threshing Machines. Threshing machines remove the kernels from the heads of the cut grain crop and clean and deliver them to one place, while the straw and chaff are being delivered to another place. Threshing machines, like most other farm machines, are available in different sizes. Size of threshers is expressed in two-dimensional measurements. For example, a $20 \times 36$ machine has a front cylinder 20 in. long. The 36 indicates that the thresher is 36 in. wide across the separating and cleaning parts at the rear of the machine. The size also indicates the threshing capacity of the machine and power requirements. The $20 \times 36$ machine is one of the smaller sizes and can be operated by a 16- to 20-belt horsepower tractor. A $40 \times 62$ thresher, fully equipped, requires up to 60-belt
horsepower for operation; the weight of this machine is approximately five tons.

Threshing machines are movable. They can be located in a feed lot or other place where straw is desired. In shock threshing, the

Fig. 307. Pitching bundles to the feeder from the clean side of a small thresher. Larger machines are usually fed from both sides. An extension feeder accommodates more pitchers.

bundle grain is brought to the thresher location by wagon, truck, or sweep rake. In stack threshing, the machine is placed at the stacks of grain.

The principal operations in a threshing machine, each requiring separate unit mechanism, are (1) feeding in the grain; (2) removing
the kernels from the head or, in some crops, the seed from the pods; (3) separating the kernels from the mass of straw and coarser material; (4) cleaning the kernels from the remaining chaff and finer residue; and (5) delivering the cleaned grain and the straw to outlets.

*The Feeding Mechanism Unit.* Sometimes considered an accessory, this is a conveyor that feeds the bundles to the cylinder. Originally, men stationed in front of the cylinder opening cut the twine bands on the bundles by hand and fed them head first into the cylinder. This was an unsafe and time-consuming procedure. The present-day *self-feeder* consists of a conveyor to move the bundles into the cylinder. *Revolving or oscillating knives* cut the bands, and a *spiked roller* feeds the grain to the cylinder. Select a self-feeder with governor controls that slow the feeder in case the cylinder becomes overloaded.

*The Threshing Unit.* This consists of the cylinder, concaves, and adjustable feed plate. The threshing principle is to pass the grain between a rapidly revolving cylinder and a stationary surface underneath known as the "concave." The common-type *cylinder* is made up of parallel bars, varying from 9 to 20, each bar having several cylinder teeth. The *concaves* are flat metal bars extending across the machine just below the cylinder. The concaves are adjustable, permitting the cylinder teeth to pass deeper between the concave teeth. The cylinder makes from 750 to 1,200 r.p.m. The cylinder teeth revolve between the concave teeth and beat out or loosen the grain from the rest of the material. Special cylinders and concaves are available for the crops requiring them. The relationship between the cylinder teeth and the concave teeth determines the quality of the threshing done. The *cylinder beater*, a four- or six-sided box-type
cylinder, strips the threshed material off the cylinder and retards its movement back onto the straw rack (Figs. 323 and 324). This beater also tends to spread the material out to expedite separation.

The Separating Unit. As used here, this refers to separating the grain kernels from the mass that passes through the cylinder and concaves. The parts comprising this unit include (1) the concave and finger grates, (2) the straw rack, (3) the adjustable check flap, (4) the grain pan, and (5) the return pan. The *concave*, although listed as a threshing member, is also a separating member, in that there are several openings or screens through which threshed grain falls into the grain pan. Select concaves with openings for the grain being threshed. The *finger grate* is a series of steel rods below and in back of the cylinder beater, between which threshed grain can fall into the grain pan (Fig. 324A). The *straw rack* has a rocking motion that loosens and shakes up masses of straw coming from the cylinder. The *fins* and *risers* act as combs to loosen the straw further, to permit any remaining grain to fall through onto the return pan. The *adjustable check flap*, as its name implies, is to check or retard the straw as it passes over the straw rack. The *grain pan*, located underneath the concave, is built into and oscillates with the chaffer and chaffer extension. The grain pan receives the grain, chaff, and unthreshed heads that have dropped through the concave opening.

![Fig. 310. Section of the threshing concaves.](image)
It also receives that which has been separated from the straw over the straw rack and has fallen through the opening onto the return pan. The material on the return pan is carried forward and emptied onto the grain pan.

*The Cleaning Unit.* Cleaning is the final basic function of the thresher in removing the grain from chaff and residue. The principle of thresher cleaning is based on an application of the law of falling bodies, which states that objects of different specific gravities fall at different rates of speed in air. The cleaning operation all takes place in a so-called "wind-tunnel" under air blast, the air or wind provided by the cleaning fan. The four main items in the cleaning unit are (1) the chaffer, (2) the chaffer extension, (3) the cleaning shoe, and (4) the fan. The *chaffer*, made up of a series of adjustable overlapping metal fins, is essentially a coarse sieve to remove the coarser particles of straw and chaff from the grain and let it fall through the shoe. The *chaffer extension*, similar to a shutter in design, has openings adjustable to meet crop and threshing conditions. These openings permit the unthreshed heads to fall through into the tailings trough, and at the same time carry over weed stems, straw joints, and other coarse material. *Tailings*, consisting largely of chaff and unthreshed heads "floated" over from the chaffer and shoe sieves, are carried to the *tailings elevator* by the tailings auger. The tailings elevator returns the tailings to the cylinder for rethreshing. *The cleaning shoe*, suspended directly underneath the chaffer, provides a second cleaning of the grain under air blast. This sieve has smaller openings than the chaffer.
sieve and can be regulated to a finer degree. The shaking action of the shoe operates in direct opposition to the chaffer. Thus, when the chaffer moves forward, the shoe moves in the opposite direction. This provides more vigorous cleaning and also a counterbalanced action to reduce machine vibration. The cleaning fan and regulating parts, wind deflector and adjustable tailboard, are to provide an air blast that will lift the chaff from the sieves, but not enough to blow the grain over and away.

The Straw- and Grain-delivery Units. Straw can be removed and stacked by a straw carrier or canvas, similar to platform canvas of a binder; commonly it is blown out by using a wind stacker. This is a wide metal pipe, adjustable in height, length, and direction. The rapidly revolving fan blows the straw out through this pipe. The grain-delivery or grain-handling device collects the clean grain and carries it by means of an elevator to the top of the machine to a weigher. The weigher, set for the weight of the grain being threshed, weighs, records, and automatically releases the grain into a bagging attachment or direct into a wagon, truck, or grain bin.

Selecting Thresher Accessories and Special Threshers. Select a machine with an extension feeder if headed or bundle-stacked grain is to be threshed. The length and size of the extension feeder will be dependent upon the size of stacks common to the area served and the capacity of the machine. Special recleaners are essential when grain contains an unusual amount of foreign material.
Although adjustments and accessories permit regular threshers to handle grasses, beans, and other farm-seed and grain crops, they are not always satisfactory. Therefore, it may be well to select machines specifically built for these crops such as clover hullers for grass-seed crops, bean hullers for peas and beans, and peanut pickers for peanuts. Other special threshers are available to remove seeds from cucumbers, watermelons, and cantaloupes.

**Selecting Combine Harvester-threshers.** The combine harvester-thresher, as its name implies, cuts the standing grain in the field and delivers the cleaned kernels or seed to a container and returns the straw to the field or places it in windrows for loading or baling. Combines were first designed for the large-acreage grower. Now they are sized in keeping with other farm equipment, the small sizes being 40 in. in width of cut. Combines now manufactured are all tractor operated.

The combine offers several advantages over the harvesting procedure which involves binding, shocking, loading, and threshing. Some of these advantages are that (1) no threshing crew is needed, (2) twine for bundles is eliminated, (3) several labor operations are eliminated, (4) less machinery is required, (5) harvest recovery is increased, and (6) a higher grade of grain is often delivered.

Combines are of two main types: those **pulled behind** the tractor.
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utilizing either the power take-off or an auxiliary engine, and the *self-propelled* type. The self-propelled combine is in one unit, with the power plant constructed integrally with the combine. The cutter bar, in front, is the widest part of the machine; no grain, therefore, is pushed down by either the tractor or the combine. The driver sits above and directly behind the cutter bar and reel with all controls conveniently at hand. Mounted on only four wheels, the machine is maneuverable into corners and close to fences. With no obstructions at either end of the sickle on a self-propelled combine, there are many

Fig. 314. Pulled-behind combine, harvester-thresher (4-ft. cut) operated through the power take-off.

Fig. 315. Front view of a self-propelled combine.
advantages. There is no back swath; it is easy to operate next to ditches, levees, and fences; no standing grain is run over when cutting around wet spots, immature grain areas, or weedy spots; forward vision permits operator to note all field conditions; and there is no difference when picking up windrows that have been cut by either right- or left-hand travel. The power unit on a self-propelled combine is used only for combining grain, so unless a large acreage can be handled annually, the overhead cost may not justify selecting this type of machine.

The combine has six functional operations to perform: (1) cutting
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the standing crop, (2) feeding the cut grain to the cylinder, (3) threshing the grain, (4) separating the grain from the straw and chaff, (5) cleaning the grain, and (6) delivering the grain and straw.

Many features pointed out in connection with both the binder and the threshing machine are also included in the combine. It heads the grain similar to a header but does not form or tie bundles as does the binder.

The Cutting Mechanism. This includes the same items as the binder—dividers, cutter bar, and reel. The operation of each is similar except that the platform is not a part of the cutter bar.

The Feeding Mechanism. This mechanism delivers the cut grain to the cylinder. Several principles are used. The canvas conveyor, on narrow-cut machines, elevates the grain from the cutter bar in a straight line to the cylinder. Two canvases are used, a lower canvas and an upper canvas near the top, to assure positive feeding to the cylinder. The combination auger scoop-type is used on the wider cut machine (Fig. 319). The feeding canvas is about the same width as the cylinder. The balance of the cut material falls into a trough and is moved to the canvas by an auger. A revolving beater assists the canvas in elevating the increased amount of material to the cylinder. The pickup attachment increases the usefulness of the combine by enabling it to gather crops that have been placed in windrows for uniform
curing. The pickup extends across the full width of the combine platform and is mounted ahead of the cutter bar. In some makes, it is first necessary to remove the knives and guards. The pickup consists principally of a drum with several rows of flexible steel teeth or fingers that slip under and lift the windrowed crop onto the platform.

**The Threshing, Separation, and Cleaning Devices.** These are similar to the threshing machine (see Fig. 325).

**The Grain-distribution Mechanism.** This is similar to the threshing machine, although the weigher is optional. The straw is conveyed to the rear of the combine where a straw spreader, a revolving unit of
four large horizontal paddles, spreads the straw back, more or less uniformly, on the ground. In some instances, farmers bale this straw using a pickup baler. In such instances, the spreader is not used but the straw is allowed to fall in a windrow, or is bunched.

Selecting Special Combine Equipment. The cylinder with regular hardened cylinder teeth is not suited to all grains. The *rasp-bar cylinder* has corrugated all-metal bars that rub or thresh the grain against the concaves which are also flat bars. A *flail-type cylinder* with
rubber-faced angle-steel bars, as well as the rasp-bar type, is often used where much green material is encountered (Fig. 326). These cylinders do not "chew up" the straw in small bits, and permit the green material to pass through almost whole. **Bagging equipment** consists of two-way spouts equipped with quick-release bag holders, and a seat for the tender. Usually the grain goes into a receiving tank that is dumped into a truck when filled.

**A Rice Shock-threshing Attachment.** For self-propelled combines this offers many advantages where drying facilities do not permit the combine method of harvesting. The machine moves from shock to shock where one or more men feed the bundles into the automatic self-feeder. A bundle cutter on each side of the feeder trims off wet butts, eliminating much moisture from the machine as well as excess straw.

**Selecting Portable Conveyors and Elevators.** The use of conveyors and elevators to move grain in or out of the farm granary is a real time, labor, and grain saver (page 356). The things to consider when selecting a portable conveyor include the following: a size suitable to the volume of grain and other crops handled; ability to handle all kinds of grain used on the farm, and baled hay if a special elevating device is not used for this purpose; the ease and speed with which it can be set up and moved from place to place; a receiving hopper of sufficient size to prevent grain spillage; a motor large enough...
to operate the conveyor easily when under full load; suitability to remove grain from the granary to trucks or wagons as well as to the granary from the trucks and wagons; an elevator spout that is adjustable; and ability to stand exposure to the elements without appreciable damage. When a blower is not available to fill silos, select a conveyor that will also serve for this purpose.

3. Selecting Corn-harvesting Machines

Corn is a multi-product crop. (1) It can be harvested in the green stage for “canned” feed as ensilage, (2) the ears can be picked and the stalks left in the field, or (3) mature corn can be cut and shocked.
CHAFFER EXTENSION
CLEANING SIEVE
CHAFFER

SHOE BOTTOM
FAN
ADJUSTABLE WINDBOARD

Fig. 325. The cleaning-mechanism members.

Fig. 326. Two cylinders recommended for combine use. (A) Rasp-bar cylinder with corrugated all-metal bars. (B) Flail-type cylinder with rubber-faced angle-steel bars.
Fig. 327. Combines designed for hillside operation, particularly the Palouse country of the Pacific Northwest, have a leveling arrangement for the threshing part of the machine. This machine is equipped with a bagging attachment.

Fig. 328. Elevated and weighed grain is collected in the grain tank and emptied at convenient points.
Fig. 329. A portable conveyor is a valuable time and labor saver in handling harvested commodities.

Fig. 330. One type of grain loader operated from the truck power take-off.
and later husked or processed with the husker-shredder which husks out the ear corn and shreds the dry fodder. Corn is cut with a corn knife, corn sled, binder, or field-ensilage harvester.

**Selecting Green-corn Harvesters.** Corn, which includes the many kinds of saccharine and nonsaccharine sorgos, is processed in two ways for the silo—by using the corn binder and ensilage cutter, or by using the ensilage harvester and ensilage blower. Corn binders are designed to cut and bind in bundles corn and sorghums and other row crops that may be fed whole as fodder, or further processed by means of an ensilage cutter, husker-shredder, or roughage mill. They are available with either ground-wheel drive or power drive, ranging in capacities from 8 and 12 acres per day with ground-drive, one-row machines, and 20 to 25 acres per day with tractor-operated, two-row machines. Two-row machines can be adjusted for rows spaced 36, 38, 40, and 42 in. apart.

Corn binders are available in two heights. The "regular" binder is preferable for the tall and average-height crops of the Corn Belt and other more humid areas. The "short" binder is adapted to those areas growing short corn. The general construction is the same except in the binder-head members.

The corn binder is divided into six parts to aid in discussing its construction: (1) power transmission, (2) frame and cutting units,
(3) gathering unit, (4) elevating unit, (5) binding and tying unit, and (6) carrying and dumping unit.

*The Power Transmission.* This is similar in both horse-drawn and tractor corn binders. Horse-drawn and other ground-driven corn binders have the power transmitted from the bull-wheel gear to the countershaft by chains. In binders driven by power take-off, the power is transmitted from the tractor engine through the power take-off shaft and transmission gears to the binder countershaft. The transmission or main gears generally are enclosed and run in oil. Select a binder having neither exposed gears nor chains because they are hazards to the operator and may clog with weeds and trash. Power is transmitted from the countershaft to the cutter bar, elevating chains, and the binding and tying unit. Select a tractor-operated binder that can be equipped with "steering stops." These stops, by limiting the turning radius of the tractor, keep the tractor and binder...
at a safe distance and prevent sharp angles from developing in the
power line.

The Main Frame. The frame is rectangular in form and supported on
two wheels; the main wheel and the grain wheel. The main or
bull wheel in horse-drawn binders supplies the power to operate the
binder similar to the grain binder. Extending from the front of the
main frame are the A-frame bases for the elevating mechanism. It
is desirable that the wheels and other members revolving about shafts
have anti-friction bearings, either ball or roller. The cutting mechanism

![Diagram of cutting mechanism](image)

FIG. 333. The cutting mechanism of the corn binder. (A) Reciprocating knife and (B) two stationary knives.

consists of three knives. Two of these knives are stationary and taper from front to rear to give a drawing stroke against the stalks as the
binder moves forward. The third knife, a large mower section-shaped knife with serrated edges, is a reciprocating knife operated by
a steel pitman and crankshaft. It cuts or shears the cornstalks against
the stationary knives.

The Gating Unit. This mechanism guides the stalks to the sickle
for cutting and then elevates them in the form of compact bundles.
The gatherer points and boards are shaped and placed to get beneath
leaning and lodged stalks, and to guide them into the elevating chains.
Select a binder with gatherer points wide enough apart to include hills
that may be out of line with the row proper. A divider stick on the
grain side will prevent stalks on the row adjacent to the one being cut
from being pulled into the binder, or run over by the grain wheel.
The Elevating Unit. This is part of the gathering unit and consists of three sets of carrier chains. Select chains of the heavy malleable-link type with lugs serving as fingers spaced intermittently. A transmission shaft, extending upward on each side of the row, drives the chains on that side. The shafts are driven by bevel gears from the countershaft. The two upper chains are comparatively short and keep the stalks in a vertical position after being cut. The center chains, extending far beyond the cutting knives, assist in straightening down stalks and carry them to the binding unit. The two lower chains, known as “butt-gatherer” chains, are on the inner side of the row. Long steel springs, known as “throat springs,” keep the stalks and weeds against the two butt chains as they move up the butt pan.

The Binding and Tying Unit. This corn-binder unit differs from that of the grain binder only in position and the fact that it is of heavier construction. It has the same functional parts:

1. Packer arms,
2. Trip-hook and trip-dog assembly,
3. Knotter and breastplate,
4. Discharge arms.

Corn binders are available to tie bundles in vertical or horizontal positions.

The Carrying and Dumping Unit. This unit consists of a strong bundle carrier and will hold one or more bundles until the operator desires to dump them. Tractor-operated corn binders are sometimes equipped with conveyor-type carriers. This is an apron carrier operated from the binder when thrown into gear.

Two-row tractor corn binders are similar to the one-row except that they have a two-row gathering and cutting mechanism.

Selecting Corn-binder Accessories. Bundle elevators or loaders elevate the bundles directly to the wagon or truck traveling alongside the binder (see Fig. 331). Most corn binders can be equipped with a low-cut attachment to cut the stalks at or below the surface. This
is one way of removing the corn borers in the stalks from the field for later destruction. A wagon hitch is available for keeping the wagon in proper position with the binder when a loader is used.

Selecting Ensilage Cutters. Silage has long been recognized as a valuable and desirable feed for livestock. It is a succulent feed that has a nutritional effect on livestock similar to green pasture. It is an aid to digestion, stimulates the appetite, and is an excellent balance for the concentrates in the usual rations.

Crops damaged by insects, frost, drought, or other causes, and coarse legume hay crops can be salvaged by ensiling. Good silage is relished by animals and more of the crop is saved by this method. Silage is usually made from corn and the sorgos. Grasses, legumes, and many forage crops can also be made into excellent silage; it is usually necessary, however, to treat such crops with molasses or certain dilute acids that act as preservatives. However, if wilted in the field, they can be ensiled without preservative.

When selecting an ensilage cutter, obtain one that will handle several kinds of crops. If possible, select one that will not only cut and elevate green corn but green hay, dry hay, and fodder.

The ensilage cutter can be considered by main parts: (1) frame and power-transmission unit, (2) conveyor and feeding unit, (3) cutting unit, and (4) blower and elevating unit.
The Frame and Power-transmission Unit. Ensilage-cutter frames are both rectangular and triangular. They are assembled from steel members, either angle iron, channel iron, or rectangular tubing; members are secured by bolts or welding. Welded units are preferred because they make rigid frames that permit no sagging or weaving and, therefore, provide a better foundation for the parts.

The triangle type with a three-wheel or tricycle mounting has advantages. The V frame requires no additional bracing. The machine can be trailed behind a tractor or truck, and will trail well without side sway or "shimmy." These units are quickly backed into place and each wheel takes its share of the load. In cutting position, the tongue can be turned under the feeder, out of the way, and does not have to be removed. Rigid vertical members provide solid support for the cutter head and alinement of other moving parts.

Power is supplied by belt direct from the tractor to the cutter-head shaft. This power is transmitted to the conveyer and upper and lower feed rolls either by enclosed gears or by sprockets and chains. Each involves a safety feature in case of overload or other obstruction. On the sprocket and chain drive, the chain serves as the safety feature and breaks when overloaded. The enclosed-gear type is protected by shear bolts on the upper feed roll. Another safety feature is an accessible lever for throwing the apron out of gear and reversing it. Select one convenient to the operator no matter on which side of the machine he may be. More than a hand lever is desired; select a
device that can be operated by the "feeder man's" body itself. Select an ensilage cutter with desirable safety features.

The length of cut is changed by the speed of the apron travel or by changing the number of knives on the cutter head. If it is done by changing the speed of the apron, it can be by selective gear transmission somewhat similar to a tractor, or by changing the sprockets in chain-drive types.

The Conveyor and Feeding Unit. The feeding unit consists of the feed table, conveyor, paddle roll, and upper and lower feed rolls. Select a table of approximately the length of a wagon for easy feeding; select a machine with a wide, deep feed trough with sloping sides to reduce hand work. The conveyor, a flexible apron, moves the corn bundles or other materials toward the cutter head. Select a conveyor of such construction that it is positive in drive and provides protection against bending slats and gumming up of the chain. The paddle roll spreads the material in part but mainly forces the material down so it is fed between the upper and lower feed rolls. The feed rolls operate similar to a clothes wringer except they may not be smooth. These rollers are positive drivers assuring a constant flow of material at a uniform rate to the knives. The upper roller, generally a fluted roller, is
under spring pressure so as to provide a positive grip on the material regardless of its bulk. As discussed in connection with power transmission, a safety device convenient to the "feeder man" throws the apron or conveyor and rolls into operating position, neutral, or reverse. Select an ensilage cutter with convenient conveyor adjustments.

The Cutting Unit. This unit shears or cuts the ensilage material into uniform lengths, and in some cases the same unit serves as the blower. The cutting units are of two types, the cylinder type and the flywheel type. The cylinder type operates similar to a lawn mower. When in operation, it has one of the curved knives always in contact with the shear plate. The length of cut is determined by the speed of the conveyor that pushes material between the knives. The flywheel type has tool-steel knives bolted to the flywheel with two large bolts fitted with lock nuts. The revolving knives cut against a shear plate. Shear bars (Fig. 440) serve as a safety feature by preventing the knives from striking the cutter bar. The length of cut is obtained by using two or four knives on the flywheel. If selecting this type, select one with a flywheel made of boiler-plate steel, or reinforced with a steel band. This construction will reduce the danger of the flywheel going to pieces when operating at excessive speeds.

The Blower and Elevating Unit. Most silage is blown into a vertical silo. A blower is not essential for pit or trench silos.

The cylinder-type cutters require a blower which takes the cut silage from a hopper below the cylinder and blows it into the silo. On the cylinder type, wings are bolted on the flywheel. These wings serve as paddles or fan veins and blow the ensilage through the elevating pipe into the silo. Select size of pipe proportionate to the size of the cutter and height of silo.

Selecting Ensilage-cutter Attachments. A molasses pump provides molasses to the ensilage as it is being cut (Fig. 340). It consists of an automatic gear-type pump, belt drive, and hose. It draws the molasses from a container and feeds it through an automatic valve.
controlled by the upper feed roll. Shredder bars shred the fodder instead of shearing it. The shredder bars replace the knives on the flywheel. The usual arrangement for a four-knife flywheel consists of two shredder bars and two knives. A knife-grinding attachment simplifies the task of having sharp knives on hand. The attachment is mounted near the blower pipe and is operated through a V belt from the flywheel shaft while the cutter is in operation. The feeder sideboard makes possible the handling of various crops when pitched onto the feed table.

**Selecting Field-ensilage Harvesters.** The field-ensilage harvester combines the work of the corn binder and ensilage cutter (Fig. 341), except in delivering into the silo. It is tractor pulled and tractor operated and cuts one row at a time. Cornstalks are cut as with the corn binder. As the stalks are moved through the machine, they are manipulated so the butt ends are fed into an ensilage cutter head. As the corn or other row crop is cut, it is blown into a truck or wagon and hauled to the silo and dumped into trench or pit silos. For above-ground silos, select an ensilage blower. It consists of a hinged hopper and blower. The hopper is hinged so it can be raised vertically while a wagon or truck pulls into place. It is then lowered to receive the material from the truck or wagon. The blower is engine or motor driven by belt and throws and blows the material through the blower pipe into the silo. This machine can also be used as a threshed-grain elevator. The portable conveyor previously discussed in this chapter is also used to elevate silage.
Selecting Mature Corn-harvesting and Harvest-handling Machines. Following the program of mechanizing the production of corn came the need for picking corn mechanically. Corn pickers, all tractor operated, are of one-, two-, and four-row sizes. The corn picker snaps the ears off the standing stalks, removes the husks, and delivers the corn to a wagon or truck being pulled behind or to one side of the picker.

The two general types of corn pickers are the trail-behind and the tractor-mounted, sometimes called the “push” type. The tractor-mounted fits right over the same make of row crop-type tractor. The picker picks two rows, one on either side, as in cultivating.

The corn picker has some construction features that are similar to those of a corn binder. Gatherer points and boards straighten and feed the stalks into the throat. Elevating chains with lugs hold the stalks vertically while they are fed into the snapping rolls, a pair of long rolls parallel to the elevator. As the stalks pass between these snapping rolls, having a spiral rib and revolving toward each other, the ears are snapped off and dropped into a conveyor trough. This trough carries them to the husking unit or husking rolls.

The Husking Rolls. These operate in pairs somewhat similar to a wringer (Fig. 346). Each pair of rolls is held together under adjustable spring pressure. The rolls have small pegs that grasp the husks
and strip them from the ears by pulling the husks through the rolls. The pressure of the rolls is adjustable to permit husking small and large ears and to do so with a minimum of shelling.

Combination Snapping and Husking Rolls. Some manufacturers use one set of rolls for each row. The rolls are long, sloping at about a 15-degree angle to the ground. The lower part of the rolls snaps the ears from the stalk. The snapped ears are moved higher up the rolls where husking fingers or pegs remove the husks. The ears from both
rows drop into one hopper behind the tractor seat and are elevated into a pulled wagon or trailer. The four-row picker deposits the ears on a traveling belt for delivery to a trailing wagon.

**Fig. 342A-B.** Corn pickers are of several types to meet varied needs. (A) One-row trail-behind corn picker operated through the power take-off. (B) Two-row self-propelled corn picker. (See also Fig. 342C-D.)

*The Wagon Elevator.* This elevator receives the clean ears from the husking rolls and carries them up to a receiving tank or drops...
them into the wagon or truck. Select a corn picker that has provision for saving the shelled corn. Also, check to see that convenient adjustment provides good husking of damp, as well as dry, corn.

![Two-row trailer behind corn picker](image1)

![Two-row tractor-mounted corn picker](image2)

**Fig. 342C-D.** (C) Two-row trail-behind corn picker operated through the power take-off. (D) Two-row tractor-mounted corn picker.

Another feature to serve as a guide in selecting a tractor-mounted picker is the ease with which the picker can be attached and detached from the tractor. Ready lubrication with pressure fittings is another
Fig. 343. A tractor-mounted two-row corn picker having combination snapping and husking rolls.

Fig. 344. A pair of snapping rolls act somewhat like a wringer as they push, or snap, the ears off the stalks. The elevating chains assist in keeping the stalk upright.
FIG. 345. The picking frame of a two-row tractor-mounted picker with combination snapping and husking rolls.

FIG. 346. Husking action of one type of roll. Right-hand roll is rubber covered and holds the ear in position while the husking pegs of the other roll rip off husks.
important feature. Select a picker with safety shields over the operating members.

**Selecting a Cutoff Corn Harvester.** The cutoff corn harvester is a new type of picker, a means to combat the corn borer, and it fits into soil-conservation programs in the semi-arid regions. This machine, which is tractor mounted and tractor powered, (1) cuts the cornstalks off like a corn binder, (2) snaps and husks the ears and delivers them to a wagon, and (3) shreds the cut stalks and delivers them back on the ground. One advantage claimed for it in picking corn is that it delivers a higher percentage of the ear corn, with less
corn shelled, to the wagon. This machine is also said to destroy 94 to 100 percent of the corn borers in the shredding process, and the shredded corn can be plowed under or left on the surface as a mulch culture to catch moisture and reduce erosion.

Selecting Field Shellers. These machines are to the large corn grower what the combine is to the grain producer with a large acreage. The ears are snapped from the stalks. Next, the ears are husked and then shelled, the shelled corn being delivered to the elevated tank. In many sections of the country it is essential to dry field-shelled corn.

Selecting Corn Shellers. Corn shellers are available in sizes ranging from the one-hole, hand-operated to the power-operated with up to 500 bu. per hr. capacity. Corn shellers are of two types, the spring type and the cylinder type. The spring type is available in one-, two-, and three-hole sizes. The ears are held by the spring-adjusted rag irons so as to accommodate different-size ears. The shelled corn falls upon the separating chains, which are agitated by cams. As the chassis carries the cobs into the cob stacker, the shelled
The cylinder type shells the corn between the revolving cylinder and the concave. The concaves are designed for a particular type of corn—ribbed for normal corn, spiral lugged for snapped corn, and perpendicular lugged for damp, tough corn. After the corn is shelled, the material is moved and separated by the cob walkers, the corn dropping through the openings to the cleaning sieve. Husks and light trash are blown away from over the cob walkers, the cobs continue on out the cob conveyor, and the shelled corn is elevated to a wagon, truck, or bin.

Selecting Husker-shredders. These machines handle corn that has been cut and cured in the shock, by shredding or cutting the stover and husking out the ears. The stover is usually blown by the machine into a barn loft or special enclosure and the husked ears are elevated into either a bin or a wagon. (See Figs. 352 and 353.)

When both the grain and stover are desired for feed, but are to be used separately, this is an ideal machine. Many sizes are available.
to meet practically any power or capacity need, but the usual size has from one to four pairs of rolls for husking. Select a feeding platform that is large enough to receive the bundles or loose fodder easily and that has adequate safety features.

Selecting Stalk Cutters.

After the portion of the crop that is removed from the land has been harvested, there often remain the unused stalks of the producing crop. These stalks, when handled by a cutter to process them for the land that produced the crop, help in the preparation of a more desirable seedbed. Stalk cutters are available in one- and two-row types for either horse or tractor power (Fig. 354). The rolling stalk cutter pulled by a tractor has no wheels; it therefore obviates the tendency of stalks to wrap around the axle next to the wheels. Lightweight sheet metal extending from each blade to the axle is an aid in preventing stalks from wrapping on the wheeled type. Blades that can be sharpened on both edges, and then turned when one edge
becomes dull, reduce the need for frequent sharpening. Another type of cutter uses a four-bladed knife that turns at right angles to the row and cuts against a shear plate. Select a stalk cutter sturdy enough to cut the largest and toughest stalks encountered.

4. Selecting Fiber-harvesting Machines

Fiber-harvesting machines for cotton, hemp, flax, sansevieria, ramie, and other fibers have been developed somewhat slowly. The nature of the fiber and its removal from the stalk, leaf, or boll, after it has dried or retted are the principal factors.

Selecting Cotton-harvesting Machines. Cotton has been the most difficult crop to mechanize. This difficulty starts with planting, especially of lint seed, and appears again with picking. The fiber matures in bolls and the bolls do not mature uniformly. The lower bolls on the plant may be open and ready for picking, while
green, unmatured bolls are developing midway on the same plant. In extreme cases, cotton blossoms may even be on the top of the plant. Thus the task of the mechanical picker is to remove the mature cotton and not injure the green bolls and blossoms.

Since inventors and engineers worked so long at the problem of harvesting cotton mechanically and yet no machine, until 1944, had been marketed on a commercial scale, the difficulty of the problem is at once apparent. Only those who have shared in the work, however, can fully appreciate the difficulties.

Hundreds of patents covering cotton harvesters have been issued since 1850. These patents cover devices of great variety but fall into five basic classes or types: the picker, the thresher, the pneumatic, the electrical, and the stripper. These experimental pickers sought to solve the problem in different ways. The picker type was designed to pick the cotton from the opened bolls by means of spindles, fingers, or prongs at any time during the harvesting season, without damaging foliage or unopened bolls. The thresher type severed the stalks near the surface of the ground and took the entire plant into the machine where the cotton was separated from the other vegetative matter. The pneumatic type removed the cotton from the bolls either by suction or blasts of air. The electrical type depended upon attracting the cotton fiber to a statically charged belt or finger to remove the cotton from the boll. The stripper type removed the cotton from the plant by combing the plant with teeth, or by drawing it between stationary slots or revolving rolls.

In some sections, particularly the arid areas, the cotton can be left in the field until matured. The cotton stripper harvests the cotton on a principle similar to that on which a corn snapper harvests corn. The stripper is pulled through the field, passing over one or two rows. The plant is caught between stripping fingers or rollers. The strippers merely strip the entire bolls containing the cotton fiber. No attempt
is made to remove the cotton from the bolls. Separating the bolls, burrs, and trash is left for an extractor at the gin.

The mechanical cotton picker is a unit machine. It is attached to, and acts as an integral part of, the tractor, and is handled by one operator. The machine straddles one row of cotton and moves through the field at 2 to 2 3/4 m. p. h. The cotton plants pass through a metal guide, directing them between two revolving cylinders.

The picker is provided with two vertical and parallel revolving drums between which the cotton plants pass as the machine moves forward along the rows. Each drum is equipped with cam-actuated picker bars on which are mounted a total of 600 rotating spindles having numerous tiny needles, or barbs, which catch the lint. The rotative speed of the picker drums is synchronized with the traveling speed of the tractor so that the projecting, rotating picker spindles enter and withdraw from the plants without any raking action and without disturbing the unopened bolls or otherwise injuring the plants. As the rotating spindles penetrate the plants and contact the lint in the open bolls, the barbs catch the cotton and extract it.
SELECTING HARVEST AND HARVEST-HANDLING MACHINES

As the cam-actuated picker bars carry these cotton-laden spindles around, they are withdrawn from the plants and the cotton is removed by rubber doffers which rotate close to the spindles and thus remove the cotton. Before the spindles contact the open bolls, they pass under moistened rubber pads that moisten the spindles to assist in doffing the cotton. There is a water-tank and metering system which supply water to the rubber pads in uniform amounts, controlled by the operator, to give best results.

![A mechanical cotton picker mounted on a row-crop type tractor enables one person to pick several acres a day.](image)

After removal from the spindles, the cotton is conveyed by vacuum to a separating chamber where considerable trash is removed. It is then blown up into the storage basket by air pressure produced by fan equipment. As the cotton enters the basket, it passes along a grating that further assists in removing trash. The basket holds approximately one-half bale of seed cotton. When the basket is filled, the cotton is dumped into wagon or truck through a mechanism powered by the hydraulic lift.

To fulfill the basic requirements of a successful mechanical cotton picker, the picker must
1. Harvest a high percentage of mature cotton.
2. Not damage the plants or the immature cotton bolls.
3. Not damage the cotton, so that the highest possible grade of ginned cotton may be obtained.
4. Have sufficient capacity to make its operation profitable as compared with hand picking.
5. Gather the seed cotton in clean condition, with a minimum amount of such foreign material as leaves, stems, bolls, and weeds.

6. Harvest cotton successfully under widely varying climatic and crop conditions and be able to meet most of the special requirements that arise from differences in types of cotton and variations in soil fertility.
7. Be mechanically sound in design so that it will provide satisfactory, consistent, and dependable operation, and be simple enough for both the operation and the ordinary servicing of the picker to be done by farm labor.
8. Be an attachment for a modified farm tractor rather than a one-purpose, self-propelled machine, so that the tractor may be readily available during the seasons when plowing, tilling, planting, cultivating, and insect-control work must be done.
9. Be distributed by an organization providing replacement parts and skilled mechanical service, as needed.

Selecting the Cotton Gin. The cotton gin is not classified generally as a farm machine. Ginning is a rural industry operating on a custom basis for cotton growers. Since cotton belongs to the grower until after it is ginned, however, it seems appropriate to discuss briefly the principles in ginning, storing, and grading. This may assist the grower in preparing his cotton and perhaps will help him in choosing the particular gin to gin his cotton.

The two main gin types are (1) the roller type, used for the long, staple sea-island and Egyptian cotton, grown in the irrigated arid sections of Texas, New Mexico, California, and Arizona, and (2) the saw type, used most extensively in other parts of the Cotton Belt.

The cotton gin performs several functions. It (1) conditions the cotton for ginning, (2) precleans, (3) prefeeds where special processes of drying, cleaning, and extracting are done, (4) feeds cotton, (5) gins or provides saw action, and (6) disposes of products, seeds, and bales. The proper functioning of all parts is essential to good ginning which, in turn, determines to some extent the grade of the cotton and, naturally, the price paid the grower.

The ginning operation is accomplished by pulling the seed cotton between the huller ribs and the saws, 70 or 80 saws to a stand, into the roll box. The saw teeth catch the fibers, pulling them from the
seed. The lint is removed from the saws by either a brush, revolving at a much higher speed than the saws, or by air blast. The latter is used most extensively. The seed cotton and later the lint is always moved by air in lint flues. The gin lint passes to the press box where it is pressed into bales. The bales, 54 by 27 by 45 in., weigh approximately 11 lb. per cu. ft. These bales have to be pressed again in a compress, often at another location, necessitating additional handling and costs. Some gins are equipped to form standard density bales

54 by 27 by 22½ in. with a density of 22 lb. per sq. ft. If possible, select a gin with this equipment.

Selecting Hemp-harvesting Machines. Hemp is grown on small acreages. During war periods, production can be speeded up if there is a shortage of hard fibers. The harvesting of hemp depends on the method of retting to follow. Retting is the initial rotting action to facilitate removal of the fiber covering or outside of the stalk. Dewretting has been employed for generations. It calls for several machines, including the hemp cutter, the hemp turner, and the gatherer-binder. The hemp cutter or, as it is sometimes called, the "turntable harvester," cuts the hemp with a cutter bar. The cut stalks are given a 90-degree turn on the turntable and deposited on the ground parallel to the cutter bar.
After several weeks in this condition, the hemp is turned with a hemp turner to expose the underside to the sun. The turner is operated by the tractor power take-off. It consists of a pickup of three chains with finger lugs which lift the hemp up an incline to a table. Here a full circle sweep, with two sets of wire prongs, revolves the hemp 180 degrees and returns it to the ground.

The gatherer-binder follows in a matter of weeks after field retting has been completed. The hemp is picked up by a series of round fingers and flat teeth mounted on nine eccentrics that are protected by a wide, curved shield at the front of the machine. From the eccentric deck, the hemp passes to the binding deck, where it is bound into bundles by a standard-type grain binder-knotter. A bundle carrier composed of two conveyor chains deposits the bundle parallel to the line of travel.

Hemp to be tank retted is cut and bound in one operation by a hemp binder and then transported to hemp mills where it is retted in a short time by being submerged in water. The hemp binder is built on the principle of a grain binder. The reel is high enough to pass over 6-ft. hemp. The platform is widened and binding head set to bind the bundles 36 in. from the butts. To reduce the amount of material hauled to the mill, the hemp tops are sheared off while being bound.
Selecting Flax-harvesting Machines. Flax is grown for two purposes: (1) flaxseed and (2) the fiber (linen). Obviously, flax grown for fiber is harvested to obtain the longest fiber. The fiber, which is inside the stalk, extends into the roots. Flax for the linen industry of Europe and in the Pacific Northwest of this country is pulled, rather than being cut with a mower or binder.

One machine, referred to as the Canadian machine, pulls a swath 3 ft. wide in three throats with two or three pairs of gripping belts. The throats and gripping belts behave somewhat like a corn binder in directing the flax. The pulling units are set at an angle of about 45 degrees and in such a position as to pull the plants out of the ground and convey them upward and rearward to a binding unit. The straw remains in a vertical position until the bundles are formed and tied. The narrow 1 ft. swath, pulled in each throat, and the vertical positions of the straw for binding tend to produce a bundle with fairly even root ends. A large number of spring-mounted rollers are employed to hold the gripping belts together under sufficient tension to pull the plants.
The other method commonly used employs either a single or a double pneumatic-tired wheel tilted backward from the vertical about 20 degrees transverse to the direction of travel, but on an offset axis. A rubber belt contacts a portion of the circumference of the tire. The flax is gripped between the belt and the tire for pulling. The forward motion of the machine and the upward movement around the circumference of the wheel uproot the plants. In the double-pulling wheel machine, the two sheets of pulled flax are brought together for binding into bundles. Flax pullers taking a 3-ft. swath operating at 3 m.p.h. have a capacity of 7 to 7 1/2 acres per 10-hr. day.

The seeds are removed by “spot” threshing, snipping, cutting, or combing. European flax is dewretted by a process similar to our method of retting hemp. Flax in the Northwest is placed in large tanks of water known as “retting tanks.” After the seeds are removed, the bundles are placed in retting tanks where water is kept at a constant temperature. After sufficient time in the tanks, the flax is placed in large shocks to dry. The dried flax is passed through an escutcher, which bends, twists, and beats the stalks. This removes the “chives” or nonfiber woody parts of the stalk, leaving the flax or linen fibers. The fibers are next combed, graded according to lengths of fiber, and thus made ready for weaving.

Some seed flax is used for fiber also. This is shorter fiber and much of it goes for tow. After the flax is cut by a regular grain binder, the heads are combed or cut off, after which the fiber is removed.

Two of the recently developed fiber plants are sansevieria and ramie. The first grows wild in southern Florida, while the latter can be grown in many southern areas. Ramie is a bast fiber; that is, the fiber is part of the stalk, similar to flax. Sansevieria fiber is in the leaves and provides our longest domestic fiber, often being 40 in. in length. The leaves are cut with a mower and then are passed through a decorticator to remove the fiber while still green.

5. Selecting Root Crop-harvesting Machines

Machines for digging, pulling, or otherwise harvesting root crops incorporate ground-working tools, particularly the plow and disks. Such machines must (1) cut or dig under the crop, (2) lift or remove it
from the ground, (3) separate the crop from the soil, and (4) deliver the crop in one place and the tops or vines in another.

**Selecting Irish Potato Diggers.** Although the potato is an enlarged underground stem, it is handled like a root crop. The potato digger consists of a shovel-like plow running under the potato row. The plow is inclined to the rear so the material cut by the plow moves up onto a wire rod chain conveyor. The conveyor has a vibrating motion to shake soil loose from the potatoes, letting it drop through. Upon reaching the top of the conveyor, the potatoes drop to the ground, or slide down a wire incline and onto an elevator for loading and bagging. The vines separate from the tubers.

Potato diggers are tractor operated with power take-off and are also pulled by horses. Horse-drawn diggers are equipped with ground-wheel drive. The tractor-operated machines are one-row and two-row in size. Agitators will remove the loose soil from the potatoes and yet not injure the tubers. Select a digger with eccentric rollers and sprockets of various designs to meet varying soil or crop-harvest conditions. With the power take-off models, a transmission is available to change the speed of the apron for varied conditions. One important thing to keep in mind in selecting any machine, espe-
cially for use on terraces or for contour farming, is to have these units short enough so that they follow the contour.

Some attachments to select as needed for a potato digger include a *vine turner* to place the vines on the ground separate from the potatoes, *rolling colters* to aid when the tops are heavy or the field is weedy, an *auxiliary engine* to operate the elevator when operating conditions are heavy, a *tongue truck* to control the depth accurately as well as to facilitate turning, a *stone trap* for use under stony conditions, a *sorting and bagging elevator*, and *extension aprons* to aid further in removing soil from potatoes.

![Fig. 363](image-url). A two-row potato digger with power take-off.

![Fig. 364](image-url). Potato-digger shovels are available to meet different crop and soil conditions.

*The Potato Harvester.* This machine is attached to a conventional elevator type of potato digger; together they form a potato-harvester combine. A hopper receives the potatoes from the discharge end of the conveyor apron. The harvester is connected to the digger in such a way that it can turn at the end of the rows as short as previously
and the potatoes are delivered onto the harvester even when the two units are at right angles to each other. No extra space is required at the end of the field for this equipment.

Provision is made for mechanically removing the vines and the potatoes attached to the vines as they drop onto the conveyor. Following the vining operation, the potatoes are delivered onto a series of rubber-covered cleaning rolls so spaced that small stones and soil drop between these rolls. The potatoes and larger stones pass over

onto a picking table, traveling at right angles to the cleaning rolls. The arrangement of these units is such that the difference in weight and shape of the stones and potatoes effect mechanical separation. The final separation is made by workers standing alongside the picking table. This table is so mounted that it can be quickly adjusted to different angles according to the shape and size of stones and potatoes, an essential refinement. The stones and soil drop off the end of the belt back onto the ground. The sorted potatoes are then delivered into another elevator, which takes them to the bagger, or to the position for delivering into crates or barrels.

The potato harvester has several advantages. It is economical of
labor, 4 or 5 people replacing 12 to 15 required to pick up the same acreage. It is adapted to potato diggers now in use. It handles potatoes carefully; the comparison in condition between hand-harvested potatoes and those harvested with this combine unit has been very favorable to the mechanical operation.

**Selecting Sweet-potato Diggers.** Sweet-potato vines form a tangled mat over all the ground. The sweet-potato vine is a good green-crop feed. Vines are removed and salvaged by sweeps running ahead of the digger, similar to vine lifters. However, for this to be done satisfactorily, the crop must be planted in well-formed beds and the bed contours maintained during cultivation. Sweeps cut the vines loose, windrow or elevate them, leaving the ground clean for the digging operation. The regular potato digger can be used for digging sweet potatoes, although less agitation is desired so as not to injure the potato covering.

**Selecting Beet Pullers.** Four different methods are used in pulling and topping beets. The beets can be (1) lifted by machine and then windrowed, topped, and piled by hand, (2) topped mechanically before they are lifted, (3) lifted and elevated over a hopper before being topped, or (4) lifted with a revolving-spike lifter which
tops them after lifting. Each method has its advantages. The first method requires considerable hand labor to handle and top the beets as well as a horse- or tractor-operated puller.

The second method employs revolving disks, parallel to the ground, which cut off the tops before pulling, and then the tops are pushed or kicked to the sides where the tractor wheels will not run over them. The digger blades then lift the beets to an agitated conveyor, or cleaning trough with rolls, which delivers them in a row on top of the ground or elevates them to a receiving tank or wagon.
intricate device has been developed, known as the "beet finder," that directs the topping disks and diggers to the beet, whether to one side or in the row proper. It is sometimes difficult to separate the beets from clods, and in soft ground the beets may be pushed over. One machine delivers the beets and clods to a conveyor from which one or two persons remove the beets.

The third method utilizes two arms sliding along the row, one on each side of the beets, which raise the tops so they can be gripped by a pair of inclined chains or V belts. While the beet tops are being raised and grasped, the beets are loosened and removed from the ground by the digger. They are suspended by the tops as the clods drop free. At the end of the incline, the topped beets drop into a hopper for elevation and the tops are windrowed, bunched, or loaded.

The fourth method includes the use of a large, wide drum having several rows of 3-in. spikes. As the machine moves forward, the beets are loosened and pierced by spikes on the drum which lift them from the ground. On the upward travel, knives top the beets, and then inclines between the spikes release the beets and drop them into a hopper.

Selecting Peanut Diggers. Peanut diggers consist of two sweeps going under the row from either side. The sweeps dig and elevate

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Fig. 368. A large revolving drum "spikes" the beets, lifts, and then tops them.
the peanuts to the top of the ground. From here two methods are employed; a small, side-delivery rake kicks the peanuts into a windrow for curing, or the peanuts are delivered onto an apron that shakes and cleans them before they are left on the ground in windrows.

![Fig. 369. A tractor-pulled beet loader for beets previously topped.](image1)

![Fig. 370. An experimental peanut harvester that digs two rows of nuts, shakes them, and places them in one windrow.](image2)

**Selecting Bulb Diggers.** Growing ornamental bulbs for flower production is fast becoming an established American industry under favorable climatic conditions. Tulips, hyacinths, jonquils, lilies, and
other bulbs are grown on a large-acreage basis. Where conventional farm machines are not satisfactory, growers often design and build their own machines.

The bulbs are harvested or dug shortly after the blossoms appear. Some growers have built high mowers operating 18 to 24 in. above the ground for cutting the blossoms.

Most bulb diggers consist of a double digger. Bulbs are planted 6 to 8 in. deep. To avoid handling a great volume of soil, bulb diggers have a plow, which removes the top 4 or 5 in. of soil. This soil is plowed away like a dead furrow. Following the plow is a regular potato-digger shovel running under the bulbs. The bulbs are then elevated and pass along an extended shaker chain. The chain is long, to eliminate severe agitation in separating the bulbs. Some units have a screen to sort the bulbs according to size. All bulb diggers are tractor pulled, some operated by power take-off and others with independent engines.

6. Selecting Special Crop-harvesting Machines

Selecting Sugar-cane Harvesting Equipment. This consists of several machines and several operations. The equipment is often built locally. The cane harvester is a large machine that tops the cane 6 to 8 ft. above the ground and then cuts it at ground level. The cane is carried to the back of the machine and laid across two-row
ridges. Some machines place three rows together known as "heap rows."

After the cane has dried, it is "flamed" or burned to destroy the leaves. Then a *buncher*, operated by a tractor, pushes the cane into bunches. This same machine, or another equipped with a *crane*, picks up the bunches of cane and loads them onto *cane carts*, wagons, trucks, or special cane-field rail cars.

**Selecting Green-crop Harvesters.** Green-crop harvesters are used for handling spinach, green peas, beet tops, alfalfa, and other similar crops. Some machines cut and load the crop in one operation and may reduce the demand for hand labor in the field by 90 percent. They are tractor pulled, but receive the power to operate them from an auxiliary internal-combustion engine. These harvesters have a 7-ft. cutter bar, platforms, and reel similar to a binder. They will cut four rows spaced 20 in. apart. After being cut, the crop falls on the platform canvas, 24 in. wide, and moves to the right where it is delivered onto the elevating canvases, upper and lower. These with the spout deliver the crop to a truck or wagon.

Some of the features to consider when selecting a green-crop harvester include the following: The cutter bar and platform should be adjustable as to height and tilt; the reel needs to be adjustable horizontally and vertically; the elevator spout should be adjustable as to the height of truck or wagon bed; dual wheels are needed where
an auxiliary engine is used to operate the harvester; and a satisfactory lubrication system is necessary to exclude dust and other abrasive material from the bearings.

Selecting Lettuce Harvesters. These are in reality especially wide gathering units. These tractor-pulled machines are 16 to 24 ft. wide with a conveyor table for receiving the lettuce heads. One person follows the machine in each row or two rows, cutting the heads and placing them on the conveyor table. The conveyor delivers the heads to one end and loads them on a truck or trailer. This machine is also used for other vegetable crops, such as cabbage. A similar machine is used to harvest pineapples.

Selecting Grain-sorghum Harvesters. Commercial growers use combines, particularly if the stover is not to be harvested, although the stover can be pastured or even cut after combining.

Grain headers used for wheat or other small grain work satisfactorily, but more grain is shattered than when combined. Special headers attached to the front of a wagon box are sometimes used. Another device to head the crop, if shocked, is a large knife operating between two closely spaced planks and attached inside of the wagon box. This knife must have one end of the blade attached between
the planks; to the other end of the blade is attached a long handle to give leverage to the operator when cutting off heads from bundles or armloads of loose fodder.

Selecting Clover Hullers. When clover and other grass crops are grown extensively for seed purposes, it is advisable to use a clover huller or equipped combine, rather than a grain thresher, to remove the seed. Some of the advantages of a clover huller in threshing grass seeds are less loss of seed, less damage to the seed, ease of adjustment for different kinds of grasses, cleaner seed, specific design for threshing grass seed only, minimum of power required, and smaller cost than for a regular thresher.

Selecting Seed Strippers. These are available in sizes ranging from a small hand size to those pulled by either horse or tractor power. A cash crop is often realized from pastures by stripping the seed from the ripened grass. Select machines in a size to meet your needs to strip the seed from ripened fields of standing grass, such as blue grass.

Selecting Bean Cutters. The ripened bean vines may be cut in several ways, although horse-drawn, two-row cutters are generally used for small acreages. Tractors pulling multi-row cutters are used by the large producers of dry beans. Buncher attachments to the
cutter may be used to pile the windrow formed by two or more rows, but when the pods are dry, shattering often results. Farmers sometimes have local mechanics construct bean cutters consisting of two heavy blades attached to a cultivator or beet lifter. These blades, attached to the gangs and set at an angle to bring the two cut rows together as a windrow, are controlled by the gang levers. Under sandy-soil conditions, some farmers use a side-delivery rake to pull and windrow beans, but under most conditions the shattering that results prohibits this practice.

**Selecting Bean Hullers.** Some kinds of beans are extremely hard to thresh; therefore, where beans are a major crop, it is well to use a bean huller in order to recover more of the beans as well as split or otherwise damage fewer of the seeds. Bean hullers have two cylinders and, because of the soil and sand in the crop, employ special wood bearings. These and other factors make them especially suited to thresh beans. Combines, properly equipped, are used to harvest a large percentage of the bean crop.

**Selecting Nut Harvesters.** Nut harvesters operate in three stages. (1) They remove nuts from the trees, (2) gather nuts from the ground, and (3) remove bulk. Some locally made tree shakers are in use. These consist of a tractor-operated eccentric connected to a tree trunk or to one of the main branches. The intermittent action of the eccentric shakes the tree sufficiently to loosen the nuts.

Two types of nut gatherers are in use. One is a large suction or
Fig. 376. An experimental tung-nut gatherer.

Fig. 377. Tung-nut huller.
vacuum cleaner mounted on a motor truck, and the other is designed on the principle of the tedder which kicks the nuts into piles. The former, powered by the motor-truck engine, creates a powerful vacuum that sucks or lifts the nuts off the ground and carries them into a container.

The nut huller, a revolving cylinder against a large diametric opening screen, removes the hulls from such nuts as the tung, the black walnut, and certain others. This method reduces storage requirements for the nuts and facilitates the drying and curing.

**SUMMARY**

1. There are at least nine common methods of harvesting hay, some of which require the crop to be handled several times.
2. The fewer times hay is handled and the less time between cutting and storage, the greater the food nutrients conserved.
3. Mowers with exposed gears are a hazard to safety and the damage from dust and grit is greater.
4. Vertical-lift mowers have an automatic control on the clutch that disengages the gears when the bar is raised beyond a certain height, and engages them again when the bar is lowered.
5. Tractor mowers are mounted at the side or to the rear, and some trail behind.
6. Some common attachments for mowers are extension guards, windrower, buncher, pea mower bar, lespedeza bar, and high-cut attachment.
7. The main kinds of rakes are dump, side delivery, and sweep.
8. Hay-loader types are either cylinder or rake bar, and the rake-bar type can both rake and load the hay in one operation. Select loaders having an automatic release hitch.
9. There are many kinds of stackers including the overshot, swing-around, buck rake, and cable.
10. Hay crushers expedite the curing of hay through crushing the stems of freshly cut hay. Crushers also cut the hay.
11. Hay balers are either stationary or of the pickup type. Pickup balers can be had that take the hay from either windrow or swath. They form various sizes and shapes of bales. Some have automatic knotters similar to that on a grain binder to tie the bales.
12. Hay choppers are of the stationary, windrow, or field-chopper type. The field chopper also mows the crop.
13. The grain binder cuts the crop and ties it into bundles, which are dropped into rows for shocking. The header, as the name implies, cuts off the grain heads and delivers them into barges which haul the heads to stacks.
14. The combine both cuts and threshes the crop. It may be self-propelled, operated by a power take-off, or operated by a separate engine.

15. The thresher separates the grain from the straw after the crop has been cut by another machine.

16. The corn binder is available in one- and two-row types and in either regular or "short" models to meet the needs of low-growing and tall corn.

17. Ensilage cutters are available either with the cylinder "lawn-mower" cutting unit, or of the flywheel type, in which the revolving knives cut against a shear plate.

18. The field-ensilage harvester cuts off the crop and then cuts it into silage which is delivered into a wagon for delivery to the silo.

19. Mechanical corn pickers are either trail behind or tractor mounted and handle one, two, or four rows, with the husked ears being delivered to a trailing wagon or a tank. Self-propelled types are also available.

20. The cutoff corn harvester, a tractor-mounted and tractor-powered machine, picks the corn and also shreds the stalks as a means of controlling the corn borer, or for mulch-culture farming.

21. The field sheller picks the corn, shells it, and delivers the grain to a tank in a job similar to that performed by a combine with small grain.

22. Corn shellers are of cylinder and spring type, with the latter having one, two, or three holes. The cylinder type can be fitted with special lugs to shell damp corn.

23. The husker-shredder husks out the ears of cured cut corn and shreds the stover which is delivered to a row, or elsewhere, as desired for later use as feed or bedding.

24. Stalk cutters of one- or more-row models cut up stalks in the field to facilitate later field operations in preparing seedbeds.

25. The mechanical picker of cotton has been one of the most difficult machines to develop because all of the crop is not ready for harvesting at one time.

26. The cotton gin removes the cotton seed and much of the undesirable trash from picked cotton and then places the cotton in bales having either 11- or 22-lb. density per square foot. Long-staple cotton is processed in a roller gin; short-staple in a saw gin.

27. Hemp to be dewretted is harvested with a special cutter, after which the crop is handled by a turner and finally a gatherer-binder. Hemp that is to be tank retted is harvested by one machine, the hemp binder.

28. Flax harvested for the fiber is pulled by special machines, while for seed the crop is harvested as other small-grain crops.

29. Ramie, a stalk or bast fiber, can be grown in southern sections of the United States and sansevieria, a long-type leaf fiber, grows wild in Florida.
30. Potato diggers are either one- or two-row machines, with the larger machines being tractor operated by either a power take-off or auxiliary engine.

31. The potato harvester is a machine attached to the digger. It grades the potatoes as to size and then sacks them, using a minimum of labor for these operations.

32. Regular potato diggers with the aprons set for a minimum of vibration can be used for harvesting sweet potatoes. The vines are first removed by sweeps or other machines.

33. Beet pullers, either horse or tractor powered, are one- and two-row in size. Some types also top the beets either before or after pulling and then place the tops in a windrow or bunches; the beets are windrowed, bunched, or elevated to a truck or tank.

34. Peanut diggers lift the crop out of the ground with sweeps on both sides of the row, leaving the peanuts on top of the ground for curing, or passed over an apron to be further cleaned and left in windrows to cure.

35. The green-crop harvester cuts such crops as green peas, spinach, and alfalfa, and some types elevate the crops to wagons or trucks.

36. The bean cutter uses blades to cut the plants below the soil surface, windrows two rows together, and cuts from two to six or more rows, depending on the power used. Some also have buncher attachments.
11. Operating and Field-servicing
Harvest and Harvest-handling
Machines

In the main, harvest and harvest-handling machines are the most complicated machines discussed so far. These machines have more moving parts than others because they do two or more things to the crop. Having more moving parts naturally means there are more places for wear and the machine can more easily get out of adjustment.

Machines or parts out of adjustment tend to do unsatisfactory work, use excess power, and continue to get more and more out of adjustment. Some of the crop is wasted and other portions may not be processed so as to obtain the quality or grade of product desired. This results in reduced returns for the entire season's work on that particular crop.

Like many other farm machines, harvesting machines are used only a short time each year. During the rest of the year they are idle and, supposedly, in storage. Storage is not only for their protection but also to assure a good harvest the following year, and for many years to follow.

Fortunately, harvesting machines, like other machines, are designed and manufactured to do a particular job, and to do so under rather adverse conditions. The manufacturers assume, however, that the operator is acquainted with the purposes of the machines and the functions of each part. It is the purpose of this chapter to assist the operator in using his equipment to the advantage of himself and the crop.

In order for some machines to perform satisfactorily, they are equipped with elements or parts that under some conditions might be considered dangerous. Mechanical safeguards are provided wherever they do not interfere with the functional objectives of the machines.
Where this provision is impossible, it is the responsibility of the operator to follow safety practices in order to avoid injury to himself and damage to the machine and to crops. The cutter bars of the mower, binder, and combine are examples. Others are the husking and shredding rolls of corn pickers and husker-shredders. Safety practice can only be inculcated in an operator as a work habit and, therefore, it is associated from the start with good workmanship. Mechanical safeguards are not, and never can be, a substitute for proper training and prudence on the part of the operator. Operating and field servicing will be discussed under the following activities:

1. Operating Hay-harvesting Machines
   - Mowers
   - Rakes and Tedders
   - Loaders
   - Stackers
   - Hay Crushers
   - Balers and Bale Loaders
   - Choppers

2. Operating Grain-harvesting Machines
   - Binders and Reapers
   - Threshers
   - Combine Harvester-thresher
   - Conveyors and Elevators—Portable

3. Operating Corn-harvesting Machines
   - Binders
   - Ensilage Cutters
   - Ensilage Harvesters
   - Ensilage Blowers
   - Pickers
   - Cutoff Corn Harvesters
   - Corn Shellers
   - Field Sheller
   - Husker-shredders
   - Stalk Cutters

4. Operating Fiber-harvesting Machines
   - Cotton Strippers
   - Cotton Pickers
   - Cotton Gins
   - Hemp Harvesters
   - Flax Harvesters
5. Operating Root Crop-harvesting Machines
   Potato Diggers
   Beet Pullers
   Peanut Diggers
   Bulb Diggers

6. Operating Special Crop-harvesting Machines
   Sugar-cane Harvesters
   Sugar-cane Loaders

1. Operating Hay-harvesting Machines

Operating Mowers. The purpose of the mower, as stated in Chap. 10, is to cut grass and other hay crops by means of a shearing action between the reciprocating knife blades and the ledger plates. When one realizes the importance of sharpness and adjustment of the household shears for cutting cloth, it is obvious that mowers must be
kept in good adjustment and all cutting members sharp if the user is to take full advantage of their peak efficiency. In fact, every part of the mower is designed to provide an efficient cutting mechanism. Yet it is doubtful that many machines are abused in use so much as the mower. All mowers, regardless of size, when in proper condition and adjustment, have no appreciable amount of side draft; therefore, if side draft is noted, it is time to service the machine. Some of the common things causing side draft and hard pulling are dull or broken knives, incorrect register of knives, lag in knife bar, dull ledger plates, knife clips sprung, wearing plates worn, poor lubrication, guards not aligned, sprung knife bar, and sickle bar tilted too far downward, permitting guards to catch in soil or other obstruction.

Horsepower mowers without a tongue truck frequently cause sore necks for the horses, but this can be overcome usually by adjusting the seat position so that the operator’s weight offsets the tongue weight. Other remedies are to shorten the traces and lower the hitch, and to adjust the lifting spring to allow a slight weight on the outer end of the cutter bar. Any operating factor that increases the draft also increases the weight on the tongue. When turning, always lift the sickle bar to avoid undue strain upon the horses’ necks as well as upon the machine.

The soles under both the inner and outer shoes are adjusted to regulate the proper height of cut. Adjust these so that the height of
the cutter bar is equal at both ends. When operating on rough
ground, adjust the soles of the shoes and tilt the front of the bar
enough to keep the knife and guards out of the ground. Always set
the inner and outer shoes on the bar for the same stationary height at
the desired cutting level, rather than depend upon the tilting lever to
control the height of cut. A very slight upward tilt of the sickle bar
helps in sliding over low obstructions that otherwise might catch on
the guard points, and it frequently reduces the draft.

Carry the bulk of the weight of the cutter bar on the wheel, thus
increasing the traction and reducing friction between the bar and the

![Figure 380. Tilting-lever (2) mechanism showing quadrant (1) and connecting rod hooked onto shoe lug. Adjust rod at A.](image)

ground. If the cutter bar is too light upon the ground, slacken the
lifting spring. If too heavy, tighten the spring.

If the outer end of the cutter bar lags behind the inner end when
lifting, shorten the gag post-adjustment link. This is done by first
removing the lifting spring and then withdrawing the pin that secures
the gag post to the inner shoe and making the adjustment as required
by lengthening or shortening the link.

The tilting lever regulates the angle of the cutter bar. This is
ordinarily maintained in a level position. However, if the ground is
covered with dead grass or stubble from a previous crop, tilt the points
upward sufficiently to prevent the old stubble from catching on the

guards. Crops that are lodged and tangled may require tilting the points down so as to get under the crop and cut it clean.

Fig. 381. Check the breakaway spring and catch to make sure that the cutter bar is free to swing back on striking a solid object.

On some mowers, the tilting lever is disengaged from the quadrant teeth by merely pulling the lever out to the side. A connecting rod, pinned to the tilting lever, is hooked onto the shoe hinge to obtain adjustment of the cutting angle of the cutter bar.

Tractor trail-behind mowers have a safety “breakaway” that functions when the cutter bar strikes a solid or immovable object. This is a spring arrangement and one that requires periodic inspection and adjustment.

Direct-connected mowers, both ahead of and behind the rear tractor wheels, are driven by V belts. These drives, including the slip clutch, require periodic inspection for servicing and needed adjustment.
Sharpening Sickles. Dull knives and worn ledger plates do poor work, and cause increased load and troublesome side draft. Grind the knife section so that the angle of the cutting edge is the same as it is on new sections. Replace knife sections that are broken or that are worn so badly that they cannot be ground to the proper angle. Keep the rivets tight. The serrated ledger plates cannot be sharpened and are replaced when worn smooth. Knife grinders and knife and guard repair blocks (Fig. 387), available at low cost, will help to maintain good cutter-bar condition. The knife grinder grinds the mower knives quickly and at the correct level.

Aline the guards so that each ledger plate makes effective shearing contact with the corresponding knife section. If necessary to straighten, the guard may be struck on the thick portion ahead of the ledger plate.

FIG. 383. Maintain proper tension on slip-clutch spring to operate cutter bar, while permitting clutch to slip when encountering hard object.

FIG. 384. Knife-grinder attachment mounted on mower wheel. These grinders enable the operator not only to have sharp knives but to retain the correct bevel edge.
to move it up or down. Grind guards battered by rocks and other hard objects to a point like the original; if they are broken, replace them.

The *knife clips or holders* keep the knives close to the ledger plates but not close enough to bind. Replace these when worn beyond adjustment. In order to fit the holder to the knife, pull the knife from under the outer holder; then this holder can be tapped down at the end. See that the holder sets firmly on the knife, yet allows it to work freely. The remaining holders are then adjusted in the same manner, working from the outer to the inner end of the cutter bar.

The *wearing plates* must always line up with each other to give the knife back a straight bearing along its entire length. When the
wearing plates become badly worn, the knife sections tend to tip up, which may result in ragged cutting. The plates are provided with slotted holes to allow adjustment as wear occurs. When all of the adjustment has been taken up, replace the plates.

Lubricating. If the mower is to do its work efficiently, all moving parts must be properly lubricated. Lack of lubrication will cause unnecessary wear and excessive draft. Maintain the recommended oil level in the gear case with a good quality of motor oil. Never use a heavy transmission oil.

Oil the pitman box and the lower end of the pitman rod frequently, perhaps several times a day, depending on conditions. Under normal
conditions oil knife guides, wearing plates, and knife clips frequently. However, in localities where the soil is sandy, do not lubricate these parts. Lubricate the following parts at least once daily: (1) clutch shifter, (2) shoe-hinge pins and bearings, (3) joints for lifting mechanism, also gag lever and cam, (4) lever bearing and pivots, (5) shoe hinge on coupling bar, and (6) main wheels.

Transporting. In order to fold the cutter bar properly and secure the stay rod for transporting, have the pitman wrist pin at either the highest or the lowest point. Otherwise, breakage may result to either the pitman or the knife head. With plain-lift mowers it is necessary that the mower also be out of gear before folding the bar. Only on vertical-lift mowers is the clutch disengaged automatically.

Operating Dump Rakes. The dump rake is a rather simple machine, yet it is often used inefficiently and abusively. Fast driving and striking solid objects with the wheels frequently bend and damage the axle and wheels. Such abuse also causes tines either to break or to become sprung out of shape. At a slow pace, the tines contact the ground closer to the windrow after tripping. By following this practice, or by hand dumping, there is less scattered hay at the windrow; this is a real help if shocks are forked by hand.
If the hay is too dry when raked, leaves are shattered and low quality, stemmy hay results.

The first trip, in opening a field with a side-delivery rake, is in the direction opposite to that of the mower. Place the windrow far enough from the fence for convenient loading with a hay loader.
Windrows that are too large cause the wheels to slide when the automatic dump is tripped. Heavy loading of the rake may cause hay to wrap on the axle next to the wheels. An old auto casing or other similar object encircling the axle at each wheel aids in preventing this. When turning, lift the tines from the ground to prevent breaking or springing. The rake is often damaged by backing with the tines in raking position. Hitch the team fairly snug for ease of operation and turning. Although the rake does not have any fast-moving parts, the draft is lessened, wear is reduced, and the ratchet works more efficiently if moving parts are lubricated daily.

Operating Side-delivery Rakes and Tedders. When a field is opened up, the first trip around is made in the direction opposite to that of the mower so as to get the windrow far enough from the fence for the hay loader to pick up. After that, the field is circled in the same direction as the mower which places the slow-drying stems to the outside of the windrow and with the leaves to the inside, where they are less apt to shatter. Rake the hay before it is dry enough for the leaves to shatter. The side delivery can be used to turn the raked hay, if necessary, to dry further what was the underside of the windrow.

When the hay is extremely dry before raking, it is well to do the job early in the morning, while the dew is on, to reduce leaf shattering. Adjust the tension of the rake against the ground as light as possible and still do a clean job. This will reduce draft, avoid shattering of leaves, and raking up of foreign material.
Check raking parts frequently for needed straightening, adjustment, and replacement. Lubricate ratchets and moving parts frequently and adequately.

The *tedder*, whether a special machine or a side-delivery rake that performing this job by being run in reverse, is cared for and operated like a side delivery. Adjust the spring tension on each fork so that it will turn back or release and not break if a solid obstruction is encountered.

![Fig. 392. Pole-shifting adjustment for a combination side-delivery rake and teder. Lifting spring-loaded pin (as indicated) permits shifting pole right or left. Pin drops in one or other notches on the shaft. A indicates clutch for reversing action as a teder.][1]

**Operating Sweep Rakes.** Regardless of the kind of sweep rake used, there are a few general principles to observe: have metal points on teeth, use long teeth because they lay more nearly flat to the ground and ride over many obstacles, use teeth made of a straight-grained, tough wood, keep all parts snugly fitted so that they will immediately respond to control levers, and use a steady team and hitch snugly to maintain better control of the rake in turning and backing. For hauling large loads, use side tines and a rear rack high enough to avoid spilling the hay.

Keep wheels in good working order and lubricated sufficiently to
reduce the draft and to make the machine responsive to controls. When bucking hay to a stacker, it is often desirable to raise the tines slightly after unloading and drive forward again to push the hay onto the stacker tines. The general principles in handling horsepower sweep rakes apply to those using motor power.

**Operating Hay Loaders.** An automatic hitch on the truck or wagon is most desirable. It will release the loader without the need of a person getting off the load of hay. Attach the hitch to the wagon or truck so that it is not endangered by the draft of the loader.

When hay is very dry, it is best to handle it early in the morning so as to avoid excess loss of leaves through shattering. This loss can also be reduced if the loader has a tight bottom. A tight bottom is also an aid for those who must handle hay where winds usually prevail. If the loader does not have a tight bottom, it is imperative to have all compressor slats in good order. Avoid moving loaders at a fast pace whether in use or on the road.

Check slats, tines, webbing, rake bars, gearings, ratchets, elevating devices, hook-link chains, sprocket wheels, and other operating parts frequently and carefully to make sure they are in good condition. Straighten or replace flexible fingers and other raking or elevating parts, if bent or broken. Keep moving parts properly lubricated according to instructions. Lubricate the hook-link chains at least
twice daily, making sure they are operating under loose tension and yet do not crawl on the sprocket gears.

**Operating Hay Stackers.** If operating an overshot stacker, be sure it is anchored securely and located at a convenient point in the field. Set the stacker lift in as low a position as possible and still get it sufficiently high for the stack. As the stack rises, gradually change the lift position as needed. An unnecessary lift causes undue strain on the stacker parts, uses more elevating power, and exposes the hay more to the wind.

Brace all derrick- and crane-type stackers to withstand the strain of heavy loads of hay usually held either by slings or a pronged fork. When elevating hay with any type of stacker, raise it carefully and slowly in order to prevent injury to the stacker when the unloading point is reached. With the overshot stacker, however, it is sometimes helpful to the person stacking if the unloading point is approached with a slight jerk to throw the hay farther over the stack.

The main requirement when using a cable hay stacker is to have high enough poles that are well set and firmly anchored in order to
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keep the cable taut. If the hay is short, very dry, or loose, the use of slings is more satisfactory than a pronged or harpoon fork. Use a trip rope strong enough to pull the slings or fork back to the hay wagon.

Since stackers are subject to jarring action, it is imperative that all parts be kept firmly bolted or otherwise securely held to avoid play that may injure the operator or cause undue wear of the machine. Keep moving parts adequately lubricated each day used and where parts slide on each other, as with an overshot stacker, be sure such parts are frequently coated with a heavy grease.

Operating Hay Crushers. These are in reality a combination of three machines: (1) mower, (2) pickup attachment, and (3) crushing rolls. The same operating instructions apply to the cutter bar as to the mower, while the pickup attachment is operated the same as the pickup part of a combine or hay loader (Fig. 396).

The crushing rollers have adjustable springs to maintain just enough pressure to crush the stems. Follow printed instructions for lubrication and belt adjustment.

Operating Hay Balers. These machines press or compact hay for more efficient storage and ease in handling off or on the farm. The best bales are obtained through uniform operation of the press, whether it be through tractor power or animal power. Maintain
an even tension on belts to avoid undue slippage. Draw ties uniformly
and twist the wire ties close to the loop to prevent danger of stretching
or untying where the joint is made. Three ties are recommended
for large bales, extremely dense bales, and for repeated handling as
in shipping. The density of the bale is regulated by adjusting the
outlet area. This increases or decreases the pressure required to
force out the compressed bale.

**Pickup Balers.** In general, the same operating instructions apply
as for stationary baler. The operation of the power unit either

through the power take-off or by belt from an auxiliary engine is
similar to methods of power transmission used on other machines.
Pickup balers are available with both wire- and twine-tying mecha-
nism. Those using wire ties have a platform and seat on each side
of the baler for those making the ties. One type with a semi-auto-
matic arrangement requires only one man, the machine forming one
loop. Twine-type balers have two knotters, similar to those for grain
binders, and are adjusted as described later under Grain Binders.

Adjust the baler to make the size and density of bale desired and
of a weight easily handled by the hand labor and bale loader if used.
The moisture content of the hay and the humidity of the air are
factors to consider when baling. In the more arid areas, it is safe
to make bales that are larger, more compact, and with a higher
moisture content in the hay than would be safe in the more humid
Fig. 397. Team work and organization speed the hay-bailing job. This includes uniform feeding, in union with the automatic feeder, having efficient persons tying on each side, and having the divider blocks ready for insertion.

Fig. 398. A counter-shaft attachment is needed to operate a power take-off tractor-driven baler by the belt pulley when used for stationary work.
areas. Where mow-curing equipment is used, it is possible to bale hay with a higher moisture content than is customary otherwise.

Operate the **bale loader** as close to the baler as convenient, unless the hay is expected to **cure some** in the bale before removal from the field. Bales left in the field are often damaged by moisture, and insects or rodents may cut twine ties. For this reason, most operators remove bales to storage as quickly as possible after the baling.
**Operating Hay Choppers.** The field-hay chopper is a combination mower, binder, combine, and ensilage cutter. The operation of the mower, reel of the binder, and the auger and canvas conveyor of the combine have been described; the mill operation is the same as that of ensilage cutters which are to be discussed later in this part of the book. The windrow chopper again combines two machines, the pickup loader and the ensilage cutter. The stationary or barn chopper is the same, in general, as a roughage mill, except that it has a blower similar to an ensilage cutter.

2. Operating Grain-harvesting Machines

**Operating Grain Binders.** Many statements on the mower, relative to the cutter bar and mechanism, apply equally well to the binder cutter bar. However, in starting a new machine or at the beginning of each season, it is desirable to run the binder at slow speed, particularly a tractor binder, for at least 5 to 10 min. This provides an opportunity to observe the operation of all parts to be sure they are running properly. The bearings can be tested to see if any are heating, and lubrication checked.

Grain binders and some other machines use canvas conveyors and have power transmitted by chain. For that reason, these two items...
The useful life of binder canvases can be greatly lengthened by good care. Always have equal canvas tension at both buckles and just tight enough to prevent slippage on the rollers. Too much tension causes increased draft, friction, and excessive wear on rollers, bearings, and canvases. Keep the elevator frames square so that the elevator canvases will run evenly. To prevent tears in the canvases, also check the binder for projections, loose bolts, and parts out of line.

Canvas shrinks when wet and is easily mildewed, so protect it at night from dew and possible rain. The best practice is to shed or cover the binder, or to remove canvases and store in a dry place. However, the more common method is to roll back the platform canvas against the elevator, release the tension of the elevator canvases, and cover with grain bundles. In case the canvases become wet, hang them in the sun and dry thoroughly before using them.

Each of the two elevator canvases has its set of rollers on which it operates. On some binders, the lower rollers on each canvas have hinged bearings that allow the rollers to be pulled up in order to loosen the canvases quickly and easily when idle.

Caring for Sprockets and Chains. Keep sprockets in true alignment, as a side pull concentrates the load on the sides of the sprocket teeth.
and on one side of the chain. Faulty alignment results in excessive wear on both chain and sprockets. When the teeth on a sprocket become badly worn, replace the sprocket to prevent injury to the chain. Place an open-jointed chain so the hook end runs forward and the slot side is out when the larger of the sprockets is the driver. When the smaller of the two sprockets is the driver, operate the chain in the reverse direction.

**Lubricating.** The tractor binder operates at a greater speed than the horse-drawn binder so the necessity for careful and frequent lubrication is doubly important. This is especially true of the fast-moving parts, including universal joints, driving shaft, crankshaft, rollers, bearings, shafts, and packers. The under parts of the binder are accessible for lubrication if the trap door in the platform is removed. The gears are enclosed so that oil can be kept in and dirt out. Inspect the level of the oil in the gear cases from time to time to make sure that the gears dip into the oil. Use oil of the consistency of transmission oil. The knotter parts and faces of the pinions and cams must be well oiled. Lubricate daily the knife guides, wearing plates, and sickle sections, except when working under extremely dusty conditions.

**Adjusting.** The cutter bar is always in alignment, inasmuch as it is an integral part of the platform. As ordinarily used, the knife sides are serrated and ledger plates smooth. Consequently the cutting edges cannot be sharpened, so are replaced when worn.

Adjust the cutting height by regulating the height of the binder in relation to the main and grain wheels. This height will vary with the condition of the grain, but keep wheel position about midway on side brackets. Set the tilting lever so the platform is nearly level with a slight tilt forward. When cutting lodged and tangled grain, it is
necessary to tilt the platform down until the guard fingers are close to the ground.

Proper functioning and adjustment of the reel play an important part in getting all the grain and placing the cut grain evenly on the platform canvas. There are two levers for adjusting the reel when operating from the binder seat. One lever raises and lowers the reel while the other shifts the reel forward and back. The one-man control from the tractor seat, however, has only the one lever for raising and lowering the reel, while the other adjustment must be made from the binder seat. Adjust these levers so the reel runs close to the top of the grain and far enough forward so the bats do not leave the grain.
until it is cut. For lodged grain, a low position with the reel set ahead gives the best results.

When ground wheel-operated binders are unable to handle all the grain properly as cut, or when there is a tendency for the bull wheel to slip, the difficulty may be overcome temporarily by cutting less than a full swath. When grain is lodged, place one extension pickup guard on the cutter bar for each foot in length and cut against, or at right angles to, the lodged grain if it is very close to the ground.

The size and shape of the bundles are important in binder operation. The position of the band on the bundle is also important for
ease in handling and shocking. When harvesting grain of uneven height, move the binding unit back and forth to prevent twine bands from being too high or too low on the bundles. Never use the butt adjuster for this purpose. Only when the grain is extremely short is it necessary to shift the grain to the binder with the butt adjuster. New binders are factory adjusted to tie bundles under compression of 24 to 30 lb. on the trip lever. The bundle handles best when moderately tight and yet well ventilated. Bundles packed too tight are subject to mold, and they frequently break the bands on being discharged. The size of the bundle is determined by the position of the trip hook. Large bundles, while more apt to mold, use less twine, handle faster, and require less hand labor for the crop. The bundle tightness-adjustment is accomplished through the tension on the spring trip and never by the tension of the twine. Some operators have been wrongly of the opinion that increasing the tension on the twine roller increases the compactness of the bundle. Increasing this tension above the 7 to 10 lb. recommended is a common cause of broken bands and undue wear on the tying members.

The binding and tying mechanism consists of numerous parts, all
of which must work together in perfect adjustment and timing if the binder is to do good work. Faulty adjustment of only one part brought about by wear, breakage, or inattention of the operator will discount the perfect adjustment or condition of other coordinated parts, and cause the machine to tie poorly.

If the knotter fails to perform satisfactorily, the operator should refer to his instruction book supplied with the binder before making any adjustments. A knowledge of what he is doing, together with a wrench, oilstone, kerosene, and a little oil is often all that is required.

If moving parts of the knotter have not been properly protected by grease or a rust preventive during storage, with the result that they have become rusted, trouble may develop unless the rust is removed before use. This can be removed with kerosene and fine sandpaper. Never use such tools as cold chisels, files, punches, and hammers on the knotter, as they are likely to mutilate it. Correctly thread the binder before making any adjustment with the knotter.

The operator should not become unduly worried if a loose bundle is thrown out occasionally, as it is useless to look for trouble until it is really present (see Figs. 409 to 412). The reason for untied bundles is likely to be one of the following:

1. Broken twine, which may indicate that the twine-holder tension is too tight for twine to pass freely enough to the twine-holder disk.
2. A loose or an untied knot may indicate that the twine-holder disk is too loose, allowing the twine to slip out while the knotter hook revolves.
3. Frequent untied knots may indicate that the needle does not come down far enough to place the upper twine securely in the disk holder.
4. If bundles are thrown out not tied, with the twine straight, and without a knot, the knotter-hook spring is too loose and must be adjusted.

At the end of the season apply a coat of grease to all knotter parts, needle, twine guides, and sickle. Then place the complete binder under cover, adequately shielded from rain, snow, and animals.

Operating Threshing Machines. At the beginning of every threshing season, check the separator for proper assembly of all members, condition, and adjustment as outlined in the owner's manual. Search for and remove any foreign objects from the machine. Pieces of wood or metal that are in the machine will cause
untold damage if left there when the machine is operated. Next, lubricate every part requiring lubrication with the specified grade of lubricant. Then operate the machine slowly to make sure all operating members are adjusted to function properly.

Upon “setting” for the first threshing operation, operate the machine at proper speed and check with a small amount of grain to be sure the machine is threshing as it should. Pitching bundles uniformly onto the self-feeder will facilitate good threshing (Fig. 413). Uneven feeding, especially throwing several bundles on at a time, tends to choke the cylinder and is apt to send a noticeable amount of grain to
the straw pile. Self-feeders, with automatic feed controls, slow down when such conditions occur.

Always operate the thresher cylinder at the recommended speed. When the speed is reduced the cylinder will not remove all the grain from the heads, while with excess speed there is danger of cracking the grain.

The same conditions are apt to occur when the concaves do not have the proper relationship to the cylinder. Too much clearance
Fig. 412. Annual checking with regular operating service will do more than anything else to deliver all bundles tied uniformly.

Fig. 413. Aline the belt properly for all belt pulley jobs. Proper alignment and tension assure uniform power and speed and reduce belt wear.
between these two members results in poor threshing, and too little clearance may cause cracking of the grain (Fig. 4.20).

It is sometimes necessary to remove some of the concaves in early forenoon threshing of shocked grain because of heavy dew. Replace the concaves or change the adjustment after the grain has dried out.

Operators are sometimes too much concerned over finding a few unthreshed heads and attempt to eliminate this loss completely in the cylinder adjustment. This results in overthreshing and may increase the loss, for the grain is apt to ride out with the chaff due to an overloaded chaffer and shoe sieves. Reviewing the various functions of the thresher in Chap. 10 will assist in locating causes for improper threshing.

The head end of the bundle goes first into the feeder.

The feed plate furnishes a threshing edge, so it is essential to maintain its proper clearance with the cylinder. Recommendations for proper clearances for various crops are generally given in the owner’s manual. As a general rule, set the feed plate as close as possible without restricting the feed in any way. Much of the threshing will then be accomplished as the cut grain passes over the feed plate where it is attacked by the revolving cylinder. The concave grate then becomes a seed-separation unit. This setting also requires less power. Setting too close may crack the seed, as stated previously. It may also restrict the feed by forcing the cut grain to back up. The straw rack is equipped with removable riser rods. If wastage occurs over the straw rack it may be corrected by removing some of the rods. The cleaning fan in the cleaning shoe should deliver just enough air to
“lift” the chaff from the sieves but not enough to blow the threshed grain over.

Operating Combine Harvester-threshers. Inasmuch as the combine harvester-threshers, both the pull-behind and the self-pro-

![Image](image1.png)

Fig. 415. Correct setting of the reel is important for good threshing.

![Image](image2.png)

Fig. 416. Reel speed varied by using larger or smaller sprocket.

...elled, do the work of the header or binder and thresher, most of the points of operation have been covered. However, combined grain is generally cut after the grain has matured more than for binding, yet
it is threshed while it contains more moisture than grain cured in the shock or stack. Thus two general points need be kept in mind: (1) Combine only when the grain is in a threshable condition and (2) maintain the proper adjustments to meet the requirements of the crop being threshed.
The cutter mechanism is like that of the cutter bar on the binder, and is operated and serviced in a similar manner. Observe the cutting parts frequently to keep guards tight, guards in line, sickle clips about \( \frac{3}{4} \) in. above knives to provide a shear cut, wearing plates adjusted to take up any looseness between knife back and guard, and all sections, as well as ledger plates, sharp. Replace broken sections, dull sections, broken guards, dull or broken guard plates, and wearing plates if worn sufficiently to permit front of sections to rise.

Adjust the reel slats to strike the grain just below the heads and turn enough faster than the combine speed to bat them well back...
Select the proper screen for the type and condition of the crop being threshed. (See also Fig. 421B.)

Fig. 421A.
Select the proper screen for the type and condition of the crop being threshed.

Fig. 421B.
onto the canvas. Should the reel carry straw around, reduce the speed of the reel by using a slower speed sprocket. If nodding grain hangs on the reel slats, place canvas, screen, or light metal strips on each set of reel arms. When cut grain flows over the cutter bar, move the reel back and directly over the sickle, also lowering it so that the grain is pushed back on the canvas. It may be necessary to add more slats to the reel and increase the reel speed, but the use of belting wipers (Fig. 417) on the slats to sweep back the cut grain may solve the difficulty. Belting wipers also used on the outer ends of the slats will clean the divider when grain clings to it; however, under
such conditions, also use loop dividers to open up lodged grain or vines to permit a clean-cut swath. Tangling of lodged grain, vines, or weedy crops on the outer end of reel slats can be overcome by uniting the outer end of slats with an 8-in. band of light sheet iron,

![Figure 424](image1)

Adjust chaffer lips so that grain works through before it passes over 2/3 the length of chaffer. Run chaffer with lips open as far as possible without admitting too much coarse material.

![Figure 425](image2)

Maintain rack speed as recommended in your Combine Instruction Book.

and reducing reel speed, as well as setting the reel forward and down close to the cutter bar. When checking and adjusting the reel, do likewise with the canvases, being sure all slats are firmly attached, rollers turn freely, and guides are smooth.

Set the cutter-bar platform evenly and just low enough to cut the
heads from low-growing grain. Should the grain not be cut smoothly, see that the knife registers properly and whether there are any bent,

Fig. 426. Fan-wind deflector rod should be in second notch for most operating conditions.

Fig. 427. Adjusting the grain elevator.

worn, or broken sections or ledger plates. If the crop is lodged or extremely heavy, requiring an unusual amount of material to be on the platform, it is often necessary to cut less than a full swath and
even to reduce field speed. For lodged grain, the use of an extension guard for each foot of cutter bar is often essential. Tangled or bunched grain may clog the cylinders. However, be certain it is not being caused by slow speed of the cylinder or that the cylinder was not cleaned, or up to operating speed, when entering the grain.

A slipping canvas, caused by insufficient tension, or canvas that does not operate smoothly in the guides may also clog the cylinder.

Some combine harvester-threshers have speed adjustments on the cylinder. These permit providing the proper speed to thresh the heads clean (Fig. 419). This will vary with the condition of the grain. A speed too slow will not remove all the grain from the heads, while
excess speed may result in cracking the grain. Other operating instructions given for the threshing machine apply also to the combine. They include cylinder and concave adjustment; feed plate, cylinder beater, straw rack, and grain pan adjustment; and selecting proper screen, chaffer, and cleaning shoe, including the cleaning fan and air blast.

Inasmuch as special cylinder equipment is available (see Fig. 326) for harvesting some crops, including sweet clover, crotolaria, soybeans, okra, and other crops difficult to feed, it is advisable to use such equipment. For harvesting peas, as in the Palouse area, use a pea bar and change reel to pick up this low-growing vine crop.

An appreciable amount of threshed grain will not pass out with the straw over the straw rack unless (1) the machine is being overfed by too-fast ground travel, (2) the cutting is too low in tall grain, (3) the flattened grain is making it necessary to handle an excessive amount of straw, (4) the tractor hitch is too high or too low, or (5) the combine is operating on steep hillsides and is not leveled by the operator.

IMPORTANT: Safety clutches are placed on the main drive shaft and elevator drive shaft. If these clutches are slipping, stop machine at
once and remove obstructions. Always stop the machine to make adjustments.

**Some Points in Servicing Combine Harvesters.**

1. Keep belts and chains in alignment and proper tension.
2. Rubberized belts deteriorate from contact with grease and exposure.
3. Treat leather belts regularly with neat's-foot oil to keep them pliable.

Fig. 430. A self-propelled combine, like all other machines, requires an alert operator who is familiar with his machine.

4. Clean chains regularly by soaking and dipping in kerosene, then dry and reoil.
5. When season is over, remove belt from machine, clean carefully, and store in dry place protected from rats and mice. Hang V belts up over two supports to help maintain proper shape.
6. If one or more cylinder bars become damaged, making replacement necessary, replace opposite cylinder bar also in order to maintain proper balance of cylinder.
7. Feeder plates may be reversed after they have become worn to present new threshing edge.

**Operating Farm Elevators.** Locate the elevator where it will be easily accessible to wagons and trucks and to deliver grain to or from the granary. Feed the grain into the hopper at the rate the
auger, grain belt, or grain cups can handle it with the power used; this is usually an auxiliary engine or electric motor. Maintain a uniform speed recommended by the manufacturer.

Place the elevator on an even keel to keep the grain in the auger housing from working to one side. Furthermore, if grain-cup or elevator-belt type is used, such a setting of the machine ensures greater efficiency in handling the grain as well as more uniform strain upon the machine.

3. Operating Corn-harvesting Machines

Operating the Corn Binder. The corn binder is similar in many respects to the grain binder. This is especially true of lubrication, the chains, sprockets, and binding mechanism.

A positive operating machine is desired. Corn binders, when delivered, are equipped to do good work under average conditions. Attachments or adjustments are provided to overcome unusual or severe conditions. Where traction is difficult, use special wheels with wide rims for ground-drive machines.

Safe operation is good operation. Here are a few “musts” for the operator of the corn binder:
FIG. 432. If the gatherer throat spring loses its tension, becomes bent, or is otherwise damaged, remove and reshape it.

FIG. 433. Detail of the binding mechanism; a “late” or “early” needle is corrected by adjustment at F.
1. Always place the power take-off shield in position on tractor-operated corn binders, before starting operation.

2. Throw the binder out of gear before making adjustments.

3. Use a piece of rope when pulling the trip mechanism to test the knoter. The rapid movement of the needle and discharge arms makes it dangerous to use the hand.

4. When using a wrench, take hold of the handle in such manner that in case of a slip the knuckles will not be skinned or other parts of the body injured.

FIG. 434. The tightness of the bundles is adjusted at point H. Bundles should trip between 10- and 24 lb. pressure on the trip.

The safe operator follows instructions in attaching the power shaft to the power take-off, throwing the machine in gear and assuring free functioning of the safety clutch and the proper shielding of the shaft. Establishing basic safety habits will do much to assure safe operation of the corn binder and other machines.

The few parts of the cutting mechanism require frequent inspection because the cutting is intermittent and of a shock nature. Keep the sickle-head guides adjusted to hold the sickle as closely as possible to the stationary knives, without binding (see Fig. 333). Shim adjustments are provided generally to take up wear. The stationary
Maintain proper tension on the twine and knotter members at all times.

(A) Knotter-disk tension, as shown, is to be approximately 50 lb. to pull the twine forward out of knotter disk.  
(B) The knotter-hook tension, with a sample knot on the knotter, should take from 20- to 40-lb. pull to strip it off the knotter hook.  
(C) Twine tension is to serve the needle. Maintain this tension at about 7 lb. and never let it exceed 10.
knives are readily removed for sharpening, while the reciprocating knife with its serrated cutting edges can also be replaced when dull.

Operate the binder as near level as possible, except when the crop is leaning or down. In that case, and by use of the tilting lever, run the gathering points close to the ground. Check the gathering chains twice daily so they are driven evenly from both sides of the sprockets. Chains operating too tightly cause excessive wear on the hook links, bearings, and sprockets, and require additional power.

The butt pan, which holds the butts in place while the bundle is being tied, is adjusted up or down to control the height of tying, which is generally lower than midway.

The two-row tractor corn binders are operated the same as the one-row. There are two cutter bars and twice the number of gathering chains, but only one binding unit.

Operation of the binding units is similar in principle to that of the grain binder, except that some makes of the former tie the bundles in an upright position. Have the bundles tight enough to be handled easily. If too tight, the bands often break as soon as they are tied, discharging loose stalks from the machine. The causes of untied corn bundles and the remedies are similar to those for grain binders.
Follow the binder instruction manual for needle travel, timing of needle, and operation and relationship of the knotter and breast-plate. The twine knife of the knotter cuts the twine after the knot is tied. Sharpen the knife when it becomes dull and replace it if bent (see Fig. 412).

Before putting the binder away at the close of the season, apply a coat of grease to knotter parts, needle, twine guides, and sickle, as recommended for the grain binder. Then place the machine under cover, adequately shielded from rain and snow.

**Operating the Ensilage Cutter.** The ensilage cutter is not a field machine. The cutter and blower, which are belt operated, run at very high speeds. High speed calls for (1) setting the machine level to eliminate strains in the frame and (2) keeping the speed of the cutter and blower at speeds recommended by the manufacturer. Steady uniform feeding assures satisfactory cutting and elevating, prevents clogging, and saves the safety shear bolts generally used to connect the flange collars on the upper transmission shaft.

The length of cut is obtained by (1) the number of knives used...
and (2) the size and relationships of the sprockets on the chains driving the apron. Sharp and properly adjusted knives are essential (Fig. 442).

Fig. 438. Transmission chains on the ensilage cutter are kept in proper tension by adjusting the chain idler (A). Length of cut is changed by use of proper sprockets.

Fig. 439. Ensilage-cutter knife adjustment. Adjustment for wear is made by loosening the nuts on the knife bolt and wedge bolt. Raise or lower the wedge by tightening or loosening the eye-bolt nut.

It is advisable to keep on hand an extra set of sharpened knives, using both sets in a day's operation. Keep the knives properly adjusted to the shear cutter bar for a clean cut.
Next in importance is using good flywheel wings. Worn flywheel wings will not do a good job of elevating the cut material. Speeding the flywheel to overcome either worn flywheel wings or a worn blower housing is dangerous and wasteful of power. Some cutters have adjustable blower housings. Keep the housing in proper relationship to the wings and replace worn wings.

![Diagram](image)

**FIG. 440.** When in proper adjustment, the cutting edge of the two vertical shear bars (A) is flush with the edge of the cutter bar (C). When worn, loosen the vertical shear bars (A) and adjust by set screw or other means provided; then tighten. Keep shear (B) sharp.

For vertical silos, use a distributor pipe (Fig. 339). This, properly manned, will place and help pack the silage uniformly, thus reducing to a minimum the air pockets where spoilage often occurs. Keep the blower-pipe joints tight and rigid. Also, keep them vertical instead of angular to avoid the feed clogging on one side of the blower pipe.

Any hard foreign material, such as stone or metal, will damage, if not wreck, the cutter.

**Operating the Field-ensilage Harvester.** The ensilage harvester is a combination corn binder and ensilage cutter. Instead of binding the corn in bundles, it turns and feeds the stalks into a revolving chopper knife, butts first. The same instruction applies
to the gathering arms and stalk-cutting mechanism as that given for
the corn binder, while the ensilage-cutter material is applicable to
the silage-cutting mechanism.

Fig. 441. To compensate for wear of the fan wings, the blower housing is adjusted closer
to the wings.

Fig. 442. A knife-grinder attachment is desirable in order to keep sharp knives ready at
all times. In grinding, it is necessary to maintain the same size and shape bevel. Care­
fully adjust the guide for uniform grinding across the knife. (A) Adjusting for inner part.
(B) Adjusting for outer diameter.

When very heavy crops are harvested, the silage-cutting mecha­
nism may not handle the crop so fast as it is cut. If reducing the
forward speed of the tractor does not take care of this, stop the tractor
at intervals until the machine cleans itself.
Fig. 443. Timely servicing prevents many costly field failures and reduces cost of operation.

Fig. 444. Some operators prefer covered trailers for collecting ensilage, claiming that the loads are filled more completely.
Operating the Ensilage and Grain Blower. This machine elevates field-cut silage into the silo and also can be used for elevating grain. Maintain the proper relationship between the blower wings and the blower housing to secure good work (see Fig. 441). Have the blower operating at the recommended speed before dumping silage or grain into the hopper.

Operating Corn Pickers. Corn pickers are now tractor operated. The same operating instructions and safety measures apply here as for other power take-off-operated machines. To be safe,
Fig. 447. When stalks are brittle, the snapping rolls are set farther apart. This adjustment is made at A.

Fig. 448. Husking Rolls must contact each other if they are to do a good job of husking.
always stop the machine before making any adjustments or removing clogging material.

The gatherers have the same function here as in corn binders, except the stalks are straightened up so the snapping rolls get all of the ears. The clearance between the gatherers is about 6 in. for average corn, but they should be set closer for light corn. In picking, follow the rows carefully, maintaining the gathering points just close enough to the ground to pick up the leaning or “down” stalks. Raise the points when turning or reaching the ends of rows.

Fig. 449. Trash rolls attached to upper end of snapped-corn elevators expel most of the stalk pieces and other trash.

Setting the snapping rolls is a job requiring care. They need to be close enough to pinch or snap off all ears. If too close, they are likely to break off dry or frozen stalks, and if too wide, they will catch and crush the ears, clog with loose material, and shell the corn. Setting the snapping rolls depends upon observations made as to the condition of the corn (see Fig. 445 to 447).

The husking rolls are in pairs and under tension. The pegs on the rolls remove the husks, as in hand husking. Dry husks or dry corn require less effort than damp husks. When an excessive amount of husk remains on the ears, set the rolls closer and increase the spring tension.

The husks are carried away by air blast which, if too strong, blows
the shelled corn out with the husks. To obtain the proper fan blast, it may be necessary to replace or tighten the fan belt, clean out the fan chute, and adjust the fan chute up or down to direct the blast as required to dispose of the husks and yet save the shelled corn. The wagon or tank elevator carries the corn away. When it fails to do this, increase the tension. If the elevator capacity is inadequate, speed it up.

A slipping clutch may indicate (1) clogged parts, (2) operating members out of adjustment, or (3) lack of tension in the clutch springs.
Check the first two before changing the spring tension. In addition to regular lubrication instructions, brush the steel roller and hook-link chains frequently with light oil.

Operating the Cutoff Corn Harvester. Operating instructions for the corn binder-cutting mechanism apply to the cutting mechanism of this machine. The corn-picker instructions relative to snapping and husking are also applicable to the cutoff corn harvester. The shredder knives and blower are similar to the ensilage cutter and husker-shredder.

Operating Corn Shellers. Adjust the elevator on the cylinder shellers so it feeds at the rate at which the shellер can handle it. Broken kernels indicate either that the shelling tension spring is too tight or that the machine is being operated too fast. If the cobs are not cleaned, it is due to insufficient tension. Adjust the tension so that it cleans and separates the grain but not strong enough to blow the kernels out with the husk material.

Operating Field Sheller. This machine performs the work of both the corn picker and the corn shellер. Adjust the picker and sheller to the size of ears as well as the moisture condition of crop. Follow the manufacturer's instructions provided with the machine.

Operating Corn Husker-shredder. Many of the general principles of operation of the ensilage cutter and blower apply to the husker-shredder. The husking rolls are operated as described under the corn picker.
Fig. 453. (A) The cylinder is the heart of the corn sheller. Select the proper screen and adjust cylinder for the corn and its condition. (B) Special cylinder for snapped corn, showing extension of feeding spiral on fore part of cylinder. (C) A lugged-type cylinder for damp, tough, husked corn.
Operating Stalk Cutters. This machine cuts stalks with a blade, which in most cutters penetrates the soil, and it is necessary to sharpen the cutter blades frequently. Even with sharp blades, it is often necessary to add extra weight on the cutter when the crop is unusually heavy, the stalks large, the ground rough, or the soil soft.

Keep the stalk hooks or gathering rods close enough to the ground to bring the stalks under the cutter blades. Dry stalks cut the best on dry ground and there is less tendency for the stalks to wrap on the cutter. Remove any material collecting on the cutter rather than burning it out.

4. Operating Fiber-harvesting Machines

Operating Cotton Strippers. The cotton stripper is a rather simple machine to operate. It is not used until all the cotton bolls are open. Follow the cotton row, enabling the gathering points to pass under the cotton-plant branches, and direct the plant into the throat. Do not pack the cotton in the truck or wagon. This crushes the bolls and makes ginning more difficult. With the gathering chains or stripping rollers in proper condition and at proper tension, the bolls are snapped off readily. Normal care, assuming the necessary lubrication, will keep the stripper and conveyor in good condition.

Operating Cotton Pickers. The cotton picker is different in operation and time of use than the cotton stripper. Since all the cotton bolls seldom ripen and open at one time, a cotton field is normally picked two or three times to harvest the entire crop. Picking several times in some areas secures a better grade of cotton. In humid areas, the longer the open cotton is exposed to the weather, the greater the chance of deterioration and discoloration, resulting in a lower grade.

The recommended time to begin picking cotton is when it is clean and fluffy, and half or more than half of the bolls are open. Avoid running the plant lifters in the ground at the sides of the furrow. This may cause dirt to enter the picker drums and damage the picker mechanism. Dirty cotton will result.

Defoliation is accomplished by applying a cyanamide compound. Removing the leaves enables the sun to hasten the opening of the unopened bolls. Removing the leaves also reduces materially the amount of trash in the picked cotton.

After the cotton is removed from the bolls, it is delivered to the
basket by vacuum and air. Inasmuch as moisture increases the weight of the cotton, it is good practice to delay picking after a rain until the cotton has dried. Permit the cotton to drop into the basket without manual packing. Do not stomp the cotton after it is dumped into a truck or wagon, as such a practice tends to grind the dirt into the picked cotton.

Before starting the tractor engine, open the drum-box doors and turn the doffers in their proper rotation to make sure the drum mechanism is free and that the doffers clear the picker spindles. Turn the crank on the mechanical oiler 100 or more times to be sure oil has reached the lower bearing of the picker bars. This is indicated by oil seeping out of the lower picker-bar pivot.

After starting the tractor engine, engage the picking mechanism and let it idle for 15 min. Then stop the picker mechanism and check to be sure oil is reaching the lower picker bearing. Next turn on the main water valve and check the moistening system. Have all water applicators functioning properly before starting to pick.

The height of the drum box is controlled by a lever. Set the drum box low enough to pick the low bolls and yet not to run in the dirt. Operate the picker drum in low speed when the tractor is operated in the low transmission speed. Likewise, operate the drum in second speed when the tractor is in second transmission speed.

A slip clutch prevents the picker-drum mechanism against damage from clogging. Keep the slip clutch adjusted tight enough for normal operation without undue stoppage, yet loose enough to permit slippage in case of choking or the entrance of any object that will not pass through the throat of the drum box.

Before operating the picker, clean all dust and trash from the fan screens and radiator screen. Check this at frequent intervals, as an accumulation at those points will interfere with the proper function of the air-delivery system.

It is possible that operating adjustments will be required during the season. Even after properly adjusting at the beginning of the season, check doffers, spindle moisteners, picker arms' balancing springs, belts and chains, picker drum, oiler and eccentric, and the separator rotor drive-shaft slip clutch.

Operating Cotton Gins. The description of the cotton gin and its part in the final grade of the cotton was given in Chap. 10 as an aid to the cotton grower in preparing his cotton. Ginning cotton is,
in reality, an industry and, therefore, is outside the scope of this book. Persons interested in operational information are referred to manuals from the respective cotton-gin manufacturers.

**Operating Hemp Harvesters.** The hemp cutter is a combination mower and turntable. The cutter bar is operated the same as the mower discussed earlier in this chapter. The operator sees that the turntable rests uniformly on all rollers and that the table drive is free from hemp stalks and trash. The hemp turner has a table similar to the hemp cutter. Keep the elevating chain in proper and uniform tension so the stalks are fed uniformly. Replace broken finger lugs or damaged sprockets. The gatherer-binder pickup attachment is adjusted so that all eccentrics operate together. If any are out of time, retim them. The binding attachment is similar to a grain binder.

The hemp machines do not, as a rule, have enclosed bearings or cut gears. For this reason, frequent lubrication of all bearings is necessary to keep dirt and dust out and sufficient lubricant is needed for the bearing. Check all assembly points to make sure the machine is in good working condition.

**Operating Flax-fiber Harvesters.** The comparatively small market for flax pullers and similar hemp machines does not warrant the assembly-line production given some of the larger machines. As a result, the operator relies more on operating instruction. He studies the work of his machine to satisfy himself as to how it operates and when it is operating satisfactorily. Keep the pulling-belt tension in good condition and the pulling wheel in alinement. The binding attachment is a standard binder.

5. Operating Root Crop-harvesting Machines

**Operating White-potato Diggers.** Keep the digger plow or shovels below the tubers so none are injured. The shovels raise the tubers, soil, and vines onto the elevator.

The soil type and condition determine the amount of elevator agitation required to deliver clean potatoes. Undue agitation or rough handling induces bruising and skinning of the potatoes which endangers their keeping qualities. The agitation can be increased in varying degrees depending upon the type of agitating sprockets used to replace the smooth rollers. Use the level-bed type of digger rather than the angle-bed type, when possible, because of reduced tendency
An alert operator follows the row and adjusts his digger to ground and crop conditions, which results in clean uninjured potatoes in easy-to-gather rows.

Agitating sprockets are to assist in removing soil from the tubers.

to damage the harvested crop. Power diggers are generally easier to operate effectively than are horse-drawn diggers, because the speed of the elevator and the power take-off are not affected by wheel slippage or slowing of forward travel.
When the tops are heavy, the ground hard, or weeds abundant, it is advisable to use rolling-colter disks. Set these disks far enough apart not to injure the tubers and yet deep enough to perform properly.

The operator must also make sure to keep chain tighteners adjusted; have safety shields well secured; lubricate adequately; and, where vines are heavy or shovel is set deep, set the vine-turner shaft as far away from the shaker as possible. When using tongue trucks, maintain the truck's wheels parallel to the pole; have the machine, including elevator, in motion when the shovel is lowered into the ground; keep the digger astride the row, especially if rolling colters are used; set pitch of shaker so that center bars just touch the ground, but, if this does not give clean separation, decrease the pitch although this scatters the potatoes more. Increase the vibration of the shaker for better separation by setting the wrist pins in the pole of the pitman crank to provide the largest throw. Add or remove rod links as needed in the elevator to secure the proper tension; however, do not have the tension tight enough to increase draft or so loose that the sag permits the top and bottom of the elevator to come together.

In cases where the picking crew is unable to keep up with the
digger, it is advisable to dig alternate rows so as to avoid running over
the unpicked potatoes. When operating on hillsides, use T-shaped
lugs to prevent downhill slippage. Remove the shovel from the soil
at the end of the day and coat with grease.

Operating Sweet-potato Harvesters. Sweet potatoes are har­
vested with moldboard plows and the same type of machine used for
the Irish or white potato. However, the vines should be removed
first to facilitate digging. Sweet potatoes do not tolerate the shaker

agitation of Irish potatoes, nor do they need it, as they are generally
grown on less sticky soils.

Operate the sweet potato-vine harvester so it just severs growth
below the surface of the ground. Keep the knives sharp. The
pickup teeth can then remove vegetation and deliver it to the ele­
vator. Run the colters in the mid-row so as to give a clean cut for
the next trip. Maintain firm tension on the packing wheel to reduce
the tendency of the vine to wrap on the machine.

Operating Beet Harvesters and Pullers. Beet harvesters are
similar in lifting the beets, whether they are ground-topped, or lifted
and then topped. Maintain sharp points on the pullers. Then keep
the points deep enough in the soil so that they do not gouge the beets
or break off the root ends. Sharp disks are essential, both for cleaning
the row and for topping the beets. Set them at the proper angle. The digger arms have much to do with removing clean beets. Set them deep enough to break the soil and still provide the desired lifting effect.

The harvesters that top after lifting require a good conveyor. V-type rubber belts are replacing chains for this, and appear to be effective. This type has a unique but complicated device for holding and topping. Keep it free from metal and stones and properly lubricated.

Adjust loading and cleaning elevators so as not to injure the beets. Keep the revolving wheel-type points straight and sharp so they will penetrate and remove the beets. Keep the topping knives sharp on this machine as on any other similar type used. Sharp knives do a clean job of topping with a minimum of effort while dull knives may mash some of the beets. Remove the ground-working parts from the soil at the end of each day's work and coat with grease. The simple beet puller drawn by either horsepower or tractor power is similar to the puller on the beet harvester. Disks are seldom used on these pullers as they often damage the tops for feed. The puller, toppers, and haulers must operate as close together as possible to avoid weight shrinkage of the beets.

Operating Peanut Diggers. Peanuts are loosened and placed on top of the ground by two long angling blades per row. Keep these blades sharp. This calls for frequent inspection, as the soil
destroys sharp cutting edges. The other main operation instruction is care of the elevating or windrowing devices. The elevator type shakes the dirt out and places the peanuts back on the ground in a windrow. Maintain the proper tension on the elevator and replace or straighten any bent or broken members. Remove the knives from the soil at the end of each day’s work and coat with grease.

**Operating Bulb Diggers.** As bulb diggers are generally constructed locally—often by the individual bulb grower—over-all operating instructions do not cover enough cases. The plow, which removes excess dirt above the bulbs, should require little or no attention. The digger, below the bulbs, is of the potato-digger type and requires the same care. The elevating and cleaning chains, also similar to a potato digger, except longer, need to be kept in proper tension and all bearings lubricated. Shield all dangerous parts and keep the shields well secured. Remove plow and shield from soil at the end of each day’s work and coat with grease.

6. Operating Special Crop-harvesting Machines

**Operating Sugar-cane Harvesters.** As pointed out in Chap. 10, cane harvesters are built locally to meet the local crop conditions. Sugar-cane harvesters are often designed around tractors, so any operating instructions apply to the harvester itself. There are several long chain-power transmission lines that need shielding, from a safety standpoint, and also to keep cane stalks out of them. Check the chains for tension and the sprockets for wear. Keep the lower and upper disk cutters sharp. Also protect them from injuring people when unit is not operating in the field.

**Operating Sugar-cane Loaders.** These machines bunch the cane in the “heap rows,” then pick up the bunches to load on carts or wagons. Keep the machine balanced when loading and guard the cables and gears.

**Operating Green-crop Harvesters.** Set the harvester used for spinach to cut the crop at the height that meets the market demands. Adjust the reel and fingers to pick up the crop for cutting and then move the crop back on the platform canvas. Operate the auxiliary engine on the harvester at the recommended speed and pull the harvester at a rate that permits the spinach to be delivered onto the truck without clogging the spout. Set the spout and the top draper at a height consistent with the truck bed. Maintain the cutter bar,
platform canvas, and elevator canvas just as you would similar parts on a combine. For loading beet tops, alfalfa, or other cut crops, the cutter bar is not used. The platform is set near the ground surface, and the reel must be set low and ahead far enough to lift and push the cut crop back onto the platform.

When harvesting peas for canning purposes, regardless of the method used, take precautions to avoid injury to the pods and have the crop delivered to the winery while it is still in prime condition. If mowers are used to cut the vines, it is necessary to set the sickle bar low enough to be under the pods. To prevent the vines from drying out and to expedite the efficiency in handling the cut crop, use a side-delivery windrowing attachment on the sickle bar. Some prefer the center-windrow device while others prefer using a reaping attachment and bunch the cut vines. If the vines are not picked up prior to the next time around the field with the mower, it is best to use the side-delivery windrow device to avoid running over the cut crop. Always use the pickup guards on the mower, about 1 ft. apart, if any of the vines do not stand erect.

If bean cutters are used to harvest canning peas, keep the knives sharp and operate low enough to avoid dragging the vines. By keeping knives sufficiently sharp, the depth of setting can be reduced. This results in cleaner vines. Bean cutters can be used with or without a buncher. After cutting, a special machine with a pickup belt similar to that on a pickup hay baler is often employed. This delivers the vines onto trucks or hayracks for delivery to the winery.

Operating Lettuce Harvesters. Move slowly through the field to permit the cutters to select and cut the marketable heads. Maintain the carrier belt at a tension that prevents slippage. Prevent the tractor, harvester, and rack from running over uncut lettuce rows. Have slatted sides on the racks that haul the boxes of hand-cut heads to the grading and packing sheds to permit free air circulation. Use racks that are low enough to be easily loaded and large enough to handle the crop speedily.

Operating Grain-sorghum Harvesters. For grain sorghums, which do not shatter easily, the combine is preferred for harvesting, especially when just the grain is to be used. The information provided in this chapter regarding the operation of a combine harvester applies here.

When headers are used to top grain sorghums, set them low enough
to get the heads, thus avoiding the handling of excess stover which, at a later date, may slow the threshing operation.

When the heading device attached to the front of a wagon, or the kind attached to the side of a wagon box, is used, the main things to keep in mind are to remove as little stover with the head as is consistent with speed of operation, and to maintain all cutting parts in good condition.

Cure all harvested heads thoroughly before threshing or, if combined, wait until the grain is very dry because threshed grain from the sorgos heats very quickly; this destroys germination. In fact, heat sufficient to destroy germination can exist in the bin without being detected. Heated grain is very likely to become musty, which lowers its feeding and sale qualities.

**Operating Clover Hullers.** Keep clover hullers properly adjusted and operate them according to instructions. They can be moved about the field while the grass crop being threshed is brought to the machine by sleds, sweeps, hayracks, or buck rakes.

**Operating Bean Hullers.** Give special attention to the speed of the cylinders to prevent broken beans. Operate the slow cylinder just fast enough to remove the beans without cracking or splitting them.
Operating Nut Harvesters. These units are all of local manufacture, so follow the instructions with each machine.

Operating Seed Strippers. Operate these at a time the crop is ready for harvest and moisture conditions will not damage the seed as gathered. The simplicity of these machines lessens the need for operating instructions. Keep the strippers clean at all times so that a satisfactory job is performed.

Operating Bean and Pea Cutters. Set the cutters just deep enough to cut the vines without dragging the beans or other vegetation. By keeping the knives sharp and setting them at a satisfactory shearing angle, a cleaner job is performed and less draft is required, because the knives can be set at a minimum depth. Many operators carry a file for frequently sharpening the blades. If using a buncher in connection with the cutter, be sure to observe if beans are being shattered. Less shattering will occur when the vines are slightly damp as they usually are early in the morning, or if the crop is cut before it is too ripe.

When peas are harvested for threshing, they can be cut by a mower, bean cutter, or special sled with a knife and platform similar to a sled-corn cutter on which the vines are carried until a shock load can be dumped. This last-mentioned device can also be used for harvesting canning peas. When harvesting devices are used that employ a stationary knife, keep the knife sharp and set at the proper depth and angle to avoid dragging the vines.

Combines can also be used to harvest dry peas, but the platform must be set low enough to get all the pods. Set the reel far enough ahead to give a lifting action to the vines, and yet set it low enough to prevent the vines from gathering on or pushing ahead of the sickle. If the vines are tangled or lodged, use extension guards on the sickle and a loop to divide the vines at the outer sickle shoe.

SUMMARY

1. To cut properly and with minimum effort, keep all mower knives sharp and held close to the ledge plates for shearing contact. The sickle bar needs some "lead," that is, having the outer end of the bar slightly ahead of the inner end when aligned with the plunger. The sickle knives need to register with the guards on the outer and inner end of the strokes for clean cutting and minimum draft.

2. Tractor mowers need a breakaway as a safety feature that lets the sickle bar swing back when striking a solid object.
3. Set the mower sickle high enough to clear trash and other obstructions; also tilt the guard points upward slightly if trash catches on guard points.

4. Side-delivery rakes are run in the same direction as the mower, except for the first, or opening, round. Since leaves are higher in food value than stems, hay is usually raked before it is dry enough for leaves to shatter.

5. Some side-delivery rakes, when run in reverse, serve as tedders to stir or lift up hay to expedite drying after a rain.

6. Sweep rakes operated by horsepower or motor power work best if the tines are set nearly flat; if using horsepower, make a tight hitch as an aid in backing or turning.

7. If hay is very dry, it is best to rake it early in the morning while the dew is on to save the leaves, and the same thing applies to the hay loader.

8. The hay stacker is subject to considerable jolting action. Therefore, keep it well anchored and keep all connecting parts securely bolted.

9. Adjust the rollers on a hay crusher with just enough tension to crush the stems; extra tension is a waste of power.

10. The density of hay bales is regulated by adjusting the outlet pressure required to force out the bales.

11. Feed stationary balers uniformly and drive the pickup baler steadily to pick up uniformly sized windrows.

12. The life of binder canvases is lengthened by having the buckles on each canvas at the same tension, keeping elevator frames square, and at night releasing the canvas tension and covering the canvases with bundles.

13. Keep hook-link chain sprockets in alinement, and have the chain slots out, with the hooks running forward, except where the small sprocket is the driver, which requires the other end of the link to run forward.

14. The binder reel is adjustable horizontally and vertically and is to be set to place the cut grain evenly on the platform canvas.

15. Large bundles require less twine than small bundles, and the crop is handled faster.

16. Adjust bundle size by setting the trip hook and not by twine tension.

17. Adjust the position of the twine on the bundle by moving the binding unit and not by setting the butt adjuster, except when grain is very short.

18. Set the thresher level and with the wind going into the feeder. Feed bundles uniformly and headfirst into the feeder for good threshing.

19. The combine includes the operations of a header and a thresher. If grain is lodged, use extension guards on the sickle bar.

20. If grain is wet, not evenly ripe, or weedy, it is first windrowed. Then the combine picks up the cured crop when dry enough for threshing.

21. Place the farm elevator on an even keel to keep the grain from working to one side of the auger housing.
22. When using binders, combines, and other machines operated by a power take-off, keep the power take-off properly shielded as well as the gears and other safety hazards.

23. Operate the corn binder and field-ensilage harvester as nearly level as possible. When the crop is lodged, it is necessary to run the gatherer points close to the ground.

24. Keep knives of ensilage cutter sharp and adjusted to run close to the shear bar; also run the machine uniformly, at the recommended speed, and feed uniformly for the best results.

25. Stop the corn picker and similar machines when making adjustments and removing clogged material as a safety measure.

26. The snapping rolls on a corn picker are set closer together for small ears and tough damp husks than for dry husks and larger ears.

27. Use a special lugged-type cylinder to shell corn that is tough and damp.

28. Cornstalk cutters work best when the blades are sharp, machine is properly weighted, gatherer hooks are set to gather the stalks, stalks are dry, and the ground is firm or dry.

29. Start the cotton picker when at least half of the bolls are open, and avoid running the plant lifters in the ground at the row sides as the soil damages the machine and makes cotton dirtier.

30. Set the potato-digger shovel just deep enough to avoid cutting the tubers and use the least amount of eccentric rollers or sprockets on the aprons to remove excess soil from the tubers in order to reduce damage to a minimum.

31. When the sun is likely to scald the potatoes, operate the digger just far enough ahead of the pickers to avoid scalding.

32. The beet puller, toppers, and haulers must operate as close together as possible to avoid shrinkage and sugar loss.

33. Operate the auxiliary engine on a green-crop harvester just fast enough to deliver the crop and not clog; too much speed wastes power and may damage the crop.

34. To avoid shattering when cutting dry beans and peas, the cutter blades must be sharp, properly angled to cut, and the crop not ripe enough to shatter. If very ripe, cut the crop when slightly damp.
12. Reconditioning and Storing
Harvest and Harvest-handling
Machines

Nearly all the machines in this part are comprised of many working parts. Most of them perform two or more operations; they are combinations of the simple farm tools of a generation ago. Harvest and harvest-handling machines were the first farm machines, next to the tractor, to utilize improved construction materials, precision construction, and other advanced mechanical developments. In fact, several of them have precision parts similar to tractors.

Chapter 11 emphasized the proper operation and field care of these machines to ensure satisfactory performance. Good operation cannot be overemphasized. These machines are seasonably operated, used but a short time annually. They are idle the remainder and larger part of the year. It has been suggested previously that, as a season's work is brought to a close, the operators make notations of any service a machine requires before starting another year's work. It is good business to inspect and recondition all machines, especially the harvest and harvest-handling machines.

No one with any mechanical appreciation would think of jumping in an automobile that had been in storage for 11 months and starting off on a cross-country trip. By the same token, it is folly to hook up a harvest machine and immediately put it into a heavy field of grain or corn, without inspection and service. The automobile and, more recently, the tractor are driven to the garage and service station periodically for inspection and service. We appreciate more and more the wisdom of using well-trained and experienced workers on equipment of this kind. It is with this in mind that the inspection, reconditioning, and storing of harvest and harvest-handling machines will be discussed under the following headings:
1. Reconditioning Hay-harvesting Machines
   Mowers
   Rakes and Tedders
   Loaders
   Stackers
   Hay Crushers
   Balers
   Choppers

2. Reconditioning Grain-harvesting Machines
   Binders and Reapers
   Threshers
   Combine Harvester-threshers
   Portable Grain Elevators or Conveyors

3. Reconditioning Corn-harvesting Machines
   Corn Binders
   Ensilage Cutters
   Ensilage Harvesters
   Ensilage Blowers
   Corn Pickers
   Cutoff Corn Harvester
   Corn Shellers
   Husker-shredders
   Stalk Cutters

4. Reconditioning Fiber-harvesting Machines
   Cotton Strippers
   Cotton Pickers
   Cotton Gins
   Hemp Harvesters
   Flax Harvesters

5. Reconditioning Root Crop-harvesting Machines
   Potato Diggers
   Beet Pullers
   Peanut Diggers
   Bulb Diggers

6. Reconditioning Special Crop-harvesting Machines
   Sugar-cane Harvesters
   Sugar-cane Loaders
   Green-crop Harvesters
   Grain-sorghum Harvesters
   Clover Hullers
   Bean Hullers
   Bean and Pea Cutters

7. Storing Harvest and Harvest-handling Machines
1. Reconditioning Hay-harvesting Machines

Inspecting and Reconditioning the Mower. The mower, one of the most common farm machines, is often operated in poor alignment. Three main parts of the mower-cutting mechanism need checking for alignment. First, check the angle of the pitman. This is done by placing a straightedge against the pitman wheel face and sighting along both the straightedge and the pitman face. The knife-bar end of the pitman should be from $\frac{1}{8}$ to $\frac{1}{4}$ in. ahead of the wheel end of the pitman. To increase this angle, the dragbar is shortened and the brace bar lengthened. To decrease this angle, reverse the adjustment procedure. When one bar is shortened and

![Fig. 459. Registering the cutter bar. (A) Bar out of register. (B) Bar in register.](image)
the other lengthened the same amount, the angle will be changed without affecting the knife register.

Adjust so the knives register, or center, with the guards at each end of the sickle stroke when the machine is in working position and

![Image of a mower showing the register being adjusted]

**Fig. 460.** In one type of mower, the register is corrected by changing the length of the coupling-bar brace (3). This is done by turning flywheel shield (2) the necessary number of turns.

![Image of students using a string to check cutter-bar lead]

**Fig. 461.** Students of vocational agriculture using a string to check cutter-bar lead in the important job of aligning the cutter bar.

the outer end of cutter bar pulled back. Should the knives travel out too far, lengthen both the dragbar and the brace bar; if the knives do not go out far enough, both bars should be shortened. When both bars are either shortened or lengthened the same amount, the angle of the pitman is not changed, although the register is changed.

The cutter-bar lead is checked when the mower is in working
position and the outer end of the cutter bar pulled back. To determine the lead, stretch a cord over the middle of the pitman and extending to the outer end of the cutter bar. With the cord taut, measure distance from a point under the cord to the back edge of knife section at inner and outer end of cutter bar. If outer end of bar is ahead of inner end, it has lead; otherwise, there is lag. Correct this lag according to the manufacturer's instructions, being sure that it does not make the angle of the pitman incorrect. Some of the most common things causing incorrect lead of the cutter bar are (1) worn yoke pins or shoe causing play in the hinge joint, (2) sprung yoke or brace bar, (3) cutter bar loose in the inner shoe, and (4) lead adjustment not set according to manufacturer's instructions. When actually working, the pitman and knife bar should be in a straight line. However, when being checked, the knife bar should have \( \frac{3}{8} \) in. lead for each foot of length; this lead is absorbed under field strain to give a straight line of pitman and knife bar.
Fig. 463. On some mowers the lead is corrected by turning the eccentric pin in the rear shoe bearing. On some other mowers the lead is corrected by replacing both shoe hinge pins.

Fig. 464. Adjusting the tilt on one tractor mower is accomplished by moving the rear bolt (Q) into a slotted hole.
Whenever it becomes necessary to replace a pitman rod, exercise care to ascertain that the holes correspond with the holes in the old rod. A complete reconditioning job on a machine generally includes a thorough cleaning, painting, lubrication, and unit adjustment.

![Fig. 465. A wheel puller provides a good method for removing wheels from mowers as well as from many other machines.](image)

**Horse-drawn Mowers.** The following list includes many jobs that are appropriate in the annual reconditioning process:

1. Clean the mower so that it can be inspected and reconditioned.
2. Adjust lead of sickle bar.
3. Adjust register of knives (sections) with guards and adjust inner and outer shoes.
4. Inspect countershaft bearings.
5. Adjust nut on end of countershaft to ensure proper meshing of beveled gears with pinion gear.

![Image](image1.png)

Fig. 467.

![Image](image2.png)

Fig. 468. Check the bevel gear and pinion to be sure that the contact is near the center of the bevel gear as shown at b.

6. Inspect pitman (crank) shaft bearings.
7. Remove wheels to clean and then relubricate bearings.
8. Examine pawls and pawl springs. Replace if necessary.
The first job in replacing ledger plates is to knock out the rivets of the worn plate, using a straight punch of proper size and a guard block.

Guard Plates are just as important as Knife Sections:
Replace worn or nicked Guard Plates.

New Guard Plate

Guard Plate worn beyond good service.
9. Examine spur gear and pinion. Replace if teeth are badly worn.
10. Test pitman-box bushing and pitman straps. Tighten, adjust, or replace as needed.

WEARING PLATES SHOULD FIT SNUGLY AGAINST KNIFE-BACK. Tap forward as shown.

Fig. 471.

Fig. 472. This farmer is removing a broken guard that he will replace to make sure his mower is ready next summer.

11. Test pitman strap connection on the ball of sickle head. If badly worn, add leather washer or replace with a new part.
12. Check and replace any badly worn ledger plates.
13. Adjust wearing plates and knife holders and replace when necessary.
14. Align and replace guards as needed, straighten and tighten guard wings, and upset guard shoulders tightly against cutter-bar back.

15. Adjust swath board and grass stick for the job.

16. Clean all oil holes and grease cups. Replace lost grease cups, cup caps, and oil connections.

17. Examine bearings for adjustment or replacement.

18. Examine lifting mechanism. Take up lost motion and replace parts as required.

19. Examine clutch-shifting lever and rod. Check tension spring and replace if necessary.
20. Examine clutch fork and adjustment. Adjust and replace as necessary.
21. Check bolts, nuts, studs, cotter keys, keys, and rivets. Tighten and replace if necessary.
22. Check tongue truck. Adjust, replace, service, and tighten parts as required.

FIG. 475. The grindstone is kept wet and turned toward the operator. The sickle must be held to maintain the correct angle; hold firmly for safety.

23. Remove and replace all worn and damaged sections.
24. Sharpen sections to original form.
25. Check mower attachments.

Tractor-operated Mowers. These machines require the same attention for similar parts. In addition, the safety release requires inspection and sometimes adjustment. The mower drive, V belt, or shaft also requires attention.
RECONDITIONING AND STORING HARVEST MACHINES

Fig. 477. Scraping off the accumulated grease and washing dirt from the mower prior to reconditioning and painting.

Fig. 478. Servicing the transmission members of a combination side-delivery rake and hay tedder. To remove drive chain (3), loosen bolts (1) that hold reel-shaft support. Move sprocket shaft forward until chain can be removed. Disconnect as shown in Fig. 403. To service other members, place frame on solid support and remove wheels and chain. Instruction books will give the remaining instructions.
Reconditioning Rakes and Tedders. The simplest machines in the hay-harvesting group are the rakes.

Dump Rakes. The following are suggested reconditioning jobs:
1. Examine foot-trip lever. Adjust or replace if worn.
2. Adjust dump mechanism, including hand dump if worn.
3. Examine wheel ratchets for wear. Adjust or replace if damaged or worn.
4. Inspect adjustment at hinge of foot lever. Take up wear at this point.
5. Replace or repair snubbing-block bolt.
6. Examine tension of trip spring. Replace if broken or weak.
7. Reverse wheels and rods if wheel ratchets or dump rods are worn.
8. Straighten or replace spokes and wheel rims.
9. Straighten or replace rods that clean teeth of hay.
10. Examine wheel bearings. Adjust or replace.
11. Replace or tighten broken teeth, nuts, bolts, and cotter keys.

Side-delivery Rakes and Tedders. These machines are often used under such unfavorable conditions as are encountered with rough ground, coarse or heavy crops, and small ditches or land that is rocky. Because of this abuse, it is essential to recondition them each year in order to obtain long and satisfactory service. Sometimes it is necessary to remove the reel from the frame in order to recondition the machine properly. Some of the main jobs to consider when inspecting and reconditioning machines used as side-delivery rakes or tedders are:

1. Wheels.
   a. Ratchets and pawls. Clean assembly and replace broken or weak pawl springs. Replace pawls if sufficiently worn to slip on the ratchet.
   b. Bearings and boxings. Replace if sufficiently worn to slip on ratchet.
   c. Caster wheels. Straighten axle if bent. Replace bearings and wheel hub if flanges are worn enough to allow wheel to slip off axle.
   d. Lubricate parts after they have been carefully cleaned.
2. Frame. Straighten bent parts, replace lost parts, replace or repair broken parts, and tighten bolts.
3. Levers. Straighten bent parts; replace worn, lost, or broken parts. Replace broken or weak springs and straighten lever rods, if bent.
4. Rake attachments.
   a. Clutch. Inspect gears for repair, and replace if badly worn or broken. Eliminate play.
   b. Teeth. Inspect teeth and straighten as needed. Replace badly bent, broken, or lost-teeth.
   c. Stripper rods. Straighten bent rods and fasten all securely.
5. Miscellaneous.
   a. Replace and tighten bolts and other fasteners.
   b. Replace any lost or damaged grease cups. Lubricate.

   **Sweep Rakes.** Reconditioning jobs include
   
   1. Wheels.
      a. Bearings and boxings. Replace or tighten if badly worn.
      b. Straighten wheels if bent.
   
   ![Fig. 479. Replacing damaged teeth on a rake loader. First remove cylinder shield (1), then remove cylinder drive chain, cotter pin (2), and the two bolts (3) that hold crank (4) to the tooth bar (5). Take out the two bolts (6) that fasten the cylinder center arm. Slide the tooth bar sideways until it is released from its bearing in cylinder. Broken or damaged teeth can now be removed and replaced.]

   c. Clean and thoroughly lubricate all working parts.

   2. Frame. Straighten any bent parts, tighten bolts, replace or repair any broken parts.

   3. Levers. Straighten any bent parts. Repair or replace badly worn or broken parts. Replace weak springs.

   4. Teeth. Replace broken teeth and points of teeth that have been lost.

   5. Miscellaneous.
      a. Inspect hitches for repairs and replacements.
      b. Tighten and replace bolts, screws, nuts, and other fasteners.
      c. Clean all parts that are lubricated. Lubricate.

   **Reconditioning Hay Loaders, Stackers, and Crushers.** There are several kinds of such implements. The following are common
reconditioning jobs, but they are not specific for any one make of implement.

**Hay Loaders.**

1. Wheels.
   a. Inspect bearings and boxings. Adjust or replace.
   b. Examine lugs or main wheels and repair as needed.
   c. Straighten spokes and repair if broken or loose.
   d. Check ratchets in wheels and repair or replace parts as needed.

![Diagram for replacing chain drives on a cylinder-rake loader. Similar diagrams are available from manufacturers for chain and belt drives on all machines.](image)

2. Frame and hay deck.
   a. Examine parts. Straighten or repair.
   b. Inspect bolts and other fasteners. Replace, repair, and tighten as necessary.

3. Hay-gathering and elevating devices.
   a. Examine all rake and elevating teeth. Repair, straighten, and replace.
   b. Inspect rake bars. Repair, straighten, and replace.
   c. Examine slats. Repair and replace.
   d. Inspect and adjust crankshaft bearings for rake bars.
4. Miscellaneous.
   a. Inspect rake drum and eccentrics. Repair and replace lost parts.
   b. Examine hitch and tongue truck to straighten or repair if worn or broken.
   c. Tighten bolts, nuts, screws, and other fasteners.

   d. Clean all working parts that are lubricated. Lubricate.
   e. Check trip rope and guides. Recondition or replace.

**Hay Stackers.**

1. Frame.
   a. Inspect bolts, nuts, and screws. Tighten and replace.
   b. Examine runners or wheels. Repair if sufficiently worn.

2. Lifting devices.
   a. Inspect teeth. Replace if broken.
   b. Inspect pulleys, ropes, trips, and cables. Clean, repair, and lubricate pulley bearings and shaft.
   c. Examine plunger and repair broken parts.
3. Miscellaneous.
   b. Inspect anchors.
   c. Inspect bolts and nuts. Tighten and replace.

*Hay Crushers.* This machine is a combination mower, pickup, and crusher. Check the bearings, oil seals, and tension of the rollers. Adjust the rollers so they are just tight enough to crush the stems without squeezing out an appreciable amount of plant juices.

Fig. 482. Inspect all parts of the baler—pickup teeth, cylinder bearings, hay feed, plunger, and the like—to make sure they are in proper coordination.

*Reconditioning Balers and Pickup Balers.* Suggested jobs are as follows:

1. Wheels.
   Inspect bearings, oil seals, axle.
   Adjust, replace, clean, and lubricate.

2. Frame.
   Inspect frame-connection bolts, nuts, and fasteners.
   Tighten, replace, and adjust as needed.

3. Pickup device.
   a. Examine all fingers or rake teeth. Straighten and replace.
   c. Inspect elevator feed. Adjust and repair.
   d. Inspect chains, sprockets, and universal joints. Repair and adjust as needed.
   e. Examine stripper-assembly rods. Straighten as needed.
   f. Inspect wind guards and flare sheets. Straighten as needed.
4. Packer and baler.
   a. Inspect plunger and plunger arm.
   b. Inspect feeder drum.
   c. Inspect bale-divider mechanism.
   d. Examine bale tension and adjust as needed. If springs are weak, replace them.

5. Automatic tying mechanism.
   a. Check twine or wire holders.
   b. Inspect and adjust needle.
   c. Inspect and adjust knotter mechanism.
   d. Adjust pitman bearings and protect with rust preventive.

![Diagram of packing machine components]

Fig. 483. To remove the pitman (5), it is necessary to remove the plunger since the plunger head pin (2) cannot be removed from inside the press chamber. After removing the crank pin, the pitman and plunger are removed together through the bale chamber and out through the back end of the press. (1) Plunger breastplate; (3) roller; (4) bottom guide; (5) roller bearing; (7) top guide; (8) cover.

6. Power unit and power take-off.
   a. Inspect and recondition engine as outlined under Tractor Engine, Chap. 15.
   b. Inspect power take-off shaft for alignment, spline connections, universal joints, and shielding.

7. Miscellaneous.
   b. Examine bearings and boxings. Replace worn parts and adjust.
   c. Inspect seats and foot rests. Make secure.
   d. Clean remaining working parts. Paint. Lubricate.
   e. Check bale-elevating and loading devices of pickup balers.

Reconditioning Hay Choppers. The field-hay chopper, which cuts standing forage, is a combination of the mower cutter bar, binder reel, combine auger and canvas elevator, and the roughage mill with blower. As it is operated by the tractor power take-off, the same
inspection and overhauling instructions apply as to the hay baler. 
The windrow-hay chopper is another combination machine. It com-
binds the pickup of the hay baler and certain parts of the field chop-
choppers, such as the cutter bar and reel. Therefore, similar overhauling 
instructions apply.

2. Reconditioning Grain-harvesting Machines

Putting Grain Binders and Headers in Working Shape. The 
grain binder is really a multiple machine, in that it both cuts and 
binds the grain. Being rather intricate and complex, it is necessary 
to clean the machine thoroughly before it is inspected and recon-
donced. Some of the jobs on horse-drawn models include

1. Main wheel and countershaft.
   a. Inspect alignment of main wheel. Align if necessary.
   b. Test bearing of main wheel. Adjust or replace.
   c. Examine main wheel sprocket and main chain. Replace badly 
      worn links and adjust to proper tension.
   d. Check entire main chain assembly.
   e. Check main wheel-raising device for freeness of movement; also test 
      the turning of the worm.
   f. Test clutch and clutch spring and check alignment of clutch, sprocket, 
      and main wheel sprocket.
   g. Check bearings on countershaft. Replace if worn sufficiently.
   h. Test countershaft for end play and take it up as needed.
   i. Clean and oil bearing of main wheel shaft and countershaft.

2. Elevators, rollers, and canvases.
   a. Remove and repair canvases.
   b. Test rollers and repair main bearings.
   c. Square up the elevators to run true.
   d. Inspect apron chains and sprockets for replacements and repairs.
   e. Test alignment of apron sprockets and align if necessary.
   f. Adjust tension of chains.
   g. Lubricate roller bearings and other moving parts.

3. Cutter bar, sickle, and pitman (see jobs under Horse-drawn Mowers, 
pages 476, 479, 481, 482, 483, and 484).

4. Reel.
   a. Replace worn gears, sprockets, or chains that drive the reel.
   b. Test bearings of reel shaft and adjust or replace.
   c. Adjust reel shaft and slats.
   d. Replace broken reel slats and arms.
5. Binding attachments.
   a. Test knotter. Adjust tension to pounds recommended.
   b. Replace worn caps or gears.
   c. Adjust needle pitman.
   d. Tighten packer bearings.
   e. Sharpen twine knife and needle point.
   f. Lubricate bearings after a thorough cleaning.

6. Miscellaneous.
   a. Test action and springs of levers. Replace or repair worn, weak, or broken parts.
   b. Adjust tension of the bundle-carrier spring.
   c. Clean and lubricate sprocket chains.
   d. Inspect bearings and then adjust or replace.
   e. Inspect tongue truck for needed repairs.
   f. Lubricate wheels of tongue truck.
   g. Inspect, adjust, and lubricate bearings and chains as needed.
   h. Tighten, replace, and adjust bolts, nuts, and other fasteners.
The general inspection jobs mentioned above will cover most of those occurring in connection with a header, which is a rather simple machine.

Reconditioning Threshers (Separators). The thresher receives the ripened and cured grain. Its job is to remove and clean the grain or heads and deliver the straw and chaff at a designated location. The following are points dealing with the inspection and reconditioning of the threshing machine:

1. Main frame.
   a. Inspect and adjust wheels and axles.
   b. Check and secure all body and housing connections.
   c. Aline pulleys and sprockets.
   d. Inspect and adjust belt and chain drives.

2. Self-feeder.
   a. Inspect and recondition feeder canvas.
   b. Inspect band cutters. Sharpen and adjust.
   c. Inspect governors controlling feed of straw to cylinder.

3. The threshing unit.
   a. Inspect cylinder bearings and drive. Recondition.
   b. Inspect cylinder teeth, concaves, and attachment. Replace broken, bent, and missing teeth.
   c. In spike-tooth cylinders, be sure the clearance between cylinder teeth and concave teeth conforms to manufacturer's directions.
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d. Remove and inspect all canvas sections and finger grates. Recondition.

4. Separating unit.
   a. Inspect condition of the feed plate. Recondition.
   b. Inspect and recondition the cylinder heads.

Fig. 486. Inspect the straw-walker rack for reshaping and repair.

Straw rack may be removed for inspection or repair by removing rack studs and withdrawing rack.

Fig. 487.

c. Check condition of the straw rack, shaker bearings, and shaker arms. Recondition.

d. Inspect and recondition grain pan and return pan.

5. Cleaning unit.
   a. Inspect chaffer and grain sieve for bent or twisted parts.
   b. Check cleaning fan, bearings, and shaft.
   c. Inspect grain conveyors, weights, and chutes.
   d. Inspect stacker for condition and overhaul.
   e. Inspect stack blower—bearings and housing.
Fig. 488. Replace sprockets having worn teeth. Such sprockets may grasp and injure chain links.

Fig. 489. With proper equipment, worn sprockets can be rebuilt.
Reconditioning Combine Harvester-threshers. Many of the jobs listed for the grain binder and thresher are also applicable to the combine harvester, whether pull type or self-propelled; the material need not be repeated. The following are other jobs to be considered in the annual reconditioning of the combine harvester-thresher:

1. Engine or power unit. This is the same as for a tractor engine. See Chap. 15.
2. Guiding or steering mechanism (self-propelled). Inspect all parts and recondition.
3. Undercarriage. Check wheels, bearings, oil seals, and other members. Inspect and recondition.

4. Inspect and check straw distributor.

5. On sidehill machines, inspect and recondition leveling device.

Reconditioning Grain Elevators. Elevators or conveyors are operated by electric motors, gas engines, and horsepower. The main jobs when inspecting these machines for reconditioning include the following:

1. Power unit.
   a. Inspect motor. Clean, adjust, and lubricate.
   b. Inspect power unit, including shaft and universal joints. Tighten bolts, nuts, and screws. Adjust gears to proper mesh. Clean and lubricate.
   c. Inspect power-jack speed reducer. Tighten, repair, adjust, clean, and lubricate.
   d. Examine belts, pulleys, sprocket, and hook links. Clean, adjust, and align to proper tension. Lubricate.

2. Elevator unit.
   a. Inspect elevator box. Repair all leaks. Tighten truss rods and clean.
   b. Examine carrying strips. Replace if badly worn. Tighten if loose.
   c. Inspect flight belt and flights. Repair if damaged and adjust to tension.
   d. Inspect bearing for flight chain or belt at both ends of elevator unit. Adjust or replace. Clean and lubricate.

3. Hopper and miscellaneous.
   a. Inspect hopper and repair leaks. Tighten, clean, and adjust rods.
   b. Inspect countershaft and hopper elevator. Clean, repair, adjust, and lubricate.
   c. Inspect truck. Clean wheel bearings and lubricate.
   d. Inspect and recondition lift attachments for wagons and trucks.

3. Reconditioning Corn-harvesting Machines

Reconditioning the Corn Binder. The procedure in checking this machine is similar to that used for the grain binder. Some corn-binder jobs, not always common to the grain binder, are

1. Cutting unit.
   a. Sharpen stationary knives.
   b. Sharpen sickle knives. Replace broken or worn knives.
   c. Aline cutting parts.
Fig. 492. Proper relationship between the needle and knott disk post on corn-binder knotter mechanism.

Fig. 493. Proper clearance between the trip stop and the binder driving dog of the corn-binder head.
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d. Check for adjustment and repair the side knives, sickle, pitman, and sickle guide.

2. Elevating unit.
a. Check for repair and adjustment the carrier chains and gathering boards.
b. Adjust chains at a tension to operate easily, and space to gather stalks properly.

c. Replace missing or damaged lugs on elevating chains.
d. Adjust spring in lower part of throat on elevating unit.
e. Replace weak, lost, or damaged springs.

Reconditioning Ensilage Cutters. The ensilage cutter is different from any other machine discussed so far. It is belt-driven, like the thresher; therefore, the undercarriage requires inspection and possible adjustment. This includes the condition of the feed-trough sides.

1. Inspect the feed apron and recondition.
2. Check the transmission, bearings, oil seals, sprockets, and chain drives. Replace damaged members, adjust, and lubricate.
3. Check and recondition shift lever, which is also the safety lever.
4. Inspect the flywheel, bearings, and oil seals to be sure assembled members are well secured.
5. Inspect cutting knives and shear plate. Sharpen and replace as required.
6. Inspect and replace damaged flywheel rings.
7. Inspect and recondition blower housing.

8. Check the control lever, a safety feature for ease of operation under load.
9. Inspect and recondition upper and lower feed rolls. Adjust tension and arms.
10. Inspect and recondition all parts of elevator pipe.

**Reconditioning Ensilage Harvesters.** The inspection and reconditioning jobs on the ensilage harvester have been discussed under Grain and Corn Binders and Ensilage Cutters; therefore, they will not be repeated here.
FIG. 496. Students of vocational agriculture replacing a gathering board on a corn binder.

FIG. 497. An ensilage knife culter gets a new edge on the implement sharpener installed in this farmer's work shop.
Reconditioning Ensilage and Grain Blowers. These machines combine parts of the ensilage cutter, particularly the blower. Additional jobs are:

1. Check the hopper-lifting device.
2. Examine pulleys and belt of blower. Aline pulleys and belts.

Reconditioning Corn Pickers. The operation of the corn picker is divided into five main headings. The jobs under these respective headings include:

1. Dividers and gathering chains.
   a. Inspect chains and sprocket wheels. Aline sprockets, clean hook-link chains, and replace broken links or lugs. Adjust chain tension, clean sprocket wheel bearings, and lubricate.
   b. Inspect dividers. Adjust to proper width, tighten bolts, repair divider wings, and straighten bent points.
2. Snapping rolls.
   b. Inspect flanges on snapping roll and repair or replace as needed.
3. Husking rolls and center elevator.
   b. Inspect husking-roll springs. Adjust tension and replace weak or broken springs.
   c. Inspect presser wheels, baffles, and rider belts. Adjust, replace, and repair as needed.

Fig. 498. Corn-picker shoes, hard surfaced with a farm welder.
d. Inspect shelled-corn saver and repair as needed.

e. Inspect husk conveyor. Adjust, repair, and replace broken or badly worn parts.

f. Inspect fan. Adjust or replace bearings, clean, and lubricate.


a. Inspect chains and flights. Tighten, adjust, replace, and clean. Lubricate chains.

b. Inspect sprockets. Aline, adjust chains, adjust bearings, clean, and lubricate.

c. Examine elevator box. Tighten, repair, and clean.

5. Miscellaneous.

a. Inspect frame. Tighten bolts and fasteners.

b. Inspect bearings. Adjust, replace, clean, and lubricate.

c. Inspect hitch. Straighten bent parts, repair, and replace badly worn or broken parts.
cutoff Corn Harvester.  This machine combines features of the corn binder, picker, and husker-shredder, so jobs will not be repeated here.

Reconditioning Corn Shellers.  Since the spring and cylinder types of shellers are radically different, they are treated with a separate list of jobs for each.

Spring Sheller.  The major jobs include the following:

1. Elevators.
   a. Inspect the feeding elevator.  Aline sprockets, replace broken links and flights.  Adjust tension of chain or belt.  Clean and lubricate sprocket bearings.
   b. Inspect cob rake.  Clean, adjust tension, check eccentric shaker sprocket, and lubricate.
   c. Inspect cob-stacker elevator.  Aline sprockets, replace worn and broken links and flights.  Clean and lubricate.
   d. Inspect shelled-corn elevator.  Repair, clean, aline sprockets and chains, and adjust.

2. Shelling unit.
   a. Examine rag iron and adjustment nut.  Replace spring if weak or broken, and replace rag iron if face is smooth.
   b. Examine beater of feed.  Adjust, to prevent ears bridging at feed, and repair as needed.
   c. Examine picker wheel.  Adjust so it runs true; this may require new bearings.  Clean bearings and lubricate.
   d. Examine shelling runner wheels.  Set at proper spacing, replace bearings if badly worn, repair broken parts.  Clean bearings and lubricate.

3. Cleaning unit.
   a. Inspect sieve.  Clean, repair, and replace as needed.
   b. Inspect fan.  Straighten blades, clean bearings, adjust bearings, lubricate, and adjust belt or operating chain.

4. Miscellaneous.
   a. Inspect frame and tighten nuts and bolts.  Replace lost or broken bolts and repair or replace broken parts.
   b. Inspect running gear or runners.  Repair and replace parts as needed.

Cylinder Sheller.  The major jobs include

1. Elevators (see Spring Sheller).
2. Shelling unit.
b. Inspect shelling cylinder. Repair and replace shelling parts as needed. 
c. Inspect shelling blades or concaves. Repair or replace as needed and adjust to cylinder.
3. Cleaning unit (see Spring Sheller).

Reconditioning Corn Husker-shredders. Typical jobs include

1. Feed unit and husker.
   a. Inspect feeder-conveyor. Repair and adjust feeder parts.
   b. Inspect auxiliary snapping rolls. Adjust, repair, and lubricate bearings.
   c. Inspect retard rolls. Repair.
   d. Inspect husking rolls and springs. Repair and adjust or replace.
2. Cutter and shredder cylinder.
   a. Inspect cutter knives. Sharpen and adjust knives to cutter bar. Lubricate bearings.
   b. Inspect shredder bars. Adjust and replace broken parts.
3. Elevators and bagging attachments.
   a. Inspect grain elevator. Repair belt, flights, and elevator chute.
   b. Inspect blower and tube. Straighten and repair blower tube. Straighten fan blades and adjust fan bearings.
   c. Inspect bagging attachment. Repair and tighten parts.
4. Miscellaneous.
   a. Inspect frame and tighten bolts. Repair or replace broken or lost parts.
   c. Inspect adjustments and set accurately.
   d. Inspect and recondition shakers, beaters, and agitators.

Reconditioning the Stalk Cutter. After being thoroughly cleaned, the stalk cutter should have special attention given to the following:

1. Bearings of wheels for adjustment or replacement
2. Bearings on shaft of cutter for adjustment or replacement
3. Springs providing tension to cutter
4. Levers controlling the cutter
5. Cutter blades
6. Gathering hooks in proper position
7. Lubrication
4. Reconditioning Fiber-harvesting Machines

Reconditioning the Cotton Stripper. This machine, with working parts readily accessible, has the following reconditioning jobs:
1. Inspect and recondition tongue and undercarriage, including wheel bearing.
2. Examine and recondition drive from wheel to stripper rolls or chains.
3. Check and recondition the stripper chains, rolls, and sprockets.
4. Check and recondition elevator.
5. Check and adjust levers and box or basket-tilting mechanism.
6. Smooth out any roughness in the side of the throat shield.

Reconditioning the Cotton Picker. There are many points in the cotton picker requiring inspection in the annual reconditioning process. They will be discussed under four major headings:
1. Power unit.
   The cotton picker is assembled on a tractor and receives its power from the tractor. Reconditioning tractors is discussed in Chap. 15.
2. Picking unit.
   a. Inspect the position of the doffer lugs so they barely clear the picker spindles. Setting them too tight results in their acting as a brake on the picker system.
   b. Set the tips of the fins on the lower side of the rubber applicators \( \frac{3}{4} \) in. lower than the upper surface of the spindles.
   c. Adjust the main drive-shaft slip clutch.
   d. Adjust the picker-drum balancing springs so it is easy for the operator to raise the drum with the lever.
   e. Adjust the belt and chain idlers to provide proper tension.
   f. Inspect and clean the moisture applicators.
   g. Inspect the picker-drive gear housing.
3. Conveyor system.
   a. Inspect the separator rotor.
   b. Examine fan, drive, bearings, and conveyor tubing.
   a. Inspect the upper grate.
   b. Check the basket for smoothness.
   c. Inspect and recondition the basket-dumping mechanism.

Cotton Gins. Chapter 11 pointed out that cotton gins were commercial and ordinarily not farm or plantation machines; for this reason they will not be discussed here.
Reconditioning Hemp Harvesters. Machines or parts included here are:

1. The hemp cutter is a combination mower and turntable. In general, the same points apply to cutting mechanism as to the mower. As the turntable is chain driven, the chain, sprockets, and table roller require inspection and adjustment. All bearings are plain bearings. Clean, inspect, adjust, and lubricate them.

2. The hemp-turner pickup fingers and chains require inspection. Check the chain links, fingers, and sprockets for damaged members; replace if damaged. The turntable instructions for the hemp cutter apply here.

3. The gatherer-binder combines a pickup attachment and grain binder, so it is reconditioned as described previously.

Reconditioning Flax Harvesters. The flax puller is the machine discussed here. The undercarriage and power take-off drive are reconditioned as described for other machines. The puller wheel and puller belt need to be inspected and reconditioned, as does the binding attachment. Maintain enough tension on the spring-mounted rollers to pull the flax plant properly, as with the Canadian-machine.

5. Reconditioning Root Crop-harvesting Machines

Reconditioning Potato Diggers (Irish and Sweet). There are several kinds of potato diggers, and they may be drawn either by horses or by tractors. Those drawn by tractors may or may not employ a power take-off. Regardless of the digger used, the following jobs are involved in reconditioning such a machine:

1. Lifting unit.
   b. Examine vine turners and shakers. Straighten and repair.
   c. Examine stone excluder. Adjust and repair.
   d. Examine depth control of shovel. Adjust hitch and lever to secure desired depth.

2. Elevators.
   a. Inspect elevators. Straighten bent rods; repair or replace. Adjust tension and repair rollers.
   b. Examine agitating sprockets. Repair or replace.
   c. Inspect sprockets and chains. Align, adjust, repair, and lubricate.
3. Wheels, frame, shafts.
   a. Inspect frame. Tighten and replace bolts as needed.
   b. Examine wheels. Repair lugs, adjust or replace bearings, straighten axle, and lubricate.
   c. Examine shafts. Straighten, adjust, and repair.

4. Miscellaneous.
   a. Inspect all safety shields. Repair and tighten in position.
   b. Inspect levers, lift controls, and springs. Straighten, repair, adjust, mesh gears properly, and replace broken or weak springs.
   c. Inspect clutch. Repair safety release and adjust.
   d. Inspect power drive. Check aligning adjustment, repair joints, repair main drive gears and enclosure. Lubricate.

Reconditioning Beet Pullers. Some machines just lift the beets, which are later topped by hand; other machines lift, top, and even load the beets. It is necessary to consider these machines separately. The common repair-job list when reconditioning a beet lifter includes the following:

1. Lifting unit.
   a. Inspect puller points. Sharpen; adjust to proper width and angle, as well as for correct penetration.
   b. Inspect levers. Straighten and note that digger arms are both held to same position.
   c. Inspect colters. Sharpen; adjust to proper width and to correct forward or back tilt. Adjust wheel bearings and lubricate.

2. Frame and wheels.
   a. Examine all parts. Straighten bent parts, replace or repair broken parts, and tighten bolts.
   c. Inspect hitch. Repair and replace damaged parts.

Machines that lift the beets and also top them are usually referred to as “harvesters” or “beet combines.” Some of the major jobs on these machines, whether they top the beets before or after lifting, include the following:

1. Lifting unit (see also Beet Lifter).
   a. Inspect jointers. Set these after sharpening in proper relation to the colter.
   b. Inspect elevating conveyor. Adjust conveyor so as to grasp the beets accurately.
2. Topping unit.  
   a. Inspect knives. Sharpen and adjust for desired gage in topping of lifted beets. If topping is done before lifting, adjust mechanism to handle crowns of varying height.

3. Elevating units.  
   a. Inspect beet-top elevator and hopper. Adjust elevator to correct tension and repair hopper.
   b. Inspect beet elevator. Adjust elevator tension. Repair and adjust hopper and dumping device.

4. Miscellaneous.  
   a. Inspect frame. Tighten bolts. Repair as necessary.
   b. Inspect wheels. Repair or replace broken parts. Clean bearings, adjust, and lubricate.
   c. Inspect, repair, and adjust hitch and power take-off.
   d. Inspect sprockets and chains. Aline, adjust tension, and repair.

Reconditioning Peanut Diggers. All peanut diggers dig and surface the peanuts by means of two long sweeps per peanut row. Reconditioning these sweeps or cutters consists of seeing that the tool bars, knives, and supports are in proper position and the knives sharp. The type that kicks and shakes out the soil and windrows, two rows into one, is operated by the tractor power take-off. Jobs to be done are to (1) inspect the transmission, oil seals, and chain drives, (2) check the tedder-arm bearings, and (3) inspect the caster-wheel bearings and levers.

The other type of digger has the peanut vines delivered onto an apron conveyor for cleaning. Inspect the drive mechanism and the conveyor members.

Reconditioning Bulb Diggers. These are built locally; it is advisable to check all moving parts for wear, adjustment, and ease of operation.

6. Reconditioning Special Crop-harvesting Machines

Reconditioning Sugar-cane Harvesters. These machines, similar to bulb harvesters, are built locally. It is advisable to use the manufacturer's manual and systematically go over the machine. Some jobs are to (1) inspect all main frame construction and bracing, (2) inspect each individual power transmission, oil seal, sprocket, chain, shaft, belt, and bearing, (3) check condition of protecting...
shields, (4) inspect the steering mechanism, (5) check condition of cutting disks, and (6) inspect conveyor system in detail.

**Reconditioning Sugar-cane Loaders.** These are so varied in design and manufacture that it would be difficult to explain their reconditioning. However, they employ many of the principles explained for other machines that have been discussed.

**Reconditioning Green-crop Harvesters.** In the main, these are adaptations of other common machines already discussed.

**Reconditioning Grain-sorghum Harvesters.** (See also other machines used, such as Combine Harvesters and Headers.) Suggested reconditioning jobs include (1) sharpening knife or knives, (2) adjusting cutting block to knife-edge of bundle header, (3) repairing or replacing cutting blocks of frame, and (4) tightening wagon-box hooks holding cutter.

**Reconditioning Clover Hullers.** (See jobs listed for Grain Thresher.)

**Reconditioning Bean Hullers.** Thoroughly clean the bean huller before inspecting and reconditioning. This is particularly necessary because considerable soil and sand are usually put through this machine when in operation. Some specific reconditioning jobs in connection with the bean huller that have not been previously mentioned include (1) inspecting second cylinder for needed repairs and replacements, and (2) inspecting and adjusting or replacing wooden bearings.

**Bean and Pea Cutters.** Some of the more common jobs to maintain this machine in condition include (1) sharpening the knives, (2) adjusting knives to row ridges or furrows, (3) tightening bolts, nuts, and other fasteners, and (4) lubricating.

7. **Storing Harvest and Harvest-handling Machines**

The design and construction of these machines, composed of many moving parts, precision bearings, and finely polished surfaces, are indicative of the necessity for preparing such machines for storage, for providing adequate protection, and for again preparing them for the next season's work. Owners that develop and follow a good program on harvest-machine storage will reap the benefits in longer life, better service, and increased crop returns each year. Stating it conservatively, one can say that the time and effort spent in protecting
Rubber tires should be relieved of weight during the idle season. Here wooden horses support the mower, and a wooden shield protects the guard points. Note the peg-tooth harrow stored on the wall.

An example of bad farm management. Much reconditioning will be needed to get satisfactory service from this mower.
and storing a machine will be returned many times over by each machine.

**Storing and Protecting Harvest-cutting Mechanisms.** The mower, binder, reaper, combine harvester-thresher, corn binder, field-hay chopper, hemp cutter, ensilage harvester, and green-crop harvester have reciprocating cutting mechanism. All but the corn machines have a sickle with several knives or sections; these, in conjunction with ledger plates, form the cutting mechanism. The action
is knife- or scissor-like and one should appreciate the necessity of keeping knives and scissors inside and dry. Therefore, remove sickles from the machine. Clean them thoroughly and cover with a rust preventive. Next, fit the points with a slit board to prevent injuring humans or animals, and then store in a safe place. With the sickle removed, clean and coat the ledger plates, sickle clips, and other bright surfaces with good anti-rust material.

Remove knives from ensilage cutters, ensilage harvesters, husker-shredders, hay choppers, sugar-cane harvesters, and beet pullers. Clean and coat them with anti-rust material; store on shelves or in a cabinet drawer.

Protecting and Storing Binding Mechanism. The binding mechanism, including packer arms, needle, bundle trip, and knotter head complete, has a precision job to perform. These parts cannot be removed from the machine conveniently. However, they can be protected so that they do not support any foreign weight. Apply a good coat of grease or anti-rust compound to all knotter parts as well as to needle and twine guides. Then, with the canvas and sickle removed, place complete machine under cover, adequately shielded from rain and show. It is understood that the twine be removed from the twine cases of grain binders, corn binders, and pick-
up balers. Cover the plunger and other polished surfaces of hay balers with anti-rust compound.

**Protecting and Storing Conveyors and Belting.** Remove all canvas conveyors from binders, reapers, combine harvester-threshers, hay choppers, and green-crop harvesters. Canvases shrink when wet and mildew easily. They deteriorate rapidly when exposed to the weather and are an invitation to mice and other rodents. After removing the canvases, and while dry and clean, roll them into compact rolls and pull the straps lightly around them. Next, hang them in a dry place, suspending them from rafters with wire. This takes them out of range of the rodents. Remove canvas, rubber, leather, and combination belts from the machine. Roll them up; label and store on a shelf or in a cabinet, or sack and suspend with wire as for canvases.

**Protecting and Storing Husking and Picking Members.** Corn pickers have snapping and husking rolls, husker-shredders have similar members, cotton strippers have rollers, and cotton pickers have hundreds of spindles. Clean these machines, removing any crop substances from them, then coat all polished metal surfaces with anti-
rust. If this is not done, these parts will rust and corrode, and an unsatisfactory performance will result.

The same can be said of cylinders, concaves, shakers, sieves, and all other metal parts of threshers, combine harvesters, and clover and bean hullers. Protect the surfaces—both wood and metal—and then store inside. Close the surface openings to these machines so that rodents, chickens, and birds do not move in.

Protecting and Storing Machines of Wood Construction.

There is some wood in most farm machines. However, it predominates in many hay tools, such as sweeps, stackers, and loaders. These machines are awkward or oddly shaped. The sweeps are wide, the loaders high, and the stackers both wide and high. It is desirable to store these machines inside, out of the rain and snow.

Keep all the wood members free from undue and unnecessary strains and stress. Weights or distorted positions are apt to warp and weaken the members.

The wood members are to be well protected with paint or other wood preservative: Coat all unpainted metal parts with grease or anti-rust compound and store inside.
Protecting and Storing Ground-working Members. This was discussed in Chap. 3. Here it applies to the shovel or plow of potato diggers, bulb diggers, beet-lifter points and arms, and peanut knives. These parts require a polished surface to function properly. Remove these parts from the soil at the end of each work day and coat with oil. At the close of the season, clean and apply a good coat of anti-rust and store in a dry place.

Preparing Machines for Next Season’s Operation. It is equally as important that a machine be conditioned for a new season’s work as it is to have a new machine ready for its work. It is assumed that sometime, during the idle period of the year, the machine was thoroughly inspected and reconditioned so that it should be ready to enter the field.

Reassemble all parts that were removed either for storage or for reconditioning. Remove protective grease and anti-rust coatings. Replace belts and canvases and adjust tension on them, as well as on other power-transmission units.

Use pressure-lubrication guns to replace all grease in the bearings. Remove old grease and relubricate. Remove coverings placed over threshers, husker-shredders, and similar machines.

Next, make a thorough search of all parts of the machine to remove
any foreign objects. With that done, apply power to the machine slowly. If all parts are functioning satisfactorily, increase the speed to normal operational speed. After running the machine idle, recheck on adjustments and lubricate. It should be ready for service.

SUMMARY

1. Several of the harvest and harvest-handling machines have many working parts and coordinating members; therefore, they are rather complicated mechanisms requiring the skill of a mechanic for reconditioning.

2. Adjust the mower sickle for the proper “lead” and “register,” according to the manufacturer’s instructions, because the procedure varies with the make of the machine.

3. The annual reconditioning job includes a complete inspection of all parts of a machine and then restoring each part to serviceable condition; one part out of adjustment or in need of repair may adversely affect a new or reconditioned part of the same machine.

4. Machines that have shearing or cutting parts and other coordinating parts working close together particularly need to have bearings snugly fitted and end play eliminated as a part of their reconditioning job.

5. The reconditioning should not be a rush job, because the success and profitableness of the year’s harvest may be dependent upon the thoroughness and exactness of a complete reconditioning job.

6. Adjust sprocket chains with a little slack. Too much tension may result in excessive wear.

7. Cleanliness in all phases of reconditioning is one essential sign of a skilled mechanic.

8. The checking and tightening of all locking devices such as nuts, setscrews, lug bolts, and cotter keys are a part of any reconditioning job.

9. When completing any reconditioning job, make sure that all safety devices, such as shields, are securely in position.

10. Coat polished parts, as a knotter, with grease or a rust preventive at the end of the work season and immediately place in dry and protective storage.

11. When storing machines, cover guard points and exposed cutting parts as a protection to workers and livestock.

12. Store the canvas conveyors, after thoroughly cleaning, drying, and reconditioning them, in a dry, protected place away from rodents, birds, poultry, and livestock. Some operators roll canvases in bundles and suspend them by wires from rafters.
PART V
MECHANICAL POWER AND TRANSPORTATION MACHINES
13. Selecting Mechanical Power and Transportation Machines

POWER is and has long been the motivating factor in agriculture's progress. Just as in industry and transportation, the tempo, or the production increase, is in direct relationship to the type and quality of power used. In many cases, power transfers the drudgery of manual labor from the back of man to the metal sinews of machines.

Fig. 509. Tractor power has set the pace for agriculture.

America's agricultural progress has advanced with farm power. Early power was limited to man and his crude machines—the crooked stick, the hoe, and the sickle. Next came the oxen pulling the plow and cart. This advance was followed by horses hitched to the steel plow and reaper. The reaper was the first instance of combining two or more farm operations into one machine. The multiple hitch with horses was responsible for increasing the size of machines and the extent to which operations could be combined in one machine.

Following multiple hitchs for horses, there appeared the large, cumbersome tractor, 20 to 45 hp., for plowing and harvesting. The
crawler-type tractor facilitated field drawbar operations on large fields, hillslides, and soft soil. Within the past two decades, the all-purpose tractor has made it possible for row-crop farmers to have the benefit of flexible tractor power for practically all field jobs.

So it is that power has been the stimulating force in agricultural progress. Electrical power now looms on the horizon. It is replacing men and gas engines on many chore jobs, and is providing some field power. Atomic energy, also, must not be overlooked as a potentially useful power source.

Through the changes of power from man to the all-purpose tractor and electricity, machines have performed the same functions. The soil is still plowed; the crops are planted, cultivated, harvested, and processed. Only the kind of power has changed, enabling the farmer to be more of a director of power than a hand laborer. Power and transportation have played and are playing such a vital part in agricultural development that we must exercise great care in selecting our source of power. Farm power must be such that it will allow the farmer to advance with agricultural progress instead of limiting him to past practices.

Concurrent with the advance of power has been the advance of transportation. While the farmer used to walk, carrying a sack on his back, he now takes the load in his speedy pickup truck. Days have changed to minutes and bushels to fields. Selecting mechanical power and transportation machines will be discussed under the following activity headings:

1. Selecting Tractors
   Selecting the Type of Tractor
   Standard four-wheel
   General-purpose
   Track-laying
   Garden Tractor
   Selecting the Size of Tractor
   Making a Selection Based on Construction Features
   Making a Selection Based on Operating Equipment to be Used
   Checking Performance Records and Service Facilities
   Making a Selection Based on Convenience

2. Selecting Stationary Power Units
   Selecting Stationary Gasoline Engines
   Selecting Electric Motors
   Selecting Windmills
3. Selecting Transportation Units
   Selecting Motor Trucks
   Selecting Combination Power and Transportation Units
   Selecting Trailers
   Selecting Wagons
   Selecting Sleds

1. Selecting Tractors

The tractor is the usual present-day source of farm power. It has replaced horses and mules on many American farms. The tractor, in the true sense of the word, is not a farm machine, but a source of power to operate farm machines. However, tractors are generally considered farm machines and will be treated as such in this book.

Tractors have progressed so much in the past 40 years that it is difficult to compare present-day models with their early predecessors. The first tractors were large, cumbersome pulling units, used primarily in the Great Plains area. They proved practical, and later on smaller models were introduced. Belt pulleys were placed on tractors to enable them to serve a dual purpose. Still later, when larger machines, including binders, were pulled by tractors, the power take-off was developed to provide positive power to the pulled machine.

Mechanizing row-crop production by means of the general-purpose
tractor has resulted in mounting many farm machines directly on the tractor, thus giving the farmer one-man units. Farming conditions and requirements vary considerably across the country, which necessitates power units adapted to specific needs. As a result, there are many types and kinds of tractors from which to make a selection. It is advisable and economical to study individual farm requirements before selecting a tractor. Thus, the tractor is fitted to the farm, rather than the farm being fitted to the tractor.

Selecting the Type of Tractor. The standard four-wheel type of tractor is well adapted to heavy belt and drawbar requirements on lands that can be negotiated readily with wheel tractors. These
tractors are good, custom belt-work units. They fit into the wheat-growing areas of the Great Plains states. Smaller models, fitted with orchard shielding, prove satisfactory in sections of Florida, California, Indiana, Michigan, and other orchard areas. These tractors range in size from 60-engine hp. (six-cylinder gasoline and four-cylinder Diesel) to 20-engine hp. units. They are flexible, comparatively fast in the field or on the highway, and readily aligned for belt operation.

The orchard tractor is similar to the standard four-wheel tractor except that it is lower, in order to operate closer to the trees and vines.

Special shielding directs branches and fruit over and around the sharp edges of the tractor to avoid injury to the trees. Tires are often of large diameter, as many orchard soils are light and loose.

The general-purpose tractor was designed originally for row crops and hay harvesting. Corn, cotton, and vegetable crops are planted, cultivated, and harvested with general-purpose tractors. There are more farm machines designed for use with general-purpose tractors than for use with either of the other types. These are provided to give one-man units for many, if not all, of the row-crop jobs. Select general-purpose tractors where row crops and hay predominate. They are available in several sizes with modifications to meet row-crop farming requirements.
The crawler, or track-laying tractor, is adapted to extremely hilly country; swampy, sandy, and other loose-type soils; large irrigated fields; and some orchards and vineyards. The long tracks distribute the tractor weight over a large number of flat track shoes, thus providing good traction and comparatively small pressure on the soil. The low center of gravity adapts this tractor to hill and mountainside terrain. This type is used almost exclusively in the Palouse hill country of the Northwest, and on other steep slope lands. Irrigated lands of the semi-arid West are often of the loose-soil type that must be leveled before being irrigated. Irrigation ditches must be made, maintained, and crossed. Track-laying tractors do these jobs very well. Operators in the swampy and peat-type Florida soils and in the Indiana and Michigan mint areas, and also orchardists, find that this type has advantages. The smaller models pass easily under low-hanging orchard trees. Farmers planning much soil-moving work, including grading yards and lots, building ponds, and doing major soil-conservation work, will do well to consider the crawler-type tractor. Small crawler tractors are sometimes equipped with special shielding for orchard use (see Fig. 511B).
The garden tractor, generally powered with a single-cylinder engine, and mounted on two wheels, speeds up truck-garden jobs. It can be equipped to do a variety of work. Select a garden tractor for small acreages, closely spaced truck crops, and mowing jobs around fences, trees, and various obstructions.

![Fig. 514. Motorizing garden work stimulates home food production. (A) A garden plow suitable for small and irregularly shaped tracts. (B) Most garden tractors can be fitted with many kinds of cultivating tools.]

Selecting the Size of Tractor. The size of the tractor is an important factor in successful motorized farming. Some points to consider in selecting the size include acreage of major crop or crops, type of soil, size and shape of fields, and size of available operating equipment. Select a tractor that will assure doing the necessary work...
in satisfactory time. If the tractor is too small and requires too many trips or "rounds" to complete the work within a reasonable time, the owner may be jeopardizing his year's income.

Select a tractor appropriate to the type of soil. A tractor that is too heavy may dig in and otherwise tear up the field or crop. By the same token, do not select a tractor too small to handle the machines to be used with it. The shape and size of the fields determine, to some extent, the size of tractor to use. Small, irregular fields require a small flexible tractor—one with tools or machines mounted directly on the tractor so the unit can turn short and back into fence rows.

Fig. 515. A small tractor with rear-mounted engine for small irregular fields and close places.

In order to do the job properly, select a tractor that matches the equipment. If farm operations call for employing a three-bottom plow, then select a tractor that will pull a three-bottom plow in all fields and still have some reserve power. The practice of buying a tractor slightly smaller than seems desirable is far too common. In such cases the tractor is overloaded, the implements used may not do good work, and the tractor wears excessively. It is better to be overpowered than underpowered. There is a tendency to combine farm operations; plow and till, or till and plant. It appears that this practice will continue to expand as efforts are made to reduce operating time in farming. This is another justifiable reason for selecting a tractor a little larger than the immediate needs seem to indicate.
Making a Selection Based on Construction Features. The tractor should be understood by the owner and operator. All tractors are alike in certain basic respects; each has a power plant or engine, a power train, a chassis or frame, and a means of moving. Every good operator knows how and why the tractor functions so that he can take proper care of it. Skilled operation and proper maintenance will assure maximum work from the tractor and its operating equipment at a minimum cost.

To enable the operator to understand the tractor and the prospective purchaser to note the desirable qualities of construction in a tractor, a brief description is given here. A tractor must be adaptable in its operation. It is called upon to work in heat and cold, dust and rain, firm and loose footing, on the level or on hills, for short or long periods of maximum effort, at fast or slow speeds. It is required to deliver power on the drawbar, belt, and power take-off.

Three aspects of the tractor will be discussed: (1) the power unit, (2) the power train, and (3) the chassis. These groups are interdependent, one with the others, just as the tractor depends upon the operating equipment to accomplish the desired results.

The Power Unit (Spark Ignition). The cylinder block is the unit that supports and provides a tight enclosure for the internal working parts of the engine, and that anchors the engine to the tractor frame. The crankcase below provides a reservoir for the supply of lubricating oil.

The pistons operate in cylinders bored in the cylinder block. Many engines have replaceable sleeves inside the cylinder spaces.
are known as "dry-line cylinder sleeves." In others, replaceable cylinders fit into the engine block and are in direct contact with the cooling water. They are known as "wet-line cylinder sleeves." Sleeve-type cylinders are preferred. When the cylinder becomes worn or scored, the condition can be corrected by replacing the cylinder sleeve instead of oversizing all the cylinders by reboring, or installing a new cylinder block.

There are several rings on each piston. Generally, rings above the piston pin seal the combustion chamber and those below the piston pin, the "oil rings," control the amount of oil left on the cylinder walls. Oil rings leave a thin layer of oil on the cylinder wall which is picked up by the compression rings. Piston rings also assist in the transfer of heat from the piston to the cylinder walls. The rings are split in order to slip them over the piston heads. More than one ring is used so that the joints may be staggered and a gastight seal thus secured.

Through the connecting rod, the crankshaft converts the straight-line motion of the piston into the circular motion of the flywheel. From here it is transferred through the clutch to the power train. The crankshaft is supported by bearings. Some engines have crankshaft bearings between each cylinder; others have bearings between each pair of cylinders.

Select an engine having bearing journal surfaces as near "filehard" as possible to resist the wear of rotation. An electric hardening treatment, employed by some manufacturers, and taking only a few seconds at an extremely intense heat, gives the bearing journals the desired depth of hardness without otherwise changing or distorting
the crankshaft. Rotating members must be supported, guided, and given freedom of motion with the least amount of frictional wear. Crankshaft bearings support the crankshaft-bearing journals and provide that support and guide. They are aided in freedom of motion by a lubricant.

The essential properties of a good bearing are that it (1) have mechanical strength to support the rotating parts, (2) be composed of material that does not break into segments or separate from the backing material, (3) will not melt at normal operating temperatures, (4) have anti-friction characteristics, (5) be sufficiently pliable to conform to the journal shapes, (6) absorb any abrasive particles that may come into the running clearance, and (7) resist corrosion.

The bearings for most engines are made of a babbitt, because of its wearing qualities, and are steel backed for support. The bearings are precision made and can be replaced when worn. Working parts must be held to close tolerances to provide efficient and quiet operation and yet allow freedom of motion. Almost all failures in bearings can be attributed to factors that cause overheating. Among these factors are friction due to dirt or grit in the running clearance, insufficient or excessive clearance, out-of-round, scored, or worn journals, and insufficient oil.

Three types of fuel are used in spark-ignition tractor engines: high-compression or high-octane (not aviation) gasoline, regular gasoline, and distillate or tractor fuel. The compression ratios of the engine, cooling systems, and sometimes lubrication are designed for the fuel used. The engine mixture is formed by properly combining air and fuel. The fuel is delivered from the fuel tank to the carburetor by either gravity or an engine-operated fuel pump through the fuel strainer and sediment bowl. Clean air from the air cleaner is
drawn through the carburetor where it mixes with the fuel and then enters the combustion chamber through the intake manifold. Select a tractor with the desired fuel and air-cleaning devices readily accessible and easily serviced. The air cleaner provides clean, filtered air to the engine air intake at the carburetor. The air enters at the top of the air cleaner through the intake cap which is fitted with a heavy screen to prevent entry of large particles of dirt, leaves, and other foreign material. From this screen, the air passes down through an oil bath that removes the fine foreign particles (see Figs. 519(A) & 569).

A governor controls the amount of fuel and air mixture down into the engine by regulating the opening and closing of the butterfly valve in the carburetor. After combustion, the exhaust gases pass out through the exhaust valves and manifold.

Engines using high-compression and regular gasoline have one fuel tank, and operate on the same fuel as that used for starting.
This is similar procedure to that of the automobile. The high-compression and regular gasoline engines have different compression ratios; each will, therefore, operate most effectively with its specified fuels. The distillate or tractor-fuel engine is started on gasoline and, after being warmed sufficiently to vaporize distillate (which has a higher vaporizing temperature), the engine is switched to distillate. This is not so convenient as the one-fuel tractor. Two fuel tanks have to be filled, and the fuel-line valve shifted, each time the engine is started and again before it stops.

Some engines are called “two-fuel engines,” or “gasoline-distillate engines.” Their ability to use two fuels is accomplished by adjusting the heat surrounding the carburetor and intake manifold (Fig. 521). Heat is increased to vaporize low-grade fuels and to start cold engines. In order to maintain proper engine temperature, it is advisable also to adjust the cooling-system thermostat for the fuel used.

The ignition system provides the electric spark to the proper cylinder at the correct time. It comprises a high-tension type of magneto that generates the high-voltage current, an ignition switch and cable, and one spark plug and cable for each cylinder. The high-tension type of magneto is generally mounted on the camshaft side of the engine and driven by the camshaft gear at one-half engine speed. An impulse coupling, which retards the spark for starting, is located in the front of the magneto to facilitate engine starting. Select a
magneto with an automatic impulse coupling for convenience and as a safety feature.

In the cooling system, a centrifugal pump circulates the cooling medium, generally water, in a closed system through the engine block, cylinder head, and radiator. A thermostat aids in the control of temperature. When the engine is cold, the water circulates within a closed cycle starting from the water pump, then through the engine-cooling jacket, cylinder head, and thermostat assembly. At the

![Image](image.png)

**Fig. 521.** Manifold shield (superimposed outline sketch) for using tractor fuel. The damper in the exhaust, controlled by a dash lever, directs heat around the carburetor and intake manifold when burning heavier fuels in two-fuel engines.

thermostat, the water is then by-passed back into the water pump. Any water escaping past the thermostat assembly into the top of the radiator is made up from the supply at bottom of radiator. This circulation during the engine warm-up period prevents formation of steam pockets. The thermostat opens when the water reaches a predetermined temperature. The temperature of the water controls the amount of opening in the thermostat which, in turn, controls the amount of water recirculated through the pump and also the amount added from the radiator. Select an engine with a thermostat control to ensure operation at a temperature conducive to full fuel vaporization, adequate lubrication, and rapid warming up of the engine. Some small engines used to operate garden tractors are air cooled.
Fig. 522. Essential parts of the cooling system. (A) Large-capacity radiator. (B) Powerful well-packed water pump. (C) Sensitive thermostats for controlling the engine temperature. (D) A radiator curtain shutter to control cooling air of a large-capacity radiator fan.
Proper lubrication is essential to the successful, economic operation and expected life of the tractor. Select a tractor with a positive engine and tractor-lubrication system. The three most common lubrication systems employed in tractor engines are (1) circulating splash, (2) pressure circulation, and (3) full-pressure lubrication. The circulating-splash system depends on cups or splashers on the lower end of the connecting-rod bearings which splash oil from troughs onto the cylinder walls, piston, connecting rods, gears, shafts, and bearing housings. This is, in reality, an oil mist that covers all surfaces. Oil enters the wrist-pin bearings as it is wiped off the cylinder walls by an oil ring. The main and connecting-rod bearings are lubricated by a pump and drilled passages in the crankshaft.

The principal parts of an internal-combustion engine requiring lubrication are pistons, piston rings and cylinder walls, main bearings, connecting-rod bearings and piston pins, valve mechanisms, camshaft and timing gears, valve stems and guides, and the governor. The oil is supplied to these parts from the crankcase oil reservoir.

In the pressure-lubrication system, the lubricating oil is directed under pressure, through rifled passages in the crankcase, to the
main bearings, camshaft bearings, timing gears, governor, valve mechanism, and the oil filter. The cylinder walls and wrist pins are lubricated in a manner similar to the circulating-splash system. In full-pressure lubrication, drilled passages in the crankcase deliver oil to all members including timing gears and rocker-arm shafts. The wrist pins and cylinders are lubricated through drilled connecting rods receiving oil from the crankshaft bearings.

The Power Unit (Diesel). Diesel engines operate without electric-spark ignition. The fuel is compressed to the ignition point in the combustion chamber. The engine does not have a carburetor or magneto. Instead, it has a Diesel fuel pump that meters out a definite quantity of fuel for each cylinder for each power stroke according to load. This fuel is delivered to the combustion chamber, under pressure through an injection nozzle at a predetermined time, to expand, heat, and ignite for the power stroke. The engine-valve mechanism is the same as the spark-ignition engine, except that the intake valve takes in only air. The fuel is injected in the compressed air near the end of the compression stroke in an atomized form. The speed of the engine is controlled by a governor built integrally with the injection pump. It controls the quantity of fuel delivered to the injection nozzles, one for each cylinder.

This feature of the Diesel offers a desirable advantage over spark-ignition engines for heavy loads. Under such conditions, the spark-ignition engine may reduce speed. In so doing, it reduces the fuel mixture drawn in, and a weakened power stroke results—both combining to slow down and eventually stop or “stall” the engine.
The Diesel, on the other hand, receives the same volume of fuel, in fact an increased volume, under governor control during heavy loads. By this means the Diesel resists “stalling” and has what is referred to as “lugging ability.”

Diesel engines require a special starting system due to their high compression and absence of an electric ignition system. Inasmuch as they operate on the heat of combustion, it is obvious that some method, aside from the engine proper, is required to create the initial heat. Four methods are employed:

1. The engine can be started with compressed air from an outside source. The compressed air is used to get the engine in motion so the Diesel cycle functions.
2. A small, independent, gasoline-starting engine is employed to crank or turn the Diesel engine.
3. A heavy torque-electric motor or electric starter with heavy-duty batteries is used to turn the Diesel engine.
4. A combination gasoline and Diesel engine is used. In this method, one lever changes the engine from spark to compression ignition. A special valve connecting the Diesel combustion chamber is opened to a larger, low-compression chamber, which contains a spark plug connected to magneto ignition. The same lever makes the Diesel injection pump inoperative and connects gasoline through a carburetor and manifold to the intake valve. This engine is started as a gasoline engine. After the engine is warmed up and has sufficient momentum to compress the air for Diesel ignition, it is switched to Diesel operation. Moving the one lever disconnects the auxiliary combustion chamber with its spark plug, disconnects the carburetor and manifold from the intake valve, and operates the Diesel injection pump.

There are semi-Diesel engines using spark-plug ignition. Some Diesel engines operate on the two-stroke cycle principle, in which every upstroke is exhaust and compression, and every downstroke is
FIG. 527. A Diesel engine that is converted from Diesel to gasoline operation for starting and then back to Diesel all with one lever. The lever (1), operating through linkage (2), opens valve (3) (one for each cylinder) to auxiliary combustion chamber (4), thus reducing the compression to that of a gasoline engine of equal size. A spark plug (5) (used in starting only), connected to the magneto, is located in the auxiliary combustion chamber. The lever also closes the butterfly valve (6), shunting the air as indicated by arrows (9) through the starting carburetor (8) and into the combustion chamber. After the engine is warmed up, the lever is released, changing the engine to Diesel operation.

FIG. 528. A four-cylinder spark-ignition engine of the type common to most tractors.
power. Air and fuel are both injected at the end of the compression stroke.

Type of Engine. Some tractors are available with two or more types of engines. These types are based on the fuel for which the engine is designed. Points to consider in selecting the engine are (1) frequency of starting the engine, (2) fuel economy, (3) flexibility of power, and (4) size of engine.

As to frequency of starting, since the same procedure is followed each time, select a high-compression fuel engine if it is to be used for short periods only. Where the tractor operates continuously for a half day at a time, which is common in farm work, this factor needs little if any consideration.

Fuel economy is given as one of the principal reasons for using distillate, tractor fuel, and Diesel fuel. Gasoline, and especially high-compression gasoline, costs more per gallon than the other fuels. Gasoline is subject to state tax in many states, which adds to its cost. The primary difference in design between the high-compression gasoline engine and the gasoline-distillate engine is in the compression ratio. This is the ratio of the volume within the cylinder when the piston is at the bottom of the stroke to the volume when the piston is at the top of the stroke. For the high-compression engine this ratio is 5.90:1, and for the gasoline-distillate engine it is 4.75:1. From a
fuel-economy standpoint, select a distillate or Diesel fuel-burning engine.

**Fig. 530.** The power train from the engine crankshaft through the clutch (1), transmission (2), and final drive (3), to the wheels (4).

**Fig. 531A.** Operation of the plate-type clutch. *(Left)* Clutch engaged. *(Right)* Disengaged.

*Flexibility of power or responsiveness* is an important consideration. It is often desirable to change the speed of the engine quickly, sometimes for short periods and again for longer periods. The high-
The compression engine is the most responsive; next comes the distillate, and then the Diesel engine.

As to size, in general, select high-compression and regular gasoline engines for small and high-speed operations; distillate and tractor-fuel engines for medium-sized, less rapid operations; and Diesels for the slower and heavier jobs.

The Power Train. This includes the clutch, transmission, differential, final drive, frame, axle shafts, and brakes. The power train of the general-purpose tractor will be discussed first.

The clutch connects the engine to the power train. The internal-combustion engine must have momentum, that is, be running, in order to pick up the desired load without stalling or jerking.

The friction-type clutch enables the internal-combustion engine to exert power and gradually pick up the load while running. Its
Fig. 532. Arrangement of transmission gears for different speeds. Arrows show direction of rotation. (Top) Low speed. (Center) Medium speed. (Bottom) Use of idler B for reverse.
driving and driven parts operate as two flat surfaces that are gradually forced together, under spring or cam pressure, until the rotary motion of the driving member has been fully imparted to the driven member and the two parts continue to turn and function as one. The clutch is then said to be fully engaged.

Disengagement of the clutch results when the operator, by means of clutch pedal or hand lever, forces the throw-out bearing against the release levers, thus compressing the pressure springs and withdrawing the pressure plate from its contact with the driven disk (Fig. 531A, right). The driven disk, no longer pressed against the flywheel, ceases to turn, as does the clutch shaft to which it is splined.

The transmission back of the clutch is a device that enables the tractor to operate at different speeds. This is possible through an arrangement of gears. The arrangement of the gears can be changed.
through the gearshift lever so the speed of the engine can be reduced through several ratios to the rear wheels or tracks. This gives approximate speeds of 2 to 5.4 m.p.h. for four-speed, steel-wheeled tractors and up to 20 m.p.h. for rubber-tired tractors. The power of the rotating drive shaft is transmitted to the rear wheels of the tractor by direct drive through bevel gears at the rear of the tractor. This, however, gives only one forward speed and would limit the tractor's range of usefulness.

On the end of the drive shaft opposite the clutch is a gear, which meshes with a larger gear, that drives still another shaft—the tr-
to reverse the direction of rotation at the speed desired introduces a set of three meshing gears (Fig. 532). When selecting any tractor, be sure that the forward and reverse speeds will fully meet your needs.

From the transmission, the power passes through the differential, which is an arrangement of gears that enables one drive wheel to move faster than the other, as in turning corners, yet neither wheel slips and both pull while turning.

The final drive is composed of two independent shafts known as "axle shafts" in carriers mounted on each side of the rear frame. In many motor vehicles, the inner end of each axle shaft is connected to one of the differential bevel gears and the outer end to a drive wheel. In many tractors, the inner end of each axle shaft carries a bull gear, which contacts a bull pinion directly forward, splined to the differential from which driving power is obtained. In some tractors, roller chains transmit the power from the differential shafts to the axle shafts. The bull gear or chains reduce the speed and increase the pulling ability of the wheels.
The main frame in the row-crop or general-purpose tractor is of a skeleton nature, leaving ample opportunity for attaching the several machines. The frame in general consists of the engine support, the clutch and universal housing—a tubular member—and the rear section. The tubular member connects the engine support and the rear-section housing. The latter houses the transmission, differential, and final drive. It also provides the support for the axle housings, or carriers, and the drawbar.

At the front of the tractor, the engine support rests on a bolster. This is a single shaft on which are located one or two wheels close together. This bolster turns and is controlled through the steering wheel and gear mechanism. A wide, standard-tread axle is available for most of these models.

The rear-section housing, which contains the transmission, differential, and final drive gears, is cast steel. The universal and clutch housing is of cast iron and is secured to the transmission case with cap screws and dowel bolts. The engine-flywheel housing is bolted to the clutch housing. The front end of the engine is carried on two channel irons that bolt to the front bolster. The bolting together of all parts mentioned makes a rigid frame construction.

The axle shafts are located on each side of the tractor, are mounted in axle carriers, and are sealed against oil leakage and entrance of dirt or water. The shafts are fitted on the outer end to receive the
Row-crop tractors need to be adjustable to various row widths. This is accomplished by moving the wheels in and out of the axles and also turning the wheels around inasmuch as they are “dished” in one direction.

Brakes in the rear wheels, axles, or differential shafts enable the row-crop tractor to make short turns at the end of the field. The brakes consist of external bands that contract on steel drums, which are enclosed. The brakes are controlled by foot pedals, one for each wheel, so that they can be operated individually. They can and should be locked together for highway and lane travel so as to operate equally on each wheel.

The chassis consists of wheels, tires, and steering mechanism. Tractors using wheels require much less power to move if they are equipped with rubber instead of steel tires. It has been determined that a three-plow tractor requires 6.4 more horsepower to move it on steel wheels than on rubber
wheels. When operated under full load, the rubber-tired tractors save 10 to 25 percent of the fuel as compared to those using steel wheels. The use of liquid in rubber tires serves as a means of securing traction weight, although it is well to select a tractor on which cast-iron wheel weights may be attached. Wheels are available with rims for pneumatic tires and others for steel wheels and steel lugs. Select pneumatic tires for all road work, light-loam soils, and ordinary working conditions. Select steel wheels and lugs for heavy field-

Fig. 539. Steering clutches and steering brakes for guiding the track-type tractor. Note transmission gears ahead of steering clutches.

drawbar work. The steering gear is usually of the worm-and-sector or worm-and-nut type. Select a steering gear that is enclosed in a lubricant-tight case.

Construction Features of the Standard Four-wheel Tractor. In many ways, this tractor is similar in construction to the general-purpose tractor. It has a complete engine as does the other tractor, and complete power train, including clutch, transmission, differential, and final drive. The main frame consists of the engine support and the rear frame. The third member, housing the clutch and universal, of the general-purpose tractor is eliminated. The four-wheel tractor is also closer to the ground. The front axle is similar to that of a motor truck. It provides the same front wheel tread as the rear wheels and
has a steering wheel and steering mechanism similar to those of a motor truck. Power is available at the drawbar, on the belt, and through the power take-off.

**Construction Features of the Track-laying Tractor.** This one is similar in construction to the wheel tractors except for the main frame and final drive from the transmission back. The transmission resembles the wheel type except that it also incorporates a steering mechanism. The track-laying tractor has only two traction members, and these control steering by being individually slowed down, stopped and started, or driven independently. In one type, the drive to the two crawler tracks is by means of steering clutches, similar in operation to the engine clutch. There is one clutch for each side. No differential is required, although one make employs a spur-type differential. Each steering clutch, which is hand operated, is also
equipped with a foot-operated brake that functions on the driven part. For making a sharp turn, not only is one of the clutches released, but the brake is applied to the track on that side. The driving sprocket drives the track as it propels and guides the tractor.

Track-type tractors are constructed with a rugged, rectangular, structural-steel frame. This is necessary to provide stability for the track and track frames. Two structural-steel members connect the engine base and the rear frame. The rear frame houses the transmission and final drive. The final drive is made up of a bevel gear and two bevel pinions, one on each sprocket drive shaft. The steering clutches and steering brakes about midway on the sprocket shaft are in the rear housing.

Driving sprockets on each sprocket shaft drive the tracks, the track chains fitting in the sprocket gears. The track frames consist of the front idler to maintain parallel upper and lower tracks, the lower track rollers assuring uniform ground pressure, and, in larger tractors, upper track rollers to support the tracks. The track frames are constructed to assure that they will operate parallel and yet be free to oscillate and conform to the ground. These tractors are powered by four- and six-cylinder vertical engines using high-compression gasoline, combination gasoline-distillate, or Diesel fuel. Three-cylinder Diesel engines have been manufactured.

Making a Selection Based on Operating Equipment to be Used. Complete motorization of field operations has become impor-
tant and necessary in order to obtain reduced production costs. It is common practice to mechanize the operations for each crop in order that "stand-by" labor can be eliminated as far as possible. Otherwise, some operations may be noticeably out of step and may affect the others. It is unnecessary to purchase all needed equipment and attachments at the time the tractor is acquired.

Tractors are designed to reduce manual labor and also to improve crop production. Various mechanical controls are employed for raising and lowering implements in the soil in relation to the crop. Select a tractor that handles the kind of operating equipment desired and on which this equipment can be hitched, mounted, and dismounted, easily and quickly. Select a tractor with convenient controls for the operating equipment.

Checking Performance Records and Service Facilities. The tractor is the heart of a power-farming program. If the tractor stalls or fails, then the entire program is in danger. To avoid that, select a tractor that has (1) proved desirable performance and (2) satisfactory local servicing facilities. All mechanical devices wear, and there is some breakage. The tractor is a precision machine like the automobile and the motor truck. Precision machines require skilled operators and service. Satisfy yourself on these points, through observation and demonstration, before purchasing a tractor.
Making a Selection Based on Convenience. Present-day tractors, whether general-purpose, standard four-wheel, or track-laying, have available equipment to deliver power three ways: (1) by drawbar, (2) by belt, and (3) by power take-off. Some have mechanisms to raise or lower the mounted equipment. The drawbar application is obvious. However, select a tractor that has a convenient and safe drawbar that conforms to standards of the American Society of Agricultural Engineers.\textsuperscript{1} It will then accommodate any make of equipment also conforming to those standards. A forward or under-tractor drawbar on general-purpose tractors is desirable where beet, bean, and other vegetable crops are to be planted, cultivated, and harvested.

Belt power is provided by means of belt pulleys, bevel geared to the clutch or power take-off shaft. For best work, select a tractor with a

\textsuperscript{1}A.S.A.E. drawbar, power take-off, and belt-speed standards.
belt pulley operating parallel to the drive wheels or tracks, and at the standard A.S.A.E. speed (r.p.m.). Such a pulley can be aligned with the driven machine readily. It is simple to adjust the tension of the belt, and proper speed can be provided for the driven machine.

![belt pulley](image)

The power take-off provides positive power for the pulled equipment. It is a splined shaft, gear driven by, and extending from, the transmission through the rear of the tractor. The power take-off is a one-

1 A.S.A.E. Standards.
speed shaft, except for special applications. It operates at a uniform speed, regardless of the forward speed of the tractor. The size, splines, speed, and position of the tractor-power take-offs have been standardized also by the American Society of Agricultural Engineers' to permit the attachment of many machines of various makes to all tractors. Power take-off shafts have safety protective shields. Keep these in place. A convenience, which has become popular, is the tractor power lift. It eliminates manipulating hand levers and other adjusting devices for (1) carrying machines in transit, (2) lifting and lowering machines at ends of fields, and (3) adjusting the functional members while in operation. The power lifts are designed to control both equipment mounted on the tractor and trail-behind units.

There are four types of power lifts used on farm tractors: hydraulic, mechanical, pneumatic, and electric. Each is operated by power from the tractor engine.

The oil pump used in the hydraulic systems is usually driven from the power take-off shaft. This pump forces oil into the lifting cylinder, which contains a ram or piston. The piston is forced outward by oil pressure within the cylinder. The outward movement of the piston, by means of a linkage with lifting arms, gives the desired lifting action.

The mechanical lift is similar in construction to that used on trailed-tractor plows but, in this case, the lifting arms are driven through gear contact with the power take-off shaft.

The pneumatic lift is operated by exhaust gas from the engine, which operates a piston, or ram, within a gastight cylinder. In each of the

1 A.S.A.E. Standards.
The hydraulic cylinder is mounted on the trail behind machine and replaces adjusting levers.

**Fig. 546A.** Tractor with hydraulic control for mounted or pulled machines; the power is controlled through cylinder on the machine.

**Fig. 546B.** Control positions of the hydraulic pump and cylinder.

**Fig. 546C.** Trail-behind plow controlled through hydraulic pump and cylinder.
three types, the lifting force is stopped automatically when the raising action is completed. The lowering action is accomplished by releasing the pressure (oil or gas) within the cylinder; this also cushions the drop of the implements. Relief valves are provided to prevent excessive pressures within the cylinder which might occur under certain field conditions.

The electric lift consists of a generator, operated by the engine, to provide energy to small motors on the operated machines.

Select tractors that are easy for the operator to mount and readily
accessibility for service and adjustment. Without such convenience, periodic service may not be provided. Give driver-comfort and safety proper consideration in selecting the tractor.

2. Selecting Stationary Power Units

Stationary power units refer to power units that operate machines but do not move themselves. Some power units are mounted in such a manner that they can be moved from one place to another to operate equipment. Portable stationary power units operate water systems, milking machines, cream separators, feed grinders, hay hoists, sheep clippers, hay driers, and numerous other farm devices.

Selecting Stationary Gasoline Engines. These engines range in size from fractional-horsepower, single-cylinder units to 100-hp. or more, multi-cylinder engines. The single-cylinder engines are used for pumping water, operating washing machines, cream separators, milking machines, compressors, some irrigation pumps, and similar equipment. The engines ranging from 1 to 5 hp. are horizontal, with either open hopper or air cooling. Some have an open crankshaft and others a closed one. Select the enclosed crankshaft, especially if the engine is to be used out of doors in moisture and dust. The enclosed crankshaft is safer. A rapidly revolving, exposed crankshaft may strike objects and is a hazard to safety. The smaller engines are mounted on bases with handles. When the engine is to be moved frequently from one job to another, select one mounted on a four-wheel carriage.

The multi-cylinder engines are in reality tractor-type engines. They
are employed for operating sawmills, feed grinders, hammer mills, farm elevators, hay-curing units, irrigation pumps, cotton gins, ensilage cutters, and blowers. When such an engine is used for more than one purpose, it is mounted on a four-wheel undercarriage.

Selecting Electric Motors. These motors have certain advantages over other stationary power machines, operating in various positions and being compact, readily portable, and easy to start. Cold and hot weather have little effect on the readiness with which the electric motor starts. It is important, in purchasing a motor for a definite job, to select one suited to the machine to be operated. It is often possible to use a motor of less horsepower than would be necessary if just any motor were used that happened to be available. It is desirable to be familiar with the characteristics of different motors, and to know something about the machines to be operated, their load characteristics, and operating conditions. Some loads require motors with high starting torque as, for example, deep-well pumps lifting a large volume of water; others operating small equipment start with little more load than the motor itself.

Alternating-current (a-c) motors may be divided into two general groups—single-phase and polyphase. Inasmuch as most farm buildings are wired for and connected to single-phase power lines, this
discussion will be limited to single-phase motors. Single-phase motors are divided into four types depending on the methods employed for starting them in a predetermined direction. These types are split-phase, repulsion-induction, capacitor, and universal or series-wound. Each has a starting characteristic peculiar to itself that makes it particularly adaptable to a certain kind of load.

The split-phase motor has a low starting torque and is selected for machines that are easy to start and bring up to speed. All motors require larger current for starting than when operating under full-rated load. Split-phase motors require from five to seven times as much current for starting as operating under load. The speed range is 900, 1,200, and 1,800 r.p.m., and motors operate nearly constant within load limits.
This motor can be reversed by interchanging the leads to the starting winding. Select split-phase motors for operating washing machines, ironers, meat grinders, grindstones, small emery wheels, and small power tools that can be started with little effort. These motors are available in capacities up to $\frac{1}{2}$ hp.

The repulsion-induction motor is available in capacities ranging from $\frac{1}{4}$ to 15 hp. Such motors may not prove economical below 1 hp. The starting current is limited to two to four times the running speed.

They are manufactured in all the standard a-c speed ratings ranging from 600 to 3,600 r.p.m. Select repulsion-induction motors for devices demanding comparatively high starting torques—compressors, positive-acting plunger and gear pumps, milking machines, cream separators, furnace stokers, and other machines requiring frequent starts under load.

The capacitor motor will start, accelerate, and operate heavy loads. It is available in capacities up to 10 hp. The starting current does not exceed $3\frac{1}{2}$ to $4\frac{1}{2}$ times that required for running at full load. Such motors operate quietly and are comparatively free from interference with radio reception. The speed of capacitor motors is fairly constant, standard ratings being 900, 1,800, and 3,600 r.p.m.
Select capacitor motors for water pumps, refrigerators, oil burners, milk coolers, concrete mixers, and similar machines that are difficult to start. Advantages of these motors include the small number of wearing parts and the absence of radio interference. When selecting a capacitor motor, specify the running load and also whether or not the motor is expected to start under load.

The term *universal* is applied to a group of fractional horsepower motors that will operate on either direct or single-phase alternating current at the proper voltage. They have a high starting torque and current. They have no inherent speed regulations; as a result, they are nearly always built into and become an integral part of the device they operate and always operate under load. Select universal motors for vacuum cleaners, sewing machines, floor polishers, food mixers, and other household appliances.

**Selecting Windmills.** Windmills are employed for pumping water as well as for operating generators for light plants and radios. This discussion is confined to the activity of pumping water. These mills are either direct stroke or back geared. The direct-stroke type
makes one complete cylinder stroke which lifts water once for each revolution of the wheel, whereas the back-geared type requires more than a revolution of the wheel for a complete cylinder stroke. The back-geared type operates on light or moderate winds. The gear ratio of such mills varies, but usually it is two or more to one. The back-geared mill, with its long, slow strokes, can readily operate a larger cylinder than the direct-stroke mill, with its shorter, quicker strokes. Back-geared mills usually are easier on the pump and mill because they are slower and easier in action.

Where light winds prevail, it is best to use back-geared mills with a rather small pump cylinder as compared to the wheel size in order to ensure an adequate supply of pumped water. Higher towers are essential where the wind rate is low. Under such conditions, select the larger wheels. Towers should always be well above near-by trees, buildings, and other obstructions.

As a rule, a properly loaded mill will pump more water, and the wear on the mill and pump will be less, than if overloaded. A large cylinder alone does not mean a large capacity; select a correspondingly large mill for best results. Wind is not a constant source of motive power; it varies. Conclusions concerning its performance cannot be based upon the assumption of a fixed quantity to give a definite number of strokes per minute. Therefore, conclusions can be reached only after continued and careful observation at different times and under widely varying circumstances.

Models with gears running in oil and requiring only yearly changes of the oil are particularly advised for conditions where it is difficult to service the mill frequently. It is advisable to have a float control to turn the mill off and on as needed to keep the pumped water supply adequate. Coordinate the size of the float and the leverage with the size and power of the mill.
The standards of most mill towers are galvanized steel with band supports every 5 ft. and cross-brace rods every 10 ft. For ordinary mills, select the following standard supports: with 8-ft. wheels, 2- by 2- by \( \frac{3}{4} \)-in. standards; with 10-ft. wheels, 2\( \frac{1}{4} \)- by 2\( \frac{1}{4} \)- by \( \frac{3}{4} \)-in. standards; with 12-ft. wheels, 2\( \frac{1}{4} \)- by 2\( \frac{1}{4} \)- by \( \frac{3}{4} \)-in. standards, and with 14- and 16-ft. wheels, 2\( \frac{1}{2} \)- by 2\( \frac{1}{2} \)- by \( \frac{3}{4} \)-in. standards. The above is about the average for four-standard mills; three-standard mills require slightly heavier supports. The height of towers varies, but most of them are from 15 to 60 ft. Select towers with a wide base spread for the open range country where strong winds prevail.

3. Selecting Transportation Units

Included here are motor trucks, combination power and transportation units, trailers, wagons, and sleds.
Selecting Motor Trucks. A motor vehicle for field and market use is a valuable piece of equipment on any farm. Seed is hauled to the field during planting time, fertilizers hauled to the field during plowing or planting, and field crops taken from field to farmstead or market. Farm produce of a perishable nature is taken to market daily. And all this can be done without undue interference with the other daily operations.

Type and Body. The kind of farming being done is one of the main considerations in selecting an appropriate motor truck. Select a light pickup truck for daily deliveries of perishables. The pickup is also...
desirable for taking supplies to the field, as well as hurrying feed and repairs from town to the farm. Fortunately, there are sizes and types of trucks to meet nearly every one of the needs. Some serve a variety of needs well. The more common uses of trucks for which

![Figure 558. A combination power and transportation unit, used (A) as a motor truck, (B) as a tractor.](image)

there are specific types of beds include hauling livestock, milk, grain, vegetables, poultry, and forage. Many trucks have several types of beds to serve the needs that arise on the average general-purpose farm. Some four-wheel drive trucks are used for heavy pulling operations.
Size. Trucks are rated according to capacity, and most of them range from $\frac{1}{2}$ to 2 tons; some larger ones are available for special needs. The smaller size is more commonly found on the general-purpose farm, whereas the specialized and larger farm finds more use for trucks with larger capacity. When fully loaded, the cost per ton-mile is generally less with the larger trucks, although their operating cost per mile is greater. Motor-truck construction is similar to that of a tractor, including engine, clutch, transmission, and final drive. The motor truck carries its load, whereas the tractor pulls its load.

Selecting Combination Power and Transportation Units. Vehicles, tractors, and powered equipment operate through woods and undergrowth, across swamps, through jungles, and over mountains. Practically all self-powered units have power applied through all wheels and axles. Therefore, many unique units have been developed to meet these special demands. Some of these transportation units have certain drawbar applications about the farm. This is true where the unit serves in that capacity as an auxiliary unit when not required for transportation.

These combination units have many applications on the farm. Some of them are a speed-hauling unit from farm to market, hauling seed to drills and planters in the field, hurrying sick animals to the veterinarian, and, in some cases, serving as a vehicle for the family. However, such power units are not tractors, and should not be com-
pared directly with them. Using a transportation unit as a power unit should be practiced only after careful consideration of all factors involved. Combination units are generally considered auxiliary units.

**FIG. 560.** Four-wheel trailers operate behind cars, tractors, or convertible power units.

**FIG. 561.** A tilt-bed trailer is a handy farm unit for transporting machines. Select one with a loading windlass.

**Selecting Trailers.** Most of these have either one, two, or four wheels and may be used behind cars, trucks, tractors, or horse-drawn vehicles. The one-wheel trailer is generally used where loads are light, for example, for service work about the farm or for transporting minor items to or from the market behind an automobile.
The two-wheel trailer varies in size from a small service unit similar to the one-wheel trailer to those used to transport heavy machines or material. Two-wheel trailers require balanced loads to eliminate stress (Fig. 559). Some two-wheel trailers have a variety of beds to serve different needs such as hauling livestock, hauling grain, and attending to service needs for other machines. A two-wheel trailer with a low bed to move machinery and forage crops is growing in popularity; such a trailer should tip down and lock in that position for loading. Some have loading hoists, which is a desirable feature.

![Fig. 562. Tractor-trailer equipped with automatic wheel brakes.](image)

The four-wheel trailers are available in many sizes and types to meet almost any need for the grain, livestock, special-crop, and general-purpose farmer. When selecting a four-wheel trailer, be sure that it trails without a tendency to weave or whip, even though the load is not uniformly distributed in the trailer. Select a trailer with auto steering, which permits front wheels to turn short. Select a trailer with automatic brakes as a safety feature and an aid in handling. Obtain one suited in strength, size, and type to the purposes for which it is to be used; also one equipped with a taillight, a positive hitch that is easy to attach and detach from the power unit, safety-hitch chains, and wheels suited in size for the work to be done.

**Selecting Wagons.** Today, wagons are not always drawn by horses or mules but are often pulled by tractors or trucks, and are even trailed singly or in tandem. The wheels may be of wood or metal, or equipped with pneumatic tires. The bed can be had in almost any size or style to meet demands.

Select a wagon reach, whether of wood or metal, that is adjustable in length, and get stake brackets that are adjustable for different widths of boxes. Dependable brakes are essential, whether used on a
wagon or a trailer, and they are needed on all kinds of running gears regardless of the kind of wheels. Stay chains are sometimes necessary.

Steel-rim wheels, when carrying heavy loads, have a tendency to sink into the ground so that they are virtually rolling up an incline, while pneumatic tires spread out and roll along easily on most surfaces. It is possible in soft fields to haul much larger loads on pneumatic than on rigid wheels. Generally speaking, narrow tires and low wheels require more power than wheels with wider tires and larger diameters.

**Selecting Sleds.** Sled use is limited to states where heavy snowfalls are common. Inasmuch as sleds are pulled, select one that will withstand heavy strains when loaded, regardless of the surface over which it is drawn. The bobsled, being especially flexible in operation and readily adjustable to terrain, is generally more practical than the rigid type of sled with only two runners. In all cases, select a sled with runners equipped with metal tires to reduce maintenance.
SUMMARY

1. The first tractors were large, heavy, and cumbersome compared to present-day models and not flexible for use in performing the many farm-power jobs.

2. The power take-off was inaugurated to provide positive power to such pulled machines as binders.

3. The crawler or track-laying type of tractor is well adapted for heavy work, particularly where the footing is difficult such as on loose, sandy, and swampy soil and where the terrain is very rolling.

4. The standard four-wheel tractor is well adapted for belt work and for drawbar work on land that can be easily negotiated with wheel tractors as in Great Plains areas.

5. The general-purpose tractor is well suited for row-crop work and is found on more farms than the other types of tractors because it is very flexible to meet the power needs of many jobs.

6. The garden tractor usually has a single-cylinder engine, and the operator walks behind to guide and control the unit and attachments.

7. Select a tractor of the size and type to match the needs of the farm, giving consideration to such factors as size and shape of fields, soil type, crops grown, terrain, and the equipment to be operated using the belt, drawbar, and power take-off.

8. The tractor has a compression ratio, cooling system, lubrication system, and fuel system designed to meet the fuel used such as high-octane gasoline, regular gasoline, and distillate or tractor fuel.

9. A two-fuel engine is started on a higher octane fuel and, when sufficiently heated, switched to a lower octane fuel. Some engines, such as the Diesel, require a spark-ignition engine or other power for starting but they continue to operate on a low-octane fuel.

10. A compression ratio of the gas in the cylinder of 5.90:1 is called "high compression" and 4.75:1 is "low compression."

11. The ability to resist stalling as the load increases is called "lugging ability," which the Diesel provides by a governor which increases the fuel injection to meet load increases.

12. Fuel to a Diesel is metered into air compressed in the cylinder at near the ignition point while the spark-ignition engine draws a gas-air mixture into the cylinder as mixed by the carburetor.

13. Dry-line cylinder sleeves fit inside cylinder spaces, whereas wet-line cylinder sleeves set in the cylinder block and contact the cooling solution. Both types are replaceable.

14. Oil rings are below the combustion rings on the piston.
15. As shafts have their bearing journals resting on and turning in bearings that are of softer metal than the journal, the wear occurs on the bearings, which can usually be replaced easily.

16. The air used by the carburetor is oil washed to remove foreign material, and the crankcase oil is filtered to remove abrasive material. Abrasive items and foreign material are harmful to bearings and other moving engine parts.

17. Oil and other lubricants work between moving parts to reduce friction, heat, and consequent wear.

18. Two-cycle engines exhaust the burnt gas and compress the new gas on the upstroke; every downstroke is a power stroke. Some Diesel and a few spark-ignition engines operate on the two-stroke cycle principle.

19. The transmission, usually located just in back of the clutch, has a series of gears on two shafts which can be meshed to attain varying speeds.

20. The clutch is a friction device which connects the engine to the power train through the transmission and the differential.

21. Portable stationary engines are used to operate such units as milking machines, cream separators, and hay hoists, whereas larger and often multi-cylinder engines are used to operate large electric plants, feed grinders, and sawmills and to pump water for irrigation.

22. The four main types of electric motors are split-phase, repulsion-induction, capacitor, and universal. Split-phase has a low starting power, repulsion-induction has a medium starting power, capacitor will start heavy loads, and the series-wound universal motor is used for small power loads such as vacuum sweepers.

23. A direct-stroke windmill makes a pump stroke for each wheel revolution, and back-geared mills turn two or more revolutions for each pump stroke.

24. Where prevailing winds are light, use large wheels, high towers, and back-geared windmills.

25. Motor trucks are available in practically any size or style desired, from the small bed pickup to the large size hauling a half carload or more.

26. Some units are combination truck and tractor-power machines. Select these only when careful consideration has been given to the effectiveness to which they will meet the power and transportation needs.

27. Trailers are of one-, two-, and four-wheel sizes. Select a size suited to meet your needs and power unit, and one that trails evenly and is provided with safety chains and automatic brakes as safety features.
14. Servicing and Operating Mechanical Power and Transportation Machines

EVEN though machines may have been selected of a size and kind best suited to the needs of the operator and his farm, ranch, or plantation, this is no assurance that useful service and economical financial returns will result. Satisfaction can be obtained only when machines are properly operated and prompt service is maintained.

All machines, including tractors, are subject to wear, in time, regardless of care and service provided. This calls for reconditioning and replacement. It is abuse more often than use that causes the early discarding of many agricultural machines. - It is a credit to an operator who, through skillful use and excellent care, has a serviceable machine to exchange for a more efficient and better suited model.
Regardless of the construction of a tractor or other machine, nothing supplants good operation and regular servicing to secure long and efficient use.

Safe operation is as important as maintaining a well-conditioned machine. A skillful operator is also a safe operator. Regardless of the care exercised in design and construction, there are conditions that cannot be completely safeguarded without interfering with reasonable accessibility and efficient machine operation. This is the main reason why good operating instructions need to be taught—

FIG. 566. The power take-off is a valuable addition to the tractor for improved machine performance. First connect the shaft properly and then attach the shield.

not told—to the operator. It is essential to instruct operators in the proper use of a machine or tractor. One should know how to operate a machine from actual experience under supervision before taking it out unattended or operating "solo," as with the airplane.

A safe, careful operator is good insurance against an accident. He never attempts to clean, lubricate, refuel, or adjust a machine, while it is in motion, or while the engine is running.

Servicing and operating mechanical power and transportation machines will be presented under the following headings:

1. Servicing and Operating Tractors
2. Servicing and Operating Stationary Power Units
   - Stationary Gasoline Engines
   - Electric Motors
   - Windmills
3. Servicing and Operating Transportation Units

Motor Trucks
Combination Transportation and Power Units
Trailers
Wagons
Sleds

1. Servicing and Operating Tractors

This activity is divided into three parts: (1) servicing, (2) driving, and (3) making periodic adjustments. The general-purpose tractor will be used as the first illustration.

Servicing Tractors. This refers to the daily and other regular schedules for providing water, lubricating oil, and fuel for the engine; power-train lubrication; chassis lubrication; maintenance of air cleaner and fuel strainer; and tire maintenance. One of the daily chores for the tractor operator is to check, according to the owner's manual, the three liquids required for successful engine operation. They are water in the cooling system, oil in the lubrication system, and fuel in the tank or tanks. Check these three items each morning and again at noon. Fuel is used to operate the engine, oil to assure smooth operation and to keep wear to a minimum, and water to maintain the proper, efficient operating temperatures.

Maintaining the Cooling System. Keep the temperature gage at 165 to 185°F. when using gasoline and 185 to 200°F. for distillate, fuel oil, or Diesel fuel. If the engine is overheating and losing water, the heat indicator will register "too hot." The heat indicator is a sentinel of the cooling system. Causes of overheating are water lost through a leak in the cooling system, drain cocks left partially open, and leaky hoses. A clogged system, a defective or stuck thermostat, may result in the water boiling away. Check the water level in the radiator periodically.

When operating the tractor during freezing weather, it is essential to drain the cooling system at night or to use a tested anti-freeze solution; otherwise the coolant may freeze and damage many parts of the engine. If anti-freeze is used, the coolant should be tested periodically, during a time when the engine is warm. Add extra anti-freeze only while the engine is in operation and the coolant is warm.

When all danger of freezing has ended, it is well to remove anti-freeze solutions from the cooling system. Then fill the cooling system with soft water. To prevent rust, some operators use a commercial
rusted inhibitor available for this purpose. If a soluble oil is used in the tractor to protect it against rust, use one ounce or less per gallon of water to avoid excessive deterioration of the rubber hose connections and rubber rings that seal the cylinders. Keep any so-called "permanent" type of anti-freeze solution in a clean container for future use.

Maintaining the Oil Level. The condition of the lubrication system is indicated by another sentinel, the oil-pressure gage. Whenever the engine is running, the oil pressure should be sufficient to keep the indicator finger in the safe area on the gage. If the indicator does not register properly, stop the engine and check the quantity of oil in the engine. Under no condition let the engine run without proper pressure as indicated on the oil gage. Oil can be lost through a leaky oil pan, leaking gaskets, worn rings, and leaking connections in the oil line.

The oil level in the crankcase is checked in one of two ways, depending on the kind of engine. Some have a bayonet stick extending into the oil pan, serving as a measuring rule, others have two drain cocks on the side of the engine. The oil should run out of the top cock before the engine is started. In addition to maintaining
the proper oil level, change the engine oil at regular intervals. The owner's manual gives instructions for this change. Oil becomes soiled as it is used. The metal parts of the motor wear, dust sifts in, and the burnt gases from the engine may enter the oil. For this reason, the oil is filtered to extend its life further. Oil filters have replaceable elements which are to be changed at intervals.

**Using Additives.** These are selected materials placed in engine oils in small quantities to give improved engine performance. Some of the common additives are oxidation inhibitors, anti-foam agents, and detergents. Oxidation inhibitors provide needed resistance to oxidation caused by high temperature and heavy-load engine conditions that otherwise might produce varnish-like deposits on pistons and other engine parts. The churning action in an engine or gear box may cause some lubricants to foam, particularly if water is present. The use of an anti-foam agent will overcome this difficulty. Engines, particularly Diesel and other heavy-duty engines, may accumulate deposits of various kinds as a result of blow-by carbon, oil oxidation, and extraneous dirt. These deposits, if excessive, result in faulty lubrication, piston-ring sticking, and greater engine wear. To overcome these problems and prolong periods between engine reconditioning, many operators use a detergent, a substance having a soap-like cleansing power. A detergent oil can remove most of the deposits already present in an engine and hold in suspension such materials as are removed either by the oil filter or when the crankcase is drained. Thus, a detergent keeps a clean engine clean and removes
undesirable material from an engine that is not clean. When first using a detergent oil after having used conventional oils over an extended period, it is desirable to change oil more frequently than usual until most of the old deposits have been removed. When purchasing and using any additives such as those described above, follow closely the recommendations set forth by the manufacturer.

Providing Fuel. A continuous supply of fuel is necessary to provide efficient power for the tractor. The fuel lines include everything from the storage tanks to the engine cylinders, and the air system from

![Diagram of Fuel System](image)

Fig. 569.

the air cleaner to the carburetor. If the fuel is always clean when it is poured in the fuel tanks of the tractor and foreign material is kept out of the tanks, there should be no trouble with the fuel system. To assure this, keep the fuel in tightly closed, clean containers until it is placed in the fuel tanks. Provide clean funnels, hose, and other devices for transferring the clean fuel from containers to the fuel tanks. Keep the vent holes in the filler plugs open to assure uninterrupted fuel travel. Check the fuel lines, including all connections for leaks. Also clean the fuel strainer and sediment bowl periodically.

There are some hazards involved with engine fuels, gasoline in particular, that must be guarded against. Gasoline, when exposed to the air, forms an explosive mixture which may be ignited from static electricity, engine exhaust, an exposed electric wire, and, especially, from lighted matches and cigarettes.
Caring for the Air Cleaner. The air cleaner functions in two ways. A centrifugal cleaner on top of the air-entrance pipe is designed to separate or screen out trash, fuzz, and chaff from grain-combining and hay operations, and corn husks in corn picking (Fig. 519-B). If these accumulate on the screen, they will clog the intake air. The lower air cleaner is usually an oil-bath type of cleaner to remove dirt particles from the air. The air is first made to pick up a small quantity of oil by air velocity sufficient to atomize some of the oil. The

![Image](image.png)

**Fig. 570.** Remove the sediment bowl with a twisting motion to avoid damaging the cork gasket.

atomized oil and air mixtures then pass through a series of baffles and metal mesh where the excess oil and dirt collected on the mesh drains back into the reservoir below. This washing down of excess oil keeps the strainer mesh fairly clean at all times. The accumulated dust and dirt settle in the oil reservoir. Lower the bottom of the reservoir periodically, remove the accumulated deposit, and then refill with clean oil (Fig. 569).

Cleaning Sediment Trap and Fuel Strainer. This is an inverted glass-bowl below an upward-flow screen (Fig. 570). Foreign material is trapped below the screen and settles in the bowl. Periodically remove, drain, and replace the glass bowl. The carburetor-fuel strainer, located near the carburetor-fuel inlet fitting, again strains the fuel. Remove, wash in clean fuel, and replace the carburetor-fuel screen.

Adjusting the Carburetor. Good adjustment is essential to satisfactory engine performance. Have air intake and fuel lines free of
damage, and all connections tight. With the fuel at the proper level in the bowl, check carburetor adjustments. Before making these adjustments, operators are advised to refer to their owner's manuals.

![Fig. 571. Remove and clean the carburetor-fuel screen.](image1)

![Fig. 572. Cross section of a float-type carburetor showing needle valves and fuel level.](image2)

The idling-speed adjustment is only a stop screw to regulate how far the throttle will close when the governor control lever is set in the idling position. Although properly set at the factory, subsequent wear may occur to the point where the tractor "dies" when idling.
This trouble is most noticeable when changing from a very volatile fuel to one less volatile. The correction is made by merely screwing in the idling-speed stop screw a turn or more so the engine idles at a speed from 350 to 450 r.p.m. (Fig. 574).

![Fig. 573. An improperly installed hose clamp leaves an opening through which dirt may enter the carburetor.](image1)

![Fig. 574. Adjusting the idling-speed valve.](image2)

When adjusting the idling mixture valve, set the throttle in the idling position and turn the needle-valve screw in until the engine begins to "roll"; then back off the screw until smooth idling is obtained. Adjusting the load or high-speed needle valve can be done by one of two methods. In either case have the tractor under load, or have the engine running at full speed with no load, and the spark
SERVICING AND OPERATING MECHANICAL POWER

retarded, if possible. Turn in the load, or high-speed needle-valve screw, until the engine begins to lose power from too lean a mixture. Then open it slowly until the engine picks up speed and runs smoothly. When making high-speed adjustments without load, it may be necessary to open the needle valve a little—not to exceed over \( \frac{3}{4} \)-in. turn

![Fig. 575. Adjust the idling air valve by turning the needle valve out or in.](image)

![Fig. 576. Adjust the high-speed or load valve by turning it in to "lean down" the mixture.](image)

per trial—if the tractor tends to stall when the load is applied. Running a tractor with too lean a carburetor mixture causes loss of power and high exhaust-valve temperatures. In some cases, this may cause valve burning.

**Lubricating the Chassis.** All other operating members of the tractor, such as the transmission, differential, wheels, and steering mechanism, require periodic inspection and lubrication depending on use. The frequency of lubrication and grade of lubricant for each location are indicated on the service charts for various tractors. Use these charts.
Checking Tires. Positive traction is essential to efficient operation of every tractor on drawbar work. The condition of the tires, the tread, and the amount of inflation have much to do with the traction.

**Fig. 577.** Post the lubrication chart in a prominent place in the tractor shelter—and follow its instructions.

Follow instruction manual and check the tire pressures daily. Use a special gage for tires filled with water and anti-freeze solutions.

**Driving Tractors.** This applies to operating the tractor on the road, in the field, and on the belt. It is assumed that all parts of the
tractor are properly adjusted and tight, that safety shields are in place and well secured, and that hazards have been eliminated as far as possible. Driving the three principal types of field tractors calls for somewhat different methods of steering or guiding. Tractors have

<table>
<thead>
<tr>
<th>RECOMMENDED AIR PRESSURES FOR TIRES USED ON FARM TRACTORS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FRONT TIRES—ALL SIZES</td>
</tr>
<tr>
<td>1.—4-Ply Tires  .................................................... 28 lbs.</td>
</tr>
<tr>
<td>2.—6-Ply Tires  ........................................................ 36 lbs.</td>
</tr>
<tr>
<td>REAR TIRES—ALL SIZES*</td>
</tr>
<tr>
<td>3.—Minimum Inflation Pressure  .................................... 12 lbs.</td>
</tr>
<tr>
<td>4.—When plowing, increase pressure in tire on furrow wheel by 4 lbs.</td>
</tr>
<tr>
<td>5.—When special heavy wheels are used, or heavy implements such as corn pickers, bedders, etc., are carried on the tractor, inflation pressure must be increased. See Tire &amp; Rim Association schedule or contact the tractor dealer or manufacturer.</td>
</tr>
</tbody>
</table>

*Exceptions are the small section dual tires which require a minimum of 20 pounds per square inch.

<table>
<thead>
<tr>
<th>RECOMMENDED AIR PRESSURES FOR TIRES USED ON FARM IMPLEMENTS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIRE SIZE</td>
</tr>
<tr>
<td>All Rim Diameters</td>
</tr>
<tr>
<td>3.00</td>
</tr>
<tr>
<td>3.50</td>
</tr>
<tr>
<td>4.00</td>
</tr>
<tr>
<td>5.00, 5.50</td>
</tr>
<tr>
<td>6.00, 6.50, 7.00</td>
</tr>
<tr>
<td>7.50, 8.25</td>
</tr>
<tr>
<td>9.00</td>
</tr>
<tr>
<td>11.25</td>
</tr>
<tr>
<td>12.75</td>
</tr>
</tbody>
</table>

Fig. 579.

three or four field speeds ranging from 2 to 5 ½ m.p.h., and those equipped with pneumatic tires have a road speed up to 20 m.p.h. The several field speeds are required to enable the machines to operate at the speeds for which they are designed. The operator will always ride on the tractor seat, or stand on the regular tractor platform.

*This is a definite part of safe tractor operation.*

Always start the tractor, whether it is operating a machine or
Wheel locking for quick turn causes wasteful wear of the traction bars or lugs grinding down the rubber unevenly.

Sudden starts or too rapid acceleration of the tractor can grind down the rubber unnecessarily.
alone, by letting the clutch in gradually to prevent sudden starts. If one "races the engine" and then "drops in the clutch," the sudden jerk strains all parts, often results in damage and breakage, and

endangers the tractor operator through possible accidents. Starting a tractor too quickly may cause the tractor to "rear up" in front. This is possible if the tractor is on a sidehill, and especially when pulling uphill, pulling out of a ditch, or crossing over a road. The
front of the tractor is then higher than the rear, so the danger of tipping by letting the clutch in too rapidly is increased.

Operating on Sidehills. Driving on sidehills, through ditches, or across roads calls for special handling. Row-crop tractors have a high center of gravity. The high rear wheels and single front wheel make it easier for these tractors to tip. Therefore, the safe thing to do is to reduce speed. This is done by either (1) reducing the governor speed or (2) using a lower transmission speed. Avoid driving on a steep contour and pulling along a steep roadside or ditch. Track-type tractors can negotiate hills and ditches more safely, as the long tracks and low center of gravity enable these tractors to move over uneven terrain and up hills. They will sometimes tip, however, when paralleling steep sidehills.

Making Short Turns. This is desirable in good field work. Many farmers like to cultivate row-crop fields consecutively, that is, to drive down one row (or two or four rows depending on size of tractor and kind of crop) then turn and come back on the next. This is more often the case with the small row-crop tractor generally used on the small, irregularly shaped fields of the South and other sections. Row-crop tractors have brakes, a separate brake for each wheel; each brake can be operated individually. "Braking" the inside wheel permits pivoting on that wheel, enabling so-called "square turns" for planting, cultivating, haying operations, and all field operations. Caution: The only time to use the individual wheel brakes on a tractor is when operating in a field at one of the low speeds. When driving the tractor for anything other than field use, connect the two brake pedals so the brakes operate together for safe control of the tractor. Crawler-type tractors are turned entirely by disconnecting power to one track.
In this way, the other track turns the tractor as it moves around the inoperative track. A foot brake is available to lock the inoperative track for short pivot turns. Make sure that the machine is not being damaged by short turns.

Operating on the Highway. Speed in tractors is advantageous for moving from the buildings to the field and between fields, and for transporting commodities from farm to market. However, when on the highway, tractors are to be operated like highway vehicles. Even the highway rules for the use of lights govern these tractors. The cautions pertaining to the high center of gravity for row-crop tractors apply here. Keep the tractor near level, watch for sudden changes in road condition and surface, and reduce speed at turns. Unless the pulled machines and tractor have their brakes synchronized, avoid sudden stops as the machine may throw the tractor out of control.

Aligning the Belt. It is necessary to align the tractor-belt pulley with that of the operated machine for efficient operation and reduced maintenance. Next, with the pulley clutch disengaged, place the belt on the machine and tractor-belt pulley. With the tractor in alignment with the machine, back the tractor to give the belt the proper tension. Then brace the tractor and machine so that they will not move toward each other. With everything in readiness, the tractor operator seats himself in the tractor seat and lets the clutch in gradually as the engine starts the machine in operation.

Making Periodic Adjustments. Efficient operating temperatures in tractor engines are necessary to obtain long life, maximum economy, and full power. Tractors are designed with a cooling system of a capacity to prevent overheating in hot weather. Thus, for light loads and operation in cold weather, it may become necessary to cover part of the radiator to increase the operating temperature. If the engine warms up slowly or runs cold, it may be the fault of the thermostat. Consult the owner's manual for location of the thermostat; remove, inspect, and release if stuck.

During the hot summer months, some drivers have trouble with their tractors overheating. If the tractor knocks considerably and the cooling water boils away rapidly, this is a sign of overheating and calls for inspection and possible service. Some of the more common causes of overheating are (1) pulling too heavy a load, (2) using a fuel too low in anti-knock rating, (3) a loose or badly worn fan belt, (4) a faulty water pump, (5) faulty timing or a weak magneto, (6) improper
carburetor adjustment (usually too lean), (7) plugged radiator fins, (8) part of radiator covered, (9) collapsed or deteriorated hose connection, and (10) badly limed and clogged cooling system.

In addition to periodic cleaning of the cooling system, the above causes for overheating can often be prevented by following this program:

1. Check the fan belt periodically for proper tension. Adjust the belt pulley; there should be approximately 1 in. of slack in V belts.
2. Inspect the water pump for leaks; if any, tighten the pump packing and lubricate.

3. If water is leaking, check all connections and tighten where water is escaping.

4. Remove accumulations of trash and dirt on the trash grill and in the radiator fins.

Checking the Intake System. Follow the instructions given previously for removing husks and other obstructions from the screen at the top of the air-intake pipe. Inspect the air-intake lines between the air cleaner and carburetor for leaks. Remove the air cleaner and wash the separating screen with kerosene or fuel oil.

Checking the Fuel System. Most tractor carburetors maintain a partial vacuum in the float chamber when the engine is running. It is good practice to examine the carburetor gaskets to make sure they are tight. Cleaning the sediment trap and the fuel screens has been covered earlier in this chapter (Fig. 571). It is advisable to use the owner’s manual and check the idling needle and load-needle valve periodically, especially when changing fuel.

Checking the Electric System. Examine all connections; clean the magneto case and around the spark plugs. Then remove the spark plugs, clean, adjust the gaps, test under operating pressure, and replace. When replacing, make sure each plug is properly seated on the gasket and of the correct length to reach into the combustion chamber.

Wipe the inside and outside of the magneto distributor cap. Clean the distributor rotor. Carefully remove corrosion from all terminal points inside and outside of the distributor cap, lubricate the magneto and generator according to the owner’s manual.
Check the condition of the battery with a hydrometer, add water if needed, clean the battery terminals, and cover them with grease.

**Checking Wheel Weights and Tires.** To increase traction, use wheel weights on either steel- or rubber-tired wheels, and liquid in rubber tires. Be sure to use the amount of weight advocated by the manufacturer for the size of tractor and the job. When using liquid, many fill the tires slightly above the top of the rim (Fig. 619). Filling the tires more completely with liquid reduces the danger of pressure loss within the tire. Filling tires nearly full with liquid further improves traction, reduces bounce, and lessens the need for checking air pressure. Water usually can be used as the tire liquid most of the year, but in freezing weather use a calcium chloride solution. Determine the concentration of the solution by the use of a hydrometer. The hydrometer readings are shown in the accompanying table.

<table>
<thead>
<tr>
<th>Amount of calcium chloride per gallon of water, lb. per gal.</th>
<th>Freezing point, deg. F.</th>
<th>Specific gravity, hydrometer reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4</td>
<td>0</td>
<td>1.450</td>
</tr>
<tr>
<td>2.1</td>
<td>-20</td>
<td>1.200</td>
</tr>
<tr>
<td>3.5</td>
<td>-40</td>
<td>1.300</td>
</tr>
</tbody>
</table>
Thoroughly wash out the hydrometer in clean water immediately after using it to test the calcium chloride solution.

When using rubber tires, observe the following points: maintain the advocated tire pressure; clean grease and barnyard acids from the rubber; repair cuts and breaks before putting tires into use; avoid high transportation speeds, particularly on rough ground; avoid overloading; when tractor is idle, keep the tires inflated, out of the sunlight, and blocked up to keep weight off them (pages 632 to 634).

Making Other Adjustments. Other periodic engine adjustments include valve-tappet clearance. Brake and clutch pedals require inspection at least once during the season. Lubricate clutch members, transmission, final drive, and wheels or tracks. Do these things according to manufacturer's directions found in owner's manuals.

2. Servicing and Operating Stationary Power Units

Operating Stationary Gasoline Engines. The operation of single-cylinder gasoline engines is similar in all respects to that of the tractor engine. Cooling is generally by water hopper, thus eliminating radiator, pump, fans, and belts. Maintain the proper water level in the hopper. Keep lubrication cups tight enough to assure lubrication. Multi-cylinder engine operation is the same as that for tractor engines (Figs. 593 and 594).

Operating Electric Motors. It is extremely important that the correct voltage be applied to an electric motor. The proper size of pulley for the job and the size and length of the wires are also important. Motor windings carry electricity and heat is generated in them. Two operating instructions apply to all electric motors: (1) Keep wires and other parts insulated from each other where insulation is intended, and (2) keep motor free from foreign substances so it can radiate the heat generated in its windings. The insulating materials have the shortest life of all motor parts. They can be damaged by excessive moisture, by excessive rise in temperature, or by such substances as oil, salt, or acid. The best insurance against failure of insulation is to keep the motor clean and dry and located where it can be ventilated. Inspect bearing-lubrication reservoirs frequently and provide sufficient oil. Cleanliness is always an operating necessity for electric motors (Figs. 595 to 601).

Operating Windmills. After a windmill has been properly installed to pump water, the quality of service rendered depends
Fig. 593. The engine that is pumping irrigation water should be protected by housing. In hot weather, open screened sides aid in keeping the engine cool.

Fig. 594. Carefully align and securely brake and block tractor when using it as a stationary power unit.
Fig. 595. Pulleys for every motor load and speed. It is imperative that the driven machine be operated at the speed recommended by the manufacturer. Otherwise, the machine may be damaged and the work unsatisfactory. This chart provides a quick method of determining proper pulley sizes when the motor pulley speed is 1,800 R.P.M. The pulley sizes for other motor pulley speeds can be readily calculated.
MACHINES FOR THE FARM, RANCH, AND PLANTATION

WIRE SIZE SELECTION CHART

For Use When Horsepower and Distance from Motor to Transformer Are Known

<table>
<thead>
<tr>
<th>Hp and Amperes at Full Load</th>
<th>WIRE SIZE</th>
<th>Maximum distances in feet from motor to transformer—220 VOLTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 1/4 Hp. 24 Amps.</td>
<td>No. 2</td>
<td>0 100 200 300 400 500 600 700 800 900 1000</td>
</tr>
<tr>
<td>5 Hp. 23 Amps.</td>
<td>No. 4</td>
<td>8 10 12</td>
</tr>
<tr>
<td>4 1/2 Hp. 14 Amps.</td>
<td>No. 6</td>
<td>8 10 12</td>
</tr>
<tr>
<td>3 Hp. 10 Amps.</td>
<td>No. 8</td>
<td>8 10 12</td>
</tr>
<tr>
<td>2 Hp. 7 1/2 Amps.</td>
<td>No. 8</td>
<td>10 12</td>
</tr>
<tr>
<td>1 1/2 Hp. 6 Amps.</td>
<td>No. 10</td>
<td>10 12</td>
</tr>
<tr>
<td>1 Hp. 5 1/2 Amps.</td>
<td>No. 10</td>
<td>10 12</td>
</tr>
<tr>
<td>3/4 Hp. 4 1/2 Amps.</td>
<td>No. 10</td>
<td>10 12</td>
</tr>
<tr>
<td>1/2 to 1 Hp. 1.4 to 3.5 Amps.</td>
<td>No. 10</td>
<td>10 12</td>
</tr>
</tbody>
</table>

FIG. 596. Save electricity and protect the motor by using the size and length of wire that reduces voltage drop.

FIG. 597. Checking motor temperature. If hand can be held on motor 10 sec., the temperature is satisfactory.
Fig. 598. Apply oil cautiously to all electric motors.

Fig. 599. Sectional view of sleeve-bearing induction motor with oil rings showing oil level and drain plug.

Fig. 600. Sectional view of capacitor motor with waste-packed bearings.
Fig. 601. Using a grease gun to lubricate motors with pressure fittings.

Fig. 602. Annual-lubrication chart for back-gear windmill.
1. Change gear-case oil bath with light oil. 2. Check the oil ring to be sure it is working properly. 3. Oil the turntable. 4. Oil the furl ring. 5. Grease the pump-pole swivel.
largely on the attention provided. Lubricate the gears and other moving parts adequately. Mills that do not have the gears running in oil usually require lubrication once a week. Those that run in oil may also need to be lubricated frequently at the turntable, pitman, and guides. For both the mill and pump rods

1. Keep the connection between the mill rod and pump rod snug.
2. Shut off the mill when there is no need to pump water.
3. Keep the float and float valve protected from livestock.
4. Maintain safety plugs or openings in the well pipe for use in cold weather when there is danger of freezing which would, in turn, break mill parts. Many windmills operate in a jerky, squeaky, and groaning manner, which indicates improper adjustments, lack of servicing, and needed repairs.

3. Servicing and Operating Transportation Units

**Operating the Motor Truck.** Under farm conditions, this piece of equipment is subjected to many uses and all kinds of road and weather conditions. This necessitates care in operating trucks and their timely servicing, if long and efficient use is to result.

Trucks are constructed to haul certain specified weights. Overloading shortens the life of the truck and tires and increases the cost of maintenance. It frequently bends or breaks frames, axles, and springs; these, in turn, often lead to other troubles. When load weights are not well distributed, premature breakdown of frame, axles, springs, truck bed, and tires may result.

The efficient driving of a truck will add years to its life as well as to its efficiency. Precautions to follow when driving a truck include: check oil, water, and fuel before starting; run engine slowly until temperature gage registers 170 degrees; drive the first few miles slowly in cold weather; maintain water-gage temperature reading close to 170 degrees; watch oil pressure and maintain proper pressure; use the same gear going down a grade that is necessary to pull the grade; when pulling a grade, shift to a lower gear before losing too much speed and, when engine shows symptoms of working too hard, shift to a lower gear; set emergency brake and leave in low gear if parked on an upgrade, but if headed downhill, leave in reverse gear; avoid overchoking and flooding of carburetor when starting; apply and release brake alternately and avoid prolonged steady pressure as this heats brake drums; start off slowly and gain speed steadily; and stop slowly, except when avoiding an accident.
The cooling system needs careful attention at all times. Each week check water level in radiator, examine hoses and connections, look for leaks at water pump, and check fan belt for tension. Use soft water in the radiator and in winter use an anti-freeze that is not harmful to the metal and other radiator parts. Flush out the radiator at least twice a year and periodically check and repack the water pump, if needed.

The engine is the "heart" of the truck and the oil must be checked often and kept at the proper level with a clean lubricant of correct weight for the season and engine. If oil dip stick shows oil to be quite soiled, the filter cartridge probably needs replacing and the oil needs changing. Dirt entering the engine through the fuel should be avoided; therefore, clean carburator air filter and fuel-pump sediment bowl as previously indicated (see Using Additives, page 578).

Checking Battery Water Level. Do this at least weekly in warm weather and keep all connections clean and tight. Keep generator clean and oil every thousand miles. Observe the ammeter frequently while driving to note that the generator is charging at the proper rate. Keep the distributor points smooth and the rotor and distributor shaft lubricated as specified for the particular make of truck.

Always maintain a minimum of at least 1 in. free travel in the clutch pedal, but the brake pedal should gradually take hold by the time 1 in. of pedal movement has been made.

Checking Tires and Wheels. These are located in a position to be easily abused. Maintain proper air pressure and never allow more than a week to pass between checking. Arrange the load so as to distribute it properly to each tire. Speed is the worst enemy of tires. Reducing the speed one-third may increase tire wear as much as 75 percent, and objects encountered at 25 m.p.h. with no damage may ruin a tire if struck at twice that speed. Wheels out of line or duals improperly matched cause undue tire damage. The rotating of tires from left to right and diagonally will equalize wear and increase tire life. Tests indicate that 38 percent of the tire wear is on the right rear tire, 29 percent on the left rear, 19 percent on right front, and 14 percent on the left front, all of which shows the uneven strain upon the tires.

Making Other Truck Adjustments. Lubricate engine bearings, knuckles, transmission, differential, and other moving parts according to the specifications made by the manufacturer. Keep all car-body
bolts tight, steering apparatus snug, painted parts properly painted, and other such general servicing maintained in order to secure maximum service at a minimum cost.

**Operating and Servicing Combination Transportation and Power Units.** The same general instructions for operating and servicing apply as those outlined for motor trucks. These units are four-wheel drive; therefore, in addition to the transmission, there is a power transfer or distributor unit. This applies power to the front wheels through a propeller shaft and another differential. The front wheels have additional universal joints, so that they can deliver power while turning. These additional parts require frequent periodic service for lubrication, tightness of the oil seal, and other adjustments.

**Using Trailers.** The precautions and rules applying to the body, wheels, and frame of a truck also apply to a trailer. In fact, there seems to be more danger of overloading trailers and not properly equalizing the load than there is with trucks. Since trailers are not used so frequently as trucks, they are often badly neglected. Trailers are often used when the tires are not properly inflated.

When livestock is hauled in trailers, tie or confine the animals so that their weight is evenly distributed on the wheels. In driving, it is well not to take corners too rapidly. Trailers having a tendency to weave or whip should not be used.

**Using Wagons.** These are used about the farm for rather light work; heavy work is mostly confined to road duty. Farm wagons are built to handle certain specified maximum loads and this at the average walking speed of draft animals. Stay within this load capacity and speed, although as the load is reduced it may be safe to use more speed. The average farm wagon with metal tires is to be moved slowly. Wagons with pneumatic tires can safely withstand some increase of speed.

A few general principles in using farm wagons are to hitch the team snug with holdbacks placed over the neckyoke; use stay chains if team is unevenly matched for speed; have reach adjusted to length of box or load being hauled; keep metal tires set or pneumatics properly inflated; keep brakes adjusted and always use on downgrades to assist team, and to prevent too much speed; operate at a slow speed and load within maximum limit; lubricate wheels, bearings, fifth wheel, and base of front bolster weekly, or as needed; keep all parts such as bolts snugly fitted; and, under rough road conditions, drive carefully.
Using Sleds. They are used only on ice or snow surfaces of sufficient depth and firmness to keep the runners from contacting the ground. Keep all loads within the strength limits of the sled and, when hauling logs or other loads of unusual length on bobsleds, adjust the reach accordingly. For safety purposes, hitch the team snugly with holdbacks in place over the neckyoke.

SUMMARY

1. Maximum service and utmost economical returns will be obtained only when sound operation and timely service are maintained at all times.

2. A skilled operator is also a safe and careful operator. Careful operation is the best insurance against an accident. Such an operator never attempts to clean, adjust, oil, or fuel a tractor or other machine while it is in motion or while the power unit is running, and he keeps all shields securely in position.

3. Use a tested anti-freeze solution in the cooling system during freezing weather. Test the solution periodically, at a time when the coolant is warm. If it should be necessary to add anti-freeze, do so while the coolant is warm and the engine in operation.

4. Successful engine operation requires checking the water, fuel, and oil, including lubrication each morning and again at noon.

5. Clean fuel and air are essential to desirable carburetion and engine performance. They, in turn, depend on periodic inspection and cleaning of the air cleaner, sediment trap, and fuel strainer.

6. Additives are selected materials that may be added to lubricating oils to give improved engine performance.

7. Pneumatic tires require proper inflation at all times if satisfactory traction and minimum wear are to be achieved; therefore, check air pressure periodically to maintain the recommended pressure.

8. Start the tractor or belt drive by letting the clutch in gradually to avoid engine damage, breakage of machines, and the tractor's "raring up."

9. Reduce engine speed and use a lower transmission gear when driving tractors on sidehills, over ditches, or across roads.

10. When braking one wheel for a short turn, reduce the speed and use a lower gear ratio to avoid "throwing" the operator.

11. Cleanliness of lubricants, fuel, air, and water and the use of oil-seal bearings are a part of skillful operation. Periodically clean air cleaners in a solvent, such as kerosene, and replace oil cleaner cartridge further to ensure cleanliness.

12. Partly filling tires with liquid further to improve traction reduces bounce.
13. During freezing weather, use a tested anti-freeze solution, such as calcium chloride, in the tires.

14. Tire life is increased by always maintaining recommended air pressure, keeping tires cleaned of grease and barnyard acids, repairing cuts and breaks immediately, storing out of the sunlight with weight off the wheels, and avoiding overloading and high transportation speeds.

15. Windmills that groan, jerk, and squeak are crying for attention, which may include lubrication, adjustment, and repair. These the careful operator provides.

16. The pitman stroke of a windmill is to be adjusted to the pump cylinder; this can be done on many mills.

17. The truck, like the tractor, is to be run slowly until the water temperature reaches 150 to 170 degrees which may be expedited by use of a radiator shutter or cover. Likewise check the oil-pressure gage.

18. Avoid fast starting and driving, overloading, quick stopping, and overheating.

19. During freezing weather, use tested anti-freeze solutions in the radiator, and flush out radiator at least twice yearly, refilling with clean soft water for best results.

20. During warm weather, check the water level in batteries at least weekly, and keep all connections clean and tight.

21. When trailers are used, the weight should be evenly distributed. This may require the tying of livestock.

22. About 90 percent of all electric motor failures are due to dirt, moisture, friction, and vibration.
15. Reconditioning and Storing Mechanical Power and Transportation Machines

The tractor is the heart of mechanized farming. The success of each year's agricultural program is dependent in large measure on the tractor being ready at all times for both major and minor power jobs.

Fig. 603. The first prerequisite for any servicing job is the removal of dirt and grease. A steam pressure outfit is most efficient.

Tractors, motors, trucks, and power units are precision machines. Their continued successful operation depends on all working parts being maintained at or near new-machine efficiency. A great deal of such maintenance is the result of daily care, skillful operation, and a preventive maintenance program. Supplementary to this is regular service-station attention.

The tractor and motor truck deserve the same periodic service attention as does the automobile; in fact, more than the automobile,
because the tractor and motor truck operate most of the time at full load or near full load, while the automobile seldom exceeds half of its capacity.

In order to show the necessity for regular service and to assist the more mechanically minded, the several service jobs to be discussed in this chapter are as follows:

1. Reconditioning Tractors
   - Tuning an Engine
   - Cleaning the Cooling System
   - Checking the Fuel and Carburetor System
   - Reconditioning Valve Mechanism
   - Reconditioning Engine Bearings
   - Reconditioning Cylinders, Pistons, Rings, and Pins
   - Making Clutch Adjustments
   - Reconditioning the Transmission System
   - Checking the Power Lift
   - Inspecting and Servicing Wheels and Tires
   - Servicing Row-crop and Track-type Tractors

2. Reconditioning Power Units
   - Reconditioning Stationary Gasoline Engines
   - Reconditioning Electric Motors
   - Reconditioning Windmills

3. Reconditioning Transportation Units
   - Motor Trucks
   - Combination Power and Transportation Unit
   - Farm Trailers and Wagons
   - Sleds

4. Protecting and Storing Mechanical Power and Transportation Machines

1. Reconditioning Tractors

An engine "tune-up" is desirable at regular intervals and after annual service. It consists of minor external and some internal adjustments sometimes referred to as "operating adjustments." The tune-up procedure may reveal the need for specific service work. The purpose of the engine tune-up is threefold: (1) to maintain operating efficiency, (2) to analyze and test the condition of the tractors and to determine service requirements, and (3) to function as the final step in major engine reconditioning.

Before tuning up an engine, get such specifications from the
owner's manual as compression pressure; spark-plug gap; valve-stem clearance; ignition-timing diagram; fuels recommended; firing order; oils and lubricants recommended; float level; fan-belt tension; rated speeds of engine crankshaft, belt pulley and power take-off; and engine speeds at various governor settings.

**Tuning an Engine.** The following steps are suggested for this job:

**Test the Compression of Each Cylinder.** Remove the spark plugs from all cylinders except the one being tested. Test with hand crank with throttle open. Compression should be uniform in all cylinders. If testing with a compression gage, it is well first to remove all spark plugs. Then test each cylinder separately, turning over the engine with starter and ignition switch turned off. Lack of compression indicates (1) poor valve condition, (2) worn pistons, or (3) worn rings. Too high a compression indicates excessive carbon deposits in the combustion chamber.

**Readjust Valve-stem Clearance.** First, tighten the connections between the cylinder head and rocker-arm assembly on valve-in-head engines. Then adjust the clearance according to the manufacturer's specifications. Oil the valve stems and rocker-arm assembly with light oil. Many tractors have pressure lubrication, which takes care of these members.

**Replace Valve Covers.** Clean portion around the valves. Check the valve-cover gasket to be sure it is in good condition.

**Clean, Adjust, and Test Spark Plugs.** One of the most common causes of ignition trouble is faulty plugs. Clean plugs that are oil-soaked, dirty, or carbon-coated. If the plugs are washed in a solvent after being cleaned, dry them before using. Check the porcelains for evident breaks or cracks. If the plugs are in satisfactory condition, adjust the gaps with a feeler gage. (0.022 for high-compression engines and 0.027 for low-compression engines, unless otherwise specified by the engine manufacturer for the fuel being used.) Test each plug outside of the engine head and under operating pressure to make certain that it will give a strong, bright spark.

**Check Ignition Wires.** Replace defective ignition wires caused by worn, damaged, or ineffective insulation. Insulation that becomes absorbent also needs to be discarded.

**Clean and Adjust Breaker Points.** Remove breaker cover or case to expose mechanism. It may be desirable to remove the magneto.
When doing this, mark it so that it can be remounted in the same position. Wipe all parts clean with a lintless cloth. Clean and smooth the contact surfaces of the points with a breaker-point file; file square across the points. Replace badly worn or pitted points. Turn the magneto until the points have maximum separation. Adjust to manufacturer's specifications. Lock and recheck the adjustment. The only lubricant recommended in this operation is magneto grease, lightly applied, on the cam. Check for proper tension with breaker-point spring action.
Clean the Distributor. Clean all parts of the distributor and wipe dry. *Never scrape these parts with a knife.* Check spring-type distributor brushes for tension. Have ventilation holes open on distributors that are equipped with such holes.

**Test Ignition Timing.** When properly timed, the impulse coupling trips as each piston reaches top dead center at the end of the compression stroke.

**Time the Magneto to the Engine.** If the magneto has been removed or if a new one is being installed, follow manufacturer’s specifications; in general, the steps in the procedure are

1. Remove all spark plugs.
2. Following the firing order, turn the crankshaft until piston 1 reaches top center at the end of its compression stroke.
3. Revolve magneto until the distributor rotor is in contact with spark-plug terminal 1, and the impulse coupling begins to compress the spring within it. Connect the magneto to the engine, being sure the lugs on the impulse coupling engage the slots in the magneto drive coupling.
4. Crank the engine to check the timing (see Test Ignition Timing above).
5. Connect spark-plug cables according to the firing order.
6. Check the timing according to manufacturer’s timing legend. The magneto unit is designed so the timing can be varied slightly without separating magneto from the magneto drive shaft.

**Test and Clean the Impulse Coupling.** Crank the engine to note action of the spring. Slow action is result of a weak spring or accumulated oil and dirt within the casing. If it is accessible, wash or flush it out with gasoline and lubricate with light engine oil.

**Cleaning the Cooling System.** While the tractor is warm, drain the cooling system; refill and warm the engine and drain again. Always use clean water and, if available, soft water. If the radiator passages are restricted with lime deposits or otherwise clogged, use commercial cleaning compounds according to directions. Other suggested methods for dissolving scale are as follows:

1. Fill the radiator with a solution of 2 lb. of ordinary washing soda mixed with 4 3/4 gal. of water. With the radiator cap removed, run the engine until the water is hot. Drain and refill with clean, fresh water. Warm engine, drain, and refill.
2. A mixture of one part muriatic acid to seven parts of water, left in the cooling system 36 hr., will loosen rust and scale. Flush all of this mixture out and refill before operating the engine.

4. Check the fuel and carburetor system. Adjust and refill the air cleaner, clean the fuel filters and strainers, drain and clean float chamber as discussed in Chap. 14.

Fig. 606. A neglected cooling system often accumulates heavy lime deposits, which reduce cooling efficiency. The hole burned in this engine head is the result of such lime deposits.

Checking the Fuel and Carburetor System.

1. Check and adjust the float level. Do this according to manufacturer's instructions.

2. Repair a leaking carburetor. Fuel leakage from the carburetor when the engine is running is caused by

   a. Loss of buoyance in the float. ([Metal floats develop leak holes; cork floats become "waterlogged."].) Replace defective floats.
   b. Worn float valve, worn float-valve seat, worn float-valve pin
   c. Dirt under float-valve seat

Reconditioning Valve Mechanism.

1. The need for this job is indicated by

   a. Loss of compression and power
   b. Engine idling unevenly—generally improved with full throttle
   c. Engine starting hard
   d. Engine overheating (indicates carbon deposits)
   e. Engine knocking (detonation, caused by carbon deposits increasing compression)
   f. Engine knocking (preignition, caused by incandescent carbon deposits)
g. Excessive oil consumption. This is often caused by worn intake-valve guides and stems, as well as by defective piston rings, resulting in rapid formation of carbon in the combustion chambers.

2. Causes of carbon deposits.
   a. Excessive idling or continued light-load operation
   b. Inferior oil or continued use of diluted oil
   c. Worn pistons, rings, and cylinders
   d. Air cleaner in need of servicing
   e. Incomplete combustion of fuel
   f. Fuel mixture too rich
   g. Valve-stem clearance incorrect

3. Effects of carbon formation.
   a. Overheating and knocking
   b. Stuck piston rings causing rapid ring wear and lowered compression
c. Sticking valves caused by carbon on valve guides

d. Fouled spark plugs

e. Burned valves and valve seats

The above items show the importance of proper valve actions to efficient engine performance. Have adjustment and repair work done in a well-equipped service station and by experienced workmen.

**Reconditioning Engine Bearings.**

1. Need for engine bearing adjustment.
   a. Engine knocks
   b. Low oil pressure

2. Causes of excessive wear or bearing failure.
   a. Use of incorrect grade of oil
   b. Continued use of diluted oil
   c. Stoppage in oil-circulating system
   d. Crankcase breather in need of service because of dust entering crankcase
   e. Out-of-round crankshaft
   f. Bearings incorrectly installed
   g. Oil leads in crankshaft plugged

This is another service job to be done in a well-equipped service station to assure efficient engine and tractor operation.
Reconditioning Cylinders, Pistons, Rings, and Pins. These members, along with the valves and connecting rods, are precision constructed and assembled. Their continual operation naturally results in some wear. However, current materials with coordinated lubrication and cooling keep this wear at a minimum. After long use, adjustment and replacement of some parts are necessary. Excessive wear is indicative of improper operation and calls for correction.

1. Need for piston and cylinder service is indicated by
   a. Fouled spark plugs
   b. Excessive oil consumption
   c. Loss of compression and power
   d. Excessive dilution of oil in crankcase
   e. Noisy pistons (piston slap)
   f. Excessive “blow-by” (compression escapes past the pistons)

2. Causes of excessive wear of cylinders, pistons, and rings.
   a. Air cleaner inadequately serviced
   b. Incorrect grades of oil used
   c. Insufficient cooling
   d. Continued use of diluted oil
   e. Continued overload resulting in overheating
   f. Carbon accumulations that cause rings to stick
   g. Carburetion too rich, causing dilution of oil film on cylinders
   h. Overchoking, causing dilution of oil film on cylinders
   i. When kerosene is used, switching from gasoline before engine has warmed up sufficiently to vaporize the heavier fuel
Making Clutch Adjustments. Test Clutch Action. This includes the following points:

1. **Gradual engagement.** The properly adjusted clutch picks up the load gradually, enabling the tractor to start moving without jerking. A "grabbing," rough-acting clutch strains all transmission parts severely.

2. **Complete release.** Move the tractor forward in first or second speed, disengage the clutch, and note whether the tractor stops immediately. A tendency to "creep" forward indicates that the clutch does not completely disengage.

3. **Spinning clutch.** With the engine running, shift into each of the various speeds. Gear clashing and difficult shifting indicate that the driven members of the clutch continue spinning when the clutch is disengaged.

4. **Slippage under load.** Have the tractor pull a load approximately of its rated capacity to determine whether the clutch will slip under working conditions.

5. **Noise or squeaks.** Engage and disengage the clutch several times. Move the tractor in the various speeds, and also run the engine with clutch disengaged to determine whether clutch is quiet in its action.

6. **Free play in pedal.** Measure the amount of free play and compare it with the manufacturer's specifications. This free play prevents tension on the clutch-release bearing when the clutch is engaged. It ensures a clearance, and that there is no wear between the clutch-release bearing and the release levers. Lack of free play causes rapid wear on the clutch-release levers and release bearing and may cause the clutch to slip under load, with consequential wear on the clutch facings and pilot bearing.
Adjust free play in clutch pedal according to manufacturer's specifications. If these are not available, adjust for a free play of about 1 in.

7. Pedal-return spring. The clutch pedal should return to position promptly through the action of a pull-back spring. In a few designs this spring is attached to the clutch-release bearing; usually it is attached to the clutch pedal. Adjust as needed to get a positive return of the clutch pedal.

Lubricate Clutch-release Bearing. Service the clutch-release bearing according to manufacturer's instructions. The method of lubrication varies in different tractors as follows:

1. Bearing is lubricated at frequent intervals through an external grease fitting with a compression gun.
2. A prelubricated bearing is packed with a high-temperature lubricant at assembly and requires further lubrication only when the clutch is removed for reconditioning.
3. No lubrication required. Bearing is lubricated for life by a special process provided during its manufacture. Porous bronze is used to absorb the lubricant and tightly sealed, oil-soaked felt provides it throughout all the life of the bearing.

Lubricate Clutch-release Linkage. Lubricate all connections between the clutch pedal, or hand lever, and the clutch-release bearing, to
make sure they work freely. Eliminate binding or sticking in these parts before assuming that the clutch itself is at fault.

Check Probable Causes of Clutch Troubles. Loose engine mountings (on tractors where engine is mounted in a frame) or worn mounting bolts make it impossible for the clutch to function properly. Tighten all engine mounting bolts and then look for these troubles:

1. **Grabbing.**
   a. Oil or grease on the disk of a dry clutch pressure plate or flywheel
   b. Hub of clutch disk is tight or stuck on the splined clutch shaft
   c. Clutch-release mechanism binding
   d. Broken disk facings or pressure plate

2. **Dragging** (incomplete release).
   a. Worn connections in release mechanism
   b. Release levers out of adjustment
   c. Excessive free play in clutch pedal
   d. Loose, bent, or broken disk facings
   e. Too heavy or cold oil (wet clutches)

3. **Slipping.**
   a. Lack of free play in clutch pedal
   b. Weak pressure springs
   c. Pressure levers not correctly adjusted
   d. Release mechanism binding (lever-pressure type)
   e. Worn friction facings
   f. Weak pressure springs (spring-pressure type)
   g. Broken pressure springs
   h. Oil on a dry clutch facing
4. Spinning.
   a. Clutch brake worn out of adjustment (lever-pressure type)
   b. Pulley brake out of adjustment

5. Squeaking and chatter.
   a. Binding or sticking release-mechanism linkage
   b. Release bearing dry of lubricant
   c. Friction linings loose or broken
   d. Grease or oil on dry clutch disk, pressure plate, or flywheel
   e. Clutch-release levers out of adjustment
   f. Loose engine mountings

Reconditioning the Transmission System. Test Transmission of Power to the Drive Wheels.

1. Operate the tractor and test it in all gears at various speeds. Note especially whether the tractor starts moving immediately when the clutch is engaged. When the clutch is well conditioned and there is a noticeable lag between engagement of the clutch and movement of the tractor, such problems as worn gears, worn splines on the shafts, or loose bearings are indicated.

2. Determine whether gears can be shifted easily. Difficulty in shifting gears may be caused not only by a dragging clutch, but also by worn transmission bearings, rough or worn gear teeth, and incorrect adjustment of the gear-shifting mechanism.

3. Gear noise indicates that the gears are worn or are out of adjustment. The bearings supporting the shafts may be worn so as to cause misalignment, or improper meshing of the gears.

4. Check the attachments of the rear wheels on the rear axles.

5. Make sure that the lugs are securely fastened to the rims on steel wheels, and that the rim lugs are tight on pneumatic wheels.

6. Make short tractor turns in both directions to determine whether the differential functions properly. Test the action of the differential brakes.
Test the Belt Pulley.
1. Determine whether there is end play in the belt-pulley shaft or backlash in the pulley-driving gears. Try to move the pulley up and down and pull it in and out to determine the condition of the pulley bearings.
2. Observe whether the oil seal is retaining the lubricant within the belt-pulley carrier, or whether there are indications of oil leakage.
3. Run the engine and test the speed of the belt pulley with a speed indicator; check with manufacturer's specifications. (This also checks the engine speed, because the ratio between the engine and the belt pulley is a fixed ratio.)

Test the Power Take-off.
1. Check the bearings of the power take-off shaft to determine whether the shaft has end play or vertical play.
2. Examine the terminal of the power take-off to determine the condition of the oil seal and to note any indications of oil leakage.
3. Test the action of the power take-off clutch.
4. Run the engine and check the speed of the power take-off shaft with a speed indicator. See manufacturer's specifications for rated speed. (This test also checks the engine speed because the ratio between the engine and power take-off is fixed.)

Checking the Power Lift. The power lift will manipulate or adjust the machine only when in good operating condition and when there is no machine or tractor-member interference.
1. Check the power lift. Do this by operating it with an implement attached. Observe the lifting, lowering, and adjusting action. All operations need to be smooth and steady. In some cases, lifting arms are connected incorrectly, making it impossible to adjust the machine.
2. Adjust the lifting devices. With some mechanical power lifts, springs are used to assist in lifting; they also cushion the fall (lowering) of the implement. Adjust these springs as required to get the best action—an easy lift and a gradual drop.
3. On hydraulic lifts, check the amount of oil in the hydraulic pump or reservoir in accordance with manufacturer's instructions.
4. Check all connections between hydraulic pump and lifting cylinders to make sure they are tight.
5. Check for the following conditions if hydraulic lift fails to operate:
   a. Power take-off clutch not engaged
   b. Oil level low; oil not reaching the pump
   c. Viscosity of oil too heavy
   d. Lifting arms incorrectly attached to the implement
   e. Air in hydraulic system; bleed out the air
f. Dirt under pump-check valves
   (Mechanical and electric lifts have gears and electric connections.)

Fig. 617. Adjust individual wheel brakes, allowing equal and proper clearance.

Fig. 618. In order to protect tires when draining gear cases, use a piece of metal to deflect the lubricant.

Inspecting and Servicing Wheels and Tires.

1. Adjust wheel brakes. Remove covers over brake bands. Clean the housings and wipe out oil and grease. Replace brake linings if necessary. Adjust free play of brake pedals according to manufacturer's specifications.
Adjust brake-band tension with screws provided to get desired braking action. Equalize the adjustment of right and left brakes.

Fig. 619. Diagram showing method of using liquid in tires as a means of increasing weight and traction.

Fig. 620. A safe power jack is advantageous when wheels or tires are to be inspected or removed.

2. Test and inspect each tire. A careful and systematic inspection of each tire will determine the service and procedure required. Such inspection will also often reveal faulty operating conditions which may be improved or eliminated to increase tire service. The proper care of tires is an important phase of tractor inspection and service.
FIG. 621. Excessive air pressure or insufficient weights lead to rapid wear of the traction bars or lugs.

FIG. 622. Operating on hard roads with low air pressure causes excessive wear on the trailing edge of traction bars.

FIG. 623. Excessive inflation, exposure to sunlight, drafts or electrical discharge will cause small cracks or checks to develop in a short time. Painting with common paints, varnished, or lacquer will cause similar checks.
3. Correctly inflate tires. Check with a low-pressure tire gage, especially designed for tractor tires. Special air-water gages are supplied with a vent hole that permits washing the gage with water after it has been used for testing tires containing calcium chloride solution. If calcium chloride remains in the gage, it will harden and ruin the gage. Tire pressures should check with the tables that have been adopted by The Tire and Rim Association (see Fig. 579).

4. Tread bars.
   a. Excessive wear on the leading edge of the tread bars indicates that tires have been overinflated.
   b. Excessive wear on the trailing edge of the tread bars indicates underinflation. Operating on hard roads with low air pressure causes excessive wear of the trailing edge of the tread bar or lug, due to the wiping action thus set up.
   c. Excessive wear at the center line, or crown, on rear tires is caused by overinflation which, in turn, causes excessive slippage. Excessive wear at the center, or crown, of front tires may be caused by faulty alignment of the front wheels on standard-type tractor.
5. Valve stems and valve caps.
   a. Test valve stems and cores for leakage. Slow leaks are particularly serious with tractor tires because of their low pressure.
   b. Twisted and worn valve stems or stems not well centered in the rim hole indicate that the tire has slipped on the rim. This is usually caused by underinflation, but it may also be caused by improper seating of the tire bead on the rim, or the use of a soap solution on the bead and rim when the tire was mounted. Remove tires that have slipped on the rim, clean the rim and bead, and remount the tire.

![Image of tractor tire with cuts and bruises]

Replace missing valve-stem caps. These caps are essential on tractor tires. The rubber washer within the cap makes a positive air seal, and the cap itself excludes dirt and grit from the valve stem.

6. Cuts, breaks, and bruises
   a. Small cuts or breaks in the carcass of the tire or side walls may be temporarily repaired by tire gum after the damaged part has been cleaned.
   b. Deep breaks or cuts, exposing the fabric, may extend to the inside of the tire. In such cases, remove the tire and send to the tire-service shop for a permanent vulcanized repair.
   c. Cuts are unavoidable under many field conditions. Rubber cuts easily when wet; therefore, caution is necessary when operating during wet weather.
   d. Bruises are more likely to occur if tractor tires are overinflated, since they are then less flexible and pliable and therefore easily damaged by impact with hard objects.
Breaks in the side walls are caused by underinflation, which permits the walls to fold and buckle continually during operation, resulting in heating and breaking down of the fabric.

Fig. 626. Hitting a sharp rock may break the distended cords and cause either a diagonal or an "X" break. (A) Cause. (B) Result.

Fig. 627. The cord body may be crushed against the rim, causing an "X" break to chafe through the tube. (A) Cause. (B) Result.

7. Side wall wear. The inside of the furrow wheel tires is often chafed and worn by rubbing against the wall of the open furrow when plowing. Prevent this by a proper hitch or more careful operation.

8. Bent or distorted rim flanges. These may be bent by striking obstructions in the field. If the flange is bent outward (away from the tire), the bead of the tire lacks proper support, and the bead may be forced off its seat by
the internal air pressure. Also, the open space between the bent rim flange and the tire bead permits grit and small stones to enter and to chafe and cut the tire bead.

9. Alignment of the tire on the rim. Check to see that the beads on each side of the tire are equally centered on the rim. Some tires are provided with a centering rib to facilitate properly mounting the tire on the rim.

![Diagram of tire and rim]

FIG. 628. (A) Low-pressure buckle or furrow breaks. The most common condition causing this occurs in plowing when the right tire runs in the furrow and is distorted by the tilt of the tire; this results in a folding action. (B) Inside appearance of buckle or furrow break. Increasing the pressure 4 lb. and adjusting the plow hitch laterally may prevent this.

Inspect the space between beads and rims to determine whether sand and pebbles have worked in; if so, remove the tire for thorough cleaning.

10. Effects of wrong inflation pressures in tractor tires.

<table>
<thead>
<tr>
<th><strong>Overinflation</strong></th>
<th><strong>Underinflation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive slippage</td>
<td>Tire slips on rim</td>
</tr>
<tr>
<td>Rapid tread wear</td>
<td>Valve stems twist or shear</td>
</tr>
<tr>
<td>High fuel consumption</td>
<td>Side walls buckle and break</td>
</tr>
<tr>
<td>Tire more easily bruised by impact</td>
<td>Rin bruises</td>
</tr>
<tr>
<td>Increased chances for punctures</td>
<td>Excessive wear at sides of tread</td>
</tr>
<tr>
<td>Excessive wear on leading edge of tread bars</td>
<td>Excessive wear on trailing edge of tread bars (especially when used on highways)</td>
</tr>
</tbody>
</table>

Servicing Row-crop and Track-type Tractors. The same service jobs apply to row-crop and track-type tractors. However, track-type tractors have service jobs peculiar to the track mechanism, steering clutches, and track-drive mechanism. These are considered service-station jobs, since they require special tools and equipment.
FIG. 629. Permitting dust seal on front wheel to become loose allows lubricant to escape and dust to enter.

FIG. 630. Removing front wheel-bearing member and cleaning all parts in a safe solvent before reassembling.

FIG. 631. Lubricating front wheel bearings with a pressure gun after bearings have been cleaned and reassembled.
2. Reconditioning Stationary Power Units

**Reconditioning Gasoline Engines.** The same procedure is followed in servicing the stationary gasoline engine, whether single-cylinder or multi-cylinder, as was outlined under Tractor Engines, so it does not need to be repeated here (see page 605).

**Reconditioning Electric Motors.** Motor windings carry electric energy in which heat is generated. Two things are essential if electric motors are to function properly: (1) The wires and other parts must be insulated from each other where insulation is intended to complete the necessary electric circuit and (2) the motor must be protected from foreign substances so that it can radiate the heat generated in the windings. Reliable sources have stated that 90 percent of all electric motor failures are due to four principal and obvious causes: dirt, moisture, friction, and vibration.

*Fig. 632. Dirt is the worst of the electric-motor enemies. Cleanliness means improved and longer service.*

Dirt is the most common enemy of electric motors. Use a dust-proof or enclosed motor in places where it is impractical to eliminate dust, such as in a feed-grinding room. Even under comparatively clean conditions, some dust and dirt will accumulate on the windings; clean the motor periodically. One of the most satisfactory ways of cleaning a motor is to blow the dust out with a hand bellows. Air blasts exceeding 50 lb. from compressor tanks have been known to disturb
the windings and cause subsequent damage, particularly if air is moisture laden. Oil films may be removed with petroleum distillates

FIG. 633. Wiping off the motor with clean rags after use and at intervals will help keep it clean and promote smooth running.

FIG. 634. Moderate fan-blast pressure will blow dust out of condenser lines or motor windings; too much pressure may cause damage.

or carbon tetrachloride. The latter is often sold as a cleaner under various trade names. Use sparingly; coat exposed windings with good insulating varnish.
With clean rags, wipe off the motor housings at regular intervals, clean commutators and sliprings, and remove dust from the wound section. At regular intervals, tighten all exposed joints in the motor frame and the motor brackets.

Moisture is the second chief cause of motor failure. It soaks and softens windings until the insulation is unable to hold the voltage. Once inside the motor, moisture unites with any dirt present to form a sticky mess. It also absorbs acid and alkali fumes present in the air—fumes that quickly change moisture to an actively destructive agent. The precautions against moisture in motors are simple. (1) Guard open motors against accidental intrusion of water from drip or splatter, and (2) run “stand-by” motors a little once a week to guard against moisture condensation during idle periods. Before motor windings are blown out, check to be sure that no water has condensed in the air line.

Friction is another common cause of motor troubles. Keep oil-hole covers down to prevent dirt entry into the bearings. In lubricating, it is important to apply the correct quantities at the right interval. Never add new oil while the motor is running. If this is done, a quantity of lubricant may escape and cause damage. This oil may deteriorate the mica insulating segments between commutator bars. It may foul the commutator bars themselves. It may soak windings to the point where rewinding is required. In general, on both plain
and ball-bearing motors, excessive lubrication may result in friction and heat.

**Fig. 636.** A metal cover will assist in keeping the motor dry.

**Fig. 637.** Check the belt tension and alignment. Misalignment and excessive tension overload motor bearings.

_Vibration_ is the fourth main cause of motor breakdowns. Excessive vibration in a motor results in parts being shaken loose, broken electrical connections, crystallizing portions of the metallic structure, and increasing frictional wear. Systematic, regular checks will help
to avoid these troubles. Check for misalignment, foundation settling, and excessive bearing wear. Insulate the motor from vibrations of the driven machine. Check for excessive belt or chain tension. The best insurance against failure of an electric motor is to keep it clean and dry, properly lubricated, and located where it is ventilated and free from vibration.

Reconditioning Windmills. Some annual jobs of reconditioning the mill include the following:

1. Thoroughly clean the gears and other moving parts of all old grease and other foreign material.
2. Bring the gears into full mesh without binding. Replace gears that have worn badly or that have broken cogs.
3. Tighten parts of the mill rod to remove play. Adjust “trueing” spider and guides for the rod to hold it in a straight line with the pump. Aline pump rod and mill rod.
4. Tighten bolts on the post joints, bands, and braces.
5. Inspect platform to tighten fasteners and replace any decayed boards or other damaged parts.
6. Adjust pitman and plunger rod to remove play.
7. Inspect gear shafts, pitman, main shaft, turntable, and other bearings. Adjust and replace as needed.
8. Inspect brake band and adjust to control the wheel when shut off.
9. Inspect wheel to tighten loose parts and straighten bent parts.
10. Inspect vane to repair supports and vane hinge rods, as well as other parts in need of attention.
11. Inspect pulley brackets, pulley wheels, pull-out chain, spring, and other parts of shutoff to make essential repairs and replacements.
12. Lubricate moving parts to prevent wear and reduce operating power.

3. Reconditioning Transportation Units

Motor Trucks. The same general instructions apply to the motor truck engine and chassis as those discussed for tractors (see page 605). Additions are the battery, lighting and starting system, chassis lubrication, springs, and body. On chassis lubrication, follow manufacturer's instructions. Brakes, especially hydraulic brakes, require periodic inspection and adjustment. Aline the wheels and keep the body tight.

Combination Power and Transportation Units. These are inspected and reconditioned as described for tractors. The process need not be repeated here (see page 605).

Farm Trailers and Wagons. The need for reconditioning farm trailers and wagons is not always apparent to the operator; therefore, such work may be neglected. Some common reconditioning jobs include the following:

1. Bed.
   a. Tighten nuts, bolts, and screws.
   b. Inspect and service the door or endgates and hinges.
   c. Inspect and repair attachment to frame.
2. Wheels and frame.
   a. Inspect frame. Tighten, repair, or straighten.
   b. Inspect springs. Replace broken parts and then lubricate.
   c. Inspect tires. Inflate to proper pressure. Set metal tires.
   d. Inspect wheels. Aline, lubricate, and adjust.
   e. Check guiding apparatus so that trailer follows properly.
3. Running gear.
   a. Inspect skeins of axle for wear. Tighten axle bolts.
   b. Inspect boisters and clamps. Tighten loose bolts and straps; repair broken and damaged parts.
   c. Examine reach and replace if broken or badly worn.
   d. Examine fifth wheel. Tighten bolts and replace plates if badly worn; lubricate.
   e. Examine tongue and tighten straps. Replace tongue if necessary.
   a. Inspect attachment and make secure.
   b. Inspect and service safety hitch and chains.

5. Miscellaneous.
   Paint after unit is thoroughly cleaned (see Painting in Chap. 3.).

Sleds. The jobs on a sled that have not been covered under previous headings include the following:

1. Inspect braces. Tighten and repair.
2. Inspect sled runners. Repair and tighten tires.
3. Inspect all wooden parts. Replace or repair those broken and decayed.
4. Clean and paint.

If it is a bobsled, check to make sure that the rear section accurately trails the first section. To correct this, the runner braces or the reach may have to be adjusted.

4. Protecting and Storing Mechanical Power and Transportation Machines

The machines discussed here, with the exception of sleds, are used more or less continuously throughout the year. However, they do have idle periods and should be protected during such times.

Protecting Tractors during Idle Periods. It is highly desirable and considered good management to "house" the tractor which is rapidly becoming the power center of farms. The tractor is depended on to operate field machines, operate many machines on the belt, and do more and more of the regular and miscellaneous hauling. Thus, it should always be ready for immediate use. Its value—as a financial investment and the heart of most farm operations—warrants its being well stored during idle times, including nights, under cover and away from the weather. When the tractor is well housed, the daily, weekly, and other periodic service jobs are more likely to be done. Special adjustments and reconditioning jobs will also receive more prompt and thorough attention. This means better power and performance. Regular storage provides wall space for lubrication charts and other illustrated instructions. Workbenches, cabinets, and essential tool equipment are generally provided under such conditions. Removing dirt and grease from the tractor is good housekeeping and good mechanics.

When a tractor is to remain idle for several days, cover the exhaust
pipe and air intake to prevent foreign matter from entering. A magneto cover and carburetor cover are desirable. If the idle period includes freezing weather, drain the cooling system, unless it is filled with a good anti-freeze solution. Cover all polished metal surfaces with a lubricant or rust preventive. Pour a few drops of lubricating oil in each spark-plug opening. Some operators prefer to remove the air cleaner and then choke the engine by drawing in rust preventive through the carburetor, after which a small amount of rust preventive is poured into each spark-plug opening. This protects the
FIG. 641. A tin can inverted over the exhaust stack will keep rain out of the engine.

FIG. 642. Wagons and machines that are made of wood deteriorate rapidly when exposed to the elements.

interior of the engine from corrosion. Take the weight off pneumatic tires by placing blocks under the axles. If a tractor has been idle for some time, replace the lubricating oil. The same applies to the transmission and differential. Apply fresh lubricant to all pressure fittings.
RECONDITIONING AND STORING MECHANICAL POWER MACHINES 635

Protecting Stationary Power Units. Gasoline engines, both single-cylinder and multi-cylinder, are treated the same as tractor engines for storage. Enclose electric motors in dustproof and moistureproof containers when not in use.

Protecting Transportation Units. The same instructions apply to these units—motor trucks, combination units, wagons, and trailers—as to tractors. Sleds are used for only a short time each year. The runners can usually be placed high in the machine shed and out of the weather. Protect the metal parts with rust preventive and the wood parts with paint.

SUMMARY

1. The tune-up for an engine is to maintain operating efficiency, analyze and test the condition of the tractor, and determine service requirements.

2. Before starting the tune-up, obtain the following information from the owner’s manual: compression pressure, spark-plug gap, valve-stem clearance, ignition-timing diagram, fuels recommended, firing order, recommended lubricants, float level, fan-belt tension, rated speed of crankshaft, belt pulley, power take-off, and engine speeds at various governor settings.

3. Lack of compression indicates poor valve condition, worn pistons, or worn rings; excessive compression indicates heavy carbon deposits in combustion chamber.

4. The spark-plug gap is 0.022 for high-compression engines and 0.027 for low-compression engines unless otherwise stated by manufacturer.

5. Recommended compounds for cleaning the cooling systems are 2 lb. of washing soda to 4 1/2 gal. of water. Engine is run until the water is hot. One part of muriatic acid to 7 parts of water left in cooling system for 36 hr. is also used to clean out cooling systems. Following the use of one of these, fill radiator with clean water; after running engine for a short time, drain out and then refill with clean, soft water. Clean radiator exterior.

6. Test the speed of pulleys and power take-off with a speed indicator.

7. There are four types of power lift on tractors: hydraulic, mechanical, pneumatic, and electrical. Test these by lifting and lowering implements; if reconditioning is unnecessary the operation will be smooth and steady.

8. To ensure uniform tension, use a tension wrench when resetting a part, such as the cylinder head, having several bolts holding it in position.

9. When replacing tires, make sure the rim, tube, and inside of the tire are clean and smooth and that the tire is evenly alined on the rim.

10. Protect the reconditioned electric motor from dirt, moisture, friction, and vibration, as these cause almost all the troubles that occur.

11. When reconditioning a windmill, make sure that all mill-operating
parts and the connection to the pump are snug to assure smooth pump strokes.

12. Aline the truck wheels to hold down tire wear and facilitate steering.

13. When the tractor is stored for a long period, it is well to clean all grease and dirt thoroughly from the motor unit.

14. Trucks, tractors, and combination units provide more years of efficient service if housed in dry and clean quarters away from livestock and poultry.

15. When a tractor is to be idle for several days, cover the exhaust pipe and air intake and place blocks under the axles to remove weight from tires; if freezing weather prevails, drain the radiator, unless anti-freeze solution is used, and remove battery to a warm place.
PART VI
GENERAL-SERVICE MACHINES AND BARN
AND PRODUCT EQUIPMENT
16. Selecting General-service Machines and Barn and Product Equipment

Fig. 643. A tractor spreader facilitates spreading barnyard manure at any time of the year.

The machines discussed in the preceding parts have been, on the whole, those designed for particular commodity production. There are other machines that are used periodically for various operations on the farm, ranch, and plantation. Some of these are peculiar to certain geographical sections and to the handling of specialty commodities, but many of them are used on the majority of farms at some time or other and these more commonly used machines will be discussed in this part.

Considerable progress toward reducing the time and labor requirements for producing crops has been made through field machines. On most farms, and particularly where dairy and poultry
production is prominent, considerable time is required to do the daily repetitious chore jobs. The U.S. Department of Agriculture figures show that a farmer spends from 20 to 80 percent of his time in and about the farm buildings. Notable progress in reducing this high percentage of chore time is being effected through the selection and use of barn equipment and general-service machines. Such machines will also be included in this part.

Agricultural conditions vary greatly in a country as large as the United States. Thus, it is apparent that a piece of equipment is not always adapted in the same way to all sections. Climatic conditions, soils, crops, and markets often govern the selection and operation of equipment used in a specific area. General-service machines and barn and product equipment will be discussed under the following headings:

1. Selecting Plant-food Distributors
2. Selecting Feed-processing Machines
3. Selecting Seed-cleaning and Sorting Machines
4. Selecting Crop-protection Machines
5. Selecting Soil- and Water-management Machines
6. Selecting Miscellaneous Service Equipment
7. Selecting Barn Equipment for Handling Hay
8. Selecting Forage and Grain Driers
9. Selecting Dairy-barn Equipment
10. Selecting Dairy-product Equipment

1. Selecting Plant-food Distributors

The importance of plant-food distributing machines for use in supplying the soil, both topsoil and sub-soil, with plant food is fast becoming a major farm problem. The use of fertilizers, both commercial and barnyard, is fairly common in all areas. In some sections, it is realized that fertilizer is as important as seed.

Hybrid-seed corn and other hybrids, with their higher yields, obviously consume more plant food than the varieties previously grown. Their increasing use necessitates the addition of plant food if soil fertility is to be maintained.

Soil scientists state that our soils today are noticeably lower in plant-food value than they were when the American Indian was first displaced as steward of the land. Two procedures can be followed to correct this situation: (1) to apply annually the quantity of fertilizer
required by the year’s crop and thus maintain the current level of fertility or (2) to replace large quantities of needed plant food to bring the soil to its original value, and then maintain that level.

Soil-conservation studies indicate that whenever water moves, it invariably carries soil nutrients with it. Thus, it seems necessary to place fertilizer under the surface of the soil as quickly as possible in order to reduce the loss of the fertilizer, and to assure its being used by the plants. However, in areas where soil blowing and sheet erosion are problems, the residue of crops is often left on the soil surface to check such erosion, retain moisture, and still serve as plant food. This background will assist in the selection of plant-food handling equipment and emphasizes the need for placing, at the appropriate time, adequate quantities of fertilizer where it will be utilized.

**Selecting Manure Spreaders.** Spreaders for distributing barnyard fertilizers are available for animal power or tractor power, and for spreading dry matter or liquid and dry material.

Manure spreaders are commonly made up of a carrying box, a feeding mechanism to move the load to the distributors, and a mechanism that shreds the material and spreads it uniformly over a wide area. Animal-pulled and some tractor-pulled spreaders are of the four-wheel type, similar to a wagon from a transportation standpoint. Some tractor-pulled spreaders are two-wheel and supported...
in front on the tractor drawbar. In all models, the two wheels (rear wheels on four-wheel machines), through the axle, provide the driving power for all the operating parts of the spreader. A ratchet is located in each wheel hub, and driving pawls and springs are secured in the pawl holder.

Select a spreader built with a rugged structural-steel undercarriage that will withstand road and lane travel and also the uneven terrain of the fields. Secure an all-metal box and drag apron with five or more rates of apron travel. It is desirable to have the axle and drag-apron shaft mounted on the same plates to assure true alignment at all times. Upper and lower beaters are essential to maintain a uniform feed rate across the spreader. Select a widespread distributor if desiring to cover an area wider than the spreader.

From a safety standpoint alone, select a spreader that has all gears and chains well shielded. In addition, good shielding prevents these members from fouling, thus increasing the efficiency and life of the entire machine. In selecting a tractor-pulled spreader, obtain one well balanced on the two wheels, with convenient hitch to the drawbar, and a lifting jack to support it when detached.

Selecting Liquid-fertilizer and Manure Distributors. Because of the known value of liquid fertilizer, it is desirable to have a spreader
SELECTING GENERAL-SERVICE MACHINES AND EQUIPMENT

These spreaders are water-tight and dip to the center where there is a sump drain for cleaning. Certain organic and some inorganic chemicals in fertilizer are not all soluble; therefore, they are difficult to keep in suspension. This necessitates an agitator. Furthermore, since some of these liquid fertilizers are acid and corrosive, it is essential to select a spreader resistant to such corrosive action. Liquid barnyard fertilizers are sometimes collected in cistern-like vats, for later distribution over the land, and these are also rather corrosive. Select a liquid-fertilizer distributor that distributes evenly, is adjustable for amount spread, is equipped with an agitator and a large holding tank, and is resistant to corrosion.

Selecting Lime Spreaders. Lime is often broadcast on the surface and then worked into the soil. The first requisite of a lime sower is that it provide the uniform spreading of the correct amount per acre. This requires an accurate and durable feed system. Three common types of feeds are the star forced feed (see Chap. 4), revolving agitator, and the rotary wing feed. Of these the first will apply from 50 to 5,000 lb. per acre, while the other two will sow 200 to 8,000 lb. per
Fig. 647. A wing-distributor type of lime spreader for use behind truck or wagon. The revolving wings or paddles spread the lime over a wide swath.

Fig. 648. The revolving-agitator type of lime spreader and an adjustable deflector board.
acre. The rotary wing feed has the additional advantage of handling cinders, graded gravel, salt, and other material for roads.

A revolving agitator is essential to keep the lime flowing uniformly to the feed openings. Other essentials in selecting a lime spreader are an adjustable deflecting board to aid in a more uniform spreading of the lime; enclosed bearings that exclude foreign material and that are fitted with pressure lubricant fittings; a screen to keep large objects from getting into the feed system; a delivery close to the soil surface to prevent undue wind action upon the lime; a hopper capacity sufficient to avoid frequent refilling; an accurate measuring device that can be quickly adjusted; and an easy-to-clean hopper.

Some manure spreaders have a lime-spreading attachment that permits them to serve in this dual capacity when the minimum amount to spread is 1,500 lb. or more per acre. Endgate and trailer lime

FIG. 649. Lime spreader cut away to show revolving agitator.

FIG. 650. Spreading lime uniformly with a manure spreader.
spreaders are also available, but these are not very satisfactory under windy weather conditions. Materials similar in consistency to lime and applied to the soil surface can be handled with most lime sowers.

Other fertilizers are placed in the ground and covered, as with the plow-sole placement (see page 40) and attachments shown with grain drills and various types of planters.

**Selecting Fertilizer-spreading Attachments.** New and concentrated fertilizers are being introduced, all requiring careful placement with respect to seed, seed piece, or plant of any particular crop. The proper location may vary depending on such factors as composition of the fertilizer, type and conditions of the soil, kind of crop, root characteristics, climate, and moisture conditions. Some crops produce the largest yields with fertilizer placed in bands at varying distances to the sides of the plants and at varying depths. Research has determined many of these placements. Manufacturers provide attachments for planters and seeders based on results of these tests. Each state agricultural experiment station provides placement suggestions for crops grown in the respective state. Check with the

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1 Fertilizer-placement studies by Bureau of Plant Industry, Soils, and Agricultural Engineering, U.S. Department of Agriculture.
state station before selecting an attachment to apply any fertilizer in contact with the seed or seed piece.

2. Selecting Feed-processing Machines

Three principles are used for processing feed: (1) the burr-type grinders or grinding plates, (2) the hammer mill, and (3) the chopper mill. There are variations of these methods for using roughages in more complete mixtures.
Selecting Feed Grinders. Burr-type feed grinders operate by cracking and crushing corn and small grains into varying degrees of fineness. Plates vary in size from 6 to 12 in. in diameter, grinding from 9 to 90 bu. per hour. Select an all-metal feed grinder that is adjustable for coarse and fine grinding and that will handle...
damp, new grains. It is desirable to have a grinder with slanting bottoms and a spiral or auger for feeding to the plates. Other desirable mechanisms in a feed grinder are a convenient adjustment for fineness of grinding, a throwout lever and an automatic safety release separating the burrs to prevent foreign objects from damaging them. Another desirable attachment is a wagon elevator with a bagging or wagon spout.

For grinding ear corn, select a model equipped with cob breakers, cob cutters, and concaves for breaking the cobs and feeding them into the mills. Select a feed grinder with cob-cutting knives and regulating feed arrangement to grind snapped ears or heads of kafr corn and milo maize, or other hard grains and high-fiber products. Always use the proper size of pulley so that the tractor engine, or other power used, will operate the grinder at the recommended speed.

Selecting Hammer Mills. These mills grind all grains including wheat, oats, and barley, and shelled corn, ear corn, and roughages. The grain is fed into a circular container with heavy steel sieve plates inside the housing. A rapidly revolving shaft, equipped with several sets of swinging hammers, beats the material into sizes small enough
A fan creates a strong suction to assist in removing the crushed feed. This operation makes it obvious that several construction features are desirable; among them are boiler plate or other type of strong housing, sufficient number of hammers of wear-resisting material, hammers reversible for additional wear, anti-friction bearings with effective oil seals to keep oil in and dust out, and bearings running in a bath of oil.

A hammer mill has several advantages over a feed grinder, especially for the big livestock feeder. Hammer mills will handle roughage or a mixture of roughages and grain more efficiently; no particular damage is done to the machine when it is run empty; they will grind feeds in a greater range of fineness; and some types will mix and other types will separate the grain and roughage.

Selecting Roughage Mills. These machines combine cutter knives similar to ensilage cutters (Chap. 10) and necessary feeding aprons. They will grind practically every type of feed, whether grain or roughage, to the degree of fineness desired. The true roughage mill is a combination hammer or burr mill with a cutter head; some of the hammer mills do not employ the cutter head and, therefore, will not effectively handle such a wide variety of materials. Some of the combination machines will do a wide variety of jobs such as grinding the grain and roughages to different degrees of fineness even though handled at the same time, separating out any desired part of the grain without grinding, mixing or keeping separate the grain and roughage, and blowing the mixed parts into storage or other containers.
Fig. 657. "Cyclone" where air is removed from the pulverized feed; the feed runs out the bottom into a sack, bag, or bin.

Fig. 658. A roughage pulverizer. (A) Knives that cut the roughage. (B) Hammers. (C) Screen. (D) Blower.
Fig. 659. (Above) Several types of grain and roughage are ground and mixed with the roughage mill. (Below) Combination forage chopper and hammer mill.
When considering a roughage mill, select one with readily replaceable screens; a wide variety of screens; a molasses-pump attachment if molasses is to be applied to the feed; readily adjustable air control; reversible swinging hammers; and such available attachments as high and low cyclones, mixers, blowers, elevators, and bagging devices.

**Selecting Hay Choppers.** These machines are sometimes classified with feed-processing equipment. They have already been discussed in Chap. 10 under Field-hay Choppers.

3. Selecting Seed-cleaning and Sorting Machines

The selection of good seed is a very important step in the production of any crop. The increasing use of hybrids emphasizes this importance. Cleaning grain before marketing and then cleaning and grading seed before planting are essential in providing good seed.

**Selecting a Type of Seed Cleaner.** There are several types of grain-cleaning and seed-sorting machines. Seed-sorting machines are available in sizes for use in elevators and on the farm, and there are some to be used with threshing operations. The more common types clean and grade seeds according to (1) the size of the seeds, (2) the shape of the seeds, (3) the exterior covering or surface of the seeds,
Selecting Fanning Mills. Fanning mills clean seeds by blowing a controlled blast of air in the seed as it passes over vibrating screens. Fanning mills are operated by electric motors, gas engines, or in some farm mills by a hand crank. The fanning mill is a modification of the "boot" in threshing machines and combines. Select sieves designed for the grain that is to be cleaned on the particular farm. Inasmuch as the mills vibrate considerably, select one well braced, with shakers adequately supported.

Selecting Disk Cleaners and Graders. Sometimes referred to as "pocket" cleaners, they grade the grain by means of revolving vertical disks. The cleaner consists of one hopper, which delivers the grain to one side of another hopper, which is cylindrical, having a diameter of 16 to 24 in. In this second hopper are 15 or more revolving disks, 2 in. smaller in diameter than the cylinder. These disks have pockets on both sides, which select seeds the size of the pockets. The grain passes from disks with small pockets to disks having pockets the size of the type and shape of the seed being graded. The disks pass upward through the material being cleaned, carrying the pocketed seed and discharging it into receptacles for various seed sizes or shapes.
Fig. 662. Two types of cleaners and graders. (A) Farm-size disk cleaner. (B) Spiral corn grader.
Selecting Cylinder Cleaners and Sorters. These operate on a principle similar to that of the disk cleaner. The pockets are indented on the inside circumference of the cylinder instead of being on the sides of the disks. For separating wheat and small seeds from oats, the cylinder pockets remove all but the oats. Similar types are available for grading corn.

Selecting Cotton-seed Cleaners. Cotton seed is graded similar to corn, by having sized holes in progressive sections of the cylinder. The action is similar to that of a sieve.

Selecting Seed Separators. The gravity separator is a vertical spiral with the grain entering at the top. This method utilizes the differences both in shape and in weight of the seeds. As the seeds flow down the spiral incline, the heavier seeds move faster and swing toward the outside of the chute, thus separating themselves from the
lighter seed. Belt separators or sorters are used to separate round seed from seeds that are not round on an upward incline movement. Muslin belts are provided to collect rough thistle-like seeds from the grain.

4. Selecting Crop-protection Machines

Machines for the control of insect pests, plant diseases, and weeds are coming into wider use with the increase in these crop hazards, increasing knowledge and availability of materials for reducing losses from such causes, and improving quality of the product.

A good crop-dusting or spraying program can be considered as a form of crop insurance. The maximum benefits obtained by either spraying or dusting will depend on

1. A good machine kept in good operating condition
2. Adequate capacity to needed applications on an effective schedule
3. Insecticides, fungicides, and soil fumigants suited to and recommended for the purpose
4. Convenient adjustment and operation to secure the proper application rate and effective placement of the materials on the plants
5. Proper timing of applications with respect to plant development, insect or disease occurrences, and weather conditions
Selecting Sprayers. Sprayers are available in sizes ranging from the small hand type to the large tractor machines operated through either the power take-off or the auxiliary engine. Some orchards have installed stationary spray systems, which remain in a fixed place. Pipes, underground or elevated, carry the spray liquid to all parts of the orchard under controlled pressure.

A sprayer consists essentially of (1) a tank with agitator, (2) a pump, (3) a pressure controller, which may be a simple relief valve on a small machine or an unloading valve (on machines of 2 hp. or more), (4) an air chamber, (5) a pressure gage, (6) a shutoff valve to the spray hose or boom, (7) delivery lines of pipes and hose, and (8) nozzles or spray guns.

Selection of a sprayer depends on whether it is to be used only as an orchard sprayer, entirely for row crops such as potatoes, or for a combination of both. If it is to be used for orchard spraying alone, select a type corresponding in wheel tread to the tractor so as not to cut new tracks through the orchard. Select a sprayer low enough to avoid damage to tree limbs and fruits, and one free from projections and sharp edges.

For row-crop use only, select a wheel tread adjustable from 60 to
72 in., to straddle two rows of from 30- to 36-in. spacing, and having adequate clearance of the crop.

For a sprayer used on both orchard and row crop, select a row-crop sprayer. Then, for orchard work, the row-crop boom is removed or folded compactly in back of the sprayer, and orchard-spray equipment of hose and spray gun attached.

After selecting the type of sprayer, obtain one with the proper **pump capacity**. Spray pumps are rated in terms of gallons per minute discharged at a definite pressure, usually ranging from 5 to 60 gal. This is the largest portable sprayer regularly used. A suggested rule is to select 1 gal. of pump capacity for 1 to 2 acres of orchard. As an example, a 20-gal. per min. pump will generally take care of 20 to 40 acres of orchard. In row-crop spraying, use 1 gal. of pump capacity for 2 acres of row crop. For example, provide a 20-gal. per min. sprayer to spray 40 acres of potatoes or other row crops.

Select a pump with the proper **pressure**. Spray pumps are generally designed with all parts, including valves, valve caps, gaskets, packings, bearings, and pressure connections for pressures up to an operating pressure specified by the manufacturer. This may be 250, 400, 600, 800, or even 1,000 lb. per sq. in. Five hundred pounds is the maximum pressure the operator can use when holding the spray gun, since the recoil of the gun is tiring. With mechanical methods of holding the spray guns or nozzles, pressures may go well above the 500-lb. figure. Four hundred pounds is the accepted pressure for row-crop spraying of most crops for effective results and economical coverage.

For animal-pulled sprayers, select an **engine-powered** unit. Provide 1 hp. in the engine for each 2 gal. of pump capacity. Orchard spraying often has to be done during the muddy time of early spring, which requires both the tractor on power take-off operated units and sprayer to be suited to this. If they are not, the entire season’s spraying results may be unsatisfactory.

Motor trucks are used for hauling both orchard and row-crop sprayers under certain conditions. Select a motor-truck-mounted sprayer powered by a separate engine. This will generally prove more satisfactory for either orchard or row-crop conditions.

Sprayer tank sizes are available usually in direct relation to the capacity of the pump furnished on the sprayer. The usual ratio is
from 12 to 15 gal. of tank capacity for each gallon per minute of pump capacity. This means that a sprayer with a 20-gal. per min. pump would regularly be equipped with about a 250- to 300-gal. tank in an orchard sprayer, and a 300-gal. size would be standard in this model for row-crop use.

**Selecting Sprayer Accessories.** Accessory spraying equipment includes lengths of spray hose for orchard spraying, type and number of spray guns or nozzles, top railing, spraying towers, operator's platform, spray-gun holders, and other accessory equipment.

For orchard spraying done from the sprayer, short lengths of hose, usually not exceeding 10 ft., are adequate to allow the spray man freedom of action. For spraying from the ground, select 50-ft. lengths of hose. Working from the sprayer, the excess hose can be coiled with approximately 10 ft. left uncoiled for the use of the spray men.

The two general types of spray guns are (1) a single-nozzle, adjustable-type gun which is used regularly for dormant spray coverage, and by some operators throughout the season, and (2) the so-called "boom," or multiple-nozzle gun. These guns are designed especially to avoid mechanical or chemical injury to foliage or fruit.
under conditions of high temperatures. The number of nozzles that can be used on a given sprayer is determined by the pump capacity. Manufacturers furnish tables of the capacity required by the different sizes of their guns and nozzles.

For spraying from the sprayer in large orchards, use a railing mounted on top of the sprayer tank or at the rear of the sprayer. This protects the operator and allows him to work with freedom. Under certain conditions a railing on top of the tank and a platform and railing at the rear of the tank make a very good combination as the spray men are then not in each other's way. The man on top of the tank or tower directs his material to the top half of the tree and the man on the rear platform covers the lower half of the tree.

Row-crop sprayers have the size of boom appropriate for the size of pump. They are selected on the basis of the number of rows, either a 4-, 6-, 8-, 10-, or 12-row model being chosen depending upon the acreage to be covered, the width of row, the nature of the land, and other local factors.

A tank refiller, which fills the tank from a separate supply of water or even from below the surface where overhead water supply is not available, works on the principle of an injector; a small stream under pressure of the pump raises a large stream from the water supply under no pressure. Sprayer accessories include a multi-nozzle gun holder, commonly called a spray mast, and special mountings for spray guns that take the recoil from the gun.

Orchard sprayers using air volume and velocity in place of the high-pressure liquid are called "speed sprayers," "air-blast sprayers," or other special names. Other new types are combination sprayer-dusters, vapo-mist dust applicators, and concentrate applicators. These laborsaving machines are undergoing rapid development to apply new materials and for combating new insects and diseases.

Airplane equipment for spraying has been used with satisfactory results under certain conditions. Most airplane spraying is done by custom operators who have built their own equipment. Although planes used for spraying are of the smaller types, there is a growing demand for larger planes to carry large quantities of concentrated insecticide long distances for forest and other mass control measures.

Selecting Dusters. Crop dusters for applying insecticides, fungicides, and defoliants are made in a wide variety of sizes and
Fig. 669. Some desirable sprayer accessories. (A) Single-nozzle gun. (B) Multiple-nozzle guns. (C) Multiple-nozzle for top-to-bottom tree coverage. (D) High platform with guards.
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designs. They may be classified as to size, type of power used, number of outlets discharging the air-dust mixture, type of mechanism for producing the air blast, or system for dust distribution to the plants. Hand dusters are plungers, bellows, or hand-cranked fan dusters, and generally of one-, two-, or four-nozzle sizes. Next in size are the traction-driven dusters, with a wheelbarrow-like frame to be pushed by hand or on a two-wheeled chassis to be pulled by animals, and having distribution accessories to treat two to four rows. Still larger dusters are built with multiple outlets for row-crop treat-

![Fig. 670. The row-crop duster, like the sprayer, has a boom extending over all rows covered and nozzles to direct the material on the plant.](image)

ment or with one or two large outlets for use in orchards. These may be mounted on a tractor, or on a trailer behind a tractor, and may be driven by an independent engine or by the tractor power take-off. Single-outlet dusters of large capacity are generally referred to as "orchard dusters" or "drift dusters."

A duster for use on row crops has these five essential functions:

1. to carry a supply of dust,
2. to feed the dust uniformly, giving adequate dosage without wasteful excess at any time,
3. to divide the dust with satisfactory uniformity among all outlets or all rows being treated,
4. to disperse the dust particles, and
5. to deliver the material effectively to all points vital to crop protection.

In selecting a multiple-outlet crop-duster unit, place particular emphasis on four characteristics: (1) a dust-feed mechanism capable of handling a wide range of dust materials with dependable uniformity, (2) relatively uniform dust distribution through all outlets,
adequate air volume to assure dust dispersion and penetration of plant foliage, and (4) rugged construction with dust-proof bearings.

Additional desirable features may include (1) convenient dust-feed rate adjustment with index for duplicating or recording feed settings used, (2) convenient on-and-off control, (3) dust outlet for emptying hopper and rebagging dust, (4) fully adjustable nozzle boom to accommodate various row spacings or the different crops to be treated, (5) folding nozzle booms for passing through gates or turning close to fences where required, and (6) convenient detachability if tractor mounted.

It is desirable to have the duster unit mounted on its own two-wheeled chassis so that it can be quickly connected or disconnected to the tractor or pulled by a team. Select individual engine power with the engine and duster built into one compact unit, where the amount of use warrants the additional initial cost.

Select duster fans on the basis of volume of air discharge per minute and the velocity of this discharge. The volume rating of these fans varies from as low as 5,000 to as high as 65,000 cu. ft. of air per minute. The velocity in terms of miles per hour ranges from just under 100 to as high as 180 in the largest type of equipment. Where tractor power take-off equipment is used, the horsepower required is indicated by the manufacturer. Tractor power take-off equipment operates at speeds faster than animals can haul the equipment, and the time in which the dust application can be most effective is usually restricted to a few hours each day.

Motor-truck mounting of dusters is satisfactory under most conditions. A pickup truck or light general-purpose truck is adequate for hauling the dusters and several hours' supply of dusting chemicals. The capacity of duster hoppers ranges from 50 to about 200 lb. Inasmuch as the usual amount of dust used per acre is 20 to 30 lb. and, rarely, 50 or more lb., it is essential to have a hopper large enough to avoid frequent refilling. For row-crop application, a boom covering from four to eight rows, with from one to two nozzles per row, is conventional equipment. For some insects and diseases and for certain crops, it is desirable to have the boom enclosed so that the material does not drift away quickly. In some cases, a fumigation effect is secured in addition to the actual contact with the dust.

Airplane Dusters. Dusting with airplanes has been practiced for several years, especially in the control of the cotton boll weevil.
(A) The set-nozzle duster distributes a sufficient quantity of insecticide with a velocity that enables it to reach and to cover trees at a distance of several hundred feet. (B) The same duster in action. Note the wide swath covered. The angle of the nozzle can be changed to meet most dusting needs.
Insecticide and fungicide dust is released in the slip stream of the airplane, through a large venturi tube. Airplane dusting, except on larger plantations, is done by custom operators who, like airplane-spray operators, assemble their own plane-dusting equipment.
Fig. 674. Three sizes and types of machines for applying soil fumigants in the control of nematodes.
Airplane Defoliators. Chemical means of removing leaves of field and vegetable crops is practiced in some areas. The objective is to speed uniform ripening of vegetables; in cotton, it both speeds boll maturity and permits cleaner picking of cotton with mechanical pickers. Defoliants can also be applied by ground machine as well as by airplane.

Selecting Soil-fumigant Applicators. Nematodes, nearly invisible, eel-like worms, attack the fine hair roots of nearly all plant life, including orchard stock. The destruction of many commodities is increasing at a critical rate, especially where land is planted to the same commodity year after year. The golden nematode of potatoes on Long Island is an example. Other examples are those that attack pineapples in the Hawaiian Islands, some varieties of citrus in the Southwest, and vegetable and truck crops in many regions. One of the main methods of control at present is the application of soil fumigants, a poison that kills earth organisms beneath the soil surface. This is done by applying the fumigant under pressure through point applicators or immediately following cultivator shovels or other soil-digging devices. The use and application of soil fumigants is undergoing rapid development (Fig. 674).

5. Selecting Soil- and Water-management Machines

A large amount of soil conservation and water-management work is done with regular farm equipment such as tractors, moldboard plows, disk plows, harrows, V drags, scrapers, and levelers. Special earth-moving machines are used on larger projects, for building ponds, and for terracing and leveling large tracts of land.

Selecting Scrapers. Several different types of scrapers are used in soil- and water-management operations.

Slip scrapers. These are used to make fills, open ditches, make trench silos, dig ponds, and construct dikes. Select these of a size suitable both to the power and to the physical ability of the operator.

Roll-over Rotary and Fresno Scrapers. Models suitable for horsepower or tractor power are available. The roll-over is easier for the operator both to fill and to dump than the slip scraper. Rotary scrapers operated with a trip rope by the person who handles the tractor are available. They are used extensively by farmers who have considerable earth to move rather short distances. Fresno-type scrapers, which do not roll over, may require a separate operator to load if they
are drawn by motor power; if horse-drawn, one person usually operates the machine and drives the team.

Carryall. Where extremely large amounts of earth are to be moved a considerable distance, and the power is available, carryall

scrapers are effective. Generally, it is considered more economical to contract for the use of this machine than to purchase it for the average farm. These scrapers are sometimes referred to as self-loading wagons and are tractor operated. A scraper on the bottom
digs and pushes the earth up into the wagon. Power-controlled gates close the bottom when loaded. Upon reaching the point of unloading, the scraper is tipped and the earth unloaded and leveled as desired.

![Roll-over scraper mounted on rubber tires speeds up the hauling time.](image1)

**Fig. 677.** Roll-over scraper mounted on rubber tires speeds up the hauling time.

![Small tractor-mounted ripper scraper.](image2)

**Fig. 678.** Small tractor-mounted ripper scraper.

**Bulldozers:** The bulldozer, a pushblade perpendicular to the tractor, is generally operated by a track-type tractor. Smaller units are also available for wheel-type tractors. The blade is mechanically
or hydraulically controlled. It digs its load and pushes or rolls it ahead of the tractor. This is an economical method of moving earth quickly for short distances. Blades that angle to one side or the other are called “angle dozers,” “trail builders,” and other similar trade names.

**Fig. 679.** Self-loading wagons scoop up big loads, haul them, and then dump or spread the soil as desired.

**Fig. 680.** The bulldozer digs its load, pushes it into place, and levels it as desired.

**Selecting Terrace-building Machines.** These machines not only move earth, but at the same time level or ridge the surface as desired.

**Graders.** These are available in two-, three-, and four-wheel types for use in terracing. The two-wheel models use the tractor drawbar
to maintain the front level of the machine. For light work and small terraces, usually constructed under contract, the larger four-wheel graders are more satisfactory.

Fig. 681. Regular farm equipment—a disk plow building terraces.

Fig. 682. Farm-size elevating grader for building terraces.

_Elevating Graders._ These are all tractor pulled. Sizes suited for different power units are available. Special terrace builders of this type are designed for regular farm wheel-type tractors.

_Whirlwind Terracer._ This is a combination plow and soil thrower. It can be described best as a plow with the moldboard cut away...
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Fig. 683. A farm-size terrace-grader.

Fig. 684. Road graders are often used on farm earth-moving jobs. Here, a four-wheel grader is being used to build a terrace.
vertically. As the soil leaves the steel moldboard, it is caught by a rapidly revolving vertical auger which throws the soil away from the plow. The speed of the auger, which controls the distance the soil is thrown, is adjustable. The auger is driven from the tractor power take-off by either gears or V belts. This is not only a terrace-building machine but a good unit for maintaining terrace contours, year after year.

Selecting Drags and Levelers. These include the V drag and the land leveler.
Fig. 687. The V drag is a convenient soil-moving unit for farm use.

Fig. 688. Using a V drag to form trenches for planting trees.
**V Drags.** These may be of wood or steel construction, but the latter are more durable and will better withstand the heavy and rather abusive use to which they are likely to be subjected when making and cleaning ditches. The main essentials of a V drag include a strong blade that can be removed for sharpening, a wing blade adjustable for width of set, an adjustment to control the tilt of the wing, and wheels or other device to control the depth of cut.

**Land Levelers.** These machines were illustrated and discussed in Chap. 1. Many types and sizes of these machines are available, and they are mainly used under irrigated conditions. They remove high spots and fill low spots in cultivated fields for the purpose of making irrigation easier and more efficient. Some of the features that any leveler should possess are a strong frame, an adjustable frame to
control the depth of cut or amount of soil to be moved, ability to pick 
up a load of soil smoothly and then deposit it evenly where it is 
wanted, suitability to the power available, enough width to level a 
broad strip accurately, and easy adjustability by the operator.

6. Selecting Miscellaneous Service Equipment

Selecting Manure Loaders. These operate as an attachment 
to a tractor. Either mechanical or hydraulic means are used in 
lifting the fork.

Any manure loader should possess the following features for 
maximum use and service: tine scoop for solid materials, tight scoop 
for loose and liquid materials, ability to be easily attached and 
removed from power unit, low headroom to get under sheds and the 
like, high lift of loads, tilt or suction of the fork, and automatic stop of
load where wanted. Loaders should also be adapted for handling gravel or snow, carrying logs, and doing other farm lifting.

Selecting a Power Post-hole Digger. Fencing usually necessitates a considerable amount of heavy digging work. A mechanical digger mounted on a tractor will do this work efficiently and will reduce the labor needs. A mechanical digger should be easily and quickly attached and detached from the tractor, be able to drill a perpendicular hole on any grade, protect the operators from the moving parts, withstand the strain of digging in all types of soil to the usual depth needs, and be adjustable to dig holes of any depth up to 3 ft. or more.

The usual size of post-hole auger is 9 in., but sizes from 4 to 12 in. are available. Other uses of these mechanical post-hole augers on the farm include digging telephone-post holes, dynamite holes for blasting stumps, digging holes for trees, and removing earth for building foundations.

Selecting Tractor Saws. Tractor-operated saws are of two main types: (1) for cutting standing trees and shrubs and (2) for cutting logs or other material into short lengths. The former has a large circular saw which can be operated at practically any angle. The second type is a unit-power buzz saw. This saw and rack are mounted on either the front or rear of the tractor and are usually operated from the belt pulley. Select a saw blade of sufficient diameter to avoid an
undue amount of turning the logs or cutting other wood members. Such turning involves heavy hand labor and slows down the cutting process. Consider the safety features of a tractor-operated saw.

7. Selecting Barn Equipment for Handling Hay

Selecting Hay Carriers. Hay is often stored in the loft or mow of general-purpose barns and dairy barns. An expanding demand exists for equipment to place hay in the mow because of increasing interest in barn curing or finishing of hay. Carriers are available in various sizes and designs for either forks or slings. A carrier with eight-track wheels or one with a long wheel base distributes the load more uniformly on the track. Four-wheel carriers have less friction than the eight-wheel type similarly mounted. Select a carrier with large rope or cable wheels, because the sharper the bend on the rope, the more rapidly it will wear. Then, too, there is less strain on the rope because on these larger pulleys the hoisting power is in direct ratio to the size of the pulleys. Roller bearings on carrier pulleys or wheels reduce the power requirements. Dust seals are desirable. To fill mows as full as possible, select a carrier that moves the hay load well up into the peak of the mow roof. Where a track is already in

![Fig. 692. Types of hay carriers. (A) Sling-type carrier for double track. (B) Fork-type carrier.](image)
the barn, of either metal or wood construction, make sure that the wheels of the carrier selected are adjustable to the track. In center-drive barns, a different type of carrier is available with one rope to hoist the load and others to move it along the track.

**Slings.** These are usually loaded more heavily than forks; however, they do not have to undergo the strain of tearing the hay apart as it is lifted from the hayrack. Select slings when the hay is very dry, loose, slick, or short, as these types of hay may not handle well with some forks. A ratchet-rope wheel takes some of the strain off the rope and prevents the load from slipping back. Some farmers, however, contend it damages the rope. Consider such features on their merits when selecting a carrier for use with slings. Slings are made with rope or chain, and they may have slat spreaders. Select slings that are adjustable as to size; for short hay, those with more ropes, chains, or slats, to reduce the size of mesh.

**Forks (Harpoon or Grapple).** These require more effort at unloading than slings, while slings may slow field loading. Grapple forks are
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Fig. 694. Several types of hay-hoisting equipment. (A) Sling. (B) Grapple fork. (C) Double-harpoon fork. (D) Rocker-type fork. (E) Spread grapple adapted for baled hay. (F) Loose-tine grapple fork.
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available with either rigid or loose tines. The loose tines are flexible and set separately to pick up almost any desired size of load, and do not require the operator to lift the entire fork. Select the grapple, loose-tine, flexible type of fork for short, dry, or loose hay; the harpoon fork, particularly with a single tine, works best where the hay does not slip apart as it is hoisted. Six-tined grapple forks are not commonly used, but some do prefer them if large loads are handled or if the hay does not bind together.

Select rope or cable that fits the channels of the pulley wheels snugly and yet does not bind. If too small or too large for the pulley groove, it wears unduly. Be safe by having all pulleys of the same groove size, and use with these a hay rope or cable of the recommended size. Cable is usually $\frac{3}{16}$ or $\frac{5}{32}$ in. in size and many users are replacing manila rope with such cable.

_Drum-power Hay Hoists._ Employed on many farms, these hoists may also be used for hoisting baled hay, hoisting grain, cleaning wells, and lifting boxes. Power hoists speed up the job of putting hay into the mow; at the same time, they can be more accurately controlled than the horsepower type. When selecting a power hoist, see that either weights or double drums are provided so the fork or sling can be returned to the hayrack without hand pulling; for center-drive barns, have a triple drum to move hay either way and return the fork or sling. See that the hoist has safety brakes in connection with the clutch; some prefer having the hoist operated by the person on the hayrack in order to avoid misdirection of operation and at the same time reduce labor needs. When the hoist is located in the barn, use electric motor power for safety reasons. Select V belts and have at least two sizes of pulleys available.

_Hay Mowers._ These distribute the hay to both sides of a mow as it is dropped from the fork or sling, saving considerable heavy hand work. Select a mower that can be easily and quickly moved into position to receive the hay and shunt it to both sides of the mow. Mowers operate on a double track, one on each side of the haycarrier track and parallel to it. Mowers give their best service in mows that are over 30 ft. wide.

8. Selecting Forage and Grain Driers

Driers for reducing the moisture in crops after they are stored, thus assuring a prime and safe product, are rapidly growing in favor.
Field driers are also available. Some forage driers and drier systems are available on the market, although most of them are constructed by the user. When selecting or constructing a drier, plan the air ducts carefully. A master air duct, metal or wood, through the center or along one side of the mow, is generally used; lateral air ducts, metal or wood, leading from the master duct, rest on the floor. Control the amount of air passing into each lateral to meet the apparent needs of the forage stored in each part of the mow. Construct all ducts tightly to avoid any loss of the air prior to it passing out of vents in the laterals.

Air-duct systems in the mow are commonly planned as follows: The main duct when made of wood is tongue-and-groove lumber, while dressed lumber is used on the laterals; lateral ducts are spaced 4 to 5 ft. apart, extending not closer than within 5 ft. of barn sides; the lateral ducts are inverted troughs and raised 2 in. off the floor. Cross-sectional area of main duct limits air velocity through it to 1,400 ft. per min.; main duct at least equals the cross-sectional area of lateral ducts leading from it; and the cross-sectional area of lateral ducts equals the escape space at the bottom of the ducts. Slatted floors are often used in place of ducts.

The fan used to force the air through the hay is usually a multi-
vane, low-pressure type. It needs to be large enough to provide 10 cu. ft. of air per square foot of mow floor space per minute through the product being dried. The size of the fan can best be determined by consulting the agricultural engineering department of your state.
college. The size of the fan, speed of fan operation, type of fan, size of air ducts, general humidity, kind of product being dried, depth of product being dried in the mow, and directness of air ducts to point of escape under the forage being dried are a few of the factors to consider when an air-forcing fan is selected. It is sometimes desirable to heat the air forced through the forage to expedite the drying process. This may be necessary in humid areas.

![An experimental rice drier—necessary when rice is combined.](image)

Have ventilators or outlets sufficient to prevent back pressure upon the air being forced through the hay or other stored material being dried. An open cupola or mow doors will usually suffice to carry away the moisture-laden air.

9. Selecting Dairy-barn Equipment

**Selecting Stanchions.** These should meet the specific condition under which the dairy is being operated. This fact will have some bearing on the investment made in the equipment selected. However, in all cases, the comfort of the animal and the utility value of the article are of prime consideration. Stanchions are of the swinging, rigid, and chain-tie types. The latter is really a stall tie.

The *swinging* stanchion is usually preferred to the rigid type because it permits freedom of movement. The all-steel stanchion and the stanchion with a wood-lined steel yoke are generally preferred because they are neater, stronger, and easier to keep clean than those having complete wood yokes. Whether the stanchion yoke is of tubular
metal or lined with wood, make sure that it is smooth and rounding on the surface next to the animal. The U bar type, when lined with wood, is strengthened. An important factor to consider when selecting stanchions is the ease with which they can be installed and adjusted to the neck size of different animals. Select a positive yoke...
catch that is cow-proof and yet easy for the operator to latch and unlatch. In fact, a simple lever-locking device which enables the operator to lock or unlock a string of cows with one lever movement, but which also permits individual animals to be locked or unlocked, is preferred by some. Others contend that this causes confusion among the cows leaving the barn. An alinement device to keep cattle, long or short, properly aligned with the gutter is available.

Rigid stanchions can be constructed of wood by the owner. For this reason they may have a lower initial cost. Some believe the rigid stanchions are preferable for the nervous animal, but the opposite is usually true. Some operators state that less feed is wasted when using the rigid type particularly if long hay is fed because it prevents the animals from throwing the feed underfoot. However, many advantages favoring swinging stanchions are lost in the rigid type. The average stanchion or stall of steel construction or of steel framework is easier to keep clean, is more readily disinfected, lessens the disease problem, is less clumsy, and reduces labor needs.

The chain-tie type of stall or stanchion permits the maximum of freedom of movement. In fact, it has such a small amount of restraint upon the animals that many do not use it for that reason. It takes longer to tie and release the animals with chain ties but, for particu-
Different Types of Stanchions

Fig. 702. Swinging type of stanchion.

Fig. 703. Another type of swinging stanchion.

Fig. 704. String of stanchions controlled by one locking device.

Fig. 705. Chain-tie-type stanchions.
Barn Equipment

Fig. 706. Individual stalls.

Fig. 707. Special calf pen for well-managed dairy farms.

Fig. 708. Hospital or maternity pens are desirable.

Fig. 709. Inside feed corner of bull pen.
larly quiet animals and for some show stock, they do offer some advantages.

For bulls and any other animals difficult to restrain, select stanchions or stalls built specifically for them. This is a safety feature that needs to be carefully observed. Other stanchions and stalls are available in size and strength for calves. When installing any type of commercial stanchions or pens, use the manufacturer's instructions for the construction of feed mangers and feed alleys.
Selecting Barn Pens. These pens for calves, bulls, and maternity purposes are a necessity in most dairy barns. They need to be convenient to the production herd and yet sufficiently secluded to ensure their most effective service. Such equipment of approved design, strength, and service is made by companies manufacturing other dairy-barn facilities. When selecting any of these, make sure that they are of a size to meet the needs and constructed to provide the service, safety, sanitation, and protection of the herd. Cows during the maternity period and calves require kind and considerate treatment under the most sanitary conditions (see page 689).

Selecting Water Bowls. The use of water bowls is a sanitary method of providing water to meet the continuous needs of an animal. Many tests show an increase in production of 10 to 20 percent when water bowls or drinking cups are used as compared with cows watered twice daily at an outside tank.

Select bowls that are durable enough not to become easily damaged, easy to clean, simple to drain in freezing weather, with no-spray plates if water is under pressure, and protected from hay or other feed that might clog them or interfere with the flow of water. Some owners prefer water bowls that serve two cows. This reduces the cost of installation and upkeep. Where the bowls are carefully aligned, the use of a governing tank with a float eliminates the need for
valves at each cup, but each cup must be so constructed as to keep dirt and feed out of the water-supply pipe. This type is less sanitary and is not so common as those with a valve at each cup.

**Selecting a Litter Carrier.** This barn device aids in expediting the cleaning of barns and materially reduces the amount of manual work; it usually increases the effectiveness of the manure as a fertilizer. The same kind of track is often used for carrying litter and feed.

![Fig. 714. A litter carrier with differential chain hoist to assist in raising when loaded.](image)

Select a track strong enough to handle the various loads around the barn. Select a litter carrier of a convenient size for a man’s use and requiring a minimum number of loads per day. The usual size is from 7 to 10 bu. in capacity, but larger and smaller sizes are available. Any carrier must be liquid tight, easy to dump, carried by trolleys that operate easily, moved along the track easily at any elevated position, made entirely of metal so it can be thoroughly cleaned, and have a differential hoist on the carrier to reduce lifting effort. If the litter carrier operates on a cable track, be sure the track has a tension bolt to keep the cable taut at all times. In some places, the regula-
tions under which milk is produced prohibit the use of carrier tracks in the barn. In this case, select a floor truck to carry the litter container, which may then be moved out of the barn when filled and placed on the track for removal to the point of disposal (Fig. 716).

_Gutter cleaners._ When operated by electric motors, these devices remove litter from dairy-barn gutters in a few minutes. They consist of a series of hardwood cleaning paddles securely fastened to a chain. When in operation, the paddles convey the gutter material to one end of the barn and either deposit the material in a spreader or in a pit, or elevate it to the spreader. The electric gutter cleaner is a real labor saver, especially for larger herds. However, it increases the number of parts to be cleaned to maintain dairy-barn sanitation requirements (Figs. 717 and 718).

**Selecting Feed Trucks.** Some dairymen use an overhead track and carrier system similar to that used for litter. Make its selection in a similar manner. If feed trucks with wheels are used, select those that have either solid rubber tires or pneumatic tires, or that have flat-faced wheels broad enough and of sufficient circumference to roll easily between feed room or silo and the feed mangers along the feed alley. If there is a feed-alley track, use flanged wheels.

Any feed truck not on a track should have a pair of wheels 10 to 18 in. in diameter and a swivel-mounted or caster wheel about 5 to 8 in. in diameter. Select a truck of a size to work conveniently in the feed alleys and negotiate cross alleys. Many trucks are approxi-
Where regulations prohibit the use of carrier tracks inside the barn, it may be well to use a litter truck or combination truck. (A) Truck inside the barn. (B) On a carrier track outside the barn.
Fig. 717. Diagram of an electric gutter cleaner.

Fig. 718. Electric gutter cleaner in a dairy barn.
mately 30 in. deep, 30 to 36 in. wide, and 60 to 72 in. long. Have one end and preferably both ends of the box sloping to facilitate the scooping of feed. When constructed of lumber, the boards should run lengthwise of the truck as an aid in scooping. An overhead cross

FIG. 719. Feed trucks operating on overhead tracks simplify feeding and reduce feed losses.

FIG. 720. Feed trucks mounted on rubber tires reduce chore time. Note caster wheel.

member on the truck for a scale to weigh feed is helpful. Where different feeds are carried at the same time, select a truck with solid divisions. Metal or metal-lined trucks are more durable and easier to clean than wood trucks, although silage and wet beet pulp may corrode some metals.
10. Selecting Dairy-product Equipment

**Selecting Milkers.** Mechanical milkers are available in single, double, and even larger units. Single units are preferred where individual milk-production records are kept, although double units are popular with a few dairymen. The size of herd and the amount of help available determine in large measure the number of milking units. Many large dairies employ a single milking unit for each 25 or 30 cows, and plan on 3 to 5 min. to milk each cow. Local conditions, herd production, size of herd, power available, and returns from dairy products are factors to consider when determining whether a milker should be purchased and the number of units to secure.

There are many kinds of milkers on the market, and they vary somewhat in construction, but the general principle of using a vacuum pulsating method to withdraw the milk is common to all. Select a milker employing a principle as near as possible to the natural method, which is alternately a lively, exercising, and stimulating pull and a massaging action, resulting in fast and thorough milking. Select a milker that is simple in construction, light in weight, and durable;
FIG. 722. The milking parlor of a show herd.

FIG. 723. Diagram showing the construction and operation of a milker. When the vacuum is applied to the teats, milk flows. When atmospheric air enters the teat-cup inflation, the teats are massaged.
that has a sanitary design with each part being easy to clean, teat cups simple to attach and detach, teat cups that do not creep up on udder, uniform weight distribution of teat-cup cluster; that is fast and thorough in milking; that has safe vacuum regulator, uniform vacuum, low power requirements, a simple vacuum pump that is of sufficient capacity, and a device to keep vapor from the milk and milk out of the vacuum line.

Selecting Cream Separators. There are many makes of cream separators on the market, each of which has its merits. The cream separator is often considered the indispensable machine for farmers and dairymen, unless all of the milk produced is sold as whole milk. Cream separators are available in many sizes using hand, belt, or direct motor power. Milk, and particularly sour milk, is inclined to be corrosive; therefore, all parts containing milk or through which the milk passes need to be of a nonrusting, smooth, stainless-steel construction. The use of ball bearings and the protection of all drive gears from dust or moisture are desirable features. Other desirable features are a bowl of the right height, easy to operate; uniform skimming at varied temperatures; parts easy to clean; base that permits cleaning beneath the machine; ease of assembling and disassembling; and ease of adjusting and lubricating (Figs. 725, 726, and 727).
Selecting Coolers. The value of immediately cooling milk after it has been drawn is well recognized by health authorities. Therefore, quick cooling is a must regardless of the kind of cooler selected. Since all types of coolers work under moist conditions, and many use salt or brine, both of which are corrosive, it is essential to select coolers that are rust resistant throughout in order better to assure uninterrupted service.

Refrigeration is a process of cooling by removing heat and is done either by the use of ice or by mechanical means. The mechanical refrigerator or cooler is available in several kinds of cabinets, such as the "reach-in cooler" which is similar to a large home-type refrig-
SELECTING GENERAL-SERVICE MACHINES AND EQUIPMENT

Fig. 726. Electric-motor-driven cream separator.

Fig. 727. An adjustable pail shelf is a desirable feature.
FIG. 728. Milk coolers reduce the temperature of the milk rapidly, thus reducing bacteria activity.

FIG. 729. Six cans of milk in a cooler.
Fig. 730. Sketch showing the operation of refrigeration. (1) Cooling coils in the tank. (2) The expansion valve. (3) The motor-driven compressor. (4) The radiator for dissipating heat from the returned liquid.

Fig. 731. A home storage unit for frozen foods.
erator; the "plain cabinet," or box, in which just cans are placed; and the larger cabinet permitting a person to enter and often referred to as a "walk-in cooler." All must be well insulated.

The heat within these cabinets is removed by a heat-absorbing unit known as an "evaporator." The refrigerant in the evaporator is a liquid that absorbs heat as the refrigerant vaporizes. The refrigerant then carries away heat that is dissipated through the condensing unit somewhat similar to an automobile radiator located outside the cabinet. A fan forces air over the coils of the condenser which changes the treated vapor back to a liquid. This process is continued over and over again as the cooling need continues. Another fan circulates the air in air-cooled cabinets to expedite the cooling (Fig. 730).

The mechanical cooler that holds milk cans is available in many sizes. Most of these units hold from 4 to 12 milk cans of 10-gal. capacity. Such coolers can be expected to reduce milk to 50°F., or less, in 1 hr. Agitators in these boxes and other kinds of cabinets hasten the cooling process and cool the product uniformly.
The walk-in cooler is similar in operation to the plain cabinet except that it is larger, enabling a person to enter, and has provision for storing different kinds of products. Since walk-in coolers are commonly used for purposes other than cooling dairy products, consider size when selecting this piece of equipment. Dairy products quickly absorb flavors and odors; therefore, a separate and tight division for the dairy products may be necessary.

An aerator is used to cool milk before it is placed in a cabinet cooler or walk-in cooler. The aerator is a series of cooled coils over which milk passes slowly in a thin, sheet-like stream. For farm use, one with a capacity of 50 gal. per hr. is most often preferred. When selecting an aerator, make certain that it is made of nonrusting material and can be easily, quickly, and efficiently assembled, disassembled, and cleaned. Some aerators have cold water flowing through the upper coils and chilled water or a refrigerant in the lower coils.
Fig. 734. An aerator quickly cools freshly drawn milk.

Fig. 735. One type of family-size milk pasteurizer that assists materially in combating increasing cases of undulant fever among farm people.

Plain water-tank coolers and brine ice tanks for cooling milk are sometimes used by the farmers who derive part of their income from dairying. The present-day farmer who is primarily a dairymen will generally select a mechanical cooler. Many water-tank and brine
coolers are homemade. When constructing one of these, allow space of at least 3 in. between cans for circulation of the cooling liquid, and an open-frame rack in the bottom of the tank to allow circulation at that point. Provide for agitation of the cans to allow for quick and uniform cooling. Make sure that the cooling liquid comes to within about 3 in. of the top of the cans. When using water, have it enter at the bottom of the tank and pass out at a point near the top of the cans.

Selecting Farm Pasteurizers. Family-size pasteurizers are available to protect the milk that is consumed on the farm or that supplies a small number of customers. They are available in 8- to 10-qt. capacities. Pasteurizers are recommended only where there is a mechanical cooler to cool the milk immediately after pasteurizing.

SUMMARY
1. Conditions vary greatly in a country the size of the United States; thus, it is apparent that the same piece of equipment is not always equally well adapted in all sections for the same purpose.
2. Our soils are lower in plant-food nutrients than when the American Indian was displaced. This condition can be corrected by applying annually the fertilizer required that year by the crop or by replacing large quantities of needed plant food, returning the soil to its original value, and then maintaining that level.
3. Crop residue left on the soil surface at all times is excellent for reducing wind and water erosion.
4. The liquid part of barnyard fertilizer is high in available plant nutrients; therefore, a watertight spreader that is acid resistant is desirable when manure has a high liquid content.
5. A manure or fertilizer spreader must distribute evenly, be adjustable for quantity spread, resistant to corrosion, and of sufficient size to reduce labor. For liquid spreaders, an agitator is also necessary.
6. Feed-processing mills are of the Burr and hammer type. Burr mills crack and crush grains to varying degrees of fineness while hammer mills using swinging hammers also reduce roughage to a size governed by a screen mesh.
7. The roughage mill is a combination machine, often combining the principles of the Burr and hammer mills, and uses cutter knives similar to an ensilage cutter. This machine is excellent to mix feeds and even to separate out all or part of the grain where the entire grain plant is processed.
8. Seed-cleaning machines sort, grade, and clean seeds according to size, shape, surface coverage, specific gravity, and a combination of these features.
9. Some of the types of seed cleaners are disk, belt, gravity, fanning, and sieve, or a combination of these.

10. Spraying and dusting machines from hand to engine-power size are used in the control of plant diseases and pests.

11. Sprayers and dusters can be had that are specific for row crops or trees, while others are suitable for both purposes. These machines are adjustable for row width, angle set of nozzles, amount of product sprayed or dusted, and pressure of application.

12. The usual sprayer-tank capacity is twelve to fifteen times the maximum spray capacity in gallons of the pump per minute. Tanks are seldom over 300 gal. in capacity, although some pumps spray as much as 60 gal. per min.

13. Airplane dusters and sprayers cover up to 20 or more acres per minute and are particularly desirable when ground conditions or the crop may hinder the conventional method of spraying.

14. There are many kinds of soil-moving machines such as scrapers, graders, roll-over rotary and standard fresnos, carryalls, bulldozers, elevator graders, terracers, V drags, and levelers. These machines are used for terracing, pond construction, making and cleaning irrigation and drainage ditches, and land leveling as needed in irrigated areas.

15. Select soil-moving machines of a size suited to the power available.

16. Manure loaders that are used for many other purposes are attached to tractors, and may be either mechanically or hydraulically controlled; the latter are more easily handled and therefore preferred by most farmers.

17. Power post-hole diggers attached either to the front or to the rear of tractor or combination power unit are available for one- and two-man outfits and can be had to dig holes of varying depth and width.

18. Tractor saws are available in types to cut either standing timber or logs. Use a blade of sufficient diameter to avoid turning of logs.

19. Hay carriers for slings and forks, either harpoon or grapple, are available for single track, double track, and cable track, and in four- and eight-wheel types with either roller or plain bearings. To reduce cable or rope wear, use a carrier with large pulley sheaves.

20. Power hay hoists may also be used for many other lifting purposes. Double drums permit returning the hay fork or sling as well as lifting the load. Drums need to be large enough to avoid damaging the cable and rope by bending it too sharply.

21. Hay mowers to spread the hay in a mow as dropped from a carrier are labor savers in wide mows of over 30 ft.

22. Forage and grain driers permit the storage of feed having too much moisture for the standard storage method. Driers need a fan to deliver approximately 10 cu. ft. of air per square foot of mow floor space.
23. Stanchions are of swinging, rigid, and stall chain-tie types, and are of sizes to meet the needs of practically any livestock.

24. Water bowls have either a governing tank float or individual valve control for each cup. Milk production is often increased as much as 20 percent through the use of water cups.

25. Litter carriers, usually 7- to 10-bu. size, are preferred by many farmers. These have safety chain hoists and can be had with either cable or rigid track. Litter trucks must be used instead of carriers in some centers in order to meet milk-production regulations.

26. Electric or other power gutter cleaners are real labor savers. They have several working parts that may be difficult to clean in order to meet some milk-production regulations.

27. Feed trucks for grain or silage can be had in wood or metal and with or without divided bed to haul one or more kinds of feed. Large wheels and a caster wheel facilitate handling of these trucks.

28. Pens are available in size and strength to meet the needs for maternity pens, bull pens, calf pens, and lounging rooms.

29. Milkers for either electric or engine power, and from one to two or more units, are available. Many dairymen figure that a single unit can handle 25 to 35 cows, with each cow requiring 3 to 5 min. for milking.

30. Cream separators of many sizes are available to suit hand, electric-motor, or engine power. Larger sizes are usually preferred as they save time.

31. Cooling quickly is a must with milk to prevent souring and to hold down bacteria. Some types of coolers are walk-in, reach-in, plain-cabinet, water-immersion, aerator, and freeze-tank. The aerator is often used to cool the milk before it is placed in a cooler.
17. Operating and Servicing
General-service Machines and
Barn and Product Equipment

OPERATING and servicing general-service machines and barn and product equipment can be divided into two groupings: (1) items in more or less general use, such as manure spreaders, feed mixers, barn equipment, and all product machines, and (2) seasonal machines—fertilizer distributors, crop-protection units, hay-handling equipment, and seed sorters. Soil- and water-management machines can be considered in the latter group, although they are used at any season of the year.

Most machines in the first group are stationary or slow moving; thus, there may be a tendency to overlook some of the preventive maintenance program necessary to keep the machines in prime operating condition. Machines in this group can be checked and serviced as soon as service is needed. If this is neglected, wear or poor adjustment will accelerate. This results in poor efficiency and loss of product.

Machines in the second group, similar to other field equipment, require operation skill and servicing either during operating days or at the end of the season.

Operating and servicing general-service machines and barn and product equipment will be discussed under the following headings:

1. Operating and Servicing Plant-food Distributors
2. Operating and Servicing Feed-processing Machines
3. Operating and Servicing Seed-cleaning and Sorting Machines
4. Operating and Servicing Crop-protecting Machines
5. Operating and Servicing Soil- and Water-management Machines
6. Operating and Servicing Miscellaneous Service Equipment
7. Operating and Servicing Barn Equipment for Handling Hay
8. Operating and Servicing Forage and Grain Driers
9. Operating and Servicing Dairy-barn Equipment
10. Operating and Servicing Dairy-product Equipment
1. Operating and Servicing Plant-food Distributors

Operating Manure Spreaders. These implements are built to be moved slowly, and have a rated capacity and travel speed.

![Image of manure spreader](image1)

**Fig. 736.** When the two-wheel spreader is detached from the tractor, it should be placed on a level area with the hitch readily accessible for the next trip.

![Image of manure spreader](image2)

**Fig. 737.** A spreader-box rear-pan attachment is desirable for conserving liquid manure while it is being transported from the barnyard to the field where it is to be spread.

Observe these features in order to secure maximum efficient service. In freezing weather wet manure may freeze, locking the conveyor in place. Check this, and if it has occurred break the manure loose.
Fig. 738. Position of drive chain on one spreader (A) when not in use, (B) when in use. Check the spring tension to prevent the chain from contacting the driving sprocket when not in use.
before operating. In general, the other operating instructions to follow when working with a manure spreader include loading within prescribed limits; driving team or tractor slowly; keeping beater clean; keeping all bearings adjusted, clean, and adequately lubricated; adjusting conveyor to an even tension on both sides to avoid undue strain on the bearings; using the brake as required; and keeping ratchet or other feed device clean. When pneumatic tires are used, keep them properly inflated and after each job remove thoroughly all barnyard manure and other material destructive to rubber.

![Figure 739](image)

**Fig. 739.** Keep ratchet and ratchet drive clean.

*Liquid-fertilizer spreaders* are to be cleaned thoroughly after each use because the product handled is often corrosive. Inspect the agitator and distributive unit carefully and keep in sound working condition.

**Operating Lime Spreaders.** Lime sowers and commercial fertilizer distributors usually handle a product that hardens quickly with a little moisture. Therefore, thoroughly clean these machines after each use. In fact, do not leave any fertilizer or lime in the machine overnight. Operate these machines slowly and carefully, giving particular attention to the feeding unit. Keep the feeding mechanism adjusted and firmly set at the feed desired per acre. Protect these parts by screening the lime or fertilizer to prevent foreign objects from clogging or breaking the feeding mechanism. Keep the agi-
tator, feed unit, and other moving parts turning freely with proper lubrication. Align sprockets and hook-link chains and set at a tension to avoid climbing the sprocket wheels and yet not tight enough to

Fig. 740. Lime spreading, like grain drilling, should be done uniformly.

Fig. 741. Lime spreaders should be cleaned after each day’s use to prevent any of the material from solidifying.

injure the bearings. For commercial fertilizers, check the placement mechanism of attachments frequently. Observe the placement of fertilizer closely in order to assure the most satisfactory use of the product.
2. Operating and Servicing Feed-processing Machines

Operating Feed Grinders and Hammer Mills. Whether using a plate, hammer, or combination mill, keep the following facts in mind:

1. The power for grinding is about the same for the different types of mills.
2. The excessively fine grinding of grain or roughage increases machine wear and increases the cost for power.
3. The power and cost of grinding increase as the moisture content of the grain or roughage increases.

![Diagram of Feed Grinder](image)

4. Grinding grain requires less power than grinding most roughages.
5. Operating at excessively high speed increases machine wear and uses more power; speeds that are too slow are not practical.
6. The peripheral speed of hammer mills, rather than the r.p.m., affects the grinding.
7. The use of a feed table is essential when grinding roughage.
8. The use of knives for the first reduction in a roughage mill increases the uniformity of product and uses less power.
9. Sharpen the knives frequently and adjust them to the cutter bar in order to save power and provide a uniform product.
10. The grinding of roughage containing grain should be fine enough to crack all of the grain, unless a separation is made of all or part of the grain for other uses.
11. The repair bill increases as lubrication, adjustment, and sharpening are neglected.

12. Keep all sprockets and driving chains aligned and adjusted.

The careful operator inspects the feed going into a grinder or chopper to remove foreign objects that may damage the machine or affect the quality of the feed. Furthermore, he endeavors to keep the feed moving uniformly into the machine but not beyond the rated capacity. Having the grain pass over magnets as it flows to the machine, and also screening the grain, will remove many undesirable foreign objects.

**Operating Hay Chopper.** This chopper has many features that are similar to the field hay chopper discussed in Part IV. Several of the items mentioned for the feed grinder and hammer mill also apply to the hay chopper. Make sure that this machine is operated uniformly at the rate specified, that knives are sharpened frequently, that knives are adjusted to operate evenly and closely to the cutter bar, that bearings are closely adjusted and adequately lubricated, and that the roughage is fed uniformly.

3. Operating and Servicing Seed-cleaning and Sorting Machines

**Operating Fanning Mills.** The main principles to follow in operating the fanning mill include the following: Set machine firmly in a position recommended by the manufacturer, run uniformly at the speed recommended for the kind of grain being cleaned, adjust the air to remove a maximum amount of foreign material without loss of seeds, select screen or screens that are specifically designed for the seeds, adjust the seed flow to allow the amount of seed that the machine can adequately handle, clean the screens and other parts when clogged, set the machine where air currents will not work adversely with those of the machine, and lubricate all moving parts according to the instructions but avoid over lubrication which may cause oil to mix with the seeds. Frequently check and tighten all bolts, screws, and other fasteners because the continuous vibration has a tendency to loosen many parts. An electric motor is the most uniform power source available. Many of the above recommendations apply to several other kinds of seed cleaners and sorters. With any machine, adjust bearings of moving members. Avoid the clog-
ging of spouts, conveyors, belts, and other methods used to move seed either to or from the machine. With gravity machines, as well as with other machines, keep all inclines smooth and dry.

4. Operating and Servicing Crop-protecting Machines

Operating Sprayers. Although these machines are comparatively simple, the best results are obtained by an operator familiar with them. A conventional, medium-size orchard sprayer with a 20-gal. per min. pump and a 300-gal. tank weighs approximately a ton; 300 gal. of water weigh 2,500 lb., then with the spray men and extra equipment quite regularly hauled on the sprayer, the total weight approaches 2½ tons. The load is lightened rapidly, however, and, in case of steep grades or soft hauling conditions, these places can usually be negotiated after part of the liquid has been applied elsewhere.

Fill the tank sprayer regularly with clean water and spray the chemical in the order of mixing recommended by its manufacturer. Spray mixtures are definite chemical formulations. For best results, use according to the manufacturer's instructions. Unless otherwise instructed, keep the sprayer agitator running from the time the first chemicals are added to the water until the last of the spray material is delivered on the trees or plants. Spraying is usually started in a
certain part of an orchard or field depending upon the slope of the land and the direction and velocity of the wind. In some cases, it is desirable to spray with the wind; under some conditions, it is most effective to spray quartering the wind or even directly against the wind. In such a case, the spray pump discharges the material against the wind and then the wind carries the material back, securing coverage on both sides of the fruit, foliage, or row crop being covered. Select nozzles of a size suited to the job and, if spraying a field crop,

![Image](https://via.placeholder.com/150)

**Fig. 743B.** Taking advantage of the wind in directing a high-pressure sprayer.

set the nozzles and wheels for the row width and adjust the arms to the proper angle with the crop. Maintain the pressure and use the spraying schedule recommended by experiment stations.

The daily care of the sprayer calls for careful checking of gages and agitator and lubrication of pump, engine, and other operating parts. At the end of the day's spraying, clean nozzles, hose, pipes, and both the inside and outside of the sprayer. This is a must for satisfactory sprayer operation. The smallest amount of spray material left to dry in the pump or in the spray-gun nozzle can cause unsatisfactory work and hours of delay when the equipment is used again. Drain all parts of the pump and engine in freezing weather. In the periods between spray applications clean the equipment, fill
the tank, whether wood or steel, with water and protect the machine from weather.

Many hours of valuable spraying time will be saved during a season if small service parts are kept with the sprayer. These include gaskets, hose couplings, an extra length of hose, an extra spray gun, nozzle disks, and a complete set of service tools. Toolboxes are regularly supplied with sprayers. Having small parts readily available may save hours of delay that would otherwise occur. Follow the instructions of the manufacturer, experiment stations, and the dealer so the modern sprayer will give desired service over a period of many years.

**Dusters.** Maximum benefits from crop dusting will require careful operation, adjustment, and maintenance of the machine. The use of a dust mask is advisable when using some kinds of dusts. Other pointers for avoiding trouble and obtaining best results are

1. Always keep dust materials dry.
2. Prevent twine, bits of paper, or other objects from getting into the dust hopper. Check the agitator parts and dust-feed opening occasionally to prevent possible interference of such materials with the proper feeding of the dust.
3. Avoid below-normal fan and agitator speeds; keep belts properly tightened and see that ample power is delivered at all times.
4. Maintain constant field speeds when the dust-feed setting and ground speed are properly adjusted for the required dust dosage. With present machines, ground speeds of 3.5 m.p.h. or less can be expected to give more effective applications than higher field speeds.
5. Keep the dust hopper at least one-fourth full of dust to avoid irregular rates of application.
6. Learn the points of the plant at which good dust application is most vital and adjust the duster nozzles accordingly. Readjust in subsequent applications as required by the growth of the plants.
7. Lubricate bearings only as recommended by the manufacturer and use only clean lubricants.
8. When any high-speed ball or roller bearing becomes worn, inspect and adjust or replace promptly.
9. Have belts and minor repair parts quickly available so that the crop-protective program will not be interrupted.
10. Empty the dust hopper when the machine is to remain unused for several days and protect parts subject to rust or corrosion by spraying or painting with a rust preventive.
11. Remove any caked accumulations of dust, especially on the fan or in the dust-distribution system.

12. The useful life of the flexible tubing can be increased by turning on the outlets occasionally and also by reversing the ends to distribute wear from abrasive dusts.

5. Operating and Servicing Soil- and Water-management Machines

Operating Earth-moving Machines. Hitch the slip scraper, whether pulled by tractor or draft animals, as close as possible to the power in order to secure maximum efficiency. When draft animals are used for power, protect them by having the traces long enough to avoid the singletrees hitting their heels when dumping the scraper. If the soil is rather hard, plow it before scraping. This makes the scraping job much easier for both the operator and the power unit.

The fresno is handled similar to the slip scraper; as with the latter, avoid turning so short that the power unit becomes entangled with the scraper or fresno. Adjust the rotary fresno to the soil for the amount of cut to pull uniformly. Regulate the dump trip to spread evenly the soil when that is desired.

The carryall is generally used as a custom machine to cut and fill to grade. Set the grade stakes accurately to avoid unnecessary work in either the cut or the fill. All parts such as elevator, carriage, dump device, and hitch must be kept in proper adjustment, adequately lubricated, and repaired.

On soil-moving machines, maintain a sharp blade at an angle to move the earth with the least effort. Set the blade to get the cut desired but angled sufficiently to permit a free movement of the soil. Since earth-moving machines are usually operated under considerable strain, check all parts frequently to keep bolts tight, gearing fully meshed, moving parts adequately lubricated, and bearings properly adjusted.

When elevator graders are used, adjust the belts and rollers to maintain sound working conditions. Keep the operating mechanism clean and free of foreign material that may adversely affect the operation.

Land Levelers. These are used mostly to prepare land for irrigation purposes, and vary in size and type. When the leveler employs a blade with scoop, set it to cut off the high points gradually and then
Fig. 744. Building a terrace. First, the land or field is surveyed and stakes placed on the terrace center line for the proper level or contour. Then terraces can be constructed with plows, terracers, or graders. (A) After making the top of the terrace on the first round, measure its base width by walking ahead of the tractor and machine. (B) Using a disk plow to build the terrace. (C) Using a road grader as a terracer for large jobs.
deposit this material evenly in the low places. Plowing before leveling facilitates the job of earth moving. Use elevation stakes to aid the operator in leveling the field. A rigid frame and wide cut are desirable features. When operating the machine, keep the blade sharp, bolts tight, levers in sound condition, and all parts in repair.

**V Drags.** Such drags generally move loose soil or clean out irrigation laterals. Keep the blade sharp and scouring. Set the arm or wheel for the angle of penetration desired. Next, set the width of cut consistent with the ditch being cut or cleaned. Some V drags have their depth of cut partly controlled by the hitch.

**Rotary Terraces.** Maintain the auger, chisels, and other devices that cut the soil and form the terraces. Follow the lines set for the
terraces recommended by soil-conservation specialists for the area. Operate at speeds that move or throw the soil the desired distance. Observe moving members and keep them snugly adjusted.

6. Operating and Servicing Miscellaneous Service Equipment

**Operating Manure Loaders.** When attaching manure loaders to a tractor or other motive power, bolt or clamp the loader securely into position. Frequently inspect drums, cables, gears, clutch, and other operating parts of mechanically operated forks or scoops. Shield moving parts that endanger the operator. With hydraulically operated loaders, check all connections to avoid loss of the fluid and see that all controls respond readily.

Use a scoop-like fork with solid sides, bottom, and back when handling sand, gravel, and very loose and liquid manure. For packed manure or manure containing a lot of straw or stalks, use a fork scoop to facilitate penetration.

To avoid undue strain on the fork arms and connections when handling manure that is compacted, it is essential for the fork to strike the manure at right angles. Inspect all braces and arms at frequent intervals to keep these parts in proper operating condition.

**Operating A Power Post-hole Digger.** The cautious operator feeds the auger into the earth at a conservative rate. This avoids
unnecessary strains and enables him to know when he encounters roots, rocks, and other obstructions. Although one man may operate some mechanical diggers, the job is expedited if one person can devote his time to the digger and another to the tractor. Marking the place for holes before digging will generally assure an accurate job. Keep the auger bit sharp and all moving parts and gears lubricated. Clean and protect the auger surface after each job in order to assure scouring.

Operating Tractor Saws. Allow the saw to attain full operating speed before beginning to cut the wood and avoid choking the saw by forcing the wood too rapidly. Always take care to feed the wood straight to the saw and thus prevent pinching or wedging the blade in the kerf which wastes power and endangers the operators.

Maintain a sharp saw at all times. As the length of the teeth becomes worn too short, the saw blade is to be gummed, jointed, sharpened, and set according to the manufacturer's directions. Soft and wet or green woods demand a saw with more set to the teeth.
than do dry or hard woods. A cautious operator and working crew are essential for safe performance.

7. Operating and Servicing Barn Equipment for Handling Hay

Operating Barn Mowing Devices. Keep haying machines, like other equipment, in prime working order. Hay is a crop that cannot wait. Handle it quickly and on time. Have the hay sufficiently dry to avoid danger of spontaneous combustion or spoiling.

![Method of arranging bales and placing the grapple hooks.](image)

Keep the carrier-truck rollers, pulleys, and fork or sling catch lubricated. Avoid getting lubricant on fiber ropes. Adjust sling loads so they will pass readily through mow doors. When using a harpoon fork, load the hay in thick layers, working from one end of the hayrack to the other, keeping the middle full so that it will bind the loads as hoisted into the mow. When an open-framed hayrack is used with a harpoon fork, take care that a prong does not extend through the rack and lift the rack along with the hay.

The operator of the hoist, whether by team, truck, or other power, must be in a position to hear the orders of the other crew members. Use a steady team for hoisting hay.

Birds may build nests on the hay-carrier track. Remove them before using the mowing equipment. The debris from birds and
poultry is damaging to carriers and may affect their efficient operation. Keep a canvas or other protective cover over the carrier when not in use; better still, prevent birds and poultry from roosting in the barn.

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**Fig. 749.** Hoisting five bales of hay with grapple hooks. The operator stands back for safety.

8. Operating and Servicing Forage and Grain Driers

In order to assure the safe drying of all forage, the amount of new material added each day must not be beyond the capacity of the drier. Freshly cut hay has 75 to 80 percent moisture. Normal field wilting usually reduces forage to 60 percent moisture or less. This must be reduced to 25 percent or less by forced air before barn storage is safe. Add new layers uniformly and loosely over the mow. Keep all air ducts closed that are below forage not in need of drying. Provide adequate ventilation to remove the air as it passes through the damp forage.
Inspect all air ducts before placing forage in the mow to make sure that there is no leakage. Leakage may occur through floors, along studdings, and through side walls. Also check the lateral and main air ducts for such obstructions as bird and rodent nests.

A minimum of 10 cu. ft. of air per minute is needed for each square foot of mow floor; thus a mow floor 40 by 50 ft. needs 20,000 cu. ft. of air per minute. Use a fan rated to supply the amount of air needed. For drying, operate the blower only when the air is dry enough to absorb moisture from the hay. During rainy spells and at night, operate the machine about 1 hr. out of three to six, depending on the humidity, to prevent heating.

9. Operating and Servicing Dairy-barn Equipment

Inspect the stanchions periodically, tighten bolts, straighten pipes, and make necessary adjustments as to size of stanchion and the freedom of movement permitted the animals. Some stanchions need to have the trip and catches of the yoke lubricated to prevent wear and to make it easier for the operator to latch and unlatch. Remove all
sharp and pointed obstructions which may endanger the animals. Stalls and stanchions made of wood lack the permanency of steel stalls and are more difficult to clean and disinfect; therefore, health standards and production are harder to maintain. For these reasons, it is more costly and difficult to maintain installations of wood on a basis to meet rigid dairy inspection.

Whenever an attendant walks through the feed alley, have him inspect and clean the water bowls as he finds it necessary. An exces-

Fig. 751. Cleaning water bowls is a sound practice that assures the cows' receiving the desired quantity of clean water.

sive amount of feed in the bowls generally indicates that they are set too low. This is readily corrected, but do not set them so high that the cows cannot use them. Water bowls can be cleaned easily; the modern dairyman cleans them as he would his own drinking utensils. During freezing weather, drain the pipes and bowls. If a governing tank is used to maintain a common water level in all bowls, it is essential that the bowls be set at a uniform height in relation to the governing bowl. Leaky valves and bowls must be given immediate corrective attention.

Move all loads slowly to the pit or manure spreader and return the carrier in the same manner to prevent strain or damage to any parts.
Fig. 752. Push the litter carrier out at a uniform safe speed.

Fig. 753. Dump the litter carriers, either in the manure spreader or a manure pit, as soon as they are filled.
Set the automatic trip firmly at the point where the load is to be dumped. At no time, let the carrier strike the trip or dead end of track with damaging force. Keep the trolleys well lubricated and, if a differential chain hoist with brake clutch is used, the bearings require lubrication. The carrier should be kept under cover and, if washed off after each use, the danger from corrosion is lessened and the fly menace reduced. Install the litter-carrier track with the carrier close to the edge of the gutter when in use. This reduces the forking distance of the manure and lessens the danger of spilling manure in the alley during loading. Keep the track firmly supported and, if a cable track is used, keep it taut by use of a turnbuckle or other tightening device.

Operate gutter cleaners as part of the daily chore duties. Keep the chain and sprockets clean. Flush the gutters and cleaner parts after use.

Keep the wheels of feed trucks adequately lubricated and the face of the wheels clean to facilitate handling the truck with ease when loaded. Care must be taken when scooping grain or other feed into or from the truck not to lift and damage any parts with the scoop. Overhead feed carriers are similar to litter carriers and require the same attention to maintain prime service.
10. Operating and Servicing Dairy-product Equipment

Daily servicing of the mechanical milker to keep all parts clean, sanitary, and in good working condition, is essential for clean milk.

Keep the following points in mind when operating a milker: Udder and teats must be dry and clean before teat cups are attached; use soft teat cups of the right size; sterilize teat cups between use on each cow; attach and detach teat cups carefully without letting them contact unsanitary objects; use proper vacuum; equip with a device to keep milk vapors and splashing milk in the pail from the vacuum line; maintain airproof pail seal; empty pails before milk is drawn into vacuum line; inspect all tubing daily for cleanliness as well as for breaks or poor attachments; wash all parts carefully and sterilize them after each milking; keep vacuum-pump connections snug and all moving parts lubricated according to specifications. Some machines can be regulated to take care of the easy- and the hard-milking cow.

When the cow is properly trained through the fast milking principle, by massaging the udder and other means, the milking may be completed in three to four min. Some dairymen consider it advisable to strip out the last by hand.

Maximum success in using a mechanical milker will be achieved when the milker and machine are both liked by the cows, there is no unnecessary confusion in the barn, the milking and feeding follow a definite routine, the udder and teats are washed in warm water and massaged just before milking starts and stripping is done immediately after the milker is removed (see pages 732 to 736).

Daily attention to the separator governs, in large measure, the length and efficiency of service rendered. Observe the following instructions: The milk is always uniformly mixed and separated at the same temperature; separation is made as soon as possible after the milk is drawn; obtain proper machine speed before beginning to separate; maintain uniform speed; lubricate parts according to direction (Fig. 758); set the machine firmly and level; clean all parts after each use just as carefully as any table utensil (Fig. 759); keep the machine in a clean place away from flies or other insects; and use care when assembling, cleaning, and disassembling the machine to avoid damage to parts. Machines with a solid base are sometimes difficult to clean from underneath the base. (See also pages 737 to 738.)
FIG. 7554-C. Preparing the barn and cows for the production of clean milk. (A) Ground lime stone spread over the floor, sweetens and dries the barn. (B) Clip the cow's udders, flanks and rear leg shanks closely to facilitate cleaning. (C) Regular grooming removes dust and dirt. (See also Fig. 7557-F.)
Preparing the barn and cows for the production of clean milk.  

(D) Wipe each udder with damp cloth freshly wrung from chlorine solution.  
(E) Foremilking with a strip cup helps produce milk with low bacteria count and is a check on the health of the udders.  
(F) Immerse the teats in a proper chlorine solution.
Fig. 756 A-B

Fig. 756. Sanitary milking procedure. (A) Put the teat cups in place quickly. (B) Support the milker if it is hung on cow. (C) Many dairymen dip the teat cups in a chlorine solution between cows as a safety precaution. (D) Weighing and recording the milk weight. Some dairymen have an especially prepared chart for these operations. (E) Milk is strained, separated, and placed in a cooler.
Fig. 756 C-E.
Fig. 757. Cleaning the milking machine. (A) Rinse teat cups and rubber parts in cold or lukewarm water promptly after use. (B) Brush and wash milker in hot water. (C) Take teat-cup cluster apart and clean inflation thoroughly. (D) Clean all parts—metal and hose. (E) Reassemble milker unit; then draw considerable scalding water through it. (F) After the milk cans have been cleaned and sterilized, they are placed on the drain rack in a clean and protected room. This procedure is essential in producing clean milk.
Set the aerator on the cooler to assure a uniform, thin stream of milk in keeping with the known cooling capacity of the machine. If cold water is used in the top half of the tubing and chilled water in the lower half, a faster flow of milk can be used than if well or spring water is depended on to do all of the cooling. Have the water flow in at the bottom of the tubing and out at the top. Keep the tubing smooth, and thoroughly rinse and clean all parts after each use.

Water-tank coolers must have the water flow in at the bottom and out at the top of the tank. Keep can lids slightly ajar and stir the milk frequently to ensure quick and even cooling. A can agitator is preferred to stirring. Have a continuous movement of water completely around the cans including the bottom. Keep a cloth or other protection over the cans when lids are not closed tightly.

Place cans in ice or brine boxes to ensure ice space or brine space.
completely around the can. Make certain that the agitator of the cans is sufficient to ensure even and quick cooling. Keep all covers of the box closed tightly to prevent undue melting of ice or lowering of brine temperature.

![Diagram](image)

**Fig. 759.** For proper care of separators, cleanliness is as important as it is in the case of milking machines. (A) Remove and clean all metal parts. (B) The three steps in disassembling the separating disks. (C) Washing the disks in a cleaning solution. (D) Rinsing the disks before drying.

Walk-in coolers and cabinet coolers are storage refrigerators for cans of milk that usually have been cooled previously by an aerator or other method. Store cans and other products here exposing as much surface as possible, and avoiding contact with other cans or surfaces. Store only those products in the cooler that are free of odors.
which might be picked up by and affect the quality of such things as milk and cream unless separate, tight divisions are used.

Clean and disinfect all tank and mechanical coolers frequently. Cleanliness aids in assuring the delivery of a prime product to the consumer. The mechanical coolers may need to have their cooling units defrosted in order to perform economically and efficiently.

Follow carefully the directions of the manufacturer when performing this job. Do not break the ice off the cooling unit.

SUMMARY

1. A large number of general-service machines and pieces of equipment are either slow moving or stationary. This results in a tendency of the farmer to overlook service requirements.

2. Operate slowly the plant-food distribution machines and clean the barnyard material from rubber tires if the machine is to be idle for a few days.
3. Thoroughly clean lime sowers and commercial fertilizer distributors at the end of each day's use because lime is quickly affected by moisture and may harden and corrode.

4. The cost, power requirements, and machine wear of feed grinders and roughage mills increase with the moisture content and fineness to which grains and roughages are ground.

5. Peripheral speed, rather than the r.p.m., affects the grinding with hammer mills.

6. The repair bill of feed-processing machines increases as lubrication, adjustment, sharpening, and proper operating speed are neglected.

7. Operate fanning mills uniformly at the recommended speed, using the proper screens and with the machine securely set at the level suggested by the manufacturer.

8. When spraying, give consideration to slope of land, wind velocity, wind direction, nozzles for the crop, pressure, the size of the crop or trees, row width, and set of nozzles.

9. Thoroughly clean all nozzles immediately after use and also clean the tank, pipe, hose, and pump.

10. Sprayer tanks are usually kept filled with water between sprayings during a season.

11. When soil is very hard, it is often profitable to plow the ground before using soil-moving machines to level or otherwise change the surface.

12. For leveling purposes, use a wide machine which has a rigid frame and which will shear off high spots and fill in low spots.

13. Keep all cutting edges sharp on soil-moving machines.

14. When making terraces, the machine operator must carefully follow the stakes set for the contour lines and levels.

15. Follow the recommendations of soil-conservation specialists when developing terraces.

16. When mechanically controlled manure loaders are operated, the moving parts are to be shielded as a protection to the operator. For hydraulically controlled loaders, the connections through which the fluid passes must be kept tight.

17. For solid manure use a loader scoop having tines. For gravel, sand, liquid manure, and loose manure use a scoop having a solid bottom, sides, and back.

18. Mark the place of post holes and sharpen the auger before operating the power post-hole digger.

19. Have tractor saws at full operating speed before beginning to cut wood and avoid cutting into wood that has embedded metal pieces. When cutting wood with gravel embedded in the fibers, keep the gravel side down as wood is fed to the saw.
20. When hay is to be unloaded with a harpoon fork, load the hay in deep layers keeping the middle full in order to assure full-sized loads when unloading.

21. Keep all air ducts of forage driers tight and force about 10 cu. ft. of air each minute through the forage for each square foot of floor space. During rainy spells, as well as at night, operate the blower 1 hr. out of every 3 to 6 hr.

22. Check all water bowls daily to keep them clean and operating properly.

23. Keep the track level and cable track taut on litter carriers and avoid having the carrier striking the end of the track with a jarring force.

24. Hose off all litter carriers and gutter cleaners daily as one step in sanitary milk production.

25. Clean and sterilize the milking machine after each use and check to see that all connections are tight and that the teat cups are of proper size and soft.

26. Keep udders and flanks of cows clipped. Clean teats just before milking and massage the udder lightly to stimulate milk flow.

27. Thoroughly clean the separator after each use and operate it at a uniform, recommended speed.

28. Avoid storing products with a noticeable odor near where dairy products are stored, unless they are in sealed containers.

29. Cans of milk in coolers must be stored to permit air or liquid to circulate completely around the cans and under the bottom. Frequent stirring hastens the cooling process.
18. Reconditioning and Storing General-service Machines and Barn and Product Equipment

PROGRESSIVE farmers realize that it is just as essential to recondition and store this type of equipment as it is to recondition and store crop-production machines. Such farmers periodically check over all their equipment to put it in prime condition for continued service. Permitting equipment gradually to go into disrepair without reconditioning may be the result of several things. Perhaps it is used daily or so seldom that the gradual wear and tear go unnoticed; it may be stationary or slow moving and, therefore, very little thought is given to its need for reconditioning; daily use does not provide an idle season for reconditioning; or the operator thinks that it does not pay to bother with the reconditioning of anything but machines used in the production of crops.

Reconditioning and storing general-service machines and barn and product equipment will be discussed under the following headings:

1. Reconditioning Plant-food Distributors
2. Reconditioning Feed-processing Machines
3. Reconditioning Seed-cleaning and Sorting Machines
4. Reconditioning Crop-protecting Machines
5. Reconditioning Soil- and Water-management Machines
6. Reconditioning Miscellaneous Service Equipment
7. Reconditioning Barn Equipment for Handling Hay
8. Reconditioning Forage and Grain Driers
9. Reconditioning Dairy-barn Equipment
10. Reconditioning Dairy-product Equipment
11. Protecting and Storing General-service Machines
12. Removing General-service Machines from Storage

Clean all machines before servicing. During the servicing, examine and tighten all nuts, studs, bolts, rivets, and cotter keys.
Replace any that are broken, damaged, or lost with new ones of the same size. After servicing, clean, adjust, paint, and lubricate.

1. Reconditioning Plant-food Distributors

The following is an outline of suggested jobs in reconditioning a horse-drawn manure spreader:

1. Inspect drive pawls and springs in rear wheels.
2. Inspect feed pawls and springs.
3. Replace pawls and springs after cleaning. Lubricate.

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4. Inspect ratchet wheel and bearing. Clean ratchet teeth.
5. Inspect feed-control lever and check to determine if the rod is straight.
6. Inspect beater-control lever and check to determine if the rod is straight.
7. Check gage bar and straighten, if bent.
8. Inspect and clean bearings of conveyor drive shaft and front conveyor drive shaft. Repair and replace as needed and then lubricate.
9. Clean grease tubes leading to conveyor-shaft bearings.
10. Inspect and clean bearings of beater and wide-spread device. Service and replace as needed and then lubricate.
11. Straighten, replace, and tighten beater teeth.
12. Inspect spiral beater and repair as needed.
13. Remove, clean, and replace broken hook-links, and then oil the hook-link belt for the beater and wide-spread device.
14. Properly replace all hook-link chains according to direction of pull.
15. Inspect endless conveyor chain, replace broken links, and adjust slot connections to proper tension.
16. Inspect and repair main sprocket drive.
17. Check and tighten lugs on drive wheels.
18. Inspect front wheel truck and axles. Clean, service, adjust, and lubricate.
19. Inspect, service, and adjust hitch, eveners, and pole.

Some major jobs specific to liquid spreaders to be checked when reconditioning are as follows:
1. Inspect distributor and adjust to spread the material uniformly.
2. Inspect container and repair any leaks.
3. Inspect agitator and service.
4. Inspect gears, sprockets, and other driving mechanisms for needed adjustment and service.
5. Clean thoroughly and paint or apply other protective material. Some use an asphalt-base paint to overcome the corrosive effect of the manure.

Although lime spreaders vary in size and type, some of the major jobs to be checked when inspecting them include
1. Inspect feeds to adjust each similarly for even distribution, and repair broken or worn parts.
2. Inspect agitator and straighten or service.
3. Inspect scattering board and service.
4. Inspect wheels—clean bearings, adjust, and lubricate.
5. Inspect hopper to tighten and repair all damaged parts.
6. Examine gears, sprockets, and hook-link chains. Align these and adjust.
7. Inspect feed controls and make sure that the gage is correct. Calibrate if gages are not accurate.

The lime sower can often be used to sow fertilizer but, frequently, the commercial fertilizers are distributed by drills or planters which actually deposit the material in the soil. This fertilizer is often planted or drilled in a definite relationship to the crop and is a part of the same machine that planted the crop. The reconditioning of such a fertilizer drill or attachment is similar to that of the grain drill or planter.

2. Reconditioning Feed-processing Machines

Reconditioning Feed Grinders. Mills that have knives require the knives to be sharpened daily or more often when the mill is grinding steadily. The time used in sharpening will be made up several times in the increased capacity of the mill and the power saved. Grind the knives at the original angle and then adjust in proper relation to the cutter bar. Whether the bar is adjusted or the knives are adjusted, they are to be set as close together as possible and yet not strike each other when the mill is running. An adjustment of \( \frac{1}{8} \) in. too much between the knife and bar may increase power needs by 75 percent. This fact emphasizes the need for accurate and close adjustment. Keep the bearings of the cutting assembly fitted closely in order to permit accurate adjustment between knives and cutter bar.

The grinding plates will gradually wear smooth, reducing the speed of grinding accordingly. For this reason, replace the plates before they consume too much time and power to perform the job economically. Some of the major jobs to perform when reconditioning a feed grinder are to

1. Sharpen knives to the original angle.
2. Adjust knives as close to cutter bar as possible without striking.
3. Fit bearings of cutting assembly as close as is practical without preventing them from being adequately lubricated.
4. Recondition face of cutter bar or replace if badly damaged.
5. Inspect spring adjustment on grinding plate and, if not sufficiently strong, replace.
6. Inspect grinding plates and replace with same size if worn sufficiently.
7. Inspect feed control to replace parts, and then adjust.
8. Test machine while operating under load for speed and then adjust power or pulley size to obtain speed specified by the manufacturer. First align the pulleys or gears under proper tension.

9. Inspect all grain-elevating devices or blowers and service as needed.

10. Examine dust eliminator and tighten all connections, using gaskets in connections if essential.

11. Inspect all bearings, and adjust or replace parts if needed.

12. Inspect safety release, and adjust so it will operate freely.

Reconditioning Hammer Mills. Many of the reconditioning jobs listed for the feed grinder apply also to this machine. The screens and rotor are items that are rather specific to the hammer mill.

Examine and clean the screens carefully and service when needed. The usual service is to straighten the screen when bent or weld in parts damaged by foreign objects getting into the mill. Hammers are often damaged by foreign objects and also worn through use.
Replace badly worn and damaged hammers and inspect the others for refacing. This refacing, which is resharpening, is done according to the directions for the specific machine.

Maintain a balanced rotor when hammers are sharpened or new ones used. Carefully follow the instructions provided with the mill on replacing hammers. Such things as rotor out of balance, mill poorly anchored, and loose bearing bolts cause undue vibration.

**Reconditioning Hay Choppers.** The instructions for reconditioning the cutter part of a feed grinder cover many of the jobs in connection with this machine. Check the feeding table carefully to make sure that the elevator operates under the proper tension. Also examine the feed rollers and repair or adjust adequately to handle the feed being cut.

3. Reconditioning Seed-cleaning and Sorting Machines

**Reconditioning a Fanning Mill.** Keep all the screens in a smooth and undamaged condition, replacing those that are distorted, cut, torn, or broken. Aline all pulleys, sprockets, and gears after they have been cleaned. Inspect and service the fan, fan housing, and belt or other drive to the agitator and eccentric vibrators. Tighten fasteners on the machine at frequent intervals.

**Reconditioning Disk and Cylinder Cleaners.** Inspect the cylinders and disks. Replace if damaged. Check the hoppers on disk cleaners to be sure that each collects seeds from the proper disks. Check all moving parts for lubrication and other apparent service needs.

4. Reconditioning Crop-protecting Machines

**Reconditioning Sprayers.** These machines need careful reconditioning between seasons, besides daily servicing when in use, if proper service is to be secured. Some of the jobs to be checked and performed as necessary when reconditioning are

1. Carefully wash out all spray material.
2. Service the engine as discussed in Chap. 15.
3. Inspect all drains on sprayer and motor to make sure that they open and close properly. Drain and leave open during freezing weather.
4. Cover all parts such as valve stems, rocker arms, and springs with oil to prevent rusting.
5. Remove ball valve on suction side of pump to clean and sand lightly. Replace if badly pitted.

6. Remove ball-valve seat and grind by turning ball on it, using valve-grinding compound. Grind until seat is smooth. Then replace the ball.

7. Insert new gaskets under valve seat and head. Oil metal parts and replace assembly.
8. Inspect all valves and replace parts that are worn or leaky.
9. Remove nozzle, clean, and place in oil until used again.
10. Inspect spray disks on nozzle and replace if holes have enlarged to give a spray instead of a mist.
11. Inspect plunger caps and fill with a recommended compound.
13. Inspect pressure gage, clean connection, oil, and replace.

*Dusters.* The parts of these machines are similar to those of a sprayer and are to be fully reconditioned to be ready for the next season of work.

5. Reconditioning Soil- and Water-management Machines

**Reconditioning Scrapers.** The slip scraper and fresno are rather simple soil-moving machines but, nevertheless, they need periodical reconditioning. Some of the jobs include
1. Tighten runner straps on bottom of slip bucket.
2. Inspect bail to repair arms on bucket and hitch swivel. Straighten if bent.
3. Inspect blade of slip and hammer out damaged spots or sharpen.
4. Inspect handles and tighten or replace if broken.

The *rotary fresno* operated by a tractor should be carefully inspected and reconditioned in a manner similar to the fresno. Other jobs are
1. Inspect the catches and trip used when loading and dumping. Service worn parts or replace if badly damaged.
2. Inspect runner arms for needed repairs due to wear or damage.

The *carryall*, being a custom machine, is generally reconditioned by the owner. The elevator, carriage, engine, and other parts are reconditioned as mentioned elsewhere where similar parts are employed. The same applies to *bulldozers* and *elevating graders*.

**Reconditioning Land Levelers.** These cover a wide strip of ground and, for this reason, are more likely to become bent or broken. Carefully inspect the entire machine to make sure that all joints, braces, and other connections are firm and true. Sharpen the blade and tightly bolt into position. Inspect the levers, trips, and other cutting and leveling controls and repair all breaks or other damage.

The various graders used to move soil and to level land are similar in most respects and are handled together for that reason. Some common reconditioning jobs are...
1. Inspect blade. Remove to sharpen and service as needed.
2. Examine all gears and other parts to adjust the blade and wheels. Bring the gears into full mesh and carefully examine all arms and levers operating these parts to remove undue play.
3. Inspect all bearings. Adjust or replace.
4. Clean all bearings, gears, and other operating parts and then lubricate.
5. Examine all wheels. Straighten, repair, or replace damaged and worn parts.

The V drags need attention and reconditioning. Some major jobs include
1. Inspect blade, sharpen, and service. Note if bent and straighten such damaged parts.
2. Inspect width adjustment. Replace any bolts or other parts that hold it in proper position.
3. Inspect arm or wheel that controls depth. Adjust or replace wheel bearing if worn and, if arm is broken or damaged, it is to be either repaired or replaced.
4. Examine hitch and, if worn, repair to prevent field breakdown.

Reconditioning Rotary Terracers. These machines operate under a speed and strain that subject them to excessive wear. Carefully inspect all blades for sharpening, service, and replacement. Adjust bearings carefully and lubricate all moving parts as recommended by the manufacturer.

6. Reconditioning Miscellaneous Service Equipment

Reconditioning Manure Loaders. The mechanical and hydraulic types differ in some respects; however, the major jobs are common to both. The following are jobs to check for reconditioning:
1. Examine all arms and braces. Straighten, repair, and replace parts as found necessary. Bolt securely in position.
2. Examine the fork; sharpen teeth, replace broken teeth, straighten teeth, and service any damaged parts.
3. Inspect fork trips and catches. Repair or replace worn or damaged parts.
4. Inspect oil pump and replace parts that may be worn enough to lose oil.
5. Inspect cylinder that operates lifting ram. Replace worn or leaky parts.
6. Inspect all cables and drums. Repair or replace worn cables. Service drums as needed.
7. Inspect clutch. Replace worn parts.
8. Tighten bolts, nuts, clamps, and other fastening or holding devices.
Reconditioning the Power Post-hole Digger. Some of the reconditioning jobs for this machine are to (1) sharpen the bit to the original angle, (2) straighten any bent parts, and (3) clean the auger and cover with a heavy grease or other rust preventive.

Reconditioning the Tractor Saw. Some of the reconditioning jobs are to (1) service and bolt securely into place all safety devices, (2) service the feed rack and all of its parts, and (3) gum, joint, sharpen, and set saw-blade teeth as recommended by the manufacturer for the wood being cut.

7. Reconditioning Barn Equipment for Handling Hay

Recondition the hay carrier and track equipment as soon as possible after the haying season when the mow is full of hay because of the accessibility of the carrier and other equipment. When carriers have been reconditioned, cover them with canvas or store in a dry place where they will not be damaged by moisture, birds, or poultry. The debris from birds and poultry is very damaging to carriers and other mowing devices; therefore, prevent birds and poultry from roosting in the barns.

Reconditioning Barn Mowing Devices. These are grouped for reconditioning as follows:

1. Forks and slings
   a. Inspect levers, trips, and other moving parts. Straighten, repair, and replace as needed.
   b. Examine ropes and slats. Service and replace worn or damaged parts.
   c. Inspect tines, sharpen to original angle.

2. Tracks and cable
   a. Inspect track. Aline and make secure all rafter brackets and track hangers.
   b. Examine trip block and safety stop. Service as needed and set securely at proper place.

3. Carrier
   a. Thoroughly clean and then inspect.
   b. Adjust wheels. Set to track width.
   c. Inspect bearings. Check wheel bearings, service, and lubricate.

4. Rope, rope cable, and pulleys
   a. Inspect rope and cable. Repair and reverse ends if worn.
   b. Inspect pulley sheaves and bearings. Clean, lubricate, and turn sheave if worn.
5. Hoist
   a. Inspect clutch and brake. Clean and adjust.
   b. Examine hitch. Note if secure and tighten as needed.

   When lubricating the bearings of carrier wheels, pulleys, and other moving parts, avoid getting the lubricant on fiber ropes. If undue rope or cable wear is noted, it may be caused by pulley sheaves being too small in diameter or the sheave opening being either too narrow or too wide. A badly worn sheave can cut a rope, but this need to replace a sheave can often be delayed by either turning the sheave or pulley so that it will wear equally on both sides. Ropes or cables, whether in use or not, must not be exposed to moisture. Store ropes and cables in a dry place where they are protected from moisture, birds, and rodents.

   Keep the electric or motor hoist in a dry, protected place after it has been reconditioned, in order to ensure continued efficient service. Before placing any mowing device in use that has not been in use for some time, clean and lubricate it.

8. Reconditioning Forage and Grain Driers

   Inspect and recondition the motor and fan in order to assure their uninterrupted service when in use. Clean the bearings and lubricate them according to the manufacturer's directions. Protect the motor from the weather and animals by adequate cover or proper storage. Fans are frequently damaged by obstructions, and this necessitates the straightening or replacing of damaged parts.

   Unless permanently constructed, the lateral ducts should be removed and placed along the mow walls when they become exposed by hay removal.

9. Reconditioning Dairy-barn Equipment

   Some of the main items of stanchions to be inspected and reconditioned include the following:

1. All connections of the stanchion and stanchion frames. Tighten as necessary.
2. Stanchion catches and springs. Service and replace those that are worn, broken, or have weak springs.
3. All metal parts. Straighten any that are bent.
4. All wooden parts. Replace any that are rough or broken.
5. Clean all parts thoroughly and paint for protection and appearance.
The valve of the water bowl, whether individual or master valve for all cups, is to be checked to make sure that it seats evenly to control fully the flow of water. The float and hinge need careful inspection and must be serviced if worn or damaged. Carefully inspect and clean the water line to make sure that it will drain properly as needed for protection during freezing weather.

Because of the factor of uncleanliness that may prevail in the use of litter carriers and gutter cleaners, they are often thoughtlessly abused. Some inspection jobs to determine reconditioning needs include the following:

1. Thoroughly clean all parts so that they may be satisfactorily inspected and reconditioned.
2. Examine litter carrier for holes or other damage. Straighten out any bends, solder or weld over any holes, and replace any parts damaged beyond repair. Recondition any worn or broken parts of the bucket trip.
3. Inspect the differential chain hoists, brake clutch, and bearings, and replace parts worn beyond repair. Lubricate.
4. Inspect trolleys. Adjust bearings, but replace if sufficiently worn. Tighten all parts of the carriage and lubricate the bearings.
5. Inspect the track. Tighten all holders or fasteners, aline the track, fit all track switch controls, and firmly set the trip. Tighten cable-tension bolt and turnbuckle on anchor to make cable taut. Reset anchor if not solid.
6. Paint or otherwise protect all parts of the litter-carrier system. Painting the interior of the litter-carrier tub with an asphalt base paint offsets the corrosive effect of liquid manure.

Inspect the wheels of feed trucks to make sure that the axle bearings are not too loose and, if necessary, make adjustment. Examine the swivel or caster wheels and adjust as necessary. Lubricate after the wheels have been properly secured and adjusted. Examine the box and tighten any loose nails, bolts, or other fasteners and replace any boards or other parts worn or damaged beyond repair. The final job is to paint it on the outside after being thoroughly cleaned. Reconditioning of a feed carrier is similar to that outlined for a litter carrier.

10. Reconditioning Dairy-product Equipment

**Reconditioning Milkers.** There are many minor parts to a milker, but usually several of these are combined to form a major part. The main reconditioning jobs, often done by a special service-man, correspond to these major parts (Figs. 771 to 777).

1. Inspect teat cups and replace those that are cracked out of shape and those that have become hardened.
2. Inspect all tubing and make sure that all connections are sealproof. Tighten connections that are loose and replace cracked, broken, and leaky tubing.

3. Examine pail and cover. Clean and adjust air cock or replace if necessary. Replace seal rubber if not sound. Service or replace all other parts that are out of condition.

Fig. 769. Examine and replace any imperfect members of the teat cups and vacuum-line members. Unless there is perfect action, milking procedure may be interrupted.

4. Inspect pulsator for adjustment, replacement, and lubrication as recommended by manufacturer.

5. Inspect vacuum line. Tighten all connections that leak air. Adjust stall cocks. Test vacuum regulator and gage.

6. Inspect motor or engine that operates vacuum pump and adjust. Repair and lubricate.

7. Inspect vacuum pump. Tighten belt if slipping. Check the piston and replace rings if not properly sealing. Tighten all parts to prevent undue vibration.

8. Inspect all lubrication points. Clean, repair, and lubricate.
Reconditioning Separators. When a separator is given essential daily servicing and operating care, very little other attention is needed to most of the parts, but a thorough annual inspection is advised.

Some of the more common jobs to perform as found necessary by a careful inspection are to

1. Level the machine and bolt firmly to a solid footing.
2. Inspect spindle and spindle bearings. Replace, if worn.
3. Inspect driving and other gears and their bearings. Replace gears and bearings if worn sufficiently.
4. Inspect bowl, bowl parts, spouts, regulating cover, float, milk bowl, and milk spigot. Service any parts that have been damaged or replace if feasible.
5. Inspect frame, milk and cream shelves, and handle. Repair any damaged parts. Replace handle-ratchet spring if broken or weak.
6. Inspect speed indicator and check against careful timing over a period of 5 min. or more. Service as needed.
7. Inspect all points of lubrication. Clean and replace with clean oil or other recommended lubricant.

Fig. 772. A lye solution is sucked by the milker pump through the line into the vacuum tank from various stall cocks. If lye fails to unplug the line, sections are taken down and cleaned.

Reconditioning Coolers. The main servicing jobs for the aerator are to keep it level and to keep all joints tight and surfaces clean and smooth. Check the supply-can brackets to assure that they are held firmly and are adequate for the load, permitting the supply to drain completely. Inspect the water inlet and outlet and service as found necessary to keep the water pipe or hose-thread connections sound.
Water-tank coolers, besides receiving adequate cleaning, are to be checked to keep water inlet and outlet open. If the tank leaks, repair it; when tank covers are used, keep them fitted snugly.

Carefully inspect ice or brine boxes for any corrosion or other damage. Frequent and thorough cleaning usually prevents corrosion.

Walk-in and cabinet coolers need to have all openings fitted tightly; therefore, keep all seals sound. Door hinges and latches are to be checked and kept repaired as needed. The motor, automatic temperature control, and refrigeration units are special items that are seldom reconditioned by the operator.

11. Protecting and Storing General-service Machines

The tendency in some areas to delay the storage of a machine after its seasonal use should be discontinued. During this period,
when it is not in safe and protective storage, considerable damage often accrues to the machine. For this reason, it is good farm management to clean thoroughly and lubricate adequately the machines and then place them in storage immediately after the season of work has ended. Place machines under protective cover during the idle periods of the regular work season. The amount of labor and cost of reconditioning will be lessened, the life of the machine will be lengthened, and the operation will be more efficient when adequate protection and satisfactory storage are provided.

**Storing Plant Food-distributor Units.** The parts that handle or contain the liquid or solid barnyard fertilizers are subjected to their corrosive effect. Thoroughly clean these machines when placed in storage and further offset the corrosive effect of the fertilizers by
coating unprotected parts with an asphalt-base paint. Many commercial fertilizers take on a cement hardness as they absorb moisture from the atmosphere. Clean out such fertilizers immediately, taking care to remove all particles that may later disturb the effective use of the machine. Coat any unprotected polished parts with an approved rust preventive.

**Fig. 775.** The lid is straightened on a special lid ring to ensure a good fit between lid and pail, the check valve is examined to see that it seats properly, and the handle is straightened.

**Storing Feed-processing and Seed-cleaning Machines.** Many of these machines are kept under cover at all times. Whether in temporary or idle-season storage, it is imperative to provide protection from moisture. Canvas cover is often satisfactory protection for short periods when the machines are used in the open. During idle seasons, clean out all seeds, roughage, and foreign material that might attract rodents, birds, and poultry which often cause considerable damage. Such material may also decay and thus damage the
parts contacted. Cover with a rust preventive those unprotected parts which are bright or polished through use and are subject to rust damage. Remove belts and store them in a protected place when not in use. Store seed-cleaning sieves on edge in mouseproof boxes.

Fig. 776. Shells of milkers are checked for trueness, and air nipples are inspected for leaks. Inflations and gaskets are examined carefully for cracks, uncleanness, and signs of wear. New rubber should be put on periodically.

**Storing Crop-protection Machines.** The suggestions for storing plant-food distributors also apply here. Where storage space is limited, remove the mechanical and sprayer parts, organize them, and place in a dry, protected place. Place all stainless-steel ball valves in a can of oil or grease to prevent corrosion and pitting. Drain all parts of spray materials and water and clean out any dusting compounds. Wash the tank, pump, and all fittings with clean water. **Pump clean water through the system until the water comes out clean.**
Storing Soil- and Water-management Machines. Most of these machines are of the rugged or heavy type, although exposure subjects them to the same damage suffered by other machines. Some of the smaller machines can easily be placed on edge or end when in storage to reduce the necessary floor storage space. On other

machines, the cutting blades and such essential parts can be easily removed for storage where space does not permit the entire machine to be placed in protective storage. If they are stored outside, it is desirable to remove rubber tires and place the machines on blocks. Cover land-polished parts with heavy grease or anti-rust. Protect in a similar manner the gears and cutting parts of rotary terracers,

Fig. 777. The pulsator is taken apart, cleaned thoroughly, reassembled, and oiled. Here it is being adjusted for proper milking speed. The serviceman often stays for one milking to be sure that the machine is running properly and that the operator is handling it correctly.
Storing Miscellaneous Service Machines. Remove these parts or attachments when not in use. Usually it is possible to hang or hoist these up out of the way of other machines in storage. Keep all connecting parts in place or marked and attached to avoid loss of these items. Protect removed parts from the weather, birds, and livestock.

![Image](image_url)

Fig. 778. Clean the parts that are to be protected and then cover them with a rust preventive.

Storing Haying and Forage-drying Equipment. Most of such equipment is kept and used under cover and, therefore, needs only essential protection from rodents, birds, and livestock which the good farm manager provides. Store all ropes, cables, and carriers in dry places away from birds and rodents. Place canvas or other cover over these parts to keep away birds if they have access to the storage place. Rope can be sacked and hung by a wire from rafters, thus avoiding rodent or bird damage.
12. Removing General-service Machines from Storage

It is understood that all machines and equipment were thoroughly cleaned inside and outside when placed in storage. Furthermore, all moving parts had been adequately lubricated to force out old lubricants and foreign material and that polished parts were protected by an anti-rust coating. It is assumed that, during the idle period of the year, the machines were thoroughly inspected and reconditioned for the following season of use.

Reassemble all parts that were removed either for storage or for reconditioning. Remove the anti-rust coatings. This is usually done with a rag soaked in a petroleum solvent. Replace and adjust belts and other transmission of power parts. With pressure guns, replace grease in bearings and thoroughly lubricate other moving parts, removing old grease. Check all units of machines to remove any foreign objects. Operate the machine slowly at first; then stop and recheck to make necessary adjustments before putting machine into normal use. Such items as wooden containers for spray materials may need to be soaked to tighten them before placing into service.

SUMMARY

1. Progressive farmers periodically check and recondition general-service machines to keep them in prime condition.

2. Machines that spread liquid and solid barnyard fertilizers, after being thoroughly cleaned, are often painted with an asphalt-base paint to overcome the corrosive effect of the manure.

3. Grind knives of feed-processing machines at the original angle and then adjust in the proper relation to the cutter bar. An adjustment of the blades 1/16 in. from the shear bar may increase the power needs by 75 percent.

4. On burr mills, the grinding plates wear smooth. It is economy to replace these before they seriously reduce the speed of grinding.

5. On the hammer mill, replace damaged screens. Hammers that are badly worn or damaged are to be discarded. When refacing or replacing hammers, keep the rotor in balance to avoid undue vibration, which is also caused by a machine that is poorly anchored.

6. The sprayer reconditioning job includes checking the gages, repairing the pump, servicing all valves, and securely tightening all connections.

7. With soil-moving machines, sharpen all soil-cutting parts. If badly worn, these are to be replaced or built up and ground to correct shape. Then straighten bent parts, tighten locking devices, and adjust the machine as needed.
8. Dairy-barn equipment may be broken, bent, or loosened; therefore, correct these as a part of the reconditioning job.

9. The milker has many parts, but faulty or loose connections, pulsator out of adjustment, and vacuum pump in need of new rings are common reconditioning jobs.

10. Separators must be leveled when reconditioned, which may include bearing adjustment and replacement, checking of speed indicator, and testing cream-screw adjustment.

11. Mechanical coolers must have all openings tightly fitted to avoid unnecessary loss of cool air.

12. Plant-food distributors need to be stored in a dry place away from livestock and birds after they have been cleaned, polished metal parts covered with a rust preventive, reconditioned throughout, and then lubricated.

13. Clean the feed out of feed-processing machines before storing, and protect all cutting parts with a rust preventive.

14. Sprayers need dry storage. First clean and drain them, including all connections, nozzles, tank, and hose.

15. Soil-moving machines are often stored in the open. If this is necessary, follow the procedure of blocking them up from the ground, clean, coat all cutting and polished parts with a rust preventive, and then lubricate.

16. Rope used in haying can be sacked and hung by a wire from rafters and thus avoid bird and rodent damage. It is well to cover the carrier with a canvas or other cover to protect it from poultry and birds.
Correlated List of Visual Aids

The following list of visual aids may be used to supplement effectively some of the material presented in this book. The films and filmstrips here listed can be obtained from the producer or distributor given with each title. (The addresses of these producers and distributors are shown at the end of the bibliography.) Frequently they can be secured also from local sources such as film libraries or film distributors; from dealers or manufacturers of farm machinery, equipment, and supplies; or from the State Extension Service, the State Department for Vocational Education, or the Soil Conservation Service.

The running time (min) and whether the film is silent (si) or sound (sd), motion picture (MP) or filmstrip (FS) are listed with most of the titles. Those not listed as color (C) are black and white. All the motion pictures are 16mm unless otherwise indicated; the filmstrips are 35mm.

For all the motion pictures produced by the U.S. Office of Education (USOE), coordinated silent filmstrips and an instructor’s manual are available. In some cases other films and filmstrips have accompanying instructor’s manuals.

Not all the films listed are obtainable without cost. In many cases a rental fee is charged or transportation costs must be paid by the user.

A short description is given for most of the film titles; in other cases the titles themselves indicate the instructional use that can be made of the film.

Part I—Seedbed-preparation Machines

The Blacksmith’s Gift (Deere 40min sd MP). A Hollywood production telling the story of building the steel plowshare.

Farming for Victory (Sinclair 25min sd MP). Shows the care and maintenance of farm machinery for better service and longer life.
Hitching and Belting Pointers (Deere 10min sd MP). Shows correct hitching of both drawn and power-driven equipment, including belting pointers.

In Our American Way (Minneapolis-Moline 80min sd MP). A travelogue from east coast to west coast depicting the manner in which modern tractors and machines enable farmers to produce more food at less cost with fewer hauls.

The Inside of Arc Welding (GE 20min sd C MP). This film is in two parts of 10 min. each; one part covers the fundamentals of arc welding, and the other part deals with a-c welding.

Irrigation Farming (Soil Conservation 12min sd MP). Presents some irrigation problems and their solutions; also shows methods of planning and installing or revising farm irrigation systems. The film is limited to use in Arizona, Colorado, New Mexico, and Utah.

Land for Men (NFBC 15min sd MP). Emphasizes the need for soil-conservation practices and shows how Canadian farmers increased war production through conservation farming methods. Also shows ways in which the Canadian government is helping returned veterans to get established in farming.

Mules to Motors (Goodyear 10min sd MP). Depicts the manner in which farming has become mechanized, using humor and romance. Three other pictures in this series, each 20 min. in running time, are Scarecrows Are Not So Dumb. Scarecrow on the Loose. The Scarecrow Takes Up Magic.

My Model Farm (International Harvester 11min sd MP). Through comedy, a warning is made to those who are content with makeshift repairs about the farm.

Planning to Prosper (Allis-Chalmers 22min sd C MP). Describes the latest developments in farming practices with special emphasis on soil conservation, erosion prevention, and the rebuilding of worn-out soils.

Plow Operations and Maintenance (Oliver FS). Describes many important plow adjustments for improved performance.

Reconditioning a Two-bottom Tractor Plow (USOE 25min sd MP). Shows how to check and repair the wheel assemblies and the power-lift assembly, how to recondition the plowshares, how to adjust the colter, and how to check and adjust the furrow wheels in the field.
A Romance of Two Hemispheres (Massey-Harris 55min sd C MP). Describes the agriculture of several countries.

A Saga of the Soil (Minneapolis-Moline 45min sd C MP). A tour of the countries in the Near East, Africa, and Europe, where agriculture had its beginnings. The film also shows some of the agricultural methods practiced in those countries today. Three continents and fourteen countries are included.

First in the Hearts of Farmers (Am Plant 24min sd MP). Shows some of George Washington's agricultural experiences, including his emphasis on plant food in a well-rounded land-management program.

That Inspiring Task (Sears Roebuck 30min sd C MP). A graphic description of the agricultural programs developed by students of vocational agriculture.

Under Western Skies (International Harvester 28min sd C MP). Shows modern dry- and irrigated-farming practices in the West and Northwest.

Welding on the Farm (GE 20min sd C MP). Shows the applications of electric welders and how to use them on farm jobs.

Part II—Crop-planting Machines

Better Performance and Longer Life in Corn Planters (Deere 14min sd MP). Shows how to care, adjust, and operate both tractor and horse-drawn corn planters; how to inspect and check valves; how to align runners; what to do before starting to plant; and what should be done before storing the planter.

Home Vegetable Garden (National Garden 25min sd MP). Shows how vegetables are sown, transplanted, cultivated, and harvested.

In Common Cause (Soil Conservation 20min sd MP). Shows what soil conservation districts have accomplished; how they are formed and operated; and the big job yet to be done in this vital program for increasing crop production and saving our soil.

More Food from Fewer Acres (Case 20min sd C MP). Depicts irrigation and intensive farming under limited conditions.

Reconditioning a Grain Drill (USOE 31min sd MP). Shows how to inspect and repair a typical grain drill; how to clean and lubricate the fertilizer and seeding mechanism; how to repair disk-
furrow openers, drive chains, and panel assemblies; and how to calibrate the seeding mechanism.

Part III—Crop-tillage Machines

**Flame Cultivation** (NH 20min sd C MP). A good picture to show the operation of the flame cultivator and its application to several crops.

**Reconditioning a Cultivator** (USOE 14min sd MP). Shows how to replace a worn wheel boxing; how to adjust yoke; how to adjust toe-in of wheels; how to check and adjust shovels; and how to check and lubricate gang expansion and steering system.

**Soil and the South** (Tenn 20min sd C MP). Shows the development and application of a conservation-farming plan, including diversification, terracing, contouring, strip cropping, rotation, fertilizing, manuring, and crop management. Uses animated drawings to show how soil is built under natural conditions and destroyed by improper cultivation.

**Soil for Tomorrow** (NFBC 35min sd C MP). Story about the Canadian “Dust Bowl” and the soil- and water-conservation practices needed to prevent its recurrence.

**This Is Our Land** (Ethyl 28min sd MP). Presents a story of soil destruction in the United States and urges soil conservation. Explains the dependence of industry, commerce, and our high standard of living on the soil.

Part IV—Harvest and Harvest-handing Machines

**The Clean Cut** (Deere 11min sd MP). Shows how to adjust, repair, and recondition a mower cutter bar. The details of the picture apply to both tractor and horse-drawn mowers of all makes.

**Cotton Defoliation** (American Cyanamid 30min sd C MP). Depicts the removal of foliage by chemical means as an aid to mechanical picking of cotton.

**18 to 1** (Massey-Harris 12min sd C MP). Shows the development of the self-propelled combine.

**Food and Freedom** (Case 10min sd MP). Shows the development of farm power and machinery through 100 years, beginning with the cradling of grain and following the succeeding stages of
development up through the use of a modern combine with straw being picked up by a pickup baler.

**The Forage Master** (Fox River 33min sd C MP). Methods of putting up forage by field chopping.

**Golden Harvest** (International Harvester 10min sd MP). A beautiful pictorial story of the California citrus fruits; various steps in producing fruit are portrayed.

**Harvesting Native Grasses** (Soil Conservation 11min sd C MP). Shows modern methods of harvesting, cleaning, processing, and storing native grasses in a soil-conservation program.

**Hay** (Allis-Chalmers 40min sd C MP). Shows new methods of handling hay; when to cut and how to store hay; and how to keep pastures green.

**High Yielding Harvesting** (Case 10min sd MP). Shows the great variety of crops grown over the entire nation that are harvested by the modern combine to obtain maximum yields—a trave-logue presentation.

**Inside Story** (Allis-Chalmers 12min sd C MP). A description of the modern harvester with glass sides, showing how it processes the grain from the heads and then separates the loose grain from the straw and chaff. There are slow-motion sequences on threshing and cleaning.

**Into Tomorrow** (Massey-Harris 27min sd C MP). Shows high-production farm machinery stepping in to make farming easier and more profitable.

**It’s More than Hay** (International Harvester 20min sd C MP). Shows the importance of hay in livestock production and livestock products and its direct nutritional value to the food-consuming public. Includes a description of old and new methods, as well as new machines, for handling hay.

**Making Hay and Silage** (Gehl 16min sd C MP). (A new film.)

**Making Hay the Case Way** (Case 10min sd C MP). While portraying the advantages of Case hay tools, this film describes a method of producing top-quality hay of a uniform moisture content to save leaves, green color, and essential vitamins.

**Making Tractor History** (Deere 30min sd MP).

**Man with a Mission** (Minneapolis-Moline 74min sd C MP). The story of a boy and girl who, dissatisfied with farm life, meet and talk with a roving farmer. In relating his experiences with modern
farm machinery, the farmer convinces them that a farm can be run like a modern factory.

**Modern Haymaking** *(New Holland 20min sd MP)*. Shows several methods and equipment for handling hay.

**More from Your Mower** *(Case 15min sd FS)*. Detailed description of how a mowing machine works, the preseason tune-up of various models, and field adjustment to correct operating difficulties.

**More Grain in the Grain Tank** *(Deere 12min sd MP)*. Shows the proper operation, care, and adjustment of combines. The four principal internal operating parts of the combine are shown through animated drawings.

**One-man Harvesting** *(International Harvester 21min sd C MP)*. Shows methods whereby one man harvests crops, including cotton.

**Operating Your Combine** *(Case 15min sd C MP)*. Shows what crops can be harvested with a combine and how to adjust the combine for proper operation with varying crops and field conditions.

**Our Daily Bread** *(International Harvester 11min sd MP)*. Describes modern harvesting equipment, the transportation of grain to market, and the making of bread.

**Party Line** *(International Harvester 20min sd MP)*. Shows, in a humorous manner, the value of corn pickers over the hand husker.

**Principles of Electricity** *(GE 2min sd C MP)*.

**Reconditioning a Mower-drive System** *(USOE 21min sd MP)*. Shows how to remove the wheel assembly of a mower, clean and lubricate the parts, and replace worn panels and springs; how to replace worn parts of the drive shaft, remove worn drive-shaft bearings, and install new bearings; how to remove, clean, and inspect gear parts, replace worn parts, and reassemble the gears; and how to lubricate the drive system.

**Reconditioning a Mower Cutter Bar** *(USOE 21min sd MP)*. Shows how to check, recondition, and repair the cutter-bar mechanism; replace and adjust knife clips and wearing plates; align the ledger plates; adjust the cutter bar to the proper lead; and adjust the sickle for register.

**Saving Grain with Better Hay** *(Allis Chalmers 20min sd C MP)*. Shows a few ways to save grain by making hay at the proper time and in the proper way.

**The Sheppards Take a Vacation** *(Deere 35min sd MP)*. Depicts the change taking place in grain harvesting on small farms,
showing how the combine reduces harvest costs by saving time, labor, and hard work.

**Starting New Combines Right** (Case 30min sd FS).  
**The Story of Binder Twine** (International Harvester 12min sd C MP). The story of binder-twine manufacture, from the sisal plantation to the finished ball.  
**That the Millions May Eat** (Case 10min sd MP). Stresses the advantage of the modern combine in reducing grain- and seed-harvesting costs as compared to earlier methods of harvesting.  
**Two Seconds from Cutting to Threshing** (International Harvester 10min sd MP). Through slow-motion photography, there is shown what happens in a combine as the grain is separated and cleaned from the straw.

**Wonder Harvest** (Massey-Harris 20min sd C MP). Shows 500 combines of the self-propelled type, which cut over a million acres in the 1944 harvest.

Part V—Mechanical Power and Transportation Machines

**Care of a Tractor** (USOE 22min sd MP). Shows the day-by-day operating care of a tractor; the importance of periodic inspection; the parts of the tractor, including the cooling system, the fuel system, and the ignition system.

**Farm Care of Your Tractor** (Deere 40min sd MP). Shows the servicing, maintenance, care, and operation of the tractor; including the fuel, ignition, lubrication, cooling, and transmission systems.

**Farmer Miller Goes into High Gear** (Goodyear 30min sd MP).

**Old McDonald Had a Farm** (Atlantic 23min sd MP). Describes the many uses of tractor power on the farm.

**An Ounce of Prevention** (Sears Roebuck 25min sd C MP).

Produced in cooperation with the National Livestock loss Prevention Board, this film presents ways and means of preventing the livestock losses that often occur through improper care and handling.

**Starting New Tractors Right** (Case 15min FS). Servicing and adjusting a new tractor for better performance and longer life. (Speaker's manual available.)
Tractor Care on the Farm Front (Standard Oil 25min sd C MP). Shows how to care properly for the farm tractor.

The Wise Choice (Dearborn 20min sd MP). Describes the functions and advantages of tractor hydraulic control of implements.

Part VI—General-service Machines and Barn and Product Equipment

Broadbase Terracing (Case 10min sd C MP). A description with sketches and field scenes, using a one-way disk plow to build eastern- and western-type terraces.

Build Good Terraces with Your Own Moldboard Plow (Case 10min sd MP). Shows the round-by-round procedure advocated by the USDA Soil Conservation Service for terrace building with a standard moldboard plow.

Building a Pond with Your Own Farm Power (Case 10min sd C MP). Produced with the technical assistance of the USDA Soil Conservation Service, this film explains, by means of field scenes and animated drawings, how to build a farm pond.

Covering the Water Front (FEM sd FS). Prepared primarily for dealer education, this film explains how to estimate water, pump, and power requirements for providing a supply of water.

Death to Weeds (Dow 20min sd C MP). Destroying weeds through the use of chemicals.

Green Hay (GE 20min sd C MP). Shows the installation of barn hay driers and their operation.

Keep It Moving (International Harvester 10min sd MP). The age-old subject of proper utilization of fresh manure is given a different treatment in this picture.

Level Farming on Sloping Fields (Case 10min sd C MP). Describes three advantages of contour farming—the saving of tractor power, the production of higher yields, and the conservation of soil and water.

The Life of the Soil (National Fertilizer 28min sd C MP). Explains why plant food must be put back into the soil to replace amounts removed by crops and erosion. Shows the necessity of applying commercial fertilizers, green manures, and barnyard manures to keep the soil productive.

Machine Placement of Fertilizer (Am Potash 20min sd C MP).
Shows methods of applying fertilizer to California orchards, lettuce, and sugar beets with various types of apparatus.

**Permanent Agriculture** (International Harvester 30min sd MP). Shows why soil conservation is essential to prosperity; how to initiate a community soil-conservation program; and how to build terraces, lay out contours, and demonstrate conservation practices.

**Plant Speaks through Deficiency Symptoms** (Am Potash 25min sd C MP). Describes deficiency symptoms on field and orchard crops; discusses soil depletion, erosion, and the effect on crops of losses of plant food. Many other similar films are available from the same producer.

**Producing Quality Milk** (Association 27min sd MP).

**Rain on the Plains** (Soil Conservation 10min sd MP). Shows the cause and effect of wind erosion on the Southern Plains, and describes the steps taken to reclaim ruined land to produce good crops through contour tillage, terracing, strip cropping, windbreaks, and the construction of dams.

**Raindrops and Soil Erosion** (Soil Conservation 21min sd C MP). Describes both the cause of erosion and the correct use and treatment of land as the foundation of effective soil and water conservation.

**Soil and Life** (Case 10min sd C MP). Describes formation of soil over millions of years and how erosion can ruin it in a very short time; emphasizes practical measures being employed by modern conservationists, including barnyard and green manuring, strip cropping, and the building of terraces.

**Soil Conservation with Regular Farm Equipment** (Deere 20min sd MP). Describes three defenses against soil erosion—contouring, strip cropping, and terracing—and illustrates the use of standard farming equipment to carry out these practices.

**Strips and Curves** (Case 22min C sd MP). A soil-conservation film showing the basic problems of Great Plains farming. Colored action drawings and field-operation views show methods of control suitable for any area where both wind- and water-erosion problems exist.

**Terracing in the Northeast** (Soil Conservation 10min sd MP). Shows steps in building terraces, laying out terrace lines on contour, and establishing outlet channels for water; and portrays actual machine operation.

**Underground Raindrops** (US Electrical 45min sd MP). De-
picts the development and use of the U.S. vertical motor, which is used in deep-well pumping and irrigation.

**Welding Comes to the Farm** (Lincoln 24min sd MP).

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American Cyanamid Co., Agricultural Chemicals Division, Advertising Department, 30 Rockefeller Plaza, New York 20

Am Plant—American Plant Food Council, 910 Seventeenth St., N.W., Washington 6, D.C.

Am Potash—American Potash Institute, 1155 Sixteenth St., N.W., Washington 6, D.C.

Association Films, YMCA Motion Picture Bureau, 347 Madison Ave., New York 17

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GE—General Electric Co., Farm Industry Division, Schenectady 5, N.Y.

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Minneapolis-Moline Power Implement Co., Advertising Department, Minneapolis, Minn.

NFBC—National Farm Board of the Canadian Government, Ottawa, Canada

National Fertilizer Co., 616 Investment Building, Washington, D.C.

National Garden Bureau, 407 S. Dearborn St., Chicago 5

Oliver Corp., 400 W. Madison St., Chicago 6
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Standard Oil Co. of Indiana, 910 S. Michigan Ave., Chicago 80
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445 Park Ave., New York 22)
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