Points on the Selection, Adjustment, and Care of Farm Machines

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POINTS ON THE SELECTION, ADJUSTMENT AND CARE OF FARM MACHINES.

Wasteful practices with farm machines occur to a greater or less extent on almost every farm. These cause a very large annual loss. To prevent this loss the farmer should master the details relative to the selection, adjustment, and care of machines. This bulletin has been prepared to aid him in doing so.

Part I.

FACTORS RELATING TO THE SELECTION OF MACHINES

When buying livestock, a farmer will have certain factors in mind that will aid him in deciding whether or not to select a certain animal. It is just as important that he use similar factors when selecting his machines.

The Foundation.

As with buildings, so with machines; a substantial foundation is absolutely necessary. In machines, this foundation consists of the frame, which should be sufficiently strong to withstand all twisting and bending strains. Under some conditions a flexible frame is desired and in such cases the bearings provided for the shafts should be self aligning. A weak frame, unless provided with self-aligning bearings, will cause the shafts to bind, which results in excessive wear and draft. The frame need not be heavy; the lighter forms of structural steel are used extensively for this purpose and they are proving entirely satisfactory, as they provide a maximum of strength with a minimum of weight. These types are shown in Figure 1.

Materials.

A knowledge of the materials of construction will prove exceedingly helpful in selecting farm machines. A brief discussion of the different kinds of iron, steel, alloys, and wood used in machinery construction will therefore be presented here.

Cast Iron is generally used in making the casting and gears used on farm machines. The casting, of course, takes the form of the mold into which the metal is poured. Thus cast iron readily lends itself to the construction of very irregularly shaped parts. As this material is so brittle, the castings need to be made sufficiently heavy to withstand ordinary strains. In some cases the use of cast iron, especially if excessive, may well be associated with cheap and unnecessarily heavy construction. The appearance of a fracture of cast iron varies from a coarse, semi-crystalline gray in the poorer grades to a fine close-grained white in the better grades. It is not possible to bend or forge cast iron.
Chilled Iron is used where a wear-resisting surface is desired, as in chilled bearings and the faces of the parts of a plow bottom. The molds into which the metal is poured are provided with means for quickly cooling or chilling, thus producing a hard, close-grained and wear-resisting surface, which is capable of taking a splendid polish. Plow bottoms made of this material seem especially well adapted to the heavier clay soils as well as to the gravelly soils.

Malleable Iron. Ordinary cast iron is hard and brittle; when it is annealed, in order to make it tough and pliable, the product is called "malleable iron." It is used in machinery construction where hard usage would break cast iron, as malleable iron will bend without breaking. It is much more reliable than cast iron, and is nearly twice as strong. The parts, therefore, need not be made so heavy when malleable iron is used. This material is replacing cast iron, especially in the better grades of farm machines. Malleable castings have a
velvety-black appearance in the interior. Malleable iron parts are usually smoother than plain cast-iron parts and they will yield somewhat if strained. The very best grades of malleable iron can be forged.

Wrought Iron. This is the purest form of iron and is made by burning the impurities out of cast iron. It is very strong and is easily welded. Though well adapted to the frame work of machines, it is not generally used, owing to its cost. It should be employed where there is much shock and vibration because it does not crystallize and therefore snap off easily as does steel.

Steel is made by removing most of the impurities from cast iron. The carbon content of steel determines the use to which it is to be put. The higher the percent of carbon the harder the steel and the more easily it may be tempered. Steel is used extensively in the construction of the frames of machines. Forms of the steel used for this purpose have been shown in Figure 1. Light weight is com-

![Figure 2. Part of Plow Bottom, Showing How Soft-Center Steel is Made](image)

bined with great strength in these forms of steel. Steel, however, is not so easily welded and forged as wrought iron.

Cast Steel is a mixture of cast iron and steel. It is hard, tough, and strong. It is used where these qualities are desired, as in the construction of large gears on machines.

Soft-Center Steel is made by welding a layer of soft steel between two layers of hard steel. The soft steel supports the hard steel and prevents its breaking. Soft-center steel is used extensively in the manufacture of plow bottoms. It is a light, but strong material, and readily forged. Figure 2 shows a portion of a plow bottom and indicates clearly how soft-center steel is made.

Case-Hardened Steel is used chiefly for pins which are placed in hinge joints and for similar purposes. It is made by adding carbon to soft steel. This makes a very hard, wear-resisting surface.

Alloys. There are a number of alloys which are used for lining bearings. These alloys are spoken of as “anti-friction metals.” It is well known that two like metals rubbed together produce more fric-
tion than unlike metals under the same conditions. Cast iron, however, seems to be an exception to this rule. The alloys are used as bushings in bearings; since they are made of different material from the shaft which runs in them, the friction is reduced in this way. They are generally softer than the shaft so as to take the wear. The bearings may be easily provided with a new bushing when the old one becomes worn.

Bronze is an alloy of copper and tin. It is a harder material than brass and should be used where the bearing surface is of small area and the pressure exerted is great; as for example, in the wrist or piston pin bearings of gas engines. A softer material used under these conditions would soon be pounded out of shape.

Phosphor Bronze is an alloy of copper and tin and a small amount of phosphorus. The phosphorus makes the bearing harder and tougher. Especial attention should be given the lubrication of bearings provided with either bronze or phosphorus, as these materials are hard and will score or scratch the shaft if the bearing runs hot or dry. These materials are die cast, and it is possible to take out a badly worn bushing and replace it with a new one. Figure 3 shows replaceable bronze bushings used on the crank shaft of a mower.

Figure 3. Removable Bronze Bushings at Each End of Crank Shaft on a Mower.

Babbitt is an alloy that varies a great deal in its composition. Tin, copper, and antimony are used in the better grades. Lead is also used. Babbitt is one of the softest of the antifriction metals. It has a low melting point and a worn babbitt bearing can be easily renewed by pouring a new one as explained later. Because of its low melting point it will melt out of a hot bearing before the shaft becomes injured. Babbitt should be used where a large wearing surface occurs and where the bearing is liable to become hot.

Wood, as a material for use in machine construction, is fast being replaced by steel. Wood is still used, however, to a certain extent for some of the bearings on machines. Hard maple is one of the best materials for this purpose, as the wood used should be hard and close grained. As steel has a tendency to crystallize when subjected to shocks and vibrations, it has not proved to be entirely satisfactory for pitmans. Hickory is considered the best material for this purpose, as a tough fibrous wood is needed for such work. Hickory and oak are also splendid materials for eveners and single trees.
Bearing.

In selecting machines, careful attention should be given to the bearings. The types of bearings used in machinery construction are illustrated in Figure 4. It is very desirable that there be some means for adjusting the bearing in case of wear, and for this reason a split bearing is generally the best. The two halves of a split bearing should be separated by shims or liners of varying thicknesses. Then, in case of wear, the upper half of the bearing should be removed and a liner
or shim of the right thickness taken from each side before replacing the bearing cap.

Roller bearings are desirable in farm machinery as the area of surface in contact between a roller bearing and its shaft is much less than that between a plain bearing and the same size of shaft. In this way friction is greatly reduced. This type of bearing also provides a good reservoir for lubricating oil. The rollers should be provided with a suitable cage to hold them in place. The roller bearings should not be used where they will be subjected to shocks and jars such as bearings in the fly wheel end of the crank shaft on a mower or the crank pin bearings of an engine. These bearings should be lined with the proper anti-friction metal.

Ball bearings should be provided where the shaft or axle has end thrust. Both ball and roller bearings should be protected from dirt and grit. Self-aligning bearings should always be used where the frame is somewhat flexible. As this type of bearing is hung in a pivot, as indicated in Figure 4, it is possible for it to move with the shaft, thus keeping the bearings and shaft parallel and preventing unnecessary wear and friction. Any bearing should have sufficient length and diameter to insure durability.

Efficient lubricating devices are an absolutely essential part of every bearing. Open oil holes, through which dust and grit can pass, should not be considered efficient. Oil holes are frequently placed where they become covered with dirt, and then, as a result, are overlooked. In such cases, it would be much better to have the oil hole drilled and tapped for a one-fourth or three-eights inch pipe. A piece of pipe long enough to prevent its being hidden by dirt should be screwed into the tapped hole. This pipe should be provided with either a compression grease cup, or a cap on its outer end which can be removed when oiling.

Figure 5. Types of Compression Grease Cups.

Lubrication of Bearings.
Compression grease cups (Figure 5) in which hard oil is used, are desirable for the bearings receiving the greatest wear. This method of lubrication, like all others, needs the careful attention of the operator, as it is necessary to turn the cap down and force the oil into the bearing, unless the device should be of the automatic feed type, which is shown on the left in Figure 5. The cap on other types should be turned down often enough to keep the bearing well oiled. This is a very desirable type of lubricating device for farm machines. It is quite possible that farm machines would be equipped to a greater extent with this type of oiler if the operators of these machines were more familiar with this kind of a lubricator.

Where gears are used, it is very desirable that some device be provided for keeping them meshing properly. This will greatly increase their life. An adjustment is especially necessary for the main gears. Some provision should be made for excluding grit and dirt from the gears. It is also very desirable that the gears be lubricated in some way unless the machine is being used where dust and grit are thrown into the gears. The lubricant used should be adhesive and have good wearing qualities. The pipe, through which oil is fed to gears when force-feed oilers are used, should deliver this oil to the gears at the point where they mesh.

Accessibility.

A machine in which no part breaks or wears out during its lifetime is not common. Because some repairs are almost certain to be made, all parts of a machine should be as readily accessible for this work as possible. It is also essential that all parts be easily reached to make necessary adjustments, either for adjusting worn bearings or gears, or the making of an adjustment that will cause the machine to do better work.

Ease of Handling.

The ease with which a machine may be handled in the field should also be considered. A machine cannot be adjusted at the factory to meet all the conditions encountered in field operations. The farmer should also consider that while he may be entirely competent to operate the machine, some of his help, not having had sufficient training, may not be able to do so.

Adaptability.

Again, when selecting a machine, the purchaser should consider whether or not it is adapted to the work to be done. For example, a single-disk drill should not be selected if the drill is to be used on a steep side hill. If the ground to be plowed is very hard and dry, a disk plow will do better work than a moldboard plow. Again, if the moldboard plow can be used, it should be provided with a type of plow bottom which is adapted to the soil conditions encountered. The size of the machine best adapted to the work to be done should also be considered carefully.
Conveniences.

It would be well for the purchaser to observe whether or not any special conveniences have been provided for the operator. Are the levers within easy reach? Are they long enough to give sufficient leverage to make them easily moved, by either man or boy? Is a comfortable and adjustable seat provided? Is it placed where it is possible for the operator to watch easily the working parts of the machine? Does the position of the seat make injury to the operator likely? Are the oiling and adjusting devices conveniently placed? These are some of the questions that may well be asked in considering the conveniences provided in a machine.

Draft.

Machines should be equipped with devices which keep the draft down to a minimum. Roller, ball, and self-aligning bearings, devices for keeping the wearing parts adjusted, efficient lubrication, etc. are some of these devices. The forecarriage or tongue trucks for disk harrows and grain binders relieve the horses of neck weight. They are therefore very desirable. Devices for keeping the draft of the machine low and for removing neck weight are especially desirable, for they contribute to the well being of the horse, besides reducing the cost of operating the machines by saving horse feed.

Simplicity.

Simplicity in design and construction is usually a commendable feature of a machine. Durability should not be sacrificed, however, in an effort to make a simple machine. Neither should devices which add to the efficiency and usefulness of the machine be left off. If a great number of adjusting devices are provided the purchaser would do well to study them carefully and determine whether or not they possess any real merit. If they do not possess any value it would be far wiser to select a machine whose construction was less complicated and whose durability would, therefore, be increased.

Repairs.

Another very important factor to be considered when purchasing machines is the ease with which repairs may be secured. If parts break, the farmer needs the repairs at once and a wait of several days for the purpose of securing repairs is very costly indeed.

New Devices.

New machines and new devices for old machines are appearing each year. The farmer may well be conservative about adopting and using them. It is often not to a farmer's credit to be the first one in any community to try out a new machine or a new device, which is being put on the market for the first time. Neither is it any more to his credit to be the last one to adopt a new thing. It is always best to buy machinery made by firms who have established a reputation for putting out machines that have been tried and found
true, even though the first cost may be a little greater. The farmer can well afford to pay more for a machine that will do a good grade of work during its life of ten years, than to pay a little less for a machine that will do a poor grade of work during a life of only eight or nine years.

Where to Buy Machines.

Farmers should buy their machines of local dealers. The usual motive for buying machines away from home is to save money. It may appear that such purchases do result in the saving of a few dollars to the buyer. In the end, however, the farmer will undoubtedly find that he is defeating the very purpose desired when he does not patronize local merchants. Money circulated among the local dealers means that these merchants can carry a larger and better stock from which to select. The farmer should also consider that the dealer can frequently render invaluable service by fixing troublesome machines, by getting repairs in a hurry when needed and by giving credit for a time if necessary. It should be evident that the future should be considered as much, or even more, than the present by the farmer when purchasing machines.

PART II.

TYPES AND ADJUSTMENTS OF FARM MACHINES.

Some of the types and adjustments of the more common farm machines will be discussed, because few farmers, comparatively speaking, have a thorough knowledge of the machines they are using.

Walking Plows.

The different types of plow bottoms are shown in Figure 6. The three general types are the sod, stubble, and the general-purpose, which is also called the turf-and-stubble. Modifications of these general types are made by all plow manufacturers and the farmer should be able to find just the type suited to his special conditions. The sod bottom is used for breaking tough sod, the general-purpose bottom is used for the lighter sods and where the soil is loose and more friable. The stubble bottom is the most effective pulverizer and is used in the heavier soils and whenever pulverizing qualities are desired.
There are some adjustments on the walking plow that should be familiar to every farmer who aspires to be a good plowman. A properly adjusted plow should swing along free and easy without any great effort on the part of the plowman. The parts of a plow bottom are indicated in Figure 7. The frog is the foundation or framework to which the other parts are attached. The share is the cutting edge. The landside is the part that receives the side pressure of the plow against the furrow wall. The moldboard turns and pulverizes the furrow slice. That part of the moldboard which receives the hardest wear, or the lower forward corner, is called the shin.

The point of the share is turned down so that the plow will go into the ground and stay there. This is termed the suction of the share. The amount of suction is measured by laying a straight edge from the heel of the landside to the point of the share and noting the greatest distance between the straight edge and share. This is indicated in Figures 8 and 9, which show two plow bottoms in which the suction varies. The amount of suction will vary from practically nothing to three-eighths of an inch. Light and moist soils do not require much suction, while heavy, dry soils require a great deal to keep the plow in the ground.

![Diagram of parts of a plow bottom](image)

**Figure 7. Parts of Plow Bottoms.**
Figure 8. A Plow That Has Three-Eighths Inch Suction.

Figure 9. A Plow With Practically No Suction.
Figure 10. A Plow With No Wing.

The heel of the share is turned up so as to present some bearing surface at this point. This is termed the wing of the share. The amount of wing is measured, as indicated in Figures 10 and 11, by laying a straight edge from the heel of landside to the heel of share and measuring the distance that the straight edge touches the share.

Figure 11. A Plow With One and One-half Inches of Wing.
This measurement will vary from practically nothing to one-and-one-half inches. Light, moist soils require much wing and hard dry soils none. If too much wing is provided for any particular condition the plow will wing over toward the unplowed land; if too little wing, the plow will lean the other way. Figures 10 and 11 show two plow bottoms in which the amount of wing varies greatly. The plow in Figure 11 has at least one and one-half inches of wing. The amount of suction that this plow bottom has is indicated in Figure 9. It is evident that this plow bottom would do its best work plowing in a loose soil. The plow bottom indicated in Figure 10 has practically no wing while that in Figure 8 has a great deal of suction. This combination is best adapted to hard and dry soils.

The measurements for suction and wing should vary not only for the different soils, but for different moisture conditions of the same soil. A farmer may notice that a plow which did splendid work in the spring has a tendency to run out of the ground and wing over to the unplowed land when used in the late summer or early fall. This is due to the fact that the soil contained more moisture in the spring and the amount of suction and wing were correct for that condition, but were not correct for the dry soil later. When a plowman needs to exert himself to any extent to keep the plow running level and at the proper depth, both the man and team are doing unnecessary labor in addition to a poorer quality of work. A walking plow which has been properly adjusted is shown in Figure 12.

If the plow bottom is made of soft-center steel, it should be taken to the blacksmith to be adjusted for wing and suction. Plow shares must be kept sharp and it will be best to take the entire plow
bottom to the blacksmith so that he may know just how much suction and wing is being given the share when sharpening it. In case a wooden-beam chilled plow is being used and it wings over to either side, the beam should be moved over toward the unplowed land if the plow leans that way and toward the plowed land if the plow leans in that direction. The castings by which the beam is attached to the plow are slotted to permit of this adjustment.

After hitching to the plow, have the horses step up so as to take the slack out of the traces, then stand to one side of the plow and note whether or not there is a direct straight line from the point of attachment at the hames to the shin of the plow. If the line is broken, the proper adjustments should be made at the hitch or bridle. The traces should be removed from the hip straps, as these throw the traces out of line if they are too short. Care should also be taken to see that the traces are of the right length. Long traces will cause the plow to run deep and short traces will tend to lift the plow out of the ground. Proper doubletrees should also be used as heavy wagon doubletrees cause the plow to handle badly.

**Sulky and Gang Plows.**

The word “sulky” is generally used where a riding plow carries but one bottom and the term “gang” plow is applied where the plow is supplied with more than one. Sulky and gang plows differ from walking plows in that every effort is made to convert the sliding friction of the landside and share in the walking plows into the rolling friction of the wheels turning on their axles in the sulky plow. A standard sulky or gang plow should be provided with a number of adjustments such as are discussed below, by means of which the sliding friction can be reduced to a minimum, regardless of the conditions under which the plow may be working. If, through carelessness, a sulky plow is so adjusted that the weight of the operator, the plow frame, and the furrow slice are carried by the share and landside the draft may easily be one-fourth more than it would be if the plow were properly adjusted.

It is very essential that the bottom of a sulky plow have suction. The suction is measured in sulky plows by lowering the bottom and adjusting the levers so that both the point and the heel of share rest on a flat surface. The distance from the heel of landside to this surface is the amount of suction. The method of measuring the suction is indicated in Figure 13. In some makes of plows the suction is changed by raising or lowering the rear end of the frame by means of a collar on the upright extension of the rear axle. In others a slotted connection between the bails and the plow frame is provided. Other devices are found on different makes of plows, as every standard plow has some provision for making this adjustment. It is well to add in this connection that a scraper should be provided for the rear wheel, for if the dirt is permitted to accumulate on the
rim it will increase the suction of the plow by raising the rear end and thus cause heavier draft. The amount of suction will vary for different soil conditions, or for different conditions of the same soil, and it will usually approximate one-half inch. Either too much or too little suction will increase the draft of the plow. When plowing, the plow bottom should swing freely without the heel of the landside touching the bottom of the furrow. It is not necessary to provide any wing to the share to keep a sulky plow level, as a lever is provided which must be used for this purpose.

![Figure 13. Indicating How the Suction of a Sulky Plow is Measured.](image)

The furrow slice, as it is being turned over, presses heavily against the moldboard, the amount of pressure depending upon the soil and its condition. This pressure would cause the landside to rub heavily against the furrow wall if provision were not made to prevent it. The rear furrow wheel is set outside the line of the landside, or toward the unplowed land, so as to hold the landside away from the furrow wall. The amount that the wheel is set over will depend upon conditions. It must be set over a sufficient amount to prevent the landside from rubbing against the furrow wall, and it may be necessary to set the wheel over one and one-half inches to accomplish this. The device for making this adjustment is usually found in
the brackets by which the rear axle is attached to the frame. Figure 14 indicates how this adjustment is made on one plow.

The pressure of the furrow slice against the moldboard tends to push the rear end of the plow around towards the unplowed land and the front end away from it. This gives the plow a tendency not to follow the team as a wagon would, and is spoken of as side draft. As an aid in overcoming this side draft, the rear furrow wheel is usually given a little lead away from the unplowed land, or, putting it another way, the wheel runs at an angle to the furrow wall, the front end of the wheel being farther away from the furrow wall than the rear end. If there is still much side draft, which may be de-

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**Figure 14.** Showing the Adjusting Device for Setting the Rear Furrow Wheel.

**Figure 15.** Devices for Changing the Lead of the Front Furrow Wheel.
terminated, among other ways, by noting whether the land wheel runs straight ahead or whether it tends to slide sidewise, it may be necessary to increase the lead of the rear wheel and give the front furrow wheel some lead toward the unplowed land. It should be understood that these adjustments tend to overcome, but do not eliminate, side draft. It must also be noted that the draft of the plow will be increased if the furrow wheels are given the leads indicated. They should therefore be kept running straight ahead whenever possible. The lead of the rear wheel is generally adjusted by shortening or lengthening the controlling rod. This controlling rod should be so attached to the pole that the in and out movements of the front furrow wheel do not affect the movements of the rear wheel unless a corner is being turned. The lead of the front wheel may be controlled either by means of a landing lever or the slotted adjustment at the pole plate. These devices are illustrated in Figure 15.

There are times when a plow must be used in stony ground. Under these conditions the plow should be adjusted so that the bottom will float; i.e., not be securely locked in the ground, and thus be free to ride over the obstructions. This is usually accomplished by adjusting a set screw so that it prevents the device that locks the plow bottom in the ground from passing center. It may be necessary to loosen the lifting spring or to take it off, so that the plow will go back into the ground. A high hitch is also desirable when plowing in stony ground.

It is possible on most plows to change the width of furrow by setting the front furrow wheel in or out on the axle or by setting both the wheel and axle in or out by means of adjusting devices found on the frame where these parts attach.

Careful attention should be given to the hitch of sulky plows. If the hitch is too low the team will lift up on the beam, thus taking some of the weight off of the front furrow wheel. Under these conditions, the wheel will not run in the corner of the furrow wall and a crooked furrow will result. On the other hand, a high hitch will put too much weight on the front furrow wheel causing the wheel to run away from the unplowed land and the plow will develop side draft. This also results in rapid wearing of the share points and an uneven furrow bottom. It is evident, too, that the draft of the plow will be increased with a high hitch. It will be necessary to hitch higher when the traces are short than when they are long. The traces should be just long enough so that they will not pull up on the beam. Traces of this length will also permit the horses to turn the corners better. The height of hitch is right if there is a direct line from the point of attachment at the hames through the clevis to the shin, when the horses are pulling the plow.

Plow Accessories.

Different types of coulters are provided for plows. The rolling coulter is used most. It should be set over at least one-half inch
toward the unplowed land. It should be one-half inch above the share. Do not set the coulter too far forward when plowing hard ground for it will then tend to carry the plow out of the ground. Set it well forward and down for stony ground. When cutting trash and corn stalks the coulter should be set back so as to cut the trash between the coulter and shin of the plow.

The jointer is especially desirable when plowing sod lands. This little miniature plow will cut out a narrow strip of sod and turn it over in the bottom of the furrow. A field that has been plowed with a plow equipped with a jointer will not have so many chunks of growing sods. Weeds and trash are also effectively buried by using the jointer. Do not set the jointer to cut deeper than one and one-half inches unless the ground should be very rough.

Gauge wheels are used with walking plows to regulate the depth of plowing. Always set them to run parallel with the furrow. The use of these wheels will increase the life of the shares and make the work easier for both the team and the plowman. It is advisable to use them in soft ground. They are generally put on a plow when a jointer is being used.

The Disk Plow.

The disk plow has been used where it is necessary to plow the ground when it is sticky or when it is very hard and dry. It is of the utmost importance that the disk plow be provided with a very strong frame and with substantial bearings. Plenty of clearance is also desirable, especially when plowing under high weeds and trash. Comparatively few plows are made strong enough to stand up when plowing in the hard dry ground. The scrapers on a disk plow perform much the same function as a moldboard does on a moldboard plow. Ample adjustments should be provided for the scrapers so that it will be possible to adjust them to do the best possible work. A number of the disk plows are so made that it is possible to add more disks so that one or more disks may be used. Better work is done by a disk plow when the width of furrow being cut is not over 10 inches. It is usually possible to change the width of furrow by setting the front wheel in or out.

Two-Way Plows.

The two-way or hillside plows are especially desirable for plowing steep hillsides as they make it possible to plow back and forth along the side of the hill. They may also be used in this way where it is desirable to eliminate dead furrows and back furrows, as, for instance, where the ground would be irrigated.

Deep-Tillage Plows.

Both the disk and moldboard types are now on the market. These plows are especially designed for deep tillage for various farming conditions. It is possible to plow sixteen inches deep with these special
machines. They are so made that the subsoil is not thrown out on top of the furrow slide.

**Disk Harrows.**

The following types of disk harrows are on the market: Full bladed, cutaway, spading, alfalfa, double-action. It is possible to secure different sizes of disks for the full-bladed disk harrow. The blades range from sixteen to twenty inches in diameter. The smaller size, or sixteen-inch blade, has a better pulverizing action than the larger sizes. It will also penetrate the soil more readily and is therefore better adapted to the clay soils. Where the soils are light and loose, the larger sizes of blades would be used to best advantage. The full-bladed disk harrow may be used as a soil packer if the gangs are set straight instead of at an angle and the machine weighted. A regular packer, however, does more effective work. It is hardly necessary to add that the blades of the disk harrow should be kept very sharp to do effective work, especially where the stubble or manure is to be disked in.

The cutaway disk harrow is used to rather a limited extent, mostly for stony and very hard ground. The cutaway is not as good a pulverizer and does not penetrate the ground as well as the full-bladed disk harrow.

The spading disk harrow is used only in very wet ground or very stony ground.

The alfalfa harrow is used for renovating alfalfa fields. There are, however, regular alfalfa cultivators which do very effective work when used for this purpose. These cultivators are also provided with hoppers so that alfalfa seed may be sown in case a place is being cultivated where the stand is thin. These hoppers may also be used for sowing other grass seeds or fertilizers.

The double-action disk harrow has proved to be a very valuable implement for the farmer. With this machine it is possible to double disk the ground without travelling over the field twice. The two sections of the harrow should be strongly connected.

The disk harrow is used extensively but, nevertheless, there are some adjustments which are not generally understood by the users. Each gang of a disk harrow should be equipped with an adjusting lever. Then, when the farmer is "lapping," the gang that is traveling over the ground previously disked should be set at a greater angle than the other gang. In this way the disk harrow will run straight ahead and not manifest the side-draft tendencies. When disking on side hills the gang on the uphill side should be set at a greater angle, so as to keep the harrow from working down hill.

The inner ends of each gang on a disk harrow do not cut as deeply as the outer ends, unless the harrow is equipped with some device for holding the inner ends down. The adjusting device will vary with the different makes of harrows, but it is to be found on all
standard makes. The device should be easily adjusted, otherwise it probably will not be used.

The bearings on the majority of the disk harrows are made of hard wood. They are made in two parts and as most of the wear comes on the upper half of the bearing it will wear out before the lower half. A number of manufacturers make the two halves interchangeable, thus making it possible to exchange the halves when the upper half becomes worn. The life of the bearings is greatly increased by means of this adjustment. Figure 16 shows the construction of a typical disk-harrow bearing.

![Figure 16. A Good Disk-Harrow Bearing.](image)

It is very desirable that a forecarriage or tongue truck be used with a disk harrow. When this is used it is essential that the attachment between the stub tongue and the forecarriage be adjustable and also that the hitch be adjustable. If the proper adjustments are made for different depths of disking and also for different heights of teams the wheels of the forecarriage are not forced into the ground, in this way increasing the draft of the harrow.

The scrapers are adjustable so that they may press either lightly or heavily against the face of the disks. These should be adjusted to suit the conditions and when not needed they should not touch the disks. In this way, neither the scrapers nor the disks are worn unnecessarily and the draft is not increased by the scrapers bearing heavily against the disks.

It is essential that plenty of horse power be used with the disk harrow. The efficiency of this, and other farm machines, is very frequently greatly lessened by neglecting to use sufficient power to operate or to pull them.
Grain Drills.

The following different types of furrow openers are found on grain drills: hoe, shoe, double-disk, and single-disk. The shoe furrow opener is not used much at the present time, the double and single disks and the hoe being the types generally used. The tendency seems to be to use the single disk more than the other types of furrow openers. This type has good penetration and cultivates the soil to a certain extent while preparing the seed bed. The single disk has slightly more draft than other types of furrow openers. With some makes of grain drills, it is possible to change the angle at which the single-disk is set so this type of furrow opener is adapted to a wide range of soil conditions. The disk should not be set at a greater angle than absolutely necessary, as the draft will be unnecessarily increased when this is done. The single disk opens the furrows in such a way that the moist soil falls over on top of the dry soil; then, when the disk moves forward, the moist soil falls back on the seed, thus insuring better germination. This is an especial advantage when drilling in grain on dry ground. The double disk is better adapted to well-prepared seed beds and to side hills. The hoe drill is widely used in the dry farming sections, especially where the ground is reasonably free from trash. It is generally possible to use any one of the four types of furrow openers on any grain drill. Care should be taken that the tension of each spring is the same so that each furrow opener will plant the seed at the same depth.

Two distinct types of feeds are used on grain drills. These are known as the external or fluted feed and the internal or rim feed. It is possible with the latter type of feed, by using special reducers, to reduce the size of the cell opening so that the grass seed may be sown out of the main hopper in case one does not want to sow grass seed and grain at the same time. In this way the main hopper may be used to sow anything from corn and peas to the smaller grass seeds.

The grain drill should be calibrated, as it frequently happens that a drill does not sow the amount of grain that the scale indicates. This should be done each season so that the farmer will know that he is sowing the right amount of grain to the acre. To calibrate the drill, determine the number of revolutions that the wheel makes while sowing an acre. To do this multiply the circumference of a wheel by this width of drill and divide the number of square feet in an acre by the number. Set the scale to sow two bushels of grain to the acre, put this amount of grain into the hopper, then block up the drill and turn the wheels until the hopper is empty. Compare the number of revolutions made with the correct number and calculate the percent of error. This test should be made several times to insure accuracy.

Manure Spreaders.

The real worth of manure spreaders is fast coming to be appreciated by farmers. In some of these machines, manure is conveyed
to the beater by means of an endless apron, in others by a return apron and in some by a drag chain operating over a solid bed.

Each type of apron has its advantages and disadvantages. The chief disadvantage of a return apron is the necessity for some mechanical device for automatically returning the apron when the load is off. The endless apron, on the other hand, is always in position for loading. With the latter type, however, the manure frequently accumulates between the aprons, thus causing the breakage of parts. There is also a tendency for the apron to slip under the manure and thus travel faster than the manure itself. Because of this, the farmer is often spreading a smaller quantity of manure to the acre than he thinks he is. With the return apron type, the load and apron must travel at the same speed since an endgate is fastened to the front of the apron. The return apron will also dry out more easily than the endless apron.

The aprons are driven either by means of pawls and ratchets or by a worm gear. The first method permits of a very wide variation in the amount of manure that may be spread. This device is not well adapted to hilly ground unless some provision is made to prevent the apron from traveling faster while going uphill than when going down hill or on the level. The worm gear does not have this fault but has the disadvantage of wearing out rapidly unless it runs in an oil bath or is well greased. It is possible to reverse the gears with some makes of manure spreaders, using this drive. It is not possible, however, to have a very wide variation in the number of loads which may be spread to the acre, when the worm gear drive is used.

Various devices are provided to prevent the manure from being thrown out in chunks. These devices consist of (1) rakes in which each tooth is independent, (2) revolving beaters and (3) rakes in which the teeth are not independent. The first two types are most effective in preventing the manure from being thrown out in chunks.

With some manure spreaders, it is possible to spread the manure wider than the bed of the machine; in other makes it is possible to put on an attachment which will spread the manure in this way. The chief advantages of spreading the manure wider than the bed are that it is not necessary to travel so far to unload a load of manure and it is possible to throw the manure under trees so that such a spreader is especially adapted for orchard work.

A manure spreader should be substantially built. Light cast parts which may be easily broken and poor lubricating devices are especially undesirable. It is of especial importance that this machine should be carefully cleaned at the end of each season as the acids and organic matter in the manure rapidly deteriorate the materials out of which the spreader is made.

Mowers.

There are a number of adjustments on mowers which will, if properly made, not only increase the life and efficiency of the machine,
but will prevent many breakages that might otherwise occur during its years of use. For example, the breaking of the knife head is a somewhat common and annoying trouble. While this breakage is caused by other things, it is frequently due to the cutter bar getting out of line with the pitman. The two parts should be in a straight line and at right angles to the crank shaft as indicated in Figure 17.

Figure 17. A Cutter Bar That is in Alignment.

A cutter bar out of line will result in the failure of the knife to register; i.e., to center in the guards. At the end of each pitman stroke the center of each knife section should rest in the center of its respective guard. If the cutter bar is badly out of line the sections will stop outside of their guards, then, as the mower is being drawn along, a bunch of grass will wedge in between the guards and the sections while the latter are at rest for an instant. As this grass will have to be cut through before the knife can start again, a great deal of strain is placed on the knife head and the driving parts. Practically all mowers have some device for realigning the cutter bar. One of the most effective devices consists of either an eccentric pin or an eccentric bushing at the hinge connection between the yoke and the cutter bar. By turning the pins or bushing a slight amount the cutter bar is easily and positively lined up. The operator of a mower will do well to keep the cutter bar in line, as excessive wear of the gears, ledger plates, wearing plates, heavy draft, the breaking of knife heads, etc., may be due to a cutter bar that has sagged out of line. Care

Figure 18. Adjustable and Replaceable Wearing Plates.
should be taken when putting a new pitman on a mower that it is neither too long nor too short, as either of these conditions result in a non-registering knife.

An important feature of a mower is the construction of the inside shoe. This should be provided with hardened wearing plates. When trouble with breaking knife heads is experienced, note whether or not these plates are so badly worn that the knife plays up and down a great deal. If such is the case, the plates should be replaced at once unless it is possible to adjust them for wear. Figure 18 shows adjustable wearing plates which may be replaced when worn out.

A streak of long stubble in a mowed field generally indicates that one or more of the guards has become bent out of line. The guards are made of malleable iron and can, therefore, be bent back into line by hammering on their ends. The operator should sight along the points of the guards while this is being done so as to insure correct alignment. Figure 19 shows a mower guard with its parts.

The guard or ledger plates, placed in the guards, are either smooth or serrated. The plates with the serrated edges are used almost entirely and should be replaced before they are worn smooth or when they become nicked. It is desirable that these plates extend back to the rear cutting edge of the guards. If they do not reach this far, fine grass, especially, will wedge in between the sections and rear end of the plates. This will cause heavy draft and the possible breakage of parts.

Figure 20 shows a mower clip. These clips are placed over the knife so as to hold the sections close to the guard plates, thus getting a good shear cut. The clips are made either of steel or malleable iron and can be easily adjusted by bending them. They should be adjusted
so that there is a very small amount of clearance, about one-sixty-fourth of an inch, between the sections and the ledger plates. Make sure, when putting on new knife sections that the clips do not bind. Either too much or too little clearance will increase the draft and the wear of the mower. If there is too much clearance the stubble will also be uneven.

![Figure 20. Section of a Cutter Bar with a Clip, Wearing Plate and Guard Attached.](image)

A wearing plate is also shown in Figure 20. These plates are either placed under the clips or at the rear of the guards for the purpose of holding the knife forward to its work. If the plates are placed under the clips, the holes through which the bolts pass are usually slotted and it should be possible to move the plates forward as they become worn. When the plates are provided for the rear of the guards, it is usually possible to reverse them when they are badly worn.

Most farmers do, and every farmer should, have at least two sets of knives. Both sets should be sharpened and taken to the field so that the mower may always be provided with reasonably sharp knives. This will greatly aid in insuring light draft, minimum wear and breakage of parts, and a long-lived machine. A good supply of extra sections should always be on hand so that as soon as a section becomes nicked, it may be replaced. Figure 21 shows a mower knife and Figure 22 shows a sickle for a mower. It will be noted that the knife sections are smooth while the sickle sections are serrated. The knife sections are better adapted for cutting grass while the sickle sections are better for stubble or dry weeds.
It is advisable to keep the gears meshing properly. This is especially true of the large bevel gear wheel on the counter shaft which meshes with the small bevel pinion on the crank shaft. Many of the manufacturers are realizing the importance of this adjustment and are providing their mowers with an adjusting device. Figure 23 shows how the gears on one mower are adjusted. This figure also indicates the use of ball and roller bearings. It is desirable, too, that the bevel pinion be readily accessible so as to be easily renewed in case it wears out. If it is not possible to remove the crank shaft, by taking off the upper half of the crank-shaft bearing and getting at the pinion in this way, the pinion may be more easily unscrewed from the crank shaft, if a punch is inserted between the teeth of the gear wheels and then the fly or balance wheel turned in the proper direction. In some cases, the pinion is provided with a left-hand thread.

The bearings for the crank shaft and the crank pin should be replaced before they become badly worn. The registering of the knife will be affected if these parts are badly worn.

Binders.

The binder is one of the most complicated machines used on the farm, and, as such, it is provided with many adjustments. Some of these are for the purpose of taking up wear and increasing the life of the binder, while other adjustments are for the purpose of increasing the efficiency of the work done by the machine. That part of a binder which has been causing the farmer the most trouble is the binding attachment. Part of an attachment is shown in Figure 27. To the knotter may be traced most of the failure of the attachment to tie bundles. This is shown in Figure 24.

TYING TROUBLES.

It is not generally known that the appearance of the ends of the loose band thrown out with a gavel, or untied bundle, is a good indication of the cause of the failure properly to tie the band around
the bundle. A number of characteristic bands of twine appear in Figure 25. A knowledge of these is of great value to the farmer, since it generally enables him to make a correction at once. As a usual thing, the operator of a binder will guess at the cause of the trouble and make some adjustments which may remedy it, but these adjustments may also result in more trouble.

By referring to Twine No. 1, Figure 25, it will be noted that the ends of the twine have been caught by the bill hook and crimped. This trouble is most frequently due to the fact that the bill hook spring has become too loose. The screw that governs the tension of this spring should be tightened a quarter of a turn at a time. If very loose, it may be tightened more and the results noted. If this spring is all right, and loose bands having the appearance of No. 1 are thrown out, the knife may be out of time and cut the twine too soon. The arm that carries the knife is made of malleable iron and so may be bent back in place. The twine should be cut immediately after the bill hook has firmly grasped both strands of twine and not any earlier or later. If these parts are all right, note whether or not the projection on the under side of the upper part of the bill hook is badly worn.

A twine which has a knot in one end of it and the other end cut squarely off, as shown by twine No. 2, indicates that the bill hook failed to grasp one of the strands of twine. A straw may have held the needle strand away from the bill hook, or the twine holder spring may be too loose. If a loose spring is suspected, trip the binder and turn the discharge arms over while pulling hard on the band with one
hand. If the spring is too loose the twine will pull out of the disk before the bill hook closes down on it. With most binders, it requires quite a pull to draw the disk strand out of the holder. A bent or poorly timed needle may also cause this trouble, although a needle in this condition usually gives the results indicated and discussed later.

At first glance Twine No. 3 may appear the same as Twine No. 2. It will be noted, however, that the untied end is irregular instead of being cut squarely off. This result is due to the twine-holder spring being too tight. In some binders the twine draws slightly through the twine holder while the knot is being tied. If the spring is so tight that the twine cannot yield, it will be pulled in two between the bill hook and the holder, and the disk strand will pull through the knottor without being tied. If both ends are irregular, due to their breaking, it is a sure indication that this spring is too tight. Trouble will also result, as indicated in the preceding paragraph, if this spring does not have sufficient tension.
The needle should deposit its strand of twine in one of the notches on the twine disk. If it fails to do so, the needle may be bent, the eye of the needle may be badly worn, or it may be out of time. Figure 26 indicates one of the results that will be obtained if the needle fails to perform its function. It will be noted that the free end of the twine is provided with a knot and that the twine leads back through the needle to the ball, instead of being held in the twine disk. When green and damp grain is being cut the operator of the binder is frequently troubled by having a bundle thrown out with the twine from this bundle leading back to the ball in the twine can. This is also caused by a bent needle. If a twine disk does not move forward far enough, due to wear in the driving parts, for the needle strand of twine to be deposited in it, the twine will also be tied around the bundle as just indicated. The needle is made of malleable iron and may be bent back into place by hammering on the point after turning the attachment so that the needle is as far forward as it will go. The blows should not be heavy and the binding attachment should frequently be tripped and put through the tying operation to insure getting
the correct adjustment. The needle is usually driven by a pitman as indicated in Figure 27 and this pitman may be shortened or lengthened. Care should be taken not to shorten the pitman too much, as this may cause it to be forced against the knife arm, thus causing the breaking or bending of this part. A short pitman may also cause the needle to project up beyond the deck so far that it interferes with the passage of the grain. In some binders the needle is driven by means of a chain and sprocket. Where this method is employed great care should be taken to have the correct number of links between marked teeth on the sprocket wheels.

![Figure 27. Part of a Binding Attachment, Showing Especially The Needle Pitman, Trip Spring, and Compressor Spring.](image)

Figure 28 indicates the results if the knotter bill hook is rough or rusty, or if the bill hook spring is too tight. The knot will be tied but will not be stripped from the bill hook. The band is usually broken on the under side near the bill hook. The bill hook should be perfectly smooth. If it is either rough or rusty, fine emery cloth should be used to put it into condition. If the spring is at fault, it should be adjusted by loosening it a quarter of a turn at a time.
If some loose bundles are thrown out when a new binder is being used for the first time the operator should not proceed to make any of the adjustments which have been indicated. The trouble will probably be due to some paint or grease on the knotter, and this will soon wear off.

All parts of the binding attachment must work in perfect time. If the attachment is to be taken apart, look for marked cogs on the bevel gear wheels, that drive the knotter. In case none are found, mark the cogs that go together before taking the attachment apart.

Figure 28. Note the Band Hanging From the Bill Hook. Trouble Due to a Rough or Rusty Bill Hook or a Tight Spring.
If the discharge arms do not run steadily, or start and stop before completing the operation, look for worn parts or a weak spring in the clutch. The shoulder against which the roller rests while the arms are revolving sometimes becomes worn so that the roller slips over it. When this happens it is best to get new parts. The trouble may, however, be remedied by riveting a piece onto the shoulder.

**HOW TO MAKE GOOD BUNDLES.**

A careful farmer readily appreciates the value of well-formed bundles; much less grain is wasted, the bundles handle better while being shocked, the shocks stand up better, and there is also the ever-present sense of satisfaction that comes to the one who does his work well.

A number of parts of the binder contribute to the making of good bundles. The reel is the first part of the binder to come in contact with the grain and the adjustment of the reel for different conditions of grain should be given careful attention if good bundles are to be formed. The reel should be adjusted so that the fans or slats strike just below the heads of the standing grain and the entire reel should be carried far enough back so as to cause the grain to fall directly back of the sickle. If the reel is too low, the grain will be thrown too far back on the platform and possibly it will be carried over and wound around the reel slats. The outer end of the reel should be supported, especially in the larger binders. This aids in keeping the slats parallel with the cutter bar, and prevents them from striking the guards. Most binders are equipped with an adjusting device whereby the outer end of the reel may be raised in case it has sagged.

The head end of the straw, especially in heavily bearded and ripe grain, tends to travel faster than the butt end, so that the straw goes up the elevator head first. This results in poorly formed bundles. The trouble can be overcome by attaching a sheet-steel strip to the outer end of platform frame so that it lies on top of the canvas where the heads will fall on it. This retards the heads somewhat. If such a metal strip is not provided with the binder, a strap or a rope, either plain or knotted, may be used. In some binders the inner end of the reel slats travels slightly ahead of the outer end. This tends to throw the heads toward the outer end of the platform, hence they have to travel farther than the butt ends. It is usually possible to adjust the device that causes the reel to operate in this way.

It is best to have the band tied about the center of the bundle. As the length of straw varies greatly, it will be necessary to shift the binding attachment very frequently. It is advisable to have the moving parts working smoothly so that a great effort will not be required to shift the attachment. A butt adjuster is provided to assist in working the butt ends of the straw down and to form a bundle with a square end. The butt adjuster should work at right angles to the elevator rollers. If it does not work in this position, a bundle with a
slanting, instead of a square butt end, will be made, which will not stand up well when shocked. Again, a butt adjuster that is drawn in a great deal will strike the straw with some force and this results in threshing out some of the grain, especially if it is very ripe. It is always best to keep the butt adjuster well forward, unless extremely short grain is being cut and to shift the binding attachment as may be necessary to place the band around the bundle where it is desired. An adjustable header board is provided on most binders. It should be adjusted well forward for short grain to assist in making good bundles. This board may be removed when cutting long grain.

The twine tension should be kept just tight enough to prevent the twine from being so slack that it will wrap around the bill hook. If the spring is kept at this tension, the twine will scarcely wear those parts through which it is threaded. Some operators attempt to make tighter bundles by tightening the twine-tension spring. This is not the purpose of the twine tension and the proper device for making tighter bundles, which is discussed later, should be used instead. A very tight twine-tension spring causes rapid wear in the parts through which the twine passes. These worn parts will cause tying troubles.

The farmer frequently desires loose bundles when cutting grain that is green or wet and tight bundles when the grain is ripe. The trip spring indicated in Figure 27 should be adjusted to suit the conditions. A loose spring will give loose bundles, and a tight spring will result in tight bundles. As this point is not always clear to the operator, perhaps a little more explanation will be in place. The volume or space into which the grain is compressed remains the same with either adjustment of the spring. If the spring is tightened, more grain will be forced into this space before the tension of this spring is overcome. As the length of the band would remain practically the same, the straw would expand more when released, thus increasing the tightness of the bundle. To make a large bundle the compressor arm should be moved back. To make a small bundle the arm should be moved forward. In binders that have a separate trip and compressor, the trip spring should be tightened when the compressor arm is moved back.

The height of the deck cover is adjustable, and it is well to have it lowered when cutting light, fluffy grain. This will cause the grain to work down better. The adjustment is made where the lower end of the deck cover is attached to the knotter frame.

CUTTING APPARATUS.

If the cutting apparatus is not in good condition, or if it is out of adjustment, the draft of the binder will be greatly increased and possibly side-draft tendencies will develop. Careful attention should be given to the cutting parts to make sure that the sickle is registering, that the ledger plates are not nicked or badly worn, that the guards are
in line, etc. The discussion relative to the adjustment of these parts on mowers applies equally well to binders.

**ADJUSTING MAIN GEARS.**

To insure the longest possible life to the two gears that transmit all of the power to the driving parts in most binders, it is essential that some device be provided for keeping the large bevel gear wheel on the counter shaft and the bevel pinion on the crank shaft meshing properly. If such a device is provided, it is to be found on the inner end of the counter shaft. Figure 29 shows how the adjustment is made in one make of binder. Care should be taken that these gears, as well as the gears on any machine, do not mesh too deeply. This results in greater wear, heavier draft, and a noisy gear.

![Figure 29. Adjusting Device for Keeping the Main Gears of Binders Meshing Properly.](image)

**THE GRAIN WHEEL.**

The grain wheel should be given attention frequently to see that the bearing is well lubricated and that it is not gummed up. This wheel should turn freely on the axle or side draft may result. It should also run straight ahead unless it is given some lead toward the stubble. The wheel should never run toward the uncut grain. It is well to make sure that the bearings for this wheel are in good condition so that it will run right.

**SQUARING THE ELEVATORS.**

The operator of a binder is sometimes bothered by the breaking of slats on the canvas or perhaps the canvases creep and do not run steadily. Either of these troubles indicates that the rollers are not at right angles to their guides. Binders are provided with a device for squaring the elevators. The upper elevator is adjusted by means of the slotted bracket which supports the rear end. The lower elevator is adjusted by means of the elevator braces. To determine whether or not the elevators are square, two light sticks or laths may be used.
These sticks should be placed together and held diagonally across the upper elevator. The end of one stick should be placed in the corner formed by the roller and its guide, and an end of the other stick placed in the corner diagonally across. The two sticks should be held together securely while removing them from this position and placing them across from the two remaining corners of the same elevator. If it is necessary to slide the sticks over each other to make them fit in their new position, the elevators need squaring. They should then be adjusted so that the measurements diagonally across the elevators are the same.

Figure 30. Device for Governing the Tightness of the Platform Canvases.

Figure 31. Devices for Loosening the Elevator Canvases.
CANVASES.

The draft of the binder may be unnecessarily increased by having the canvases too tight. They should be just tight enough to run steadily, and care should be taken to have each strap at the same tension. It is desirable to have the binder equipped with devices for quickly loosening the canvases at the end of the day's work. These devices, which are shown in Figures 30 and 31 are a great help in putting canvases on a binder. The canvases should be put on so that the buckles lead or run ahead of the straps.

CHAINS.

Tight chains will increase the draft of the machine, besides causing unnecessary wear. Have the chain just tight enough to prevent its jumping off the sprockets or riding them. The elevator chain should always be put on with the hooks ahead and the open part of the hook on the outside. A groove will be worn in each tooth of the sprocket wheel if the chain is not put on this way. The links will tend to catch in these grooves, thus causing the chain to break. If a closed-link drive chain is used it should be put on with the small end of the link ahead. A very loose or a muddy drive chain will result in the chain riding the sprocket. This causes an irregular, jerking motion.

THE ADJUSTMENTS CITED FOR DIFFERENT MACHINES SHOULD MAKE IT VERY EVIDENT THAT ALL MACHINES HAVE SOME ADJUSTING DEVICES. THE SKILLFUL AND CAREFUL OPERATOR OF FARM MACHINERY WILL MAKE IT HIS BUSINESS THOROUGHLY TO FAMILIARIZE HIMSELF WITH THOSE ADJUSTMENTS WHICH WILL LENGTHEN THE LIFE AND INCREASE THE EFFICIENCY OF EVERY MACHINE THAT HE USES. ON THE OTHER HAND THE OPERATOR WILL UNDERSTAND THAT ADJUSTMENTS ARE NOT TO BE MADE UNLESS THEY ARE NEEDED. ADJUSTMENTS THAT ARE NOT MADE INTELLIGENTLY USUALLY RESULT IN A WORSE CONDITION OF THE MACHINE THAN IT WAS IN BEFORE.

PART III.

THE CARE OF FARM MACHINERY.

Many farmers are penny-wise and pound-foolish in their farming operations. Great care will be taken to get the crop into the ground in the best possible condition so as to insure maximum yields; or again the harvest will be gathered very carefully so that none of the grain spoils or is lost. A farmer exercises great care in these respects because his income is thereby increased. This is as it should be, and the farmer would have sufficient cause for regret if his crop should be injured so as to reduce his income one or two hundred dollars.
Yet the same farmer's income may easily be lessened this much or more by his neglect properly to care for the machines with which the crops were tended.

**Care of Machines While Out of the Field.**

It is essential that all machines be protected from the elements while not in use, and a building should be provided for this purpose. The plan and elevation of a machine shed suitable for average conditions is shown in Figures 32 and 33. The material for such a building should not cost more than $110.

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**Figure 32. Plan for Machine Shed.**

**Figure 33. Elevation of Machine Shed.**

The bill of materials for this building is given below:

- 14 pieces — 6 x 6 x 10 ft. No. 1 Com. Rough.
- 20 pieces — 2 x 6 x 14 ft. No. 1 Com. SIS.
- 3 pieces — 2 x 8 x 20 ft. No. 1 Com. 
- 54 pieces — 2 x 4 x 16 ft. No. 1 Com. 
- 12 pieces — 2 x 4 x 10 ft. No. 1 Com. 

16 pieces — 1 x 8 x 16 ft. No. 2 Com. Finish.
10 pieces — 1 x 4 x 10 ft. No. 2 Com. Finish.
140 pieces — 1 x 12 x 14 ft. No. 1 Com SIS.
320 pieces — 1 x 4 x 10 ft. No. 1 Com. Sheeting
1800 L. O. G. Batts
12 M. E. Star A Star Shingles.
4 — 24 x 24 x 1\(\frac{3}{8}\)" 2 lts Window Frames,
8 casings for same.

Investigations on the depreciation of farm machines made by a government agent working in cooperation with the Minnesota Agricultural College are reported in Minnesota Bulletin No. 117. The items given in the table below are taken from this bulletin.

Average depreciation per year based on original cost as 100%

<table>
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<th>Machine</th>
<th>Depreciation</th>
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<td>Hay loader</td>
<td>11.78%</td>
</tr>
<tr>
<td>Manure spreader</td>
<td>11.67</td>
</tr>
<tr>
<td>Corn binder</td>
<td>10.03</td>
</tr>
<tr>
<td>Harrows</td>
<td>8.72</td>
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<td>S. plows</td>
<td>8.42</td>
</tr>
<tr>
<td>G. binder</td>
<td>7.91</td>
</tr>
<tr>
<td>Mowers</td>
<td>7.80</td>
</tr>
<tr>
<td>Gang plows</td>
<td>7.40</td>
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<tr>
<td>Hay rakes</td>
<td>7.80</td>
</tr>
<tr>
<td>Gas engines</td>
<td>7.35</td>
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<tr>
<td>Corn cultivator</td>
<td>7.25</td>
</tr>
<tr>
<td>Grain drills</td>
<td>6.75</td>
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</tbody>
</table>

These figures on depreciation apply to machines which have been housed. Authorities estimate that machines depreciate twice as quickly when they are not housed.

Just to see how the neglect to protect his machines from the elements affects the farmer's income we will take a farm which requires $600 worth of machinery properly to equip it. The average Western Oregon farm requires about this outlay in farm machinery. If these machines are properly housed they will depreciate approximately $48 in value each year, but if they are not carefully housed the depreciation may be at least $96 a year and in some cases very much more. It is evident that the money invested in the building will yield a dividend which would soon repay the cost of the building. After this is paid for the farmer will find that the dividend is quite a factor in increasing his annual income.

In addition to this, if the farmer should desire to sell some of his machines at any time, he will find that they will bring a much higher price if they bear evidences of careful housing than they would if they were weatherbeaten in appearance.

When the farmer does not properly house his machines, the depreciation due to their exposure is not the only loss suffered, for when they are exposed to the elements during idle seasons much more
time and effort is required to get them working properly. This extra
time and effort is frequently expended during the busiest season when
the farmer's time may easily be worth several dollars an hour.

It often falls to the lot of farmers who are indifferent about housing
their machinery, to have the trying experience of getting a harvesting
machine to do even a poor grade of work when the crops are spoiling.
No doubt there are many costly experiences during the life-
time of such farmers, any one of which might pay for the entire cost
of building a suitable machine shed. How much better it would have
been to get rid of this waste and worry by erecting a building adequate
to the needs. A farmer who takes pride in keeping his premises look-
ing shipshape, certainly cannot afford to have machines scattered
about the barnyard, lanes, and fence corners. This practice greatly
detracts from what might otherwise be a neat and tidy place.

Care of Machines in the Field.

While it is essential that machines be properly cared for while
not in use, it is also essential that they be properly cared for while
they are being used. When a machine is operating in perfect adjust-
ment it has a characteristic sound. A careful operator of machines,
knowing this sound, is able to detect at once when anything is wrong
and stops immediately to find the cause of the trouble. It may be
that the discordant note was caused by a bolt which has become loose.
If this bolt is tightened at once the machine is again in perfect running
condition. If, however, the loose bolt is not given immediate attention
it means, in many cases, the breakage of a part that causes a delay of
several days. The skillful and efficient operator of farm machines
takes a keen delight in listening to the hum of machinery operating
in perfect adjustment.

Attention at End of Day's Work.

It is a splendid plan to go over the machine after the day's oper-
ations, adjusting bearings and gears for wear where it is possible to
do so, tightening loose bolts, making sure that the lubricating devices
have been working properly and that the cutting parts are sharp.
The machines may be examined at any time it is most convenient
after the day's run and before starting again. If this plan is followed
systematically, it will require but a few minutes time each day and
will prevent many breakages that, because of the delay in waiting
for repairs, are far more costly than the mere expense of their re-
placement. A machine kept in constant repair will also have a longer
life and give more satisfactory service during its lifetime than one that
is repaired in a haphazard way.

Tools.

Every farmer should provide himself with a kit of tools, contain-
ing at least a hammer, screw drivers, punches, cold chisels, pliers,
files, and an assortment of bolts, rivets, spring cotters, etc. The tool boxes provided with most machines would not hold these accessories. As it would probably not be possible to equip all the machines with suitable boxes, a canvas bag or a wooden or a metal tool kit could easily be made in which the tools and accessories could be carried to the field and left at some convenient place. With this equipment, most of the ordinary repairs could be made in the field. The more serious breakages could be taken to the work shop, with which every farm should be provided. A kit of tools and accessories as indicated need be used but one season to have their value fully appreciated.

Every farm should be equipped with a workshop where at least minor repairs to machines can be made. This will save many trips to town which are usually made when time is very valuable. Such a shop also provides employment during bad weather and provides a place for the farm boys to develop their mechanical interest. The equipment for this shop, to start with, need not be large. The following tools, however, will be needed: anvil, forge, work bench, vise, tongs, hammer, hardies, chisels, punches, and drills. This entire outfit, of quality sufficiently good for the purpose, can be provided for about $30.00, the price varying, of course, with the quality of the tools. This outfit will be needed in addition to the ordinary farm tools such as saw, square, chisels, wrenches, plane, etc.

Time Marks.

Whenever it becomes necessary to take a machine apart, especially if it is complicated, the parts that go together should be marked. These marks greatly help one in getting the machine back together again. If no marks are provided they should be made with a chisel or a center punch. Gear wheels, especially those that travel in an exact relation to each other, are usually provided with what are known as time marks. A tooth of one gear wheel should come between two marked teeth on the other gear wheel. The reducing gears on gas engines and the gears that drive the binding attachment of grain binders are examples of gears that are marked this way. By noting these marks, or making similar marks before taking the machine apart, one can easily get a machine back together in perfect time. These marks also aid one in determining whether or not the machine is running properly timed.

Selecting Oils.

The operator should use judgment in selecting oils that are to be used on his machines. There are at least three things that should be considered when selecting oils. First, what is the speed at which the shaft or journal runs; second, how much pressure does the shaft exert against the bearing; and third, what are the temperature conditions under which the oil will be used?
The object of a lubricant is, of course, to reduce the friction and thus increase the life of the bearing, and decrease the power required to operate the machine. Two metallic surfaces, which appear perfectly smooth to the naked eye, will show ridges and grooves when viewed with a microscope as indicated in Figure 34. Figure 35 shows the roughness of a bearing surface. Great friction results when metals are brought into contact and then rubbed together, because of the tendency of these rough surfaces to interlock. A lubricant reduces this friction by filling the depressions and coating the shaft and bearing with a thin film of oil, which prevents contact between the metallic surfaces; then, as the shaft rotates in its bearing, the resulting friction is that of the low internal friction of the oil rather than the high friction between the metals. Figure 36 indicates how an oil prevents metallic contact. An oil that does not have sufficient body or viscosity, will, of course, be forced out from between the shaft and its bearing, thereby permitting metallic contact and higher friction. An oil that possesses sufficient viscosity or body for average conditions may become
either too thin if the temperature rises, or too thick if the temperature falls. Oils are also made to withstand different temperatures. Ordinary lubricating oils are entirely useless for lubricating steam or gas engine cylinders, as they would burn away when subjected to the high temperature existing in an engine cylinder. Again, it is not desirable to use a heavy oil on high-speed shafts, as the internal friction of the oil is so great that it tends to retard the motion of the shaft. It should now be clear why heavy grease is used on the axles of a wagon and light grease or oils on the axles of a buggy. In this first case the speed of the wheel is not fast and the pressure exerted by the axle in the hub is great. In the second case, the wheel travels faster and the pressure is less. Similar pertinent examples could be given for all classes of farm machines, but it should be evident that special lubricants are made for special purposes and the purchaser should consider well the conditions under which the lubricant is to be used and make his selections accordingly. An oil which is almost invaluable for one purpose will be practically valueless for another. While other tests of oils could be made, the best test is use. A farmer may well do a little careful experimenting with different oils. These experiments should not be continued indefinitely, but should be carried on for a short period of time, as a poor grade of oil might ruin a bearing. As soon as a suitable oil has been found, the operator should insist that this oil be secured and used. Many times a farmer is urged to purchase a new oil which is claimed to be the "best ever." In actual use such an oil may prove to be the "worst ever."

The Use of Oil.

The oil should be used just as carefully as it was selected; hence a few general facts will be given which should govern its use. Do not use too much oil. The excess oil not only runs off and is wasted, but it causes dirt and grit to accumulate around the bearing. Used in this way, oil may be harmful rather than helpful. It is well to be certain that the oil is put in the oiling device instead of guessing that
it was put there. The oil put on the outside of the bearing will not be effective in reducing the friction in the bearing. Oiling should be done systematically, not a great deal of oil now and then but a little oil applied frequently is what is needed to increase the life of bearings and shafts. Make sure that the oil reaches the bearing, as the passage-way for the oil may have clogged up.

Adjusting Bearings.

The bearings should be given careful attention while a machine is being used to make sure that they are not too tight or too loose. Those bearings which are subjected to hard usage and which are adjustable for wear, should be given attention every few days. The halves of a split bearing should be separated with enough liners or shims to permit the bolts to be securely tightened without causing the bearing to bind on the shaft. Hot bearings are due to one of the following causes: dirt or grit in the bearing, poor oil, a lack of oil, or a bearing that is too tight. Cylinder oil should, if available, be applied to a hot bearing as it is not so readily burned as ordinary oil. Water may be used to cool most hot bearings. Oil and not water should be used to cool a hot brass bearing. It is advisable to put cotton waste in open and exposed oil holes, as this aids in keeping dirt and grit out of a bearing and it also causes the oil to feed down more slowly.

Babbitting Bearings.

Many farmers have cast aside a machine which could have been used much longer if the babbitt lining in the bearings was only renewed. Instructions for babbitting bearings will therefore be given. This work requires such tools as a hammer and chisels, a ladle, fire pot, and a small level. If a fire pot is not available, the babbitt may be melted in some other way, although the fire should be close to where the babbitting is to be done. The ladle should be large enough to hold more babbitt than the bearing will require. This will insure getting the bearing filled with hot metal. The babbitt should be heated slowly; this may be done while the following preliminary steps are being made.

The old babbitt should be removed from the bearing. A hammer and chisel may be used for this purpose, or, if a blow torch is available, heat may be applied to the metal so as to melt it out of the bearing. When this latter method is used, the shaft should not be in the bearing. Whatever method is used to remove the babbitt, great care must be taken to get the babbitt out of the retaining holes in the bearing, as the babbitt is anchored and held in the bearing by means of these holes. The bearing and shaft should also be free from either moisture or grease, before the metal is poured, for if either of these is present bubbles will be formed in the hot metal, and, as these bubbles burst, the molten babbitt may be thrown out of the bearing with considerable force, endangering the operator who is doing the work. If this does not happen, the bearing will be pitted with "blow holes."
Both split and solid bearings require rebabbitting, and, as the method for doing each differs somewhat, the method for babbitting a split bearing will be considered first. The two halves of a split bearing should be separated by several shims on each side. The shims are usually made of thin sheet metal or of cardboard. It is well to have these shims of varying thicknesses, although none should be over three-thirty-seconds of an inch thick; then as the babbitt wears away the upper half of the bearing should be removed. If there has been much wear, a thick shim should then be taken from each side of the bearing so that there will be the proper amount of play between shaft and bearing. Enough of these shims should be provided so that there will be sufficient space between the shaft and bearing for a good thickness of babbitt. These shims should be provided with a number of V-shaped notches if the two halves of the bearing are to be babbitted at the same time. The side with the notches in it should be placed next to the shaft and should touch it. These notches permit the babbitt to flow to the lower half of the bearing.

The shaft must be placed in the center of the bearing, after the shims are in place, and it must be parallel with other shafts if there are any. The shaft may be supported in this position by blocking, or a small block of wood or a piece of leather may be placed between the shaft and the lower half of the bearing. The upper half of the bearing should not be attached, unless it is desired to pour the halves of the bearing separately.

Either putty or stiff clay should be used to keep the babbitt from running out of the ends of the bearing. It is advisable to put cardboard collars next to the bearing and then apply the putty or clay on the outside of these collars. Air holes must be provided on top of the shaft. One of these holes, having been enlarged and made funnel-shaped, may be used as a pouring hole. If the babbitt is poured at one end of the bearing, the oil hole should be stopped up by driving a wooden plug through the hole until it reaches the shaft. If the metal is poured through the oil hole the babbitt may be either drilled or punched out after it is cold, or the hole may be prevented from closing by inserting a nail of the proper size into the oil hole as quickly as possible after the metal has been poured. When the upper half of the bearing is removed, it should be noted whether or not the oil hole is entirely open. If a single thickness of good paper is put around the shaft it will aid in securing a good, smooth bearing. Before pouring the babbitt the shaft and bearing should be warmed, if cold. This may be done by applying a flame or a red hot bar of iron to the parts.

The babbitt should be hot enough to readily char a pine stick and the scum should be removed just before it is poured. If a lump of rosin about the size of a walnut is added, it will make the babbitt pour better and will lessen the danger of bubbles that may form in the bearing causing it to be pitted. When all is in readiness the hot metal should
be taken quickly to the bearing and poured as rapidly as possible, without stopping, until the bearing is entirely filled. Allow the metal to cool a moment, remove the nuts that hold the upper half of the bearing in place, and separate the two halves of the bearing by driving a cold chisel between them. The rough edge should be smoothed off with a half-round file and small grooves cut from the oil holes to within % inch of the edge of the bearing. These grooves aid in oiling the bearing and must be provided.

The procedure in babbitting a solid bearing is much the same as that just given for split bearings, except that the shaft should be covered with a single thickness of good paper. The paper should extend beyond the ends of the bearing and its edges should be lapped and glued. Sometimes it is sufficient to coat the surface of the shaft with soot or chalk, but the paper is the better as it will be sure to prevent the shaft binding so tight that it cannot be turned. Oil grooves may be provided by winding some cord over the paper. The cord and paper should be removed after the babbit is cold.

Use of Paint.

There are many reasons why it is desirable to keep the machines well painted. Farmers' Bulletin No. 474 entitled "The Use of Paint on the Farm," covers this and other painting problems so thoroughly that the reader is strongly advised to ask his Congressman for it, or write the Secretary of Agriculture, Washington, D. C., for a copy. The following paragraph is quoted from this bulletin:

"There is probably no one point more neglected by the average farmer than the judicious use of paint, not only on his house and outbuildings, but also on machinery and various agricultural implements. It is, perhaps, the rule rather than the exception in some sections to see houses and agricultural implements on the farm sadly in need of paint. The idea seems to be prevalent that paint is used solely for ornamental purposes, and its use is regarded as a luxury rather than a necessity. While paint does, of course, serve the purpose of improving the appearance of property, it is far more useful for protection than for ornament. A small amount of money and work expended in keeping a valuable piece of machinery properly painted will add greatly to the length of its life. The same may be said of buildings. Another useful object which is accomplished by painting is the improved sanitary conditions of buildings and out-houses. It is not the purpose in this bulletin to give instructions for artistic painting, or even for doing the class of work which would be expected of a first-class master painter, for such work cannot be expected of one engaged in another business. But any man can do an average job of painting and can thereby not only improve the appearance of his place but add to the durability of all articles painted. The cost of such work is small, the necessary equipment is not expensive and, with proper care, will last a long time. An attempt will be made to give directions for the care of paint and of the necessary points used in its application and for the proper selection of different paints for various purposes, their preparation and application, and their approximate cost."
Anti-rust Preparations.

The farmer who conscientiously cares for his machines, frequently desires some anti-rust preparations for covering the bright parts of his machines. Axle grease is, of course, excellent for keeping plow bottoms from rusting. It may also be used for the bright parts of other machines. Paint is also a good rust preventive but is hard to get off. There are a number of easily prepared anti-rust compounds and the following is a good one: An ounce of camphor should be dissolved in a pound of melted lard. The scum which forms should be taken off. If it is desired to have the preparations the same color as the machines, lead may be added. This mixture should be applied to the well-cleaned parts and allowed to remain for twenty hours, when any excess may be rubbed off. This anti-rust mixture forms a coating which will take a good polish if rubbed with a soft cloth.

Acknowledgments

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A number of machinery and implement companies kindly furnished engravings.