



Combine-Harvester Maintenance and Operation

The life and efficiency of the combine depends largely upon the condition and adjustment of the working parts and adequate lubrication. Hurried or temporary repairs are not satisfactory and often lead to considerable loss of time in the busy season of harvesting. A systematic check-up of the entire machine during some slack season before the combine is needed in the field will pay dividends in both time and money.

Frames, Wheels and Supporting Parts.—The entire frame and supporting parts should be inspected and checked for loose bolts and rivets. All braces should be tight and in their proper place and truss rods should be drawn into position so that the whole frame will be in alignment, not warped out of shape.

The main wheel bearings should be inspected and if they are of the adjustable type the machine can be raised on a jack and the bearing tightened until the wheel does not rotate freely, then backed off one notch on the adjusting lock or about one-eighth of a turn of the adjusting nut. Where plain bushings or roller bearings are used, washing out all the old grease and dirt with kerosene and filling the bearings with fresh grease will lengthen the life of the bearings. If the wheels are mounted on rubber tires these should be inspected for bruises, cuts and cracks and any repairs made. During the working season the tires should be checked daily and kept up to the recommended inflation as found in the instruction book. Under-inflation will quickly break down the tire sidewalls and cause cracking of the tire which will materially weaken it. Overloading the tire will also reduce its length of life.

Platform Table and Cutting Bar.—The cutting bar with its guards and sickle should be in a straight line from end to end. Any sagging should be removed by adjusting the trusses and angle irons which support it and tie it to the back wind board. Often if all other attempts to take the sag out of a cutting bar fail, it may be straightened by removing the guards, jacking the bar up on blocks until it is in a straight line (weights may have to be placed on the high sections), and then replacing the guards and tightening them up before the cutting bar is taken off the blocks. A cutting bar which is not in good alignment requires extra power, will not cut the grain clean, and causes unnecessary wear on the sickle and ledger plates.

Worn sickle plates and ledger plates should be replaced with new ones and the sickle holding clamps adjusted to hold the sickle in position on the ledger plates, but not tight enough to make the sickle bind.

Wherever an adjustable bearing is used on the sickle drive pitman, care should be exercised to see that the sickle sections are centred over the respec-

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tive guards properly in time at each end of the sickle stroke. A sickle which is not centring will make a very ragged stubble and require excessive driving power leading to breakage of the sickle head or pitman. The sickle head guide should be inspected for wear at the same time. It should guide the sickle head so that the first 5 or 6 sickle sections will lie flat on the ledger plates.

The sheet iron on the bottom of the table may be dented or damaged from running over stones or other obstructions and should be hammered out reasonably smooth so that it will not cause wear on the canvas slats or retard the flow of grain in an auger type conveyor.

The auger will require little attention except to see that the stripper bar is set close enough to the auger to keep the straw from winding around the auger.

Canvas repairs should be made according to the needs of the canvas on inspection. A canvas cement is now available at hardware stores which can be spread between two layers of canvas and then pressed with a hot iron, making a bond or patch which will last for the life of the canvas. Badly worn buckles and adjusting straps should be replaced before they have any chance to break while running.

The reel should be inspected for loose bolts and the truss rods (if truss rods are used), tightened to hold the reel pipe rigid. The long span of reel pipe on a 20-foot combine can be improved and strengthened by cutting all the reel slats at the centre of the cutting platform and placing an extra reel support and bearing in the middle of the reel. One extra reel spider and its reel arms may be necessary to make this change on some machines.

Wherever the lagging has become worn on the canvas rollers, it should be replaced with new lagging. All canvas slides should also be inspected to ensure that the metal is not worn thin and apt to break off, allowing a section of iron to go into the cylinder of the combine.

Feed House and Cylinder.—The feeder raddle is subject to stretching and wear of the cabin, and wear or cracking of the slats. The chain may be shortened when stretched, so that it is climbing the sprockets by placing each steel section of the link in a heavy vise and striking it a blow on the end with a hammer, then replacing it in the feeder house. If, however, the malleable section of the link is worn or stretched, the chain must be replaced. Where common steel-link chain is used in the feed raddle, it may be shortened, if not badly worn, by placing each link in a vise and closing the hooks with a blow from a heavy hammer. A few hooks will break off, but if care is used most of the links can be shortened to their original length. Worn or cracked slats should be replaced with new slats.

Grain shields and deflectors in the feeder house should be inspected to make sure that they are securely fastened and cannot break loose and fall down into the cylinder. Where a wooden cover is used on the feeder house, it should be kept painted and in good condition so that it will not break through if the operator stands on it while the machine is running. The feeder beater and its bearings should also be inspected to ensure that it will run free without vibrating or tending to wobble.

The Tooth-type Cylinder and Concaves.—When doing any major work on the cylinder, it is advisable to take the concaves out of the hangars, so that both the cylinder and concaves may be worked on easily. Removing the nut and lock washer and hammering on the side of a broken, bent or worn tooth will loosen it, so that it may be lifted out easily. When replacing worn or broken teeth in the cylinder, a new tooth should be placed directly opposite the tooth replaced, to keep the cylinder in balance. The tooth which was replaced for balancing should be kept to replace other teeth in the cylinder and not spoil the cylinder balance. Cylinder bearing trouble may often be traced to the vibration set up

by a cylinder which is out of balance. An unbalanced cylinder also requires more power than one which is well balanced. If a number of teeth in the concaves require replacing, a full row of new teeth should be put in at the front of the concave or in the first full concave and the back row of the first concave or the second concave should be filled with teeth which are still in reasonably good condition. When the concaves are replaced in their hangars, the teeth should be lined up and spaced with the teeth of the cylinder, so that the same clearance will be maintained on each side of passing teeth. New teeth should be drawn into the concaves or cylinder bars to the same level at the tips of the teeth as those already in place, so that the concaves may be raised to their high position without the teeth striking. At the same time, the cylinder should be checked for end play. The end play should not be more than $\frac{1}{4}$ " nor less than that which will allow the cylinder to rotate freely when all belts and chains are removed from the cylinder shaft.

Bar Type Cylinders.—On many bar type cylinders, the bars are reversible, and when the faces of the bars shows signs of wear, the bars may be removed and reversed. If replacement is necessary, it is usually advisable to replace all the bars in the cylinder at the same time. When only one bar requires replacement through stone damage or similar mishap, the bar opposite it should also be replaced to maintain cylinder balance. Bars on the concave grating or concaves, will not require replacement as often as the bars in the cylinder. Cylinder end play is not an important factor in the bar type cylinder, but it should not be allowed to become excessive.

Beaters and Deflector Curtains.—The beater behind the cylinder will seldom require much attention except a check-up to make sure that all rivets and bolts are tight, and that the blades of the beater are not badly worn. Worn beater blades should be replaced or a whole new beater installed. The deflector curtains, both steel and canvas, should be kept in good condition, and if the canvas curtain is worn away, it should be replaced or a new piece added to it to bring it back to its original length.

Straw Walkers, Decks and Rattles.—The straw walkers or straw decks should be carefully checked for loose, broken, worn or lost slats or sections which would allow short straw to fall through with the grain. The same inspection will be necessary on rattle type straw decks. All worn or broken slats and sections should be replaced as they are a hazard to the whole machine when it is operating. The straw walkers should be inspected for loose bolts or rivets which might catch between the rotating straw walkers and wreck the walkers or twist the driving crank shaft out of shape. The wooden bearings should be adjusted and tightened by the removal of shims from the bearing halves so that the walkers will run true and not rub on each other or on the sides of the combine. All hardened grease and dirt should be removed from the bearings while they are apart.

If the straw walkers do not run true after the bearings are adjusted, the trouble is probably due to a bent or twisted crank shaft. The crank shaft should be removed from the combine and taken to a machine shop equipped with a lathe. By setting the crank shaft in the lathe, it may be checked for a twisted or bent condition and straightened. Crank shafts which are found to be badly out of shape should be replaced rather than trying to straighten them.

The rattle chains on rattle type straw decks are similar to the chains in the feeder rattle and should be repaired in the same way. Replacement is seldom necessary in the deck rattle chains.

Grain Pans.—The check-up on the front and rear pans will include inspection for cracks in the fluted bottoms, loose, broken or worn fishbacks and general tightness of the pans. The type of repair necessary will be indicated by the

condition of the pans. The wooden bearings or supporting blocks should be checked to make sure that they are fastened securely to the pans and that the bearing holes do not have too much play on their support arms or pivot bearing pins. If worn, they should be replaced, as shimming the block bearings is only a temporary repair. When installing new bearing blocks, make sure that the nuts are well locked on the bolts, so that they will not loosen from the vibration of the pans.

Rear Shoe, Recleaner Shoes and Sieves.—The cleaning shoes will usually require little attention, except to make sure that the sheet metal is not developing cracks and that the shoe runs true with the frame of the combine. Wherever cracks have developed in the shoes, a patch of sheet iron may be placed over the crack and riveted to the shoe with tinner's rivets, or the crack may be welded with welding torch. The shoe bearing blocks and support blocks should be treated in the same way as the blocks on the grain pan. Weak shoes may be strengthened by riveting reinforcing plates of sheet iron on the sides of the shoes and welding or riveting a strip of light angle iron on the bottom of the shoe.

Sieves should be inspected for loose corners in the frames and warped side pieces. Reinforcing strips may be fastened under the sieves to keep them from sagging. A sagging sieve will not handle as much grain as one which is in a flat condition, and, since the capacity of the sieves and rear shoe to handle the grain is often the limiting factor in the capacity of the combine, the sieve should be kept in condition to handle the maximum amount of material without grain loss. The adjustable sieves should be inspected to make sure that the lips are not bent and that all the louvres or lips are opening the same amount.

Elevators and Augers.—Elevator chains and cups or drag blocks are the greatest source of trouble in the elevators. Chains which are only slightly stretched or beginning to show signs of wear may be shortened by placing each link of the chain in a vise and closing the hooks with a hammer. This job can best be done by removing the whole chain with its cups from the elevator and closing each hook without taking the chain apart, leaving only the last hook open for rehooking the chain when it is replaced in the elevator. One or two extra links may be necessary to bring the chain up to its original length. Chains which are badly stretched so that they are climbing the sprockets or are weakened by wear, should be replaced. All bent cups should be straightened, and the rivets which fasten the cups or drag blocks to the links of the chain checked for tightness, while the chain assembly is out of the elevator. Before replacing the chain assembly in the elevator, the dividing board in the centre of the elevator should be checked, and if worn so that the supporting bolts in it are beginning to show, it should be replaced with a new board. A hardwood dividing board will last much longer than a soft piece of spruce board, but is harder to fit into the elevator, due to the difficulty in drilling the holes true in the hardwood. Marking the board in line with the desired position for the holes with a carpenter's square, and drilling the holes half way through the board from each side, will assist in getting the holes true. The guide plates which are used in some elevators to guide the cups from the sprocket to the dividing board, may be bent or worn and should either be replaced or straightened.

The elevator casing will seldom require any attention other than seeing that it is well nailed and bolted to the dividing board which also acts as a tie between two halves of the elevator casing. Making sure that the elevator is securely fastened in its proper position completes the elevator check-up, with the exception of the bearings, which will require replacing when worn.

The proper chain tension for upright cup elevators is such that the chain has just enough slack to allow the cups to be slapped against the side of the

elevator casing. A tight chain wears rapidly, and one which is too loose will allow the cups to buckle back under load, and thus reduce the elevator capacity. Elevators which are being overloaded may be improved by the addition of more cups, simply by removing one link between each of the cups and extending the chain with extra cups and the links which have been removed until the chain reaches its original length. The practice will also lighten the load and prolong the life of the V-belt drives on the new combines using that type of drive for the elevators. Drag elevators or elevators running on a slope will require slightly more slack in the chain than the upright type for efficient and trouble-free operation. They should have just sufficient slack to allow the drag blocks to rest firmly on the bottom of the elevator casing.

The augers and auger housing should be inspected to find and correct worn or dented housings and bent augers and auger shafts. Worn auger shafts and bearings can be repaired by building up the shaft with welding and replacing the bearing with a new one. If light pipe is used for auger shafting, it will be advisable to replace the pipe rather than attempt to build it up by welding.

Fans and Fan Housings.—Recleaner fans will not require repairs except in rare cases, but the lower shoe fan may need new blades. The dust and chaff entering the fan housing will wear the fan blades thin in one or two seasons, making replacement necessary. Covering the blades with sheet iron is not satisfactory, as dust getting between the wooden blade and the sheet iron will throw the whole fan out of balance. The wind board at the rear of the fan should be inspected when repairing the fan, and, if worn thin or broken, it should be replaced. If both the fan blades and the wind board are replaced before they are too badly worn, they may be used as pattern to make new boards from ordinary lumber of the right thickness, making a less expensive repair.

The fan housings seldom require much attention other than inspection for cracks or dints which might interfere with the fan blades.

Slip Clutches, Chains and Belts.—All slip clutches should be inspected for worn clutch facings. Badly worn clutch facings or plates should be replaced with new parts. If the facings are in good shape, they should be taken apart and all the dirt and grease washed out of them before reassembly. The spring tension on the clutch should be just tight enough to carry a slight overload without slipping, but so that they will slip under any increase over a slight overload. Slip clutches which are set up too tight will not protect the machine against serious breakage. In such cases, the machine would be the same as if it had no slip clutches at all.

All steel roller chains should be removed and washed in a bath of kerosene to remove the dirt and old oil from the rollers. Soaking the chains overnight in the kerosene bath will help to soak the dirt and grease out of the rollers. The chain should then be hung up until all the kerosene drips out of it and then be dried off with a rag. Wear and looseness in the chain links may be discovered by laying the chain out full length on a board or bench and shoving the two ends together to get the shortest length. Mark the length on the board or bench and then pull the chain out at one end to its longest position. The difference between the short and long lengths of the chain will indicate the amount of wear. If the wear is more than $\frac{1}{4}$ " per foot of length of the chain, it should be replaced with a new one. When replacing a steel roller chain, it is generally advisable to replace the sprockets on which it runs at the same time, unless the old sprockets are in really good shape. In all cases where the faces of sprocket teeth are worn hook shape, the sprockets should be replaced. Building up the teeth by welding and smoothing them to shape with grinding will make a satisfactory repair, but usually costs nearly as much as a new sprocket. Where trouble has been experienced with roller

chains running warm or climbing on the sprocket, it is generally due to sprockets being out of alignment or a stretched chain. The sprockets can be moved on the shafts to bring them in true alignment and a stretched chain should be replaced. Chains which have been running on sprockets that are out of alignment are often stiff at the joints and will not bend easily. This condition is often referred to as a frozen chain. Replacement of the chain is the only satisfactory repair.

New chains and old chains which have been washed should be soaked in a bath of oil to penetrate the rollers before being placed on the machine. Brushing the chain with light oil a few times daily during operation will lengthen the life of the chain and sprockets unless the machine is operating in sandy soil. In such soil, the chain is better running dry except for an occasional cleaning and bathing in light oil to lubricate the rollers. The right tension for a roller chain is such that the chain will be slack enough to fall freely upon the sprockets without tending to follow round the sprockets as it leaves them. A chain which is run tighter than this will soon start to climb the sprocket teeth and cause stretching of the chain and unnecessary wear. Spring tighteners should be watched as they tend to put too much tension on a roller chain.

Steel link chains should be treated in the same way as the elevator chains of the same type. They may also be shortened if slightly stretched or worn by closing the hooks. Badly stretched or worn chains are dangerous and should be replaced before they are apt to fall apart or start climbing on the sprocket teeth. The sprockets should receive the same treatment as the roller chain sprockets.

Loose Chains.—Malleable link chains will require no attention except to make sure that they are running true and at the right tension until they become worn when replacement is the only repair. The proper tension for both malleable and steel link chains is as loose as they can be run without slapping or tending to wrap as they leave the sprockets. A chain which is too loose will slap and eventually jump off the sprockets, and one too tight will stretch and tend to climb on the sprocket teeth. Chains should be run on the sprockets with the hook end leading forward in the direction of travel and the slot side out.

V-type belts are used extensively on late model combines and, due to the shortage of rubber, every possible precaution should be taken to preserve them and lengthen their life. One of the greatest enemies of rubber is mineral oil, so all grease and oil should be kept off the belts. All belts should be loosened while not in use, if possible, and the proper tension should be maintained while in operation. V-belts should run as loose as possible and still grip the pulleys without slipping under load. Some belts may have to be run quite tight, as slippage in the pulleys will damage and shorten the life of the belt quicker than extra tension on the belt itself. The belt should be run as nearly in line and with as few twists as possible. The pulleys should be set so that the belt will run free and not chafe or rub on pulleys or where the belt crosses, causing unnecessary wear. When the belts are to be stored for any length of time, they should be removed from the machine, washed in warm soapy water, well dried, and painted with a coat of rubber tire paint, then hung up in a dry place where the direct rays of the sun cannot reach them.

Bearings.—All roller and ball bearings should be inspected for play or wear which will lead to vibration and other troubles. Time spent in washing old grease and dirt from the bearings is well spent. Adjustable bearings should then be set up until the shaft just begins to bind, and then the adjustment backed off far enough to allow the shaft to turn freely. Non-adjustable bearings which are worn should be replaced. A semi-fluid grease will lubricate ball and roller bearings much better than heavier bodied greases.

Heavy gun grease may often be mixed with a small quantity of transmission oil, about 10 to 15 per cent, to make a satisfactory bearing lubricant which will stay with the bearing especially at high speeds. Little can be accomplished in the way of overhauling plain bearings, except cleaning and greasing them and replacing worn bearings when necessary. Wooden bearings should be scraped clean of grease and dirt and then may be soaked in hot oil, after which they will not require lubrication, as the oil will seep out of the wood and lubricate the bearing. Loose or worn wooden bearings should, of course, be replaced. Wooden pitmans should be treated in the same way as wooden bearings.

Pickups.—The windrow pickup is an attachment on the standard type of combine for picking up windrowed or swathed grain. All bent pickup teeth should be straightened and any broken teeth or fingers replaced.

The bearings in the pickup should be checked and any found to be worn should be replaced. The raddle and raddle chain on raddle-type pickups is similar to the feeder raddle, and will require the same repair treatment. The cams, cranks, and cam tracks in this type of pickup will be subject to a large amount of wear, as they are working under very dusty conditions. They should be inspected and worn parts replaced. Bent or twisted rotating drums or guide bands will require straightening, so that they will direct the grain onto the platform in a steady even flow.

Servicing, Lubrication and Greases.—Regular servicing of the combine will include a general inspection of the working parts for alignment, loose bolts or rivets, and broken pieces while greasing the machine. The bolts or studs should be tightened with a flat side of the nut or head parallel to the sides of the parts which they fasten together, when the machine is overhauled. A loose bolt or stud will then be quickly discovered as soon as it is out of the parallel position, and the whole machine may be checked for loose bolts without the use of a wrench. All belts and chain drives should be checked for proper tension, and the machine should be turned a few times by hand, to ensure that all the parts are working freely. The cylinder and concaves should be inspected to make sure that the teeth or rub bars have not been bent, or that the concave adjustment has not changed due to small stones or other hard materials passing through the machine unnoticed while in operation. The entire machine should be well greased at the beginning of every day's run. The grain is usually on the tough side early in the morning, and time may be well spent in thoroughly lubricating the combine and checking the machine while the grain is drying. Many of the gun greases on the market may be improved as a combine lubricant by mixing about 10 per cent or more of transmission oil with the gun grease, to form a semi-fluid grease. This combination grease will be somewhat sticky in nature, and will cling to the bearing even at high speeds, and has the ability to resist hardening and drying out when used in high speed roller and ball bearings. A second regular greasing of all high speed bearings and plain bearings which have a small grease capacity will be required after a run of from 5 to 6 hours, and, when running very long hours, a third general greasing may be required. A small amount of grease and greasing often will provide much better lubrication than a large amount of grease at a time with long runs between greasing. A few bearings which are subject to heavy loads or very high speeds such as the pitman and shaker bearings and fan bearings should be greased every 2 or 3 hours. Under tough cutting conditions, the sickle pitman may require greasing every hour. Experience and observation will be a valuable guide in determining how often and how much grease each bearing on the machine will require for adequate lubrication. Many wooden block type bearings, if soaked in hot oil at the beginning of the season, will operate throughout the season without additional lubrication. If lubrication is required, a fluid oil applied

on the edge of the bearing will lubricate the bearing better than gun grease. Gun grease alone is a poor lubricant for a wooden bearing, as it will squeeze out to the edge and form a trap for dust and dirt which will eventually work into the bearing.

Operating Hints and Adjustments.—The most important adjustment on any combine is the setting of the cylinder speed. With the exception of one or two combines, all machines in the field will have the secondary drives taken from the cylinders, and, if the cylinder is operating at its correct speed, all other parts of the combine will be operating at the speed for which they were designed.

Too low cylinder speed will result in: poor cleaning of grain; loss of grain over straw deck and shoe; failure to thresh grain from the heads; or overloading of the entire threshing machine.

Too high cylinder speed will result in: cracking or hulling of the grain; loss of grain over straw deck and shoe through bouncing; excessive wear and vibration on all working parts.

If changes in speed or any other adjustment is made, the machine should be stopped before making the adjustment. A few precautions must be taken and care exercised at all times, to avoid accidents. Safety-first must come before everything else in farm machinery operation.

For average threshing conditions, the sieves should be set on the level. The level of the sieves may be checked by using an ordinary carpenter's spirit level. The fan doors should be opened fairly wide, about three-quarters open, for average threshing, and then closed or opened as required to suit varying conditions of cleaning. Always keep in mind the fact that more grain is usually lost over the sieve by using too little rather than too much wind blast. When the fan blast is not strong enough with the fan doors wide open, it will be necessary to increase the fan speed by changing the drive ratio. This may be accomplished by changing to a smaller sprocket on the fan with a chain drive or by placing shims between the pulley sheaves on the V-belt driven fan. The blast of air should be directed fairly well toward the front of the sieve by adjusting the wind board behind the fan. The blast should be directed nearer to the front of the sieve, as the mass of chaff and grain on the sieves becomes thicker or heavier.

Always run the concaves as low as possible, and still be able to thresh the grain out of the heads. When the grain is tough or the chaff is tight, it will be necessary to raise the concaves all the way up with the front concave adjustment. In real tough threshing conditions, it may be necessary to put in extra rows of concave teeth in the tooth type cylinder or raise the rear adjustment of the concaves in the bar type cylinder. Some bar type cylinder machines adjust the height of the cylinder with respect to the concaves, rather than adjusting the concaves.

Machines which are hitched with the front of the combine supported on the tractor rather than using a front wheel or truck, will depend on the height of the hitch for the levelling of the machine. The hitch should be adjusted for height so that the deck and sieves in the rear shoe will be running level when operating in the field.

Western Agricultural Engineering Committee.