Ferguson

DEALER SHOP MANUAL

COVERING

TE-20, TO-20, & TO-30 Tractors

PREPARED BY

THE SERVICE DEPARTMENT OF

HARRY FERGUSON, INC. • DETROIT, MICH.

(All specifications are subject to change without notice)

Foreword

This manual has been prepared by the Service Department of Harry Ferguson, Inc. in order to provide a complete and accurate reference for all shop operations of Ferguson tractors. It contains information pertaining to disassembly, servicing, reassembly and repair of both major and minor components. It is felt that the material is covered completely and by referring to this manual, any competent mechanic should be able to perform the various operations described.

The material contained in this manual is devoted entirely to the servicing of the TE-20, TO-20 and TO-30 Ferguson tractors. It has been especially prepared for the qualified Dealership equipped with the necessary facilities, such as suitable tools and adequate light and shop space.

The Dealer Shop Manual is divided in five major groups: Engine and Clutch, Engine Systems, Power Train and Brakes, Ferguson System and Front Axle and Steering. This grouping has been made to integrate related subjects in accordance with the usual servicing procedures so as to present the material in a logical and easily understood manner.

A thorough and complete presentation of all procedures is given for the sections included in each major grouping. The components or component assemblies are discussed in detail in regards to various servicing phases. All illustrations are referenced in the subject matter. At the end of each section, space is provided for referencing Service Bulletins. Also ruled lines are included for important service information notations.

A table of contents at the beginning of the manual lists the contents of the body of the book and serves as an outline of the material present. An index has been provided at the rear to assist in easily locating various items.

Each Ferguson service man should study and become familiar with the contents of this manual in order to provide himself with the necessary know-how for performing reliable service.

TABLE OF CONTENTS

ENGINE AND CLUTCH

ENGINE & CLUTCH

The Ferguson engine, an integral member of the tractor frame, consists of numerable precision parts assembled into an efficient, long wearing power source. The clutch assembly is installed to the engine flywheel and provides a mechanical means of controlling the flow of power to the transmission.

ENGINE

The model Z-129 engine used in the TO-30 tractor is manufactured by the Continental Motors Corporation. It is a four cylinder, spark ignition, overhead valve, internal combustion, wet sleeve type engine with a bore of 3 1/4 in. and a stroke of 3 7/8 in. The displacement is 129 cubic in. and the compression ratio is 6.5 to 1. The weight of the bare engine with manifold and flywheel is 375 pounds. In Nebraska Test 466, the TO-30 developed 30.27 corrected belt horsepower. A peak torque of 107 pound-feet occurs at approximately 1100 RPM. The model Z-120 engine used in the TO-20 and TE-20 is of the same type and design but differs slightly in some of the basic dimensions. The Z-120 engine has a bore of 3 3/16 in. and a stroke of 3 3/4 in. The displacement is 120 cubic in. and the compression ratio is 6.1 to 1. In Nebraska Test 392, the TO-20 developed 26.5 corrected belt horsepower. The maximum torque of 88 pound-feet occurs at approximately 1200 RPM.

Some inspection can be made of the complete engine before any disassembly is started. Look the engine over for any evidence of leaks of water, gasoline or oil. Check the radiator hoses, draincocks, sediment bowl, carburetor, oil drain plugs, oil filter, oil pan and valve cover gaskets. Check the oil and coolant level. Check the air cleaner, gasoline tank, sediment bowl and fuel filter for dirt or water. Inspect the condition of parts which deteriorate such as fan belt, wiring insulation, radiator hoses and gaskets. Any defects should be noted at this time.

The engine may be removed from the rest of the tractor by following the steps listed below. Drain water and oil. Observe the condition of the oil for tell-tale traces of engine bearing failure. If there is any evidence of failure, save a sample of the oil for future reference. Place a jack under the engine or use a chainfall and take the weight off the front wheels. Remove the hood, battery and gasoline tank. Disconnect the radiator hoses and upper radiator support rod from the engine and remove the radiator. Disconnect rear end of tie rods and drag links. Remove four bolts attaching front axle support to engine and roll the complete front end assembly forward, see Fig. 1. Remove the starting motor, wires from coil and generator, air cleaner tube, exhaust pipe, choke rod and U-bolt from the throttle torque rod.

Note: If engine is to be mounted on K.R. Wilson engine stand, the jack may be placed under the transmission case and after the front wheels are removed, the front end of the tractor may be raised and the engine bolted to the stand without the use of a chainfall, see Fig. 3. To bolt the engine to the stand attach stand at a starter hole and front left axle support mounting flange.

Unbolt the engine from transmission case and attach to engine stand, or swing forward and up on a chainfall.

The engine may be reassembled to the tractor by reversing the removal procedure.

Note: In the case of the TE-20, the hood support rod must be removed from the fuel tank before the radiator hoses are removed, and the struts holding the front axle support to the transmission case, see Fig. 2, must be removed before the front end assembly can be wheeled away from the tractor.

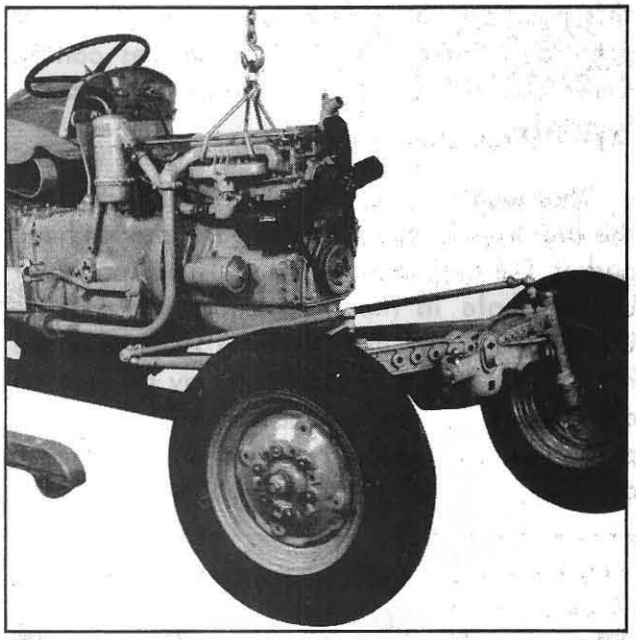


Fig. 1

CYLINDER HEAD

The valve-in-head type cylinder head is a grey iron casting which contains the valves, the combustion chambers and the valve coolant passages.

REMOVAL

The following steps are recommended for removing the cylinder head assembly.

1. Drain radiator and disconnect upper radiator hose and radiator support rod from the head.

2. Remove battery, disconnect fuel line from fuel filter and remove fuel tank.

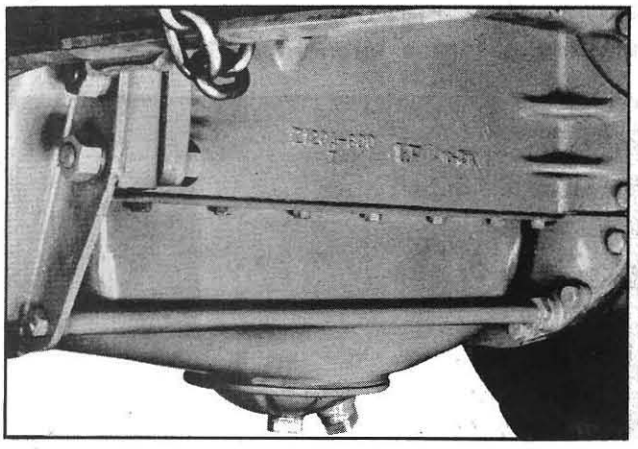


Fig. 2

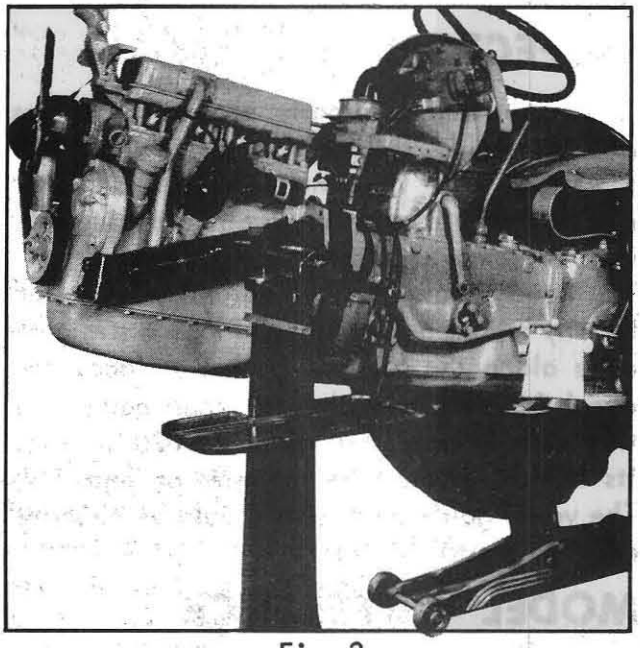


Fig. 3

3. Detach governor compensator spring link from governor linkage rocker and loosen U-bolt.

4. Loosen throttle rod clamp, remove the throttle control rod ball joint from throttle control plate and withdraw throttle control rod.

5. Detach wires from spark plugs.

6. Detach exhaust pipe and carburetor from manifold.

7. Remove cylinder head cover and four studs securing rocker arm to head.

8. Remove thirteen nuts and rocker arm shaft assembly. The cylinder head, valves and manifold may now be lifted from the engine block as an assembly, see Fig. 4.

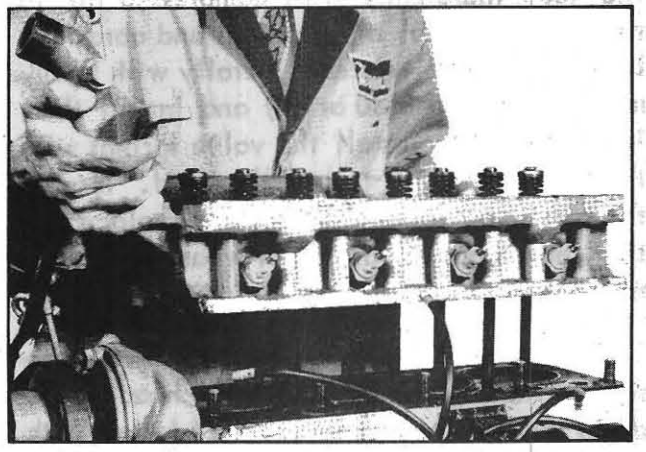


Fig. 4

INSPECTON

All the removable parts, such as the valves and manifold, should be disassembled from the head and the entire head thoroughly cleaned with a wire brush and cleaning solvent to remove all grease, dirt and carbon. The head should then be carefully inspected for any cracks or warpage. Place a straight-edge along the cleaned gasket surfaces and check for warping with a thickness gauge. If the head is warped as much as .020 in. over its length, it must be replaced or reground. The valve guides and seats should be checked as will be outlined later.

MODEL DIFFERENCE

On TO-20 tractor engines before Serial Number Z-120-158787, the cylinder head cover is not recessed for the nuts that hold it down. On these tractors the rocker arm studs which project through the cover are longer than on more recent tractors. The later type cylinder head cover with the recessed bolt holes and the removable vent tube may be used on the older tractors provided the short studs are also used. The same head may be used on the TO-20 or TE-20 tractors but the TO-30 head cannot be used on the TO-20 or TE-20.

INSTALLATION

Blow out the valve ports and other parts of the head thoroughly with compressed air to remove all traces of grindings and abrasive. Lubricate the valve stems liberally with heavy machine oil (SAE 30 or 40) and install them in the guides. Install the valve springs with the dampening coil toward the head. Inspect the retainers, locks and caps and replace any that show signs of damage or wear. Install all new oil guard gaskets on the intake valves.

It is a good idea to check the entire valve reconditioning job by setting the head upside down and filling the cylinder domes with gasoline. . If, after the head has remained in this position for a few minutes, no sign of gasoline leakage through the valves can be detected, the valve job has been done satisfactorily.

Thoroughly clean the mating surfaces of the block and head. Choose the proper head gasket (TE and early TO models had no water by-pass hole in the front end of the gasket. Late TO-20 and all TO-30 models have the hole). Gaskets with the hole may be used on any model tractor and gaskets without a by-pass hole can easily be punched to have an opening for the by-pass hole, see Fig. 5.

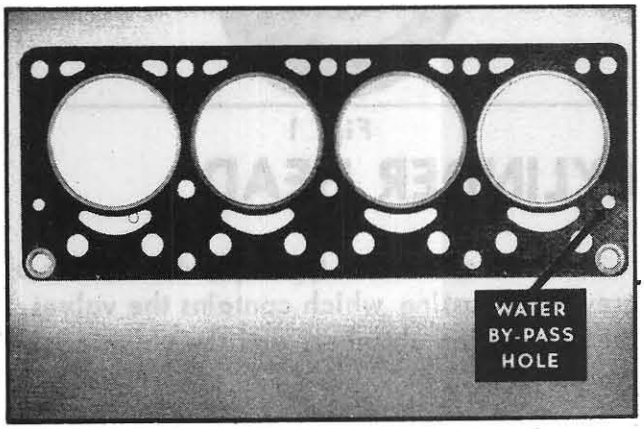


Fig. 5

NEVER install a gasket without taking special pains to see that this water opening is not sealed shut. Coat the gasket on both sides with a commercial sealing compound. If no compound is available, cup grease may be used.

Tighten the head nuts in the proper sequence, see Fig. 6 , from the center out and use a torque wrench for final tightening

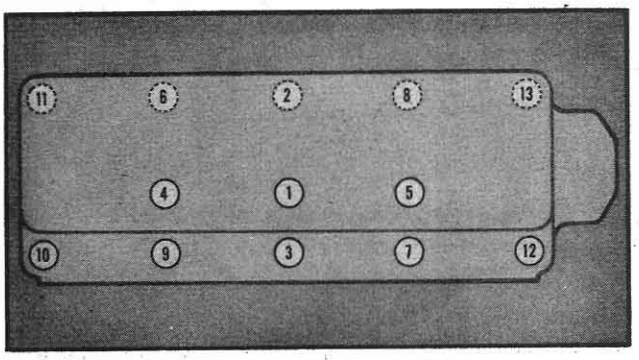


Fig. 6

to 70-75 pound-feet. Tightening the nuts in wrong sequence on a dry gasket may result in a cracked cylinder head. Tightening the bolts too tight may distort the head or block, ruining the precision valve job you have just finished.

VALVE TRAIN

The valve train of the Continental Engine consists of an intake and exhaust valve assembly for each cylinder, rocker arms for each valve, a rocker arm shaft mounted in four supports, push rods and tappets for each support and valve, see Fig. 7. The function of the valve train is to control the flow of fuel mixture to the cylinders to prevent its escape during the compression and burning cycles and to permit its escape after it is burned.

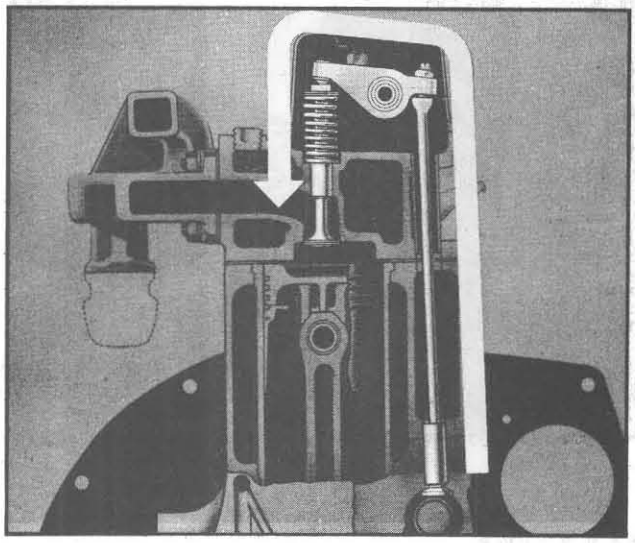


Fig. 7

The importance of a properly functioning valve train cannot be over-emphasized. Valve failures are expensive, especially if they come at a time when the tractor is urgently needed to plant or harvest the crop from which the farmer makes his living. In the modern high compression engine which powers the Ferguson tractor, terrific demands are placed on the valves. The chief reason for loss of power and performance and for wasted fuel and oil is faulty valve action. It is, therefore imperative that the valves be serviced whenever a compression test or any erratic action indicates that they may not be in peak operating condition. It is a good plan to adopt regular intervals for the servicing of valves but these intervals depend upon operating conditions and it is impossible to make specific recommendations. In general, the valves should be reconditioned whenever the engine is disassembled for the installation of new rings. Certainly, they should be removed and checked whenever the head is removed.

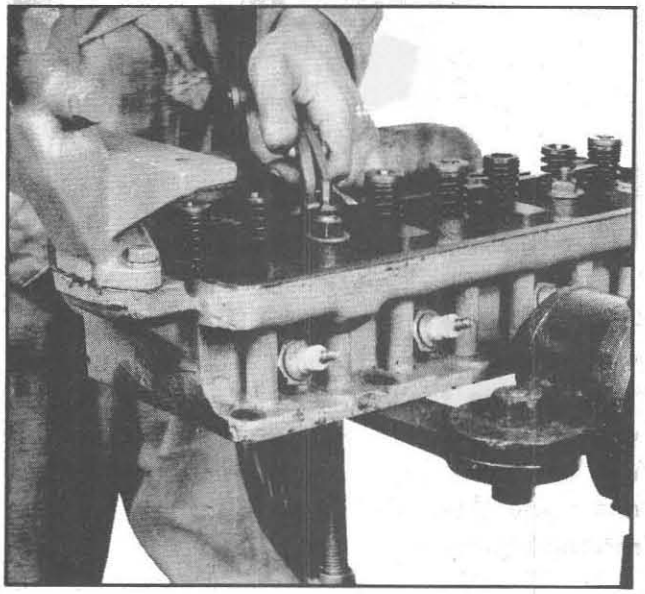


Fig. 8

DISASSEMBLY

Following is a recommended procedure for servicing the valves in the Continental engines. Remove the cylinder head as described on page 3. Remove the valves from the head using a suitable valve spring compressor, see Fig. 8 and Fig. 9. As each valve is removed from the head, it should be placed in a rack in such a manner that it can be reinstalled in the same position. Clean carbon from the head block thoroughly, preferably with a motor driven wire brush, see Fig. 10 and then with a solvent. After cleaning, remove all loose carbon particles and foreign material with compressed air. The valve guides should be cleaned with a valve guide cleaner, see Fig. 11, and checked with a light to be sure

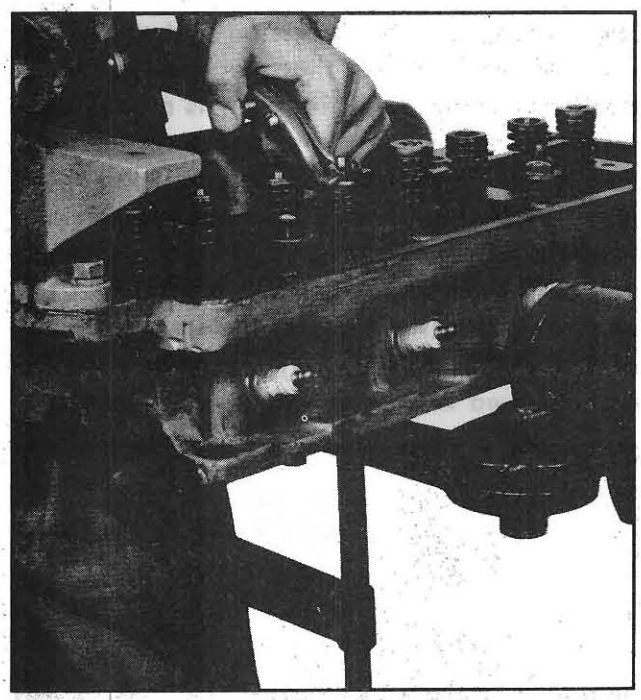


Fig. 9

they are bright. A bright burnished surface will retard carbon formation in the finished job. Clean the valves in a solvent and then with a fine wire brush, see Fig.12. Do not use sandpaper as it may scratch the valves and cause them to stick or fail when they are returned to service.

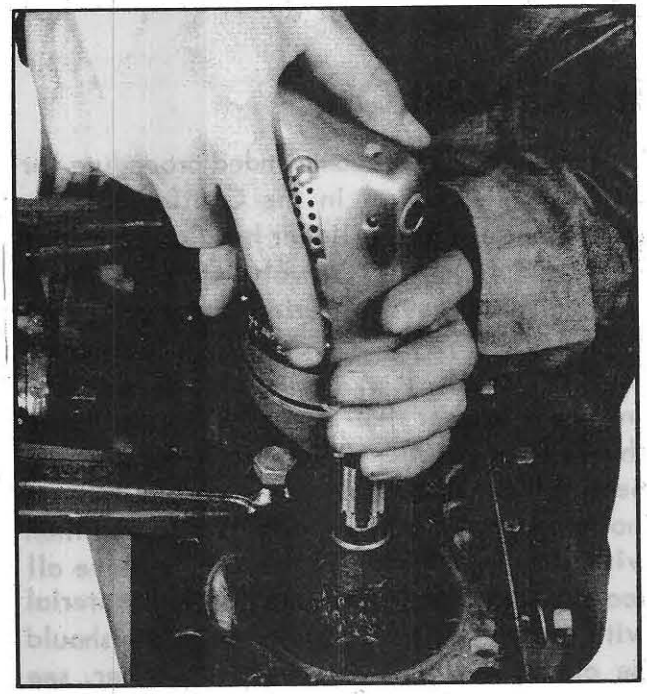


Fig. 10

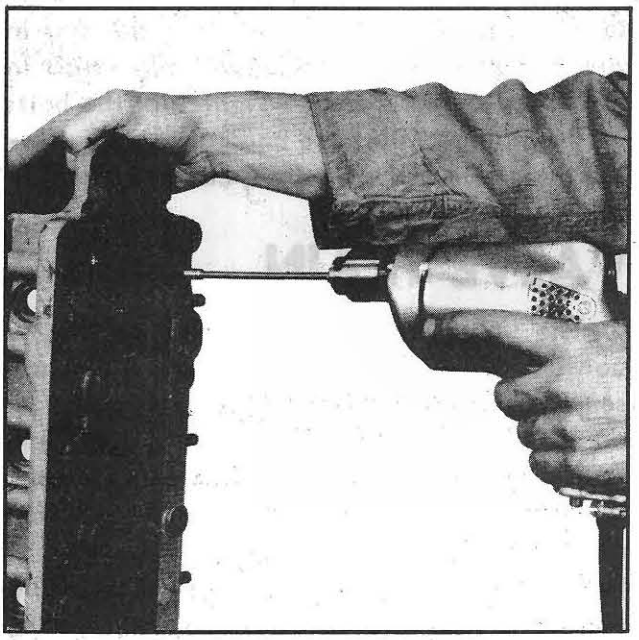


Fig. 11

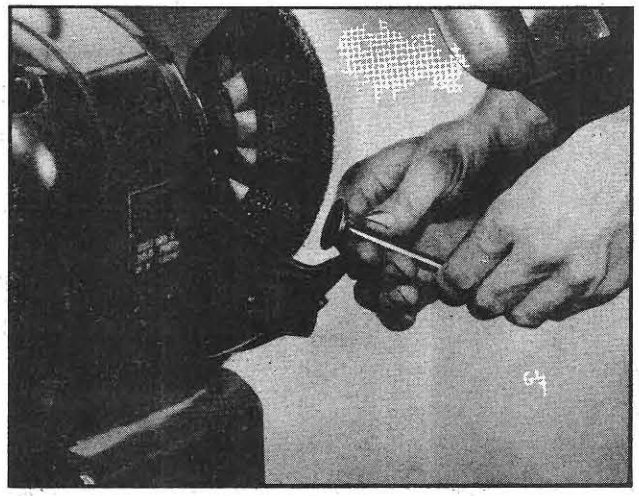


Fig. 12

VALVES

Fig.13 shows the names of the various parts of the valve. Notice particularly the sections marked "Head", "Margin", "Face" and "Stem".

The intake valve is held in place by the valve spring, an oil guard and a retainer which in turn is secured by the retainer pin inserted through a hole in the stem near the tip. Between the oil guard and the spring retainer is a neoprene seal which prevents excessive oil being sucked into the cylinder

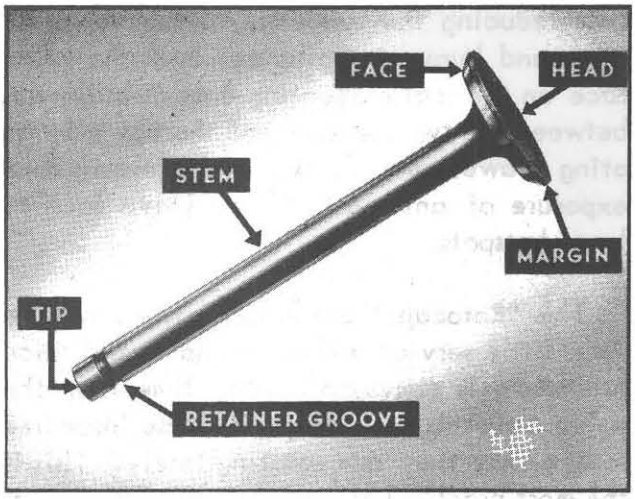


Fig. 13

through the valve guide. Whenever the valves are removed, a new seal should be installed. A cap is fitted over the top of the valve stem and it should be free to rotate and should not bind on the stem.

INTAKE VALVE

Each intake valve is a one-piece steel forging with a retainer pin hole drilled through the end of the stem. The valve, valve spring and retaining assembly is shown in Fig. 14.

The dimensions and markings of the intake valves for the TO-30, TE-20 and TO-20 are listed below.

	TO-30	TO-20 & TE-20
Head Dia.	1.273-1.283"	1.010-1.020"
Face Angle	30°	45°
Margin	3/64"	3/64"
Stem Dia.	.3141-.3149"	.3141-.3149"
Total Length	4"	3 31/32"
Head Marking	"IN"	"IN"
Stem Marking	Z-205	Z-222

The stem is marked near the pin end and the "IN" is forged on the under side of the head.

EXHAUST VALVE

The exhaust valve is also a one-piece forging but is made of a special X.C.R. alloy steel. A retainer lock groove is cut in the

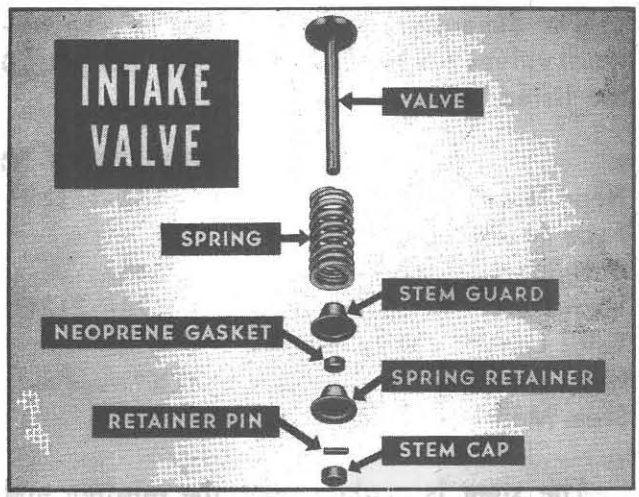


Fig. 14

stem near the tip and a hole to receive the valve cap is drilled into the end of the stem. This arrangement is shown in detail in Fig. 15.

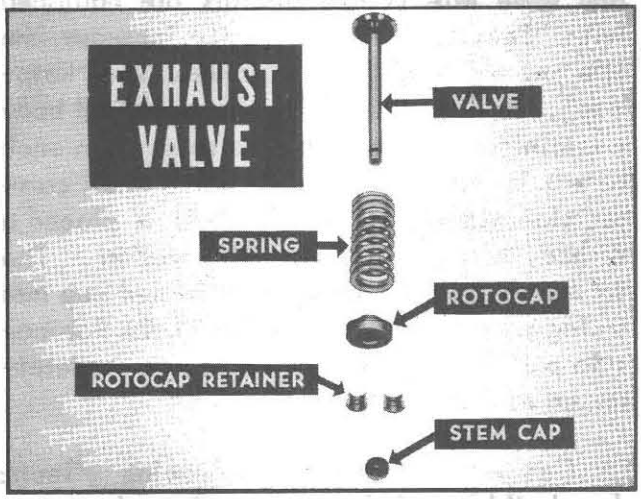


Fig. 15

The exhaust valves used in the TE-20 and early TO-20 engines were not equipped with rotocaps. These valves incorporated a hole in the stem and a retainer pin similar to the arrangement used on the intake valve. The assembly, however, did not include a neoprene gasket and the spring retainer is of one-piece construction.

The rotocap kits, available for installation on TE-20 and TO-20 tractors, do not include the special valve cap. When this kit is installed, the rocker arm is in direct contact with the valve stem.

The dimensions and markings of the exhaust valves for the TO-30, TE-20 and TO-20 are listed below.

	TO-30	TO-20 & TE-20
Head Dia.	1.135-1.145"	1.135-1.145"
Face Angle	44°	45°
Margin	3/64"	3/64"
Stem Dia.	.3124-.3132"	.3124-.3132"
Total Length	4 1/16"	4 1/16"
Head Marking	"EX"	"EX"
Stem Marking	Z-208	Z-203

The stem is marked near the retainer end and the "EX" is forged on the under side of the head.

The exhaust valves of all TO-30 tractors and some late TO-20 tractors are equipped with "Rotocaps" which greatly increase the life and efficiency of the valves. The "Rotocap", see Fig. 16, consists of a machined body containing recessed inclined races. In each recess is fitted a steel ball and a small compression spring. Over this ball is placed a dished, spring steel, Belville washer. The washer is held in place by a formed cap and spring snap ring. The function of the Rotocap is to positively rotate the valve at a predetermined rate.

This rotation has the following effects: less build-up of deposits on the valve stem, thus reducing the tendency of the valve to stick and burn, a wiping action of the valve face on the seat preventing deposit build-ups between the two surfaces and thereby eliminating blowby and burning and prevents long exposure of any part of the valve face to local hotspots.

The "Rotocaps" are trouble-free, require very little service and no special installation procedure is necessary. Any time that the valve cover is off, they should be inspected to see that they are rotating freely. This is the most practical test of their condition. If for any reason, the Rotocaps appear damaged or defective, they should be replaced by new Rotocaps and the valve lash reset. The Rotocaps are secured to the valve by split-type retainers. A .130 in. diameter hole is drilled into the end of the valve stem to receive a valve cap.

INSPECTION

As the valves are removed from the head, they should be placed in a numbered rack. After each valve has been inspected and reconditioned, it should be carefully returned to its proper position in the rack so that it will always be reinstalled in its original place in the engine.

The valves should be given a visual inspection for the following defects.

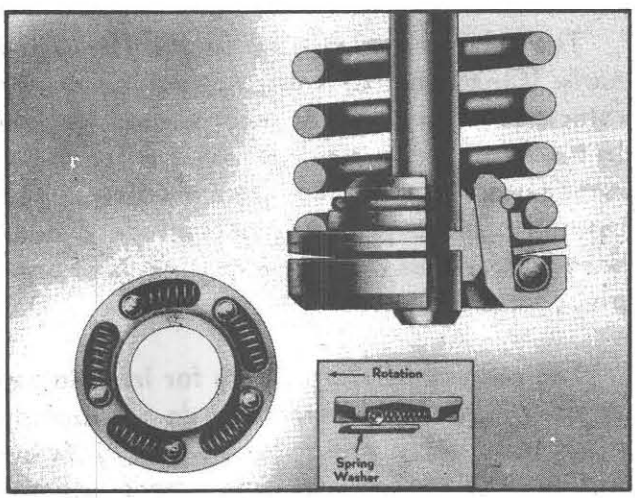


Fig. 16

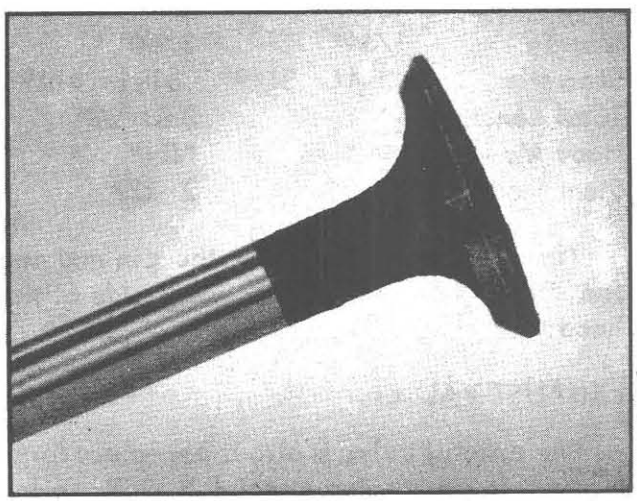


Fig. 17

1. Deep burns. Fig. 17. Valves which have deep burns should not be reused as grinding away enough metal to produce a good face will leave too small a margin. The metal behind deep burns is also very likely to have lost its original physical properties, making its future life very short.

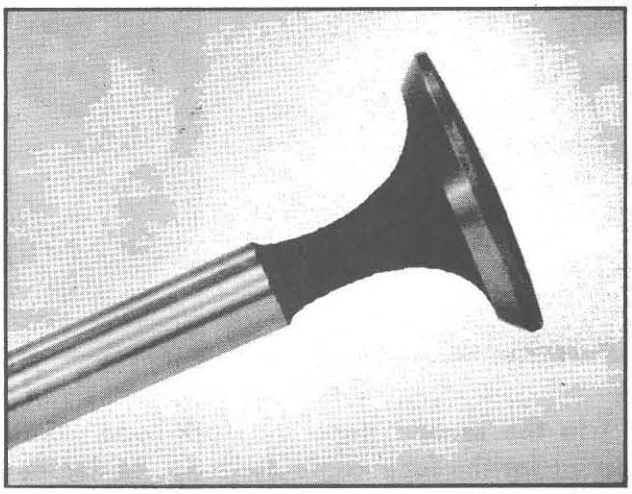


Fig. 18

2. Necking. Fig. 18. This will show up as a smaller stem diameter near the head of the valve and is a result of intense heat and corrosion. Necked valves may break in use and result in very expensive damage to the engine.

3. Scuffing. Badly scuffed stems cause rapid guide wear and should be discarded. Slight scuffing at the ends of the guide contact area may be polished with crocus cloth and the valves returned to service provided the stem diameter is within tolerance specifications as given later.

4. Worn keeper grooves. Worn grooves will allow the spring retainer to cock which lets the valve tip in its guide, producing rapid guide wear and possible face leakage.

If the valve appears to fall even a little short of meeting the necessary requirements of a good valve, don't take a chance, discard it. Usually, it is good practice to replace the worn valves in an old engine that has been opened up for other work. The extreme heat conditions under which valves work, can over a period of time, change the structure of the valve metal. Thus, an old valve may pass tests but still, because of unseen metal weakness, have a very small amount of useful life left. In this case, the cost of new valves is justified to prevent early failure which would require another valve job.

Close tolerances in the valve assembly train are very necessary for efficient engine performance. Several gauge checks must be made on the valve before it can be determined if it is suitable for use. The checks apply to new valves as well as worn ones. The valve may be set up on V blocks or between lathe centers but it is much more convenient to use a specially designed gauge fixture as shown in Fig. 19. Check for a bent stem as follows:

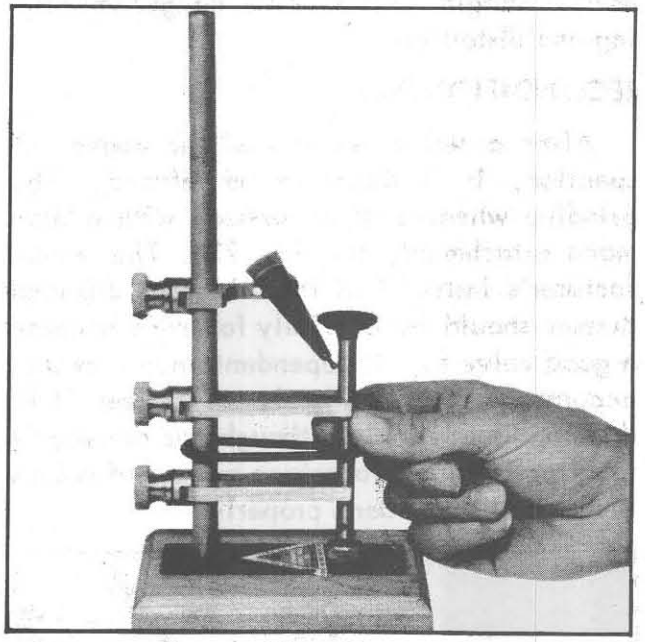


Fig. 19

1. Measure the diameter of the stem at several locations along the shiny guide bearing area with a micrometer, as shown in Fig. 20. If the measurement is more than .001 in. below that of a new valve stem (.3141 intake and .3124 exhaust), it should be discarded, as the valve must be a sloppy fit in the guide.

2. Measure the thickness of the valve head margin. If the margin is less than 1/32 in., see Fig. 21, it should not be used. A

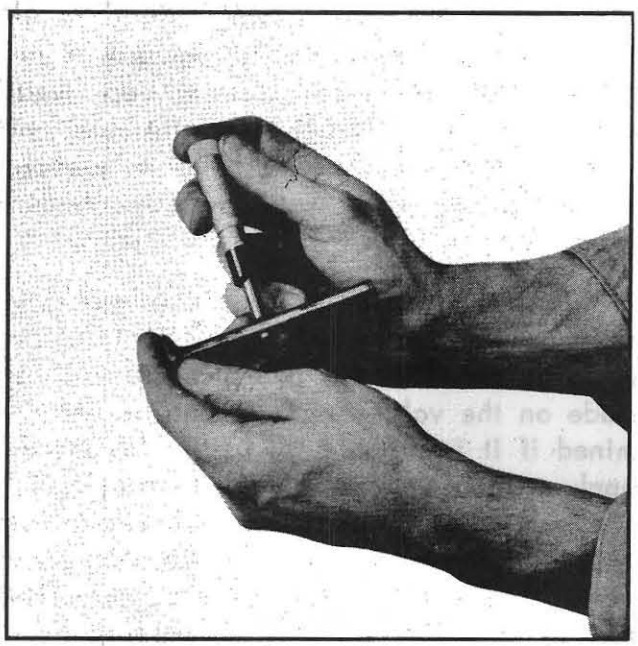


Fig. 20

narrow margin increases the danger of burning and distortion.

RECONDITIONING

After a valve has passed the above inspection, it is ready to be refaced. The grinding wheel must be dressed with a diamond attachment, see Fig. 22. The manufacturer's instructions for using the diamond dresser should be carefully followed because a good valve face is dependent upon a smooth accurately dressed wheel. Frequent light dressing is advisable although one dressing is usually sufficient to reface one set of valves if the grinding is done properly.

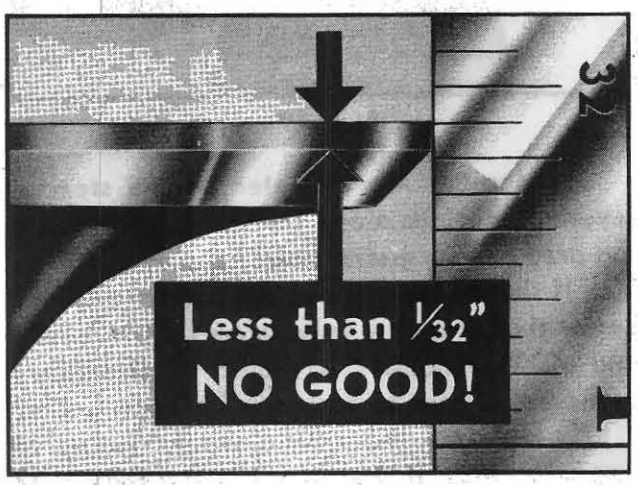


Fig. 21

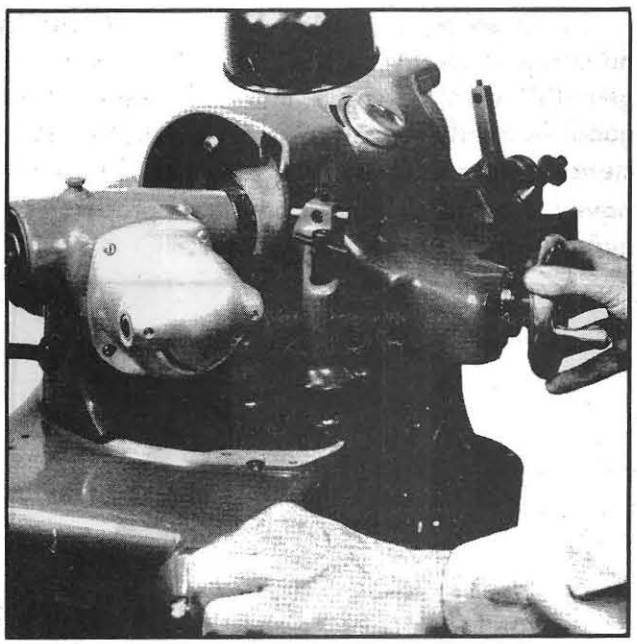


Fig. 22

In the second step, the work head should be set for the face angle desired. 44 degrees for TO-30 exhaust, 30 degrees for TO-30 intake and 45 degrees for all TO-20 and TE-20 valves. Most modern grinders have a scale which is graduated for interference angles as well as the conventional angles of 30 degrees, 45 degrees, etc. Notice that the TO-30 exhaust valve has a face angle of 44 degrees while the seat is ground to 45 degrees. This leaves an interference angle of 1 degree. The purpose of the angle is to provide a narrow line of contact between the valve and its seat so that the effect of carbon deposits is minimized. The illustration, Fig. 23, shows

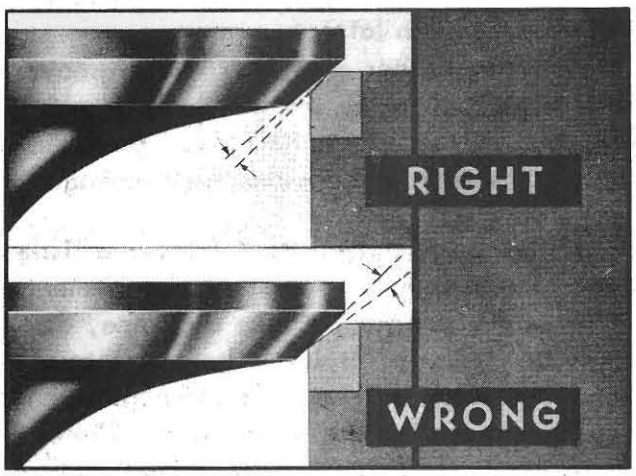


Fig. 23

the right and wrong ways to grind this angle. It is ALWAYS the angle of the valve face that is made less than the seat because the contact line should be at the top of the valve seat. In the "wrong" illustration, there is an opening between the valve and seat that is exposed to the combustion chamber. Carbon deposits would build up rapidly in this case and soon cause trouble.

In the third step, the valve is chucked in the work head. The jaw surfaces and the valve stem must be clean so that the valve axis is held true to the center line of the work head arbor. An experienced operator will tell whether the valve stem is distorted or bent on the first pass of the valve over the grinding wheel by the intermittent grinding sound. Valve stem distortion or bending takes place in the section of the stem exposed to the greatest heat, or that portion between the valve guide and the head of the valve. When the valve is chucked in the grinding head, the section liable to distortion is outside the chuck. If this section of the stem is bent, it will impart an eccentric or wobbling motion to the valve head. Consequently, on the first pass across the grinding wheel, only part of the valve face will contact the wheel, giving an easily recognized grinding sound. After the first pass, stop the machine and make a visual check. The valve face will look like Fig. 24 if the stem is bent.

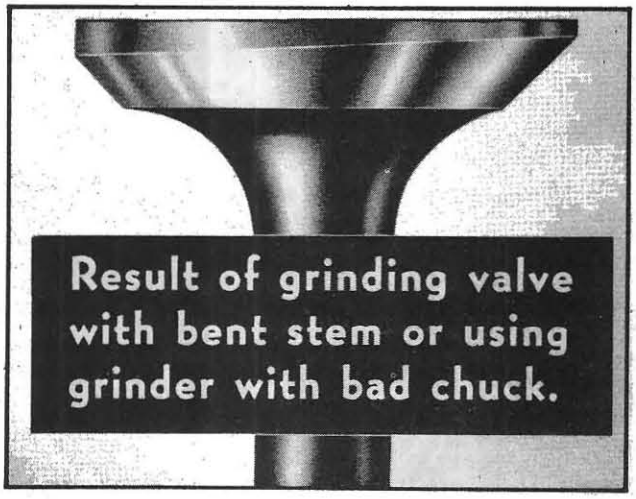


Fig. 24

Very light grinding cuts should be taken across nearly the full face of the wheel to distribute abrasive wear evenly. Only enough metal should be removed to true the valve face and provide a continuous even bright surface. The more metal ground away, the narrower the margin becomes. See Fig. 25.

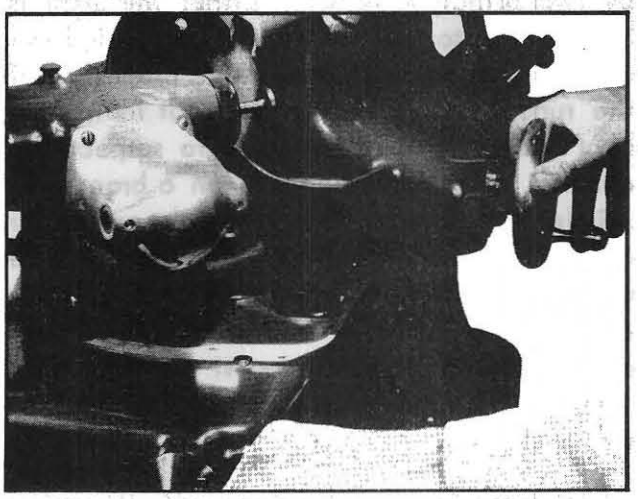


Fig. 25

The fourth step concerns itself with inspection procedures. The margin should be checked again to make sure grinding has not reduced it to less than 1/32 in. in thickness, in which case it should be discarded.

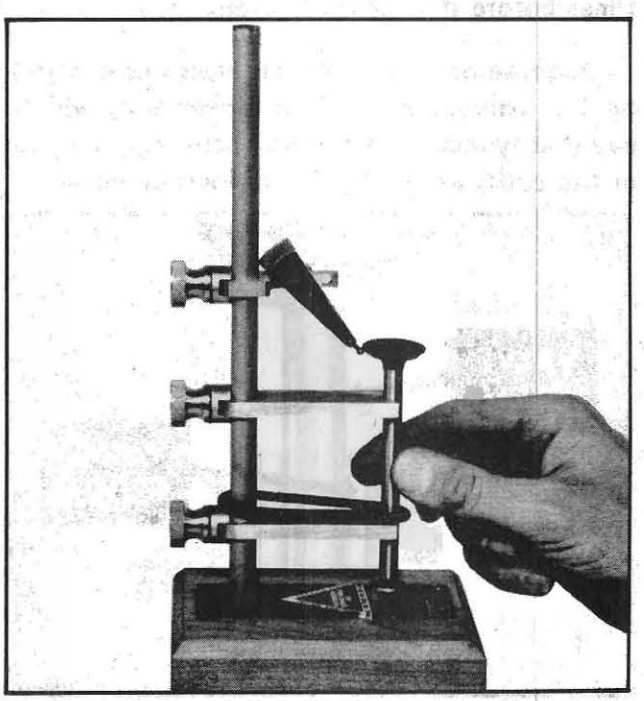


Fig. 26

Finally, the face runout is checked with the gauge fixture. This is shown in Fig. 26. Most recent model valve grinders in good condition and properly adjusted should produce a smooth, shiny valve face with not more than .0005 in. to .001 in. total runout. An excessive amount of runout can be caused by two principal faults. Either the stem is bent and distorted, or the grinder work head chuck is not centering the valve properly. If the runout gauge fixture does not indicate a bent stem, it is fairly safe to suspect the chuck. It is possible for even a brand new grinder to have a faulty chuck and older grinders with worn parts are very likely to be off. The total maximum face runout must not exceed .002 in. That is, the total dial indicator reading variation must be less than .002 in.

VALVE GUIDES

In order to obtain a tight seal, the valve face must be concentric with the valve seat. As the name indicates, the function of the valve guide is to hold the valve stem true in the center of the valve seat, see Fig. 27. On an average, a valve opens and closes approximately one hundred million (100,000,000) times before it needs servicing.

Because of wear and side pressures exerted on the valve stem by the rocker arm, which eventually make the guide bore egg-shaped at the ends, we must provide for replacement.

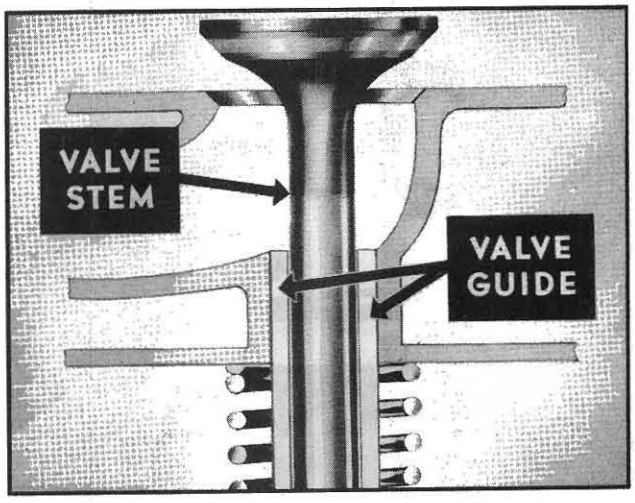


Fig. 27

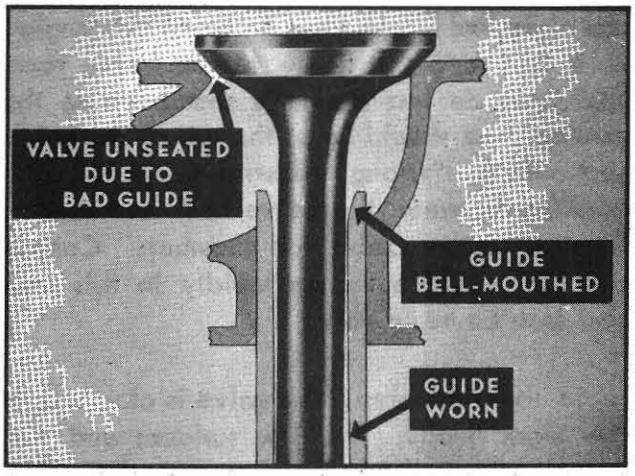


Fig. 28

In order to properly grind a valve seat, the grinder must be guided by a pilot. This pilot fits into the valve guide and depends upon it to maintain the true centerline of the valve seat. If the guide is excessively worn, is worn off center, or is bell-mouthed, Fig. 28, is should be replaced before seat refacing operations. It is, therefore, necessary that the guide be within specifications before proceeding further.

The head of the valve operates at a temperature from six to seven times as great as the water jacket. There is, therefore, a transfer of heat from the valve head to the water jacket. From the illustration, Fig. 29, it can be seen that there are two paths for this transfer. One is through the valve face to seat contact and the other is through the

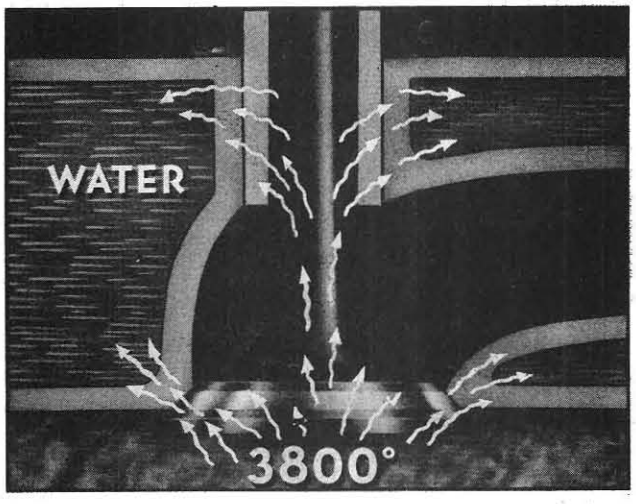


Fig. 29

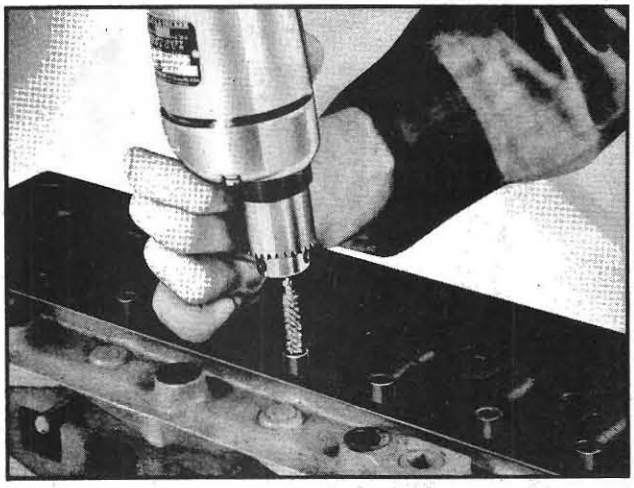


Fig. 30

valve stem to guide contact. Thus, a secondary, but very important, function of the guide is to conduct heat from the valve to the coolant. Notice that the stem to guide contact area is much greater than the face to seat area, plus the fact that face to seat contact is maintained for a relatively short time. As the valve guides wear, the heat transfer efficiency is lowered. This is aggravated by the fact that worn guides tend to allow varnish and carbon deposits to build up faster, which further impedes the transfer of heat. From this discussion, it may be seen that proper maintenance of the guide is important to the life of a valve.

When the valve guide bore becomes overly worn, it can be the prime cause of excessive oil consumption. The differential pressure resulting from the partial vacuum in the intake port and atmospheric pressure on the top side of the cylinder head forces the oil down between the guide and stem into the combustion chamber where it is burned.

INSPECTION

The guides should be thoroughly cleaned with a motor driven wire brush manufactured expressly for this purpose, see Fig. 30. They should be cleaned with a solvent and blown dry by compressed air. Replace any guides which are damaged or show severe scoring of the inner bearing surface. The next step is a dimensional inspection. The inside diameter should be checked with one of the small-bore gauges which are inserted, fitted, locked and then measured with a standard micrometer, see Figs. 31 and 32. The small-bore type gauge should be used because it is difficult to detect bell-mouth and oval wear with a plug gauge. The inside diameter must not exceed .3177 in. at any point.

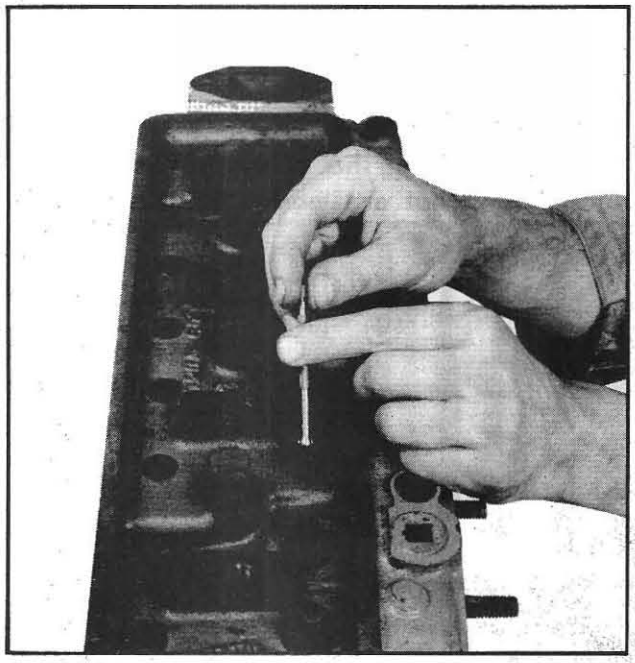


Fig. 31

Fig. 32

INSTALLATION

Guide installation must be carefully done to prevent distortion of the guide which might result in throwing the valve out of line. It is especially essential to prevent damage or distortion of the port end of the guide. Replacement is made easy by the use of the special tools, seen in Fig. 33, which are Ferguson

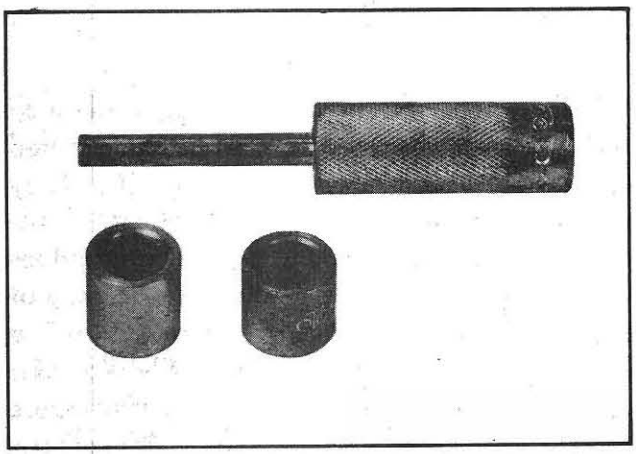


Fig. 33

designed and have been released by specialty tool manufacturers. A long bushing is used for the TO-30 exhaust valve guide which has a deep counterbore in the head. The short bushing is used on the TO-30 intake valve guide. The short bushing will also be used for both intake and exhaust guides on the TE-20 and TO-20 engines. In use, the bushing is placed over the top end of the old guide, a combination mandrel and aligner furnished with the bushings is used to center a new guide placed on top of the old one. An arbor press must be used as the guide should never be pounded into position. Using the method illustrated in Fig. 34, the old guide is used to properly position the new guide for insertion. As the new guide is pressed into position it forces the old guide out. This has the advantage of combining two operations into one. The new guide which is always inserted from the TOP of the cylinder head, is pressed down until the mandrel contacts the top of the bushing. This automatically positions the top of the guide the correct distance below the top surface of the head. NEVER ream

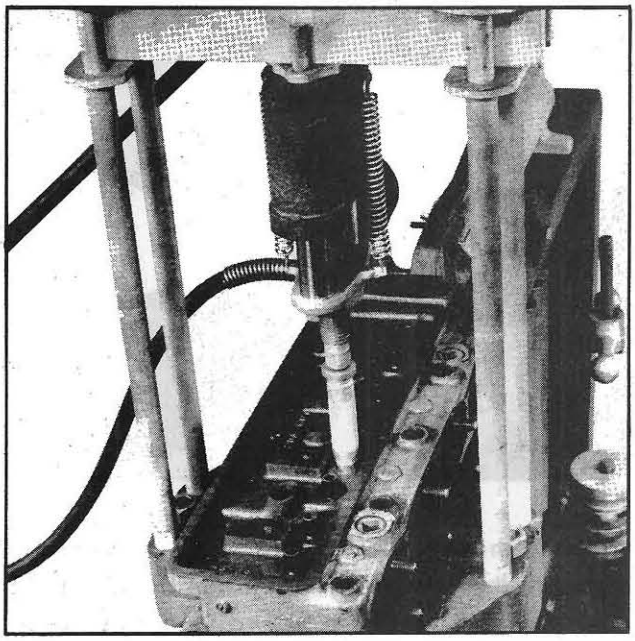


Fig. 34

Ferguson guides after installation as all service guides are finished to the proper diameter. Ertel guides, Fig. 35, are used to service all Ferguson tractor engines. These are a new development incorporating a fine spiral groove machined into the inside surface much as in the barrel of a rifle. The groove assists in maintaining proper lubrication of the valve stem and helps to prevent varnish formation. Since the groove is only .002 in. deep, careless reaming would quickly destroy its effectiveness.

VALVE SEATS

After checking the valve guides and replacing any that are worn or damaged, the

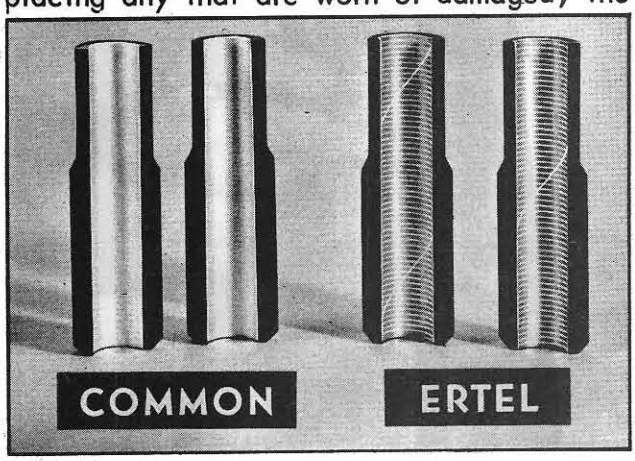


Fig. 35

next step is to recondition the valve seats. Valve seats serve two primary functions. In the first place, they provide a sealing surface for the valve face. Tremendous heat and pressures must be sealed into the combustion chamber and a poor valve face or valve seat cannot hold them. A leaking valve seat will permit loss of fuel mixture on the compression stroke of the piston and loss of power on the power stroke. On the exhaust valves, the blow-by of hot gases will quickly ruin the valve. Poor valve seating quickly ruins efficient tractor performance. In the second place, good contact between the valve face and valve seat serves to conduct heat from the valve head to the coolant.

INSPECTION

After cleaning all carbon from the seats with a wire brush, wash them with a solvent and dry with compressed air. Make a visual inspection for fine hair-line cracks which are most likely to be found in the exhaust port seat inserts. Check the inserts very carefully for looseness. If a seat is cracked or loose, it must be replaced. Install a new insert also if any of the old ones are badly burned or pitted.

INSERTS

Removing an old insert and replacing it with a new one is a relatively simple mechanical operation. Nevertheless, this procedure is a critical one and poor workmanship can lead to a lot of unnecessary trouble and expense, both of which result in a dissatisfied owner. The old insert may be removed by using one of the special tools developed for this purpose. Fig. 36 shows the Bishman ring extractor tool in use. It is essentially a fixture with three hardened points which is installed so that the points contact the junction of the bottom of the insert with the bottom of the recess. As the points are expanded, they bite into the insert and it can then be pulled out of the recess. This method of removal gives a minimum of head distortion and recess damage.

In preparing the old recess for the new insert, the problem of interference arises. Since both the seat insert and the recess have straight, smooth walls, we must provide some method of holding the insert into the recess. Inserts used in Ferguson tractors are a cast iron alloy and depend upon an interference fit to hold them in place. The recess is cut .003 in. smaller than the outside diameter of the insert. This makes the insert a very tight fit into the recess see Fig. 37. The amount of interference used is rather critical. If too little interference is used, the insert may loosen and cause trouble. Oddly enough, if too much interference is present, the same trouble will develop. Some mechanics have been careless in their proce-

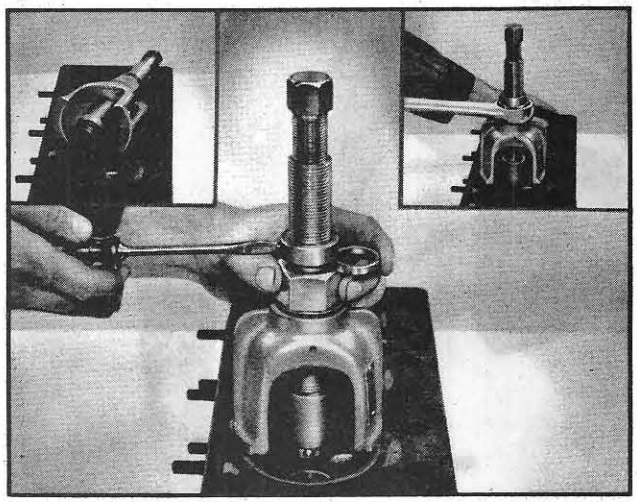


Fig. 36

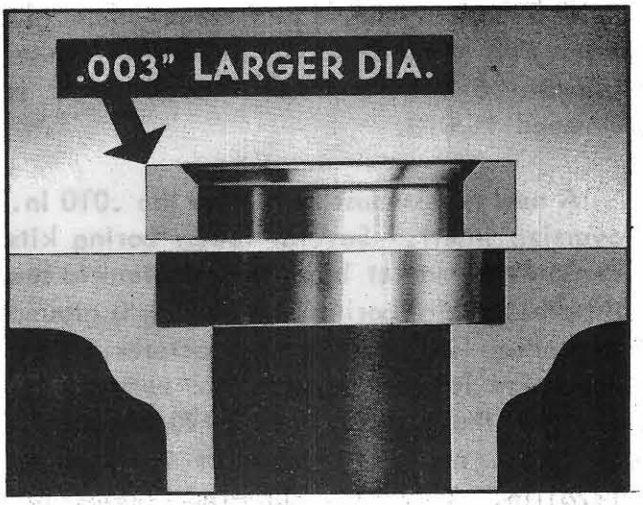


Fig. 37

dure and had new inserts come loose after a short time. They wrongly assumed that there hadn't been enough interference and used still more interference next time. When excessive interference is used and the insert expands due to normal engine operating temperature, it has been found that terrific pressure is developed which crushes the crystalline structure of the iron in the insert and head. As soon as this occurs, the insert quickly loosens. The more interference used or the tighter the fit over .003 in., the quicker the insert loosens in use.

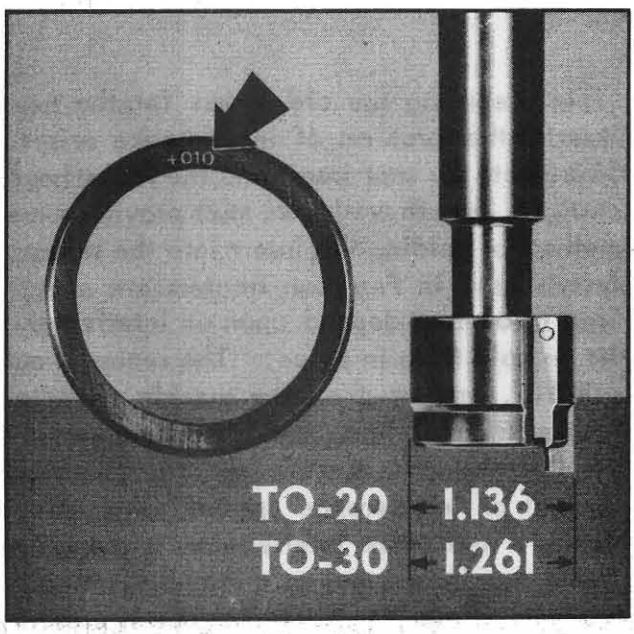


Fig. 38

Because the accurate fit of the old recess is likely to be changed by removal of the old insert, all of the inserts furnished for service use are .010 in. oversize. Each insert is stamped + .010.

A new recess must be cut for the .010 in. oversize insert. Several recess boring kits are on the market but it is important to see that the special boring tool, which is ground to precise limits by the manufacturer, is the right size for the insert. The cutter, Fig. 38, for the TO-20 and TE-20 should be 1.136 in. and the cutter for the TO-30, 1.261 in. The pilot is inserted in the valve guide, a cutter head and spindle positioned

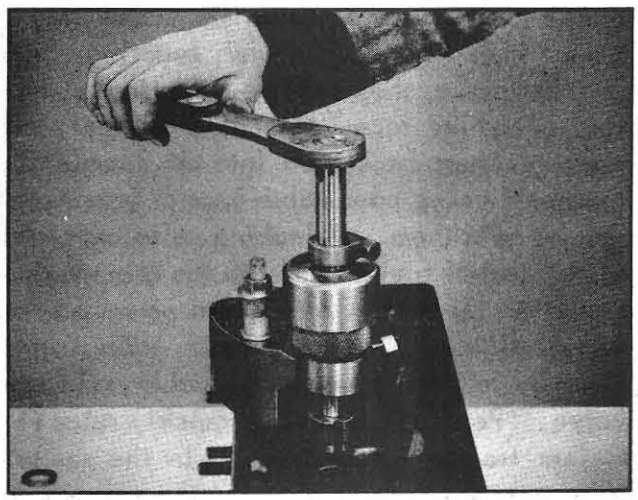


Fig. 39

and the boring tool holder bolted to the head, see Fig. 39. Specific instructions for this installation are given by each manufacturer for his particular equipment. The cutter may be either hand or motor driven, one way does just as good a job as the other except for the factor of speed. The main things to watch for are, that the cutter has not worn to the point where the recess is undersize, that the recess walls are smooth and even and that the floor of the recess is square with the sidewalls. Before installing the new insert, make sure that the recess is CLEAN. Any chip, carbon or dirt under the insert will prevent it from seating properly.

NEVER install a seat without using a pilot

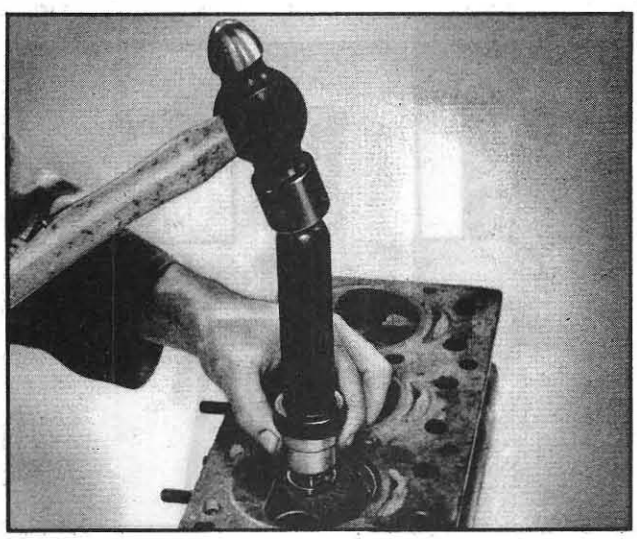


Fig. 40

to make sure it is square with the recess. The pilot used in boring the new recess is left in place, the new seat positioned and a driver with the correct size extension dropped over the pilot, see Fig. 40. Some mechanics like to use a light coating of a special cement on the valve seat ring. Others prefer to peen or roll a small amount of the head metal over the insert edge after installation to insure a tight permanent fit. Either or both of these precautionary measures have much to recommend them although they are not absolutely necessary if the proper interference has been provided.

GRINDING

A motor driven seat grinder is a must. Several types are on the market and operating procedure varies slightly depending upon the kind used. The manufacturer's recommendations should be carefully followed and when new equipment is purchased, a demonstration should be insisted upon. There are several makes of motor driven grinders available. Three basic types are offered—straight concentric grinders, vibro-centric grinders and eccentric grinders. It is not the purpose of this manual to discuss the relative merits of each, other than to say that they will all do an acceptable job if correctly used.

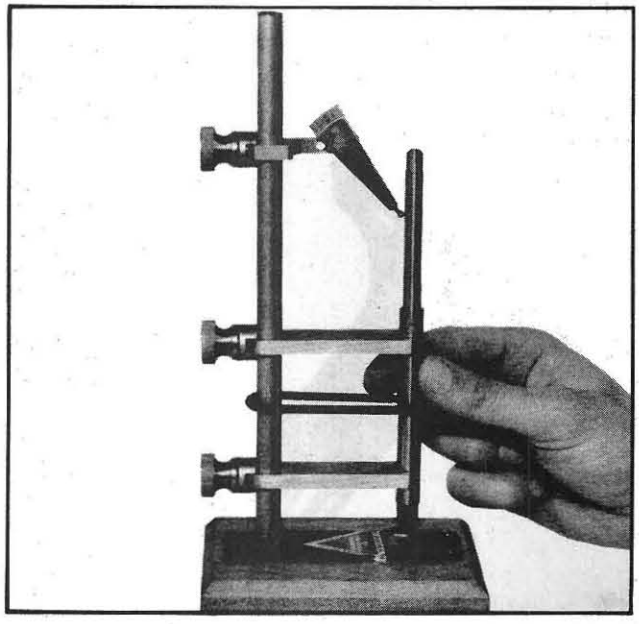


Fig. 41

General procedure consists of the following:

1. Inspect pilot to make sure it is not bent by checking it on the gauge, see Fig. 41. Use a micrometer to check for excessive wear.

2. Unless the seats are in extremely bad condition, a fine grit seat dressing stone should be selected and dressed on the special fixture provided, see Fig. 42. Take very light cuts across the face with the diamond dressing tool and remove only enough grit to true the face. If the diamond is moved slowly across the face, a smoother surface will result which is a desirable condition.

3. Tighten the pilot in the valve guide, see Fig. 43, and lubricate it with a few drops of light oil. Install the stone on the grinder motor and place over pilot. On TE-20 and TO-20 engines, a 45 degree stone is used for both intake and exhaust seats. On TO-30 engines, a 45 degree stone is used on the exhaust seats and a 30 degree stone on the intake seats. Feed the grinder down onto the seat slowly, being careful not to exert pressure downward or sideways, see Fig. 44. Take very light cuts and check often so that only enough metal is removed to clean up the seat and give a continuously bright surface. Remove the grinder and install a seat runout

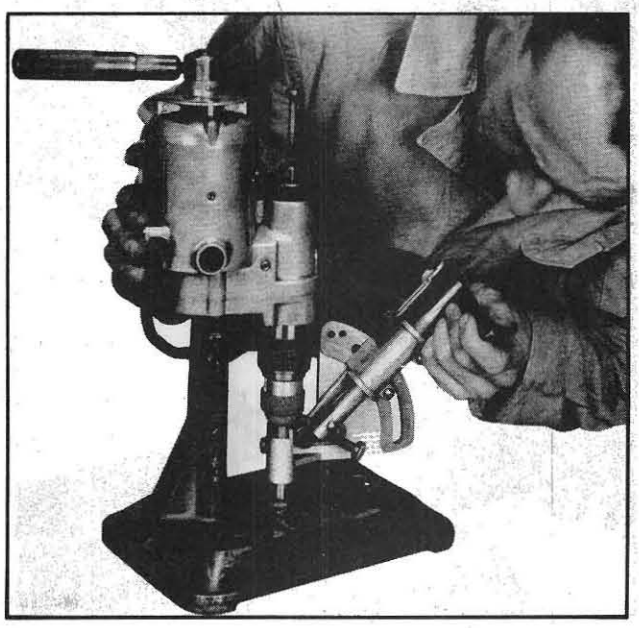


Fig. 42

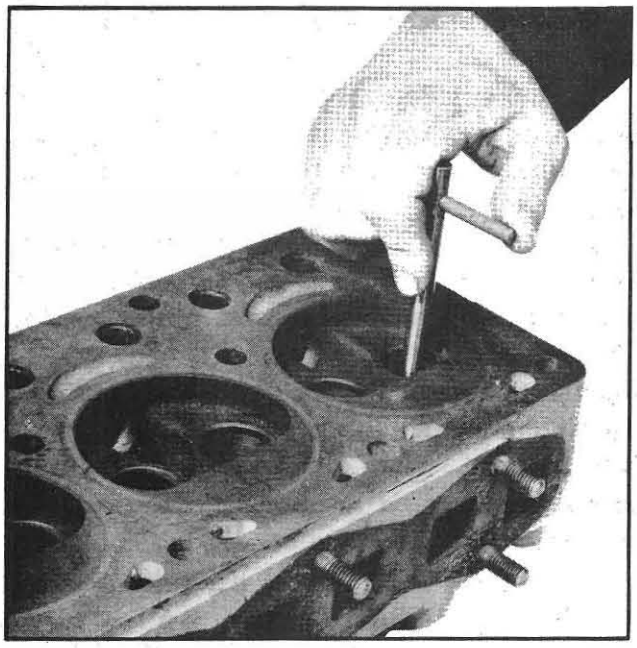


Fig. 43

indicator, furnished by the grinder manufacturer, on the pilot spindle. The indicator is a special fixture holding a dial indicator gauge and a contact point which rides on the valve seat, see Fig. 45. The point transmits any face irregularities to the gauge. The seat faces are relatively small and may require a special contact point before the in-

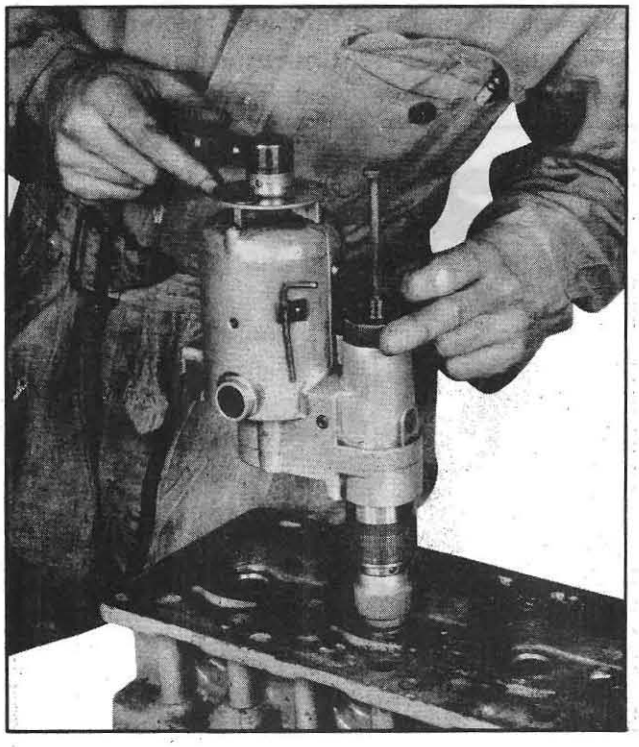


Fig. 44

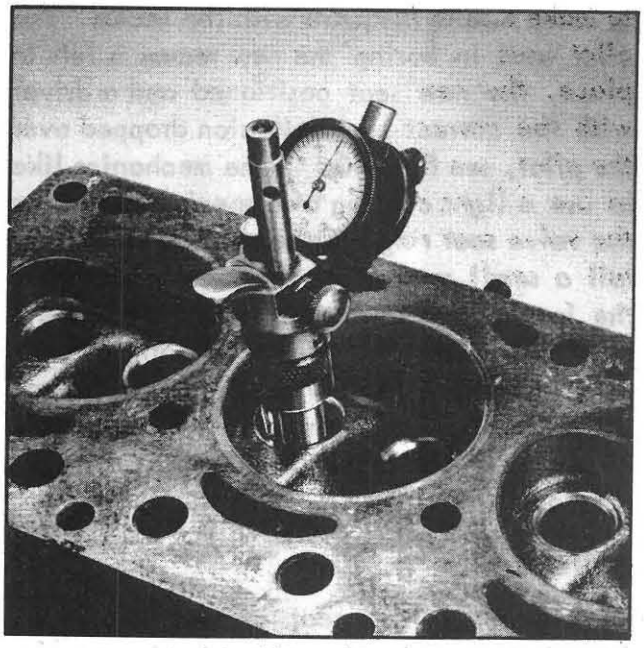


Fig. 45

dicator will work. Seat runout must not exceed .002 in. total indicator reading.

4. The width and location of the contact area are the next things that should be checked. Apply a light coat of prussian blue to the face of the valve, insert it into its seat and turn it through an angle of 10 to 15 degrees. The area of the valve face from which the blue has been removed will indicate the width of the seat and its location on the face, see Fig. 46. The contact area must fall in the middle of the face so that the two sharp edges of the seat may chip away any carbon or lead deposits which might interfere with the sealing action. If the contact area is too

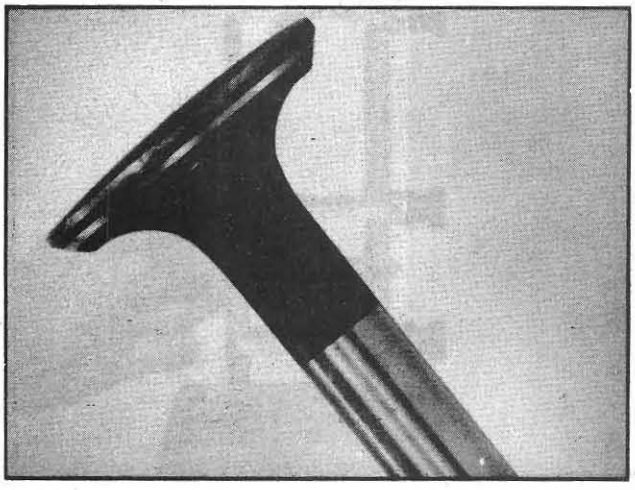


Fig. 46

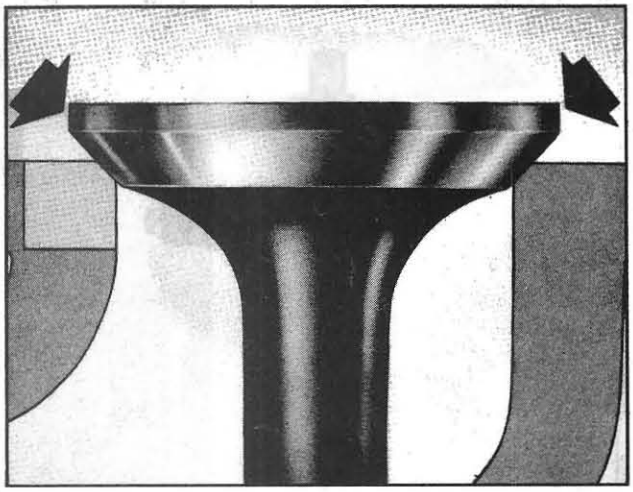


Fig. 47

low on the valve face, see Fig. 47, the outer or thin edges of the valve can become too hot through poor cooling contact. The remedy is to cut deeper with the seat grinder.

If the contact area is too high on the valve face, see Fig. 48, the sharp edge of the seat does not contact the face and carbon build-up is encouraged. A few light cuts with a 10 degree stone on 30 degree seats and a 15 degree stone on 45 degree seats will lower the location of the contact.

Notice in Fig. 49 that the contact area is now lower on the valve face but it is still too wide. This may result in a low valve closing pressure which would encourage formation of carbon deposit between valve face and seat. The width of the contact area is a very im-

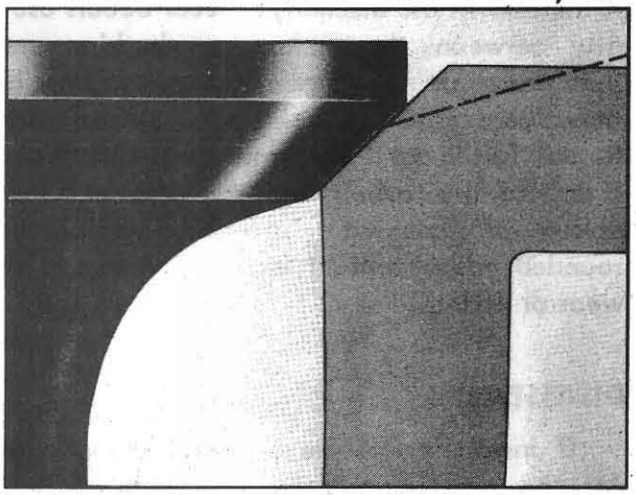


Fig. 48

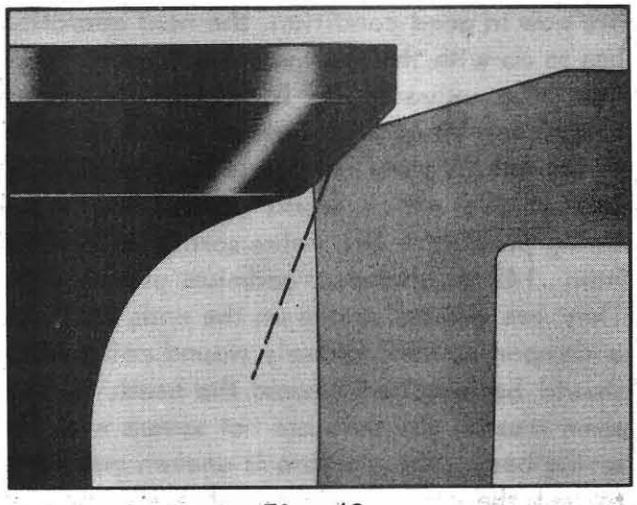


Fig. 49

portant factor in the life of the valve. The seat must always be narrower than the valve face and in our engine should be approximately 1/16 in. wide. If a seat is too wide, it tends to collect excess carbon. If it is too narrow, the transfer of heat from valve face to coolant may be less efficient, and the valve may hammer down into the seat, decreasing the amount of lash. If the contact area on the blued valve face is still too wide after the above operations, a 60 degree to 70 degree narrowing stone may be used to remove enough metal from the bottom edge of the contact area to bring the seat to its proper width. Fig. 50 shows valve correctly seated.

VALVE SPRINGS

Since the valves, the guides and the seats

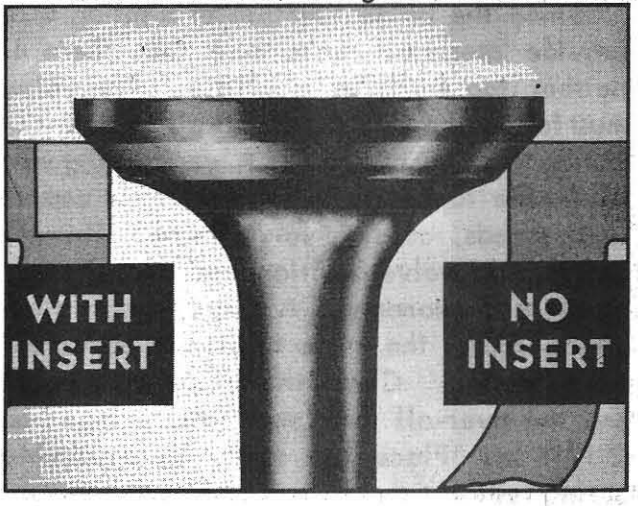


Fig. 50

are now in good condition, the next operation has to do with the springs. The primary function of a valve spring is to hold the valve closed and make the tappet follow its cam movement. Valves are opened by mechanical cam action which works against the valve spring pressure. The valve springs are coiled from .142 in. diameter cadmium plated wire. They are ground square on the ends and have a dampening coil (closely wound coil) which should be installed toward the head. If, for some reason, the ends are not square with the spring body, the pressure is uneven and tends to wear the valve guide out-of-round and also contributes to "sticking" valves. Therefore, the first test will be to use a square to see that the ends are square with the body, see Fig. 51.

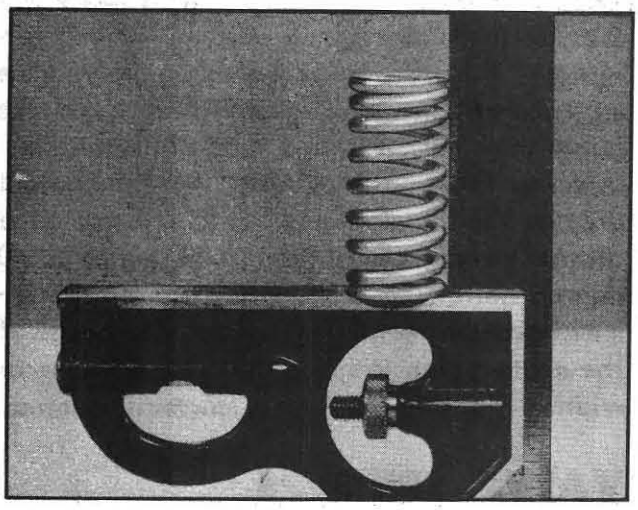


Fig. 51

Since the prime function of a spring is to provide pressure, make sure that there is neither too much or too little. The valve must follow the cam closely at all times or the timing will be affected. A weak spring will allow the tappet to be thrown off the cam at high speeds, causing valve flutter. This affects all the valve functions and means loss of power and economy. A spring which is too strong causes the valve to give its seat a severe beating. Check the springs by measuring the over-all free length which should be 2 1/16 in. Place the spring in a suitable spring tester as shown in Fig. 52 and compress the spring until its length is 1 45/64 in. A

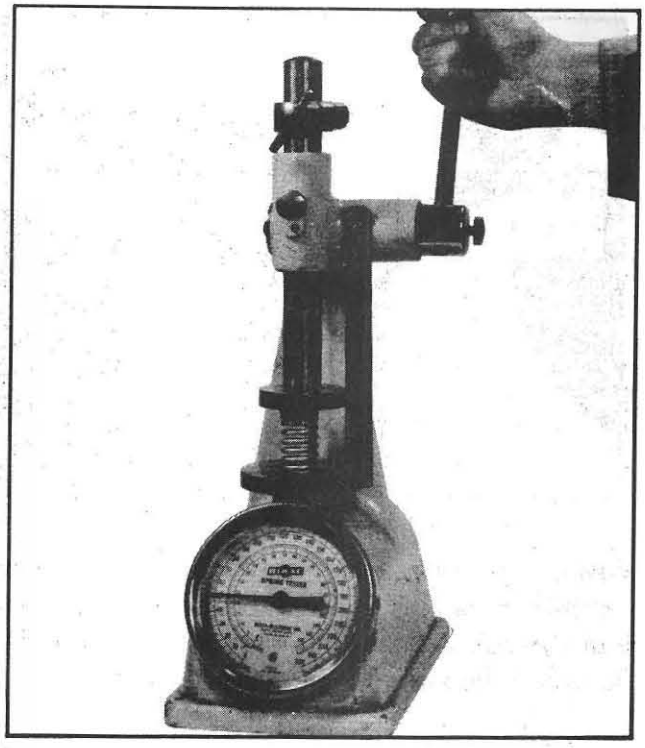


Fig. 52

load of from 47 to 53 pounds should be indicated on the dial. Compress the spring until its length is 1 27/64 in., a load of 96 to 104 pounds should then be indicated on the dial. Replace any spring which does not meet this specification.

ROCKER ARM ASSEMBLY

A visual inspection of this assembly should be made to detect evidence of excessive wear and to determine whether it will be necessary to tear down the assembly. Wear occurs usually between the rocker arm bushing and shaft, also on the hardened rounded face at the valve end of the rocker arm. Check first to see if the arms are loose on the shaft and if any of the springs between the arms are broken or damaged. Second, examine the rounded valve contact buttons for excessive wear or pitting.

DISASSEMBLY

If inspection of the assembly shows need for new parts or refacing of rocker arm buttons, disassemble as follows:

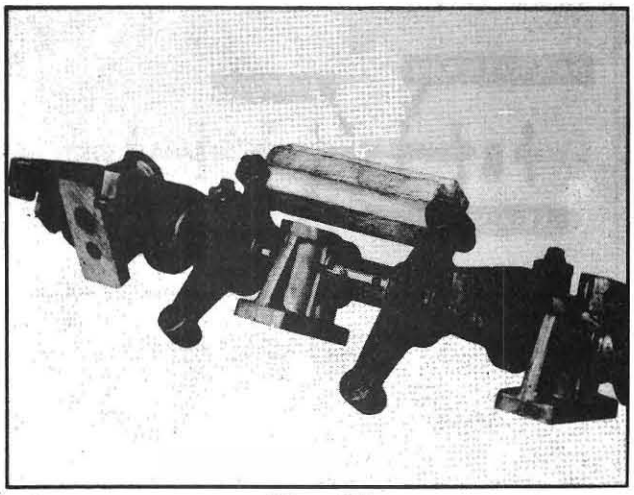


Fig. 53

1. Remove the oil plug from each end of the shaft.
2. Take out the locating pin, see Fig. 53.
3. Press the arms, supports and springs off the shaft, as shown in Fig. 54.
4. Wash the shaft and parts in a solvent, being careful to clean out any sediment from inside the shaft and make sure all oil holes are open.

INSPECTION

The rocker arm shaft is made from heat-treated, seamless steel tubing with lubrication holes and a locating pin hole. It is ground to an outside diameter of .622-.623 in.

First, check the rocker arm bearing surfaces of the shaft for scoring. Use a new shaft if serious scoring is found. Slight scoring may be remedied by polishing with crocus cloth.

Second, if no scoring is evident, use a micrometer to measure the diameter of the shaft at the points where there has been rocker arm bearing wear, see Fig. 55. Use a new shaft if diameter is less than .621 in.

The rocker arms are of stamped and welded construction with a bronze bushing pressed in place and broached to a diameter of .624-.625 in. The bronze bushing is not serviced separately and if it is worn and needs replacing, the complete rocker arm must be replaced.

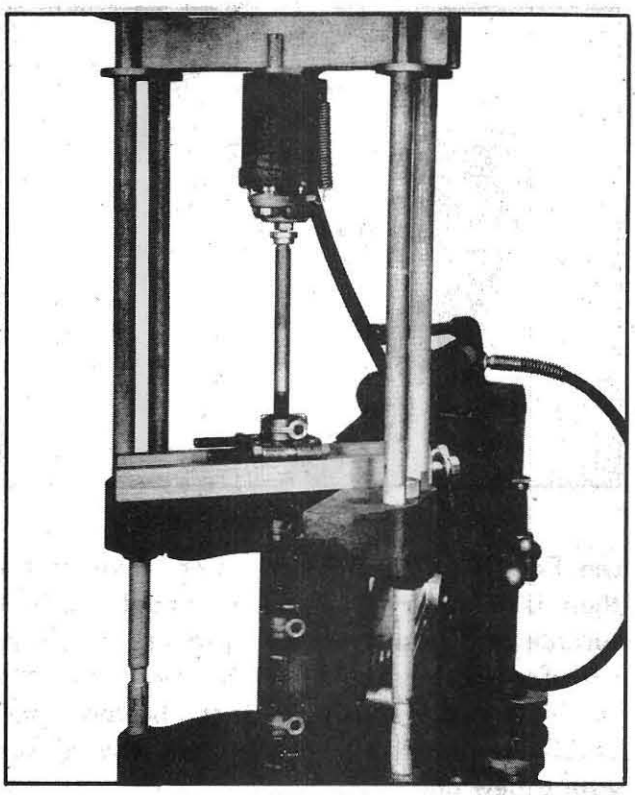


Fig. 54

Third, use a hole gauge to measure the inside diameter of the rocker arm bushings, see Fig. 56. They should not be more than .626 in.

Slight wear or pitting of the rocker arm button may be corrected by grinding to a 5/16 in. radius, using the special fixture provided with the valve grinding machine,

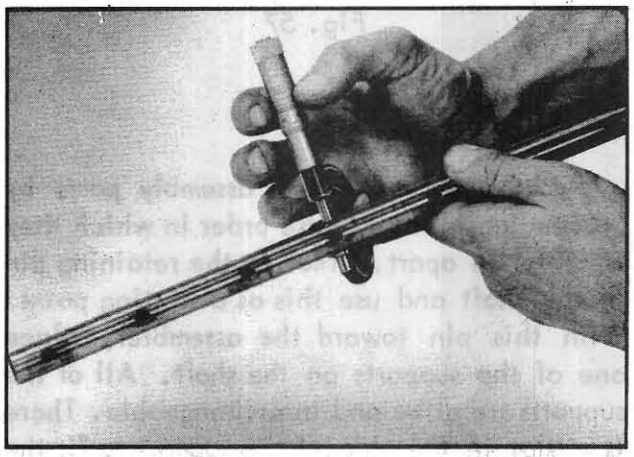


Fig. 55

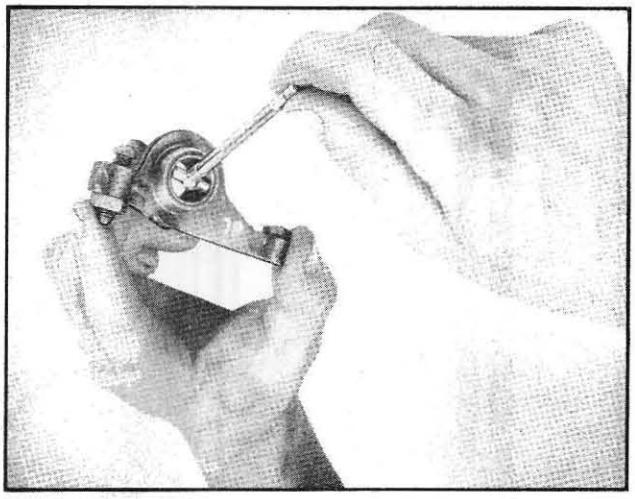


Fig. 56

see Fig. 57. Do not remove any more metal than is necessary to produce a smooth, bright surface. Consult valve grinding machine manufacturer's specific instructions for the machine you are using. If the button is severely worn or pitted, replace the rocker with a new one.

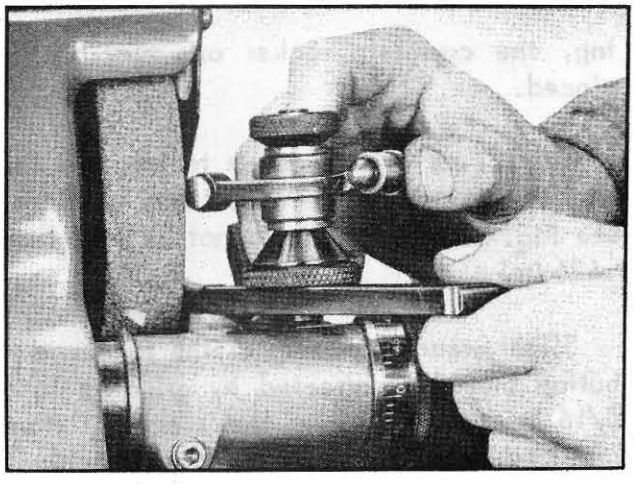


Fig. 57

REASSEMBLY

Reassemble rocker arm assembly parts by proceeding in the reverse order in which they were taken apart. Notice the retaining pin in the shaft and use this as a starting point. With this pin toward the assembler, place one of the supports on the shaft. All of the supports are alike and interchangeable. There is a slot in the side of the support to fit the pin. Because of this slot, the support can be

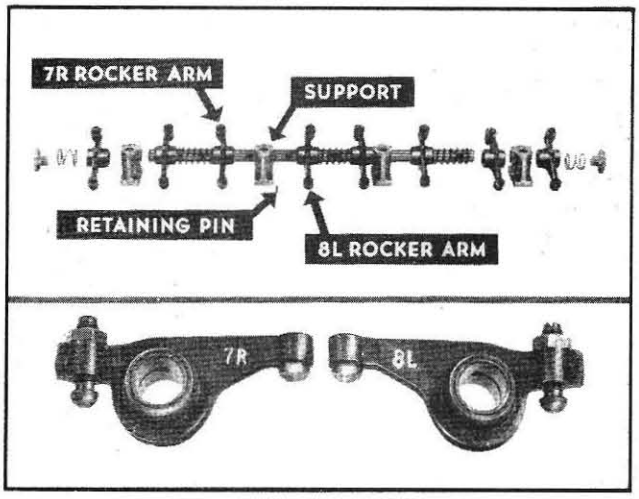


Fig. 58

assembled only in the correct position. Now look at a rocker arm. It is stamped either "7R" or "8L" meaning that it is a right or left-hand rocker and the rockers are not interchangeable. Oil the bushings of all the rocker arms prior to assembly. Place a "7R" or right-hand rocker to the LEFT of the support with the valve or nonadjustable end toward the assembler, see Fig. 58. Next, place a heavy spring, an "8L" rocker, another support, a "7R" rocker, a light spring and then the oil plug in the order given. Starting at the RIGHT side of the pin, place an "8L" rocker, a heavy spring, a "7R" rocker, a support, an "8L" rocker, another heavy spring, a "7R" rocker, a support, an "8L" rocker, a light spring and finally, the oil plug in the exact order given. This completes the assembly.

Because of the locating pin, it is impossible to have the oil inlet and outlet holes in the shaft in the wrong position. Note the oil inlet hole in the bottom of the left end of the shaft as it is assembled; it must match the oil hole in the rear end of the head assembly. Check to be sure each rocker arm lines up with its valve.

PUSH RODS & TAPPETS

The push rod is used to transmit cam action from the tappet to the rocker arm. The bottom end of the push rod is rounded to fit the ball

and socket joint in the tappet. The upper end has a half round socket to receive the ball end of the adjusting screw. A visual inspection of the ball and socket joints should be made, discarding any that are excessively worn or scored. If scoring is found on one joint, it is safe to assume that its matching ball or socket, such as the one you cannot see clearly in the tappet, is also scored and both should be replaced. Discard any push rod that is bent or damaged.

TAPPET ADJUSTMENT

Reinstall the cylinder head as instructed on page 4 . Drop the push rods into the holes in the head, making sure that they seat properly in the tappet sockets. Fasten the rocker arm button in the socket of its push rod.

It is desirable to make a rough lash setting before the engine is started. For this purpose use a feeler gauge to set the tappet clearance at .015 in. cold.

As an engine warms up, its parts expand and dimensions change, therefore, it is recommended that a small auxiliary fuel tank be connected to the carburetor so that the tappet adjustment can be made with the engine running at operating temperature, see Fig. 59. Run the engine at a fast idle for at least twenty minutes to warm it up. Reduce

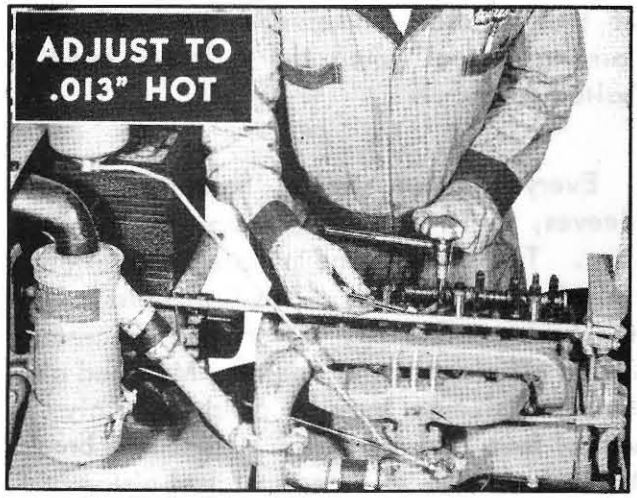


Fig. 59

speed to a slow idle. Loosen the lock nut on the push rod end of number one rocker arm. Turn the adjusting screw until a .013 in. feeler gauge will just pass between the rocker arm face and the cap on the valve tip. (The feeler should be inserted from one side and moved to the other side. If inserted from the front, the rolling action of the rocker arm button might have a tendency to pull the gauge through and give a wrong indication). Tighten the lock nut and check the setting again to be sure it is correct. Repeat this procedure for all valves, setting the intake and exhaust valves the same. This applies to TE-20, TO-20 and TO-30 models. Install the cylinder head cover, using a new gasket on mating surfaces which are clean and smooth.

CYLINDER BLOCK

The cylinder block is the main structural part of the engine. It is a one piece casting made from alloy grey cast iron. It has drilled oil passages which eliminate all external lubrication piping. Passages surrounding the cylinders and valve seats carry the coolant. Passage openings in the top of the block register with similar openings in the head, thus joining the coolant and lubricant passages in the head with those in the block. The block is properly machined to accept the heavy, cast, wet type cylinder sleeves.

INSPECTION

After the cylinder block has been stripped of all removable parts, except the studs which are screwed into it, the entire casting should be thoroughly cleaned of all carbon, oil and dirt. The coolant passages should be cleaned of rust and mineral deposits. A rifle brush should be run through all the drilled oil passages to clean out any carbon or other foreign matter.

The block is now ready for inspection. The main thing to look for is cracks. These sometimes occur between the cylinders or around the mounting holes. Any broken or

damaged studs should be removed and replaced. Check the top surface of the block with a straight edge and thickness gauge. If it is warped .020 in. or more, it must be replaced.

MODEL DIFFERENCE

Replacement blocks for the TO-20 and TE-20 are now being cast from the TO-30 patterns. These blocks have the drilled passage to the center camshaft bearing and must be serviced with a TO-30 crankshaft bearing insert set. Installing a TO-20 main bearing insert set in either the replacement block or the regular TO-30 block will result in a starved center camshaft bearing. The replacement block, cast from the TO-30 pattern is easily recognized and all engines should be checked before servicing. The replacement block has a cast boss on the rear right side of the block and two small cast bosses on the right front of the block, see Fig. 60. This rear boss is used to mount the external oil filter on the TO-30 engine and the two small bosses are used to attach the generator mounting bracket. On blocks intended as replacement blocks for TO-20 and TE-20 engines, none of the bosses will be drilled.

The cylinder blocks of the TO-20 and TE-20 tractors are the same and can be interchanged. They differ from the block of the TO-30 in the following respects: the TO-30 block has a cast boss and the necessary drilled oil passages for mounting an external oil filter. The diameter of the lower cylinder sleeve hole in the block where the two neoprene water seals are located is larger in the TO-30 than in the TO-20 and TE-20. The TO-30 also has mounting pads to which may be attached a generator mounting bracket. The center camshaft bearing of the TO-30 is pressure lubricated, therefore, the block contains a drilled oil passage joining the center camshaft and center crankshaft bearings.

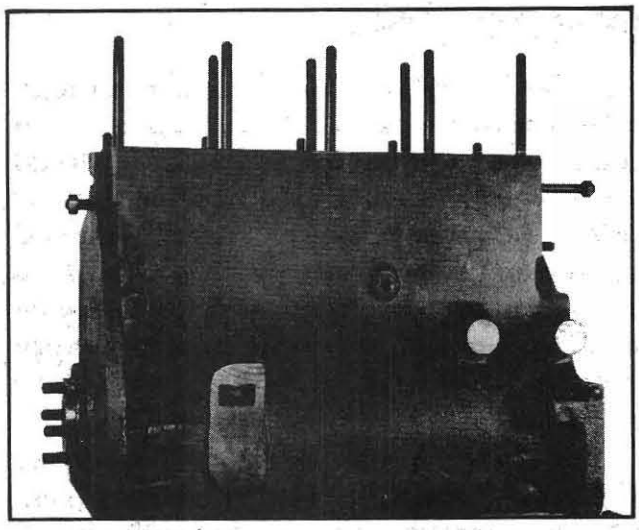


Fig. 60

SLEEVES

The cylinder sleeves are of alloy cast iron. They are wet type sleeves, that is, the coolant comes in contact directly with the sleeves. The sleeves are sealed into the block by two neoprene O-rings which fit in grooves around the bottom of the sleeve. These grooves and the O-rings are manufactured to very close tolerances and they should be treated with care at all times. The top of the sleeves have a rim which fits into a recessed diameter in the top of the block. The sleeves are designed so that they will protrude .0020-.0045 in. above the top surface of the cylinder block when they are assembled. This causes the rim of the sleeve to be forced down tightly against the bottom of the recessed diameter in the block thus forming a seal when the cylinder head is bolted down.

Every Ferguson sleeve, including service sleeves, is fitted with a piston at the factory. The sleeves and pistons are available only in matched pairs. This is done to insure the best possible fit, a condition necessary for an efficient, quiet engine. Matched pistons and sleeves may be purchased only in sets of four. However, the Dealer may break them down and sell one matched piston and sleeve if the need arises.

REMOVAL

It is possible to replace cylinder sleeves without removing the engine from the tractor; however, when such an extensive overhaul job is attempted, it is usually easier to remove the engine from the tractor and mount it on a stand or bench, as instructed on page 2. Once the cylinder head has been removed, as described on page 3, and the pistons have been removed, see page 27, the cylinder sleeves may be pulled from the top, see Fig. 61. Remove the seals from the bottom of the sleeve and discard them.

Fig. 61

INSPECTION

Clean the sleeves thoroughly and inspect them carefully for any visual signs of wear or other defects. If they appear to be in good condition, measure them very carefully with inside micrometers, see Fig. 62. The sleeve is manufactured with an inside diameter of 3.250-3.252 in. The maximum limit for out-of-round is .001 in. and the bore should taper from .0002-.0015 in. being larger at the bottom than at the top. Whenever the cylinder is worn so that the inside diameter at

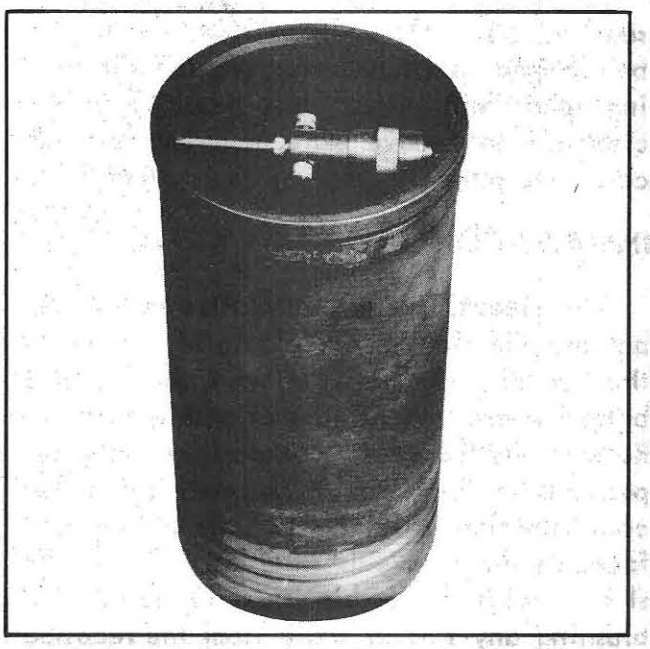


Fig. 62

any point exceeds 3.262 in., the cylinder must be replaced. Under no circumstances should any attempt be made to rebore or ream the cylinder sleeves but whenever the piston rings are replaced, use a cylinder hone to remove any varnish or glaze from the cylinder wall. The use of the cylinder hone tends to smooth out any irregularities in the cylinder wall and conditions the wall for better seating of the new rings. This can best be performed while the sleeve is still in the block,

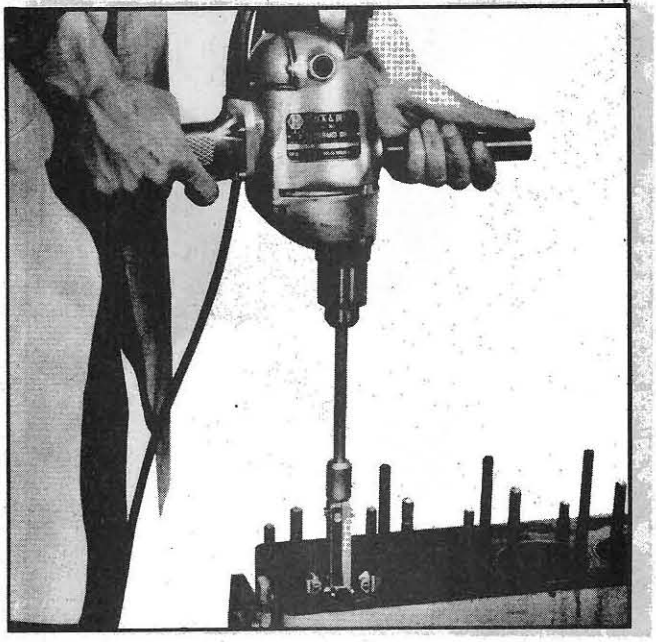


Fig. 63

see Fig. 63. Also, the cylinder sleeve may be clamped in a soft-jawed vise for this honing operation. Great care should be exercised not to remove more material than necessary to properly clean up the cylinder.

INSTALLATION

The sleeves should be installed as follows: be sure the sleeves are absolutely clean on the outside, especially around the top and bottom where they are to seal with the block. Remove any loose rust or scale from the water passages in the block. This will insure that contamination will not get on the sealing surfaces as the sleeve is inserted. Clean the sleeve holes in the block, scraping or wire brushing any rust or scale from the recessed seat at the top of the block and from the tapered portion of the lower seat which guides O-ring seals into place, see Fig. 64. Wash these areas with white gasoline and blow out with compressed air. Coat the packing rings with vasoline, slip them over the lower end of the sleeves and seat them in the grooves being very careful not to get them twisted. Coat the entire sealing surface of the cylinder with vasoline, see Fig. 65, and slip it into the hole in the block being careful not to unseat the seals as they pass through the top

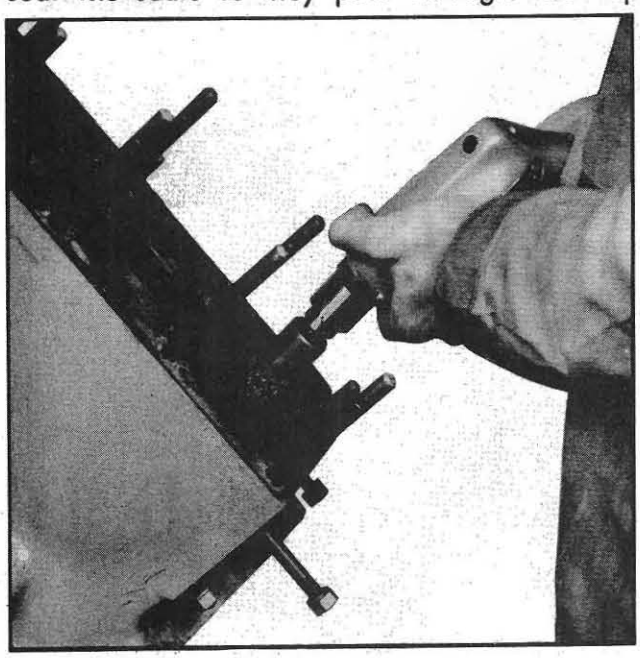


Fig. 64

Fig. 65

hole in the block. Center the lower end of the sleeves in the lower hole in the block. In some cases, it may be necessary to lay a block of wood across the top of the sleeve and tap it into place with a mallet, see Fig. 66. Install all the sleeves in the same manner.

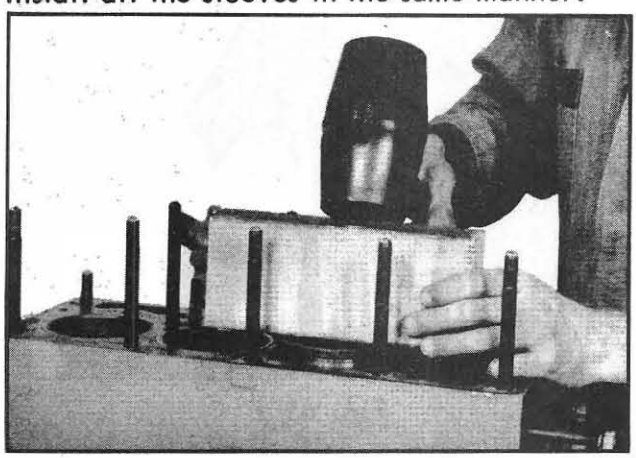


Fig. 66

MODEL DIFFERENCE

The design specifications and servicing recommendations given for the TO-30 tractor cylinder sleeves apply to the TO-20 and TE-20 tractors with the following exceptions: the inside diameter of the TO-20 and TE-20 sleeve is 3.1875-3.1895 in. instead of 3.250-3.252 in. as in the TO-30. When these sleeves are worn so that the inside diameter at any point exceeds 3.1990 in., they should be replaced.

PISTON ASSEMBLY

The pistons are cast from an aluminum alloy. This material is light in weight to minimize inertia forces and has a high heat conductivity property which causes the piston to dissipate heat rapidly and run at a cooler temperature. The piston has four ring grooves, there are three compression rings and one oil control ring. The piston is of the "T Slot" type. It has a T-shaped slot cut through the skirt on the compression thrust side and a series of oil holes located just below the bottom piston rings in the power thrust side. The piston is cam ground; that is to say, it is of greater diameter at right angles to the piston than it is in line with the piston pin. This combination of slotting and cam grinding causes the flatter sides of the piston to be forced outward when it expands due to the engine heat, making the piston assume a round shape. This design permits the piston to expand without seriously reducing the operating clearances.

REMOVAL

Whenever the pistons are to be inspected, they should be removed as described below.

Fig. 67

Assuming that the cylinder head and oil pan have been removed, see page 3, the next step is the removal of the ridge from the top of the cylinder. This operation is performed by any one of several commercial tools which are on the market and are designed for the job. Instructions for the operation of this tool should come with the tool but essentially the operation consists of moving the piston to the bottom of its strike and inserting the tool so that the cutter is in position to remove the ridge, see Fig. 67. The cutter is then fed into the ridge until it just bears and a series of light cuts is taken until the ridge has been removed. Be very careful not to cut into the area of piston ring travel. If the piston is forced out of the cylinder before the ridge is removed, the ring grooves may be spread and the lands bent or broken.

Rotate the crankshaft till the piston to be removed is at the bottom of its stroke. Remove the cap from the connecting rod and rotate the crankshaft till it is out of the way. Remove the bearing liner from the connecting rod and with a stick or hammer handle, press on the end of the connecting rod forcing the piston up out of the cylinder, see Fig. 68. Clean the entire assembly by immersing in any solvent which will loosen the carbon and

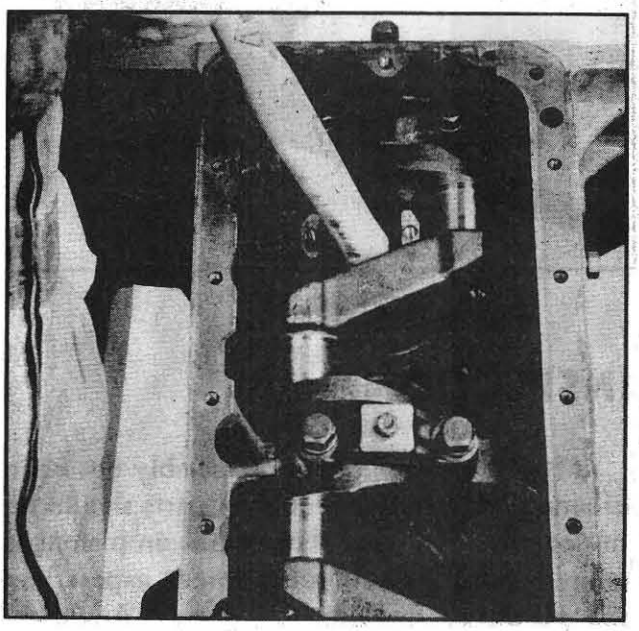


Fig. 68

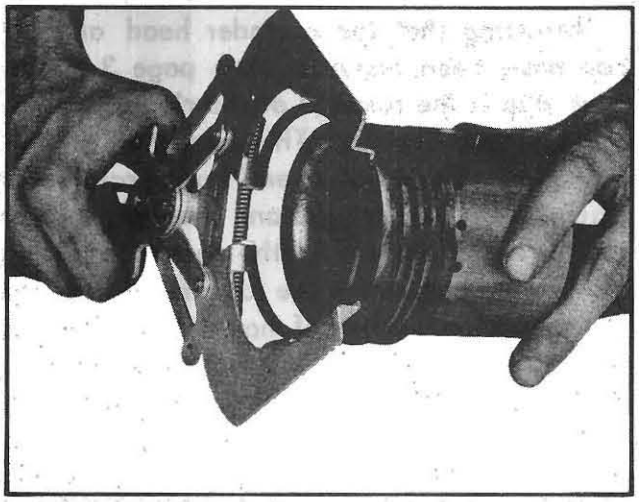


Fig. 69

varnish deposits. The piston rings should be removed with a piston ring tool, see Fig. 69. Be sure all oil holes are clean and clean the ring grooves with a groove cleaner, see Fig. 70. To remove the piston pin from the piston, it is necessary to use a brass arbor or a hardwood dowel or else immerse the assembly in hot water until the pin may be easily removed.

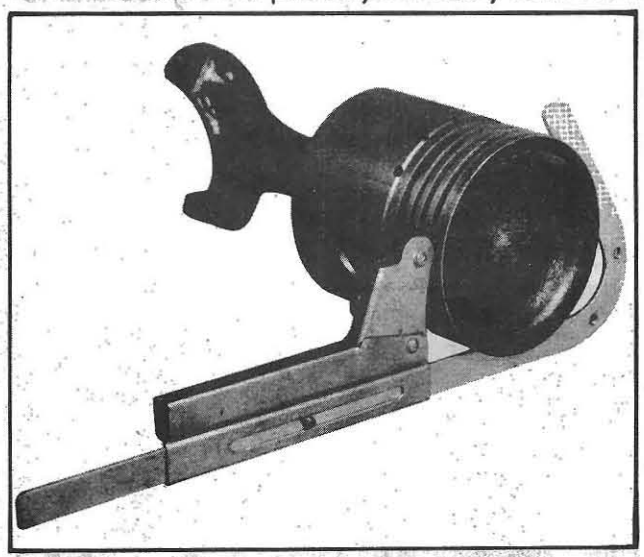


Fig. 70

INSPECTION

After the piston and rod assembly has been cleaned and disassembled, the parts should be inspected. The wear that occurs on pistons is caused chiefly by sideward forces imposed on the piston by the connecting rod. Any dirt, either in the air in which the engine operates or in the oil, will, of course, hasten this wear. Such wear results in excessive clearances and is responsible for oil consumption and engine knocks. The piston must be carefully checked for scuffing or scoring, collapsed skirts, worn or damaged ring grooves and lands, cracks, burned spots and correct fit in the cylinder.

Scuffing or scoring is usually apparent on the thrust faces as scratches or grooves worn in the piston skirt. If the scuffing is severe, the piston must be discarded.

Fig. 71

Worn ring grooves are obvious when a new ring is placed in the groove and a feeler gauge is inserted beside it as shown in Fig. 71. If the clearance between the side of the ring and the wall of the groove is .005 in. or more when measured at a point 1/16 in. from the outside diameter of the piston ring groove, the piston and sleeve must be replaced.

If the skirt of the piston is collapsed, this condition can be recognized by measuring with a micrometer, see Fig. 72. Measure the diameter of the top of the skirt at right angles to the piston pin and compare this with the diameter of the bottom of the skirt also measured at right angles to the piston pin.

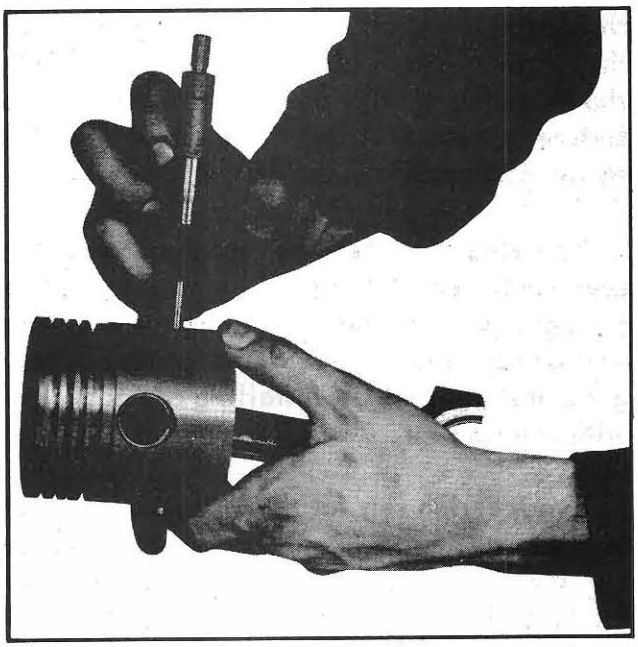


Fig. 72

The diameter at the bottom of the skirt of a new piston should be .0012 in. greater than the diameter of the top of the skirt. No minimum allowable diameter of the piston is given here. The maximum allowable wear on the cylinder sleeve is .010 in. It is felt that this amount of wear will occur on the cylinder sleeve before a serious amount of wear occurs on the piston itself. Since both the sleeve and the piston must be replaced together in matched sets, the inside diameter of the sleeve best indicates the wear that has occurred.

MODEL DIFFERENCE

The principal difference between the pistons of the TO-30 and those of the TO-20 and TE-20 is the concaved, or dished in, recess in the top of the TO-30 piston and the differences in the diameter of the two pistons. The approximate diameter of the TO-30 piston is 3 1/4 in., while the approximate diameter of the TO-20 or the TE-20 piston is 3 3/16 In.

RINGS

The production piston rings with which the engine is equipped are close grained cast iron. There are three compression rings and an oil control ring. The first or top ring has a straight face and the word "TOP" stamped on it. The second and third rings have a tapered outside face and also have the word "TOP" stamped on them. The fourth ring is a ventillated type oil control ring.

There are two service ring sets available. One to service the TO-30 tractor and the other to service the TO-20 and TE-20 tractors. The first kit is a standard ring set, composed of four cast iron rings for each piston. This kit may be used to service engines in which the maximum cylinder sleeve wear is .004 in. or less.

The second kit includes the following: a tapered face, hard chrome-plated top ring; two grooved outer face second and third rings; and a ventillated oil control fourth ring with a special ring expander.

The extremely hard chrome facing resists wear and tends to smooth the cylinder walls, thus giving much better and far longer service than ordinary replacement ring sets. The spring expanders are supplied to be used with the oil control rings and they accomplish two things. First, they cause the ring to flex and conform better to cylinders which have worn out-of-round or tapered. Second, they tend to support the piston centrally in the cylinder sleeve, thus reducing piston slap.

The installation of the "Standard" ring kit is at best a "Stop-gap" procedure and in no instance should this kit be used if the cylinder wear exceeds .004 in. It is strongly recommended that wherever possible the "Chrome Ring" kit be installed. The owner will be more than compensated for this additional cost by the extended life and better performance of the tractor engine.

The replacement chrome ring kits are made to service cylinders which have worn as much as .010 in. oversize. If it is found that

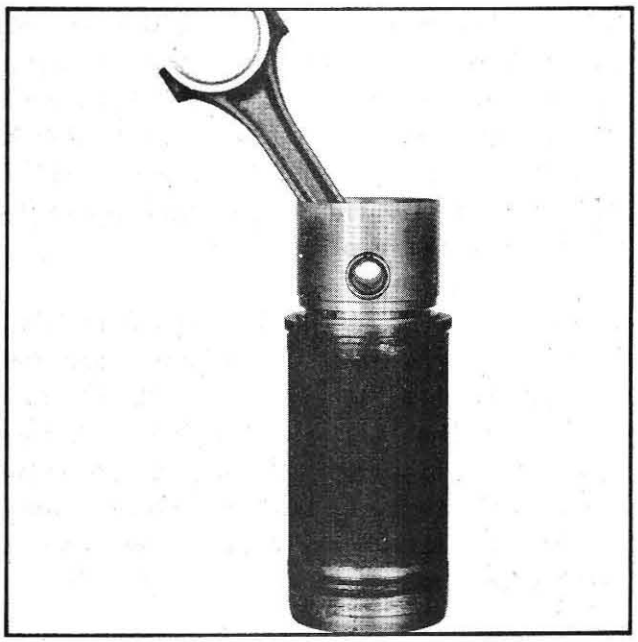


Fig. 73

the cylinder is worn more than this amount, the piston and sleeve must be replaced. Before installing new rings, roll them around the groove of the piston to be sure they do not bind in any spot. Check the side clearance of the rings at this time as previously described. It is also desirable to check the end clearance of the rings when they are installed in the cylinder. With an inverted piston, push the ring down into the cylinder until it is near the bottom of its usual travel, see Fig. 73. When measured with a feeler gauge, the gap between the ends of the ring should be at least .007 in., Fig. 74. If the gap is too small, the ring can be filed till the correct gap is obtained. This operation should be done with the aid of some sort of a fixture to assure filing the ends of the ring square and parallel, see Fig. 75.

Fig. 74

The rings can best be installed with the use of a piston ring tool. The rings should be arranged so that the gaps on adjacent rings are on opposite sides of the piston. Very good instructions for installing are packaged with the ring set.

Service ring sets for the TO-20 and TE-20 tractors are similar in appearance to those for the TO-30 tractor, the difference being in the ring diameter. The reason for this is that the older model tractors incorporate a smaller cylinder bore. All service procedures are the same for all three tractors.

PINS

A full floating type piston pin joins the piston to the upper end of the connecting rod. It rides in piston pin bosses and in a bushing pressed into the connecting rod. It is held in place by snap rings which fit into the piston at each end of the pin. The pin is hollow to reduce weight. It is made of alloy steel and is case-hardened, ground and lapped to provide an extremely smooth, durable wearing surface.

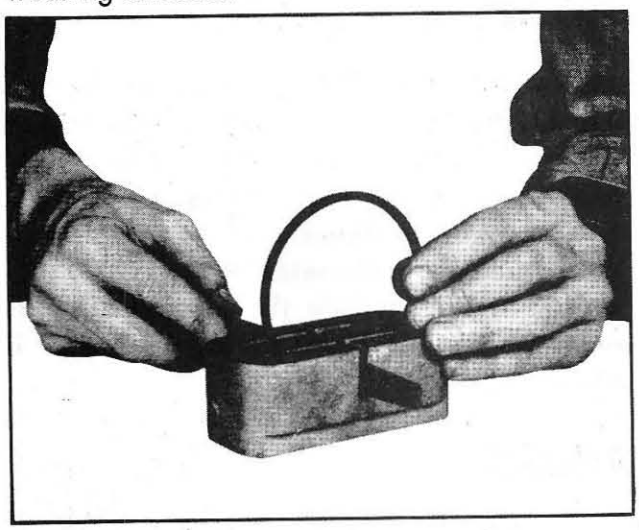


Fig. 75

CONNECTING RODS

The connecting rods are of drop-forged steel construction with an I-beam cross section. Their weight is accurately held within 1/4 ounce. The rods and their crankshaft caps are numbered according to the cylinder in which they are installed. The crank ends of the rods are fitted with replaceable bearing inserts. The piston pin bushings are of rolled-bronze with an oil hole which aligns with a hole in the rod. The bushings must be reamed to fit the piston pins. After removal from the piston as described previously, the rods must first be checked for straightness on a connecting rod aligning fixture, see Fig. 76. Remove the bearing inserts and install the bearing cap and piston pin. Then examine the condition of the bores, the piston pin bushing and the cap bolts. The same rod and cap is used in the TO-30, the TO-20 and the TE-20 engines.

To check the piston pin bushing in the connecting rod for wear, insert the piston pin to be used in that particular connecting rod and check for any looseness or slop. If any looseness is detected, it is strongly recommended that a new bushing be installed and

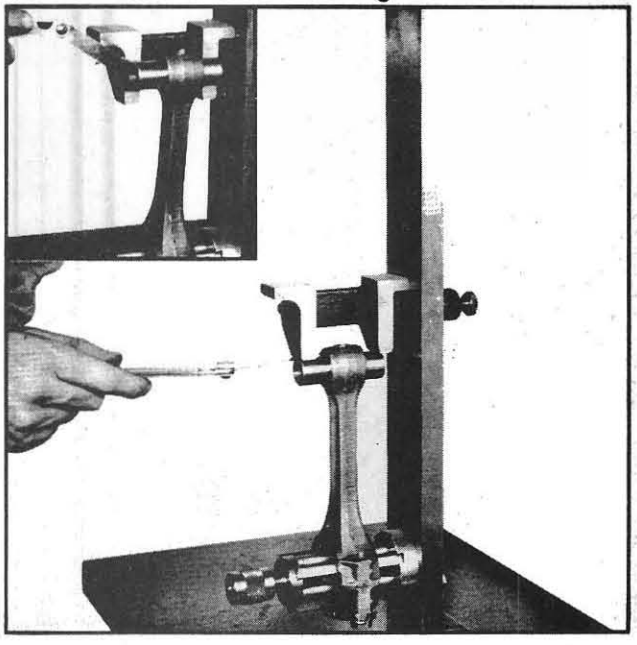


Fig. 76

honed to fit the pin as outlined below. While a slight amount of play between the piston pin and the bushing will cause no serious damage, it does make a very noisy engine which is undesirable in any case. The bushing removal and the procedure for pressing in a new bushing is described on page 32. The fit of the crank-end bearings is described on page 34. The fit of the rod on the piston pin and the assembly procedure are described on page 32.

The manufactured diameter of a new piston pin is .8593-.8591 in. If the piston pins show any sign of wear or damage, they should be replaced. If the piston pin appears to be in good condition and the proper fit can be obtained in the piston, that is, a tight press with the heel of the hand as shown in Fig. 77, the pin can be used and a new bushing

Fig. 77

pressed into the connecting rod and honed to properly fit the pin. If the engine has operated any appreciable amount of hours, the piston pin bosses in the piston are probably worn to the extent that a satisfactory fit cannot be obtained unless an oversize piston pin is used. There are available .003 in. oversize pins for this need. In order to install these oversize pins, it will be necessary to hone the bearing surfaces of the piston pin bosses. An expanding hone should be used, see Fig. 78, to enlarge the piston pin holes in the piston to such a size as to allow the

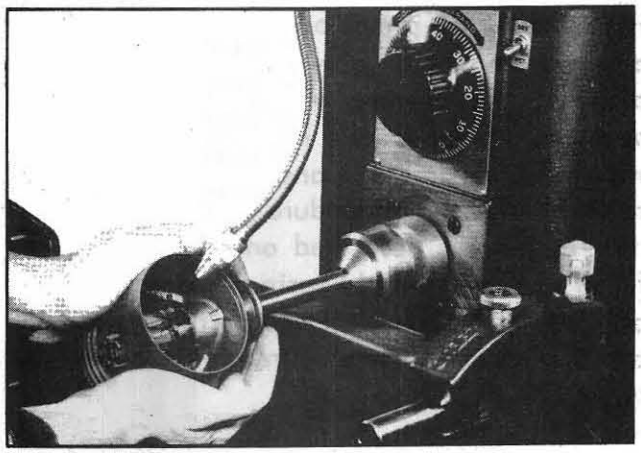


Fig. 78

pin to be pressed into place in the piston with the heel of the hand. If a new piston pin,

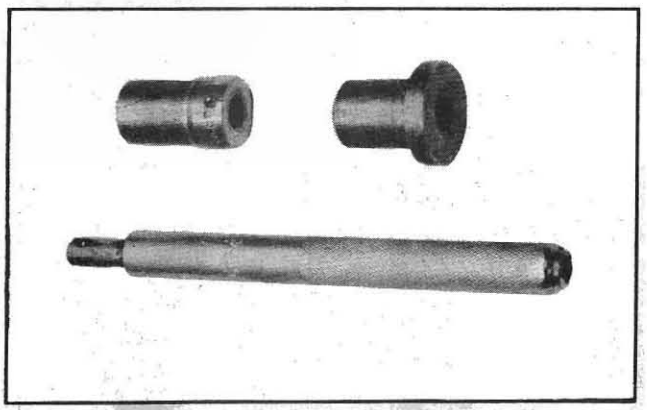


Fig. 79

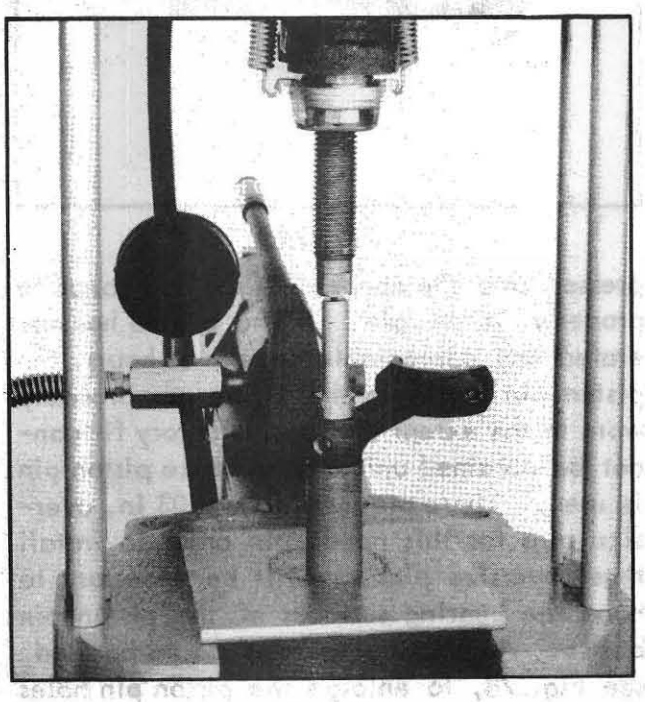


Fig. 80

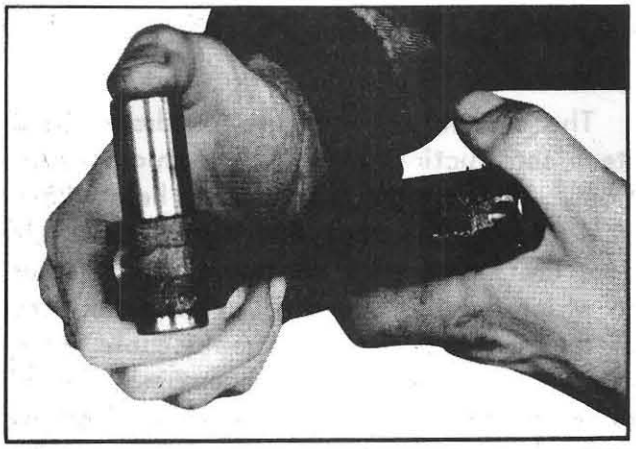


Fig. 81

either standard or oversize is installed, a new bushing should be pressed into the connecting rod. To remove the old bushing and install a new one, use the special tools shown in Fig. 79. Support the connecting rod in a press and use the special bushing driver to press out the bushing as shown in Fig. 80. Place the bushing in position on the connecting rod, making certain that the oil hole in the top of the connecting rod is in line with the oil hole in the bushing. Use the second special bushing driver to press the bushing into place as shown in Fig. 82. Press the bushing in until the driver contacts the face of the connecting rod. Whether a new bush-

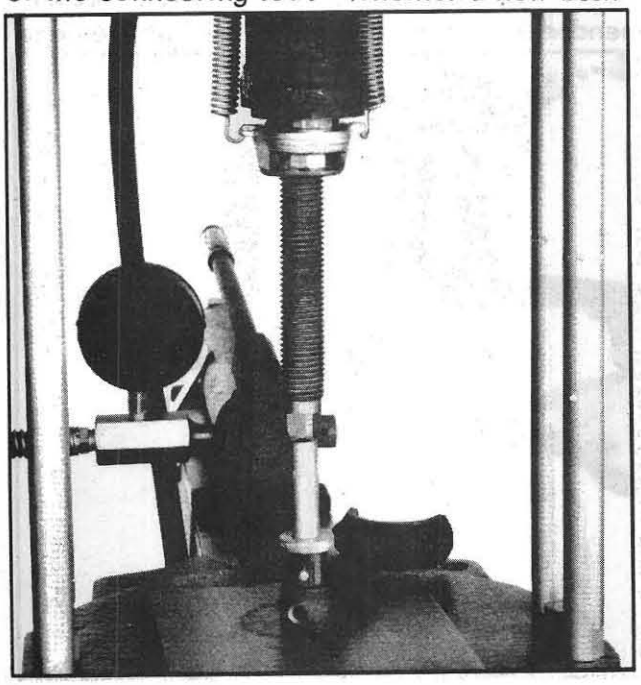


Fig. 82

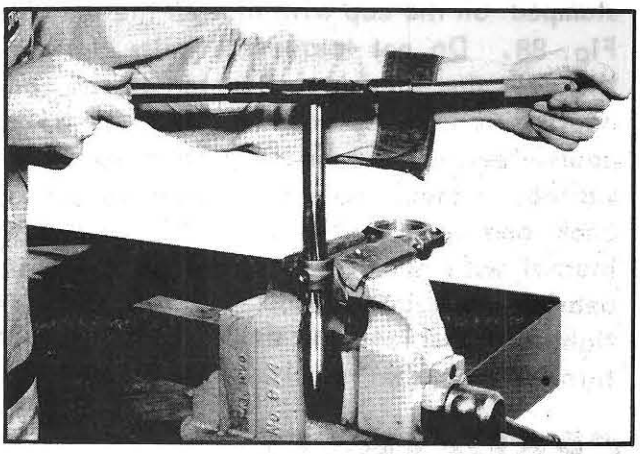


Fig. 83

ing is installed or the old bushing reassembled, the piston pin must be a thumb press fit in the bushing, see Fig. 81. If a new connecting rod bushing has been installed it will be necessary to remove considerable material from the bushing to obtain the correct fit of the piston pin. To prevent excessive wear of the honing stones, most of this material may be removed with an expanding reamer as shown in Fig. 83. Carefully clamp the connecting rod in a soft-jawed vise for this operation, so that the rod will not be distorted. Be extremely careful not to remove too much material and always leave sufficient material so that a fine hone may be used. The use of a hone gives a smoother finish and, therefore, a greater bearing area between the bushing

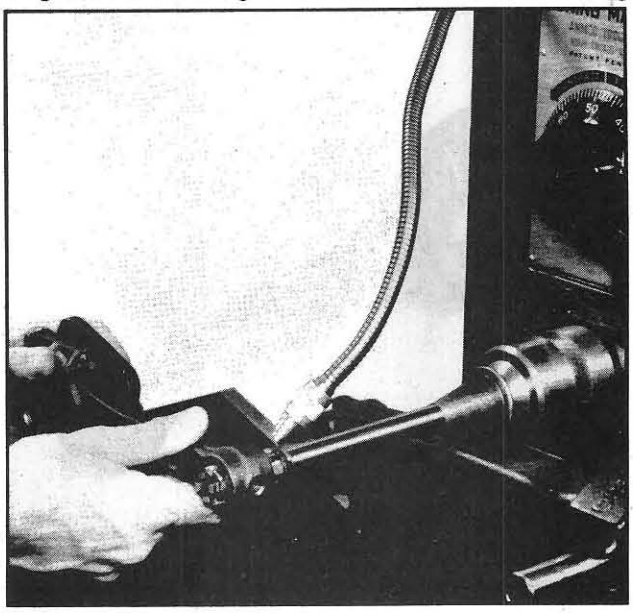


Fig. 84

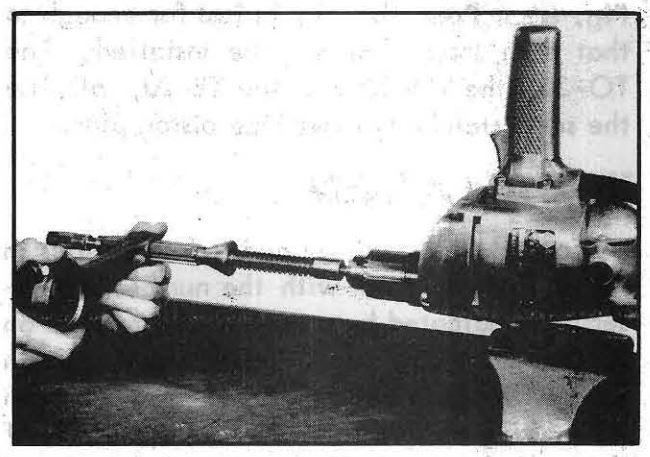


Fig. 85

and the pin. Also extreme care should be exercised when honing the bushing to make sure that too much material is not removed. Check the fit of the pin often during the honing operation. Either a wet type or a small portable dry hone is satisfactory for this job. Figs. 84 and 85 show the use of both types.

As with any honing operation in the engine, be very careful to remove all abrasive dust after the job is completed.

When assembling the connecting rod to the piston be very careful to have the oil spray hole in the lower end of the connecting rod, facing the opposite direction from the vertical slot in the skirt of the piston, see

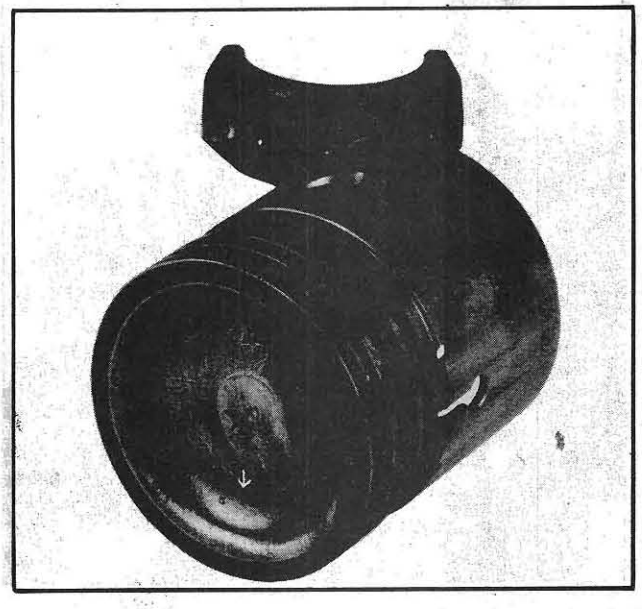


Fig. 86

Fig. 86. Press the pin in just far enough so that both snap rings may be installed. The TO-30, the TO-20 and the TE-20, all use the same standard or oversize piston pins.

INSTALLATION

To install the piston and rod assemblies in the cylinders, start with the number one assembly (indicated by a number (1) stamped on the top of the piston). Lubricate the piston rings with clean engine oil and compress them with a ring compressor. Be sure the inside of the cylinder is wiped clean and is lubricated with oil. Slip the skirt of the piston into the cylinder and turn it so that the arrow stamped on the top of the piston points toward the front of the engine. Revolve the crankshaft till the number one journal is at the bottom of its stroke. With the handle of a hammer, tap the piston into the cylinder until the end of the connecting rod is within an inch or so of the crankshaft journal, see Fig. 87. Be sure the connecting rod and the cap is clean and dry before putting the bearing inserts in place. Lubricate the bearing inserts and tap the piston until the rod is seated on its journal. Guide the rod so that the edges do not scratch the crankshaft journal. Install the connecting rod cap, matching up the number stamped on the cap with that on the rod, see Fig. 88. Do not torque the bolts until all the caps are in place. Tighten all the connecting rod bolts, torquing them to 35-40 pound-feet. If the bearings are properly installed, it should be possible to move the rod back and forth end-wise on the crankshaft journal with one hand. After all the main bearing caps and connecting rod caps are tightened in place, it should be possible to turn the crankshaft easily with the crank.

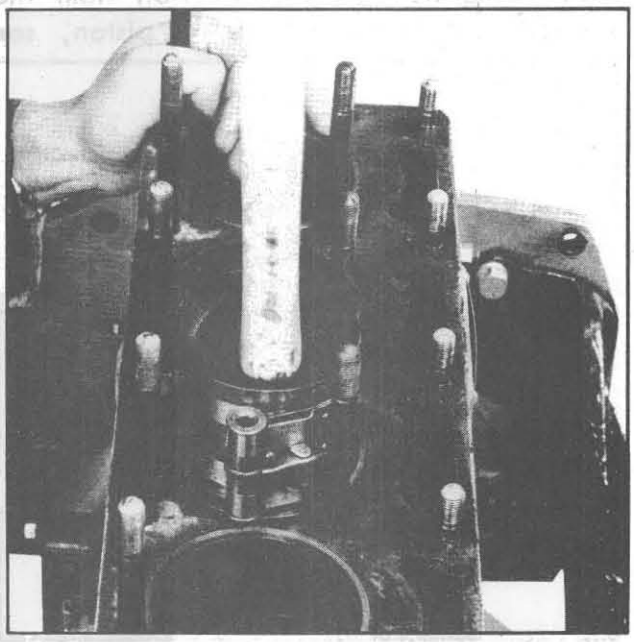


Fig. 87

CRANKSHAFT

The crankshaft used in the Ferguson tractor is a one piece, steel forging, carefully heat-treated. The crank throw bearing journals and main bearing journals are very carefully ground to exact specifications and the crankshaft is carefully balanced before being installed in the engine. Drilled oil passages in the shaft supply lubrication to the various bearing surfaces.

The crankshaft is supported in the engine block by three main bearings and is provided with an oil seal at each end to prevent the oil from leaking out around the crankshaft.

The oil pump is mounted on the front main

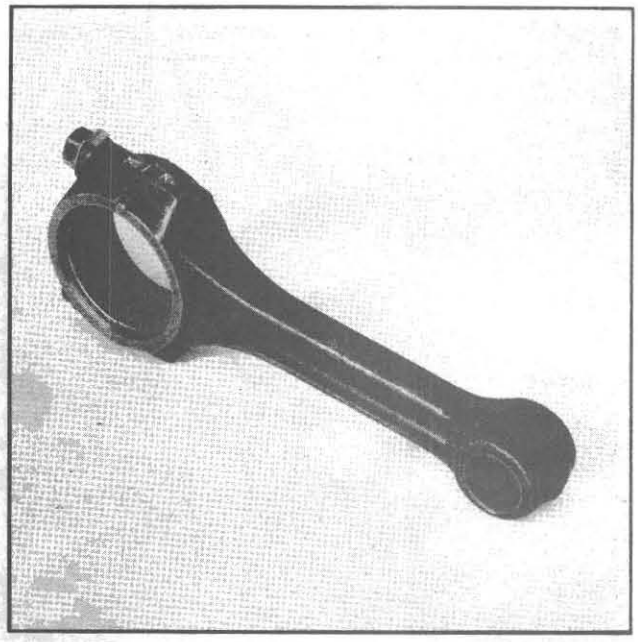


Fig. 88

bearing cap, both being secured with the same cap screws. The rear main bearing cap is a section of the engine block. The removable section of the block is ground to fit tightly into the block and two grooves are filled with packing to prevent oil leaks. The crankshaft will seldom be removed without disassembling the rest of the engine. However, if such is the case, simply remove and mount the engine as previously outlined on page 2 . Then proceed with the disassembly.

REMOVAL

1. Turn the engine over and remove the oil pan..
2. Remove the flywheel and rear oil seal.
3. Remove the nut, washer and pulley from the front end of the crankshaft. Use the special V-belt pulley remover as shown in Fig. 89, to prevent damage to the pulley.
4. Remove the governor cover assembly.
5. Remove the oil tube assembly.
6. Disconnect the connecting rod bearing caps and remove all bearing shells. Keep the bearing shells together so that they may be replaced in their same position if new shells are not used. The pistons may be left in the sleeves if only the crankshaft is to be checked.
7. Remove the three main bearing caps. Lift the shaft out for inspection and checking.

NOTE: Bearing liner seats are machined in line with the bearing caps attached, therefore, the caps must always be installed in the same position as they were machined. This may be done if a light chisel mark or mating punch marks are made before the cap is removed for the first time. Also, it may be helpful to note that the notches for the tongues of the liners must be on opposite sides of the shaft.

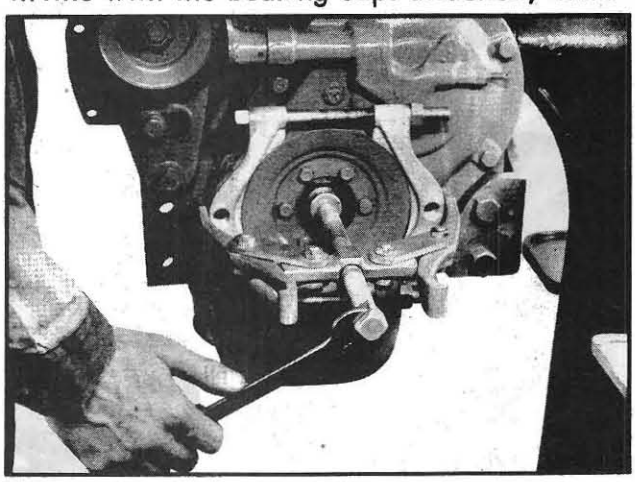


Fig. 89

INSPECTION

The crankshaft should be completely cleaned in a grease solvent. Run a rifle brush through the oil passages to clean them. All bearing journals on the crankshaft should be inspected for forms of wear such as scoring or ridging. If any such evidence is visible, the crankshaft is unfit for use and must be reground. Installation of new bearing shells on a badly worn, scored or ridged bearing journal will result in very short bearing life and may possibly score the journal so badly that it will be impossible to recondition the shaft by regrinding.

If the visual inspection of the shaft shows it to be in good condition, the bearing journals should be checked for wear and out-of-roundness with a suitable micrometer, see Fig. 90. The crankshaft for all three engines, TO-30, TO-20 and TE-20, are ground to the same specifications. The specifications are as follows:

Main bearing journals-2.250-2.249 in.
Connecting rod journals-1.9375-1.9365 in.

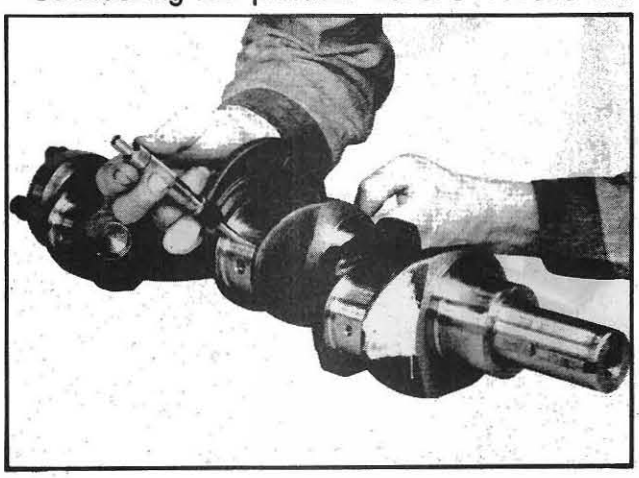


Fig. 90

In general, if it is found that the main bearing journals or the crank pin journals are more than .0015 in. out-of-round or that the taper wear of the journals exceeds .001 in., the shaft is not suitable for use and must be reground. When reconditioning a crankshaft, the journals should be ground down until their diameters are .010 or .020 in. less than the original diameters as listed above.

Measure each journal at a minimum of four places to determine the size and the amount worn out-of-round. Also measure each end of the journal to determine the amount of taper.

If out-of-roundness is present in any degree, the bearings must be fitted with the proper clearance over the largest diameter of the journal. Full bearing life cannot be expected with this condition existing.

INSTALLATION

After all bearings have been fitted to the bearing journals, as described in the following pages, torque the main bearing cap screws, see Fig. 91, to 85-95 pound-feet. Assemble the thrust washer, shims, thrust plate and oil slinger on the crankshaft. Replace the governor housing and drive pulley and tighten the cranking nut to 130-140 pound-feet torque. Check the crankshaft end play by inserting a screwdriver and pry the crankshaft as far as possible toward the rear, see Fig. 92. Check with a feeler gauge, the clearance between the thrust face on the crankshaft and the fiber thrust washer on the TO-30 or the thrust face of the bearing shell on the TO-20. This clearance should be .003-.007 in. It may also be checked with a dial indicator. If the clearance is not correct adjust by either adding or removing shims between the thrust plate and the thrust washer.

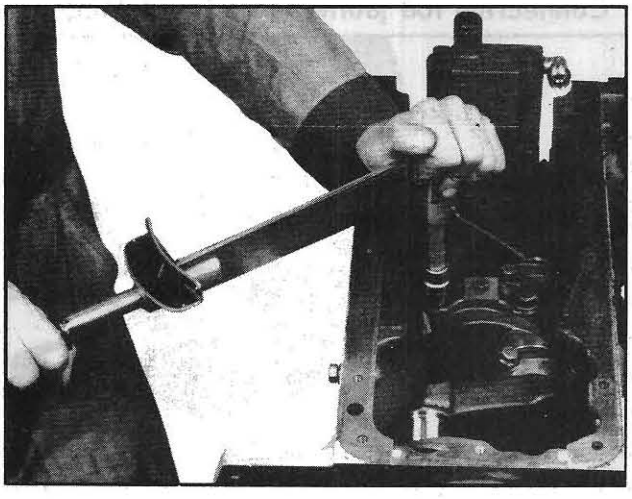


Fig. 91

MODEL DIFFERENCE

The crankshaft used in the TO-30 differs from that used in the TO-20 and TE-20 tractors in that the crankthrows have been lengthened 1/16 in. on the TO-30 crankshaft, thus giving the engine a 1/8 in. longer stroke. For this reason, the TO-30 crankshaft is not interchangeable with that used in the TO-20 and TE-20. The crankshafts used in the TO-20 and TE-20 are interchangeable and are mounted in the same manner as that of the TO-30 except that the original front bearing shell of the TO-20 and TE-20 has a flange which acts as the thrust face instead of the fiber thrust washer found in the TO-30, see Figs. 93 and 94.

For service, the fiber washer may be used in the TO-20 and TE-20 provided the TO-30 shells are also used.

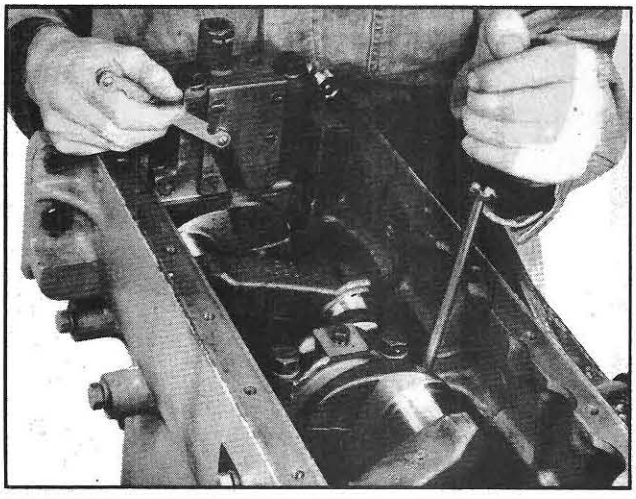


Fig. 92

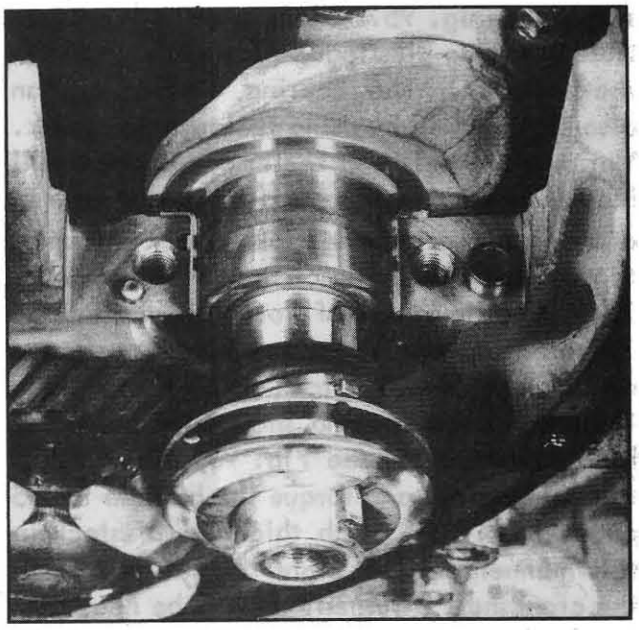


Fig. 93

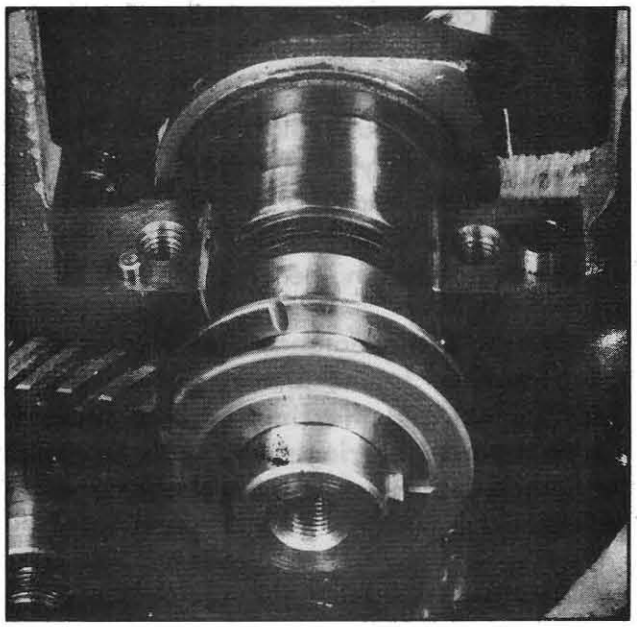


Fig. 94

MAIN & CONNECTING ROD BEARINGS

Both the main bearings and the connecting rod bearings are precision, replacable insert types. The inserts are steel-backed and have a lead base babbit bearing surface. Replacement bearing shells are available in standard size and .002, .010 and .020 in. undersize.

The main bearing shells are grooved and drilled to aid in directing the flow of oil, and in maintaining a film of oil between the bearing surfaces. It is always good procedure to check the oil hole locations in the replacement bearing shell by comparing it with the old shell that was removed. Always check to see that the oil hole in the bearing shell registers with the oil hole in the block.

The bearing shell is held in position in the bearing housing by the small projection called a locking lip. The lip fits in a special slot provided in the housing, preventing endwise movement of the bearing shell and keeping it from rotating as the edge of the lip butts against the face of the mating half of the bearing housing.

During operation of the engine, there is a tendency for the crankshaft to move longitudinally or endwise in the bearings. This movement is called "end play" and must be controlled within specified limits if the engine is to give satisfactory service over a long period of time. The forward thrust of the crankshaft is taken by a fiber thrust washer placed between the thrust face machined on the crankshaft, and the front main bearing. The rearward thrust is absorbed by a bronze thrust washer between the crankshaft timing gear and the block. The end play of the crankshaft is adjusted by varying the number or thickness of shims on the front of the crankshaft. These shims are available in the thickness of .002 or .008 in.

In fitting bearings to the crankshaft, it is of greatest importance to maintain the proper oil clearance between the bearing and the crankshaft journal. The oil pumped under pressure to the bearings, has two important functions. First, it prevents metal to metal contact and in turn reduces the coefficient of friction by providing an oil film between the moving parts. Second, it serves to cool the bearing. Also, it should be noted that correct oil pressure is necessary to assure each

bearing a controlled flow of oil and meters a correct flow of oil throw-off.

It has been found that, for the size of journals and the type of bearing used in the Ferguson tractor engines, an oil clearance of from .0015-.0025 in. will give the best results and provide long bearing life.

Note: "Oil Clearance", as used here is, the difference in the diameter of the crankshaft journal and the finished bore diameter of the installed bearing shell. It is important in fitting bearings that these limits be maintained.

INSPECTION

The recommended method for checking oil clearance is by using Plastigauge. Plastigauge is a plastic material which flattens out when placed between the crankshaft and the bearing.

To determine the bearing clearance, place a piece of Plastigauge the width of the bearing and crosswise in the bearing cap. Place the cap on the bearing with the Plastigauge between the bearing and the journal, and tighten the cap to the correct torque (85-95 pound-feet). Be sure the center bearing cap is installed. Remove the bearing cap and match the width of the flattened Plastigauge with the chart on the Plastigauge packing to determine the clearance in thousandths of an inch, see Fig. 95. More detailed instructions for using Plastigauge are packaged with the material. The bearing clearances can also be checked by using feeler gauge stock. Various thicknesses of feeler gauge stock will have to be tried until one is found that creates a drag on the bearing. The stock thickness then will indicate the clearance in the bearing. Obtain pieces of stock 3/4 in. long by 1/4 in. wide and remove the edges using an oil stone. Coat the stock with oil and place it between the bearing shell surface and the bearing journals, see Fig. 96, then install the bearing cap and torque the bolts to 85-95 pound-feet. Try each thickness of stock in this manner until a slight drag is felt when the crankshaft is turned. It will be necessary to check each of the main bearings in this manner to determine the clearance of each bearing.

Note: The main bearings should be checked with the piston and connecting rod assemblies out of the engine.

When using this feeler gauge method to test connecting rod bearings, no noticable drag can be detected by rotating the crankshaft. Check by moving the rod back and forth endwise on the shaft.

Carefully check the clearance between each bearing and its journal. Make sure that they are all within the specified limits.

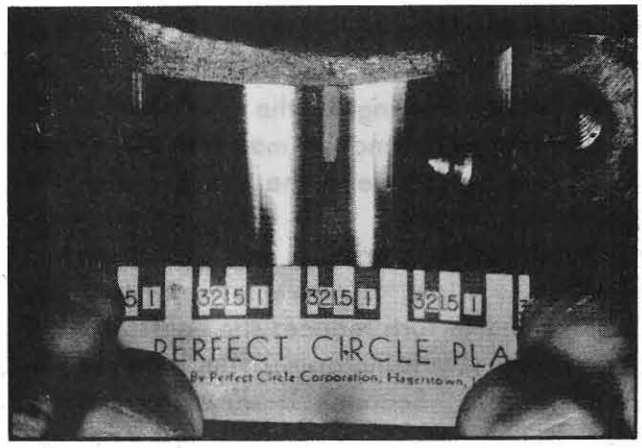


Fig. 95

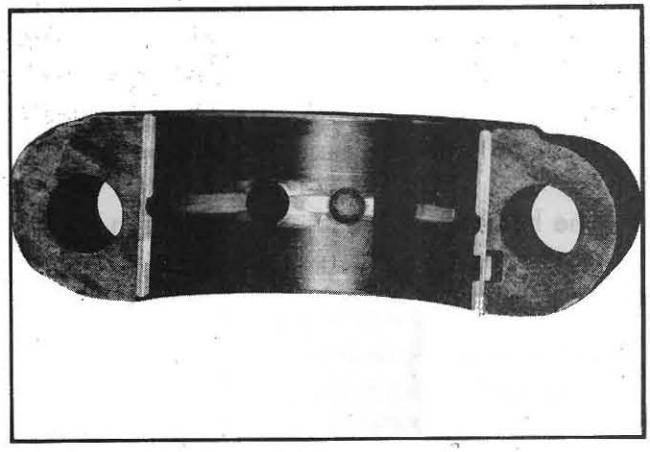


Fig. 96

INSTALLATION

After the rear bearing cap is installed for the final time, the grooves in its sides must be packed with Rear Bearing Cap Packing. A very satisfactory tool for this purpose can be made by cutting the flat end off an old screwdriver and grinding a flat along the length of one side to allow room for the wicking to feed into the hole with the tool, see Fig. 97. Force packing in by hand until the hole is about one half full then drive it down firmly with a mallet. Continue this process until the hole is solidly filled. Trim off the excess, flush with the surface, using a razor or sharp knife.

MODEL DIFFERENCE

As stated before, the front main bearing insert on the TO-20 and TE-20 has a thrust flange on the rear side of the bearing. On the TO-30 engine, this flange is replaced by a thrust washer. The second difference in the two sets of bearing inserts is the center insert on the TO-30 engine which has a hole that registers with a drilled passage in the block. This passage supplies oil to the center camshaft bearing. The center camshaft bearing on the TO-20 and TE-20 engines is lubricated by oil returning to the crankcase from the rocker arm assembly. It is permissible to use the TO-30 insert (the one with the extra oil hole) in the TO-20 and TE-20 but the old style insert (without the extra oil hole) must never be used on the TO-30. TO-20 and TE-20 replacement blocks, previously covered, also have a pressure lubricated center cam bearing, therefore, the TO-30 insert must be used in order to have adequate lubrication.

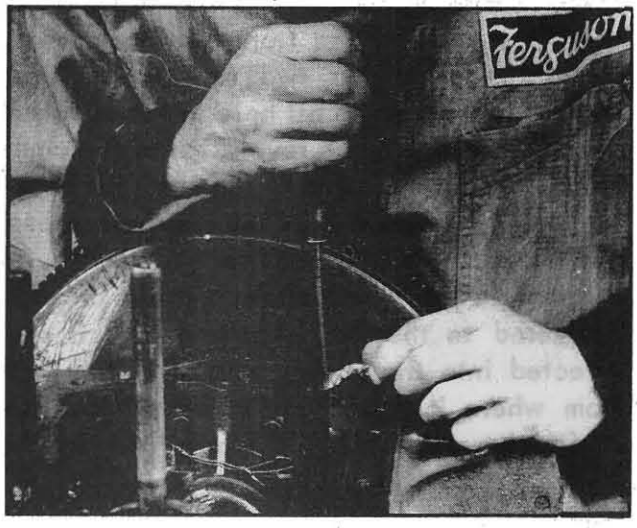


Fig. 97

CRANKSHAFT OIL SEALS

The crankshaft is provided with two oil seals front and rear. These spring-backed leather seals should be carefully inspected for signs of damage or wear whenever the engine is disassembled. The rear oil seal is held in position at the rear of the engine block by a special retainer.

REMOVAL

The front seal is pressed into position in a recess in the governor housing. The seal may be pressed out and a new one pressed in, as shown in Fig. 98. A felt dust seal is installed between the front oil seal and the fan drive pulley. The bearing surface of the fan pulley hub must be in perfect condition.

INSPECTION

The oil seals should be replaced whenever there is any doubt as to their condition. If

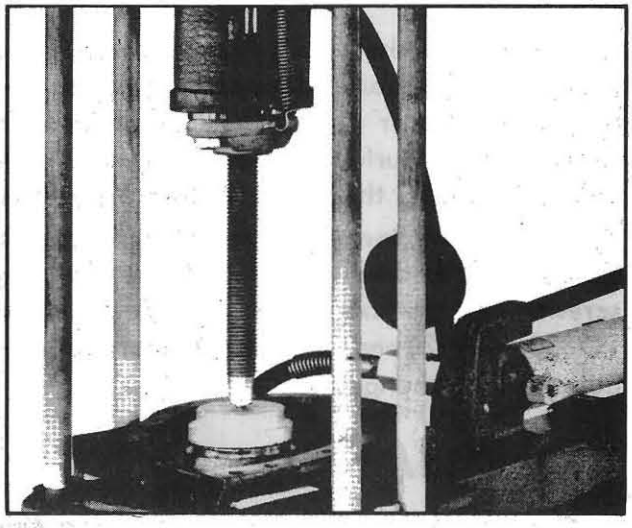


Fig. 98

the seals show any signs of wear, scratches or cuts, they should be replaced. It is always good practice to replace the seals whenever the bearings are replaced.

INSTALLATION

Extreme care should be used when installing the rear oil seal on the shaft. Coat the leather surface of the seal with vasoline. Use the special protector to slide the seal on to the shaft, as shown in Fig. 99. When installing oil seals, always make sure that the feathered edge of the seal faces the source of oil. It is also very important that the bearing

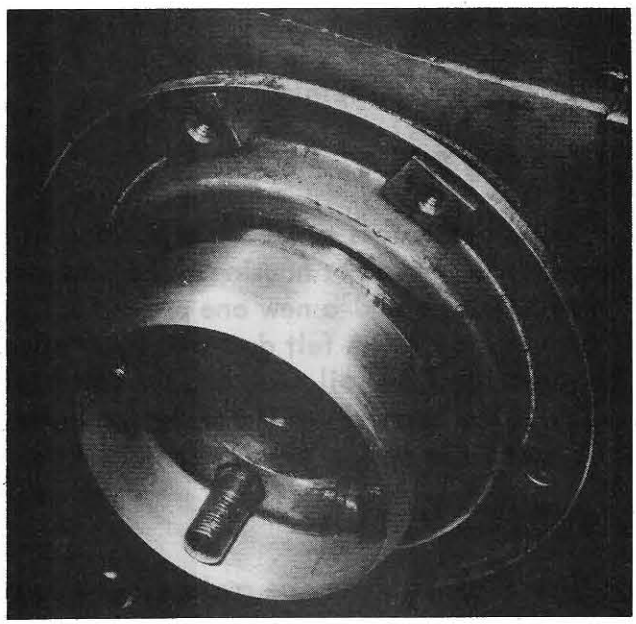


Fig. 99

surface of the shaft on which the seal rides be perfectly smooth and free from any scuffing, scratches or nicks. A good practice is to polish these surfaces with fine emery cloth before installing the parts. Accurately center the seal when assembling and check to see if the seal is forced off center when the attached screws are tightened. The oil seals on the TO-30, TO-20 and TE-20 engines are identical and interchangeable.

CAMSHAFT

The camshaft in the Ferguson tractor engines is of cast iron alloy construction with precision ground cams and bearing surfaces. The camshaft turns in three ground bearing surfaces in the engine block. The end play is controlled by the thrust plate that bolts to the front of the engine block. The TO-20 and TE-20 engines use the same camshaft. The lobes of the TO-30 camshaft have been redesigned, therefore, it should be used only in the TO-30 engine.

The three camshaft bearings are lubricated as follows:

Front camshaft bearing, all engines, receives oil under pressure through a drilled passage from the front main bearing. Rear camshaft bearing, all engines, receives oil under pressure through a drilled passage from the rear main bearing. Center camshaft bearing, TO-30 engine, receives oil under pressure through a drilled passage from the center main bearing. For the center camshaft bearing of the TO-20 and TE-20 engines, a boss at the top of the bearing collects oil that is returning to the crankcase through the push rod holes from the rocker arm assembly, and delivers it through a drilled hole in the center camshaft bearing.

The front of the camshaft is drilled to a depth of about four inches. The front bearing journal has a drilled passage from the oil groove to the hollow portion of the shaft. There is also a passage from the oil groove to the thrust face of the front bearing journal. The thrust plate has two metering notches that register with the oil hole in the camshaft thrust face once each revolution of the camshaft. Oil is delivered to the camshaft bearing under pressure and as the camshaft rotates and the hole in the thrust face registers with a notch in the thrust plate, a squirt of oil is delivered to the timing gears. Oil is also directed into the hollow portion of the shaft from where it moves out past the governor shaft, thus lubricating the governor and the timing gears.

The camshaft is driven by the crankshaft

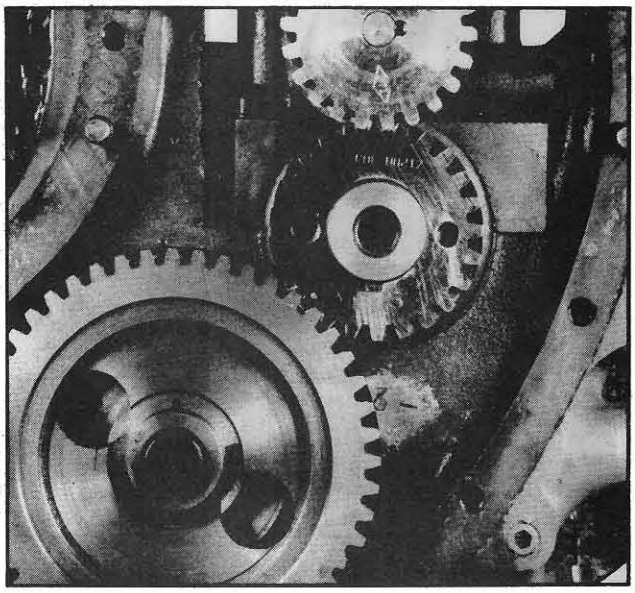


Fig. 100

through the timing gears and its purpose is to open and close the valves of the engine at the proper time. To aid in timing the camshaft, two teeth on the camshaft gear and one tooth on the crankshaft gear are marked with punch marks. In assembling, when meshing the two gears, place the marked tooth on one gear between the two marked teeth on the other gear, see Fig.100.

REMOVAL

With the engine turned upside down, the rocker arm assembly, the push rods and the governor housing removed, slide the governor shaft and race assembly out of the end of the camshaft. Remove the nut which secures the governor driver assembly. This removal can best be accomplished with the timing gears in place as the crankshaft can be blocked to prevent rotation, see Fig.101. Remove the governor drive assembly and pull the camshaft gear, see Fig.102. After removing the two bolts from the thrust plate, the camshaft may be pulled forward and out of the block.

The procedure for removing the TO-20 camshaft is as follows: Remove the four screws retaining the governor weight plate to the camshaft timing gear and remove the plate. Proceed as for the TO-30 or if the crankshaft has been removed, rotate the camshaft until the bolts in the thrust plate can be removed through the holes in the timing gear. Carefully withdraw the camshaft through the front of the block.

INSPECTION

Measure the bearing journals of the camshaft with a suitable micrometer. If the diameters of the journals are less than the following, the shaft must be replaced.

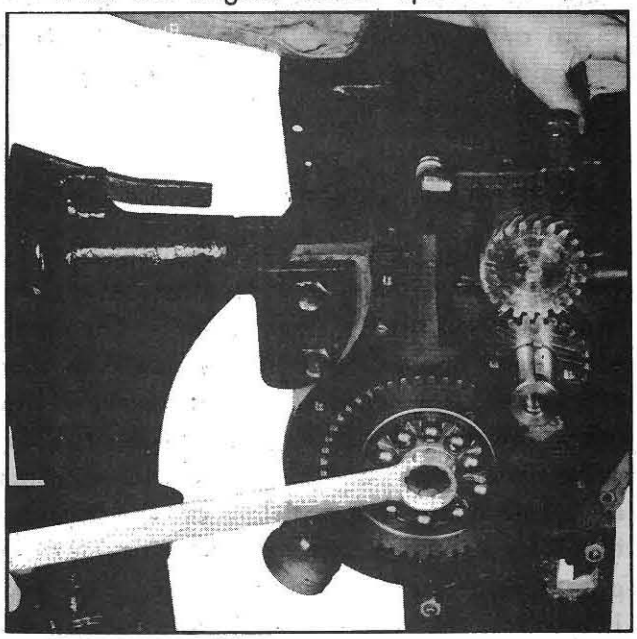


Fig. 101

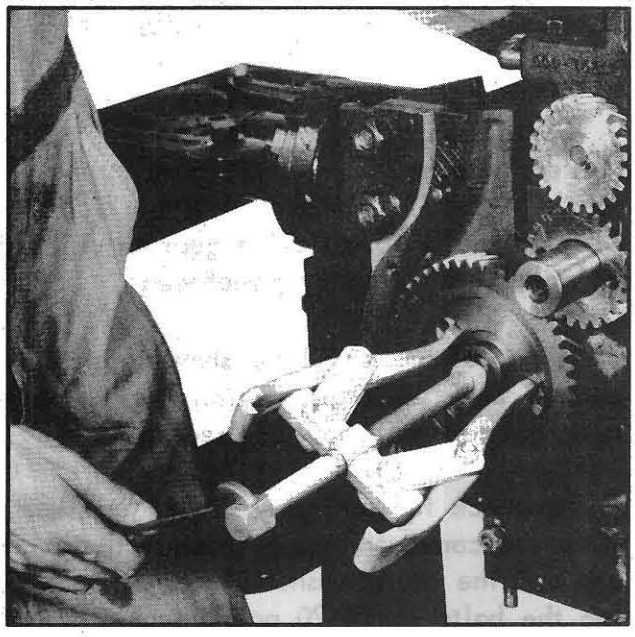


Fig. 102

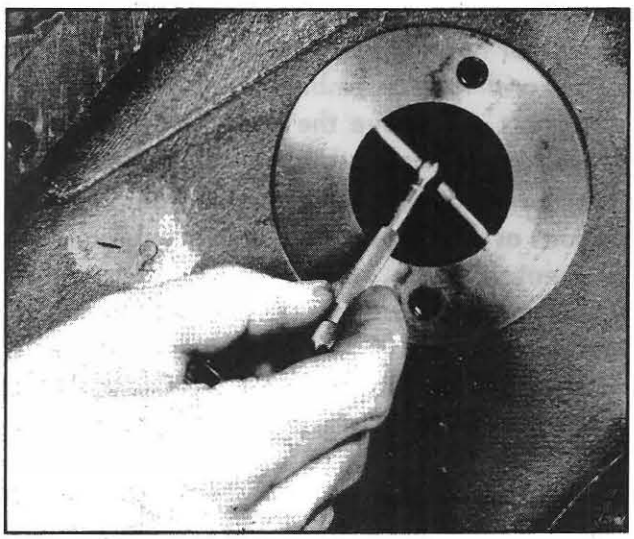


Fig. 103

Front journal-1.8070 in.
Center journal-1.7440 in.
Rear journal 1.6815 in.

The wear of the camshaft bearings in the block may be checked with a hole gauge and micrometer, see Fig.103, or by inserting a new camshaft and a 1/4 in. wide piece of feeler gauge stock .002 in. thick. This shim should produce a very definite drag when the camshaft is rotated. When measuring the camshaft bore of the block with a telescoping gauge and micrometers, the block should be considered unfit for further use if the measurements of the bore exceeds the following:

Front bearing bore-1.8015 in.
Center bearing bore-1.7480 in.
Rear bearing bore-1.6855 in.

Check the distributor drive gear for chipped or broken teeth or any signs of wear.

If any of the cam lobes show signs of excessive wear, pitting, scoring or other damage, the camshaft should be replaced.

To check the end play in the camshaft, slide the camshaft into position in the block and bolt the thrust washer in place, tightening the bolts to 15-20 pound-feet. Install the timing gear and tighten the retaining nut

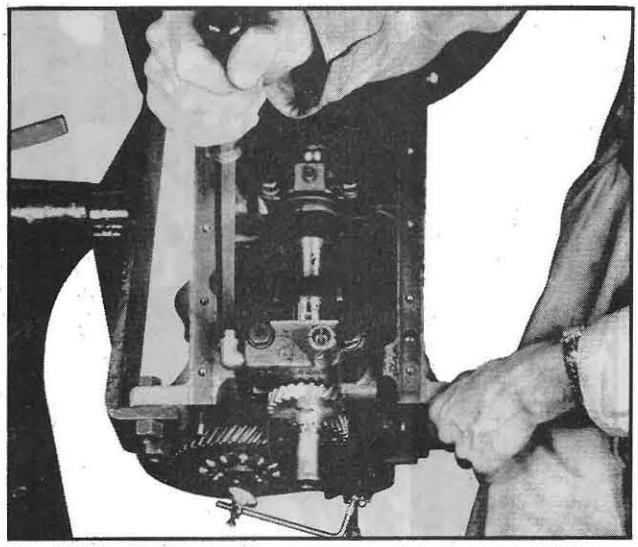


Fig. 104

to 75 pound-feet of torque

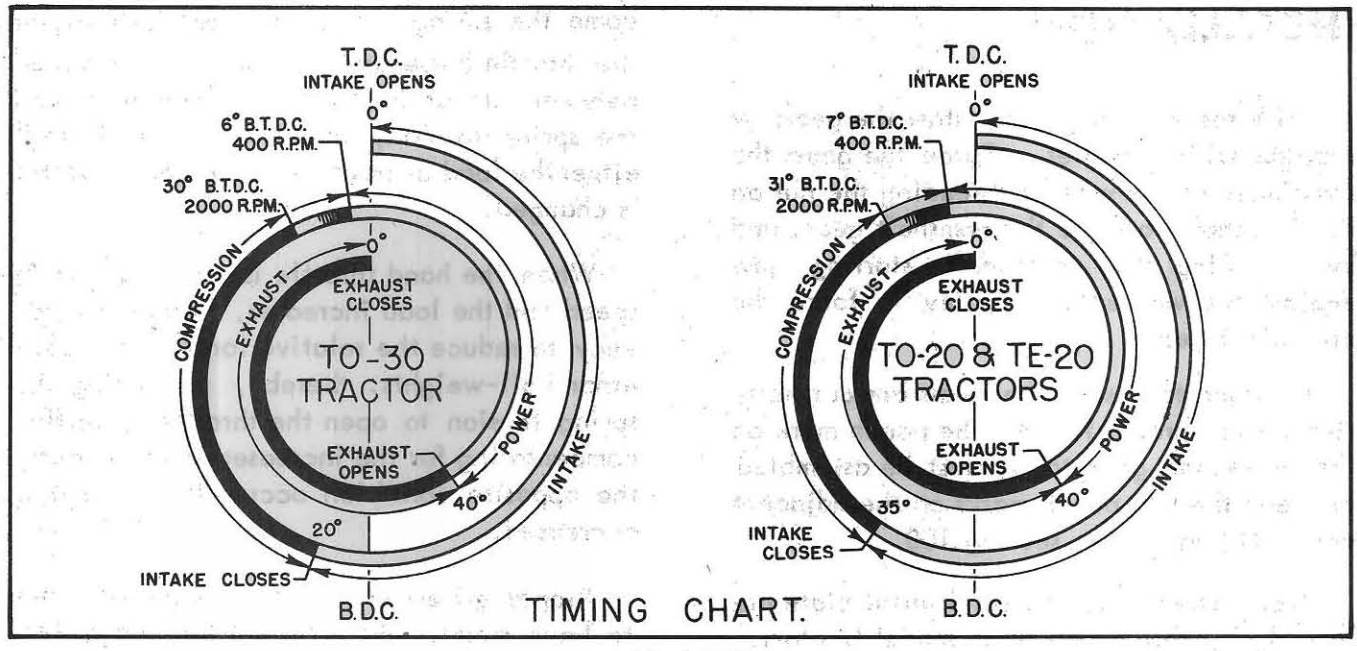
Set up a dial indicator as shown in Fig.104 and pry the camshaft as far rearward as possible. Set the indicator at "zero" and pry the camshaft as far forward as possible. The end play should be between .003-.007 in. If the end play exceeds .007 in., install a new thrust plate.

INSTALLATION

Before installing the camshaft for the final time, be sure all the bearing areas are wiped clean and lubricated with engine oil. It is also essential that the tappets be in place before the camshaft is installed.

TIMING GEARS

The timing gears couple the crankshaft to the camshaft causing them to rotate in a constant relationship to each other. The camshaft gear has twice as many teeth as the crankshaft gear, thus causing the camshaft to rotate one half as fast as the crankshaft. The valves must open and close at definite points in relation to the position of the piston, therefore, the two timing gears must mesh in proper relationship to each other. Fig. 105 illustrates the valve timing relationship to piston travel and spark plug discharge.



TIMING CHART.

Fig. 105

Both the crankshaft gear and the camshaft gear are available in standard, under or over sizes. The gears are stamped "S" for standard "U" for under size and "O" for over size with a number to show the amount of over or under size.

The cam gear section of the block is also stamped to show the original estimate of the correct combination with an "S" or a + or − (plus or minus) and a number to indicate the amount of over or under size.

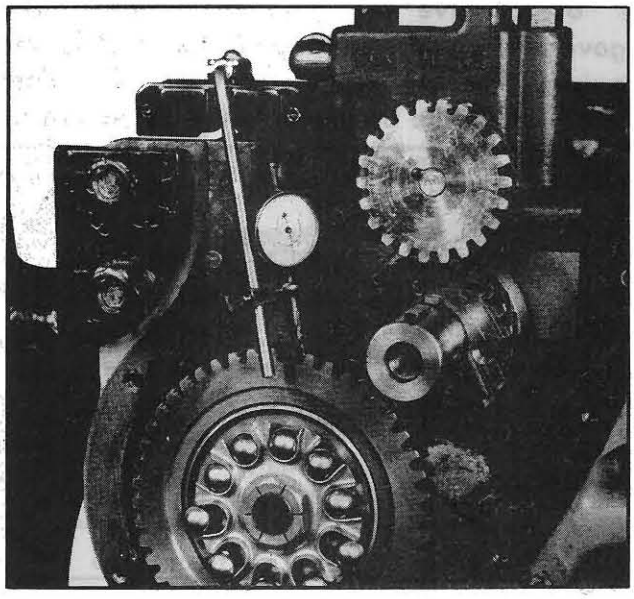


Fig. 106

INSPECTION

Determine if the gears are visibly worn or have broken or chipped teeth. Check the backlash between the camshaft and crankshaft gear by mounting a dial indicator, as shown in Fig.106, and measuring the free movement of the gear. The backlash can also be measured with a narrow thickness gauge. The free movement should be .002 in. or less. Worn camshaft and crankshaft bearings can also cause excessive gear backlash. If excessive clearance is experienced, make sure the crankshaft and camshaft bearings and journals are in good condition. However, if the wear is found to be in the timing gears, one or both will have to be replaced.

REMOVAL

The crankshaft gear has two tapped holes in its face which will take bolts used in pulling. The camshaft gear is removed with a puller as shown in Fig.102.

If new gears are to be installed, be guided by the size of gears that were removed. The backlash of .002 in. or less will be the final determining factor.

INSTALLATION

With the keys in place, start the gears by tapping with a mallet. Force the gears the remainder of the way by threading the nut on the camshaft to force the camshaft gear, and by threading the crankshaft starting jaw against the washer and pulley to force the crankshaft gear.

In order to assure the gears are correctly meshed for proper timing, the punch mark on the crankshaft gear tooth must be assembled between the two punch marks on the adjacent camshaft gear teeth, see Fig.100.

Note: The timing gears and thrust plate are interchangeable on all three model tractors.

GOVERNOR ASSEMBLY

Late TO-20 and most TO-30 tractor engines have a variable speed, centrifugal governor which regulates the engine speed as the load varies. The unit has ten evenly spaced ball-weights held in a metal retainer which is attached to the camshaft gear. The governor mechanism is enclosed in the timing gear cover and connected through its linkage to the throttle and the carburetor butterfly. The governor is lubricated by engine oil metered from the front camshaft bearing.

By use of the hand throttle, a selection of engine speeds from 400-2,200 RPM can be obtained. Also, any selected speed between 1,000-2,000 RPM can be maintained even though the load may vary.

ACTION

Opening the hand throttle increases the governor spring tension. This causes the governor linkage to overcome the force of the ball-weights, thereby, opening the carburetor throttle butterfly and permitting a greater amount of fuel mixture to enter the cylinder which increases the engine speed. The increase in speed gives greater force to the governor ball-weights, which begin to overcome the spring tension and partially closes the throttle butterfly. A balance is reached between the action of the ball-weights and the spring tension, and is maintained until either the load or position of the hand throttle is changed.

When the hand throttle is set for a certain speed and the load increases, there is a tendency to reduce the relative force of the governor ball-weights, thereby, permitting the spring tension to open the throttle butterfly, compensating for the increased load. Exactly the opposite condition occurs if the load is decreased.

Proper governor action must be obtained to have steady and efficient lugging power. Any binding or maladjustment will result in faulty or erratic operation.

To check the governor action:

1. Start engine (must be at operating temperature).
2. Set hand throttle for 1,000 RPM. Use the engine tachometer in the On-The-Farm Service Unit. Engine should be "revved-up" then reduced to desired RPM.
3. Set master brake.
4. Shift to fourth gear.
5. Release clutch gradually, see Fig.107.
6. Observe the governor action. The governor lever should pull the throttle rod quickly forward without delay. If it does not, see if the bumper screw is backed away

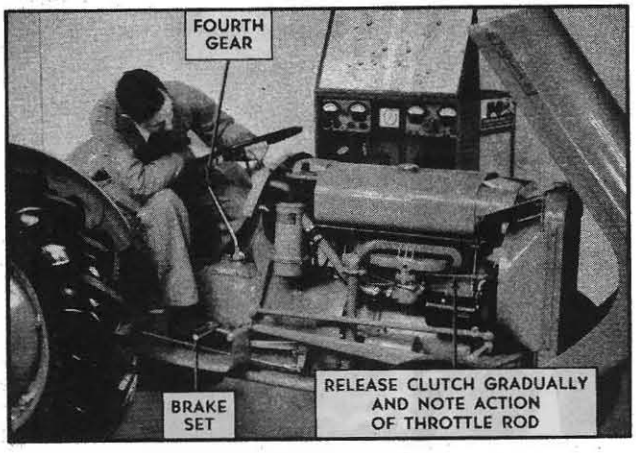


Fig. 107

from the bumper spring. This is accomplished by backing the bumper screw out till no spring tension can be felt.

7. Recheck operation procedure 1 through 5, if insufficient action is still present, check external governor linkage for binding and proper geometry as described under Governor Adjustment. If the governor action remains inoperative at 1,000 RPM, the difficulty probably results from internal binding of the mechanism or from the governor bumper spring extending too far away from the gear cover assembly. The latter condition can be checked by disconnecting the governor spring from the governor lever arm and pushing the governor lever to the idle position. If while in this position, springy action is noted, the governor bumper spring extends out too far and must be bent in towards the cover.

REMOVAL

To remove the governor mechanism from the tractor engine:

1. Remove the tractor hood, fuel tank and radiator.

2. Place a portable jack under the engine crankcase and remove the bolts attaching the front axle support to the engine block.

3. Raise the jack to a height sufficient to allow removal of the crankshaft pulley. Remove the fan belt, the cranking nut and the pulley.

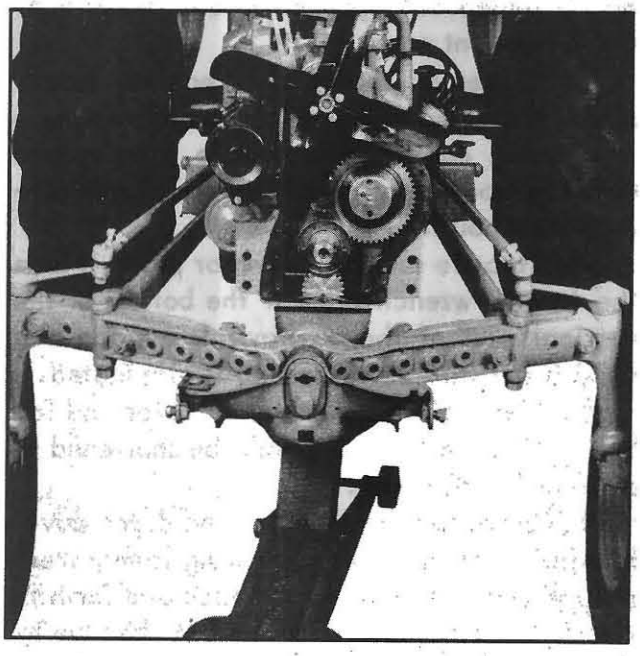


Fig. 108

4. Disconnect the carburetor control rod and the governor spring from the governor lever assembly.

5. Remove the timing gear cover and the governor cup assembly, see Fig.108. Remove the governor weight plate from the camshaft gear. To do this on the TO-30, it is necessary to first remove the timing gear retainer nut. On the TO-20 or TE-20, simply remove the four screws which attach the weight plate to the timing gear.

REASSEMBLY

The governor shaft assembly is supported in the timing gear cover by two sets of needle bearings. An oil seal and dust seal are installed in the housing around the governor shaft. The shaft is held in position in the housing by a pin through the governor lever and the shaft.

The flyweights for the flyweight type governors are sold as service items but in the case of the ball-weight type, the weight plate and weights must be replaced as a unit.

The governor bumper spring is riveted to the timing gear cover, the tapered bumper screw is threaded into the housing and is positioned in front of the bumper spring.

To replace the needle bearings, oil seal, dust seal or the governor shaft, it is necessary to remove the shaft from the cover assembly. To do this, carefully center punch the center of the pin retaining the rocker arm to the shaft and the pin positioning the inner bearing. Drill the pins out using a 5/32 in. drill, see Fig.109. Withdraw the shaft from the housing and pry the oil seal out of the housing using a heavy screwdriver. The needle bearings may be driven out of the housing using a mandrel as shown in Fig.110. Before reassembling, be sure that all the drill shav-

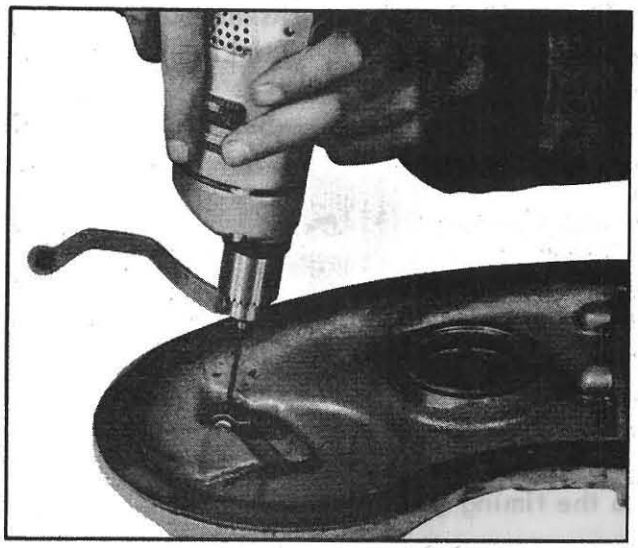


Fig. 109

ings are cleaned from the housing. When reassembling the shaft in the housing, always use a new oil seal and dust seal; the old seals will be ruined while removing. New needle bearings can be driven into the housing with the same mandrel used to remove them. Carefully drive the first set into the housing until it just clears the pin hole in the housing. Drive the second set in until it is flush with the bottom of the counterbored oil seal hole. Drive the oil seal into position using a suitable bushing driver as shown in Fig.111. Replace the dust seal, governor shaft and rocker arm. Line up the holes in the shaft and rocker arm and insert a new pin. Carefully head the ends of the pin to hold it in position.

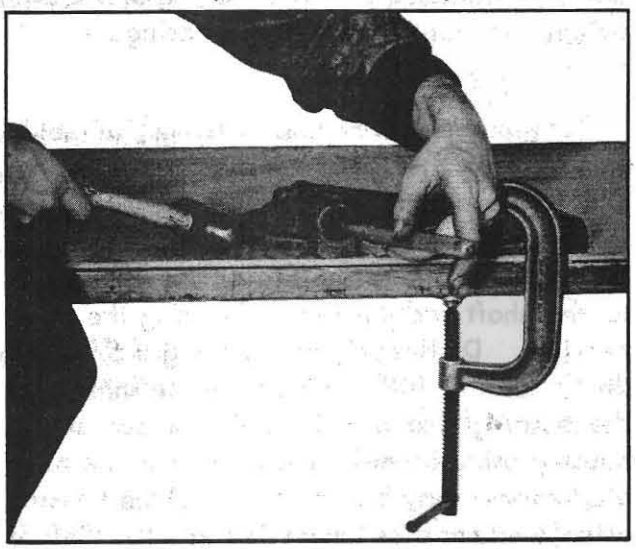


Fig. 110

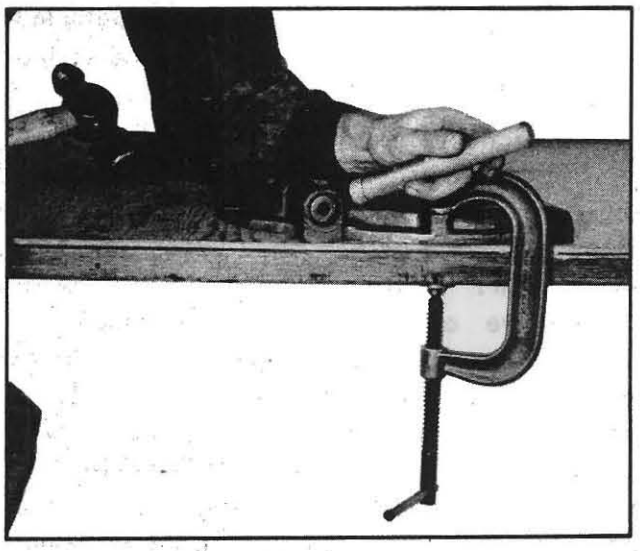


Fig. 111

ADJUSTMENT

After the governor mechanism and linkage is completely assembled, see Fig.112, check the bumper screw to make sure it is not interfering with the bumper spring. The screw should be locked approximately one turn out from the spring. Next, check the exterior governor linkage for binding by opening and closing the hand throttle and noting the points listed below. If interference is present in the geometry of the linkage, adjust to obtain the desired results as a proper functioning governor is dependent upon complete freedom of all component parts.

1. Governor spring and engine block. Move the U-bolt assembly forward on torque rod, being careful not to have interference between compensating spring and water outlet elbow housing.

2. Throttle rod and governor plate. Place the tractor wrench against the bottom of the vertical part of the governor lever arm and bend it outward until binding is eliminated.

3. Vertical arm of governor lever and fan belt. The throttle rod should be shortened to prevent interference.

4. Governor lever shaft and front cover housing. Remove governor spring from governor rod slot and move lever back and forth to check for binding. Binding may be due to dirt or a damaged shaft. The latter will re-

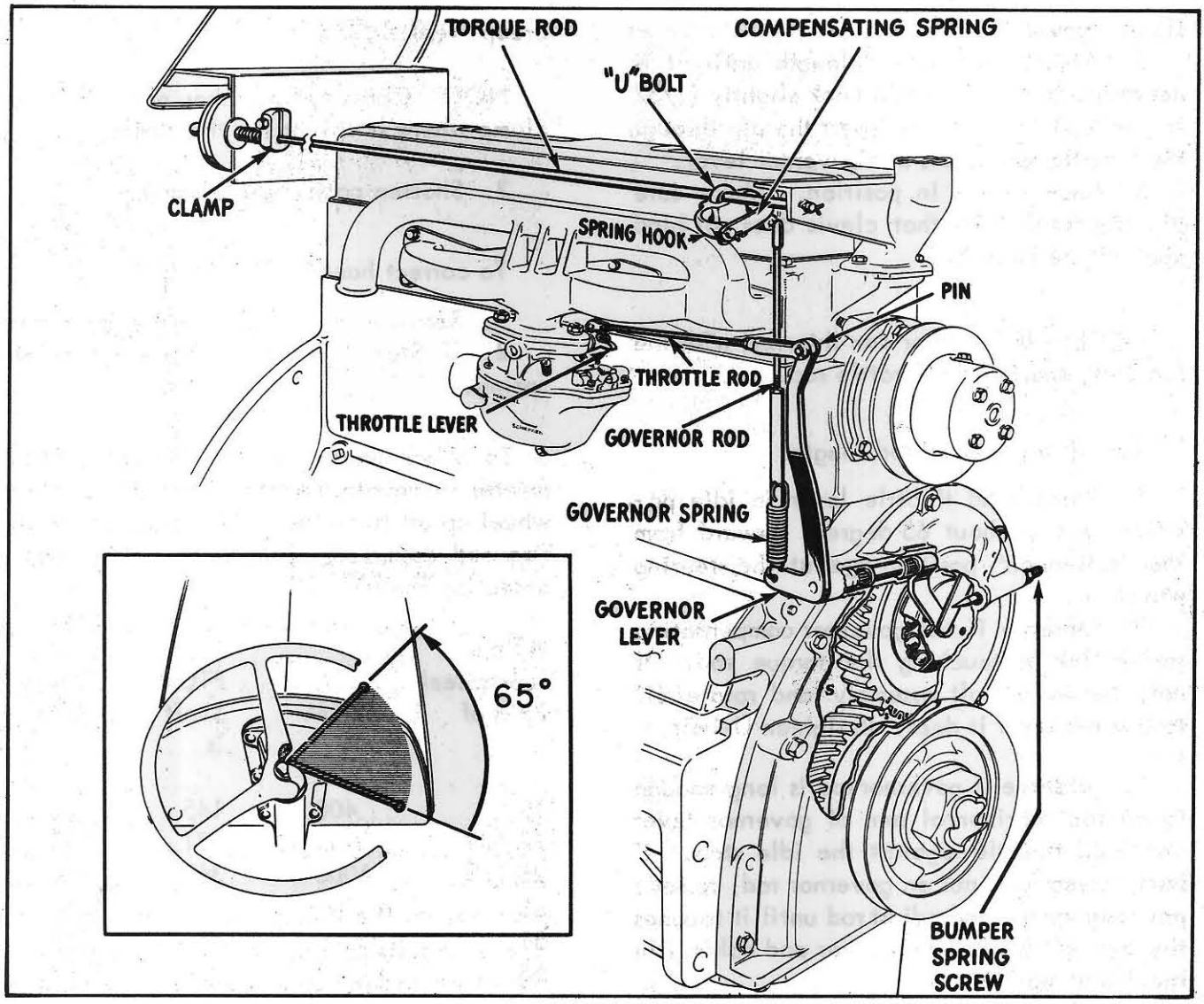


Fig. 112

quire removing the front cover to correct.

5. Compensating spring or top of governor rod and water outlet elbow housing. Move U-bolt assembly back on torque rod until binding is eliminated. Recheck Step (1).

6. Throttle rod clevis pin and governor arm. Loosen lock nut and retighten, holding clevis in a position where no binding occurs.

7. Cotter pin on carburetor end of throttle rod and throttle lever assembly. Cotter pin should be installed from the top of the throttle rod with the pin neatly wrapped around the throttle rod.

Before checking linkage for length, check engine idling speed as follows:

1. Disconnect throttle rod from governor lever.

2. Start engine.

Caution: Care should be taken to hold throttle rod in an idle position when starting engine. If this precaution is not taken, the engine will speed beyond its normal maximum engine RPM.

3. Hold throttle rod against idling stop and adjust idle speed screw until 400-450 engine RPM is obtained.

4. Stop the engine.

To adjust throttle rod length:

1. Open hand throttle fully to create ten-

sion on governor spring.

2. Adjust throttle rod length until it is necessary to move the rod back slightly (1/32 in. or less) in order to insert the pin through the throttle rod clevis and governor lever.

3. Lock clevis in position. Make sure pin fits freely and that clevis does not bind against governor lever.

NOTE: If governor arm interfers with the fan belt, shorten the throttle rod.

To adjust governor rod length:

1. Place hand throttle lever in idle position, i.e., about 65 degrees forward from the "full-open" position against the steering wheel.

2. Observe if the governor compensating spring link is touching the torque rod. If not, loosen U-bolt assembly and rotate on torque rod until it does. Retighten U-bolt.

3. Observe if governor rod is long enough to contact horizontal arm of governor lever and hold throttle against the idle stop. If not, loosen lock nut on governor rod, remove governor spring and adjust rod until it touches the arm of the governor lever and holds it in the "idle" position.

4. Recheck top engine speed, if not 2,100 -2,200 RPM loosen U-bolt on torque rod and adjust. If hand throttle interferes with hood, a weak governor spring is indicated. Spring should be replaced or shortened slightly. If governor surges, it will be necessary to loosen bumper screw and screw it in until surging is eliminated. This adjustment should be made with engine running at 1,000 RPM.

Caution: Do not turn bumper screw in any farther than necessary as it will deaden the action of the governor.

To remove hand throttle creep:

1. Increase spring compression on friction disc under dashboard. If this does not remove creep, replace friction disc.

NOTE: Care must be taken not to position clamp where it will strike the battery.

2. Shorten compensating spring.

To correct hand throttle arc:

1. Remove and shorten governor spring.
2. If Step (1) did not correct, replace spring.

To check engine speeds without a tachometer or revolution counter, jack one rear wheel up off the ground, place a mark on the tire and count revolutions per minute, while operating the tractor in first gear.

With a rear wheel RPM of	Engine RPM is	PTO Shaft is	Pulley RPM is
10	400	145	270
12 1/2	500	181	338
25 1/2	1000	363	676
38	1500	543	1014
51	2000	727	1358
56	2200	800	1493

MODEL DIFFERENCE

The major portion of all TO-20 and TE-20 tractor engines are equipped with a flyweight type governor which has four evenly spaced die-cast weights. TO-30 engines from Nos. 333437 to 334669 and from Nos. 334699 to 334742 have the flyweight type governor. The weights are attached to the governor weight plate by clevis pins and are free to pivot on these pins. The weight plate is attached to the camshaft gear. The action, service and adjustment of both types of governor is basically the same. The TO-30 governor assembly (Part No. Z-120 S-3080) may be used to replace similar parts of the flyweight type governor.

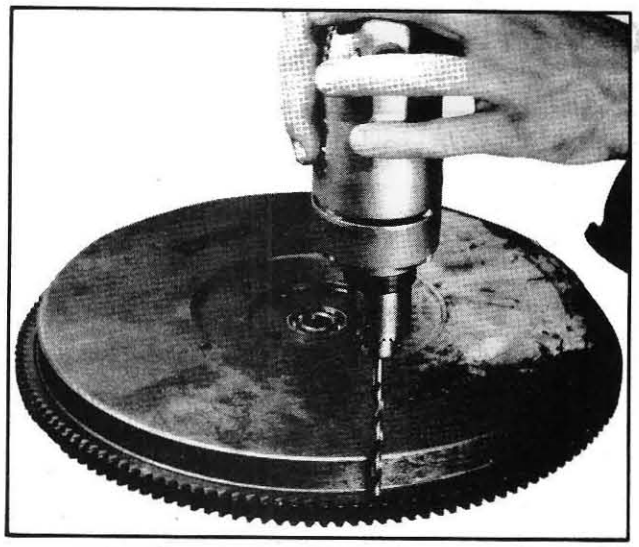


Fig. 113

FLYWHEEL

The flywheel is a grey iron casting with a flange around its outer edge. A ring gear is shrunk onto the outer diameter and rests against the flange.

The drive pinion of the starting motor engages this large ring gear. The rear face of the flywheel must be smooth and true as it serves as one of the pressure surfaces of the clutch. The holes in the hub are drilled in such a way that the flywheel may be bolted to the crankshaft in only one position. The flywheel is removed by merely removing the four nuts and lifting it off.

The ring gear should be thoroughly cleaned and inspected for possible cracks, warping and chipped or broken teeth. If the surface which contacts the clutch plate is scuffed or ground, it should be turned down to produce a smooth surface. If the teeth of the ring gear are chipped or badly worn, the gear should be drilled with a 3/16 in. drill, as shown in Fig. 113 then cut with a cold chisel. The new gear should be heated to 560 to 570 degrees Farenheit and driven firmly into place against the rim of the flywheel.

The flywheel of the TO-30 and that of the TO-20 are the same and are interchangeable but the flywheel of the TE-20 is different. It has a rim around the center of the flywheel and the ring gear is shrunk onto the forward side of the outside diameter.

Note: On TO tractors produced prior to Serial No. 10282, the ring gear is mounted to the engine flywheel from the rear. If the ring gear has become dislodged or needs replacing, no attempt should be made to install a new ring gear on the old flywheel. Instead, a new flywheel, Part No. Z-120 C-4020 should be used.

TROUBLE SHOOTING

TROUBLE	POSSIBLE CAUSE
Excessive Fuel Consumption	1. Fuel Leak 2. Fouled Air Cleaner 3. Dirty or Improperly Adjusted Carburetor a. Metering Jet b. Float Level c. Idle Adjustment d. Main Adjustment 4. Faulty Ignition a. Timing b. Automatic Spark Advance c. Distributor Points d. Spark Plugs e. Wiring 5. Improper Valve Timing 6. Worn Pistons, Rings or Sleeves 7. Burned, Worn or Sticking Valves 8. Improper Valve Adjustment, Worn or Bent Push Rods 9. Engine Overheating 10. Clutch Slippage 11. Excessive Power Train Drag Due to Binding or Wear 12. Brakes Dragging
Excessive Oil Consumption	1. Oil Leak 2. Plugged Breather Pipe 3. Worn Valve Guides 4. Worn or Illfitted Rings 5. Worn, Scored or Out-of-Round Cylinders or Pistons 6. Worn Ring Grooves 7. Inverted Rings 8. Stuck Piston Rings 9. Loose Hubbard Plugs 10. Worn Neoprene Oil Guard Gaskets on the Intake Valves

TROUBLE	POSSIBLE CAUSE
Loss of Power	1. Dirty or Improperly Adjusted Carburetor 2. Faulty Ignition 3. Worn Rings, Pistons or Sleeves, Burned or Sticking Valves 4. Faulty Governor Operation 5. Crack in Intake Manifold or Leaking Gasket 6. Blown Head Gasket 7. Brakes Dragging 8. Valve Adjustment, Worn or Bent Push Rods 9. Connecting Rod or Main Bearings Too Tight 10. Excessive Exhaust Back Pressure
Erratic Misfire	1. Dirt in Carburetor 2. Weak or Broken Valve Spring 3. Sticky Valve 4. Faulty Ignition
Pre-Ignition	1. Low Anti-Knock Fuel 2. Ignition Timing Too Far Advanced 3. Engine Overheating 4. Heavy Carbon Deposits in the Combustion Chamber 5. Spark Plug Not of Proper Heat Range 6. Overheated Valves are Caused By: a. Thin Edged Valves b. Insufficient Tappet Clearance c. Incorrect Width of Valve Seats 7. Distributor Advance
Continuous Misfire	1. Stuck or Burned Valves 2. Blown Head Gasket 3. Faulty Ignition

ENGINE KNOCKS

Locate the knock by using a sounding rod or by shorting out each cylinder in turn

TYPE OF KNOCK	DISTINGUISHED BY	POSSIBLE CAUSE
1. Main Bearing	1. Usually a heavy metallic "bump", most noticeable upon acceleration under load	1. Badly diluted or thin oil. Low oil pressure. Insufficient oil supply. Excessive main bearing clearance. Excessive crankshaft endplay. Out-of-round crankshaft journals. Loose flywheel. Loose timing gear.
2. Connecting Rod Knocks	2. Usually a light pound or knock of much less intensity than a main bearing knock, usually more noticeable during deceleration	2. Badly diluted or thin oil pressure. Insufficient oil supply. Excessive connecting rod bearing clearance. Out-of-round crankshaft journals.
3. Piston "Slap"	3. In some cases piston slap causes a clicking noise, but usually it makes a hollow, muffled bell-like sound	3. Excessive piston-to-cylinder bore clearance. Insufficient piston pin connecting rod bushing clearance. Collapsed piston skirt. Connecting rod misalignment. Eccentric or tapered cylinders.
4. Piston Ring Noises	4. Usually a sharp click or rattle during acceleration	4. Excessive side clearance of ring in groove. Broken rings. Ring striking ridge at top of cylinder bore.
5. Piston Pin Noise	5. Generally a sharp double, metallic knock, most noticeable when the engine is idling	5. Excessive piston pin clearance in either piston or connecting rod, or both. Piston pin rubbing cylinder wall, retaining ring not installed or improperly installed.
6. Other Knocks		6. Excessive camshaft end play. Loose or broken timing gears. Excessive backlash in timing gears. Damaged governor assembly. Loose cranking nut.

SERVICE BULLETINS

No.	Date	Subject

NOTES

SERVICE BULLETINS

No.	Date	Subject

NOTES

CLUTCH

The clutch used in Ferguson tractors is a spring-loaded, single dry plate type. The springs are supported between the clutch cover, which is fastened to the engine flywheel with cap screws, and the pressure plate. In operation, the clutch thrust springs exert pressure against the clutch pressure plate which in turn transmits the pressure through the disc assembly to the engine flywheel, thus establishing a firm frictional contact between the disc and the flywheel.

When the clutch pedal is depressed, the clutch release fork moves the clutch release bearing forward on the retainer and brings it in contact with the clutch release levers assembled to the clutch cover. The levers are depressed, thus causing the pressure plate to move away from the disc assembly, thus releasing the pressure on it. The engine flywheel is now free to rotate independently of the main drive gear shaft. When the clutch is disengaged in this position, the engine flywheel rotates about the shaft extension of the main drive gear. A clutch pilot bearing pressed into the engine flywheel supports the shaft.

Most TO-30 tractors are equipped with the Rockford clutch, see Fig.114. However, the following Serial Numbers are TO-30 tractors

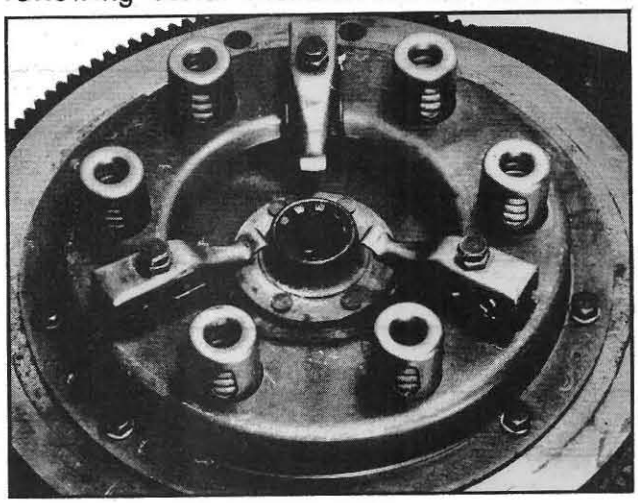


Fig. 114

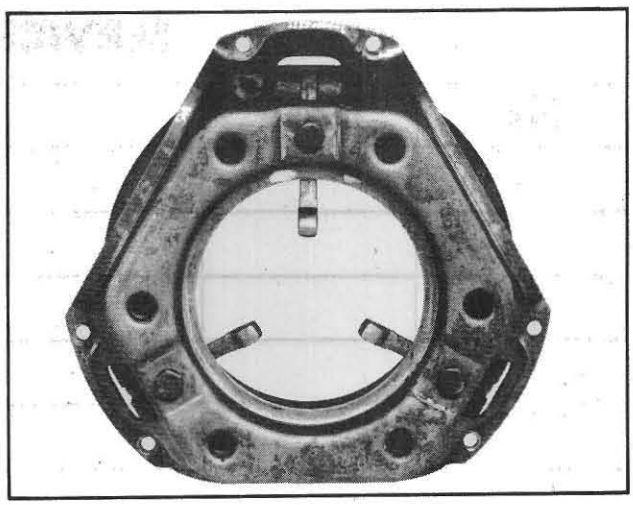


Fig. 115

equipped with the Long clutch, see Fig.115.

TO-103262 thru TO-106684
TO-107688 thru TO-108168

TO-20 tractors are also equipped with both the Rockford and Long clutch. The Rockford clutch, Fig.114, is the same as the one used on the TO-30 tractor with the exception of the pressure spring specifications. The TO-20 Long clutch is similar to the Rockford clutch, however, the parts are not interchangeable except when the disc assembly in the Long clutch cannot be repaired, the Rockford clutch disc assembly may be substituted. The Long clutch assembly, Fig.116, used in TO-20 production will be referred to as the TO-20 Long Clutch to distinguish it from the TO-30 Long Clutch. The following Serial Numbers are TO-20 tractors which were equipped with Long clutches.

TO-15634, TO-15635, TO-16052
TO-16076 thru TO-16311
TO-18571 thru TO-19319

The TE-20 tractor is equipped with a Borg & Beck clutch, see Fig.117. The Rockford and the Borg & Beck clutch cover assembly and the disc assembly are interchangeable as units, however, the individual parts that make up the two assemblies are not interchangeable.

Note: Whenever possible, Rockford clutch parts should be used to service all TO and TE tractors. See Tractor Parts Book.

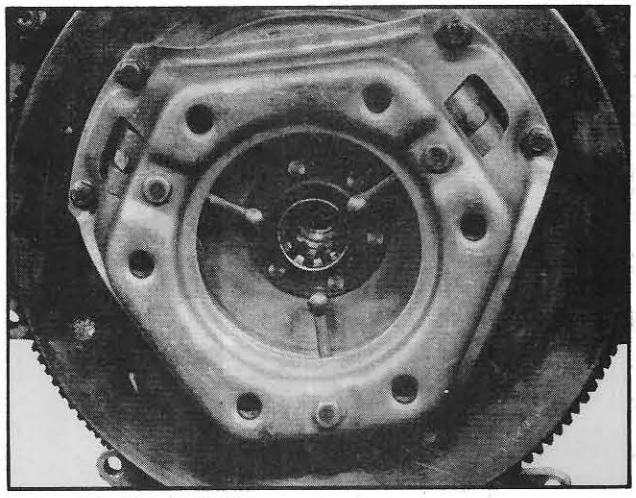


Fig. 116

REMOVAL

1. Remove the battery.
2. Disconnect the primary wire from the voltage regulator and the starter switch leaving the wiring assembly attached to the dash.
3. Disconnect the oil line at the gauge.
4. Loosen U-bolt holding the governor linkage to the hand throttle rod.
5. Disconnect the air cleaner hose from the carburetor and the exhaust pipe from the manifold.
6. Remove the choke rod.
7. Remove the bolts holding the fuel tank to its rear support bracket.
8. Place two wood blocks between the front axle and front axle support to prevent the engine from tipping.

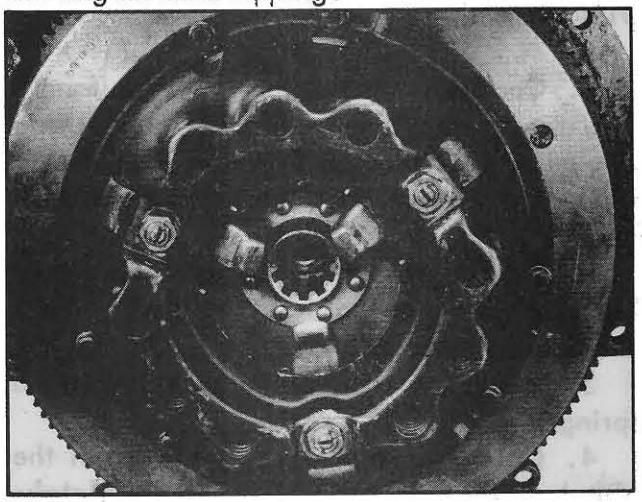


Fig. 117

9. Disconnect both radius rods at the transmission and disconnect the steering drag-links from the steering gear sector arms.
10. Place a wheeled jack under the transmission housing and support the engine so that it will not tip.
11. Remove bolts holding transmission housing to engine, move transmission and engine apart. Support rear of engine on a stand, see Fig. 118.
12. Remove the six cap screws holding the clutch assembly to the flywheel by loosening each cap screw a turn-or-two at a time. This prevents the clutch cover rim from bending.

ADJUSTMENTS

Never make the final adjustment of the clutch release levers without first installing a new disc assembly. If it is desired to reinstall a used disc assembly after the clutch cover assembly has been dismantled, the clutch release levers should be adjusted with a new disc assembly in place. Then remove the clutch assembly and replace the used disc assembly. Install the clutch on the flywheel without disturbing the release levers.

ROCKFORD CLUTCH

Beginning with tractor Serial Number TO-114747, a cushioned segment disc assembly was installed. The clutch facings are riveted to six steel spring arms, see Fig.119. These spring arms are slightly curved or dished, thus giving a cushioning effect as the driven plate is compressed. The cushioning effect results

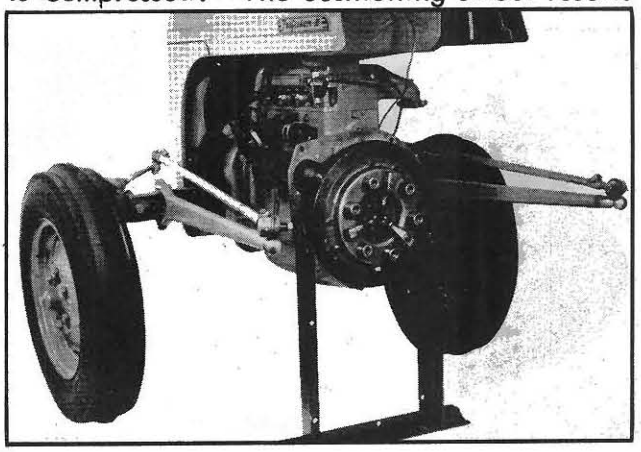


Fig. 118

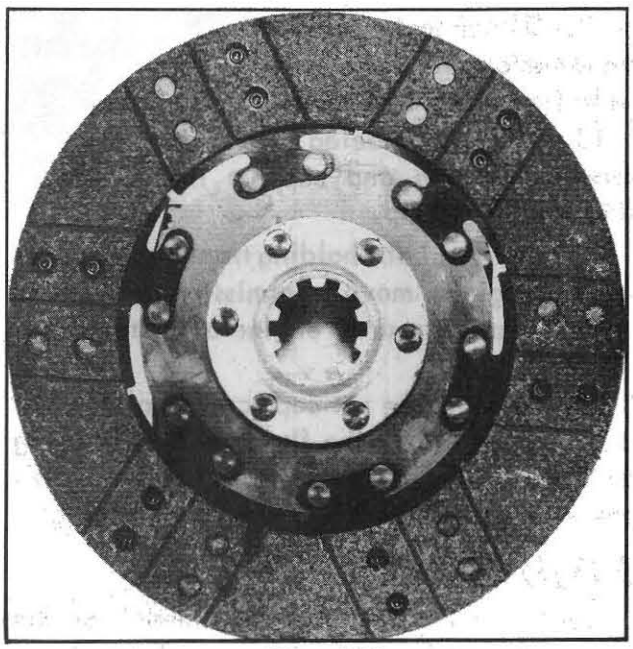


Fig. 119

in a smoother clutch engagement. This cushioned disc should be used to service all Rockford clutches. The part number of this cushioned disc is TO-7550-3.

Although the cushioned disc is somewhat thicker than the old type disc (TO-7550-2) no change is made in the adjustment of the clutch release levers. The adjustment is the same for both types of driven discs.

The additional thickness of this cushioned disc is compensated for by a greater clutch pedal travel. If a cushioned disc is installed in a clutch which formerly had the old type driven disc and the release levers are adjusted

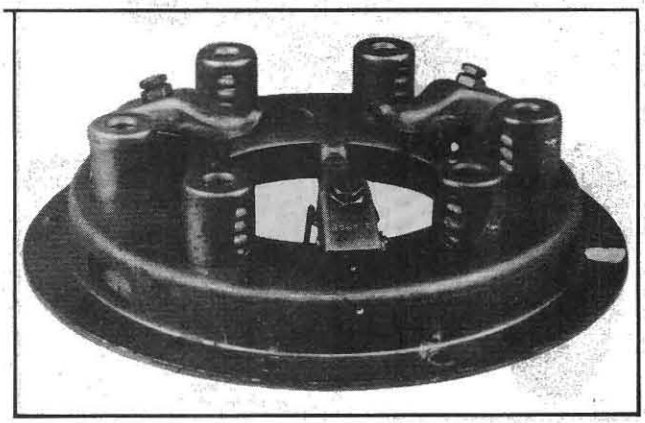


Fig. 120

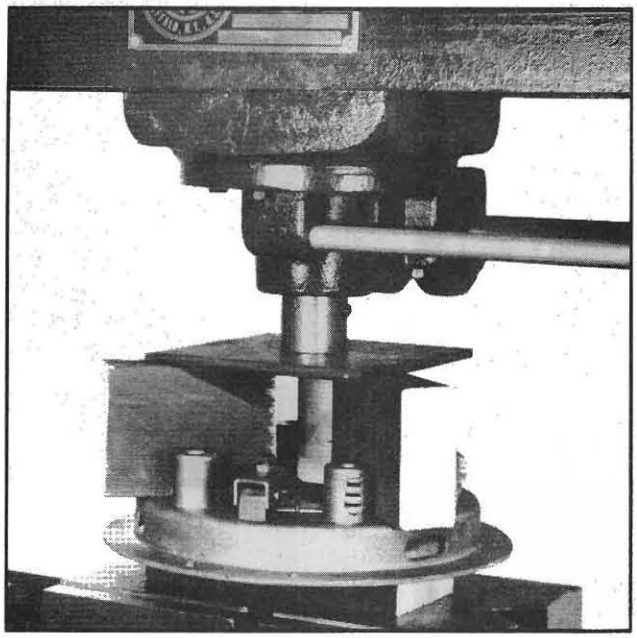


Fig. 121

as outlined in "Adjustments", and a clean release cannot be obtained after assembling the tractor, it will be necessary to remove the old clutch pedal and replace it with the new revised pedal. The clutch pedal has been revised to permit 5 in. of pedal travel instead of 4 in. allowed by the old style pedal.

Before disassembling the clutch, mark the pressure plate and cover plate with a center punch so that they can be reassembled in the same relative position to preserve the balance, see Fig.120.

DISASSEMBLY

1. Compress the clutch cover uniformly in a press, as shown in Fig.121, or by using C-clamps until the springs are compressed enough to release the pressure on the clutch levers.
2. Remove the cotter pins and the clutch lever release pins that hold the clutch levers to the pressure plate.
3. Remove the clutch release levers and springs.
4. Carefully release the pressure on the clutch cover until the springs are completely released and lift off the clutch cover plate.

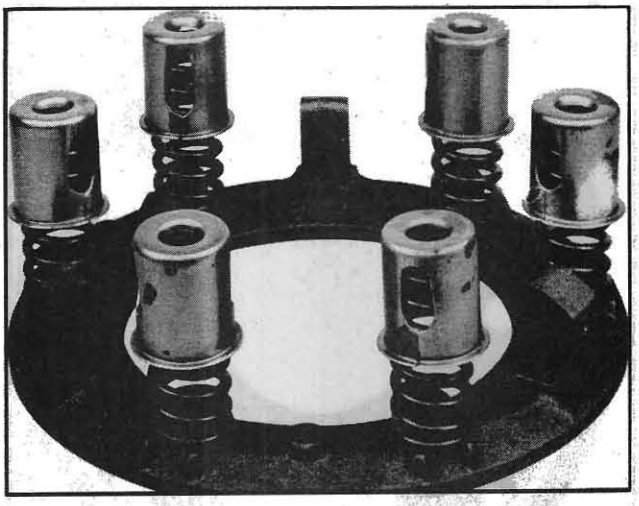


Fig. 122

ASSEMBLY

1. Place thrust springs and thrust spring cups on the bosses on the pressure plate as shown in Fig.122.

2. Place the clutch cover in position by lining up the punch marks made before disassembly.

3. Compress the assembly until the release levers can be installed. Make sure that the spring on the clutch lever is hooked under the clutch cover, see Fig.123. This spring keeps the lever from rattling when the clutch is engaged.

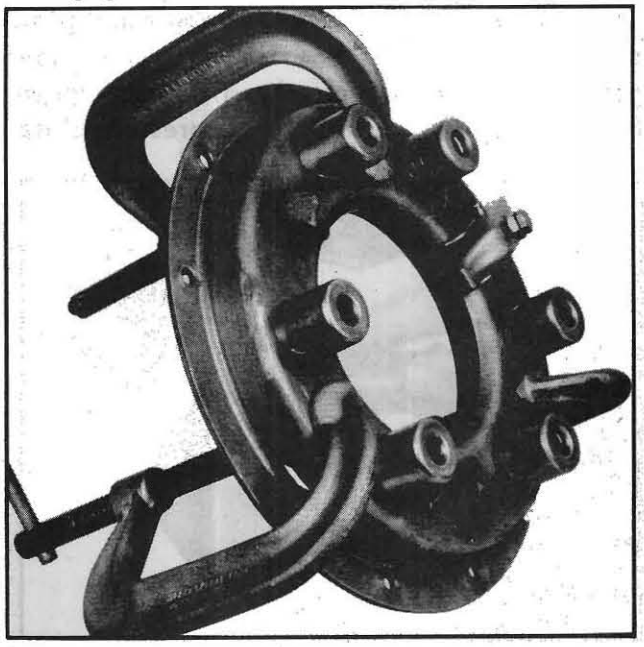


Fig. 123

4. Install the pin in the lever and secure the pin with a cotter pin.

ADJUSTMENT

The release levers are set so that the bearing contact surface of the levers are 1 13/16 in. from the face of the flywheel. The height of the lever is changed by turning the adjusting screw with a new friction disc in place. Adjust each lever until they just contact the gauge, see Fig.124, and lock the adjusting

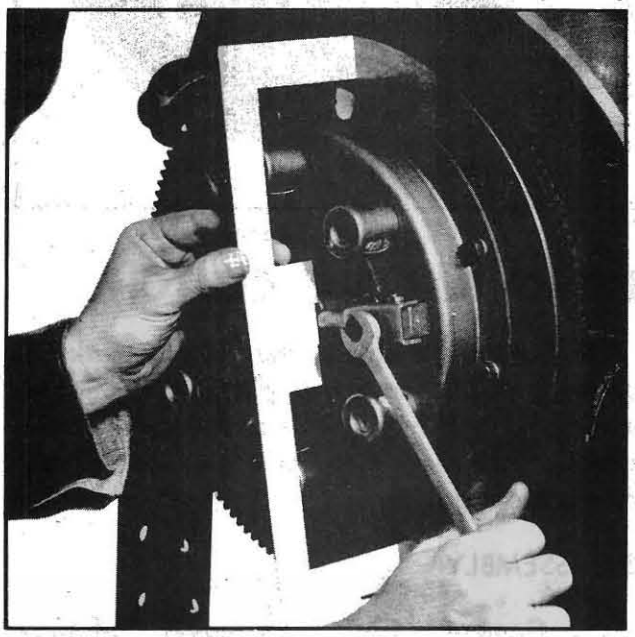


Fig. 124

screw in place by tightening the locking nut. Check adjustment after tightening the lock nut to make certain that there has been no change in the adjustment. The correct notch on the gauge for this clutch is marked "Rockford".

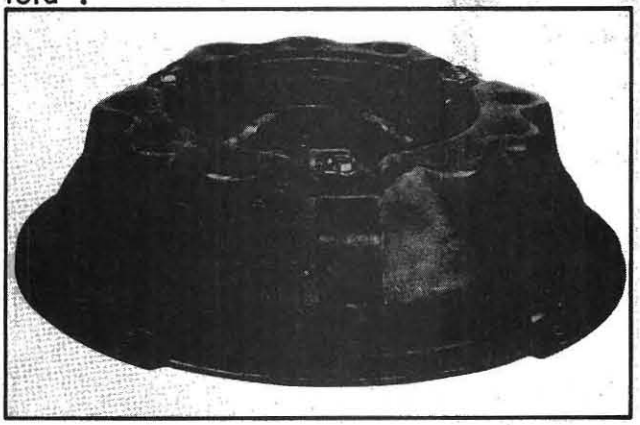


Fig. 125

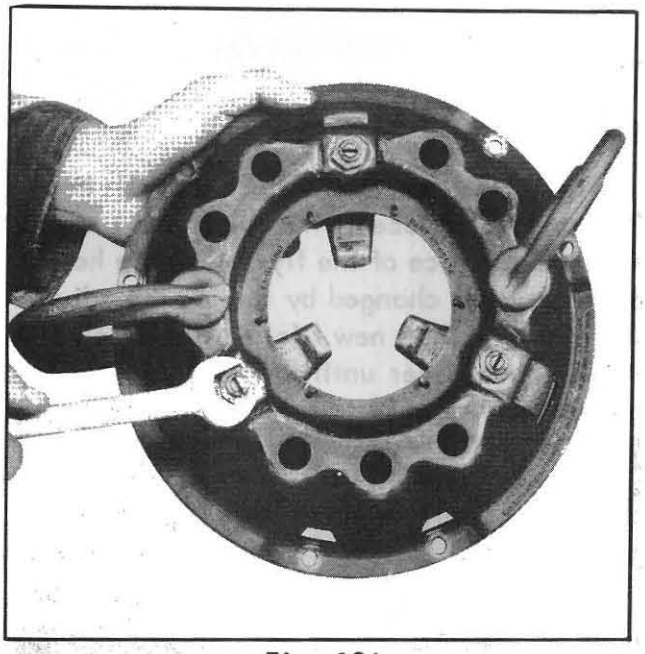


Fig. 126

BORG & BECK CLUTCH

Before disassembling the clutch, mark the pressure plate and cover plate with a center punch so that they can be reassembled in the same relative position to preserve the balance, see Fig.125.

DISASSEMBLY

1. Compress the clutch cover uniformly in a press or with C-clamps, as shown in Fig. 126. Remove the adjusting nuts with a wrench.

2. Lift off the cover and note the location of all parts. Lift off thrust springs.

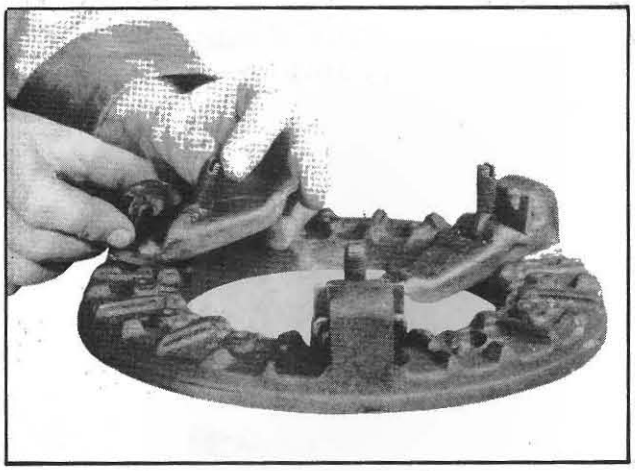


Fig. 127

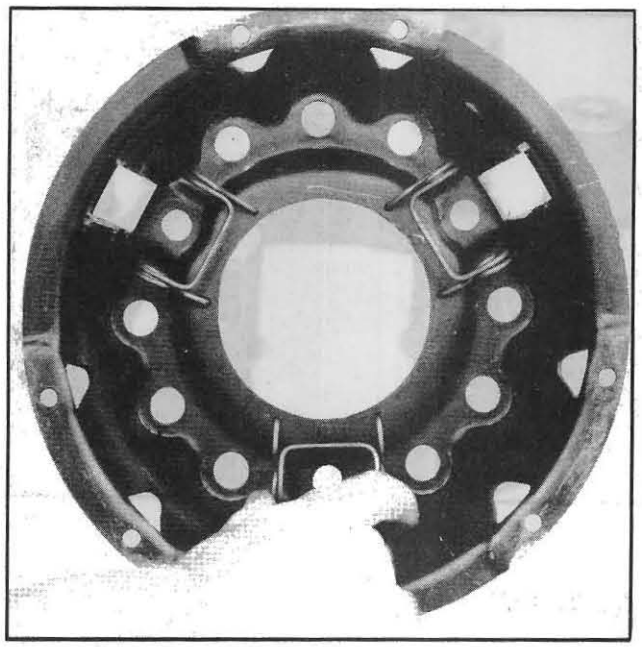


Fig. 128

3. To remove the levers, grasp the lever and eyebolt between thumb and fingers so that the inner end of the lever and the upper end of the eyebolt are close together. Keeping the eyebolt pin seated in its socket in the lever and tilt strut back until it clears the end of the lever as shown in Fig. 127. Lift the lever and eyebolt off the pressure plate.

ASSEMBLY

1. Assemble the lever, eyebolt and pin. Holding the eyebolt and lever as close together as possible, grasp the strut as shown in Fig.129. Insert the strut in the pressure plate

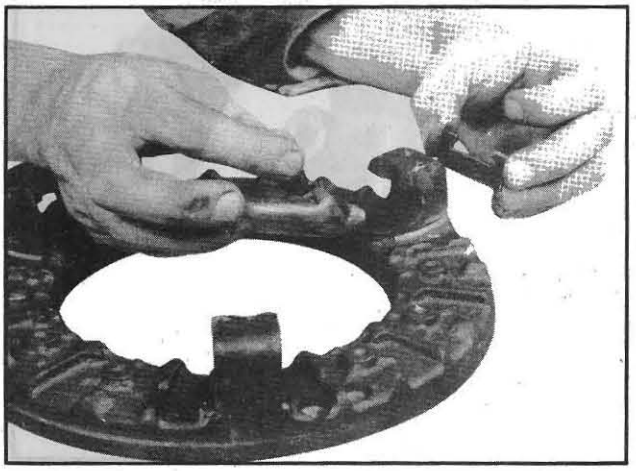


Fig. 129

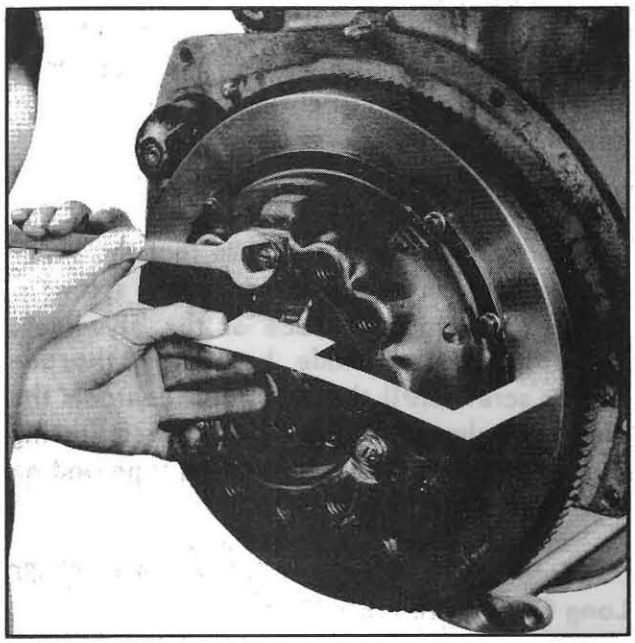


Fig. 130

lug slots, drop it slightly and tilt the lower edge back. Insert the unthreaded end of the eyebolt into the hole in the pressure plate with the short end of the lever under the hook of the pressure plate lug, see Fig.127. Slide the strut upward in the slots of the lug, lifting it over the ridge on the short end of the lever and drop it into the groove in the lever.

2. Replace the pressure springs on the bosses of the pressure plate.

3. Assemble the anti-rattle springs in the cover as shown in Fig.128.

4. Place the cover on top of the assembled parts, lining up the punch marks made before disassembly.

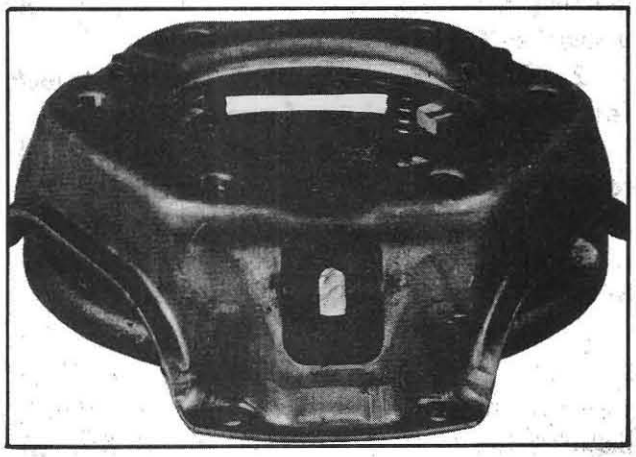


Fig. 131

5. Place the clutch assembly in a press. Slowly compress the thrust springs while guiding the clutch cover so that the lugs and springs of the pressure plate are allowed to mate with the holes and seats in the cover. Turn the adjusting nuts on to the eyebolts until their tops are flush with the tops of the eyebolts and remove the assembly from the press. Final adjustment of the clutch lever must be made with the clutch installed on the flywheel.

ADJUSTMENT

The release levers are set so that the bearing contact surface of the levers are 1 15/16 in. from the face of the flywheel. Adjust the height of each lever until it just contacts the gauge by turning the adjusting nut as shown in Fig.130. The adjusting nuts are then locked by a chisel mark across the slots.

LONG CLUTCH

The Long Clutch used on TO-30 tractors is very similar in appearance to the one used on the TO-20 tractor, however, the only repair parts that are available to service both the Long Clutches are the clutch disc refacing kit and the disc assembly. If any other parts are badly worn, broken or defective, the complete pressure plate and cover assembly should be replaced with a Rockford pressure plate and cover assembly.

Before disassembling the clutch, mark the

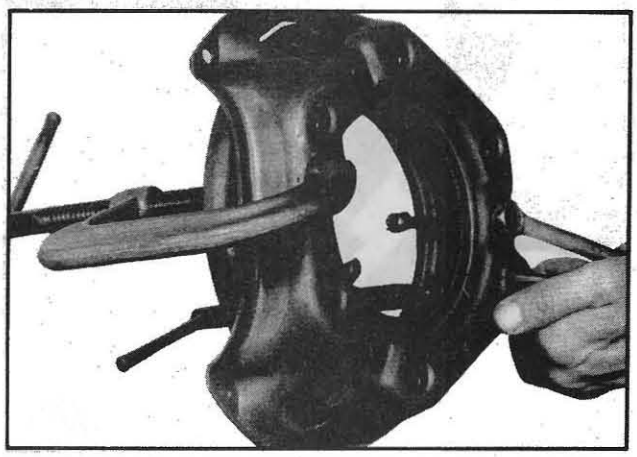


Fig. 132

pressure plate and cover plate with a center punch so that they can be reassembled in the same relative position to preserve the balance, see Fig. 131.

DISASSEMBLY

Compress the cover uniformly in a press or with C-clamps and remove the three cap screws attaching the clutch cover to the release levers, see Fig.132. Slowly release the clamps and lift off the cover.

The pins attaching the release levers to the pressure plate are staked in place and since repair parts are not available to service this clutch, it is pointless to disassemble the unit further. If the pressure plate, release fingers or clutch cover are damaged or worn to the point where it is unfit for service, the entire unit should be replaced with the standard Rockford unit.

ASSEMBLY

1. Place the fiber washers and pressure springs on the bosses of the pressure plate and place the cover in position, lining up the marks made before disassembly.
2. Slowly compress the thrust springs making certain that the springs are seated in the clutch cover. Replace and tighten the three cap screws retaining the cover plate to the clutch levers. Adjustment of the levers must be made with the clutch installed on the flywheel.

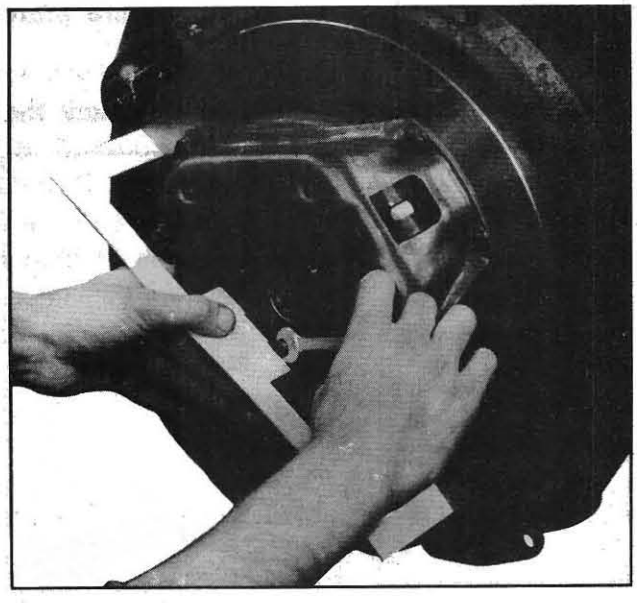


Fig. 133

ADJUSTMENT

The release levers are set so that the bearing contact surface of the adjusting screws is 1 13/16 in. from the face of the flywheel. The adjustment is made by turning the adjusting screw until the screw just contacts the gauge as shown in Fig.133. The adjusting screws are the split, self-locking type and no locking device is necessary.

Note: The release levers on the TO-30 Long Clutch are not adjustable.

CLUTCH FACING

The clutch facing should be replaced before wear on the facing brings the metal rivets in contact with either the engine flywheel or the clutch pressure plate. If excessive slipping has caused the disc to overheat and deform or be otherwise damaged, it should be replaced with a new disc assembly. If there is no sign of damage to the disc and the facings are worn enough to require replacing, new clutch facings should be installed on the original disc.

To install new facings on the clutch disc, proceed as follows:

1. Carefully remove the old facings by drilling the rivets and driving them out with a small drift punch.
2. Clean the metal surfaces and check for distortion and signs of overheating.
3. Place the two grooved, annular clutch facings on the discs and rivet securely in position, using the tubular rivets provided and a suitable riveting tool to form a uniform head on the tubular end of the rivet.

NOTE: The grooved, annular clutch facings available in the clutch facing kit should be installed in all TO-30 and TO-20 disc assemblies, regardless of the fact that some of

the discs were originally equipped with segmented type facings. A clutch facing kit is available for the Borg & Beck clutch used in the TE-20 tractor. The facings in this kit are not interchangeable with those of any other kit.

SPRINGS

Whenever the clutch assembly is removed from the tractor, the plate and cover assembly should be disassembled and the clutch thrust springs tested in a suitable spring tester, as shown in Fig. 134. If one or more of the springs do not meet the specifications listed in the clutch chart, see Fig. 138, a complete new set of matched springs should be installed.

New pressure springs are not available to service either of the Long clutches and no other springs should be substituted in this clutch. If the springs are damaged or worn, the Long clutch cover and plate assembly should be replaced with a Rockford clutch cover and plate assembly.

In the early TO-30 production, six lavender colored springs were installed in each clutch. However, it was found after extensive testing that a more desirable clutch pedal pressure and performance was obtained by installing alternately in the clutch, a lavender and a brown spring. It is recommended that this procedure be followed in servicing the TO-30 clutch.

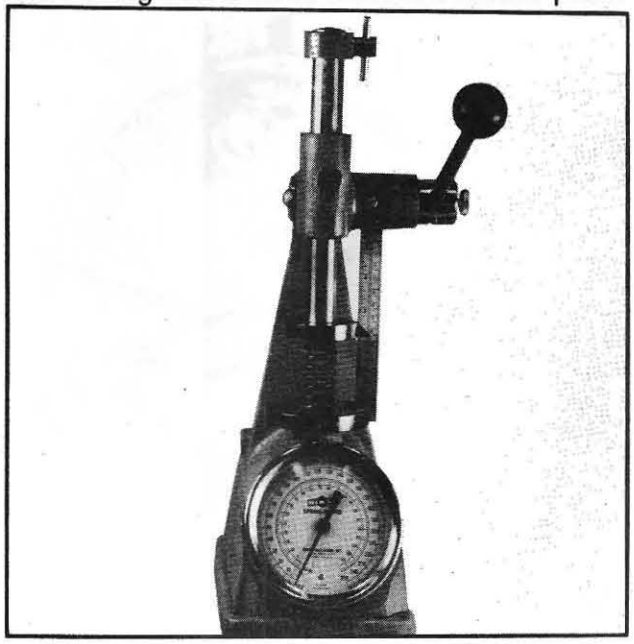


Fig. 134

Whenever the TO-30 Rockford clutch cover plate assembly is dismounted for inspection, the springs should be tested in a suitable spring tester. If the springs meet the specifications listed in Fig. 138 on page 63, they are suitable for service. Regardless of the arrangement and type springs used ordinarily in the clutch, it should be reassembled using three lavender springs, Part No. TO-7572-B, and three brown springs, Part No. TO-7572, arranged alternately.

The TO-20 clutch may be serviced either with six brown springs, as used in the original clutch, or with three lavender and three brown springs, as outlined above for the TO-30 clutch.

GENERAL INSPECTION & SERVICE

Check the clutch release levers and release lever springs and replace all parts that are damaged before reassembling the clutch.

Remove the four nuts holding the flywheel to the crankshaft, remove the flywheel. Examine the flywheel for indications of oil leaking by the rear of the crankshaft oil seal. If there is any reason to believe that the seal is leaking oil, it should be renewed before sufficient oil has leaked to damage the clutch facing. To renew the oil seal, remove the engine oil pan and detach the seal assembly, install the new seal and replace the oil pan. Check the hubbard plug at the rear of the camshaft and make sure it is tight as an oil leak may develop at this point. If there is any indication of a leak or if the plug is loose, remove it and install a new plug. Clean and inspect the clutch pilot bearing.

If the bearing needs to be replaced, press out the old bearing and press in a new bearing as shown in Fig.135. When pressing in the new bearing, make certain that the open side of the bearing is toward the engine side of the flywheel. Pack the bearing with a good grade of high melting point bearing lubricant, being careful to use only enough to properly lubricate the pilot bearing. Excessive amounts of lubricant may work back along the main drive shaft and damage the clutch disc. An oil impregnated bronze bushing has been used in place of the ball bearing in the late TO-30 production. This bushing is to be used for service whenever it is available. The bushing and the ball bearing are interchangeable and whichever is available may be used. Bolt the flywheel to the engine crankshaft and torque the nuts to 30-33 pound-feet.

Clean the grease and other foreign material from the face of the flywheel and clutch pressure plate. Clean and lubricate the spline in the friction disc and the main drive shaft with a dry lubricant, such as DGF 123.

Before assembling the clutch to the flywheel, the face run-out of the flywheel should be checked. Mount a dial indicator on the engine mounting flange and position

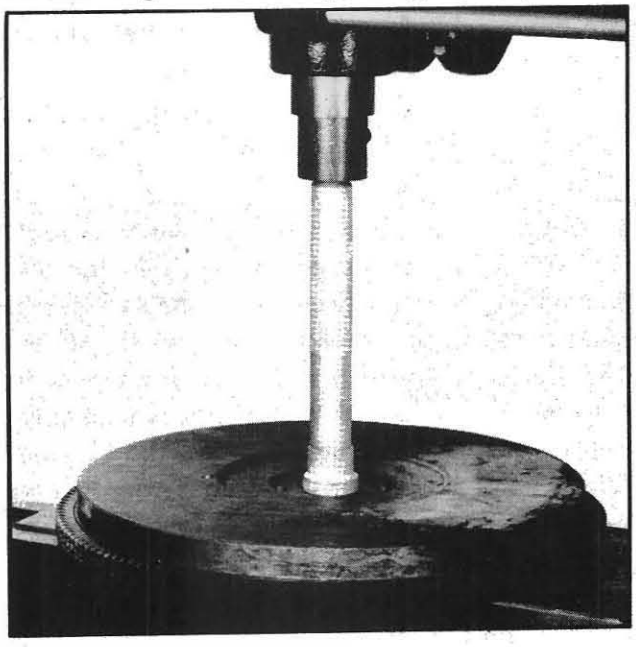


Fig. 135

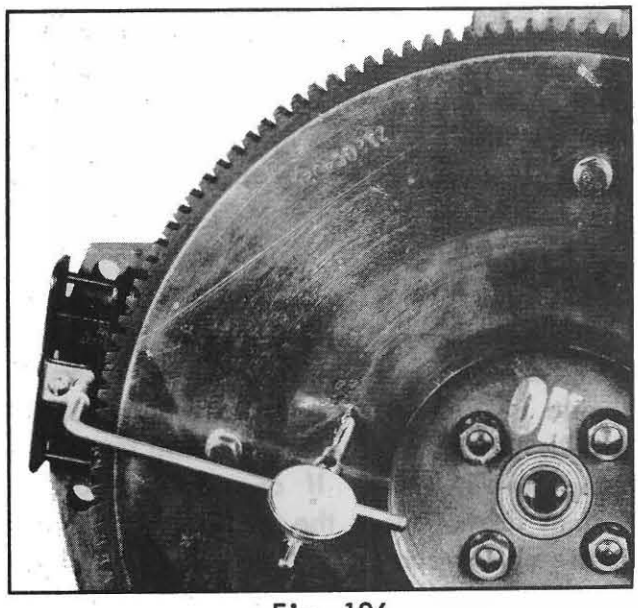


Fig. 136

the indicator in the center of the clutch contact area, as shown in Fig.136. If the total indicator reading exceeds .003 in., the flywheel should either be refaced or replaced with a new one.

Use a clutch pilot tool, SDT-100, to line up the clutch disc before bolting the assembly to the flywheel, see Fig.137. The clutch disc must be installed so that the side having the shorter hub is toward the engine. Secure the clutch cover to the flywheel by tightening each cap screw a turn or two at a time in

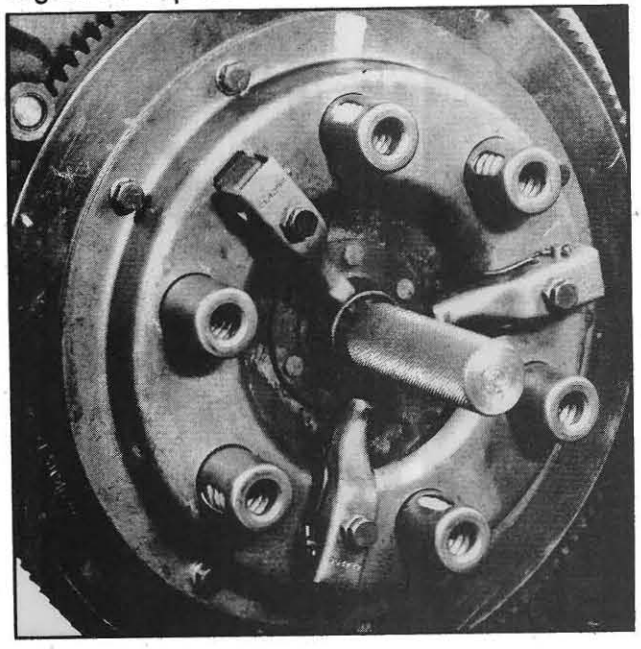


Fig. 137

Clutch	Tractor Model	Pressure Springs			Release Lever Height from flywheel	Facing Kit	
		No.	Color	Working Height & Load		Disc	Part No.
Rockford	TO-20 & TO-30	3	brown	1 13/16" @ 140-150 lbs.	1 13/16"	Standard	TO-7548
		3	lav.	1 13/16" @ 180-190 lbs.		Cushion	TO-7544
	TO-20	6	brown	1 13/16" @ 140-150 lbs.			
New Long	TO-30	6	orange	1 9/16" @ 170-180 lbs.	Not adjustable	Not available use TO-7550-5	
Long	TO-20	6	brown	1 9/16" @ 145-153 lbs.	1 13/16"	Not available	
Borg & Beck	TE-20	9	orange	1 11/16" @ 90-100 lbs.	1 15/16"		59621

Fig. 138

rotation until all are torqued to 10-12 pound-feet. Remove the pilot tool and adjust the clutch release levers as described previously.

LINKAGE

Slide the release bearing from the release bearing hub and inspect the bearing. Remove the release bearing springs from the hub, see Fig.139. Remove and inspect the hub.

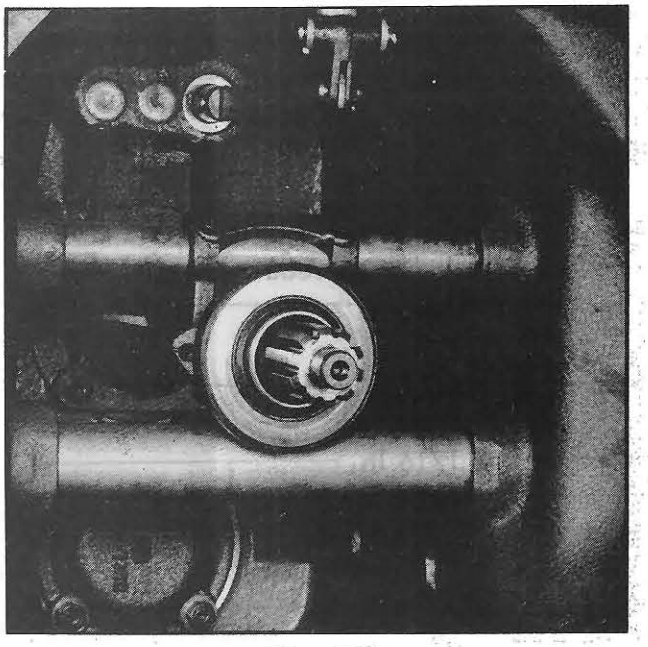


Fig. 139

The clutch throwout bearing and hub on the TO tractor is interchangeable with the bearing and hub on the TE tractor.

Remove the two bolts that hold the clutch release fork to the shaft and withdraw shaft.

Remove both brake rod and yoke assemblies from the arms, remove one brake arm (keyed to shaft) and withdraw shaft.

Inspect both clutch shaft and brake shaft bushings. Renew if damaged or badly worn, see page 124 under "Transmission Housing" for the proper procedure for servicing these bushings.

To make the final assembly of the tractor, follow through the steps listed in the "Tractor Split" in reverse order.

After the tractor is completely reassembled, the clutch pedal must be adjusted. Loosen the pedal clamp bolt and with a spark plug wrench handle in the hole in the end of the clutch shaft, as shown in Fig 140, turn until a free movement of 3/16 in. is obtained, measure movement as shown and tighten the clamp bolt.

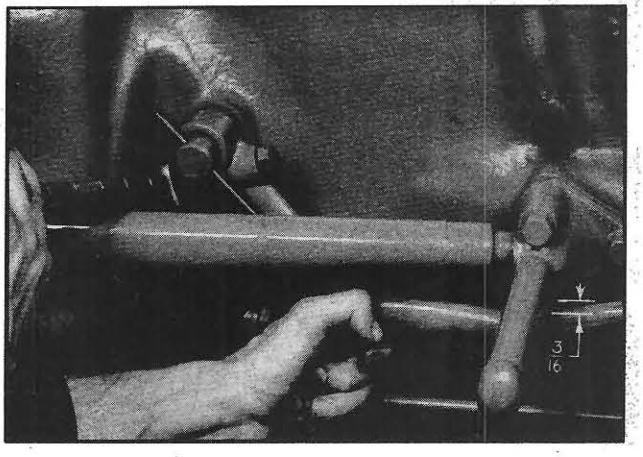


Fig. 140

SPECIFICATIONS

	TO-30 (Z-129)	TO-20 & TE-20 (Z-120)
VALVES		
Intake Valves		
Head Dia.	1.273-1.283 in.	1.010-1.020 in.
Face Angle	30 deg.	45 deg.
Margin	3/64 in.	
Stem Dia.	.3141-.3149 in.	
Overall Length	4 in.	3 31/32 in.
Head Marking	"IN"	
Stem Marking	Z-205	Z-222
Intake Valve Seats		
Seat Angle	30 deg.	45 deg.
Type	Ground in head	
Exhaust Valves		
Head Dia.	1.135-1.145 in.	
Face Angle	44 deg.	45 deg.
Margin	3/64 in.	
Stem Dia.	.3124-.3132 in.	
Overall Length	4 1/16 in.	
Head Marking	"EX"	
Stem Marking	Z-208	Z-203
Exhaust Valve Seats		
Seat Angle	45 deg.	
Type	Insert	
Cutter Dia.	1.261 in.	1.136 in.
Replacement Insert Dia.	1.2635-1.3645 in.	1.1385-1.1395 in.
Allowable Valve Wear		
Min. Stem Dia.	.001 in. less than new	
Max. Face Runout	.002 total indicator reading	
Min. Margin Thickness	1/32 in.	
VALVE GUIDES		
Max. Allowable Internal Dia.	.3177 in.	
VALVE SPRINGS		
Free Length	2 1/16 in.	
47-53 Lb. Load Length	1 45/64 in.	
96-104 Lb. Load Length	1 27/64 in.	
ROCKER ARM SHAFT		
Dia. of Shaft	.622-.623 in.	
Min. Allowable Dia.	.621 in.	
ROCKER ARM BUSHING		
Dia. of Bushing	.624-.625 in.	
Max. Allowable Dia.	.626 in.	

	TO-30 (Z-129)	TO-20 & TE-20 (Z-120)
CYLINDER SLEEVES		
Max. Out-Of-Round	.001 in.	
Taper	.0002-.0015 in.	
Original Dia.	3.250-3.252 in.	3.1875-3.1895 in.
Max. Allowable Dia.	3.262 in.	3.199 in.
PISTONS		
Piston Taper	Bottom dia. .0012 in. greater than top dia.	
Piston Rings		
Side Clearance of Ring in Groove	.006 max.	
End Clearance	.007 min.	
Piston Pin Dia.	.8591-.8593 in. also available in .003 in. oversize	
CRANKSHAFT		
Main Bearing Journal Dia.	2.250-2.249 in.	
Connecting Rod Journal Dia.	1.9375-1.9365 in.	
End Play	.003-.007 in.	
Bearing Oil Clearance	.0015-.0025 in.	
CAMSHAFT		
End Play	.003-.007 in.	
Timing Gear Backlash	.002 in.	
Camshaft Journal		
Front Journal Original Dia.	1.8090-1.8095 in.	
Front Journal Min. Dia.	1.8070 in.	
Center Journal Original Dia.	1.7460-1.7465 in.	
Center Journal Min. Dia.	1.7440 in.	
Rear Journal Original Dia.	1.6835-1.6840 in.	
Rear Journal Min. Dia.	1.6815 in.	
Camshaft Bearing		
Front Bearing	1.8115-1.8125 in.	
Center Bearing	1.7490-1.7500 in.	
Rear Bearing	1.6865-1.6875 in.	

CLUTCH SPECIFICATIONS (See Fig. 138)

TORQUE SPECIFICATIONS	
Cylinder Head Nuts	70-75 lb. ft.
Connecting Rod Studs	40-45 lb. ft.
Main Bearing Cap Screws	85-95 lb. ft.
Camshaft Nut	60-80 lb. ft.
Flywheel Nut	50-55 lb. ft.
Cranking Nut	130-140 lb. ft.
Oil Filter Base Cap Screws	30-35 lb. ft.
Spark Plugs	32 lb. ft.
Clutch Cover Cap Screw	10-12 lb. ft.

SERVICE BULLETINS

No.	Date	Subject

NOTES

ENGINE

SYSTEMS

ENGINE SYSTEMS

Several processes and systems are involved to properly integrate the previously discussed engine components into a functioning unit. The principles of the internal combustion engine necessitate the combination of a lubrication system to reduce friction and prevent wear between the moving parts; a cooling system to dissipate heat created from combustion; a fuel and air system to obtain proper combustion and an electrical system to provide a source of energy for starting and ignition. This section is concerned with the functioning and servicing of these systems.

LUBRICATION

The Ferguson tractor engine uses a full

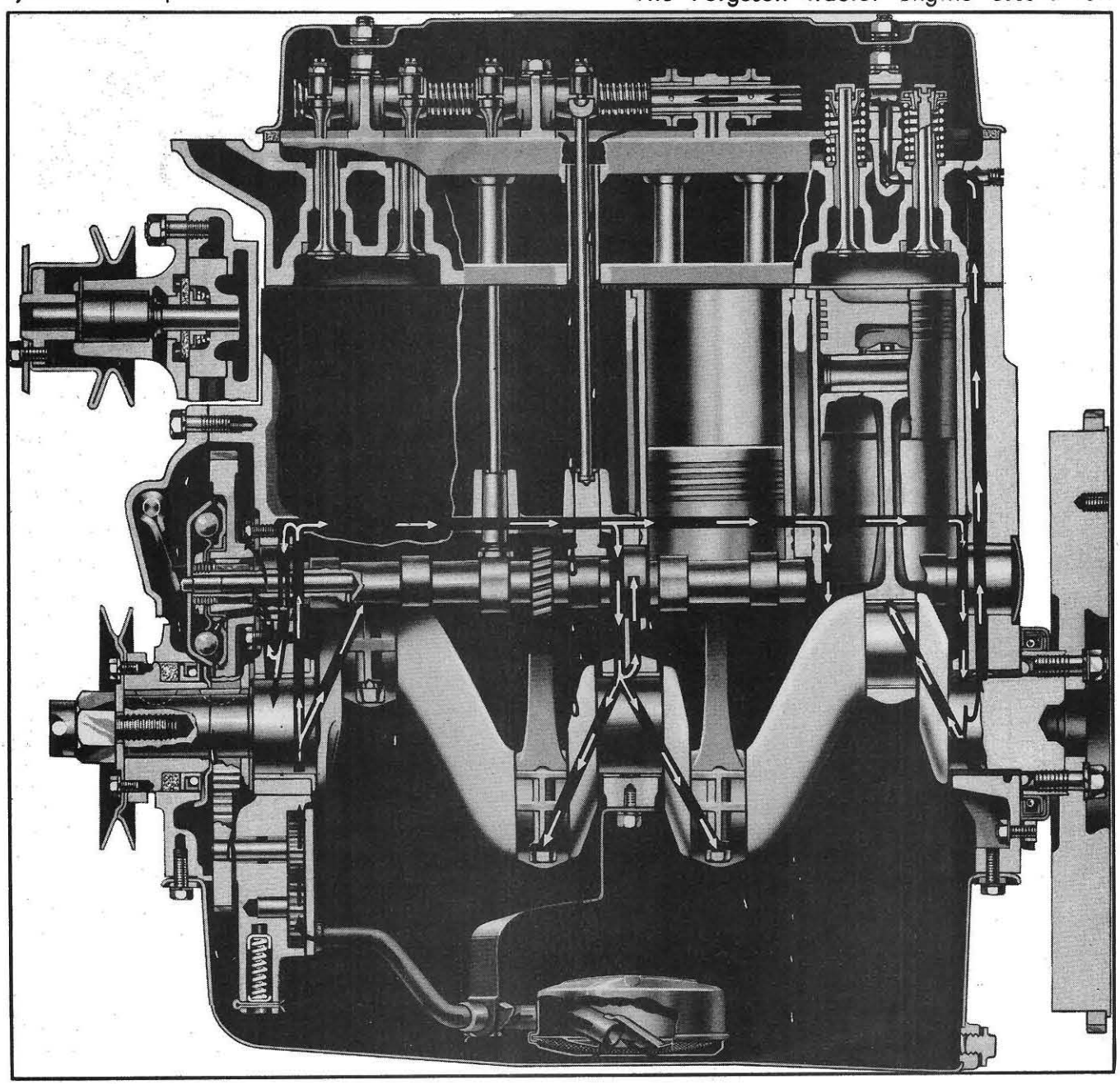


Fig. 141

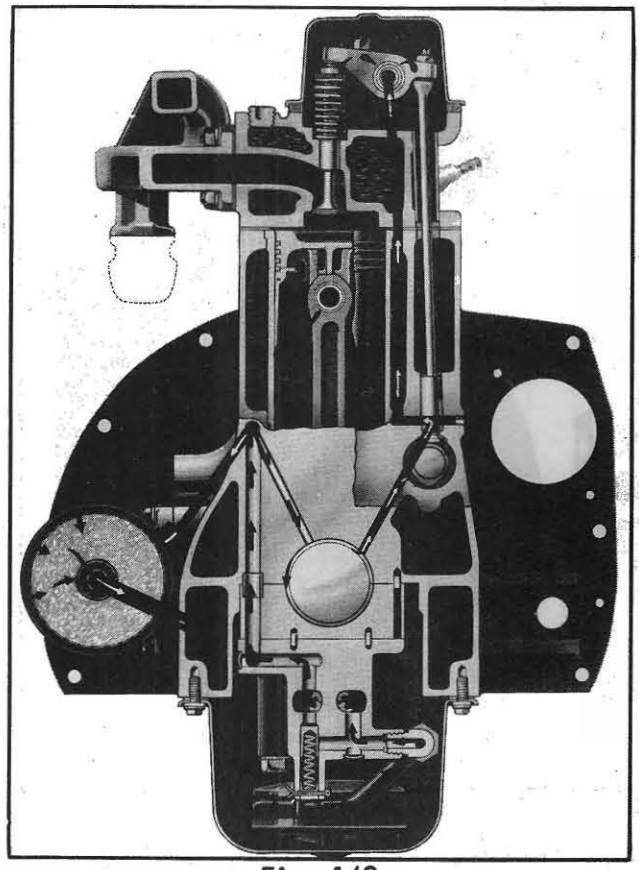


Fig. 142

pressure lubrication system in which oil from the engine crankcase is pumped under pressure to all the bearing surfaces in the engine.

The essential parts of this system are the crankcase and oil supply, oil pump, screened oil intake, drilled oil passages, oil filter, relief valve, pressure gauge and oil level indicator.

In the operation of the TO-30 engine, see Fig. 141 and 142, the oil is drawn into the oil pump through the floating strainer assembly and discharged from the pump under pressure through a drilled passage in the cylinder block to the oil gallery which runs the length of the block. From the front of the oil galley, the oil is directed through a drilled passage to the front main bearing. The oil from the front main bearing follows the drilled passage in the crankshaft to No. 1 connecting rod bearing. The connecting rod has a 1/16 in. squirt hole, the bearing shells are also drilled to match this hole which registers with the oil passage in the crankshaft once each revolution and delivers a squirt of oil, directed upward, to lubricate the wrist pins and cylinder walls. The wrist pins are lubricated by oil holes through the top of the wrist pin boss which collects the oil from the squirt hole and the piston ring groove holes, and directs it to the wrist pin. Oil is also directed from the front main bearing through a drilled passage to the front camshaft bearing where it is metered through a hole in the camshaft retaining plate to the governor and timing gears.

Oil is supplied to the center main bearing through a drilled passage from the oil gallery. From the center main bearing, the oil is directed through a drilled passage to the center camshaft bearing. Oil is delivered to No. 2 and 3 connecting rod bearings through a drilled passage in the crankshaft from the center main bearing.

Oil is delivered through a drilled passage from the oil gallery to the rear main bearing and is further directed to the No. 4 connecting rod bearing through another drilled passage in the crankshaft. From the rear main bearing, the oil is supplied through a drilled passage to the rear camshaft bearing where it is metered through a passage to the rear rocker arm shaft support. The oil is carried through the rocker arm shaft and provides lubrication for the individual rocker arm bushings and for the valves. The oil is returned to the crankcase through the push rod holes and lubricates the cams and tappets as it passes downward.

The oil filter is supplied through a drilled metering passage from the main oil gallery. The filtered oil returns through a drilled passage to the crankcase.

The TO-20 and TE-20 engine lubrication systems are the same as the TO-30 system, with the following exceptions, see Fig. 143.

1. The capacity of the crankcase is six

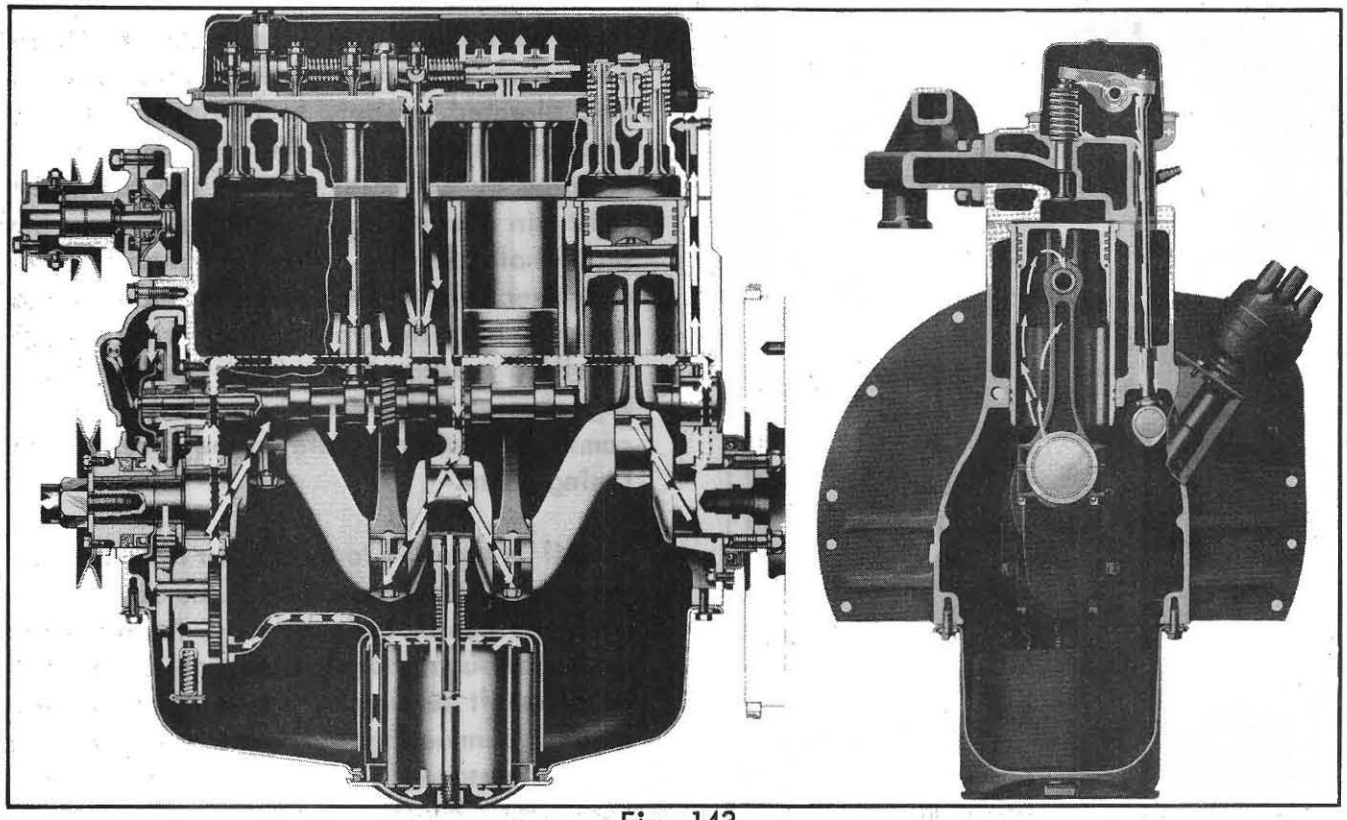


Fig. 143

U.S. quarts as compared to the five U.S. quart capacity of the TO-30 engine.

2. The oil filter is located in the crankcase and is supplied with oil from the center main bearing through a standpipe with two metering holes.

3. Oil is drawn into the pump through the inlet pipe from inside the screen near the bottom of the crankcase.

4. The center camshaft bearing is lubricated by the oil returning from the head through the push rod holes.

OIL PUMP

The oil pump is a positive displacement, single-stage gear-type pump driven by the crankshaft timing gear and bolted to the bottom of No. 1 main bearing cap.

REMOVAL

To remove the oil pump from the TO-30, see Fig.144, proceed as follows:

1. Drain the oil and remove the oil pan.
2. Remove the float assembly and inlet tube.
3. Remove the cap screws retaining the pump body to the block and remove the pump, noting the number of shims present.

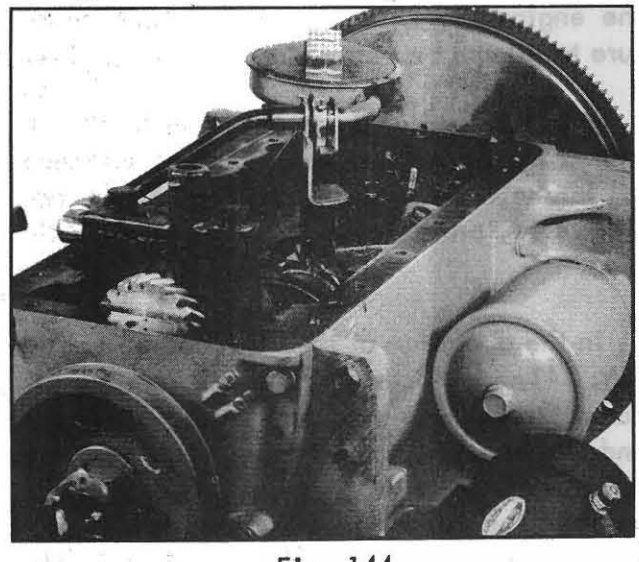


Fig. 144

The oil pump is removed from the TO-20 and TE-20, see Fig.145, by following the procedure outlined below.

1. Drain the oil.
2. Remove the hand hole cover and oil filter.

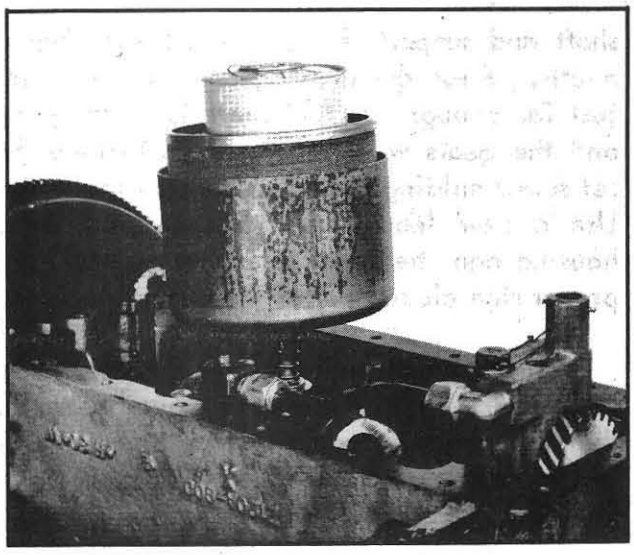


Fig. 145

3. Remove the oil pan, oil strainer and cover.

4. Disconnect the oil inlet tube.

5. Remove the cap screws retaining the pump body to the block and remove the pump, noting the number of shims present.

DISASSEMBLY

To disassemble the oil pump, remove the screws retaining the cover plate and remove the plate. The oil pump idler gear can then be lifted from the shaft. Remove the set screw from the oil pump drive gear and shaft. Set the pump up in a press and use a mandrel to

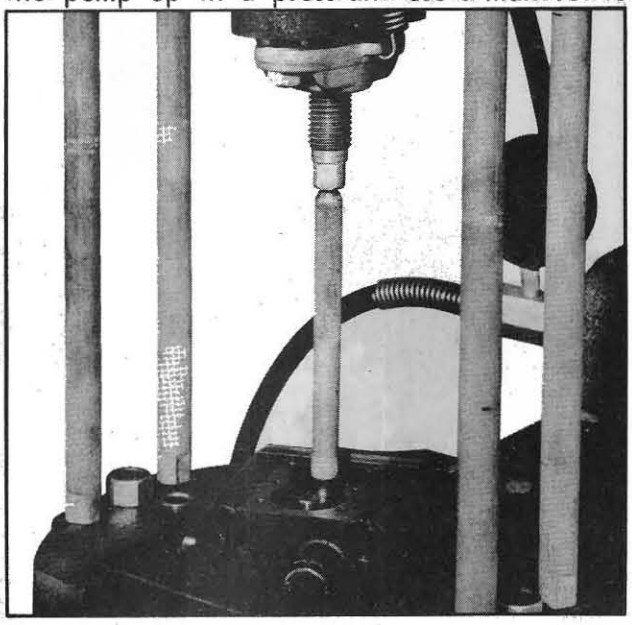


Fig. 146

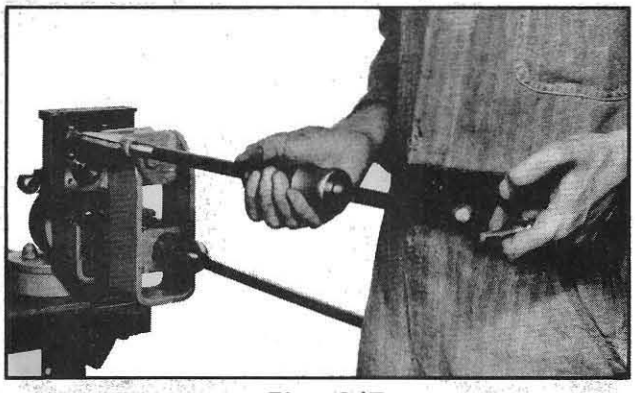


Fig. 147

press the shaft from the gear and housing. The bushings may be removed from the pump housing as shown in Fig.147.

New pre-sized bushings are available for service and can be pressed into the pump housing, using a bushing driver as shown in Fig.146.

INSPECTION

Inspect the pump gears and pump body and replace any defective or badly worn parts. Reassemble the pump gears in the pump body and check the following:

Check the backlash in the pump gears with a dial indicator as shown in Fig.148. The backlash should not exceed .007 in.

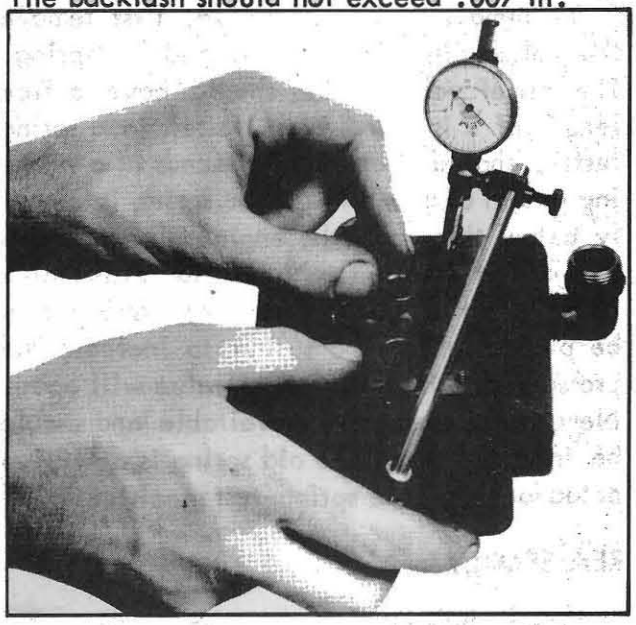


Fig. 148

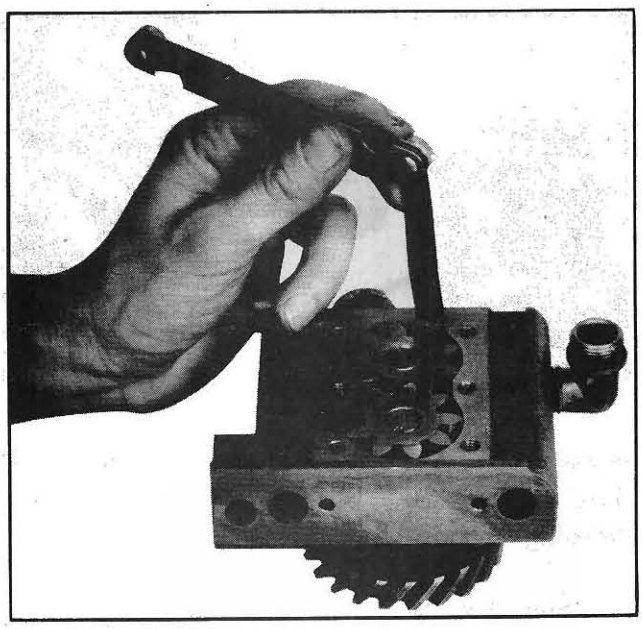


Fig. 149

Check the clearance between the pump body and the outside diameter of the pump gears, see Fig. 149. This clearance should be .003-.004 in. If the clearance exceeds .005 in. with a new drive gear and shaft in place, a new bushing must be pressed into the housing body. Excessive clearance between the pump body and gears may be a factor causing low engine oil pressure.

RELIEF VALVE

To remove the relief valve, first remove the cotter pin, the retainer and the spring. The relief valve spring should have a free length of 2 in. and when tested in a spring tester, should check 8 1/4 pounds at a working length of 1 3/8 in. If the spring is slightly below this or if the engine oil pressure is low and it is suspected that the relief valve is relieving at a lower pressure, spacers may be placed under the spring to increase the pressure at which the relief valve will open. New valve springs are available and should be installed when the old spring is defective or too far below the spring-test specifications.

REASSEMBLY

When reassembling the pump, align the tapped hole in the gear with the one in the shaft and support the gear shaft from underneath. Press the drive gear onto the shaft, just far enough so that there is no end-play and the gears will turn freely. Replace the set screw holding the drive gear on the shaft. Use a new lead gasket between the pump housing and the cover plate to maintain the proper side clearance for the pump gears.

Bolt the pump and front main bearing cap in position, using the shims removed between the pump housing and the bearing cap, and torque the cap screws to 85-95 pound-feet. Lock the cap screws with a wire.

With a dial indicator, check the backlash between the pump drive gear and the crankshaft timing gear as shown in Fig.150. This backlash should be .005-.010 in. If the backlash exceeds .010 in., remove enough shims from between the pump housing and the bearing cap to properly adjust the backlash. If the drive gear has less than .005 in. backlash, it will be necessary to add shims.

Reassemble the oil intake. When replacing the oil strainer and cover assembly on the TO-20 and TE-20 engines, make sure the oil filter cover spring is in place as shown in Fig.145. Also make sure the two felt washers,

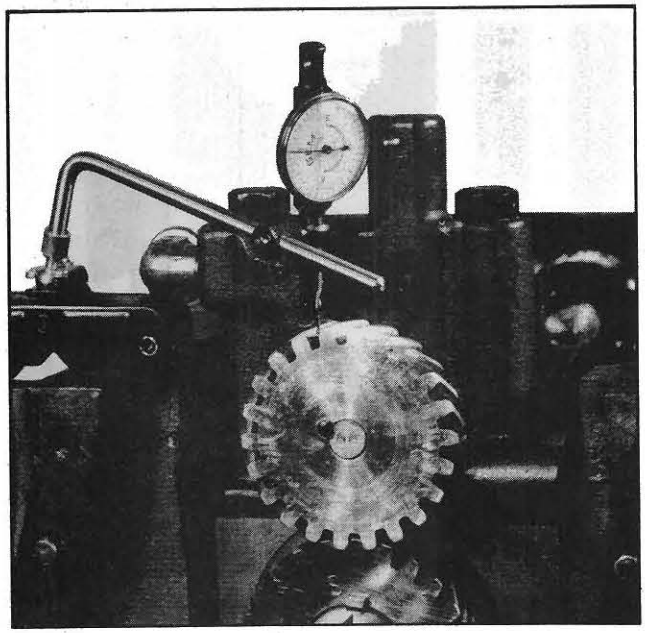


Fig. 150

one on the oil filter tube between the spring and cover, and one on the inlet tube between the cover and the inlet tube support are assembled. Before replacing the oil pan, clean the gasket surfaces and remove any dirt or sludge from the pan. Add the correct amount of engine oil after the pan is assembled. Start the engine and immediately check the oil pressure gauge. If everything is working properly, the oil pressure gauge will register within a very few seconds. If there is no indication of oil pressure, stop the engine and determine the cause. Do not operate the engine unless some pressure is registering on the oil pressure gauge.

If oil pressure is registering on the gauge, run the engine at a fast idle until it is thoroughly warm and again check the oil pressure gauge, the readings should be as follows: 20-30 PSI at 2200 RPM and 15 PSI minimum at idle speed.

After checking the oil pump and relief valve, and properly reconditioning them, low oil pressure may indicate worn bearings or some other similar difficulty.

OIL FILTER

The oil filter housing on the TO-30 tractor engine is bolted to a boss on the rear right side of the engine block.

The oil is delivered to the filter through a drilled metering passage from the main oil gallery and is returned to the crankcase through a cast passage. The oil enters the filter housing around the outside of the filter element and passes through. The clean oil is drained from the center of the filter element and returned to the crankcase.

To remove the filter element, remove the cap screw and cover and withdraw the element, see Fig. 151. Clean the filter housing and install a new Ferguson replacement element, Part No. TO-18662-A, whenever the oil on the dipstick indicates dirt or at every

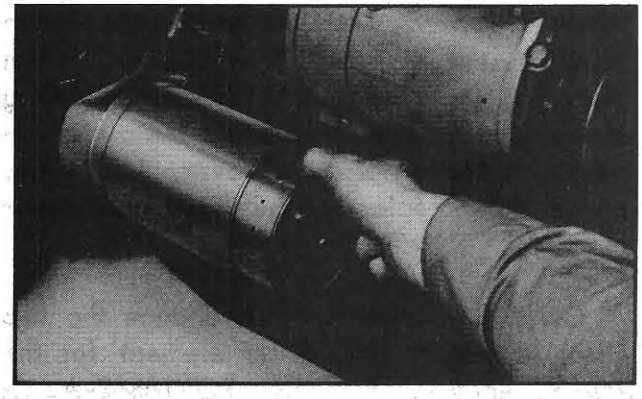


Fig. 151

second oil change. Use the new gaskets packaged with the element. The filter body or housing can be removed from the base by removing the four cap screws inside the filter body.

The oil filter on the TO-20 and the TE-20 is located in the engine oil pan. The oil filter element surrounds the standpipe from the center main bearing cap and fits inside the oil screen. The pump inlet tube draws oil from between the oil filter and the oil screen. Oil is supplied to the filter from the center main bearing and enters the filter element through two metering holes in the standpipe. The movement of the oil through the filter is from the center to the outside.

To remove the oil filter, drain the crankcase, remove the cap screw retaining the cover and remove the cover and filter element, see Fig. 152. The screen assembly and screen cover can be removed through the bottom of the crankcase for cleaning, when the

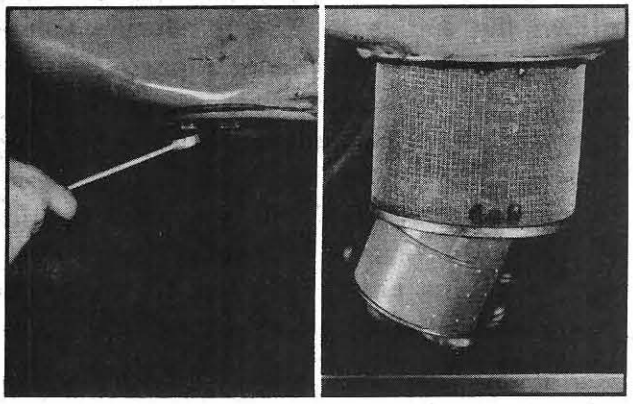


Fig. 152

filter is removed. Install a Ferguson replacement element, Part No. TO-18662-2. When replacing the filter cover, be sure the spring is replaced between the stop on the oil standpipe and the oil strainer cover. Use a new gasket when replacing the hand hole cover assembly.

CAUTION: Do not interchange the two filter elements. The filter element for the TO-30 engine, Part No. TO-18662-A, is designed for oil flow from the outside to the center. The filter element for the TO-20 and TE-20 engines, Part No. TO-18662-2, is designed for oil flow from the center to the outside. If the elements are interchanged in the engines, the relative flow of oil will be reversed and plugging will result.

OIL PRESSURE GUAGE

The oil pressure gauge is located on the instrument panel. The gauge is connected to the main oil galley by an oil pressure tube and fitting threaded into rear right side of the engine block.

Never operate the engine without an oil pressure gauge or with a gauge that is not operating properly. Replace any gauge that is defective. Failure to note oil pressure may result in serious damage to the engine.

CRANKCASE VENTILATION

The engine crankcase is vented through the vent tube in the valve cover. The vent tube allows the engine to "breath" during operation and prevents a build-up of pressure in the crankcase. Improper crankcase ventilation, prevents the condensation from vaporizing and escaping to the atmosphere. This condition will result in oil dilution which creates sludge and in time will cause extensive damage to engine parts. A plugged vent tube can also be the cause of excessive oil consumption.

Whenever the tractor is serviced, the vent tube should be checked, and if necessary removed and cleaned. When the vent tube is replaced, tighten the four mounting nuts to 40-55 pound-inches.

On the TE-20 and early TO-20 tractors, it is possible for a build-up of sludge in the valve chamber to solidly plug the space between the vent baffle and the vent tube. On these tractors the vent tube is welded to the valve cover, see Fig. 153, and it will be necessary to remove the fuel tank and then remove the valve cover for cleaning.

Beginning with engine number Z-120-E-158787, the valve cover has recessed bolt holes and a detachable vent tube. This vent tube can be removed for cleaning without removing the fuel tank.

The newer valve cover, see Fig. 153 may be used to replace the older type, provided the two shorter rocker arm studs are also used.

To guard against oil leaks, always use new gaskets when installing the valve cover.

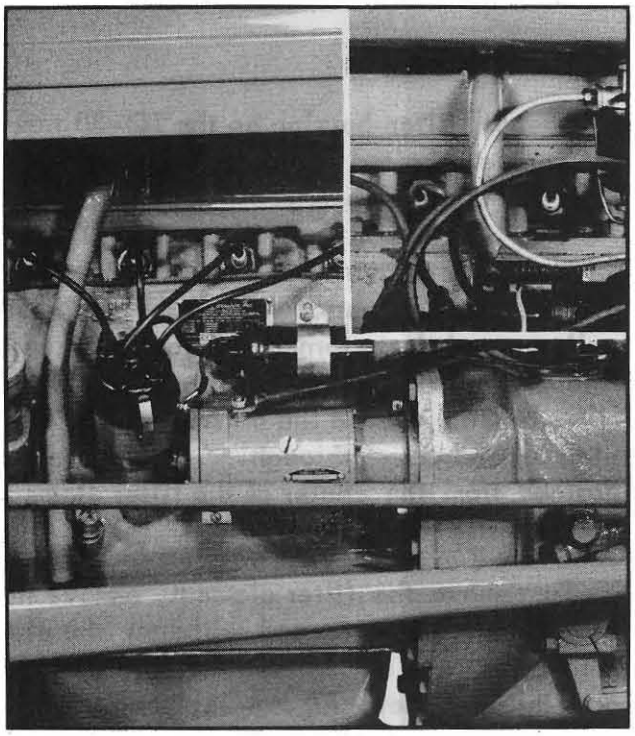


Fig. 153

SERVICE BULLETINS

No.	Date	Subject

NOTES

COOLING

The cooling system consists of a pressure type radiator and cap, fan, water pump, thermostat, hoses, the circulating passages and ten quarts of coolant.

In operation, see Fig.154, coolant in the system is drawn into the pump through the lower radiator hose and is circulated around the wet sleeves, through the passage-ways, into the head. The coolant then circulates through the engine head and passes out through the outlet elbow, through the hose and thermostat and into the top of the radiator where it moves downward and is cooled. When the engine is cold and the thermostat is closed, the coolant cannot move through the upper hose and into the radiator. Beginning with engine Serial Number 124345, a passage has been drilled from the head through the block and into the water pump housing. Before the thermostat opens, the warm water from the head returns through this passage to the pump and is pumped into the block. This recirculation gives a uniform warm-up without hot or cold spots. When the block is uniformly warm, the thermostat opens and allows sufficient flow through the radiator to give the necessary cooling.

On tractors with engine Serial Numbers below 124345, the recirculating passage is not present. Do not attempt to drill the passage in the engine block, the casting is not thick enough for drilling. If the operation of the engine is not satisfactory, a recirculation system can be incorporated by installing a 1/2 in. hose between the water outlet elbow plug and the bottom radiator hose. A special adapter will be needed to replace the 5/8 in.

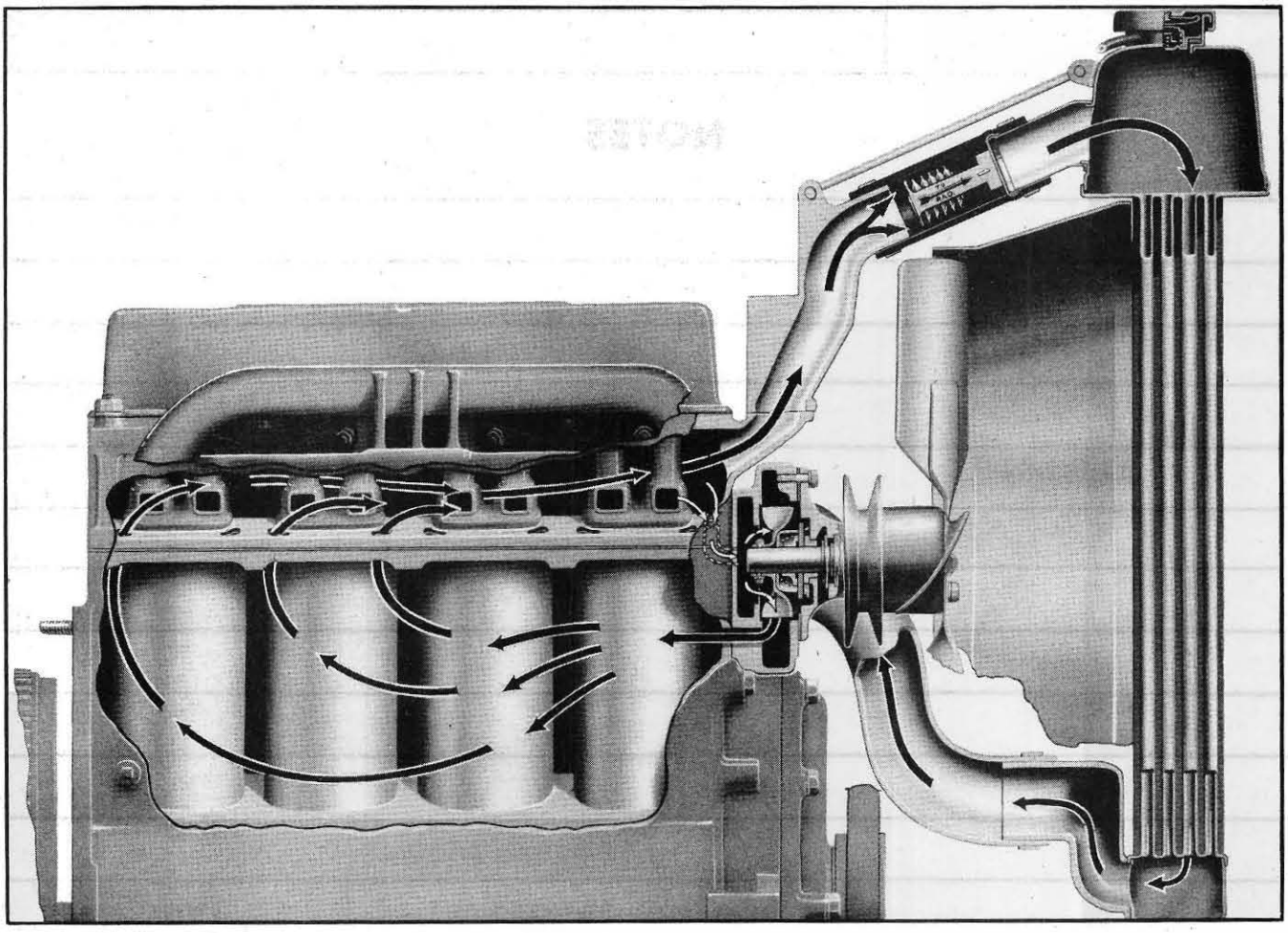


Fig. 154

plug for the hose connection to the outlet elbow. On the bottom radiator hose, a heater hose adapter will be needed to join the two hoses. A shut off should be installed in the 1/2 in. hose for proper metering. During the warm months, it may be necessary to stop this recirculation completely.

RADIATOR

The radiator is a copper tube and fin type in which the coolant enters at the top, passes down through the tubes and is returned to the water pump from the bottom hose outlet. The radiator cap is a spring-loaded, pressure type cap which causes the cooling system of the TO-30 to operate at a pressure of seven pounds per square inch. At this pressure, water must be heated to 232 degrees F. before it will boil. This permits the engine to operate at a higher, more efficient temperature. By raising the boiling temperature of alcohol or other coolant, the pressure system reduces evaporation losses of valuable anti-freeze. The TO-20 and TE-20 tractors have a pressure cap which maintains four pounds per square inch of pressure resulting in a water boiling temperature of 224 degrees F.

REMOVAL

To remove the radiator from the tractor, proceed as follows:

1. Drain the cooling system and remove the hood and grill assembly.
2. Disconnect the upper and lower radiator hose connections and remove the radiator tie rod.
3. Loosen the two cap screws retaining the radiator to the front axle support and remove the radiator.

Note: The radiator is assembled to the tractor in the reverse order of the above steps. The radiator hoses should be inspected and replaced if they show signs of deteriorating.

FLUSHING

If the cooling system has become plugged or partially plugged with loosened rust, sediment or other foreign material, the system should be thoroughly flushed. If reverse pressure flushing equipment is available, proceed as directed by the manufacturer of the equipment. If flushing equipment is not available, take the radiator to a competent radiator repair shop for cleaning.

Note: It is recommended that a good grade of rust-inhibitor be used in the cooling system at all times. To prevent the formation of rust particles so clogging will not result.

WATER PUMP & FAN

The water pump is an impeller type and is driven by the fan belt. The four blade fan is mounted on the pump pulley and the pump and fan are supported by a double row, sealed, pre-lubricated bearing that needs no periodic lubrication. Two types of impellers have been used, a stamped brass type and a cast iron type, see Fig.155. Both impellers contain the seal which is a spring-loaded rubber ring, sealing against the shaft and against a graphite washer. The graphite washer turns

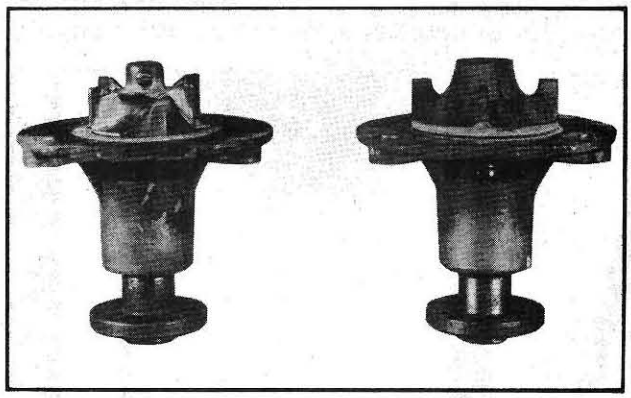


Fig. 155

against a polished face on the pump housing and prevents water from passing out around the shaft. If a leak should develop at the seal, the small brass slinger ring, see Fig.156, prevents the water from moving along the shaft and causing damage to the bearings. Instead the water is thrown against the pump housing and drains out through the drain hole.

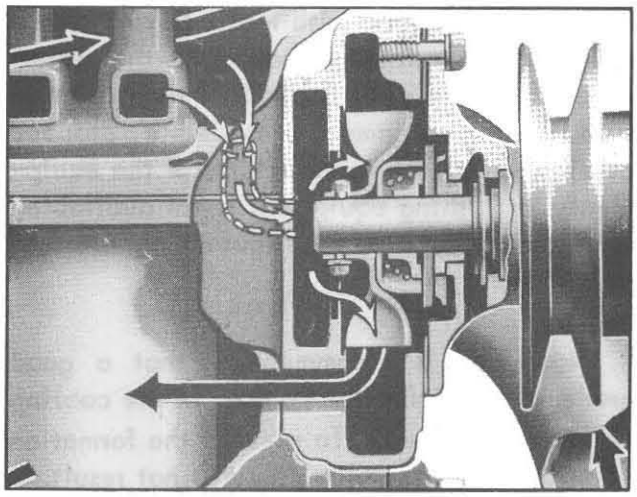


Fig. 156

Water leaking from the drain hole will be the first indication of a worn or defective water pump seal.

REMOVAL

1. Drain the cooling system and remove the lower radiator hose.
2. Remove the fan blade, loosen generator securing bolts, move the generator toward the block and slip the fan belt off the pump pulley.
3. Remove the three nuts retaining the pump shaft support to the pump body and remove the support assembly and pump body.

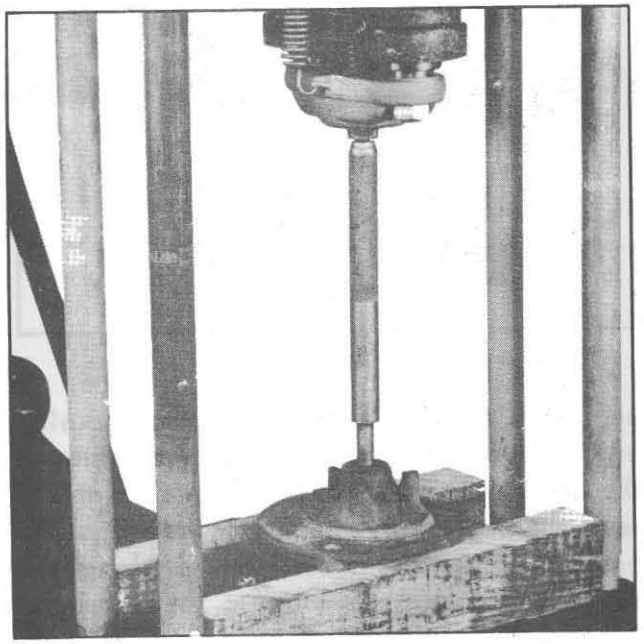


Fig. 157

DISASSEMBLY

To disassemble pump shaft assembly:

1. Remove the snap ring from the front of the housing.
2. After removing the bolt, the stamped type impeller may usually be pried off the shaft with a screwdriver. The cast iron impeller is removed by pressing the shaft out of the impeller as shown in Fig.157.
3. Remove the pump seal assembly.
4. The shaft and bearing assembly can now be pressed out of the shaft support toward the front. If the bearing is pressed out the rear, the inner collar in the shaft support will be broken.

The pump seal is a bushing cast in place in the shaft support housing and cannot be renewed. If the seat is worn uneven or scored, it should be refaced, see Fig.158. If it cannot be refaced satisfactorily, the shaft support housing should be replaced. The pump seal and the pump impeller are individually available as service parts and should be replaced if worn or damaged. The shaft and pre-lubricated bearings are serviced only as an assembly.

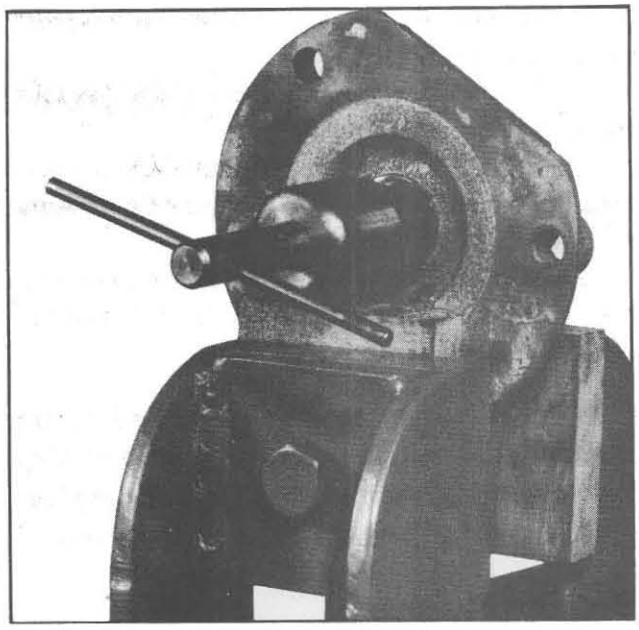


Fig. 158

REASSEMBLY

To reassemble the water pump, press the shaft and bearing assembly into position through the front of the shaft support housing. Replace the snap ring and install the seal and impeller. Always use new gaskets when installing the pump on a tractor.

THERMOSTAT

The thermostat is located in the top radiator hose with the expansion bellows toward the engine. Its purpose is to keep the engine outlet closed and cause the coolant to recirculate through the engine until warm. A sufficient rise in temperature of the circulating coolant will cause the bellows of the thermostat to elongate and open the passage to the radiator. Similarly, a decrease in temperature will cause a shortening of the bellows thus closing the passage to the radiator.

To check the thermostat, place it in a container of water with a thermometer and heat slowly. Watch the thermostat and check the temperature at which the thermostat begins to open and the temperature at which the thermostat is fully open. The thermostat used in Ferguson tractors should begin to open at 155-165 degrees F. and be fully open at 185-195 degrees F. These opening and closing temperatures have been found to give the best engine operating temperatures.

Caution: Never operate the tractor without a thermostat or with one that does not conform to the above specifications.

FAN BELT

After final assembly of the cooling system components, the tension on the fan belt should be checked and adjusted. The correct tension is obtained when 1/2 in. free play exists between the fan pulley and generator pulley as shown in Fig.159.

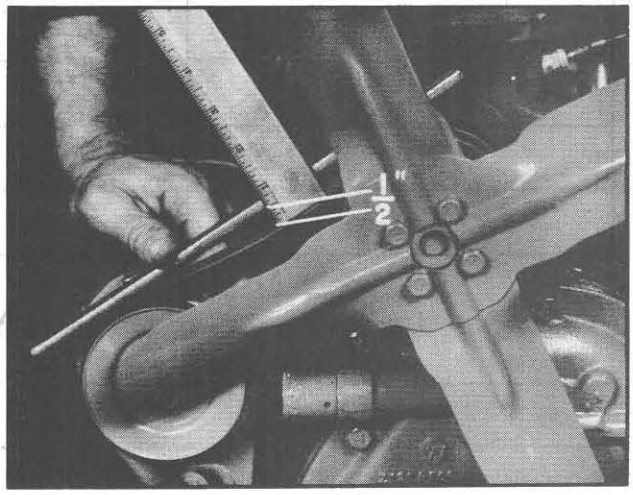


Fig. 159

TROUBLE SHOOTING

TROUBLE	POSSIBLE CAUSE
Engine Overheats	1. Low Water Level
	2. Clogged Radiator Fins
	3. Loose Fan Belt
	4. Collapsed or Damaged Radiator Hose
	5. Defective Thermostat
	6. Clogged Radiator Core and Cooling System
	7. Defective Water Pump

SERVICE BULLETINS

No.	Date	Subject

NOTES

FUEL & AIR

The fuel and air system of the Ferguson tractor engine is composed of the following parts, illustrated in Fig.160, fuel tank, fuel filter assembly and fuel line, air cleaner and air tube and carburetor and intake manifold.

In operation the fuel flows from the fuel tank through the shut off valve, fuel filter assembly and into the fuel line into the carburetor where it mixes with the clean air from the air cleaner. The fuel-air mixture is then drawn into the combustion chamber through the intake manifold.

FUEL TANK

The fuel tank has a capacity of ten U.S. gallons, including a one gallon reserve, and is mounted above the engine but not attached to the hood. The front of the tank is bolted to a bracket on the water outlet elbow and the rear of the tank is bolted to a bracket on the battery platform.

The fuel tank requires little service. Drain and flush the tank periodically and use clean fuel and reasonable care when fueling the tractor. Clean fuel is of prime importance in the proper operation of the fuel system. The fuel tank is equipped with a vented cap which allows air to enter the tank as the fuel is used or allows air and vapors to escape as the fuel becomes warm while the engine is operating.

Two types of fuel tank caps have been used in TO production tractors. The regular cap was used on all TO-20 tractors and many of

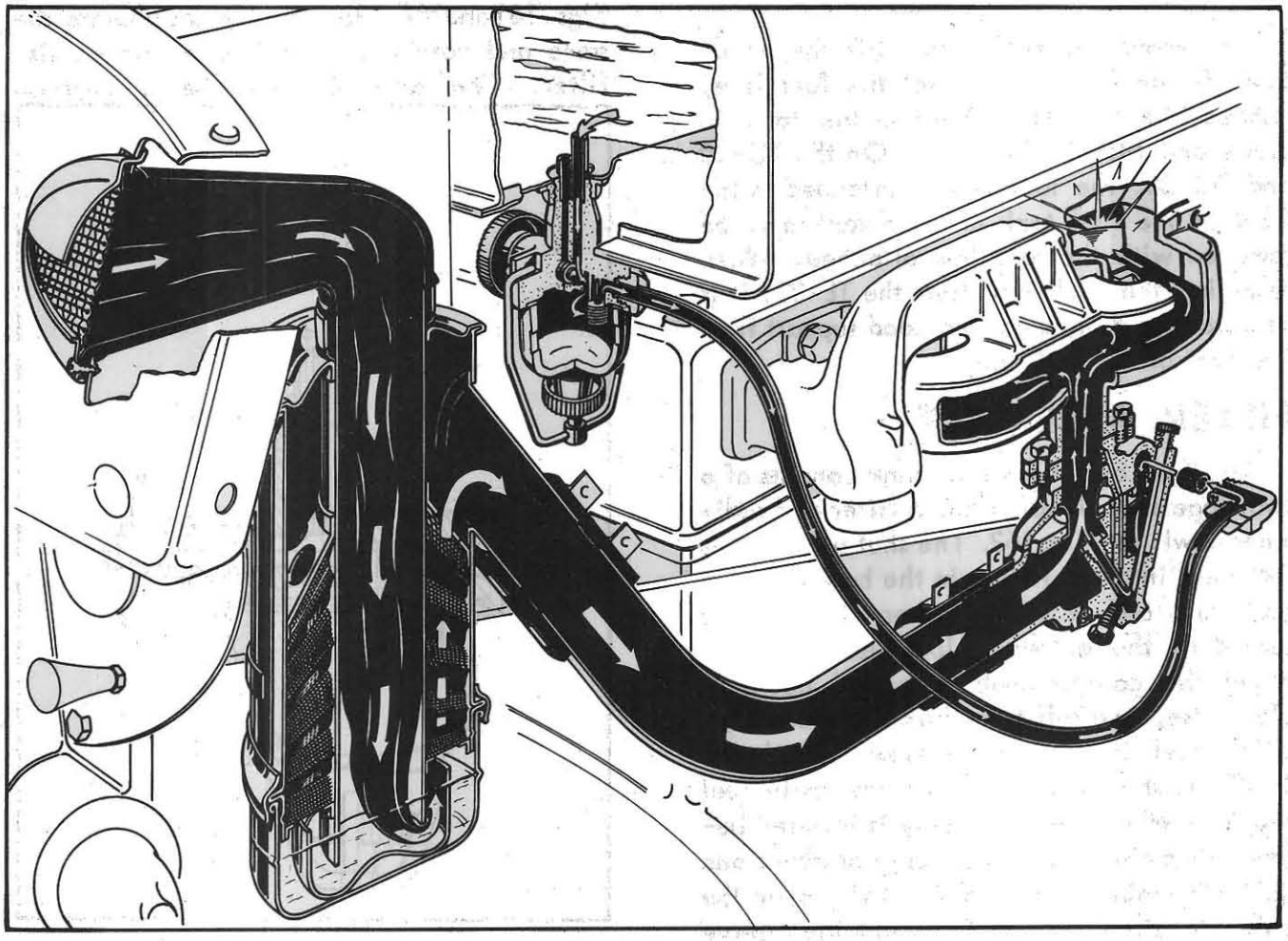


Fig. 160

the early TO 30 tractors. The anti-splash cap is now being used on all production tractors and for service parts. If any TO-20 or TO-30 tractor, equipped with a regular cap, shows that there has been an excess of fuel splashing from the tank, the anti-splash cap should be installed. This cap will not fit the TE-20 tractor fuel tank.

Caution: The engine oil filler cap will fit the fuel tank but for safety's sake, never use or allow an owner to use this cap on the fuel tank. The oil filler cap is not vented and will cause a build-up of pressure as the fuel in the tank becomes warm. This pressure may become great enough to break the glass sediment bowl, and result in a fire and possibly an exploded fuel tank. Always check this and make sure that the correct cap is in place on the fuel tank.

To remove the fuel tank, lift the hood, shut off the fuel, disconnect the fuel line, remove the four bolts holding the tank in place and lift off the tank. On the TO-20 and TO-30, the tool box is attached to the front of the fuel tank and the tank may be removed with the tool box attached. When removing the fuel tank from the TE-20, it is necessary to disconnect the hood support from the front of the fuel tank.

FILTER ASSEMBLY

The fuel outlet from the tank consists of a two stage shut off valve and a filter and sediment bowl, see Fig. 162. The shut off valve is threaded into the fitting in the bottom of the fuel tank and is closed when the knob is turned to the extreme clockwise position. When the control knob is turned counter-clockwise, two full turns from the closed position fuel is allowed to flow through the 1 1/2 in. standpipe. This is the main fuel supply. When the fuel supply is lowered below this point, a reserve supply of about one gallon remains in the tank. Fully open the valve to allow fuel to flow from the reserve supply.

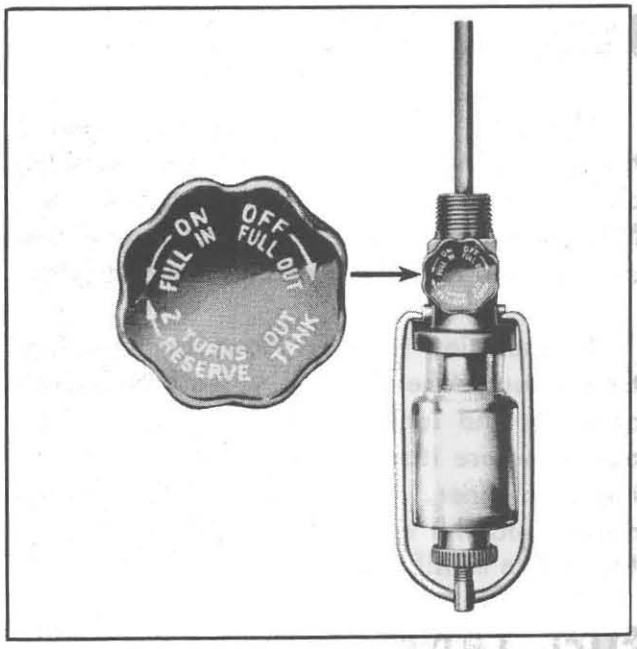


Fig. 161

There were two types of sediment bowl assemblies used on TO tractors, as shown in Figs. 161 and 162. Both assemblies operate the same and both contain the same stacked disc filter. The assembly now being used on

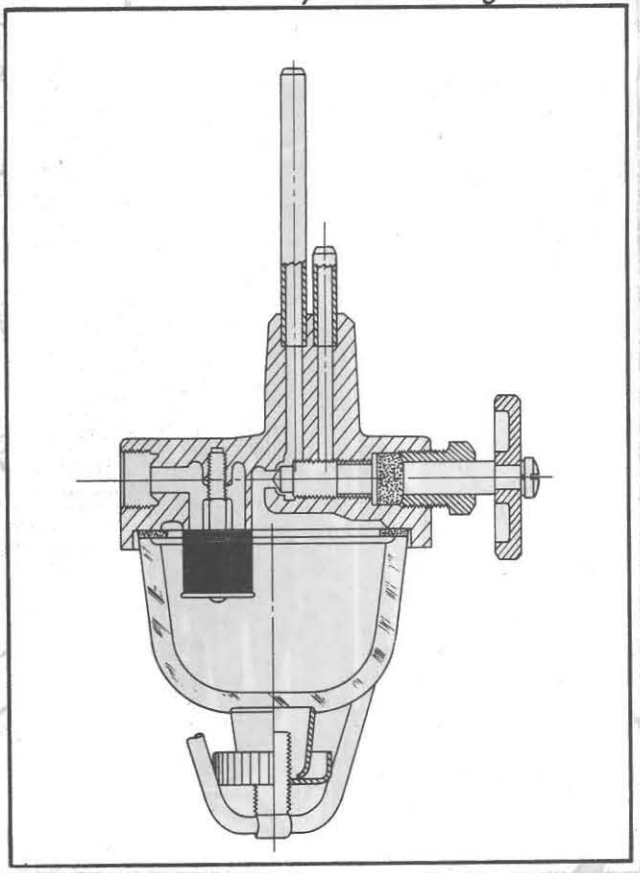


Fig. 162

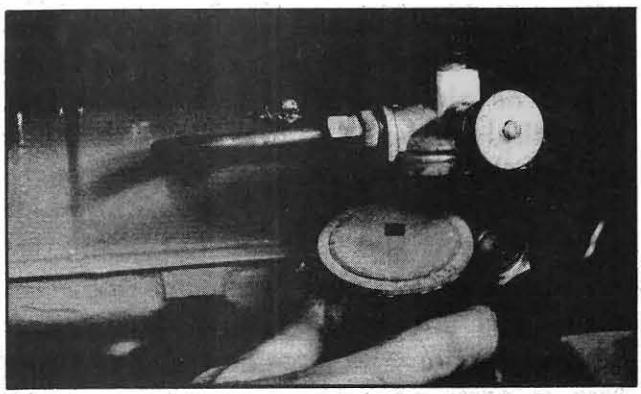


Fig. 163

production tractors may be used to replace those used in early TO-20 production. On the TE-20, the fuel must pass through a fine screen over the standpipe before entering the sediment bowl, see Fig.164. The fuel must then pass through the small flat screen as it leaves the sediment bowl, Fig.163.

The sediment bowl is easily removed by unscrewing the knurled nut at the bottom of the bowl. The stacked disc filter can be unscrewed for cleaning, see Fig.165, and the complete assembly should be washed in a varnish solvent. When replacing the stacked disc filter assembly, tighten only finger-tight. To clean the wire screen over the standpipe of the TE-20, it is necessary to drain the tank and unscrew the valve assembly. If the fuel valve is badly coated with varnish or if the valve or sediment bowl is leaking, the assembly should be removed from the tank, disassembled and immersed in a carburetor cleaner or varnish solvent. Remove the cleaner as recommended by the manufacturer

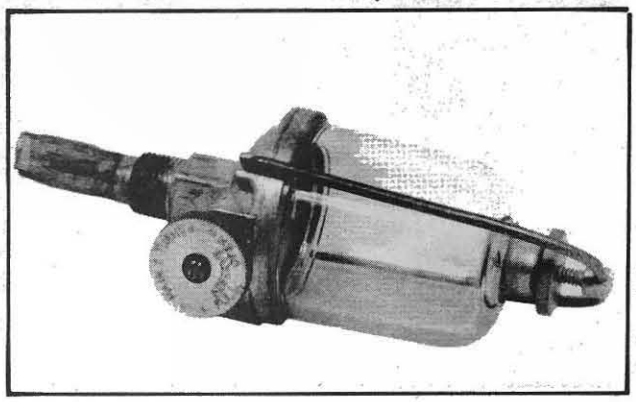


Fig. 164

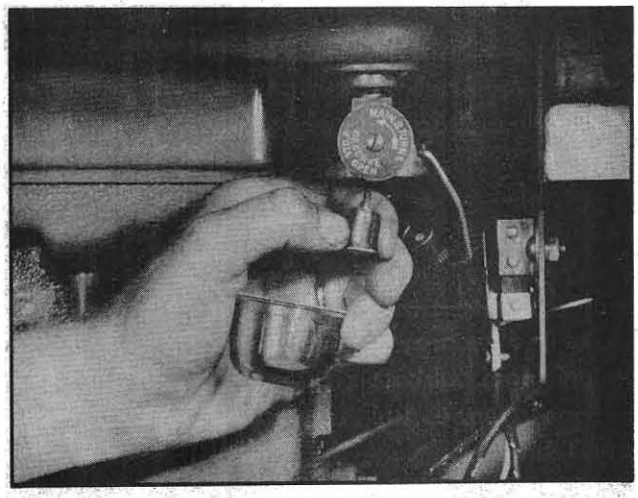


Fig. 165

and blow out all openings and passages in the assembly with compressed air. When reassembling the cleaned unit, always use a new valve stem packing and a new filter body to bowl gasket.

AIR CLEANER

The oil bath air cleaner used on all the Ferguson tractor engines is designed to remove all the foreign material from the air before it reaches the carburetor.

The air cleaner is located at the right-hand side of the engine and is mounted on the battery platform. The air cleaner consists of a pre-cleaning screen, body and cleaning element and the oil container. On the TO-20 and TE-20, the pre-cleaning

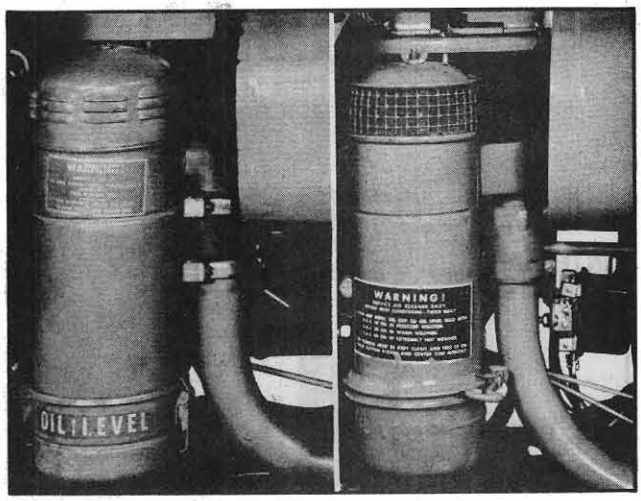


Fig. 166

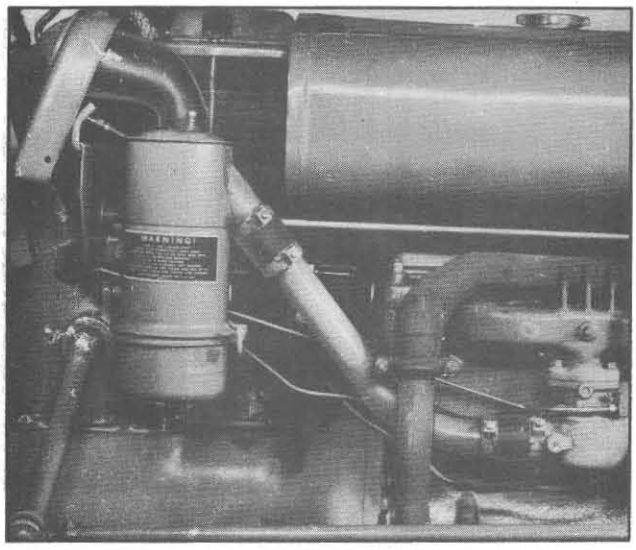


Fig. 167

screen is contained in the top cover of the filter as shown in Fig. 166. The pre-cleaning screen on the TO-30 is mounted in an opening in the instrument panel and the air is conducted through a rubber hose to the top of the air cleaner, see Fig.167.

In operation, the air is drawn in through the pre-cleaning screen and moves down the center tube, see Fig.168. With the correct level of oil in the oil container, the bottom of the center tube is below the level of the oil. The air moving down the center tube must displace the oil from the inner deflector ring of the oil cup in order to pass into the cleaner element. The air, moving at a high velocity, must make a sharp 180 degree turn to pass upward out of the deflector ring. The centrifugal force caused by the sudden change in direction throws a large part of the heavier foreign particles down into the oil. The air moves up through the packing material where the remaining foreign material is removed. The oil that is carried up into the packing by the air washes the dirt from the packing and carries it back down into the oil cup. The clean air passes out through the outlet tube near the top of the air cleaner and is conducted to the carburetor through the air tube.

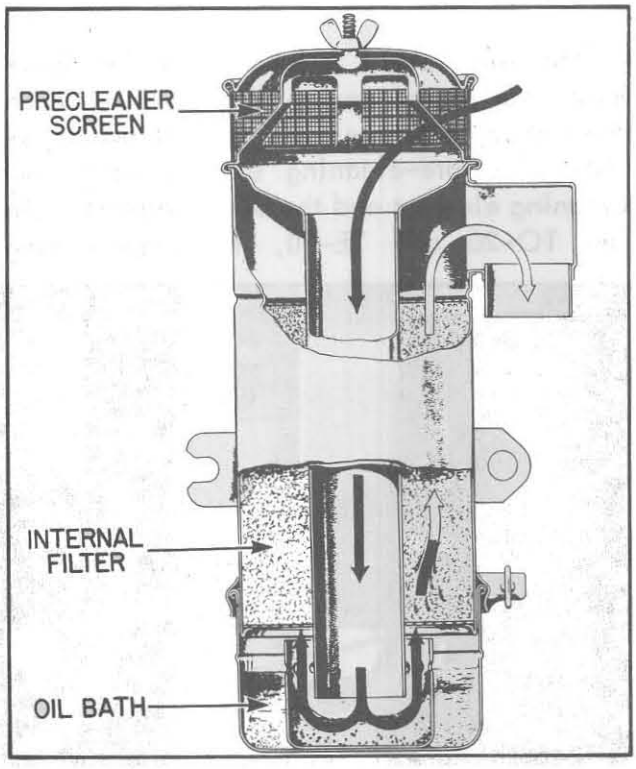


Fig. 168

To service the oil cup, simply loosen the clamp ring assembly and remove the cup, see Fig.169.

Daily the oil container should be removed, cleaned and refilled to the indicated level with the proper grade of oil when operating under average dust conditions. When operating under severe dust conditions, it may be necessary to clean the oil container at more

Fig. 169

frequent intervals. For best results, the oil cup should be cleaned and refilled whenever the accumulation of foreign material reaches a depth of 1/4 in. in the bottom of the cup.

The pre-cleaning screen should be removed and washed in gasoline whenever the oil cup is removed for cleaning. To remove the pre-cleaning screen from the TE-20 or TO-20 air cleaner, lift the hood and remove the cover wing nut and lift off the screen assembly, see Fig.170. To remove the screen from the TO-30, remove the retaining screw and lift off, see Fig.171.

The grade of oil used in the oil cup should be the same or lighter than that used in the engine crankcase. If the oil is too heavy, it will have a choking effect and if it is too light, it will be drawn into the carburetor.

During cold weather, it is recommended No. 10W oil, with 10 percent kerosene added, be used from 0-15 degrees F. Use 10W oil with 25 percent kerosene added in temperatures consistently below zero. To remove the air cleaner body from the tractor, remove the two bolts holding it to the battery platform, and disconnect the air tube from the carburetor. On the TO-30, slip the inlet hose off the top of the cleaner as it is removed.

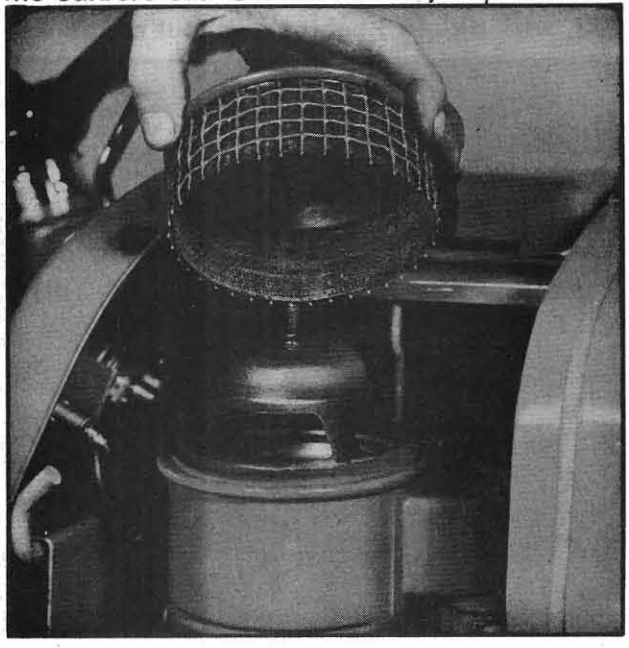


Fig. 170

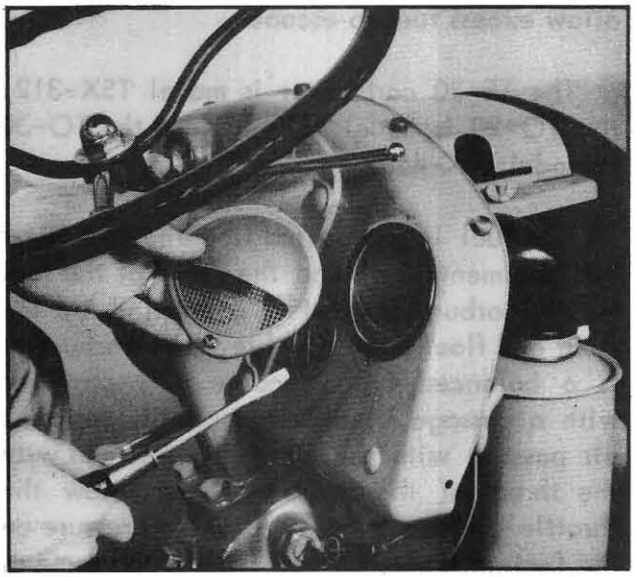


Fig. 171

The air cleaner body should be removed once or twice a year and thoroughly flushed with gasoline. Check the packing to determine the amount of lint or other material that has become lodged there. Remove as much of this material as possible, as it adds resistance to the passage of air and may cause excessive fuel consumption. If the packing is badly plugged, the body of the air cleaner should be replaced. Check the hose connections between the air cleaner and the carburetor. A slight air leak at either hose connection while the engine is operating under dusty conditions will allow enough dust to enter with the air to severely damage the engine in a very short time. Check the short pieces of hose carefully and if there is any doubt as to their condition, the hoses and clamps should be discarded and new ones installed. Check the hose clamps often and keep them tight at all times.

CARBURETOR

The carburetor used on all three tractor engines, TO-30, TO-20 and TE-20 is a balanced up-draft type. These carburetors are fully sealed against the entrance of dust and are provided with porous drain plugs which

allow excess fuel to escape.

The TE-20 carburetor is model TSX-312, the TO-20 is model TSX-361 and the TO-30 is model TSX-458.

The fuel is gravity fed from the fuel filter and sediment bowl and the level of the fuel in the carburetor bowl is controlled by the float and float control valve. The carburetor is a balanced type because it is provided with a passage which connects the entrance air passage with the float chamber and with the throat of the carburetor just below the throttle plate. As a result, the pressure on the fuel in the carburetor bowl is the same as in the air passages of the carburetor. This system maintains a constant air-fuel mixture under all operating conditions.

Most carburetor troubles are a direct result of either or a combination of two things: First, maladjustment. Second, dirt or varnish in the passages of the carburetor. Carburetor adjustments are easily made and should be the first thing checked if the engine is not operating properly. The proper adjustment of the carburetor is outlined in detail on page 89.

The major cause of carburetor trouble is foreign material in the fuel system. It takes only a small piece of lint, dirt or rust to partially plug the main jet and cause the engine to misfire under load or to fail to develop its rated horsepower.

The deposits in the sediment bowl indicate the nature of the material that is plugging the system. In some cases, however, the fuel becomes contaminated with a very fine lint which is difficult to see and which remains suspended in the fuel and will not settle out in the sediment bowl. Whenever carburetor trouble is encountered, or even suspected, the following steps should be taken.

1. Drain the fuel tank and discard the fuel.
2. Remove the carburetor, disassemble and clean it, as outlined on pages 88 and 89, using new gaskets and new parts as necessary, assemble and adjust the carburetor as outlined on pages 89 and 90.
3. Remove the shut off valve and fuel line. Blow out the fuel line with compressed air. Disassemble and clean the shut off valve as outlined on pages 82 and 83.
4. Remove the fuel tank and flush it out thoroughly with clean fuel.
5. Check the air cleaner and make sure it has the right amount and correct weight of clean oil. Also check to see if the screen is clean and that the packing is not plugged.
6. Reassemble the above parts, fill the tank with fresh, clean gasoline and adjust the carburetor as outlined on page 89. Operate the tractor until the engine reaches operating temperature, then adjust the main jet under load.

If the trouble reoccurs after thoroughly cleaning the fuel system as outlined above, shut off the fuel and remove and disassemble the carburetor. Check the main jet carefully and determine if there is any dirt or lint caught in the jet. If there is, this indicates that the fuel or the tank is still contaminated. The addition of a ceramic filter at the entrance to the carburetor, as shown in Fig. 172, will aid in keeping dirt out of the car-

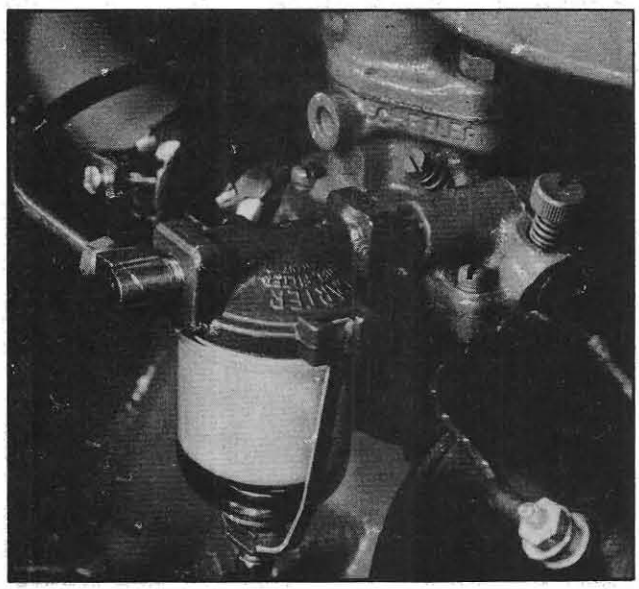


Fig. 172

buretor and extend the time between necessary cleanings.

The functional parts of the carburetor are illustrated in Fig. 173. They are as follows: Choke plate, poppet valve, excess fuel drain, bowl drain plug, metering jet, main jet, main jet adjusting needle, air lightening passage, float, float control valve, idle jet, idle air adjusting screw, venturi and throttle plate.

The carburetor incorporates two fuel systems which are designed to provide the correct fuel and air mixture from idling to top speed and from "no load" to "full load". The two systems are the idle fuel system and the main fuel system.

IDLE FUEL SYSTEM

Referring to Fig. 173, note the idle fuel passage which is drilled from just above the throttle plate down into the fuel bowl. The fixed idle jet is installed in this passage. A second passage is drilled down from the space surrounding the venturi into the fuel passage, just above the idle jet. The idle air adjusting needle is seated in this passage and controls the amount of air entering the idle system. Note also that there is a second passage drilled from just below the throttle plate, to the idle passage.

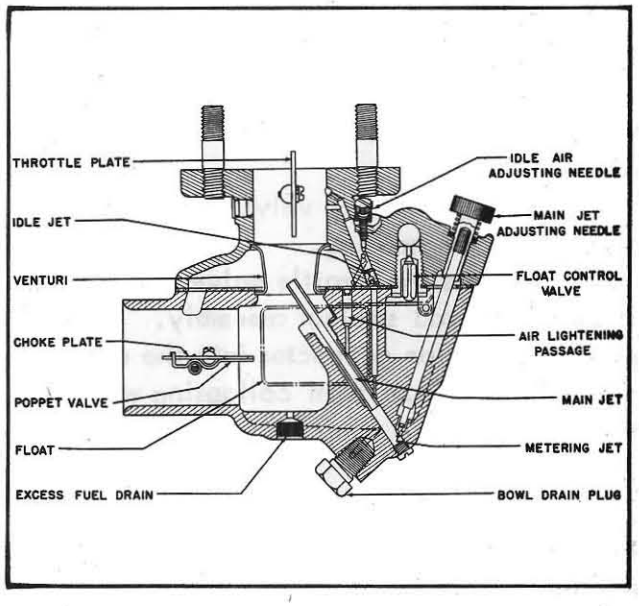


Fig. 173

With the engine running at idle speed, the throttle plate will be in a closed position. The high vacuum on the engine side of the throttle plate causes fuel to be drawn up through the idle fuel passage, through the fixed metering jet where it is broken into a finely divided state and mixed with the idle air around the air adjusting needle. Additional air is added to the mixture from the passage drilled below the throttle plate as the fuel and air passes into the intake manifold through the passage above the throttle plate. The amount of fuel entering the idle system is controlled by the fixed metering jet and cannot be adjusted. The adjustment is made in the amount of air that passes by the idle air adjusting needle. The proper method of adjusting the idle air will be covered in the section "Adjustments" on page 90.

After the idle air has been adjusted to give the proper fuel-air proportions for low engine RPM and the throttle plate begins to open, the sudden rush or air past the edges of the throttle plate cuts down the vacuum and tends to upset the air-fuel ratio. This is offset by the fact that the passage which was below the throttle plate and allowed air to pass into the idling passage, is now above the throttle plate, see Fig.173. This lower passage now, instead of supplying air to the idle system, is subjected to the same vacuum as the upper passage and helps draw up additional fuel to maintain the air-fuel ratio until the main fuel system begins to function.

MAIN FUEL SYSTEM

The principle upon which the operation of the main fuel system depends is the Venturi principle, named for the man who discovered it. The Venturi principle states, that in an air passage of variable cross section, the quantity of air which passes any section in a given time is the same, but its velocity is inversely proportional to the areas of the sec-

tions. The points of high velocity are points of low pressure and the points of low velocity are points of high pressure. The pressure is greatest at the largest cross section and least at the smallest cross section.

The venturi is simply a restriction made in the air passage to create a low pressure and high velocity in the passage. The main jet is located at the point of least cross section.

In operation, the air passes through the carburetor in large volume and at rather high velocity, see Fig.173. As the air passes through the venturi, the velocity increases with a resulting drop in pressure. The pressure on the fuel bowl is the same as that in the air passage before and after the air passes through the venturi, since it is connected to these points by drilled air passages. The difference in pressure on the fuel in the fuel bowl and at the main jet in the venturi causes the fuel to flow from the main jet and mix with the passing air. The amount of fuel that flows into the fuel well is controlled by the main jet adjusting needle. The maximum amount of fuel that can enter the main jet is controlled by the metering orfice.

Note in Fig.173, the drilled passage from the space surrounding the venturi to the main jet, marked "Air Lightening Passage". Air is drawn in through this passage out of the main jet with the fuel. This aids in the fuel flow and in atomizing the fuel as it comes from the jet.

CHOKE

The choke is a manually controlled valve that shuts off the main supply of air at the carburetor inlet, admitting air only through the spring loaded poppet valve and providing an easily ignited rich mixture. This is of vital importance in starting the engine, especially in cold weather.

Closing the choke shuts off the main supply of air and brings the vacuum from above the throttle plate down into the carburetor. The air balancing passage, the passage connecting the air inlet to the float chamber, allows air from outside the choke to pass into the float chamber. The pressure on the fuel in the float chamber forces fuel up through the jet, where it mixes with the air entering through the poppet valve, making a very rich air-fuel mixture.

DISASSEMBLY

Before attempting to disassemble the carburetor, shut off the fuel at the fuel valve and drain the carburetor bowl. Remove the air intake hose, choke rod, governor-to-carburetor control rod and remove the nuts from the studs holding the carburetor to the intake manifold and remove the carburetor. To disassemble the carburetor, proceed as follows:

1. Remove the main jet adjusting screw to avoid damaging the adjusting screw when the body of the carburetor is separated.
2. Remove the four screws holding the upper and lower parts together and separate the two parts.
3. Pull the hinge pin and remove the float; the float needle valve will now drop out.
4. Remove the float valve seat using a wide screwdriver.
5. Remove the main discharge tube, using a 3/8 in. thin-walled, deep socket.
6. Remove the two screws from the choke valve shaft and pull the choke valve out with pliers.
7. Slide the choke valve shaft and return spring from the housing.
8. Remove the throttle valve and the fuel inlet elbow and strainer assembly. Screw a pipe plug or pipe connector into the elbow to prevent the elbow from collapsing when unscrewing it with a wrench.

After the disassembly, all the parts except the gaskets should be immersed in a suitable carburetor cleaner or varnish solvent until all deposits are removed. Remove the cleaner as

recommended by the manufacturer and blow out all the openings and passages in the carburetor with compressed air.

CAUTION: Never attempt to clean or "blow out" a carburetor without completely disassembling it. Blowing compressed air through the elbow and strainer will serve only to rearrange any loose dirt or deposits that may be in the strainer screen or in the carburetor bowl and may plug small passages even tighter.

INSPECTION

Inspect all parts and replace those that are worn or defective. Make sure that the small spring that holds the poppet valve closed is in place on the choke valve and is in good condition. Note the dust seal on the choke shaft. The seal is not sold as a service item since the choke is not operated enough to produce a great deal of wear.

The dust seal on the throttle shaft is sold as a service item and should be replaced if it does not securely seal on the shaft. If this seal is worn and leaks, dust may be drawn into the carburetor and pass into the engine.

Inspect the float valve and valve seat and replace them if the valve is not seating properly.

REASSEMBLY

Reassemble the carburetor in the reverse order of the steps in the disassembly. Always use new gaskets after cleaning carburetor.

After completing the assembly of the top half of the carburetor, the float level should be checked. The correct setting is 9/32 in. from the surface of the gasket to the top of the float. Hold the carburetor upside down and make the measurement as shown in Fig. 174. Adjustments are made in the float level by bending the float hinge in the required direction.

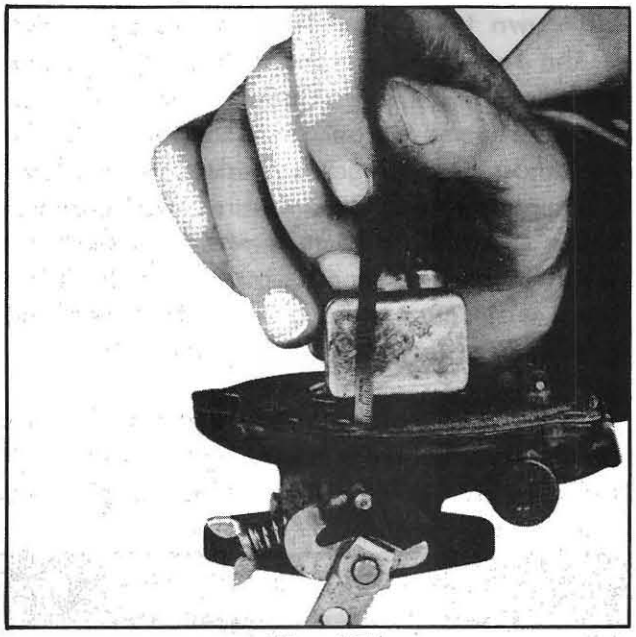


Fig. 174

Complete the assembly of the carburetor and install on the tractor.

ADJUSTMENTS

Make the following adjustments before turning on the fuel. Remove the drain plug and attach a rubber tube and glass tube as shown in Fig.175. Hold the top of the glass tube just above the gasket level and turn on the fuel. Measure the distance from the gas-

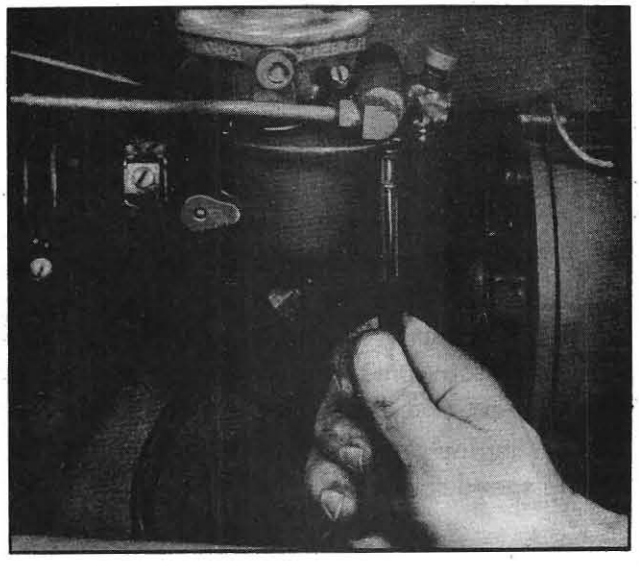


Fig. 175

ket down to the fuel level in the glass tube. If the fuel level is more than 1/16 in. above or below the 1/2 in. mark, the carburetor should be removed and the float level adjusted by bending the hinge as needed. A low level will cause a lean fuel mixture, will probably cause the engine to miss and most certainly result in a loss of engine power. A high fuel level will cause the carburetor to "flood" resulting in a very rich fuel-air mixture.

Set the idle air adjusting screw at 7/8 of a turn open. Set main adjusting screw at 1 1/4 turns open, see Fig. 176. Start engine and allow it to warm up.

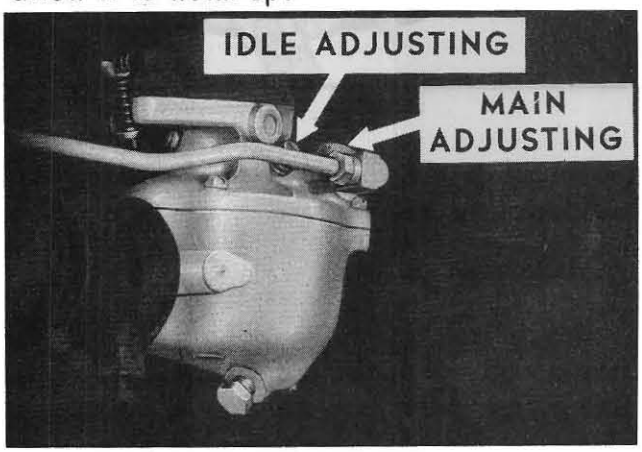


Fig. 176

After the engine reaches the operating temperature, slow to idle speed and adjust idle air adjusting screw until engine operates smoothly. Using a tachometer, set the screw on the throttle shaft arm so the engine idles at 400 RPM.

To make the idle adjustment by the manifold vacuum, remove the plug from the intake manifold and attach the vacuum gauge, see Fig. 177. Start and operate the engine at idle speed. Turn the idle adjusting screw in until the vacuum reading decreases, then turn the screw out until the vacuum gauge gives the highest and most constant reading. Readjust engine speed to 400 RPM by turning idling speed screw.

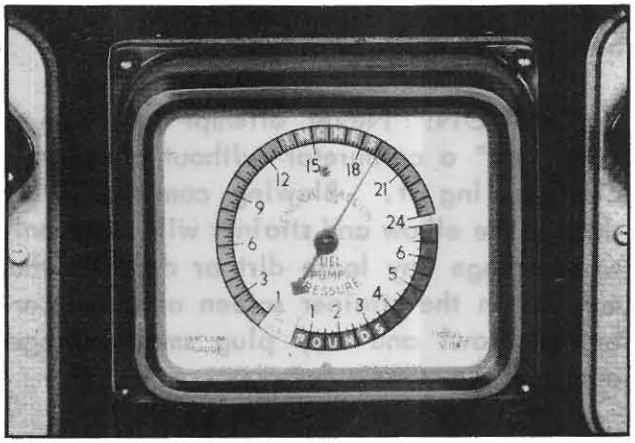


Fig. 177

The main jet setting is approximately 1 1/4 turns open. This should be checked under load however. With the tractor under normal load, quickly move the throttle from half open to the full open position. If the engine coughs or stalls, the mixture is too lean. Open the main jet until the engine responds immediately to increase acceleration and runs smoothly and evenly. The main jet must never be set at less than one full turn open, regardless of the load or operating conditions. An excessively lean fuel mixture will rapidly burn the valves and result in extensive and costly repairs.

MANIFOLD

The intake and exhaust manifolds are cast together and need very little service. The manifold should be inspected for cracks and leaks and new gaskets should be used when the manifold is removed and replaced. Inspect the gasket contacting faces for warpage and evidence of leaks or blowby. A leak at any of the intake port gaskets is very serious since it not only upsets the mixture and requires an uneconomical carburetor adjustment but also permits fine abrasive dust to be drawn into the engine which results in premature and excessive wear.

SERVICE BULLETINS

No.	Date	Subject

NOTES

ELECTRICAL

The electrical system of the Ferguson tractor is composed of a storage battery, starting motor and switch; generator and voltage regulator; coil, distributor and spark plugs; ignition switch; ammeter or warning light and the necessary wiring. These components are discussed in the text below, with the exception of the electrical tests. The reader is referred to the On-The-Farm Service Unit Manual for the Electrical System diagnosis.

BATTERY

The Ferguson battery used in the TO-30, TO-20 and TE-20 tractors is a 6-volt, 80 ampre-hour lead-acid storage battery and is positively grounded to the tractor frame. The battery supplies the necessary electrical energy to the starting motor and ignition system for starting purposes and also suppliments the generator charging rate when the load demands placed upon it are greater than the generator output.

The physical condition of the battery is an important factor in the amount of electrical energy available and also battery life. If the case is wet and dirty, surface discharge will result. To clean, wash the top with a soda solution.

Caution: Care should be exercised to prevent the soda from entering the vent holes as a neutralization effect with the electrolyte will result.

A cracked case of soft sealing compound is an indication of an excessive charging rate and overheating.

A cracked or missing cap will allow foreign material to enter the cells and may cause shorting. A plugged cap will prevent the escape of gas and cause damage.

If the battery carrier has been installed with its top tightened down excessively, expansion due to higher temperatures will be restricted and damage may result.

The battery cables and connections should be inspected for frays, wear and tightness.

Examine the level of the electrolyte. The level should be 1/4-3/8 in. above the surface of the cells to obtain accurate specific gravity readings.

The specific gravity measures the degree of charge in the battery. The state of charge as indicated by the specific gravity readings is given below for both the 1.280 and 1.260 fully charged batteries. The readings are based on a 20 hour discharge rate.

100% Charged	1.280	1.260
75% "	1.230	1.220
50% "	1.180	1.170
25% "	1.130	1.120
Discharged	1.080	1.070

Note: TO-30 tractors are now being equipped with fully charged batteries having a specific gravity of 1.260. These batteries are clearly designated by a marking on the cell connector.

STARTER Delco-Remy

The starting motor on the Ferguson TO-20 and TO-30 tractors is a Delco-Remy motor with a Bendix Drive, see Fig. 178. The motor is a 4-pole, 4-field, 6-volt unit with a clockwise rotation when viewed from the drive end. The armature shaft rotates in two oilless bushings, one at the commutator end and one in the end of the drive housing. The Bendix Drive is keyed to the armature shaft and located by a screw pin. The pinion is mounted on a threaded sleeve in such a way that when the shaft revolves, the threaded sleeve turns in the gear, causing the gear to move along the shaft and mesh with the teeth of the flywheel. As the engine starts to run under its own power, the flywheel drives the Bendix gear at a higher speed than the threaded sleeve is revolving, causing the gear to move

away from the flywheel and disengage. The heavy drive spring is arranged to take the sudden shock when the Bendix gear meshes with the flywheel.

It is recommended that whenever the brushes require replacing, the starting motor be disassembled and thoroughly cleaned. Since the commutator is almost inaccessable through the cover band openings, it is impossible to effectively use a brush seating stone to seat the new brushes.

The Bendix Drive should be inspected and any worn or damaged parts should be replaced. This drive should be thoroughly cleaned and oiled lightly before reinstalling.

REMOVAL & DISASSEMBLY

To remove the starter:

1. Disconnect the cable from the starting motor terminal.
2. Remove the two cap screws that retain the starting motor drive housing to the engine block and remove the assembly.

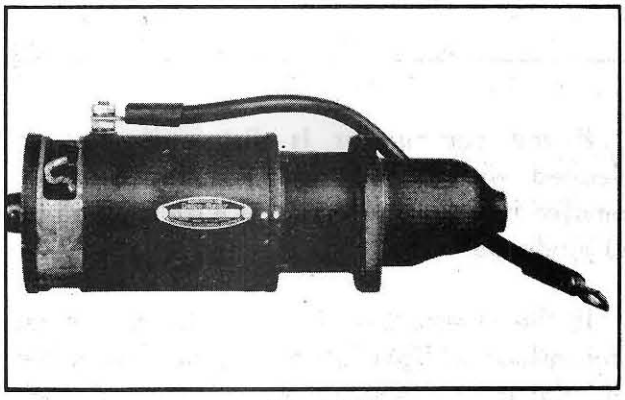


Fig. 178

To disassemble the starting motor, proceed as follows:

1. Loosen the screw and remove the cover band.
2. Remove the two end plate retaining screws. Loosen the two screws and remove the field leads from the brushes. The commutator end can then be slipped off.
3. Mark the drive housing and the motor housing with a chisel or center punch to show the correct position for replacing, see Fig.178.

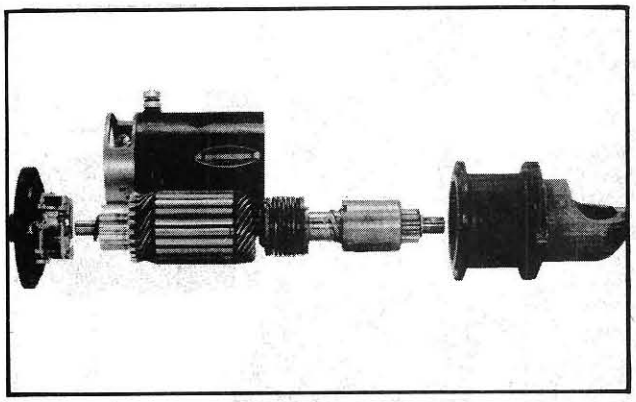


Fig. 179

Remove the screws holding the drive housing to the motor housing. The drive housing and armature can then be removed. The component parts of the starting motor are shown in their relative positions in Fig. 179.

4. Remove the snap ring from the pinion and barrel assembly and remove the thrust washer and pinion and barrel assembly. The remainder of the Bendix Drive can be removed from the armature shaft by moving the lock ring until the pilot screw is exposed, compressing the spring and anchor plate and removing the screw, see Fig. 180. The drive assembly can then be slipped off the shaft.

INSPECTION & REPAIR

Inspect the condition of the fiber thrust washer in the starter drive shaft assembly. A thin steel washer should be present to protect the fiber washer. All starter units with a Serial Number 2L13 and later incorporated

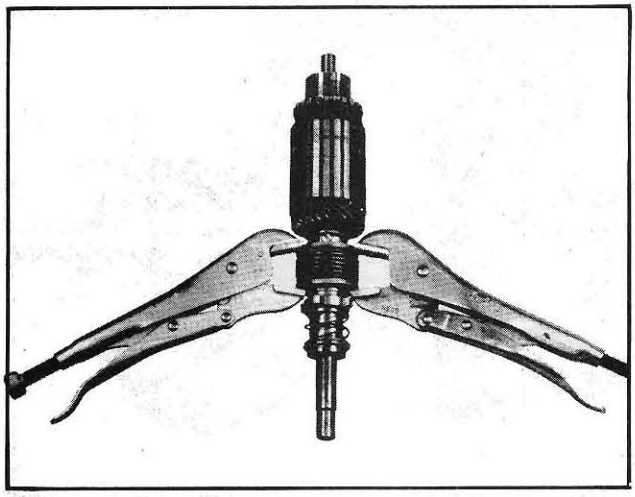


Fig. 180

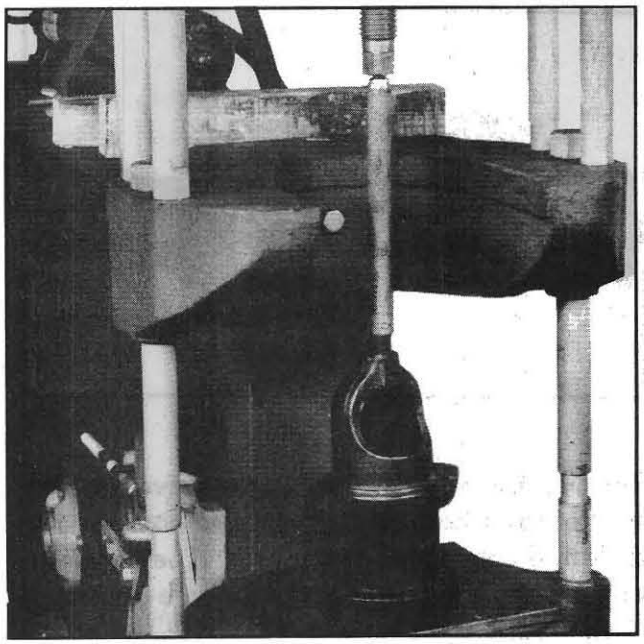


Fig. 181

this change. If the steel washer is missing and the fiber washer found to be damaged, a new starter drive shaft assembly, Part Number 1878420, with a spring steel washer should be used, see Service Bulletin 53-44.

The oilite bushing may be pressed out and a new one pressed in using a standard bushing driver as shown in Fig.181. Use a new expansion plug in the commutator end. Lubricate the bushings with a few drops of light oil before reassembling.

The brushes should be checked and replaced if they are less than one half their original length.

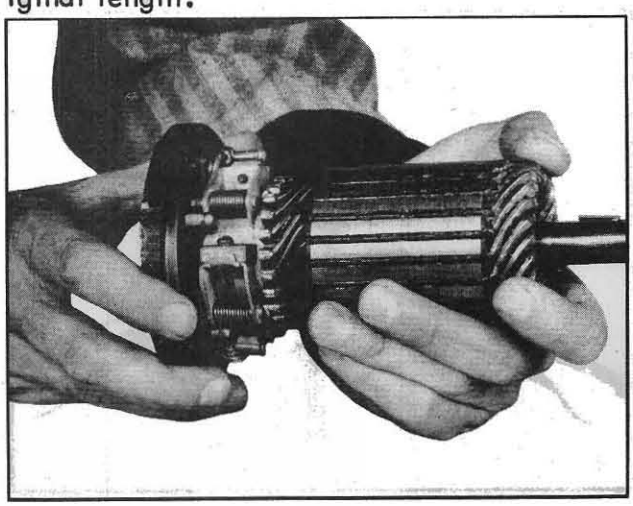


Fig. 182

While the motor is disassembled, tape a piece of 00 sandpaper around the commutator and install the end plate with the new brushes in place, as shown in Fig. 182. Slowly rotate the armature in the direction it normally turns until the brushes are sanded to a full seat. It is important that the brushes make full contact with the commutator bars if the starting motor is to develop its full power.

The brush spring tension should be checked while the end plate is mounted on the armature as shown in Fig.183. The spring tension should be 24-28 ounces, just as the brush is lifted free of the commutator. Replace any springs that are not within this specification.

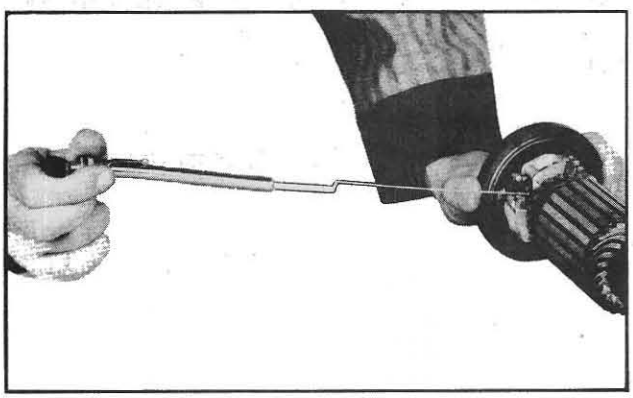


Fig. 183

If the commutator is dirty, it may be cleaned while the starting motor is disassembled by lightly dressing it with a piece of 00 sandpaper.

If the commutator is rough, burned or has high mica, a light lathe cut should be taken and the mica undercut about 1/32 in. It is recommended that the unit be returned to the nearest United Motors Outlet for such repair.

Clean the armature with compressed air. Never clean the armature or field coils with a grease solvent as the solvent may damage the insulation.

REASSEMBLY

To assemble the starting motor, merely reverse the disassembly procedure. Make sure that the two thrust washers are in good condi-

tion and are properly positioned as shown in Fig.179 and the half-moon key is installed between the Bendix Drive and the shaft.

To determine the cause of faulty motor operation, it is advisable to thoroughly check both the battery and starting motor. For methods and test procedure, refer to the On-The-Farm Service Unit Manual.

STARTER Lucas

The starting motor used on the Ferguson TE-20 tractor is a Lucas, 6-volt, 4-pole motor and quite similar to the Delco-Remy design used on the TO tractors. The motor is equipped with a Lucas barrel type outboard drive with a 9-tooth pinion, Fig. 184.

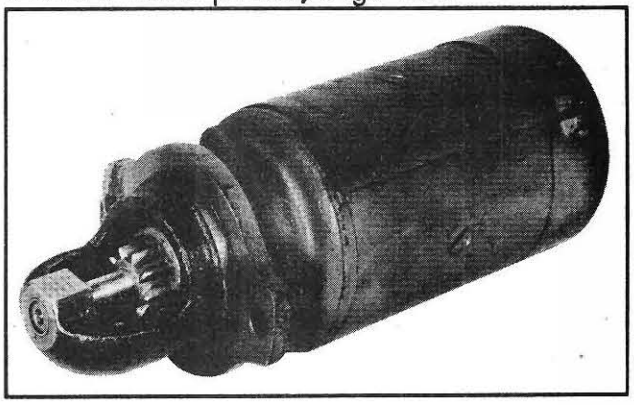


Fig. 184

The first model TE-20 tractors were equipped with starters having the terminal on the side of the motor housing. The later models have the terminal at the commutator end.

Note: Refer to the Delco-Remy instructions on repair when servicing the Lucas starting motor.

REMOVAL & DISASSEMBLY

The Lucas starting motor is removed in the same manner as outlined for the Delco-Remy. The method of disassembly differs somewhat and is outlined below.

1. Remove the cover band and hold back the brush spring, remove the two brushes attached to the field coils from their holders.

2. If the starting motor has the terminal in the end plate, remove the two nuts and the end plate will slip over the terminal post. Remove the two through bolts, and the commutator end plate.

3. Remove the drive end housing. The component parts are shown in their relative positions in Fig. 185.

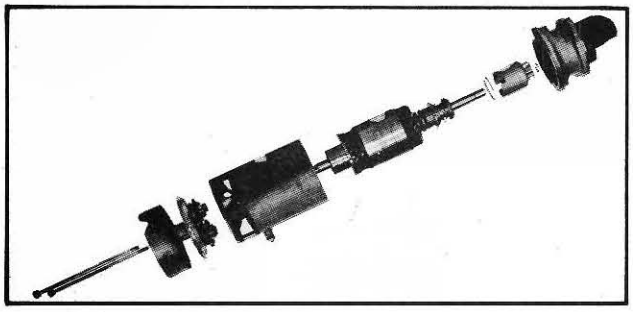


Fig. 185

To disassemble the starter drive:

1. Remove the locating ring from the end of the armature shaft and the snap ring from the inner end of the pinion barrel.

2. Remove the pin securing the locating nut and remove the locating nut which is a left-hand thread. If any difficulty is experienced driving out the locating pin, shear it when the locating nut is unscrewed. The rest of the pin can be driven out with a pin punch.

Note: On later models the locating nut is

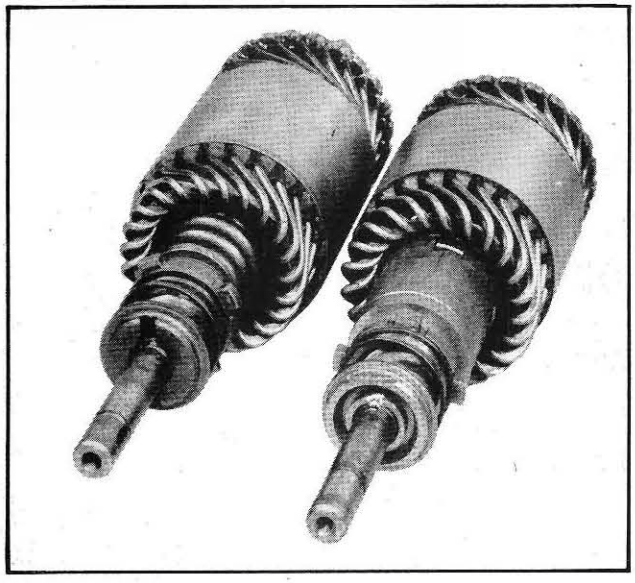


Fig. 186

secured by caulking the nut in the shaft keyway, see Fig. 186. When assembling the starter drive, use a new locating nut.

3. The remaining parts are easily removed by sliding them from the shaft.

INSPECTION & REPAIR

The bronze bushings in the drive housing and the commutator end plate can be pressed out and new ones pressed in using a standard bushing driver as shown in Fig. 187. Before reassembly, lightly coat the bushings and fill the commutator bearing cup 1/4 full with high melting point grease.

Compare the brushes with a new brush and replace them if they are less than one half their original length. To replace the brushes, unsolder the brush leads and solder the leads of the new brushes in place. The brushes are preformed and need no seating.

To replace the commutator end plate, lift the two brushes that are attached to the end plate in their holders and wedge them with the spring as shown in Fig. 188. Slip the end plate in place, release the brushes and install the spring correctly. Then install the other

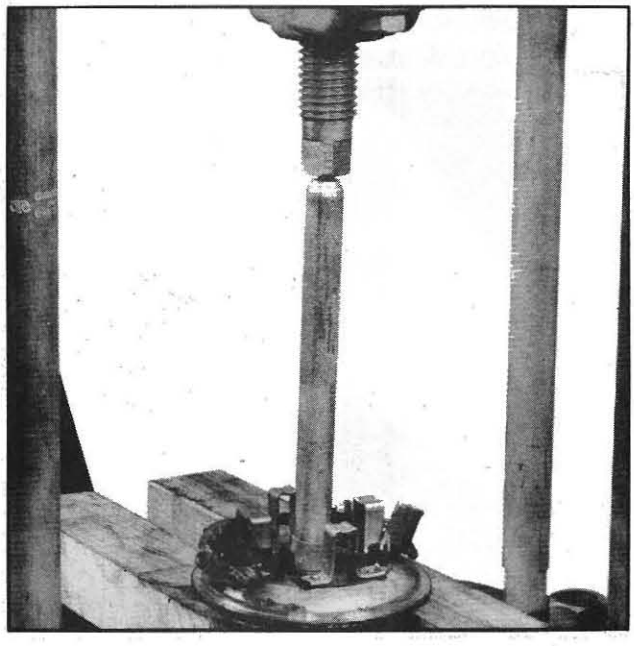


Fig. 187

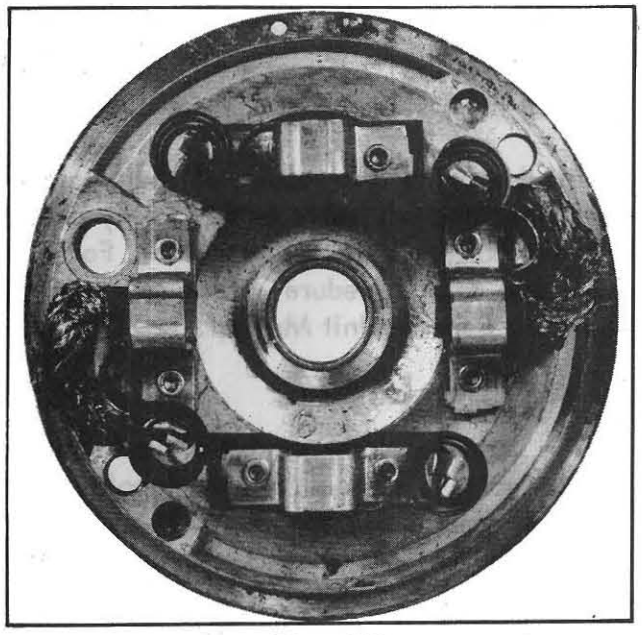


Fig. 188

two brushes. Check the brush spring tension as shown in Fig. 189. Replace any spring that is not within the specifications of 32-40 ounces.

REASSEMBLY

Reassemble the drive and motor in the reverse of the above steps. Replace the locating nut and tighten it before replacing or brading this pin or before the locating nut is caulked into the keyway.

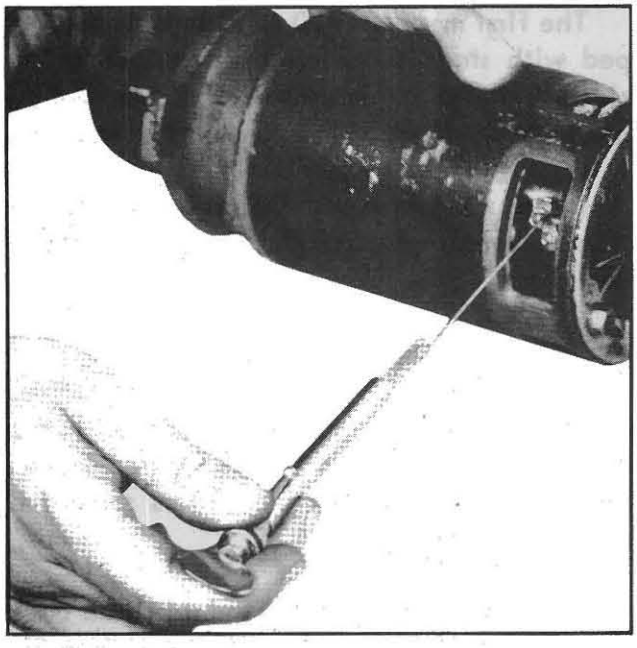


Fig. 189

STARTER SWITCH

The starter switch is mounted on the transmission housing just forward of the steering column, and is held in place by four cap screws. The contact points are completely sealed against the entrance of dust and moisture. The switch is actuated by a rocker on the underside of the switch which in turn is actuated by the connecting link from the forward end of the reverse shifter rail. Contact is made by moving the gear shift lever in the direction opposite to the reverse position.

REMOVAL

To remove the starter switch:

1. Disconnect the three wires from the switch and remove four bolts holding the switch to the transmission housing.
2. Raise and tilt the switch forward. Secure the connecting link with a piece of wire to prevent it from dropping down.
3. Remove the cotter pin and clevis pin that attaches the rocker to the switch bracket, see Fig. 190.
4. Remove the two cap screws holding the switch to the switch bracket.

The starter switch is serviced as a unit and defective switches should be replaced rather than attempting to repair the old switch.

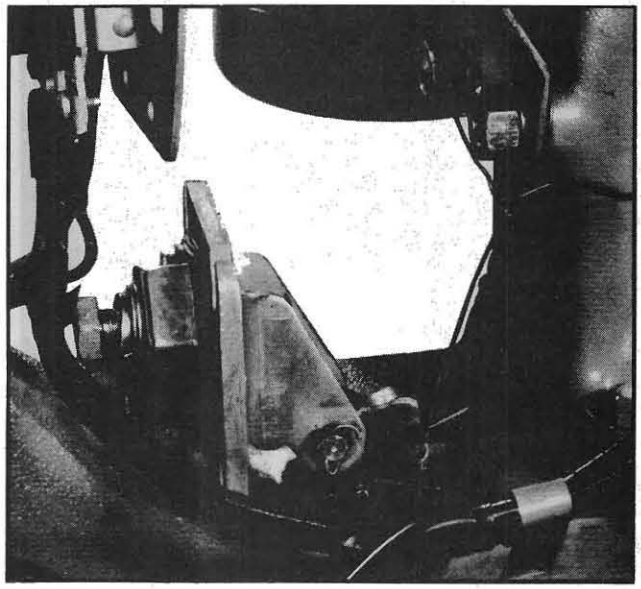


Fig. 190

INSTALLATION

When replacing the switch, assemble the switch to the switch bracket, attach the rocker to the connecting link and secure the clevis pin with a cotter pin. Remove the wire attached to the link and place the switch in position. Replace the retaining cap screws but leave them loose and adjust the switch as follows:

1. Move the switch in the slotted holes as far toward the rear as possible and tighten a couple of cap screws.
2. Test by shifting the gear shift lever into start position. If the switch fails to make contact or makes poor contact, loosen the bolts and move the switch forward slightly and check the contact in the new position.
3. Repeat the above until the switch makes a good, full contact.

Caution: Mounting the switch too far forward will tend to cause the switch to jam and stick.

GENERATOR Delco-Remy

The generator used on the TO tractors is a Delco-Remy, 6-volt, 3-brush design with a ball bearing in the drive end and a bronze bushing in the commutator end, see Figs. 191 and 192. The third brush conducts current to

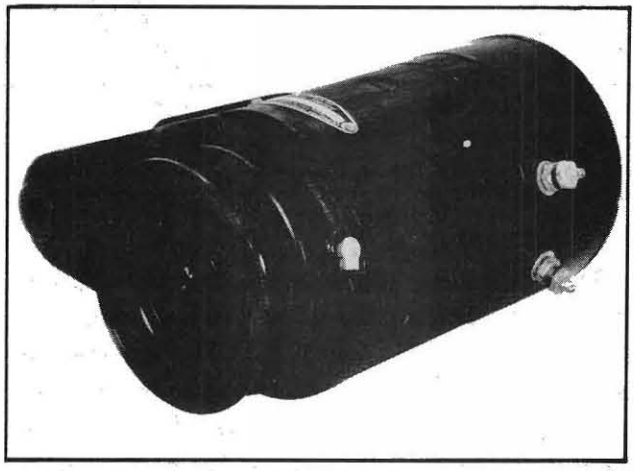


Fig. 191

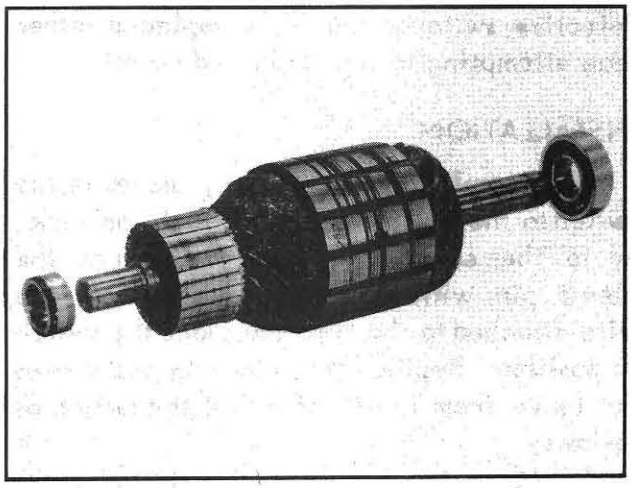


Fig. 192

the field windings from the commutator and provides the internal means of controlling the maximum output of the generator, see Fig. 193. A special drive end frame and support bracket provides a hinge type mounting and permits adjustment of the drive belt tension.

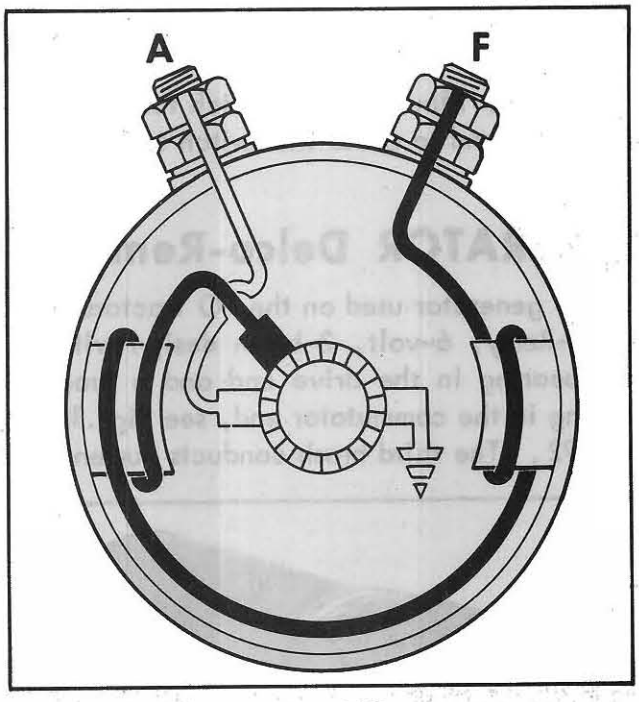


Fig. 193

The mounting brackets on the TO-30 and TO-20 generators differ somewhat and are shown in Figs. 194 and 195. The difference in the mounting brackets makes it impossible to interchange the two model generators. The service and testing procedures for both models are the same.

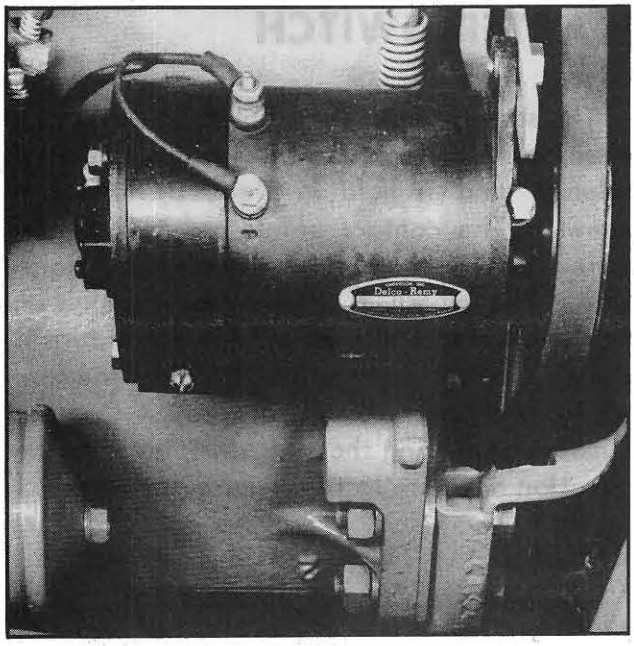


Fig. 194

REMOVAL & DISASSEMBLY

To remove the generator:

1. Disconnect the wires from the generator terminals and loosen the hinge bolts and the adjusting bracket bolt.
2. Push the generator toward the block and slip the drive belt off the pulley.
3. Remove the hinge bolts and the bolt from the tension adjusting bracket and lift off the generator.

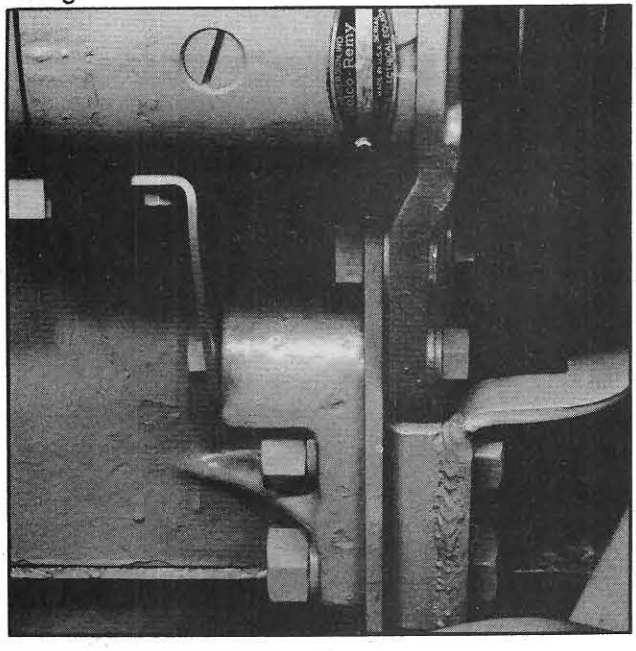


Fig. 195

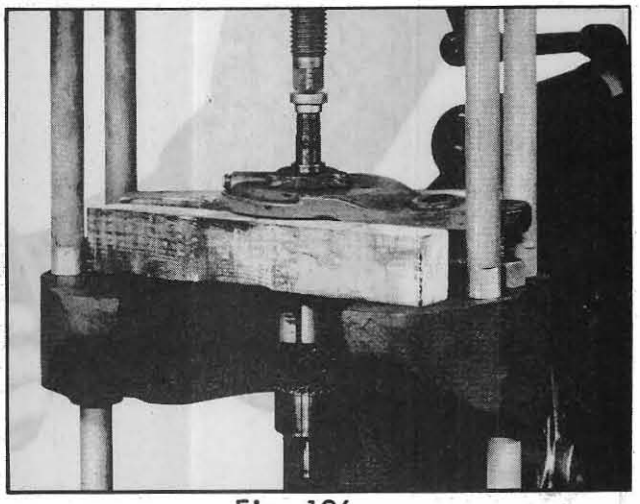


Fig. 196

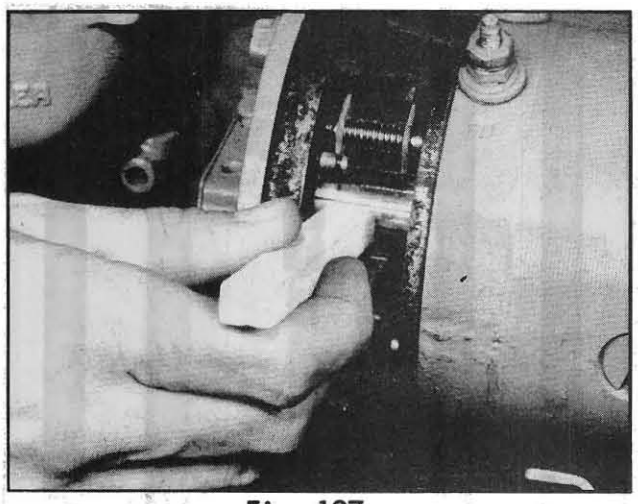


Fig. 197

To disassemble the generator:

1. Remove the cover band and disconnect the field lead and armature terminal lead from the brushes.

2. Remove the two retaining bolts and slip off the commutator end plate.

3. Withdraw the pulley, end plate and armature shaft from the generator housing.

4. Remove the nut, pulley and woodruff key from the end of the armature shaft and press the armature shaft out of the end plate, as shown in Fig.196. The spacer collar can then be removed.

5. The roller bearing can be removed by removing the retaining plate from the inside of the drive end plate.

6. Remove the cover from the commutator end plate and remove the oiler wick.

INSPECTION & REPAIR

Inspect the generator periodically to determine its condition. Inspect the external wiring, tightness of the terminals and the condition and tension of the drive belt. Remove the cover band and inspect the brushes, commutator and internal connections. If the commutator is dirty, it may be cleaned by holding a brush seating stone against the commutator while the generator is in operation, as shown in Fig. 197. Move the stone back and forth across the commutator. Dirt and gum should be cleaned off in a few seconds. A piece of 00 sandpaper and a wood stick can also be used to clean the commutator. Always blow the dust from the generator after the commutator has been cleaned.

If the commutator is rough, worn out-of-round, or has high mica, a lathe cut should be taken from it and the mica undercut about 1/32 in. If qualified personnel using the proper tools are not available, it is recommended that the unit be returned to the nearest United Motors outlet for such repairs.

Compare the brushes with a new one and if the brushes are worn to less than half their original length, they should be replaced. New brushes should be seated with a seating stone to make sure that they make full contact with the commutator. When replacing or renewing the brushes, note that one brush in the set is of darker and softer material. This is the third brush and is to be installed on the third brush plate. The generator output should be checked after replacing the brushes as this may change the position of the third brush and thus change the output. Refer to the On-The-Farm Service Unit Manual.

If the bronze bushing in the commutator end plate is worn, it can be pressed out and a new one pressed in as shown in Fig.198. The inside diameter of the replacement bushing is .008-.012 in. undersize. The correct procedure for installing the bushing follows:

a. Press the new bushing into the end plate as shown above. The new bushing does

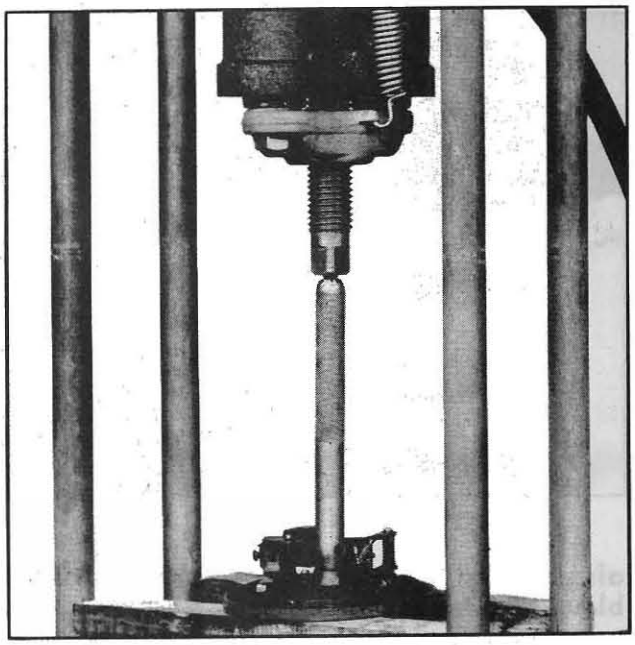


Fig. 198

not have an oil hole and must be drilled after installation, as shown in Fig. 199. Using a 1/4 in. drill, drill through the bushing so that the oil wick will make good contact with the armature shaft.

b. Using an expanding type reamer, carefully ream the bushing until it will just slip freely on the armature shaft. Thoroughly clean the assembly. Install a new oil wick and new oil hole plug and replace the cover and the end plate.

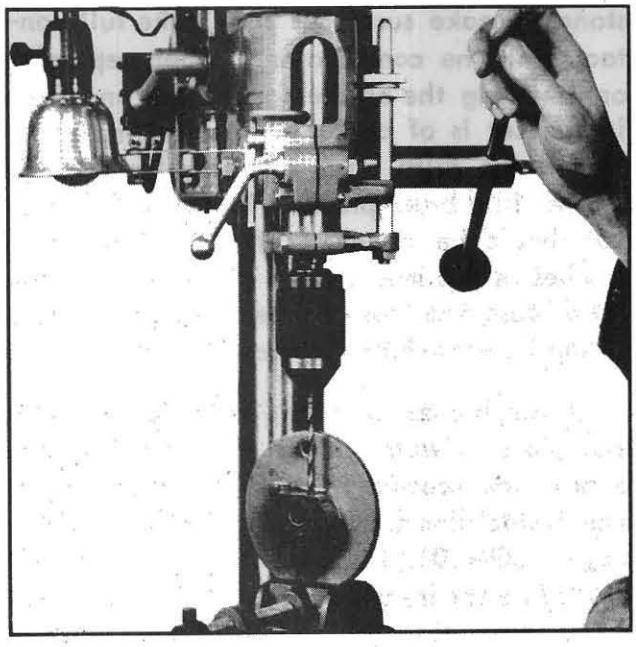


Fig. 199

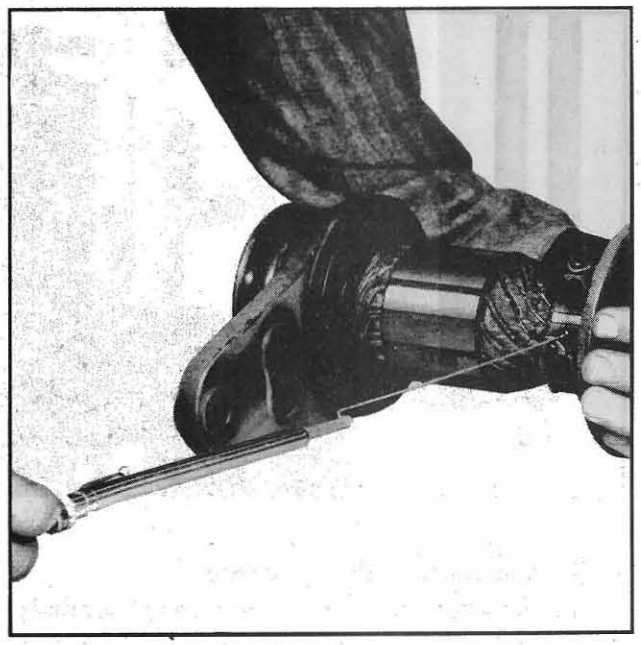


Fig. 200

Install the commutator end plate on the commutator and check the brush spring tension as shown in Fig. 200. It should be between 17 and 18 ounces. If the spring fails to meet this specification or if it shows signs of overheating, always replace it.

The model generator used on the Ferguson tractor makes use of a "swivel type" brush holder which can be removed by removing the screws attaching the brush holder to the

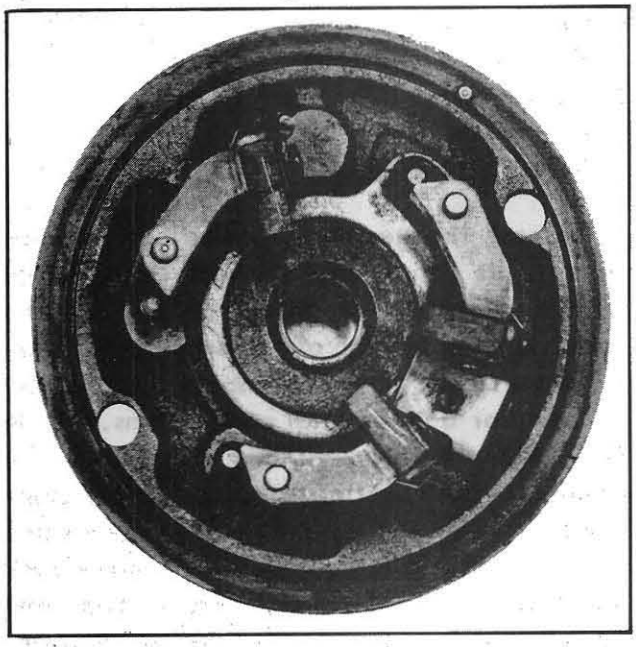


Fig. 201

end plate, see Fig. 201.

While the generator is disassembled, it should be cleaned, using compressed air. The armature and field coils should never be cleaned with a grease solvent, the solvent may damage the insulation.

All parts should be cleaned and carefully inspected before reassembly. Damaged or worn parts should be replaced. The roller bearing in the drive end should be repacked with high melting point grease.

REASSEMBLY

1. Replace the end plate, pulley and retaining nut on the armature shaft and place the armature in position in the housing.

Note: Both end plates are doweled and cannot be installed in the wrong position.

2. Assemble the commutator end plate. Spread the brushes and slip the end plate in place. Replace and tighten the two through bolts.

3. Connect the two internal leads to the brushes.

Note: The field lead is connected to the third brush.

4. Mount the generator on the tractor and replace the drive belt. Connect the two external leads. Connect the "F" terminal of the generator to the "F" terminal of the voltage regulator. The "A" terminal of the generator is connected to the "GEN" terminal on the back of the voltage regulator.

Caution: The generator must be polarized before the engine is started. Failure to do this may result in burned relay points, a run-down battery or damage to the generator itself. To properly polarize the generator, momentarily connect a jumper lead between the armature terminal of the generator and the negative terminal of the battery. This

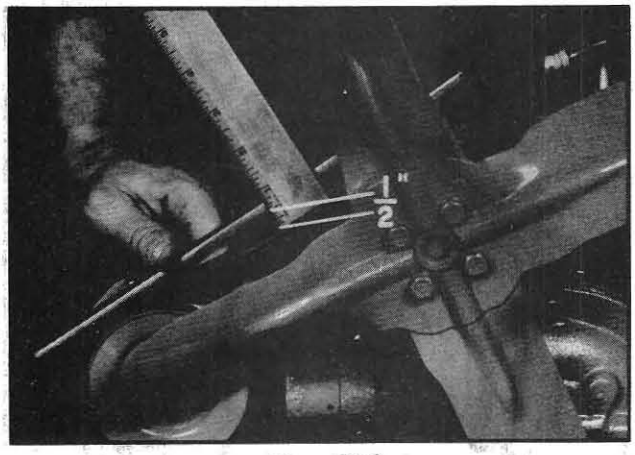


Fig. 202

permits a surge of current to flow through the generator which correctly polarizes it.

5. Adjust the tension of the drive belt by moving the generator toward or away from the engine block until there is 1/2 in. free movement, measured as shown in Fig. 202.

Whenever the generator has been disassembled or the brushes replaced, the generator output should be checked. Even the reseating of worn brushes can change the relative location of the third brush and affect the maximum output of the generator. Refer to the On-The-Farm Service Unit Manual.

GENERATOR Lucas

The TE-20 is equipped with a Lucas, 6-volt, two-brush type generator see Fig. 203. The output is controlled completely by the voltage regulator. The armature shaft is supported by a bronze bushing at the commutator end and a ball bearing at the drive end. The generator leads have non-reversible plug-in terminals which can be installed on the generator only in their proper position.

The bronze bushing is lubricated by a spring loaded felt pad. The spring and pad should be removed and the lubricator filled about one half full with high melting point grease whenever the generator is disassembled.

Note: Refer to the Delco Remy instructions on page 97.

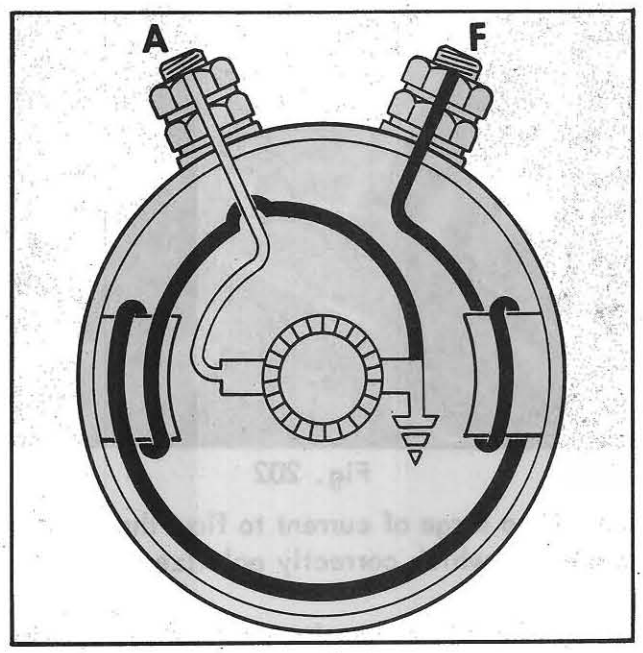


Fig. 203

REMOVAL & DISASSEMBLY

The generator is removed in a similar manner, as outlined for the Delco-Remy.

To disassemble the generator:

1. Loosen the two through bolts and remove the commutator end plate. There are no internal connections to be uncoupled before removing the end plate.

2. The drive end plate, armature and through bolts can be withdrawn from the generator housing.

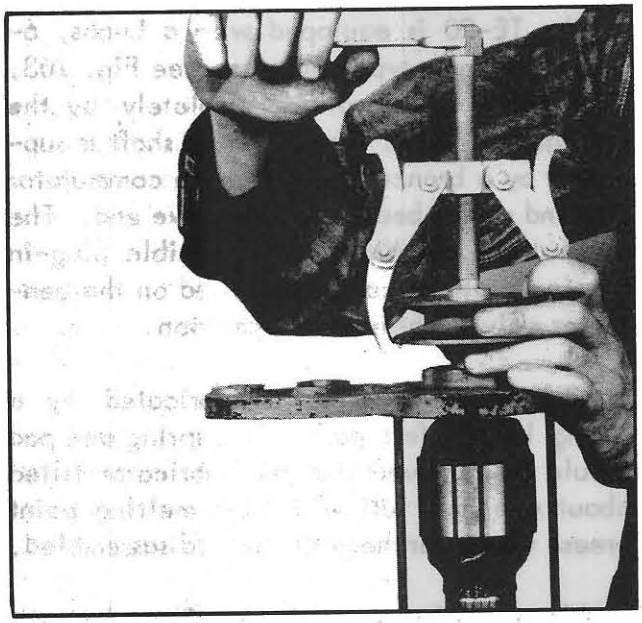


Fig. 204

3. Carefully clamp the armature shaft in a soft-jawed vise and remove the drive pulley. It may be necessary to use a small puller to remove the drive pulley as shown in Fig. 204.

4. Press the armature shaft out of the drive end plate as shown in Fig. 205 and remove the through bolts.

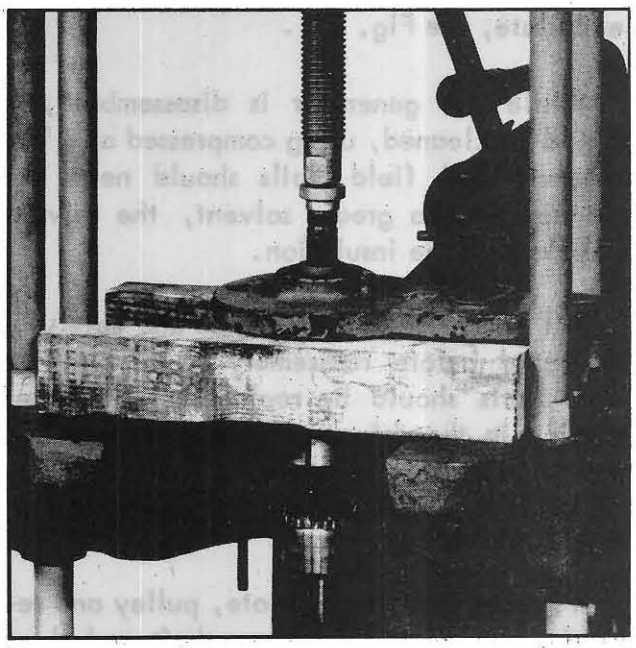


Fig. 205

INSPECTION & REPAIR

If the brushes are worn so that they do not make good contact with the commutator, they should be replaced. New brushes are preformed and do not require seating. Install the commutator end plate on the commutator and check the brush spring tension with a spring scale, as shown in Fig. 200. The spring should be replaced if the reading is not between 22-25 ounces.

The commutator should be examined and cleaned with fine sandpaper if dirty. If the commutator is very dirty, pitted, worn out-of-round, or has high mica, a cut should be taken from it in a lathe. The mica should then be undercut 1/32 in. and the commutator thoroughly cleaned before installing.

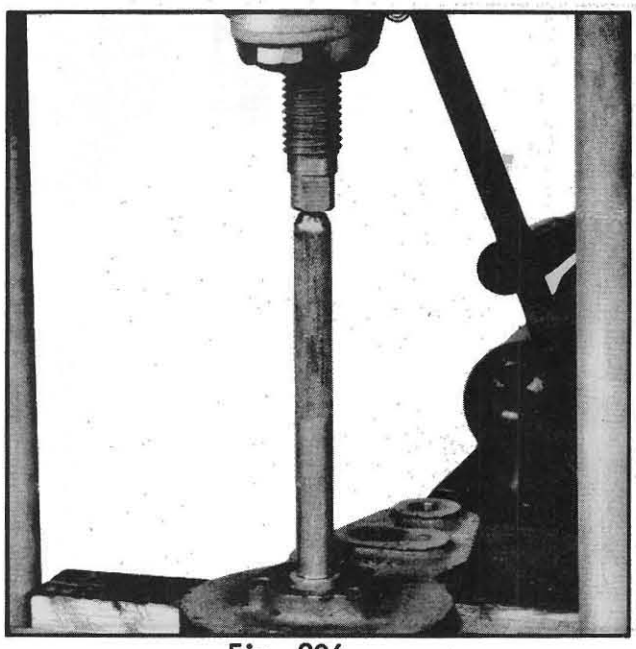


Fig. 206

If it is necessary to remove or replace the roller bearing in the drive end plate, knock out the three rivets from the retaining plate and remove the plate. Press the bearing out toward the armature side of the plate as shown in Fig. 206. Renew the felt grease seal if needed. Before replacing the bearing, pack it with high melting point grease. Replace the bearing by pressing it in place. Replace the retaining plate and insert the three hollow rivets from the outside of the end plate and spread the rivets with a punch.

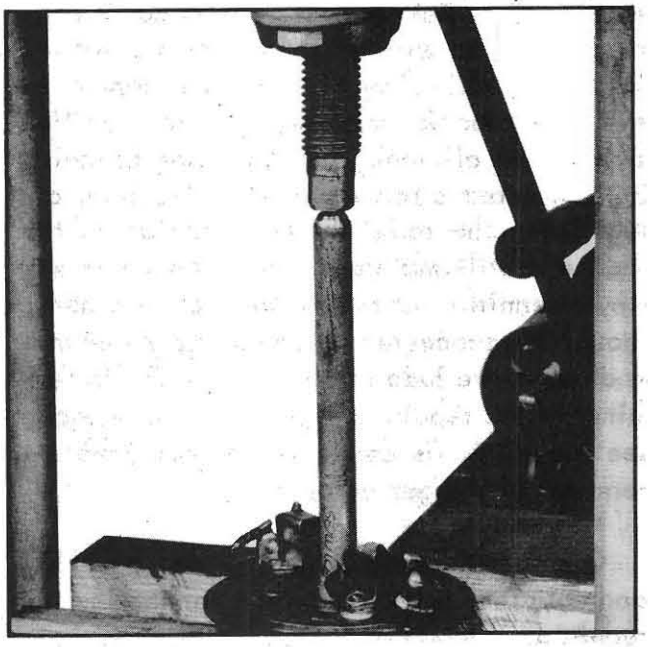


Fig. 207

To remove the bronze bushing from the commutator end plate, remove the outside protective cap. Press out the bushing as shown in Fig. 207. Press the new bushing in place and lubricate it lightly. Fill the lubricator about half full of high melting point grease and replace. Replace the protective cap. It is recommended that the unit be taken to a reliable electrical equipment service shop for such repairs if trained personnel and the proper equipment are not available in the Dealership.

REASSEMBLY

1. Press the armature shaft into position in the drive end bracket.
2. Replace the through bolts in the holes in the end plate, replace the drive pulley and tighten the retaining nut.
3. Slide the armature and drive end assembly into the generator housing. Note, that both end plates are doweled and can be installed on the housing in only one position.
4. Raise the brushes in their holders on the commutator end plate and wedge them in this position by locating the springs on the sides. Make sure that the brush is far enough up in the holder to clear the commutator as the end plate slides on.
5. Slide the end plate on the shaft until the brushes are just started on the commutator. Release the brushes and return the springs to the center of the tops of the brushes.
6. Push the end plate in position, insert the through bolts and tighten securely.
7. Mount the generator on the tractor and adjust the drive belt tension until there is 1/2 in. of free play in the belt, measured as shown in Fig. 202.

Caution: Before connecting the terminal wires to the generator, the generator must be repolarized to make sure it has the correct polarity with respect to the battery. To correctly polarize the Lucas generator, momentarily connect a jumper lead between the neg-

ative terminal of the battery and the armature terminal of the generator. This is important and must be done to avoid damaging the ignition system.

Whenever the generator has been removed and disassembled for cleaning or repairs, the generator output should be checked after mounting the generator on the tractor. Refer to the On-The-Farm Service Unit Manual.

REGULATOR Delco-Remy

The TO tractors are equipped with a Delco-Remy voltage regulator, model No. 1118308 or model No. 1118291. The difference in the two models being in the method of adjustment.

The regulator is a two unit, combined current-voltage regulator and a cutout or reverse current circuit breaker. The regulator is especially designed for use with a third brush generator having an externally grounded field circuit. The unit also has a special wiring circuit which adapts it to the type of service encountered in farm tractor operation. The function of the voltage regulator is:

1. Breaks the circuit between the battery and generator when the generator voltage falls below the battery voltage. This prevents discharge of the battery through the generator when the tractor is running at idle speed or stopped.
2. Controls the current and voltage output of the generator.

The Delco-Remy current-voltage regulator also incorporates a temperature compensating device in the form of a bimetal hinge on the regulator armature. This allows a higher output when the regulator is cold and reduces the output as the regulator becomes warm. This gives a quick charge immediately after starting, when there has been a heavy drain on the battery.

The regulator is sealed against moisture and dust by means of a rubber gasket. The cover is crimped in place and should be removed only after it has been determined that the regulator needs adjustment or repairs. Refer to the On- The-Farm Service Unit Manual for regulator tests.

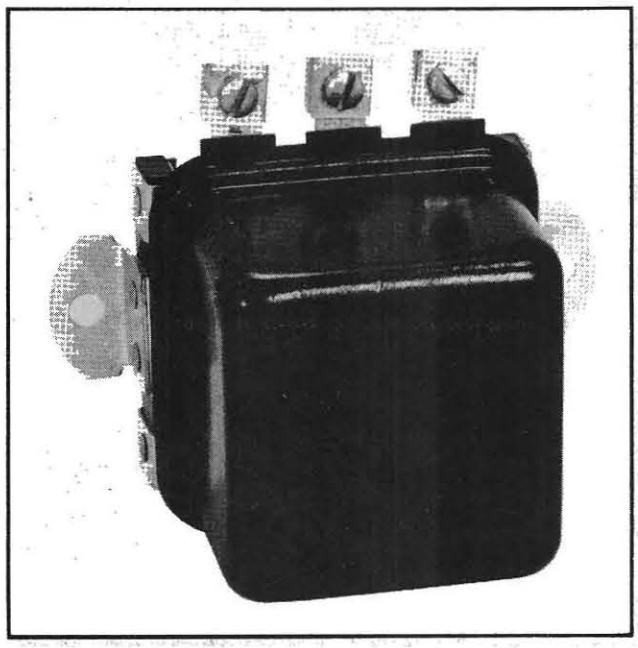


Fig. 208

The voltage regulator has four external terminals. When the unit is in position on the tractor, the three terminals along the bottom edge are marked "F", "Bat" and "L", see Fig. 208. The "F" or field terminal is connected to the field terminal of the generator. The "Bat" or battery terminal is connected to the wire from the hot side of the starter switch. The "L" or load terminal of the regulator is connected to the ignition switch and all loads, such as lights, should be connected to this terminal. By so connecting them, the regulator compensates for the load and still maintains the battery charge. Any intermittent, heavy load, such as a horn, should be connected to the battery terminal and not to the load terminal. The fourth terminal of the regulator, located on the back, see Fig. 209, is connected to the armature terminal of the generator.

Check the wiring diagrams, see page 115, and note the wire colors when connecting the regulator. If there is any uncertainty as to the color of the wiring, the wire should be

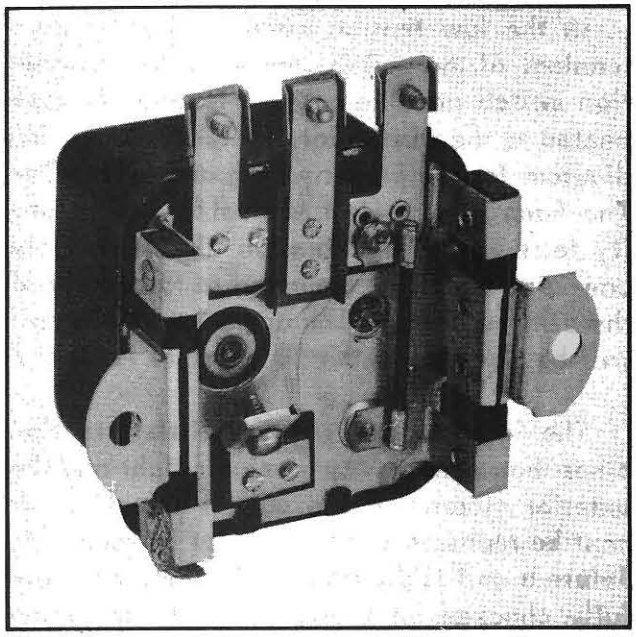


Fig. 209

traced with an ohmmeter or a suitable test lamp. An improperly connected regulator may result in burned contact points the moment the engine is started.

If for any reason, the regulator appears to be functioning improperly, the following points should be noted before referring to the On-The-Farm Service Unit Manual for electrical tests.

1. Fan belt tension, see page 79 .
2. The state of charge of the battery, see page 92..
3. Crossed generator or regulator connections.
4. Broken wiring or poor connections.

REGULATOR Lucas

The TE-20 tractor is equipped with a model RF-97, Lucas combination cutout and voltage regulator. This model is designed to operate with a two brush, shunt wound, generator and is the only control of the output of the generator. It should be noted then that an important characteristic of this type generator is that as the generator speed is increased, the output will rise accordingly, since there is no internal control of the maximum output.

The Lucas regulator is a two-unit, temperature compensated type completely sealed against dust and moisture. The temperature compensating device allows a higher output when the regulator is cold and reduces the output as the regulator becomes warm. This gives a quick charge immediately after starting. The compensating device is in the form of a bi-metal strip which, due to the unequal expansion of the two metals, increases the pressure of the adjusting spring.

The regulator has three functions:

1. Breaks the circuit between the battery and the generator when the voltage falls below the voltage of the battery.
2. Controls the maximum voltage reached by the generator.
3. Controls the maximum current output of the generator.

The Lucas regulator is equipped with four plug-in terminals, marked "F", "A", "E" and "D" on the regulator housing, see Fig. 210. Terminal "F" or field is connected directly to the field terminal of the generator. Terminal "D" is connected, by way of the warning light or ammeter, to the brushes of the generator. Terminal "E" is grounded, usually to a bolt in the starter switch plate. Terminal "A" is connected to the battery or hot side of

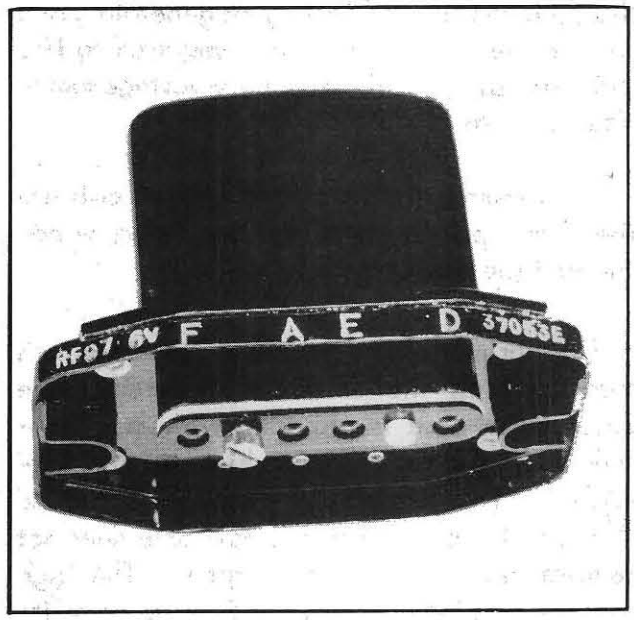


Fig . 210

the starter switch. When removing the regulator from the tractor, first remove the two screws and the retainer plate, see Fig.210. If the wires are pulled from the regulator without removing the retainer plate, the end terminals will be pulled from the wires. Check the coloring of the wires when connecting the regulator. If there is any uncertainty as to the color of the wiring, the wire should be traced with an ohmmeter or a suitable test lamp. Improperly connected regulator may result in burned contact points the moment the engine is started, see section on the TO regulator on page 104 when the regulator is not functioning properly.

IGNITION COIL

The Delco-Remy coil used on TO tractors and the Lucas coil on TE tractors is a conventional 6-volt type, oil-filled and hermetically sealed to prevent the entrance of moisture. The oil permits a more rapid dissipation of heat and provides greater insulation. The sealing of the coil prevents moisture being drawn into the coil during the cooling off period. This eliminates one of the greatest causes of coil failure, the damage to the insulation by moisture.

The purpose of the ignition coil is to take the current from the battery or generator, and step up the voltage to a point required to fire the spark plugs. This secondary voltage sometimes goes as high as 20,000 volts.

The essential parts of the ignition coil are the core, primary winding, secondary winding and the case.

The primary and secondary windings are assembled on the core and mounted in the case. The case is provided with two low-tension terminals and one high-tension terminal. The secondary winding is ground through the primary so the coil case does not require grounding to the engine. The high tension terminal is protected by a bakelite insulator.

In the low tension circuit, the negative terminal of the coil is connected to the ignition switch and the positive terminal is connected to the distributor. Refer to the wiring diagram for the proper wiring and to the On-The-Farm Service Unit Manual for coil polarity tests. The high tension circuit has only one wire which is connected to the center of the distributor cap. The operation of the coil will be discussed under "Distributor Action".

The ignition coil requires little attention other than keeping the terminals tight and the exterior clean. If the coil is defective, it must be replaced since it cannot be repaired. Before a coil is discarded, it should be carefully checked on a good tester to determine that it is actually defective.

DISTRIBUTOR Delco-Remy

Both the TO-20 and TO-30 tractors are equipped with Delco-Remy distributors. The distributors are very similar in design but neither the distributor nor its component parts are interchangeable. The main difference in the distributor is the design of the advance weights and springs and the resulting difference in the characteristics of the advance curve. The other difference evident from a visual inspection, is the method in which the low tension terminal is insulated, see Fig. 211.

The TO-30 tractor uses Delco-Remy Model No. 1111740 and the TO-20 uses Model No. 1111722 with crankshaft rotation advance of

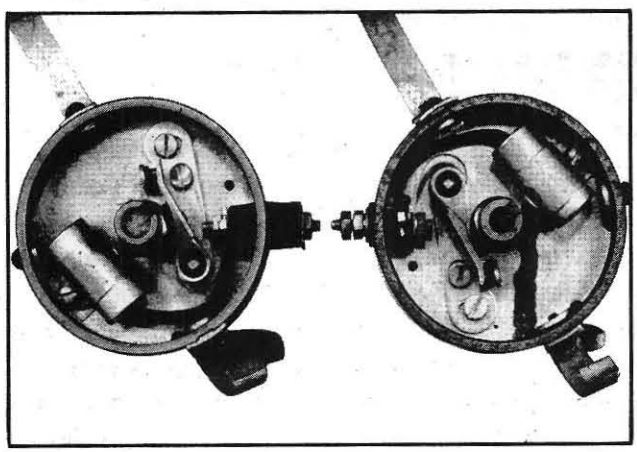


Fig. 211

26 and 24 degrees respectively, both models are fully automatic.

The distributor is made dust proof by a seal between the cap and housing and a felt seal around the distributor shaft. The cap is ventillated to permit the escape of ozone and condensation.

The distributor has three distinct functions.

1. It makes and breaks the low tension circuit, so that the primary winding of the coil is supplied with intermittent surges of current.
2. It times the surges to meet the engine requirements.
3. It directs the high voltage surge to the spark plug which is ready to fire.

The centrifugal advance mechanism is incorporated in the distributor to automatically vary the timing of the spark with respect to the position of the piston in the cylinder. At high speeds, the spark must occur at the plug earlier in the compression stroke in order for the fuel mixture to deliver full power.

The advance mechanism consists of an advance cam, breaker cam, a pair of advance weights, springs and a weight base that is integral with the distributor shaft. At low speeds, the advance weights are held in toward the center by the spring tension. As the speed of the distributor shaft increases, the centrifugal force overcomes the spring tension and the weights move outward and the toggles on the weights engage the advance cam. This rotates the advance cam and breaker cam which in turn allows the breaker cam to open and close the contact points earlier, thus advancing the spark.

The distributor is assembled with a supply of oil in the built-in oil reservoir. It is recommended that whenever the distributor is removed from the tractor, the oil be drained and the reservoir refilled with clean 20W engine oil.

REMOVAL & DISASSEMBLY

To remove the assembly:

1. Disconnect wiring.
2. Remove the distributor cap and note position of the rotor in relation to the distributor assembly.

Note: If the engine is not cranked after the distributor is removed and the rotor is replaced in the same position, when the distributor is assembled to the tractor, the engine will be roughly timed.

3. Remove the clamp cap screw and remove distributor.

To disassemble the distributor:

1. Remove the plug and drain the oil from the oil reservoir.
2. Remove the distributor cap, rotor and dust seal.
3. Disconnect and remove the condenser and the moving contact point.
4. Remove the insulated low tension terminal.
5. Remove the three screws holding the breaker plate in place and remove the plate.
6. Support the housing and shaft on wood blocks and carefully drive the pin from the drive pinion. The pinion can be slipped from the shaft and the shaft removed from the housing.

The porous bushing may be pressed out of the housing and a new bushing pressed in place using the proper size mandrel as shown in Fig. 212. Great care should be exercised when installing new bushings as the amount of oil that seeps through the porous bushing is seriously affected by scratches and scuffed areas on the surfaces. The bushings are manufactured to exact size and must not be reamed, scraped or filed.

REASSEMBLY

Reassemble the distributor in the reverse order of the above steps. Note the spacer

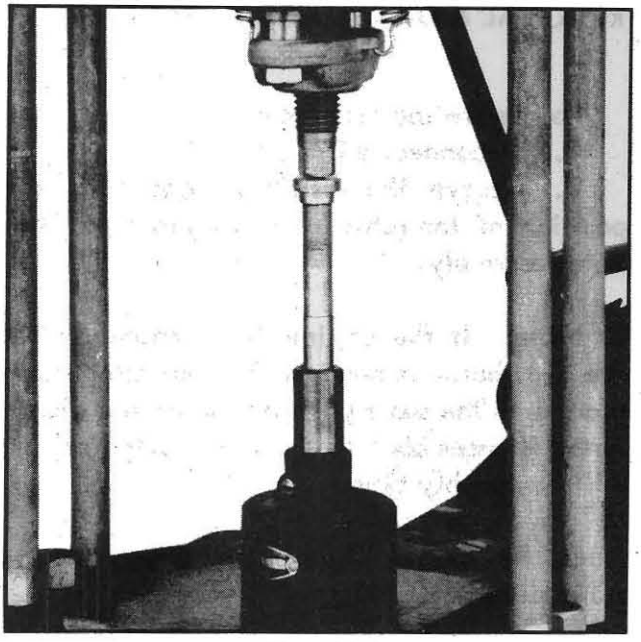


Fig. 212

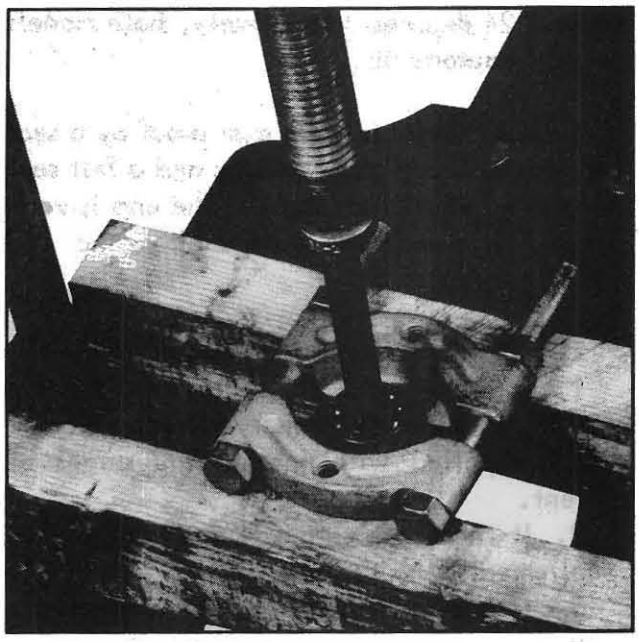


Fig. 213

washer between the housing and advance weights and the spacer washer and shim between the housing and the drive pinion. This is to control the end play in the shaft which should not exceed .010 in. Rivet the pin securely in the drive pinion. Adjust the points as outlined under distributor inspection and adjustment.

DISTRIBUTOR Lucas

The TE tractor is equipped with a model D-3A4 Lucas distributor. This unit is very similar in design and function to the Delco-Remy Model used on all TO tractors. The Lucas distributor is equipped with an automatic, centrifugal advance mechanism which gives the correct engine timing for various engine speeds.

Refer to the section on the Delco-Remy distributor for information and adjustment on distributor action, disassembly and adjustment of the Lucas Distributor. Note the following differences:

The distributor shaft is supported at the upper end by a ball bearing and at the lower end by a bushing. The bushing is removed and replaced similar to that of the Delco-Remy. The ball bearing can be removed from the distributor shaft and replaced as shown in Fig. 213. The ball bearing should be repacked with high melting point grease whenever the distributor is disassembled.

Note: When reassembling the distributor, make sure that the fiber washer is in place between the housing and the drive pinion. This controls the end play in the shaft.

INSPECTION & ADJUSTMENT

All wiring should be checked for insulation deterioration, terminal and wire corrosion due to poor connections (particularly in high tension side), loose connections and excessive oil, grease and dirt. The distributor should be inspected to determine if:

1. Centrifugal advance mechanism is free. Place rotor on distributor shaft and turn in direction of rotation, then release. No binding should be felt and rotor should return to original position snappily when released. If binding is noted, the cause must be located and corrected.

2. Cap and rotor have chips, cracks or carbonized paths. This would allow high tension leakage to ground. Such defects require replacement of part.

3. Contact points are properly aligned.

Points should meet squarely; however, if they do not, bend the fixed point with needle-nose pliers until they do. This is particularly important when installing new points.

4. Point gap is properly set. Contact point opening is 0.022 in. on the TO-20 and TO-30 tractors and 0.015 in. on the TE-20. The point opening of used points cannot be checked correctly with a flat feeler gauge, since a flat gauge measures from high point to high point on the contact surfaces and not the actual point opening. An accurate method of checking used points is with a dial indicator. However, it is suggested that the points be set with the dwell meter, see On-The-Farm Service Unit Manual. If the points appear in a workable condition, they should be cleaned with a few strokes of a clean, fine-cut contact file. Attempting to remove all roughness or to dress point surfaces too smooth will shorten point life.

Note: Never use emery cloth or sandpaper to clean points, since particles will imbed and cause arcing and rapid burning of points.

5. Contact point spring tension is correct. The tension should be 17-21 ounces for TO-20 and TO-30 tractors, 20-24 ounces for the TE-20 tractor. This should be checked with a spring gauge hooked on the breaker lever at the center line of the point and at right angles to the breaker arm, Fig. 214. The reading should be taken just as the points open. If the spring does not meet the specifications, it should be bent with needle-nose pliers until correct tension is obtained, Fig. 215. This check is important on a new spring, as excessive pressure causes rapid wearing of rubbing block, decreasing the point gap; while insufficient pressure will permit high speed point bounce, causing arcing and burning of points and a missing engine.

6. The points are burned. This can result from:

a. High voltage which causes excessive current to flow through the distributor breaker points and burns them. This can be caused by an improperly adjusted or inoperative regulator or an excessively advanced third-brush adjustment.

b. Crankcase vapors which deposit a residue on the point surfaces and causes burning. This can be caused by a plugged breather pipe which permits crankcase pressure to force oil or vapor up the distributor. Over-oiling the distributor or handling the points with greasy hands will also cause point burning.

c. Contact point opening too small. The points will be closed too long a period of total operating time, permitting too high a current flow through the points and causing them to burn too rapidly.

d. High series resistance in the condenser circuit, caused by a loose condenser

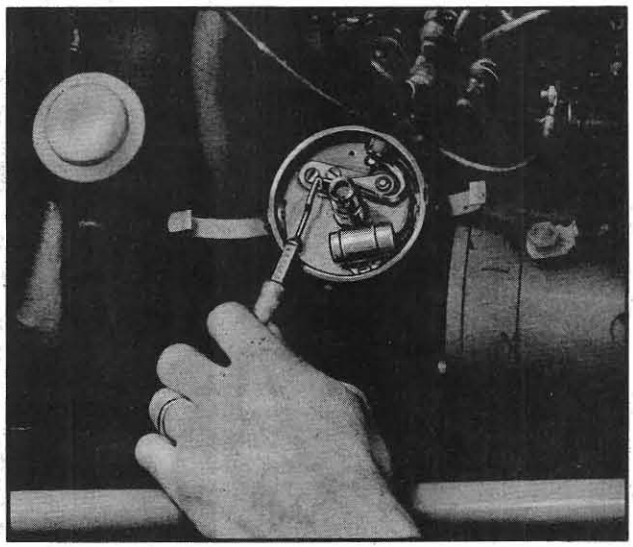


Fig. 214

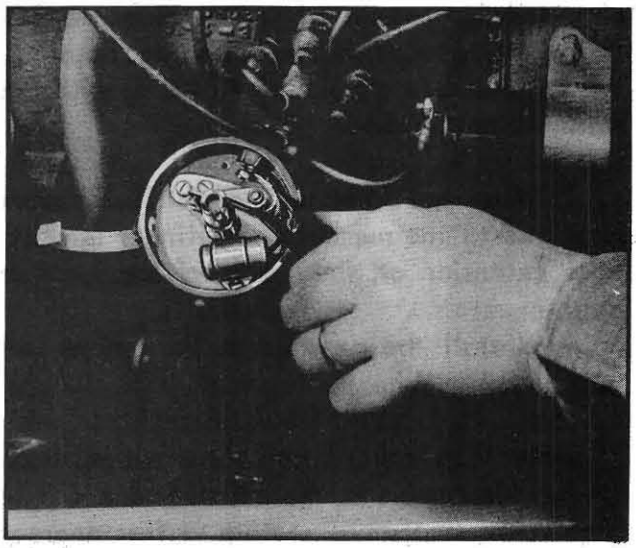


Fig. 215

mounting or connection or by poor connections inside the condenser. This will prevent normal condenser action, consequently the points will burn too rapidly.

7. The points are pitted. This results from an unbalanced condition in the ignition system, causing a transfer of tungsten from one point to the other. Thus a tip builds on one and a pit forms on the other. Such pitting in the Ferguson Electrical System usually indicates that the condenser is defective and should be replaced. It is recommended that whenever the points are burned or pitted and require replacing, the condenser also be replaced.

ENGINE TIMING

The distributor automatically varies the timing for the best performance and economy at any given engine RPM. Even though the distributor is properly calibrated, it cannot provide correct ignition advance unless it is timed to the engine when installed.

To rough time the engine:

1. Remove number one spark plug.
2. Crank engine until number one piston starts up on compression stroke (this can be determined by holding thumb over the spark plug hole) and reaches top dead center.

Note: The exact top dead center can be obtained by removing timing plug on TO tractors from left-hand side of engine housing. The "DC" mark should be lined up with the mark on the housing.

3. Turn the rotor of the distributor until it points to the number one cylinder ignition wire extension on the inside of the ignition cap.
4. Install the assembly to the tractor engine in this manner.

Note: Due to the nature of the curved teeth of the spiral gears on the camshaft and distributor, the rotor will rotate a few degrees when the assembly is installed in the block. It may be necessary to remove the assembly and compensate for this by setting the rotor a few degrees back of the extension.

5. Bolt the assembly to the engine. To accurately time the engine, a timing light must be used as outlined below.

To time TO tractor engines using a timing light:

1. Remove button plug from left-hand front side of engine housing, see Fig. 216.

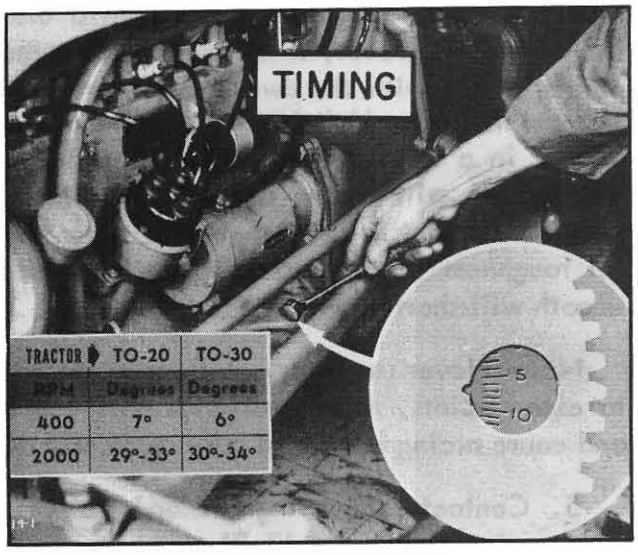


Fig. 216

2. Connect the primary leads of the timing light-Black lead to battery cable terminal at starter switch; Red lead to tractor ground.
3. Connect blue secondary lead to No. 1 spark plug, Fig. 217.

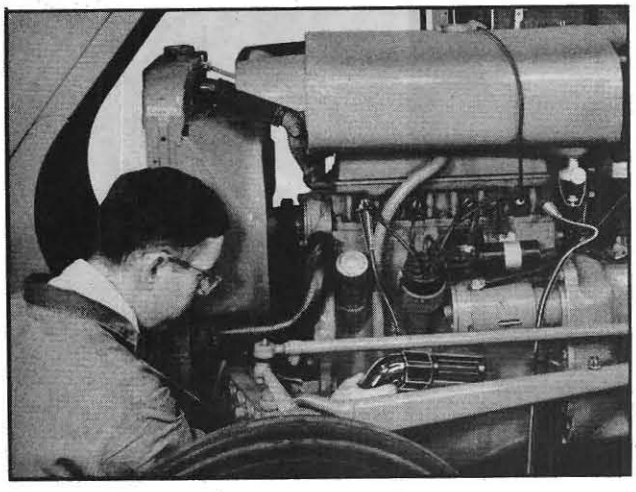


Fig. 217

4. Connect tachometer leads-Black lead to distributor post; Red lead to tractor ground.

5. Start and run engine at 400 RPM.

6. Use timing light to observe position of timing marks (located on flywheel) in relation to the marks on the housing.

7. If timing does not agree with specifications, loosen holding screw on distributor base and rotate distributor until it does.

8. Observe position of timing marks at 400, 1000 and 2000 engine RPM.

Tractor RPM	TO-20 Degrees	TE-20 Degrees	TO-30 Degrees
400	7°	0°	6°
1000	21°		16°
1500			23°
2000	31°	29°	32°

If the timing does not advance properly, check for binding in the distributor shaft and weights.

Note: The TE-20 tractor is not provided with a timing hole and timing marks on the flywheel. Instead, timing marks were placed on the timing gear cover and on the crankshaft pulley, see Fig. 218. However, with the radiator and shroud in place, the timing marks are inaccessable to a timing light. To make a permanent timing mark that can be readily seen when using the timing light, proceed as follows:

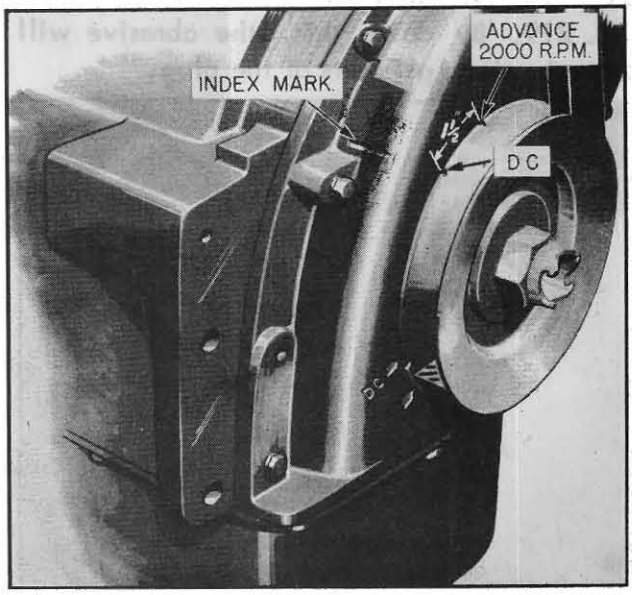


Fig. 218

Remove No. 1 spark plug and crank the engine until No. 1 piston is on the compression stroke. Turn the crankshaft until the notch in the crankshaft pulley lines up with the D.C. mark on the timing gear cover. Select a point on the gear cover and pulley that can be seen accurately with a timing light. Make permanent matching marks with a chisel or punch as shown in Fig. 218. Looking at the pulley from the rear, measure up counterclockwise 1 1/2 in., on the outside diameter of the pulley, from the first mark. Make a permanent mark at this point. This second mark is the advance mark for 2000 engine RPM.

SPARK PLUGS

The spark plug basically consists of two electrodes positioned in the combustion chamber and separated by an air gap. The center or insulated electrode receives high voltage surges from the distributor which discharges to the side or ground electrode forming a spark to ignite the air-fuel mixture in the combustion chamber.

The importance of the proper selection, cleaning and adjustment of spark plugs cannot be over emphasized. Any fault in the plug will cause poor performance or non-operation of the cylinder to which it is attached.

There are several methods of classifying spark plugs, such as, type of construction, size, type of thread, number of electrodes and heat characteristics, however, the recommended plugs for the TO-30, TO-20 and TE-20 tractor engines as listed below are concerned only with the heat range.

Make	Size	Heat Range		
		Standard	Hot	Cold
Champion	18mm	8 com.	C7	6M
AC	18mm	86 com.	87 com.	85 com.

The term heat range refers to the length of the path the heat must travel from the combustion chamber to the water jacket. This is controlled by varying the length of the insulator that extends below the gasket.

REMOVAL

The following procedure should be followed when removing the spark plugs from the engine. Always use a special deep socket, spark plug wrench. Make-shift wrenches may slip and break the insulator.

1. Loosen all plugs three or four turns and use compressed air to blow out the dust and dirt from the plug recesses and seats.
2. Reseat the plugs, start the engine and let it run at a fast idle for a minute or two.
3. Stop the engine and remove the plugs.

The reason for this procedure is that the first few threads on the bottom of the plug extend into the combustion chamber. During engine operation, hard carbon forms on these threads. When the plugs are unscrewed, the carbon flakes off and falls into the combustion chamber. If not blown out, the carbon pieces may get under a valve, hold it partially open, and give a false indication on some further check. By tightening the plugs and running the engine, the carbon is blown out of the combustion chamber and will give no further trouble.

The gasket from a properly tightened plug will be approximately one-half its original thickness.

CLEANING & ADJUSTMENT

If the center electrode has become worn down or the ground electrode worn thin at the sparking area, the plug will probably not perform efficiently and should be discarded.

If the plugs are found to be in good condition, they should be cleaned, regapped and replaced in the engine.

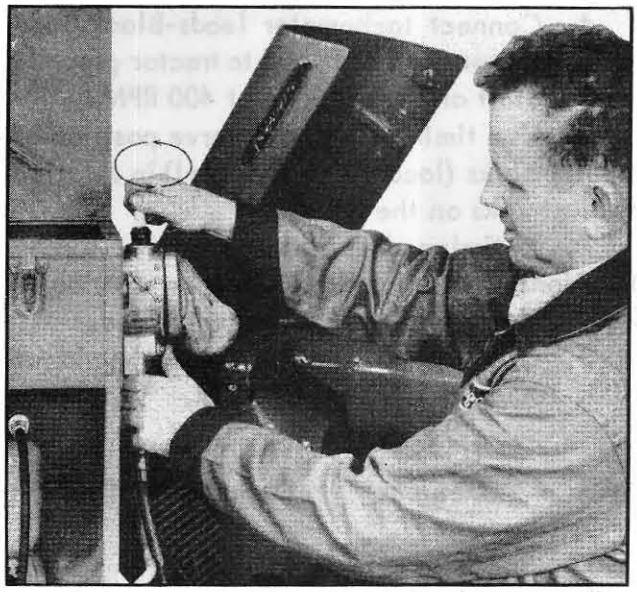


Fig. 219

Spark plugs should be cleaned and regapped after every 100 hours of operation. Always remove the old gaskets from the plugs before cleaning. Any plugs that have oily deposits on the firing end should be cleaned in gasoline or other suitable solvent that can be quickly dried with an air blast. Dry the plug thoroughly before sand blasting or the abrasive may pack inside the spark plug.

When using the abrasive blast, place the plug in the rubber adapter and holding the plug at the terminal end, move the top of the plug in a circle while applying the blast, see Fig. 219. By doing this, the abrasive will properly clean all parts of the plug.

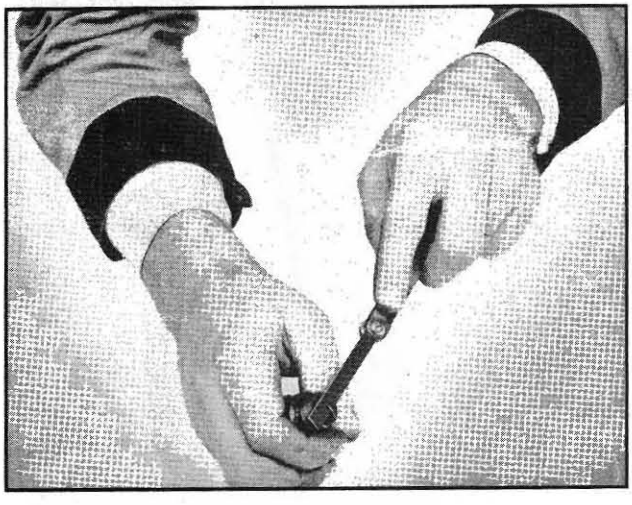


Fig. 220

About three seconds is usually sufficient time for the abrasive to clean the plug, but the cleaning time should be limited to that necessary to clean the deposits from the insulator nose. Prolonged use of the abrasive blast will wear away the insulator and damage the plug. Blow the abrasive out of the plug after cleaning with the air jet on the cleaner. Remove the dust and other foreign material from the threads with a wire brush.

Before setting the gap of a cleaned plug, pass a thin point file between the sparking areas to produce flat, parallel surfaces, see Fig. 220. Adjust the gap by moving the ground electrode. Check the gap with a wire feeler gauge. The plugs for all three tractor engines, TO-30, TO-20 and TE-20 are set at .025-.027 in.

The Ferguson tractor engine will operate more efficiently under most conditions when equipped with the standard plug. Cold plugs should be used only if the engine is to be operated continually above normal speeds or loads.

Hot plugs should be used only if the engine is in good condition and is to be used for light work.

If the plugs are of the correct heat range for the operating conditions but appear to be operating either too hot or too cold, find the real cause. Never change heat range to compensate for trouble elsewhere in the engine.

INSTALLATION

1. Check the cylinder head threads and gasket seats. The gasket seats should be clean and free from dirt, old gaskets, rust and other foreign material. To clean the cylinder head threads, place a few drops of penetrating oil or kerosene on the thread. Remove the gasket from an old plug and check the threads to make certain that they are in good condition. Screw the plug into the cylinder head as far as it will go. Remove the plug. This will clean out any deposits on the threads.

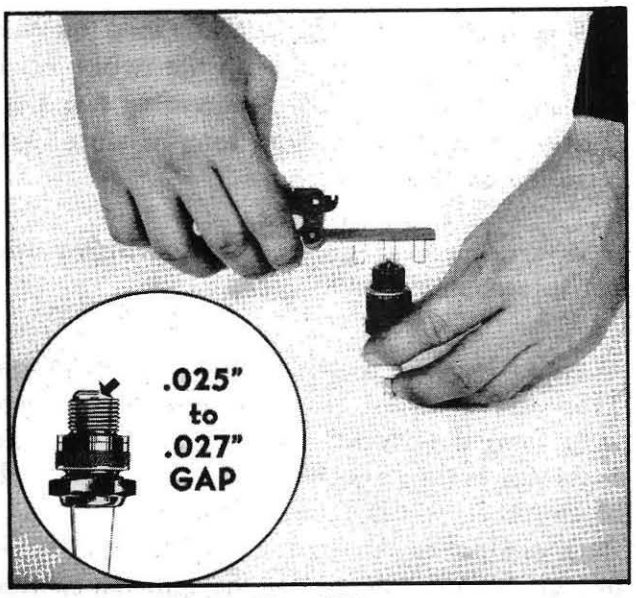


Fig. 221

2. Using a wire gauge as shown in Fig. 221, check the spark plug gap and set at .025-.027 in., check all plugs before installing. Just because the plug is new is no assurance that the gap is properly set.

3. Install new gaskets and screw the plug into the cylinder head finger tight. If the threads are clean and in good condition, the plug should seat on the gasket with only finger pressure. Using a torque wrench, tighten the plugs to 32-38 pound-feet or by threading the plug in until finger tight and tightening 3/4 of a turn.

It is recommended that whenever spark plugs are replaced, a new gasket be installed.

After the plugs have been installed and the wires connected, start the engine and allow it to warm up. Close the throttle and let the engine idle. If the old plugs were in bad condition and the idling adjustment has been set for these plugs, it may be necessary to readjust the idling jet to get smooth idling with the new or cleaned plugs.

IGNITION SWITCH

The ignition switches used on the TO-20 and TE-20 are of similar construction. Both are two-terminal, key actuated switches provided with an "on" and "off" position.

The ignition switch, 31083, used on the TE-20 may be replaced with the switch used on the TO-20, TO-3684, providing two SAE H-104 straight spoke type terminals are first installed on the wiring ends.

The component parts of the switches are not interchangeable.

Referring to the wiring diagram on page 115, the ignition switch is inserted in the wire from the "load" terminal of the voltage regulator to the negative low tension terminal of the coil, on both the TO-20 and TO-30. One terminal of the warning light is also connected to one terminal of the ignition switch on the TO-20.

The TE-20 ignition switch is in line from the hot side of the starter switch to the negative low tension terminal of the coil. One terminal of the warning light is also connected to one terminal of the ignition switch.

The switch used on the TO-30 is a combination light and ignition switch. The switch has three terminals and four positions. The positions on the switch are marked "off", "ignition, "ignition and lights" and "lights".

The terminals of the switch are marked "B" for battery, "I" for ignition and "L" for lights.

The ignition terminal of the ignition switch is connected to the negative low tension terminal of the coil. The "battery" terminal of the switch is connected to the "load" terminal of the voltage regulator. If lights are installed on the tractor, connect them to the "light" terminal of the switch.

WARNING LIGHT

The purpose of the warning light, used on TO-20 and TE-20 tractors, is to indicate to the operator when the battery is discharging.

The units used on the TO-20 and TE-20 are interchangeable as such, but the component parts are not interchangeable. The TO unit, composed of TO-3691 socket, TO-3692 bulb, TO-3681 nut, TO-3680 lock washer and TO-3690 lens, may be installed on the TE-20 tractor by soldering the white lead, from the ignition switch, to the center terminal of the socket and soldering the yellow lead, from the generator to the voltage regulator, to the outside end of the socket.

Referring to the wiring diagrams on page 115, note that the warning light is connected between the ignition switch and the armature terminal of the voltage regulator on the TO-20 tractor and between the generator armature wire and ignition switch on the TE-20 tractor.

AMMETER

The TO-30 tractor is equipped with an ammeter in place of the warning light. The type ammeter used is of necessity rugged in construction. The rugged construction prevents incorporating a greater degree of sensitivity in the instrument and it is intended to and only indicates to the operator whether the battery is charging or discharging.

Referring to the wiring diagram on page 115, note that the ammeter is connected in series with the charging circuit and all the current flowing to and from the battery passes through it. The ammeter is in the line between the "hot" side of the starter switch and the "battery" terminal of the voltage regulator.

AMMETER INSTALLATION

If it is desired to install an ammeter on the TO-20 or TE-20 tractors, several changes in the wiring must be made. The ammeter will not operate if installed in place of the warning light.

To install ammeter on the TO-20 tractor:

1. Remove the large button plug on the left side on the instrument panel. If an instrument is already in that position, a 2 1/32

WIRING DIAGRAMS

COLOR CODE 1 Black 2 White 3 Red 4 Grey 5 Yellow 6 Black & Yellow 7 Green & Black 8 Brown & White

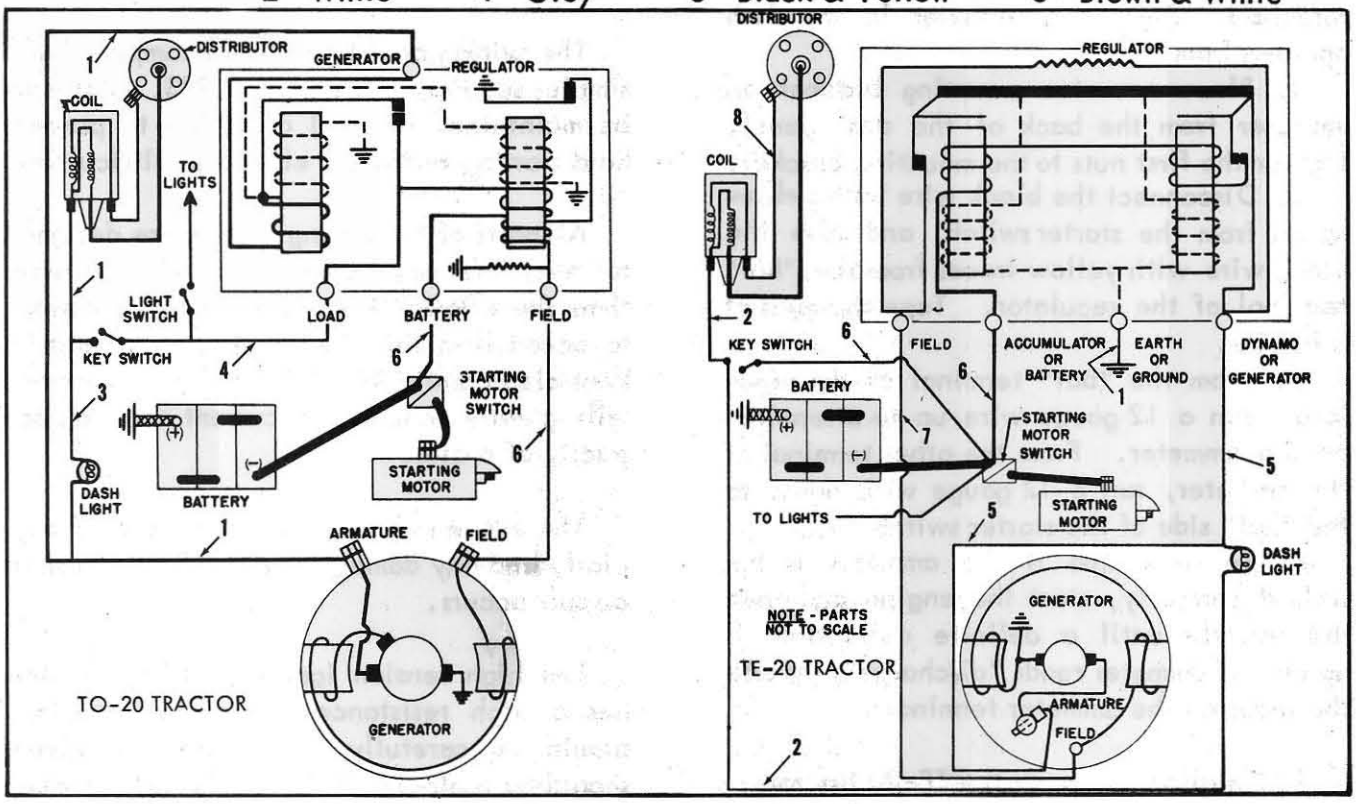


Fig. 222

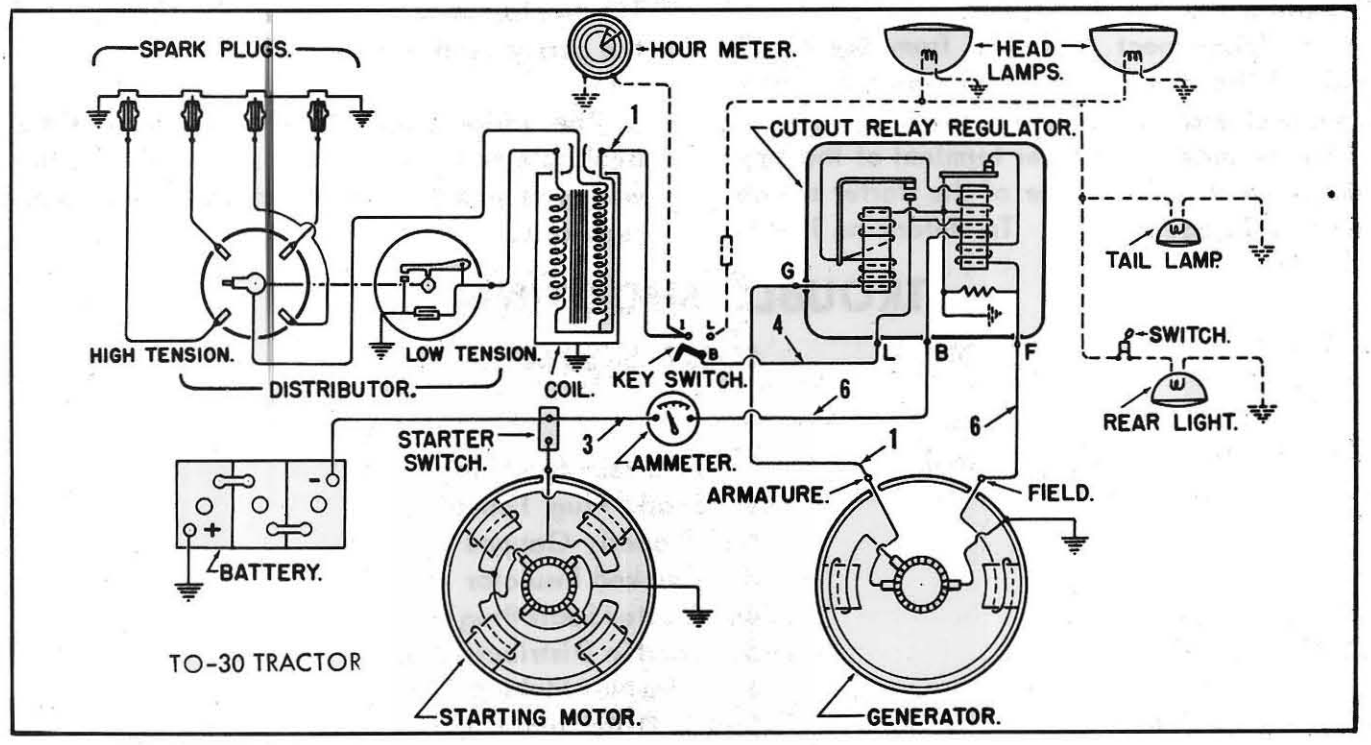


Fig. 223

in. hole will have to be made to the top right of the present opening.

2. Remove the mounting bracket from the ammeter by removing nuts and washers on the terminals. Place the ammeter in the dash opening from the top.

3. Place ammeter mounting bracket on ammeter from the back of the dash panel. Tighten the first nuts to the mounting bracket.

4. Disconnect the black wire with yellow traces from the starter switch, and also the black wire with yellow traces from the "Bat" terminal of the regulator. Tape the ends of this wire.

5. From the "Bat" terminal of the regulator, run a 12 gauge wire up to a terminal on the ammeter. From the other terminal of the ammeter, run a 12 gauge wire down to the "hot" side of the starter switch.

6. To determine if the ammeter is installed correctly, start the engine and open the throttle until a definite deflection is noted. If ammeter reads "discharge", reverse the leads on the ammeter terminals.

To install ammeter on the TE-20 tractor:

1. Proceed with Steps (1), (2) and (3) as listed for the TO-20.

2. Disconnect the wire from the "hot" side of the starter switch and attach this wire to one side of the ammeter.

3. Connect the other terminal of the ammeter to the "hot" side of the starter switch with a 12 gauge wire. To determine if it is installed correctly, refer to Step No. (6) listed for the TO-20.

TRACTOR WIRING

The wiring on the tractor is comparatively simple, see Fig. 222 and Fig. 223, but it must be maintained in good condition to prevent hard starting and other electrical difficulties.

All parts of the wiring harness are designed to carry the required current with no more than the allowable voltage drop, however, to accomplish this the contact areas must be kept clean and tight. Dirty or loose contacts will greatly reduce the current carrying capacity of a circuit.

The entire system should be inspected regularly and any damage repaired before a short circuit occurs.

The high tension ignition wiring, which has a high resistance insulation covering, should be carefully inspected. The wiring should be replaced if the insulation is broken or cracked. All high tension wiring on the TO tractors may be used on the TE tractor if the correct ends are fitted to the wire.

The various parts of the wiring harness are available as service parts. Any time that the wiring is found to be defective, it should be replaced.

TROUBLE SHOOTING

TROUBLE	POSSIBLE CAUSE
Continuous Misfire	1. Incorrect Type Plug 2. Spark Plug Fouled or Not Properly Gapped 3. Cracked Insulator 4. Shorted Spark Plug Wire 5. Short in Distributor Cap 6. Wire Not Making Contact in Distributor Cap 7. Spark Plug Wires Crossed

SPECIFICATIONS

	TO-30 (Z-129)	TO-20 & TE-20 (Z-120)
ENGINE OIL		
Weight	SAE 30 above 50 deg. F.	
	SAE 20W below 50 deg. F.	
	SAE 10W below 10 deg. F.	
Crankcase Capacity	5 qt.	6 qt.
Oil Pressure (Operating Temp.)		
Idle (400 RPM)	15 PSI min.	
Full Throttle (2200 RPM)	20-30 PSI	
OIL PUMP		
Pump Gear Backlash	.007 in. max.	
Pump Gear Side Clearance	.003-.004 in.	
Drive Gear Backlash	.005-.010 in.	
RELIEF VALVE SPRING		
Free Length	2 in.	
Test Length	1 3/8 in. @ 8 1/4 lbs. load	
FILTER		
Element Part No.	TO-18662-A	TO-18662-2
Base Cap Screw Torque	30-35 lb. ft.	
Cover Cap Screw Torque	85-95 lb. ft.	

SERVICE BULLETINS

No.	Date	Subject

NOTES

POWER TRAIN AND BRAKES

POWER TRAIN & BRAKES

The power generated by the engine is transmitted through a train of linkages to the rear wheels where an external reaction is available for motivation. The power train in this section begins at the point the clutch transmits the energy to the transmission for reduction and rotational direction. The transmission in turn conveys the power to the differential assembly which directions it at right angles into the rear axle assemblies to the rear wheels and also to the PTO shaft which drives the hydraulic pump and provides an external power outlet.

This section also includes the brake assemblies which are mounted on the outer extremities of the rear axle housings. These offer a means of controlling rear wheel rotation both for tractor braking purposes and for turning.

TRANSMISSION

The Ferguson Transmission has forged, constant mesh, helical cut gears that provide four forward speeds and one reverse speed.

The shifter forks are of forged construction and provide positive movement of the shift collar when the shift rails are moved. Detent pins locate in notches in the shift rails and control the position of the rails in neutral or when in gear.

There is a ball and pin arrangement in the rear flange of the transmission that acts as a safety device. When one rail moves, the two balls are pressed into notches in the other two rails making it impossible to shift into two gears at the same time.

In the constant mesh transmission of the Ferguson tractor, the gears are always in mesh but they are not splined to their shafts; instead, they float. Power is transmitted through these floating gears by sliding shift collars which lock the gears to their respective shafts. The collars are splined to the shafts and engage small teeth around the hubs of the gears. This type of transmission is quieter and results in less clashing of gears during shifting. The bearings which carry the shafts in the transmission are tightened until they cause a slight drag on the shaft as it turns. This so-called pre-load of the bearings assures that there will be no end-play in the shafts even after they have started to "wear in" slightly. It is necessary that there be no appreciable end-play if the transmission is to shift easily and quietly and not jump out of gear. Too much pre-load results in hard shifting.

REMOVAL

To remove the transmission:

1. Drain the oil from the three drain plugs, transmission, hydraulic pump and the rear axle assembly.
2. Remove the battery.
3. Disconnect the primary wire from the coil and the wires from the generator and from the starter switch so that the wiring assembly will be left attached to the dash.
4. Disconnect the oil line at the gauge.
5. Remove choke rod and loosen the U-bolt holding governor linkage to hand throttle rod.
6. Disconnect the air tube from the air cleaner.
7. Remove the bolts holding the fuel tank to the rear support bracket.
8. Disconnect both radius rods at the transmission and disconnect the steering drag links from the steering gear arms.
9. Disconnect the brake rods at their front ends.
10. Remove both step plates.
11. Remove exhaust pipe and muffler.
12. Remove the 7/16 in. hex bolts holding the steering housing to the transmission housing and lift off the steering assembly.
13. Remove the four bolts holding the PTO assembly to the center housing and withdraw

the PTO shaft. See page 148.

14. Remove PTO shifter and cover plate.

15. Place a jack or a support of a suitable height under the engine crankcase and a portable jack under the transmission case, remove the bolts holding the transmission case to the cylinder block and separate the two s ns. (Insert blocks between front axle and support to prevent the front assembly from tipping).

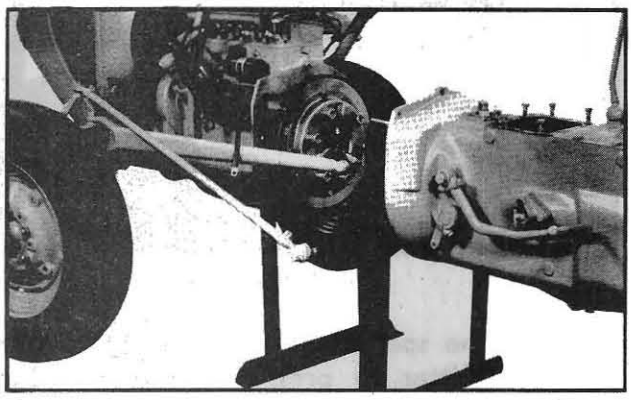


Fig. 224

16. Bolt suitable stand to the front of the transmission housing, see Fig.224, and move jack to the rear of the transmission housing.

17. Remove the bolts holding the transmission housing to the center housing and roll the rear wheels back. Bolt a suitable stand to the end of the transmission housing.

Fig. 225

DISASSEMBLY

1. Remove the transmission cover assembly and disconnect starter switch linkage from the reverse shifter rail.

2. Remove the lock screws from the shifter forks and selectors. Remove the three detent springs. Remove the shift rail stop plate at the rear of the transmission case and remove the three shifter rails being careful not to lose the two steel balls and small inter-lock plunger at the rear of the transmission case. Remove the detents and reverse gear shifter fork.

3. Remove the first and second gear shifter fork.

4. Remove the transmission main shaft rear bearing retainer and pull the main shaft.

5. Pull the main shaft from the rear, using the slide hammer as shown in Fig. 225.

Note: Be prepared to catch the 104 needle bearings from the first-speed main shaft gear which will fall out when the shaft is withdrawn from the rear of the transmission housing. Remove the loose gears from the case. Remove third and fourth gear shifter fork. Pull main drive shaft gear rearward and lift out.

6. Remove the PTO support assembly. See Page 148. The countershaft can now be removed as an assembly. Slide the assembly back in the transmission case until the forward end can be tipped up and lifted out through the top of the housing.

7. Remove bolt-and-stop from reverse gear shaft. Pull the shaft back and out of the housing and lift out the gears.

8. Remove the clutch throwout bearing, the clutch release bearing springs and the clutch release bearing hub, see Fig. 226.

9. Remove the two bolts that hold the clutch release fork to the shaft and withdraw the shaft. Remove the brake pedal (keyed to shaft) and withdraw shaft.

10. Remove the cap screws from the main shaft bearing retainer and from the countershaft bearing retainer and lift out the retainers.

11. If either the main drive shaft gear

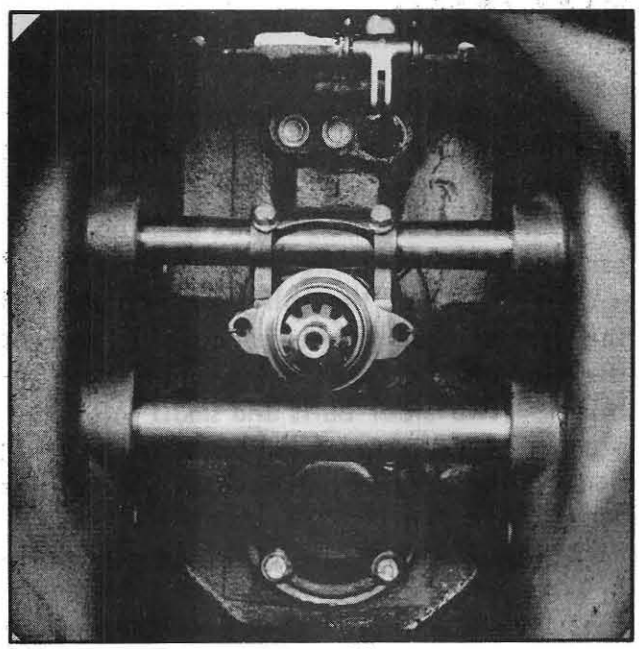


Fig. 226

bearing or the tapered-roller bearings are worn or damaged and require replacing, the bearing may be removed from the shaft by inserting a bearing splitter between the gear and the bearing and pressing the shaft out of the bearing as shown in Fig. 227. Use care in tightening the bearing splitter if it is desired to save the bearing to install on another shaft. Make sure that the bearing splitter contacts the inner race of the bearing to prevent damage to the bearing cage. To install the bearing on the shaft, position the bearing

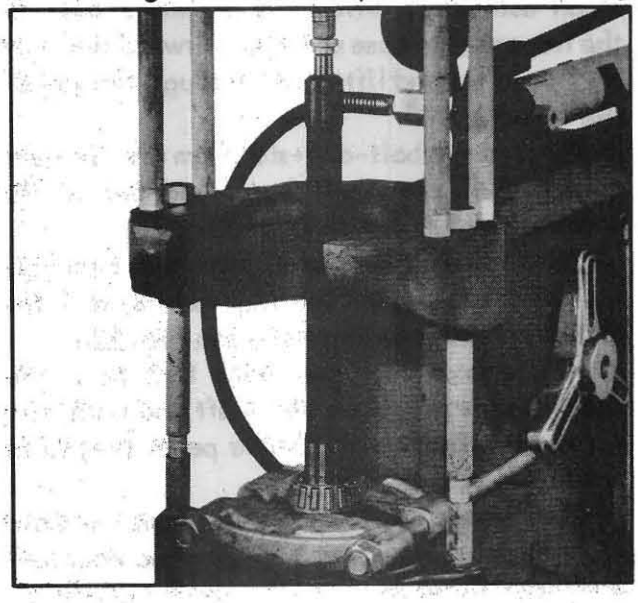


Fig. 227

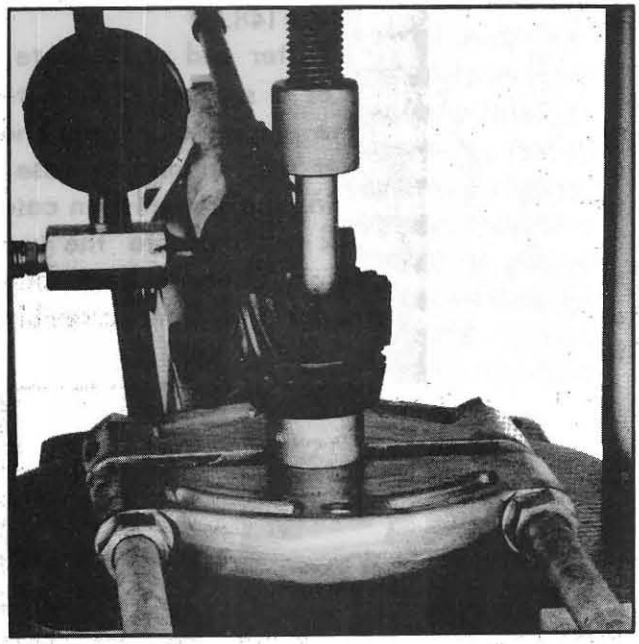


Fig. 228

and use the special collar, SDT-101, and bearing splitter to press the shaft into the bearing as shown in Fig. 228. The special collar contacts only the inner race of the bearing and prevents damaging the bearing cage.

If it is necessary to replace any of the following bearing cups: PTO support bearing cup, front main bearing cup, front countershaft bearing cup or the rear main drive shaft bearing cup, they may be pulled from the retainer as shown in Fig. 229 or by using an ex-

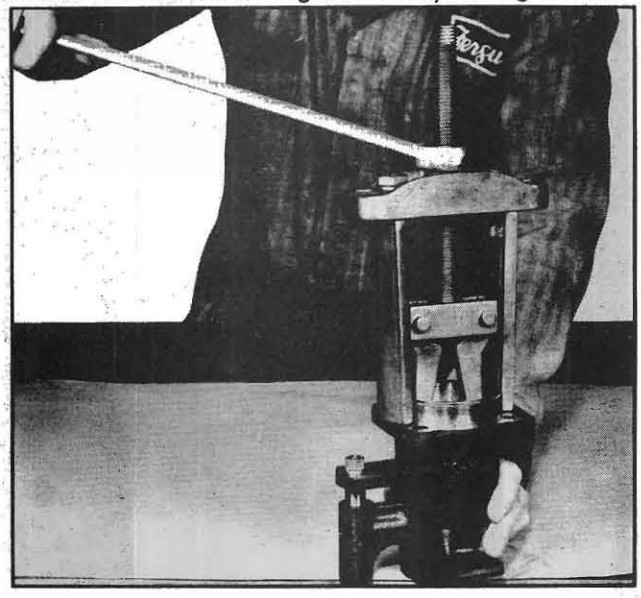


Fig. 229

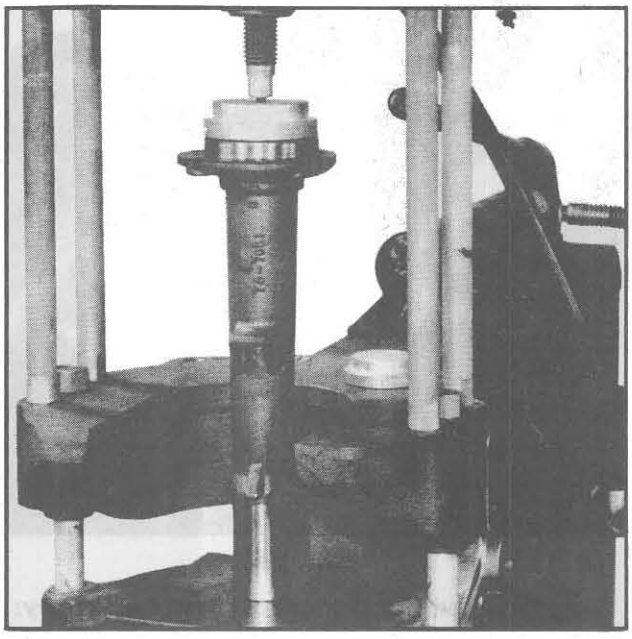


Fig. 230

panding type puller and a slide hammer.

To install a new bearing cup, select a standard step plate with an outside diameter slightly larger than the outside diameter of the bearing cup, and use the step plate to press the bearing cup into the retainer until it bottoms in the recess, as shown in Fig. 230.

Check the condition of the main drive shaft bearing retainer oil seal. This is a very critical oil seal and may be easily damaged when installing the main drive shaft. If there is any doubt as to its condition, the seal should be replaced while the transmission is disassembled. Use an expanding type puller

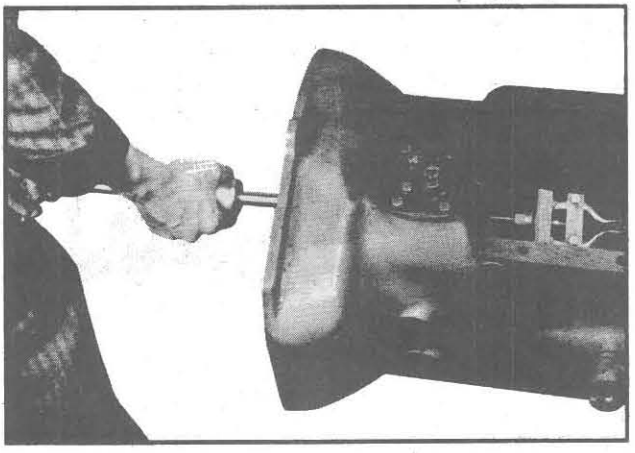


Fig. 231

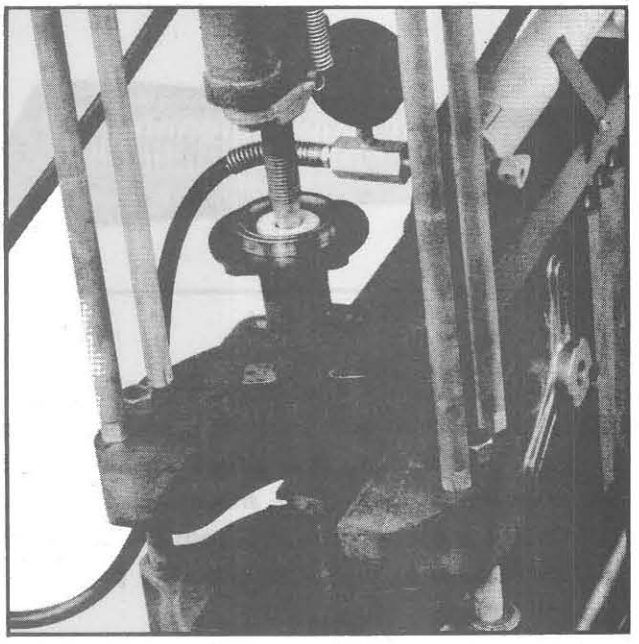


Fig. 232

and slide hammer to remove the old oil seal. Position a new seal in the retainer and use the special seal installer, SDT-102, to press the seal in place, as shown in Fig. 232. Press the seal in until the seal installer contacts the face of the retainer.

Check the condition of the reverse shifter rail oil seal. This is another critical oil seal and should be replaced whenever there is any doubt as to its condition. The old seal should be removed from the housing using an expanding type puller and slide hammer as shown in Fig. 231. To install a new seal, position the seal on the special seal driver, SDT-103, so that the feather edge of the oil seal will be

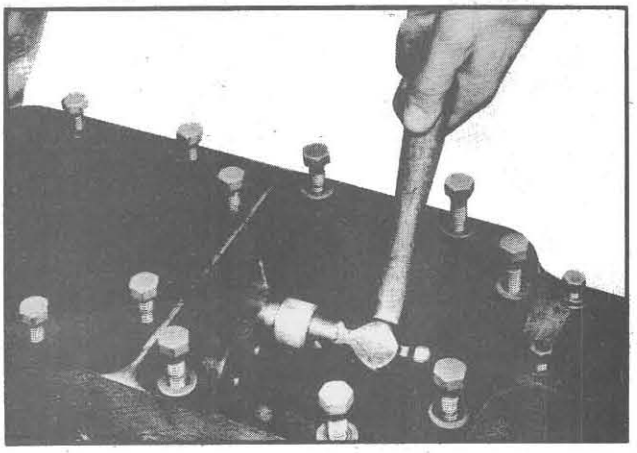


Fig. 233

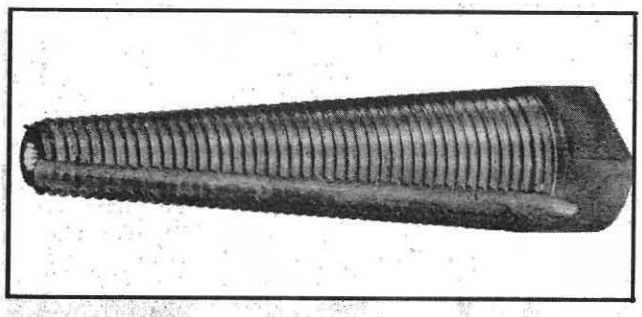


Fig. 234

toward the rear of the transmission housing. Place the driver and seal in position in the bore of the housing and drive the seal into place with a hammer as shown in Fig.233. The tool is a close fit in the bore of the housing and serves to pilot the seal into position.

The clutch and brake shafts are suspended in replaceable bushings in the transmission housing. Worn bushings allow undesirable slop in the clutch and brake linkage and also allow dust to enter the forward part of the transmission housing. The wear in these bushings can best be determined by inserting the shaft and feeling the amount of slop or clearance. To remove the old bushing, screw a threaded bushing extractor and use a slide hammer to pull the bushing as shown in Fig. 235. To install the new bushing, select the proper size standard bushing driver and using a mandrel and hammer, drive the bushing into position as shown in Fig. 236.

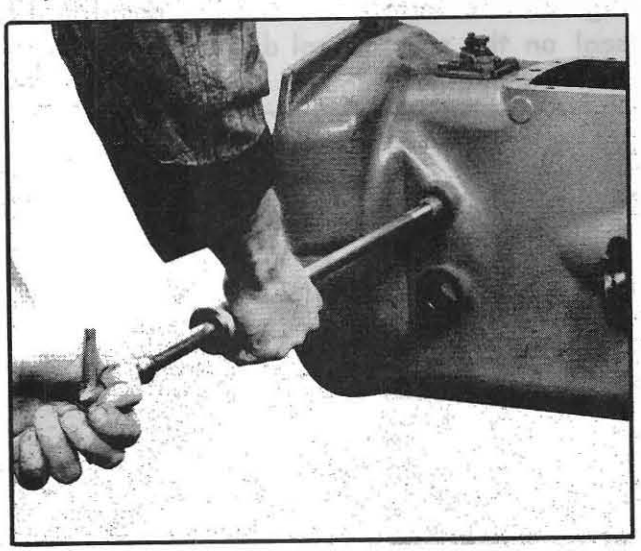


Fig. 235

Fig. 236

To disassemble the countershaft assembly:

1. Pull the large gear and tapered-roller bearing with a gear puller as shown in Fig.237.

2. Lift off the fourth gear and connector and remove the snap ring holding the third

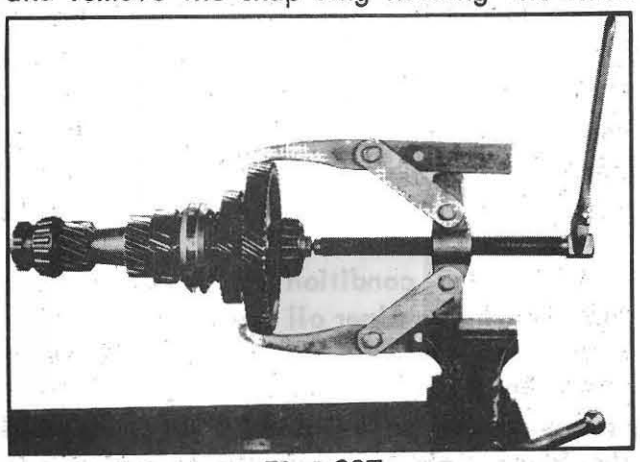


Fig. 237

gear to the shaft, as shown in Fig.238.

3. Lift off the bronze washer and third gear. Catch the 76 needle bearings.

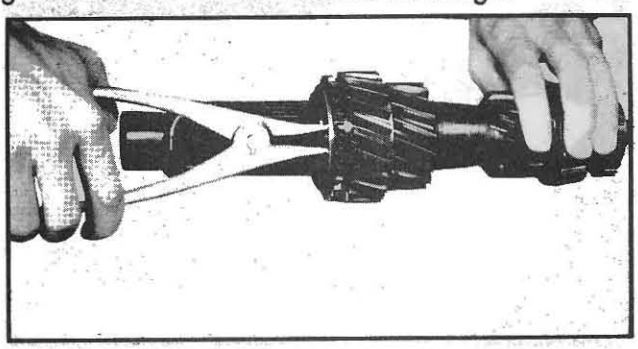


Fig. 238

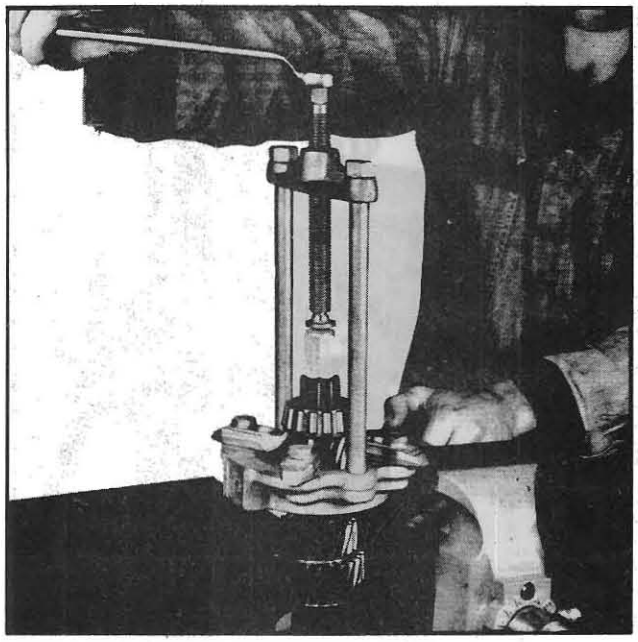


Fig. 239

4. If the bearing on the end of the countershaft is damaged and requires replacing, remove the hex head bolt, washer and PTO clutch hub from the end of the shaft. The bearing may then be pulled from the shaft as shown in Fig. 239, or carefully driven from the shaft with a punch. To install a new bearing, position the bearing on the shaft and using the special collar, SDT-104, and bearing splitter, press the shaft into the bearing. Use of the special collar prevents damaging the bearing cage.

In the TE transmission, the main shaft first-speed gear and the countershaft third-speed gear rotate on bronze bushings. Worn bushings are serviced by replacing the gear and bushing as an assembly.

In the TO-20 and TO-30 transmission, the main shaft first-speed gear, and the countershaft third-speed gear rotate on double rows of needle bearings. There are 52 needles in each row (total 104) in the first-speed gear and 38 needles in each row (total 76) in the third-speed gear.

The reverse drive gear and reverse idler gear both rotate on bronze bushings. Worn bushings are serviced by replacing the gear and bushing as an assembly.

INSPECTION

While the transmission is disassembled, all gears should be carefully examined for signs of excessive wear, cracked, chipped or broken teeth, or other damage that might affect the operation of the transmission assembly. Any damaged parts should be replaced.

Clean, examine and count the needles in the two needle bearing assemblies. Replace any needles that are lost, cracked, chipped or otherwise damaged.

If the bronze bushings in the main shaft first and second gears, or the countershaft fourth gear are damaged, or severely worn and need replacing, the gear and bushing must be replaced as a unit.

Check all tapered-roller bearings and bearing cups and replace any defective parts. It is advisable to install a new oil seal on the reverse shifter rail and on the transmission main drive shaft whenever the transmission is overhauled. Be extremely careful when inserting the reverse shifter rail and the main drive shaft through their oil seals. If these seals are cut or nicked even slightly, they may leak, allowing oil to pass into the forward part of the transmission housing where it may interfere with clutch operation or leak to the ground.

ASSEMBLY

1. Replace the reverse gear assembly. Install the bronze washer with the grooved-side facing the reverse idler gear. The washer has a small hole which permits locking at the rear of the transmission housing. Install the shifter collar with the side marked "FRONT", facing the front of the tractor, see Fig. 240. The beveled teeth of the reverse driver gear must mesh with the beveled teeth on the shifter collar. Secure the shaft in place with the lock plate and cap screw.

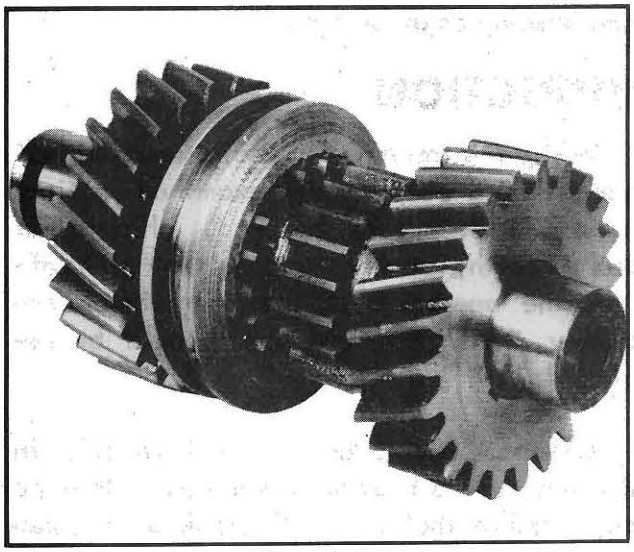


Fig. 240

2. Assemble the countershaft.

a. Place one bronze washer, TO-7253, and one spacer, TO-7572, on the shaft.

b. Coat shaft with heavy vaseline around the needle bearing surface and stick one row of needle bearings in position. Hold needles with an elastic band that has two fine wires attached on opposite sides.

c. Add second spacer, TO-7252, and second row of needle bearings, holding with an elastic band with two wires attached, see Fig.241.

d. Add third spacer washer and slide the third gear carefully over the needle bearings. Remove the elastic bands by pulling the wires as the gear slides into place.

e. Add second thrust washer and lock ring.

Slide the remaining gears onto the shaft

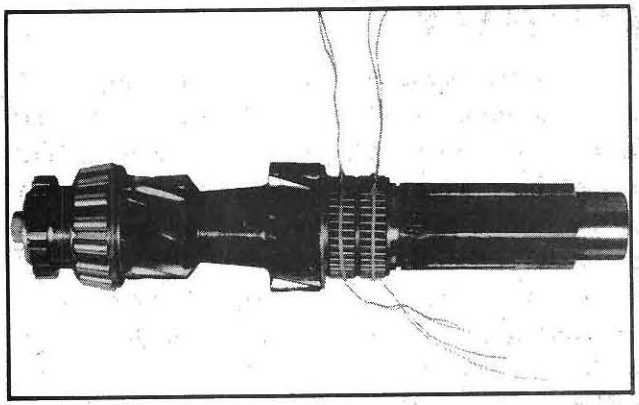


Fig. 241

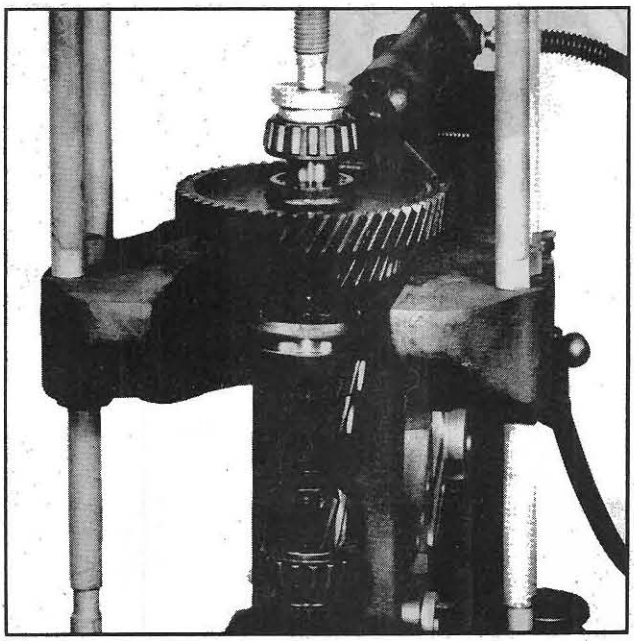


Fig. 242

in the following order; connector, TO-7127, coupling, TO-7106, fourth gear, TO-7121 and countershaft gear, TO-7113. Press the roller bearing onto the end of the shaft as shown in Fig.242.

3. Using a new gasket, install the countershaft bearing cap in the front of the transmission housing. Torque the cap screws to 24 -28 pound-feet.

4. Install some shims under the PTO housing and bolt the housing properly in place, torquing the cap screws to 24-28 pound-feet. Using a pound-inch torque wrench, and a 9/16 in. socket and extension, determine the torque required to turn the countershaft as shown in Fig.243. This torque should be 7-12

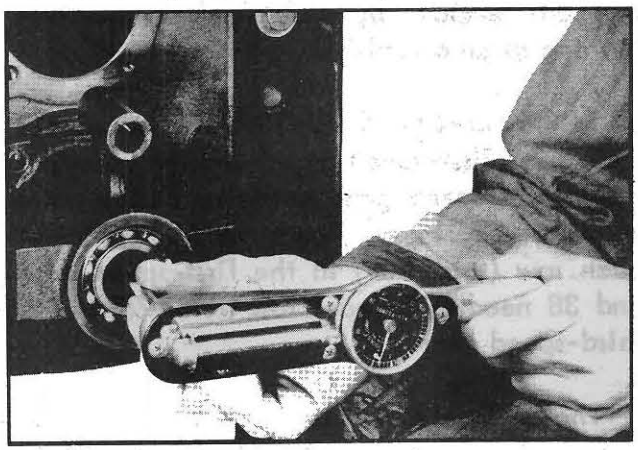


Fig. 243

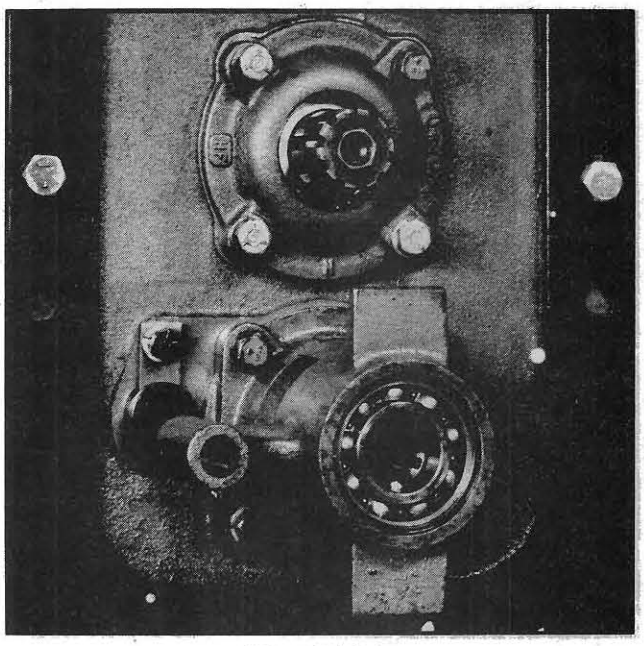


Fig. 244

pound-inches on a new transmission or 5-10 pound-inches on a transmission that has been "run-in". If the torque is not correct, the PTO shifter housing will have to be removed and the number or thickness of the shims adjusted until the proper torque is obtained.

NOTE: If the tractor has a magnesium transmission housing, a .002 or .003 in. shim should be removed after the proper torque has been obtained.

5. When the main shaft bearing retainer has a full flange, the following step will be necessary in order to install the main shaft bearing retainer. When correct number of shims have been determined for the countershaft, remove the PTO housing and turn 1/4 turn out of phase and tighten bolts enough to hold countershaft in place, see Fig. 244

6. Install the transmission main shaft bearing retainer assembly in the front of the transmission housing using new gasket. Torque the cap screws to 24-28 pound-feet. If the area where the seal engages the main shaft gear is rough, polish with crocus cloth. Slip the special protector cap over the end of the main shaft gear, see Fig. 245 and carefully slide the shaft through the oil seal into place in the retainer.

7. To install the main drive shaft, proceed as follows:

a. Coat the first gear bearing surface of the shaft with heavy vaseline or grease and place the two rows of needle bearings (52 per row) with the spacer, TO-7063, between the two rows. Hold the bearings in position with the two elastic bands with wires attached, see Fig. 246

b. Starting at the rear of the transmission, install the following: first gear, TO-7100-A, connector, TO-7105, coupling, TO-7106, second gear, TO-7119-A, and third gear, TO-7102. Slide the shaft carefully through the rear bearing hole and through the gears. As the needle bearings enter the gear, the elastic bands may be removed by pulling the wires.

c. Install third and fourth gear shift fork with lock screw to rear. Then install the fourth gear, TO-7110, with the offset to the rear. Using the slide hammer with adapter screwed into the end of the main shaft as a handle, push the main shaft through the gear

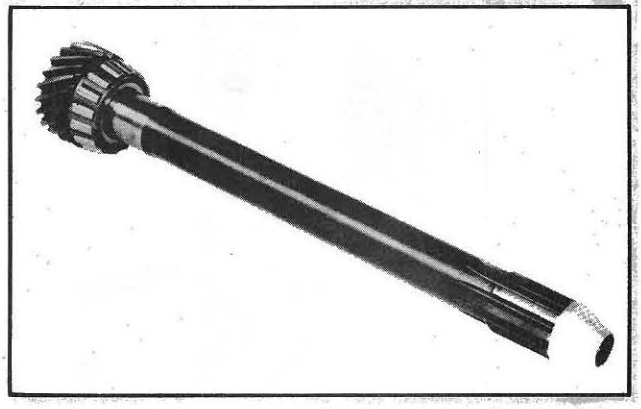


Fig. 245

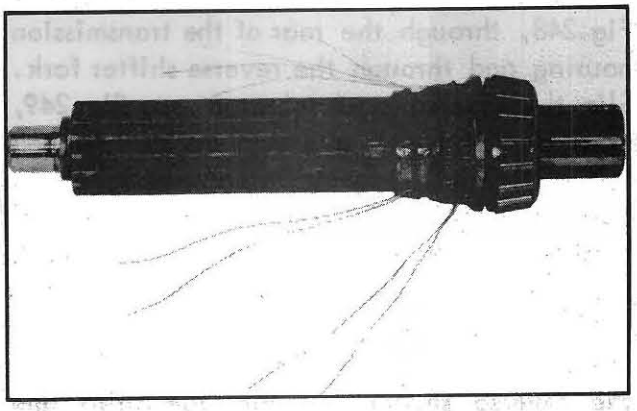


Fig. 246

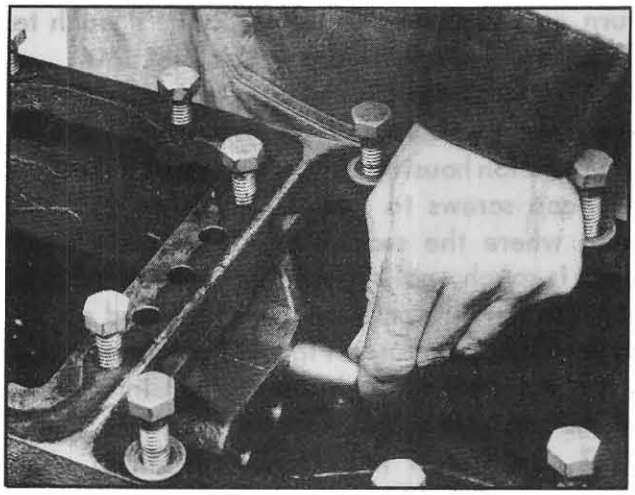


Fig. 247

and install the flat spacer washer. Insert the pilot bearing in the cone in the main drive shaft gear and seat the main shaft firmly with the slide hammer.

8. Install the reverse gear and the first and second gear shifter forks.

9. Coat the reverse shifter rail oil seal with vaseline and carefully insert the protective cap, SDT-105 through the oil seal from the front of the housing, as shown in Fig.247. Slip the reverse shifter rail, see

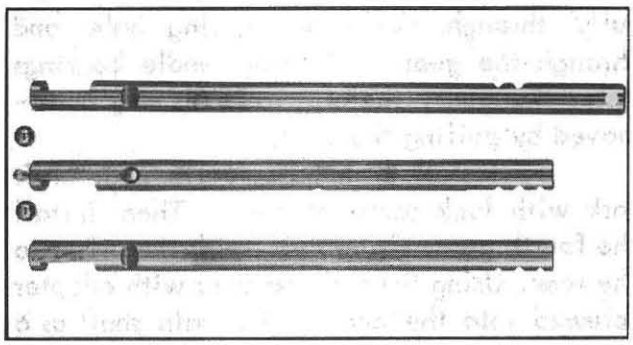


Fig. 248

Fig.248, through the rear of the transmission housing and through the reverse shifter fork. Slip the reverse gear selector, see Fig.249, onto the shifter rail and push the rail through to the front of the transmission housing. Hold the protective cap in place until the rail bottoms in the cap, then use the rail to push the cap out of the seal as shown in Fig.250.

10. Place the steel ball in the passage at the rear of the transmission housing between the reverse shifter rail and the third and fourth gear shifter rail. The third and fourth

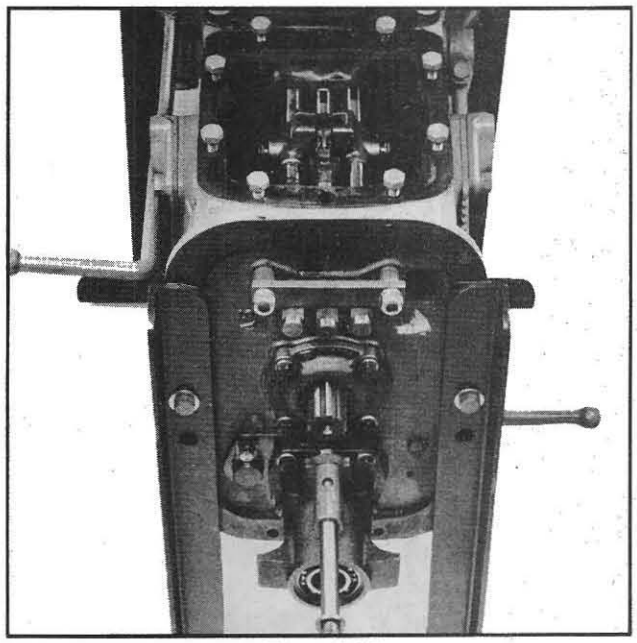


Fig. 249

gear shifter rail has a hole through it at the rear for the interlock plunger, see Fig.248. This distinguishes it from the first and second gear shifter rail which has only an indentation for the steel ball.

Place the plunger in the hole in the third and fourth gear shifter rail and slip the rail into the center hole in the rear of the transmission housing. Slip the rail through the third and fourth gear shifter fork and push it into position.

11. Place the second steel ball in the passage between the third and fourth and first

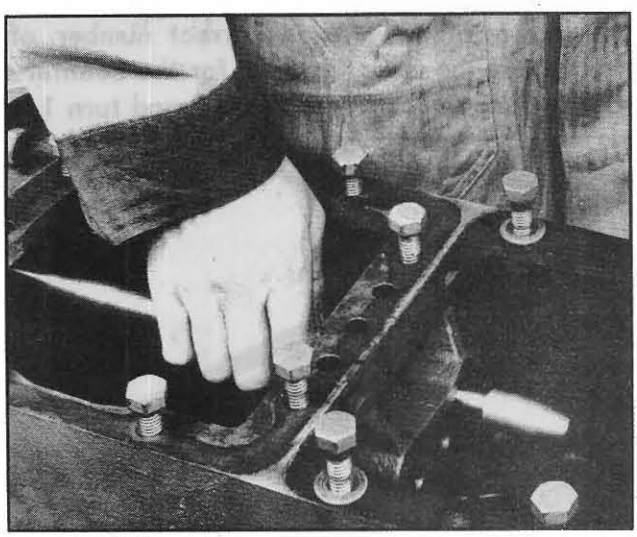


Fig. 250

shifter rails. Slip the first and second gear shifter rail through the rear of the transmission housing, through the shifter fork and selector and into position. Install the shifter rail stop plate.

12. Position the shifter forks and selectors and replace the lock screws and install the lock wires.

13. Install the rear main transmission bearing cap and shims and tighten in place, torquing the cap screws to 24-28 pound-feet.

14. With all gears assembled and set in the neutral position, the preload on the main shaft bearings should be adjusted by adding or removing shims so that the torque required to turn the main shaft is 7-12 pound-inches for a new transmission or 5-10 pound inches for a transmission that has had some use. Use the special socket, SDT-106, to adapt the torque wrench to the splined shaft, see Fig. 251, or screw a bolt into the tapped hole in the end of the shaft and use a socket and extension.

15. Replace the detents and springs, the transmission top cover, the brake shaft and the clutch release shaft and clutch release fork. Install the clutch release bearing hub,

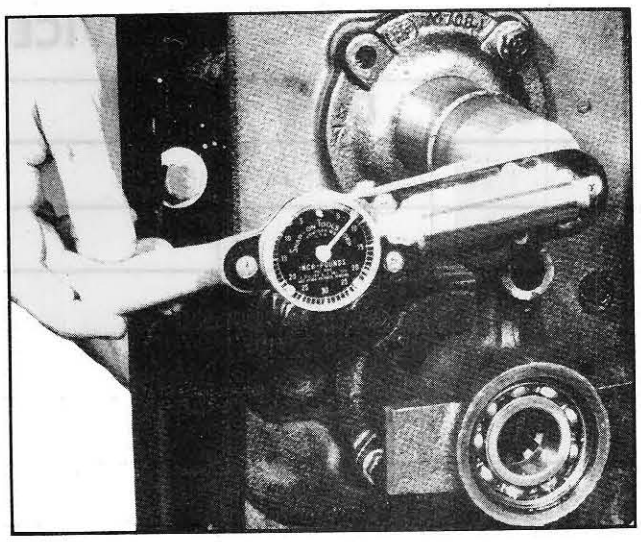


Fig. 251

springs and release bearing. Install the clutch release bearing hub, TO-7561, with the heavy part of the ears down. This will prevent the binding action that may occur if the hub is installed upside down.

To make the final assembly of the transmission to the tractor, remove the starter from the tractor then follow in reverse order the steps listed for removal from the tractor.

SERVICE BULLETINS

No.	Date	Subject

NOTES

DIFFERENTIAL & PINION ASSEMBLY

The differential consists of a spiral bevel gear and matched pinion, a differential spider, four differential pinions, two side gears and the case. The side gears and pinions are mounted inside the differential case and are backed with thrust washers. The ring gear is riveted to the differential gear case and the entire assembly is suspended in the center housing by two tapered-roller bearings, one located in each axle housing.

The drive pinion is straddle mounted, having two opposing roller bearings at the front and a straight roller bearing at the back of the pinion. The differential and pinion assembly is shown in Fig. 252

The two tapered-roller bearings which carry the differential assembly are lubricated by oil splashed up by the ring gear. The oil is caught in two troughs which lead to points where it drips down on the bearings.

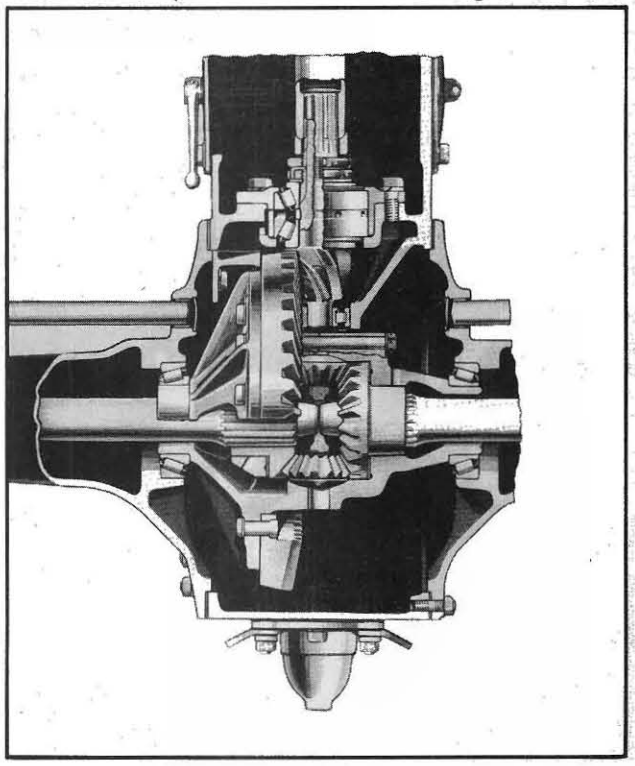


Fig. 252

DIFFERENTIAL REMOVAL

The differential assembly can be removed without disassembling the transmission or hydraulic system by following the steps below:

1. Drain the oil from the transmission, hydraulic pump and the center housing.
2. Jack up and remove both rear wheels.

Caution: If only one wheel is raised, the tractor weight on the one axle, without the other axle in place to butt against, may cause the remaining axle to slide in slightly and damage the oil seal, resulting in an oil leak on the brake linings. If the right wheel is not removed, the inner end of the axle will tilt upward making it difficult to reinstall the differential assembly.

3. Remove the lower link assemblies and the leveling rods. Disconnect both brake rods at the rear.
4. Remove the left brake drum and the six nuts holding the bearing retainer and brake backing plate to the axle housing.
5. Withdraw the axle shaft from the axle housing, noting the position of the gaskets and shims and being very careful not to let the weight of the axle rest on the oil seal.

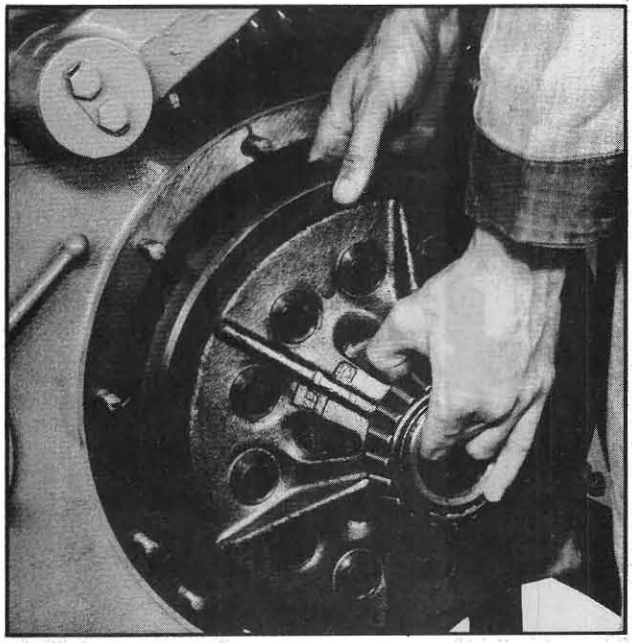


Fig. 253

Remove the left-hand fender.

6. Remove the left-hand axle housing and lift out the differential case, see Fig.253.

DIFFERENTIAL DISASSEMBLY

1. Mark both halves of the differential case with a center punch or chisel, see Fig. 254, to insure reassembly in the same relative position.

2. Remove the locking wire and the retaining bolts and separate the two halves of the case. The differential pinions, spider and side gears can then be removed.

3. The tapered-roller bearings may be removed from the differential case as shown in Fig.255. Make sure that the bearing splitter contacts the inner race of the bearing if it is desired to save the bearing. If either of the tapered-roller bearings require replacing, the mating bearing cup must also be replaced to maintain the proper preload on the bearings. See page 141 under Rear Axle Assembly for information on replacing the differential support bearing cups.

4. To remove the ring gear from the case, drill the rivets and drive out with a punch.

DIFFERENTIAL REASSEMBLY

Inspect all parts of the differential assembly for signs of excessive wear or other damage. Check the bronze thrust washers and if they show signs of wear, they should be replaced, as worn thrust washers behind the pinions and side gears will cause excessive backlash between these gears and may also prevent the gear teeth from making full contact. When installing a new ring gear, bolt the ring gear and case together with the special bolts provided with the new ring gear. Tighten all bolts evenly to 83-88 pound-feet torque.

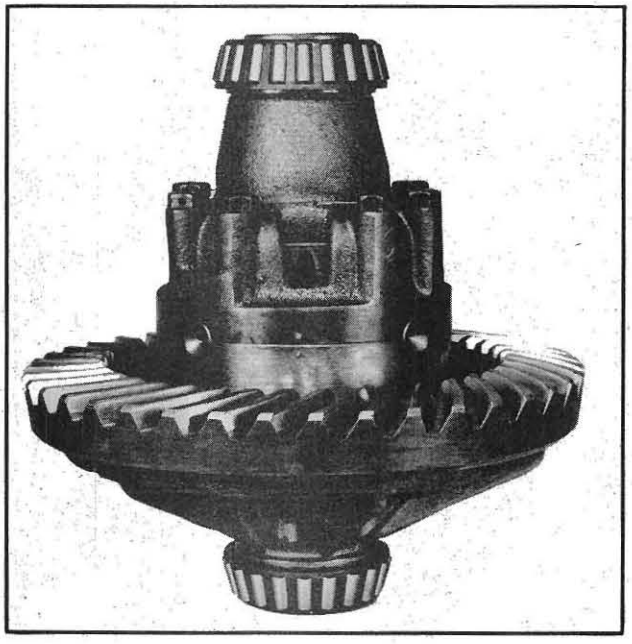


Fig. 254

The reassembly of the differential case is the reverse of the disassembly. The thrust washers must be replaced behind the side gears and pinions. Be sure that the two halves of the case are reassembled in the same relationship to each other they had before disassembly. Support the assembly as shown in Fig.256, tighten the bolts to a torque of 47-53 pound-feet and lock in place with a lock wire.

If either of the differential carrier bearings are removed, they may be replaced in a press before the two halves of the differential case are reassembled or after final assembly of the case is made as shown in Fig.258. In

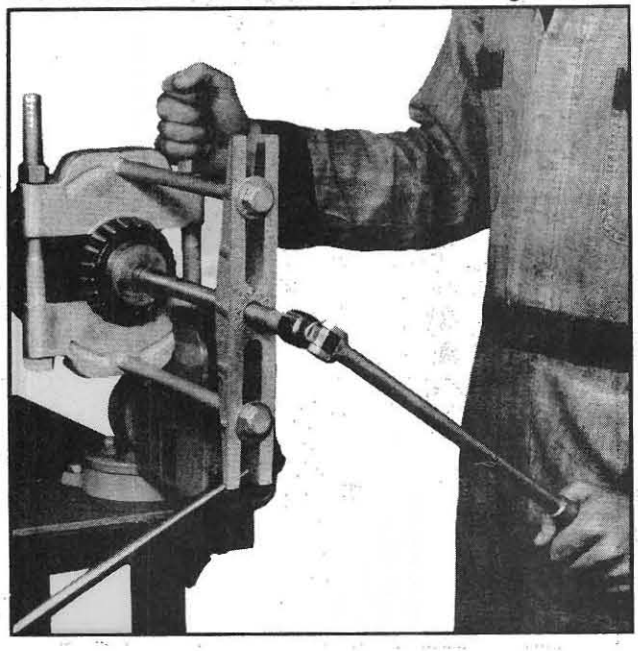


Fig. 255

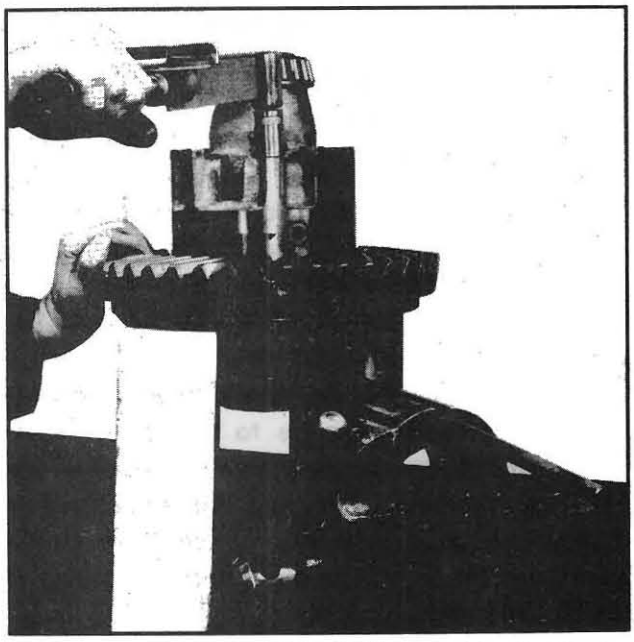


Fig. 256

either case, use the special step plate, SDT-107, to press the bearing onto the case. The use of this special recessed step plate permits the bearing to be pressed onto the case until it contacts the shoulder of the case without damage to the bearing cage.

The ring gear backlash and mesh patterns and the preload of the differential carrier bearings are fixed and non-adjustable and are

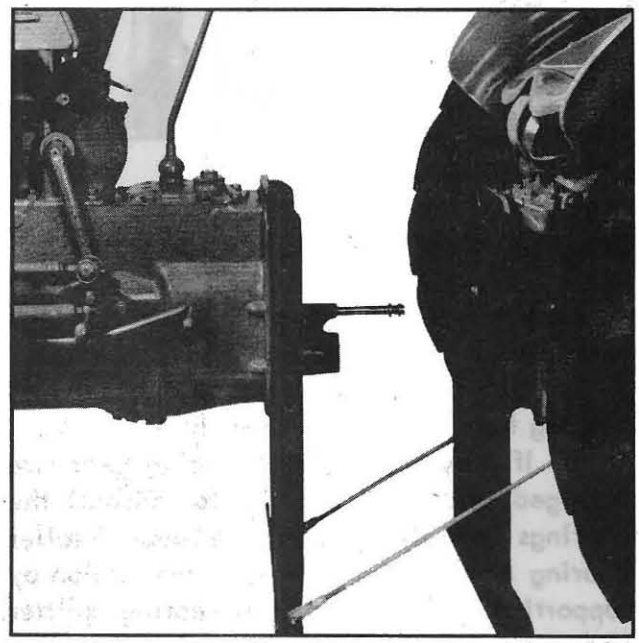


Fig. 257

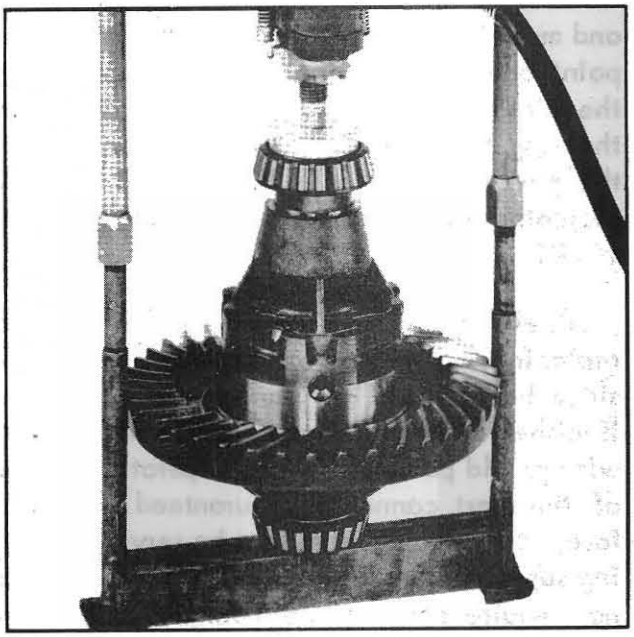


Fig. 258

controlled by the machining tolerances and gaskets.

In order to measure the amount of wear that has occurred in the ring gear and pinion, it will be necessary to first remove the PTO shaft and PTO shifter cover and split the tractor between the transmission and the center housing, as shown in Fig. 257. Remove the drive shaft from the pinion shaft and second gear

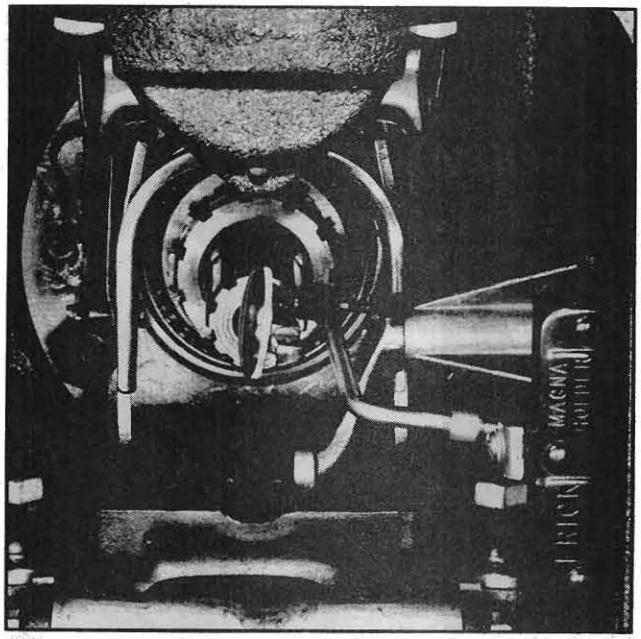


Fig. 259

and mount a dial indicator so that the contact point bears on a spline of the forward end of the pinion shaft, as shown in Fig.259. Lock the ring gear so that it can't move and rotate the pinion as shown in Fig.260. The total indicator reading should be between .010-.014 in.

If either the ring gear or pinion require replacing, both must be replaced as a unit since they are available only in matched sets. If either a new ring gear or pinion is mated with an old part, satisfactory operation or life of the part cannot be gauranteed. Therefore, the customer will best be served by being supplied a matched set. Matched sets do not require checking for backlash as this has been accounted for in the matching process.

BEVEL PINION REMOVAL

The bevel pinion unit is removed from the center housing as follows:

1. Remove the muffler, both step plates, the PTO shifter cover and shaft.
2. Remove the bolts from the hydraulic lift cover, disconnect the control fork from the control valve, and remove the hydraulic lift unit as described in the section on the Ferguson System.

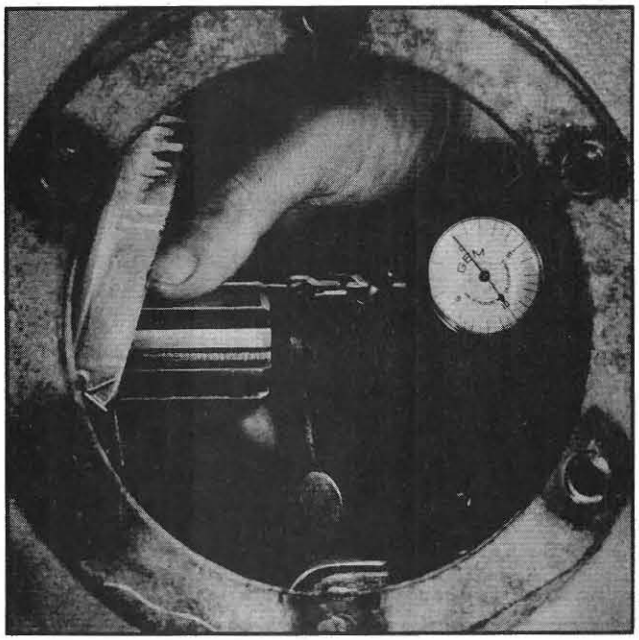


Fig. 260

3. Remove the bolts securing the hydraulic pump assembly to the tractor and remove the pump.
4. Place a portable jack under the transmission housing, remove the bolts attaching the transmission housing to the center housing and roll the front of the tractor forward.

Note: Place blocks between front axle and front axle support to prevent the front assembly from tipping.

5. Remove the six cap screws retaining the pinion bearing sleeve to the center housing. Pinion and bearing sleeve assembly can now be removed. It may be necessary to screw two bolts into the sleeve to force the pinion assembly out of the housing, as shown in Fig.261.

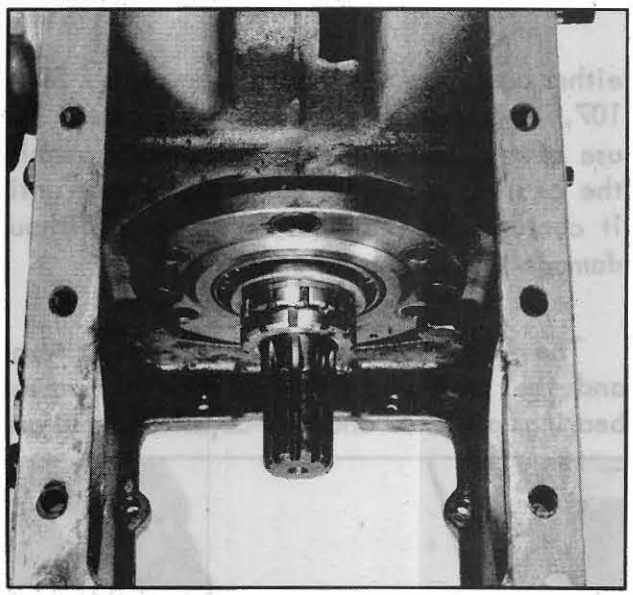


Fig. 261

BEVEL PINION DISASSEMBLY

1. Remove the two pinion bearing lock nuts, special lock washer and thrust washer.
2. Remove the pinion and the tapered bearing from the sleeve assembly.
3. If only the pinion and ring gear are damaged and it is desired to reinstall the bearings on a new pinion, the tapered-roller bearing may be removed from the pinion by supporting the bearing in a bearing splitter and pressing out the pinion as shown in Fig. 262. Make sure that the bearing splitter makes

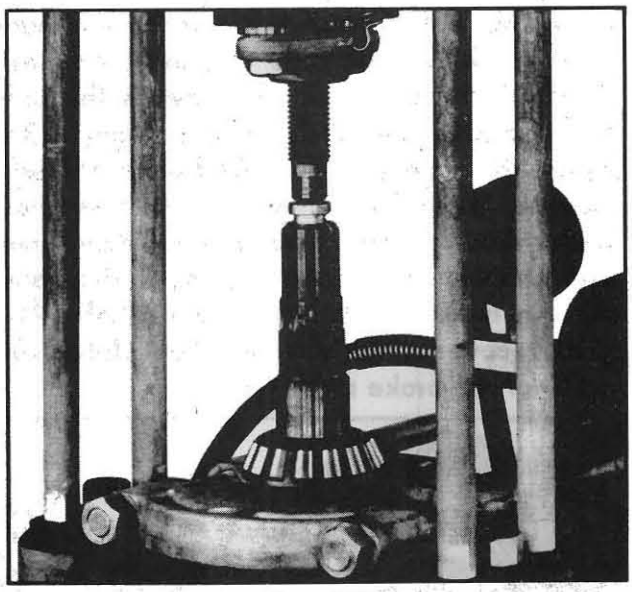


Fig. 262

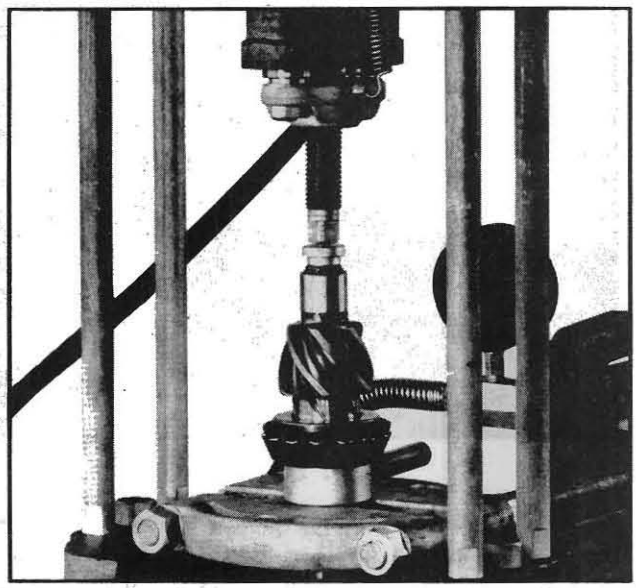


Fig. 263

a good contact with the inner race of the bearing to prevent damage to the bearing cage.

On the TO-30 pinion, the straight-roller pilot bearing may be removed from the end of the pinion by supporting the bearing in a gear splitter and pressing out the pinion.

4. If the bearings are damaged and require replacing, proceed as follows:

a. Remove the tapered bearing from the pinion as instructed above.

b. TO-30—Remove the pilot bearing as instructed above. The bearing cups are not serviced separately and it will be necessary to replace the bearing sleeve assembly.

c. TO-20 - TE-20—The bearing cups may be pulled from the bearing sleeve assembly using a standard puller. Pull the pilot bearing from the housing using a puller and slide hammer. If either of the tapered roller bearings require replacing, the mating bearing cup should also be replaced.

BEVEL PINION REASSEMBLY

1. Use the special sleeve, SDT-108, and bearing splitter in a press, as shown in Fig. 263 to press the pinion into the bearing.

2. Press the pilot bearing on flush with the end of the pinion shaft with a flat step plate on the TO-30 pinion. Use a soft faced hammer to tap the TO-20 and TE-20 pilot bearing in place in the center housing, being careful to properly align the bearing with the bore in the housing before driving in the bearing.

3. Use the special step plate, SDT-109, to press the bearing cups into the sleeve assembly of the TO-20 and TE-20, as shown in Fig.264.

4. Place the pinion in the sleeve assembly and install the front roller bearing thrust washer, and the two locking nuts with the special lock washer between them.

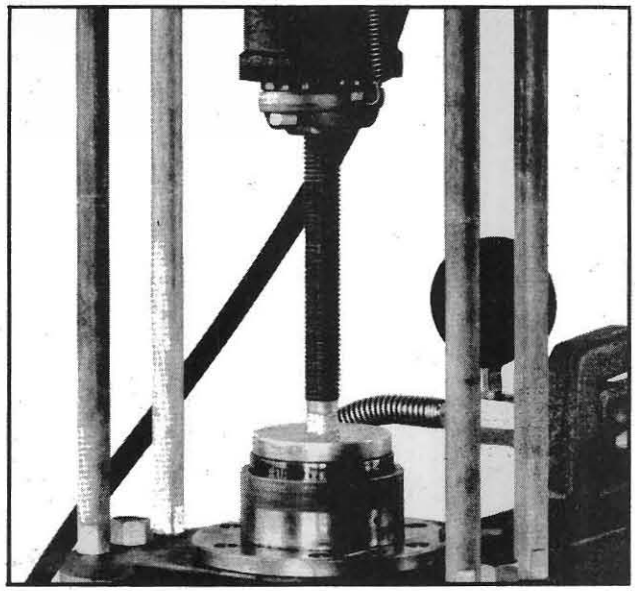


Fig. 264

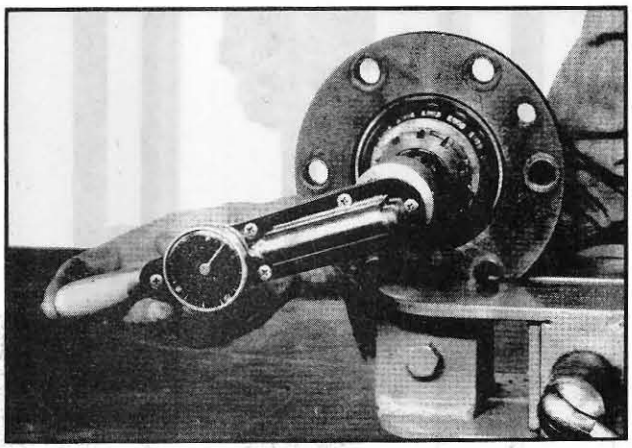


Fig. 265

5. Place the assembly in a vise and tighten the lock nut until a drag of 6-8 pound-inches is obtained when rotating the pinion shaft steadily. Use the special socket, SDT-110, and pound-inch torque wrench as shown in Fig. 265. After the proper torque is obtained, tighten the locking nut using two spanner wrenches as shown in Fig. 266. Lock the nuts securely with the special lock washer.

6. Install the pinion assembly and securely tighten the six cap screws.

INSTALLATION

Slide the differential assembly into the center housing and onto the right-hand axle as far as it will go. Replace the left-hand axle housing. Use only one manufacturer's standard thickness gasket between the axle shaft housing and the center housing. Replace the axles, as described under the section on "Rear Axle", wheels, lift assembly and hydraulic pump. Replace the drive shaft and connect the center housing to the transmission housing, install the PTO shaft, PTO shifter cover, muffler and step plates and connect the brake rods.

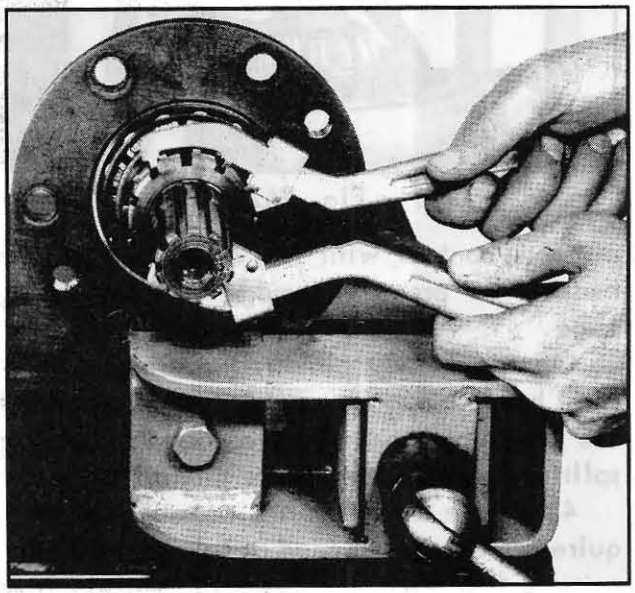


Fig. 266

SERVICE BULLETINS

No.	Date	Subject

NOTES

REAR AXLE ASSEMBLY

The rear axle assembly consists of a right and left hand axle housing, axle shafts, bearing retainers, bearings and oil seals.

The axle housings are attached to the center housing and contain the lower link pins which are the pull points of the tractor.

The axle shafts are of forged steel construction with their inner splined end supported in the differential side gears. The outer end is supported by a tapered roller bearing located in the bearing retainer which is bolted to the outer end of the axle housing. The tapered bearing, held in place by a retaining ring, prevents the axle shaft from moving out of the housing, while the inward movement is controlled by the axles butting together in the differential.

On the TO-30 tractor, an oil seal is installed in the outer end of the axle shaft housing and the outer bearings are packed with grease. The axle shaft must be removed or pulled partially out to repack the outer bearings with grease. The two oil seals, one in the axle housing and one in the bearing retainer, hold the grease in the bearing retainer housing, see Fig. 269.

The outer bearings on the TO-20 and TE-20 tractors, see Fig. 268, are lubricated by oil thrown out from the differential. The oil is prevented from going past the bearing by the oil seal in the outer flange of the bearing retainer.

REMOVAL

To remove a rear axle assembly, proceed as follows:

1. Jack up both rear wheels and drain the oil from the center housing.

Caution: It is essential that both rear wheels be jacked-up even though only one

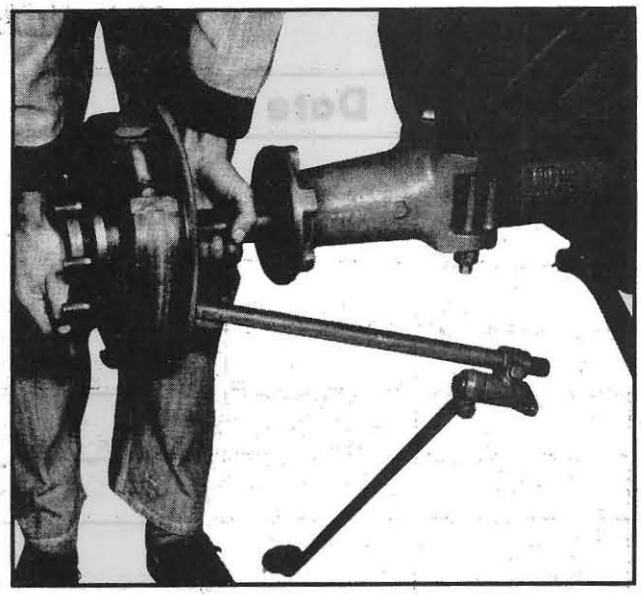


Fig. 267

rear axle is to be removed. If only one wheel is raised, an uneven weight distribution could be concentrated on the axle remaining. With this condition existing, any movement of the tractor may result in damage to the oil seals in the housings.

2. Remove rear wheel, fender and brake drum.

3. Remove the lower link assembly and lift leveling rod. Disconnect brake rod at the rear.

4. Remove the six nuts holding the bearing retainer and the brake backing plate to the axle housing and withdraw the axle shaft, as shown in Fig. 267, noting the position of the gaskets and shims.

5. Block up the center housing and remove the axle housing.

DISASSEMBLY & SERVICING

The oil seal, bearing and bearing retainer are held in place by a shrink fit between the bearing retainer collar and the axle shaft. In order to replace the oil seal, bearing, bearing retainer or axle shaft, it is necessary to first remove the bearing retainer collar.

To remove the retainer collar, drill it with a 1/4 in. drill and split with a cold chisel.

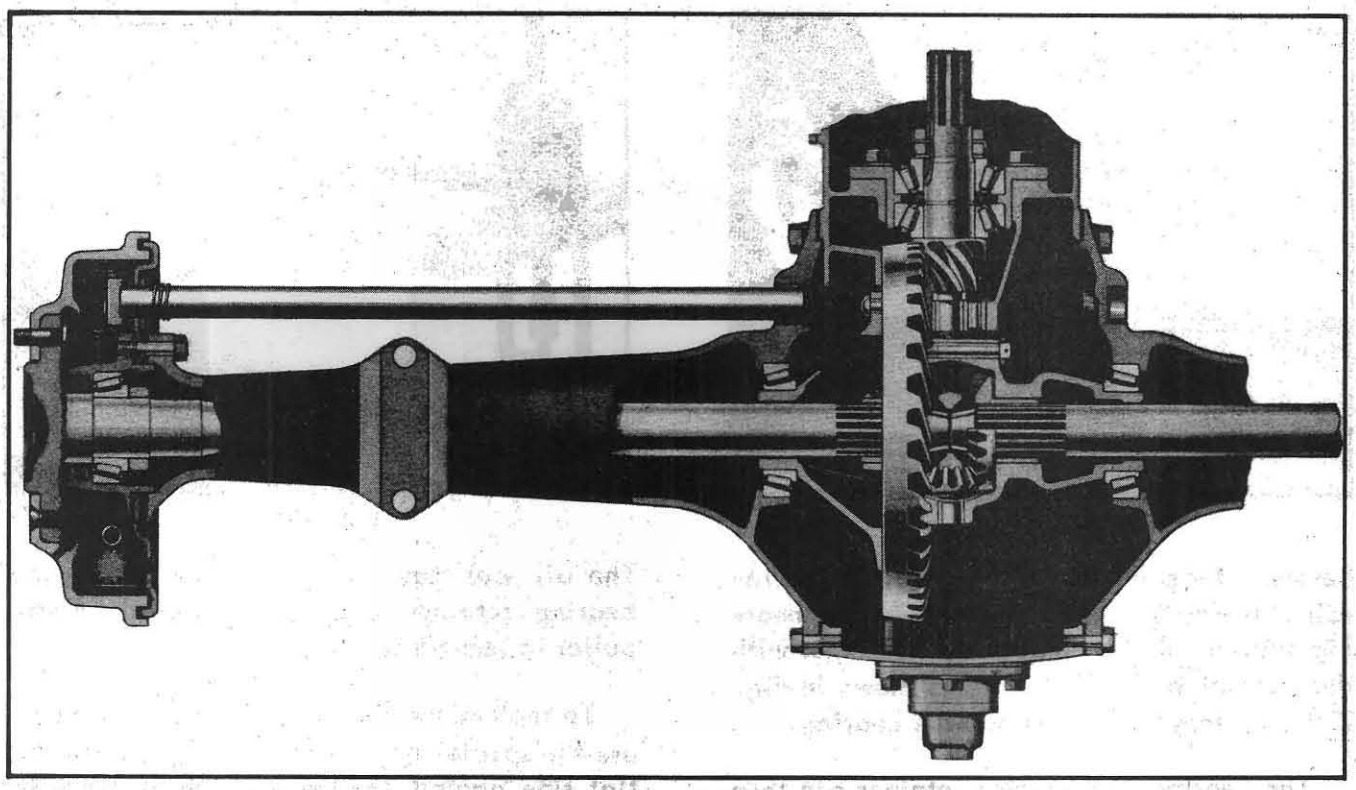


Fig. 268

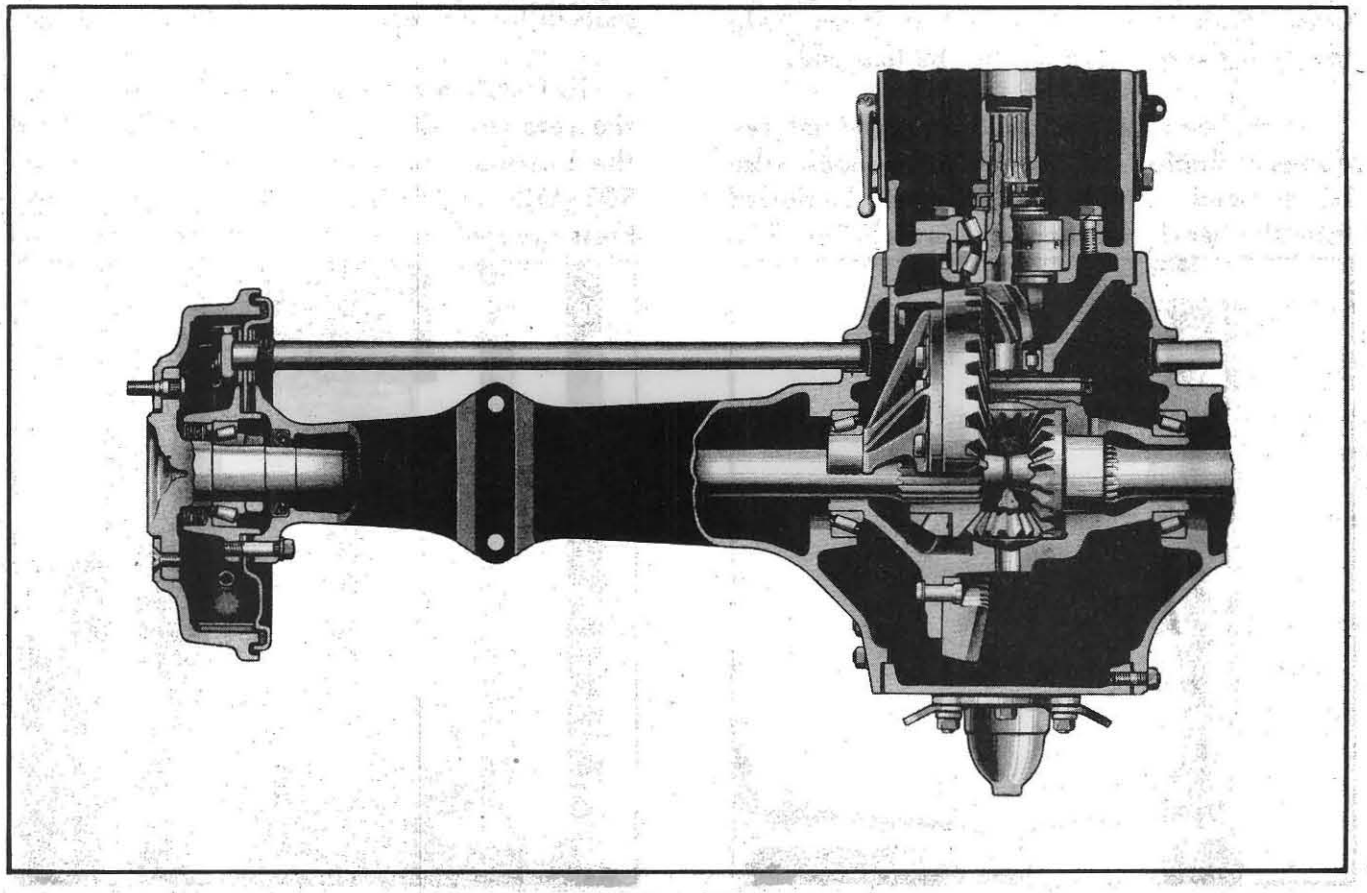


Fig. 269

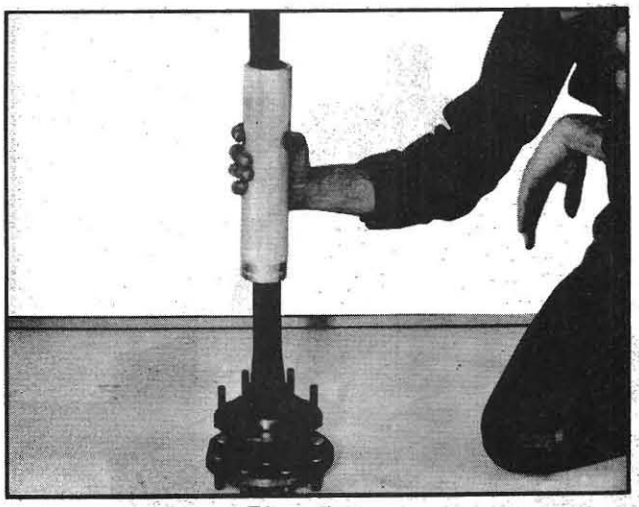


Fig. 270

Before attempting to pull the bearing and retainer it may be some help to strike the bearing retainer collar sharply several times with the special tool, SDT-111, as shown in Fig. 270. This may help to loosen the bearing.

The bearing and bearing retainer can then be pulled from the shaft as shown in Fig. 271 Once tension is put on the puller, it may help to strike the axle sharply on the hub end.

If the bearing has been damaged and requires replacing, the bearing cup should also be replaced. The bearing cup may be pulled from the bearing retainer as shown in Fig. 272.

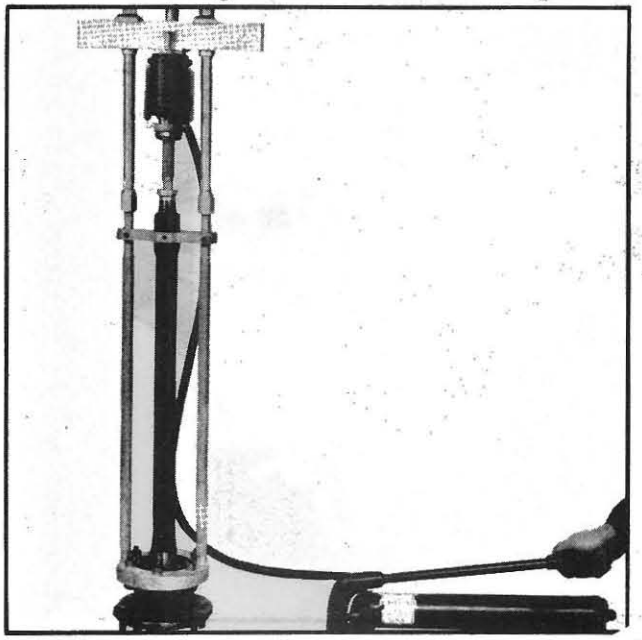


Fig. 271

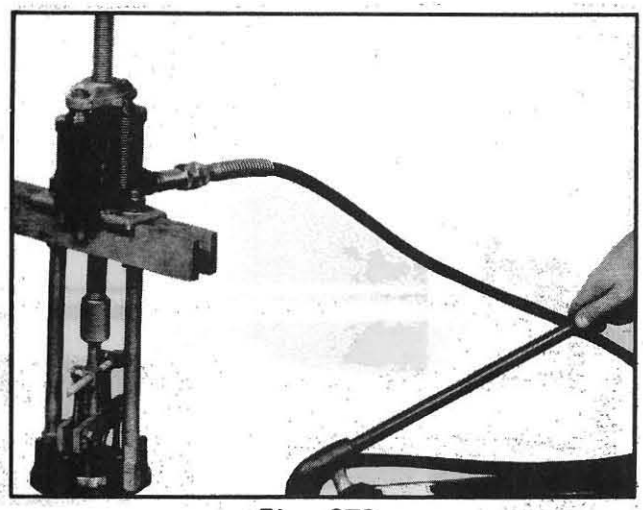


Fig. 272

The oil seal may be removed by turning the bearing retainer over and using the same puller to remove the seal.

To replace the bearing cup in the retainer, use the special step plate, SDT-112, with the flat side against the bearing cup as shown in Fig. 273, and press the bearing cup in until it seats in the bottom of the bore in the retainer.

To install a new seal, position the seal on the retainer with the feathered edge toward the bearing, and with the special step plate, SDT-112, positioned as shown in Fig. 274. Press the seal in until the shoulder of the step

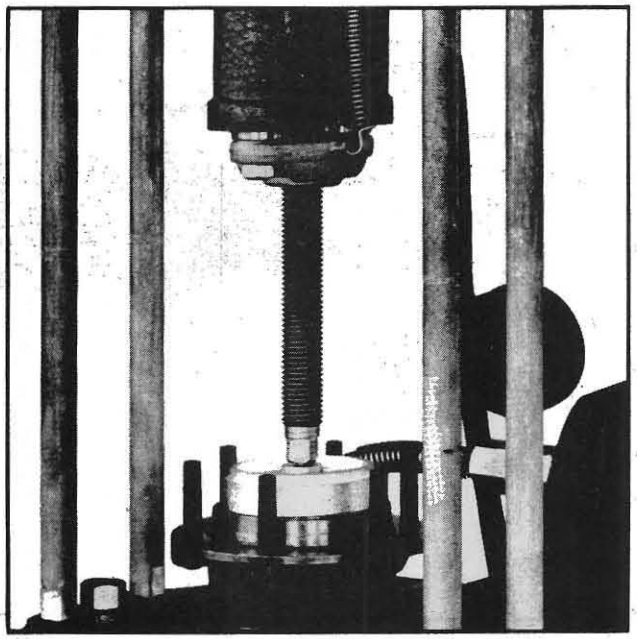


Fig. 273

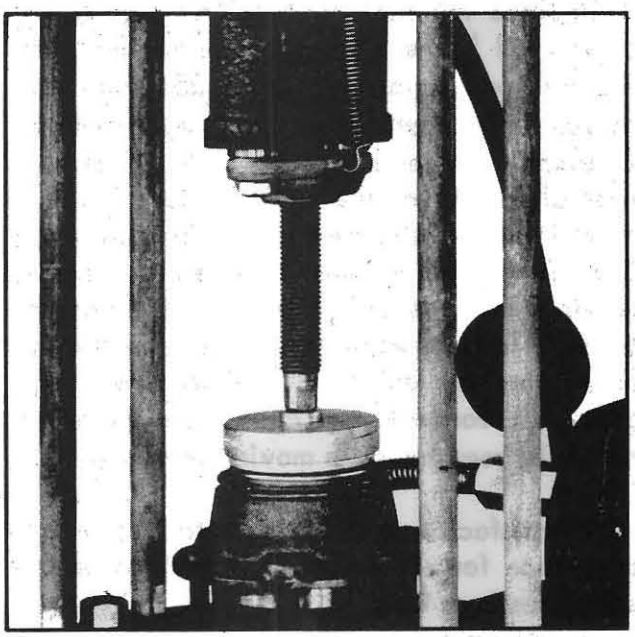


Fig. 274

plate contacts the bearing retainer. This positions the seal correctly.

Before reassembly, the axle shaft should be examined at the oil seal location for roughness. If the axle is not perfectly smooth, it should be polished with fine emery cloth to prevent damage to the seal. The new seal should be thoroughly soaked in oil before installing, and the axle shaft coated with grease at the oil seal location to prevent damage to the seal before proper lubrication reaches it.

Two types of rear axle shafts have been used on Ferguson tractors; the butt end and the button end. The butt end type has a flat end of approximately 1 1/4 square in., the button end has a machined button on the end which provides a rounded point of contact. When replacing an axle, install the same type as the one removed.

Place the bearing retainer housing in position on the axle shaft, drop the tapered bearing over the end of the shaft and drive into position using the special tool, SDT-111. Heat the bearing retainer collar to approximately 250 degrees F., drop it over the axle shaft and drive it firmly into position against the bearing using the special tool, SDT-111, as shown in Fig. 270.

If the differential carrier bearings are damaged and require replacing, the inner bearing cup in the axle housing should also be replaced. The inner bearing cup can be removed from the axle housing, using puller as shown in Fig. 275

Press the new bearing cup into position us-

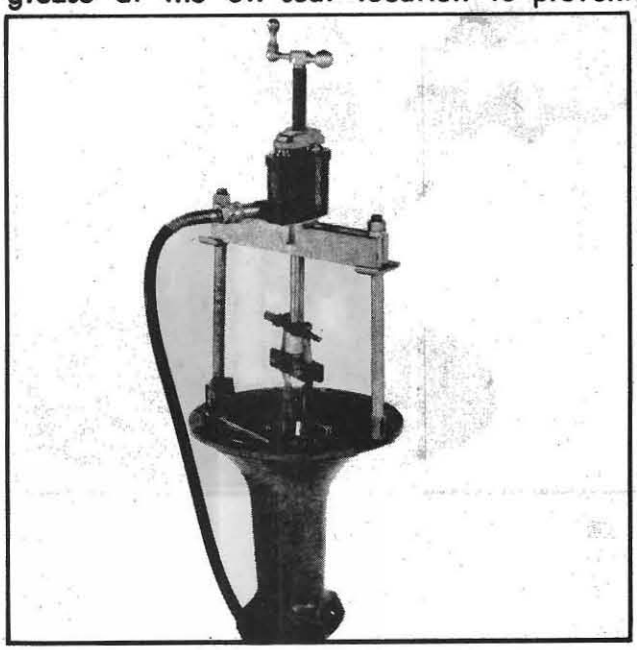


Fig. 275

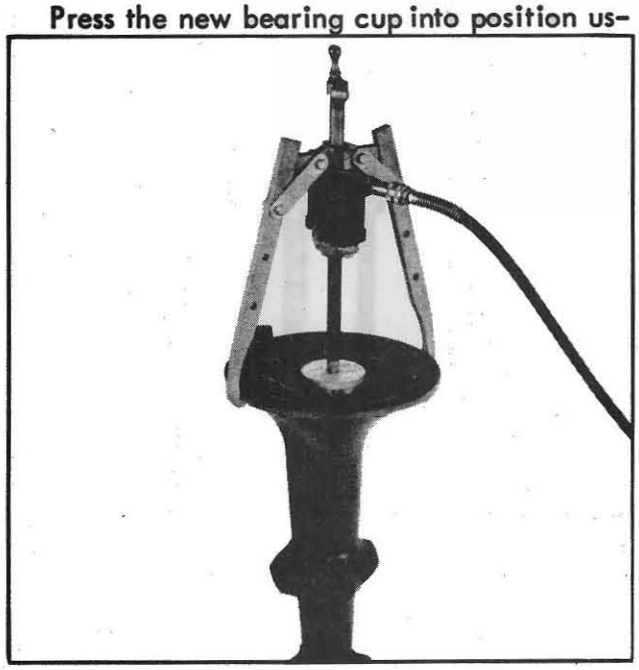


Fig. 276

ing the special step plate, SDT-113, as shown in Fig. 276

To remove the oil seal from the TO-30 axle housing, use a puller and set up similar to Fig.275.

Press the new oil seal into position, using the special step plate, SDT-114, as shown in Fig. 277 To remove the brake cross shaft bushing, first drive out the expansion plug with a drift and then drive out the bushing using the correct size bushing driver. Install the new bushing as shown in Fig. 278 Install a new expansion plug.

REASSEMBLY

Bolt the rear axle housing to the center housing, using one new gasket between the housings. Pack the wheel bearings and install the axle in the housing, using the shims removed and a new gasket between the brake backing plate assembly and the axle housing.

Caution: Use great care when installing a TO-30 axle; coat the spline with heavy vaseline and carefully push it through the oil seal.

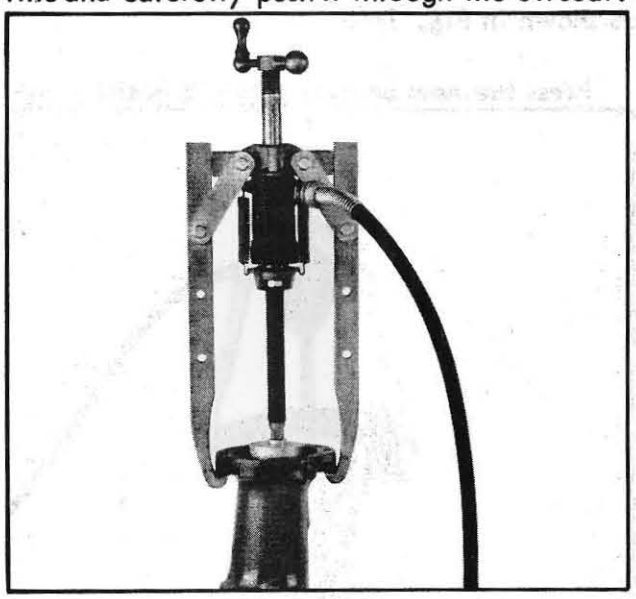


Fig. 277

Replace the nuts holding the bearing retainer and brake backing plate assembly to the axle housing and tighten to 35 pound-feet torque. With both axles in place, check the clearance between the two axles. The correct clearance of the butt end axle is .002-.008 in. The adjustment is obtained by varying the number of shims between the bearing retainer and the axle housing. If no clearance is left between the axles, the friction may cause the axles to weld together. Too great a clearance may cause damage to the oil seals from the axles moving in and out.

A satisfactory method for obtaining proper clearance for either the butt end or button end axles is as follows:

1. Remove enough shims so when one axle is rotated, friction causes the opposite axle to turn in the same direction.
2. Then add shims in increments and follow (1) above until the axles do not turn together.

Replace brake drum, lower link assembly and leveling rod. Connect the brake rod and replace the fender and rear wheel.

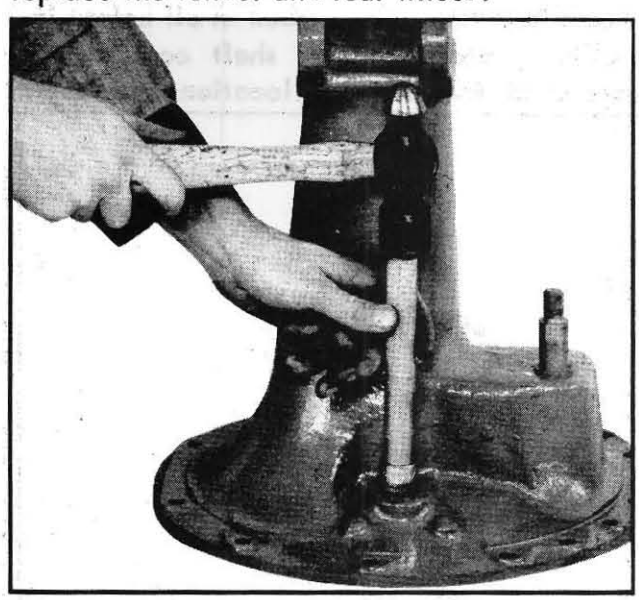


Fig. 278

SERVICE BULLETINS

No.	Date	Subject

NOTES

BRAKES

The TO tractors are equipped with self-energizing, mechanically operated, double internal-expanding "Bendix" brakes. The brake is 11 in. in diameter and each lining is 12 1/2 in. x 2 in., giving a total braking surface of 100 square in.

The brake pedal arrangement is designed so that each wheel may be braked individually by means of independent brake pedals on each side of the tractor, or they may be operated together by means of a single pedal on the right side of the tractor. It also includes a pawl which when engaged will lock the brakes to prevent the tractor from rolling.

The TE-20 tractors are equipped with a 14 in. diameter internal expanding, "Girling" brake. The 13 1/2 in. x 2 in. linings provide a total braking surface of 108 square in. The brake pedal arrangement is the same as that of the TO tractors.

DISASSEMBLY

To remove from TO tractors:

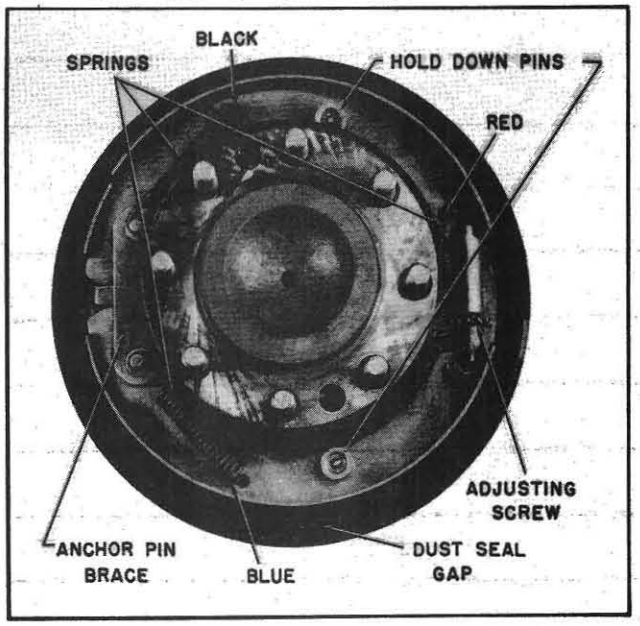


Fig. 279

1. Place a jack under rear of the tractor and remove rear wheel.

2. Remove the screws which attach the drum to rear axle hub and remove the drum.

3. Remove the three springs and the anchor pin brace, see Fig.279. Remove the two brake shoe hold-down pins and springs, and the brake adjusting screw and lift off the brake shoes.

If the brake linings are worn and need replacing, they may now be renewed by replacing the old brake shoe with a new brake shoe and bonded brake linings. The separate, riveted-on brake linings have been eliminated. Bonding of the lining gives a longer life to the brake lining and eliminates damage to the drum by exposed rivets. The lining is bonded to the shoe by a special process which cannot be performed by the Dealer.

A felt dust seal is cemented to the brake backing plate. The only difference between the right and left hand brake backing plate is that the gap in the felt dust seal must always be on the bottom. This allows any wear products from the linings or dust to work out at the bottom instead of interfering with the brake action.

The removal and replacement of the bronze brake shaft bushing is discussed under "Rear Axle Housing".

An oversize brake-shoe and lining kit is available for replacement if drum has been worn to the extent that it will no longer operate satisfactorily with a standard size brake shoe. These shoes are .030 in. oversize on the radius. The drum must be smoothly resurfaced to an inside diameter of 11.060-11.065 in. in order to insure proper braking action.

To remove the assembly from TE tractors, proceed as follows:

1. Place a jack under rear end and remove rear wheel.

2. Remove the screws securing the brake drum to rear axle and remove the brake drum.

3. Remove cotter pins from anchor pins and remove anchor pin brace, see Fig. 280.

4. Remove the two brake springs. Remove the cotter pins, nuts and washers from the steady pins and lift off the brake shoes and the adjusting screws.

5. Lift off the brake shoe actuating cam and unhook the lever return spring. Note that the return spring is connected between the pin on the backing plate and the top hole in the control shaft assembly.

The brake shoe and lining are serviced as a unit regardless of whether the lining is riveted or bonded to the brake shoe. If the lining is worn and needs replacing, the brake shoe and lining must be replaced as a unit.

Check the wear that has occurred between the brake shaft and bushing in the anchor plate assembly by moving the end of the brake control shaft. If excessive wear is indicated by considerable free play of the shaft in the bushing, it will be necessary to remove the brake control shaft and replace the bushing.

To remove the brake control shaft, loosen the set screw in the control shaft collar, loosen the locking bolt in the linkage and bushing assembly and pull the brake control shaft completely out of the assembly.

To replace the bushing, remove the two hex nuts that hold the anchor pin and plate assembly and the bushing assembly to the brake backing plate. Replace the bushing assembly with a new part.

The removal and replacement of the bronze brake shaft bushing in the rear axle housing is discussed under "Rear Axle Housing". Replace the brake control shaft and tighten all the attaching bolts and screws.

Check the remaining parts of the brake assembly and replace parts that are broken, distorted or excessively worn.

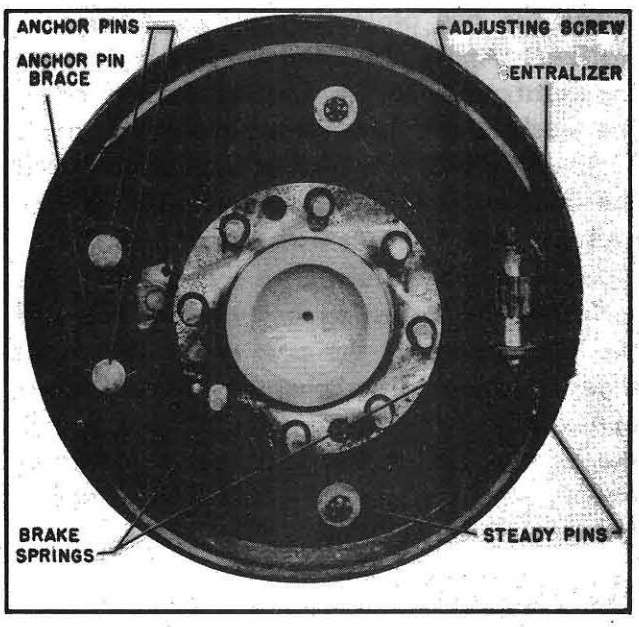


Fig. 280

REASSEMBLY

To reassemble the brakes on TO tractors, proceed as follows:

Replace the brake shoes, the shoe hold-down pins and springs, the adjusting screw and the anchor pin brace.

Install the black spring to the cam end of the top (secondary) shoe and the blue spring to the cam end of the bottom (primary) shoe. The red spring connects both shoes at the adjustment end.

Replace the brake drum and wheel, first making sure the drum and linings are clean and free of grease and oil.

To reassemble the brakes on TE tractors, proceed as follows:

1. Install the brake shaft return spring, one end to the pin in the backing plate and one end to the top hole in the control shaft assembly. Apply a small amount of high melting point grease to the bearing surfaces of the cam and install the cam on the control shaft pivot pin with the straight edges up.

2. Position the shoes on the steady pins and install the adjusting screw, making certain the flange of the adjusting screw is be-

tween the two projecting springs of the centralizer. Apply a small amount of high melting point grease to the flat washers and install the washers and hex nuts on the steady pins. Tighten the hex nuts against the washers until the washers can just be rotated with the fingers and lock the nuts with cotter pins.

3. Install the brake shoe springs, the short spring at the adjusting end of the shoe and the long spring at the cam end of the brake shoes. Install the anchor pin brace and secure it with cotter pins. Check the action of the brake pedal to see that everything works freely, then replace the brake drum, attaching screw and rear wheel.

ADJUSTMENT

To adjust the brakes on a TO tractor, proceed as follows:

1. Jack up both rear wheels and remove the cover from the adjusting hole in the backing plate.

2. Using a screwdriver, as shown in Fig. 281, turn the adjusting screw star wheel counterclockwise, when viewed from above, until a drag is felt as the wheel is turned then back off the star wheel until the wheel rotates freely.

3. Check the adjustment of the master brake to see that both brakes react evenly. This should be done by driving the tractor on level ground and applying the master brake. If the brake linkage is correct, the tractor will come to a stop in a straight line. If it is not correct, the tractor will pull to the side with the shorter linkage. Shorten the longer brake linkage by adjusting the clevis on the brake rod. Both brake linkages should have a small amount of free play before the brakes are applied, so care must be taken not to get them too tight.

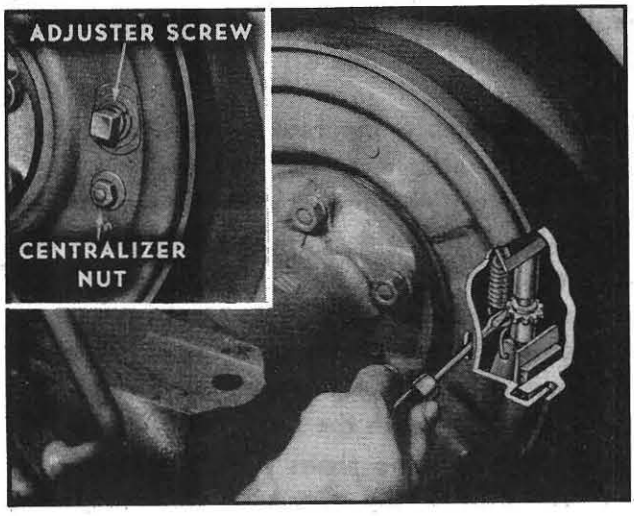


Fig. 281

Note: Be sure the linkage and bushing assemblies are lubricated and are free to rotate on the stop and shaft assemblies.

When new linings are installed, it is necessary that the linings be "burned-in" to insure maximum braking performance and longer braking life. To "burn-in" new linings, proceed as follows:

1. Jack up both rear wheels.

2. Start the tractor engine, shift into second gear and lock one wheel with the turning brake.

3. As the opposite wheel rotates, partially apply its turning brake and continue this procedure until the brake drum is too warm to touch. Repeat this operation to "burn-in" the opposite brake.

4. Let the brake drums cool and make final adjustment as outlined above.

To adjust the brakes on TE tractors:

1. Jack up both rear wheels.

2. Make sure all shafts and pins work freely. Check to see when the brakes are disengaged, the brake pedals are against their stops.

3. Loosen the centralizer nut "B" as shown in the insert in Fig. 281. Turn the adjuster shank until the shoes are fully expanded in the drum and the wheel is locked. Tighten the centralizer nut and then loosen the adjuster shank until the wheel is just free to turn without drag.

4. Check the adjustment of the master brake as outlined in the TO adjustment.

5. Be sure the linkage and bushing assemblies are lubricated and free to turn on the stop-and-shaft assemblies.

6. "Burn-In" new linings as outlined under TO adjustments.

SERVICE BULLETINS

No.	Date	Subject

NOTES

POWER TAKE OFF

Drain the oil from the hydraulic system, transmission and differential and remove the PTO assembly.

After removing the four retaining cap screws, the PTO assembly should easily slide from the center housing. If difficulty is encountered removing the shaft, this is an indication that the shaft is either bent or twisted. Do not attempt to force the shaft out with a pry bar or any type of puller, as considerable damage to the hydraulic pump can result from such action.

If the PTO shaft assembly cannot be withdrawn easily from the housing, it is very likely that a twist has occurred in the splined portion of the shaft between the hydraulic pump and the PTO assembly. To determine the exact nature of the trouble it will be necessary to split the tractor between the transmission and the center housing. This will expose the front end of the PTO shaft.

If the shaft has only a slight twist it may be possible to grind away a portion of the splined area of the shaft with a portable grinder enabling it to pass through the hydraulic pump. However, it may be easier to either cut or burn through the PTO shaft just back of the pump, disconnect the control valve and drop the hydraulic pump.

Note: The shaft cannot be removed from the pump toward the front, it must be pulled out toward the rear.

Regardless of how the shaft was removed, the center housing and all component parts should be thoroughly cleaned before reassembling the tractor.

To disassemble the power take-off shaft assembly:

1. Remove the PTO cap from the end of the shaft.

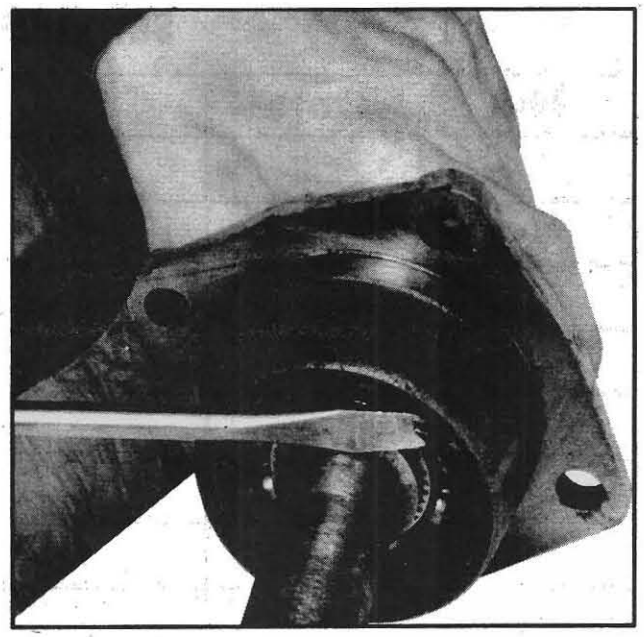


Fig. 282

2. Remove the large internal snap ring from the inside of the PTO housing, as shown in Fig.282 and with a lead hammer, carefully drive the PTO shaft, bearing and sleeve from the housing.

3. Inspect the bearing and if it requires replacing, remove the snap ring from the end of the shaft and supporting the bearing in a bearing splitter, press the shaft out of the sleeve and bearing as shown in Fig.283. Place the flat side of the bearing splitter next to

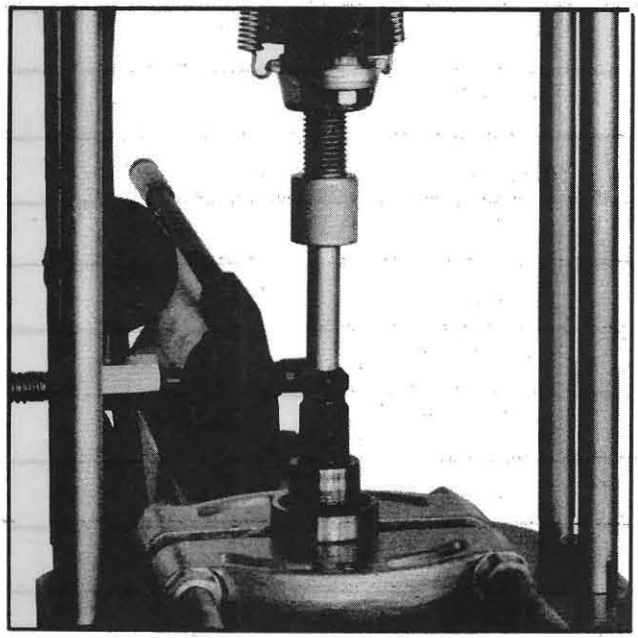


Fig. 283

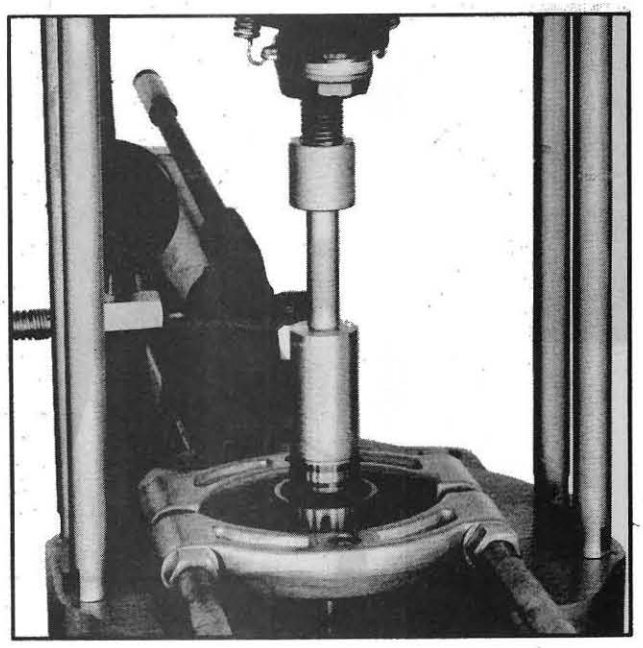


Fig. 284

the bearing and tighten it so that it contacts the inner race of the bearing to prevent damage to the bearing.

4. To replace the bearing and sleeve on the shaft, place the shaft in the bearing splitter so that recessed side of the bearing splitter jaw contacts the shoulder on the shaft. Tighten it firmly in this position. Place the bearing and sleeve in position and use the special sleeve, SDT-115, as shown in Fig. 284 Press them on to the shaft until the bear-

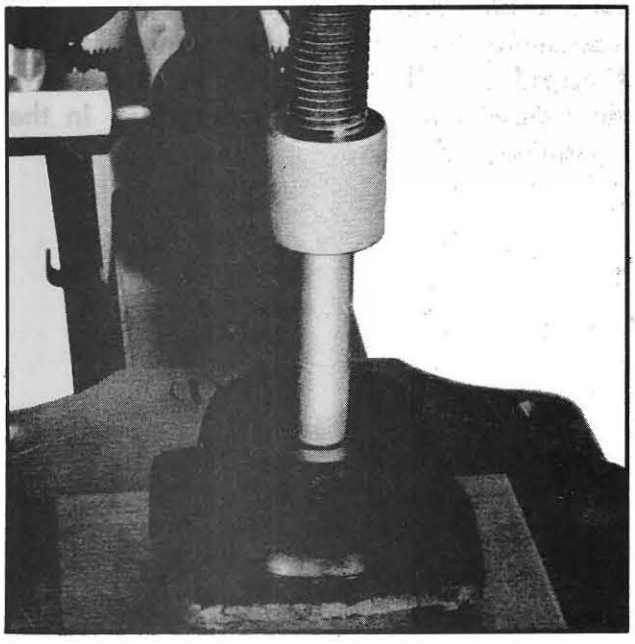


Fig. 285

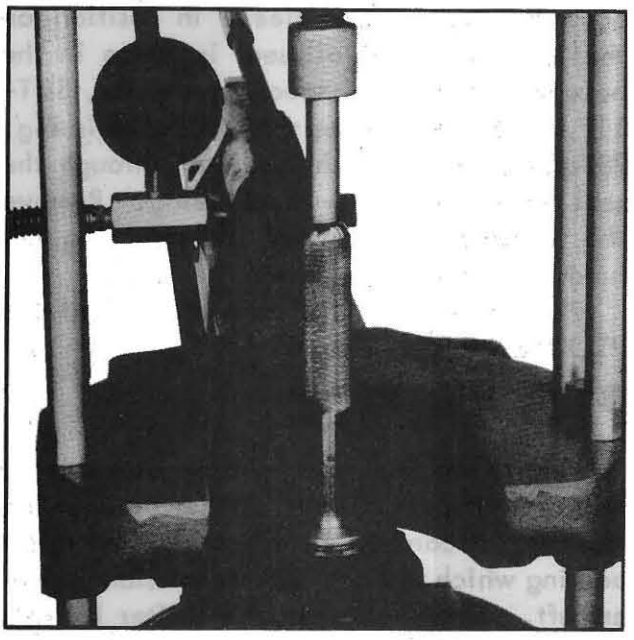


Fig. 286

ing contacts the shoulder. Replace the snap ring on the shaft.

5. To replace the oil seal, use a No. 9 step plate, as shown in Fig. 285, to press out the old seal, pressing the seal toward the outside of the housing. Make certain that the step plate clears the snap ring still in the housing.

Use the special seal driver, SDT-116 and mandrel, as shown in Fig. 286 to press in the seal. Position the seal in the housing so that the felt dust seal is toward the outside and the feathered edges of the oil seal are toward the inside.

6. To reassemble the shaft in the housing,

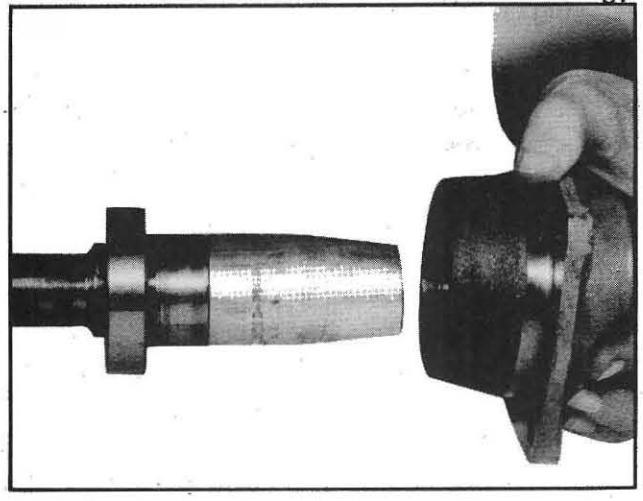


Fig. 287

have the bearing and sleeve in position on the shaft and the oil seal in place in the housing. Place the special protector, SDT-117, on the end of the shaft as shown in Fig. 287and carefully push the shaft through the seal into position in the housing. Remove the protector and replace the snap ring that holds the bearing in place.

7. Replace the PTO cap and install the PTO shaft in the tractor.

PTO SHIFTER

The power take-off shifter assembly is bolted to the rear wall of the transmission housing. It carries the race of the rear roller bearing which supports the transmission countershaft. Shims between the shifter housing and the transmission housing are used to adjust the end play of the countershaft. The end of the countershaft protrudes through the wall of the transmission housing into the shifter housing. To this end of the shaft is attached a splined hub. A splined sleeve slides on the PTO shaft and may be shifted forward with the PTO shift lever until it couples the PTO shaft directly to the countershaft. If any trouble is encountered in the PTO shifter assembly, it will be necessary to separate the tractor between the transmission and the center housing, see Fig.288. The assembly is then exposed and may be removed for servicing by merely removing the four cap screws which attach it to the transmission housing.

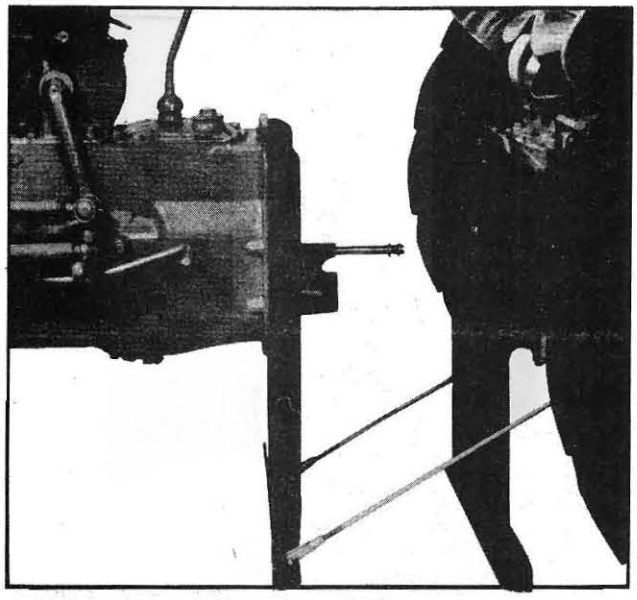


Fig. 288

To disassemble the unit, remove the nut and washer which secures the shifter rail stop to the shifter rail and withdraw the rail. Catch the lock ball and spring. The clutch sleeve may be removed by pulling the bearing race with a puller or by removing the snap rings and ball bearing from the rear-end of the housing.

Carefully inspect the gears for broken or severely worn teeth. Inspect the ball bearing and the roller bearing race. Replace any parts which seem to need replacement and reassemble the unit in the reverse order of disassembly. The unit should be attached to the transmission housing as described in the Transmission section.

SPECIFICATIONS

TRANSMISSION	
Type	Constant Mesh
GEAR RATIO	
First	1 to 4.29
Second	1 to 3.11
Third	1 to 2.26
Fourth	1 to 1.08
Reverse	1 to 3.71
OIL CAPACITY	
Hyd. System & Diff.	6 gal.
BEARING PRE-LOAD	
New Transmission	7-12 pound-inches
Used Transmission	5-10 pound-inches
Magnesium Transmission Housing	See Text
DIFFERENTIAL	
Differential Carrier Bearing Pre-Load	Not Adjustable
PINION	
Pinion Bearing Pre-Load	6-8 pound-inches
Ring Gear to Pinion Backlash	.010-.014 in.
TORQUE	
Bearing Cap Screws	24-28 pound-feet
Differential Case Cap Screws	47-53 pound-feet
Pinion Sleeve to Center Housing Cap Screws	47-53 pound-feet
Axle Housing to Center Housing Studs	33-38 pound-feet

SERVICE BULLETINS

No.	Date	Subject

NOTES

FERGUSON

SYSTEM

FERGUSON SYSTEM

The Ferguson System consists of the hydraulic pump, ram cylinder, lift arms, lower links, top link, master control spring, finger-tip control lever and the control forks.

Without attempting to cover trouble shooting, which will come in a later section, outlined here are some visual inspections and checks which can be made on the hydraulic system before any disassembly is begun.

CONTROL SPRING

Every six months, the control spring adjusting yoke should be removed and the threaded portion of the plunger lubricated to prevent the yoke and plunger from freezing together. Failure to do this may result in damage to the forks as excessive force will be necessary to free the yoke for adjustment. Also, there is a possibility on TE and TO-20 tractors of the vertical fork becoming unhooked from the control valve cross member.

With a two-bottom plow in the raised position, check to see whether you can just turn the spring with your thumb and forefinger, see Fig.290. Adjustment is obtained by screwing the yoke in or out of the spring. An ideal setting results when the spring is free to turn, yet has no end play and will not bind.

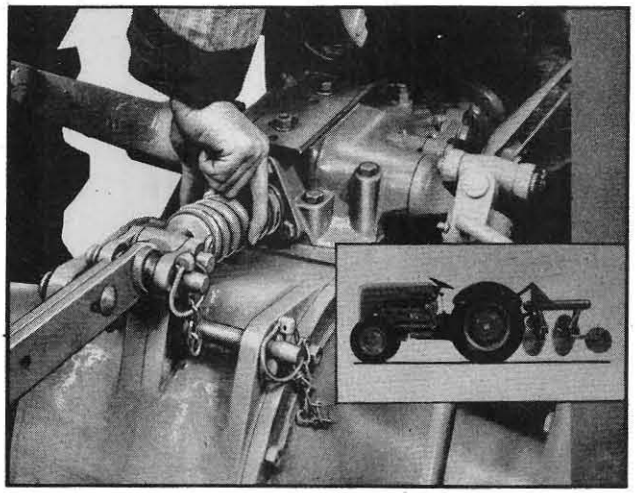


Fig. 290

CONTROL LEVER

The finger-tip control lever positions the automatic draft control pivot point. The quadrant assembly must be properly adjusted with regard to the control lever neutral position in order for the automatic system to function efficiently. If the neutral point is too far up the quadrant, the control valve will not be able to move to full intake position, thereby, affecting the lifting action. If the neutral point is established too far down the quadrant, the depth control will be shortened to the point where it is impossible to get sufficient depth with a ground engaging implement without danger of going into overload release. The best way to check the quadrant setting is to place the lever in the raised position and make a mark on the quadrant at the bottom edge of the lever. Measure down 2 1/2 in. from this mark and make another, see Fig.291. The lower, or positioning mark may be made permanent by notching with a file if desired. Now, starting with the attached two-bottom plow in a raised position and the finger-tip control lever at the top of the quadrant, move the lever down the quadrant until its bottom edge is at the lower mark. At this point, the plow should just start dropping slowly. If the plow doesn't move or if it drops before reaching the mark, you must make a new quadrant adjustment.

If adjustment is necessary, first place the plow in a raised position and leave the finger-tip control at the top of the quadrant. The quadrant mounting plate is fastened to the tractor body by four cap screws in slotted holes allowing the plate to be moved forward and backward. Loosen these four screws just enough so that you can move the plate as far toward the rear as possible. Now set the bottom edge of the control lever at the lower mark on the quadrant or 2 1/2 in. down from

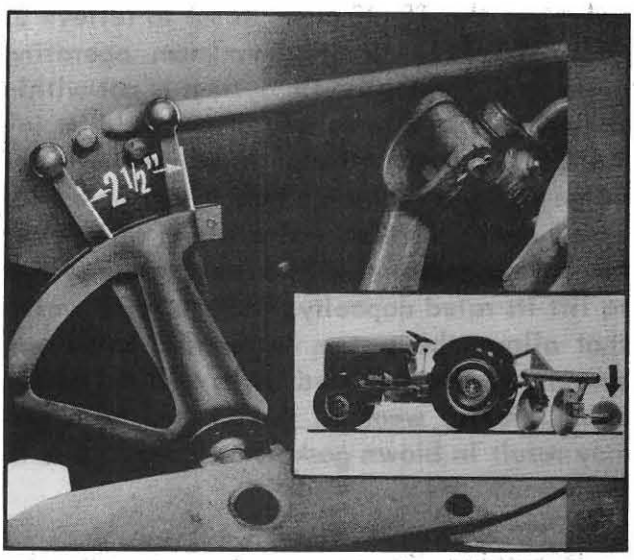


Fig. 291

its raised position. Using a long, heavy screwdriver or a pry bar as a lever, pry against the rear center edge of the plate, so that it remains level as it is moved, and slowly force the mounting plate forward until the plow just starts to lower, see Fig.292. Retighten the four cap screws equally and repeat the check on the quadrant point at which the plows start to lower. Sometimes tightening the mounting plate changes the adjustment and it must be compensated for. This is most likely to happen if you loosen the plate too much before making the adjustment.

NOTE: If the finger-tip lever will not hold its position or if there is any sticking or binding of the lever when it is moved, check the condition of the friction disc. Some of the late TO-30 model tractors have a rubber friction disc but the majority of tractors have a cork disc. If the rubber disc causes any binding or sticking of the finger-tip control lever it should be replaced with a cork disc.

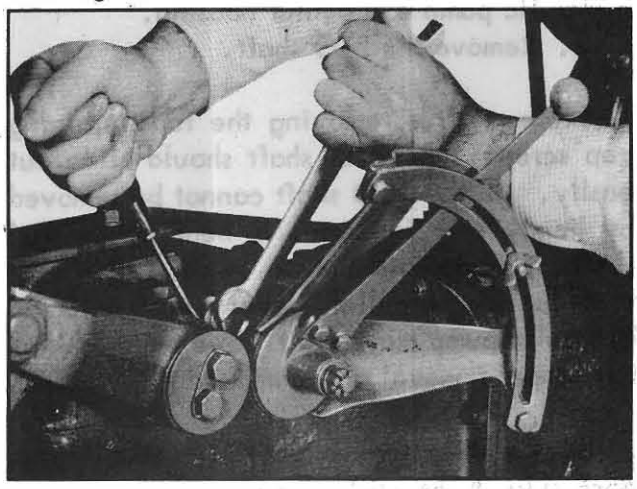


Fig. 292

The cork disc sometimes becomes permanently compressed and loses its ability to overcome the tension exerted on the finger-tip lever by the retracting spring when the forks break out at the hinge. By carefully increasing the pressure on the cork disc by tightening the castillated nut slightly, it will usually function correctly again, see Fig.293. If adjusting the pressure on the cork disc does not correct the action of the finger-tip lever, it will be necessary to replace the disc. Avoid excessive pressure on the disc because it will result in premature breakdown of the cork granules, in which case a new disc must be installed.

The links should lift a two-bottom plow with a smooth upward motion. When the plow has reached the top of the lift and the engine is shut off, the plow should not drift down to the ground in less than fifteen minutes. If the system will meet these conditions, you may be sure the ram cylinder, piston and rings, the oil tube and the check valve are in good condition and the control valve is not leaking. If the plow drifts downward too quickly, remove the oil level indicator cover and look

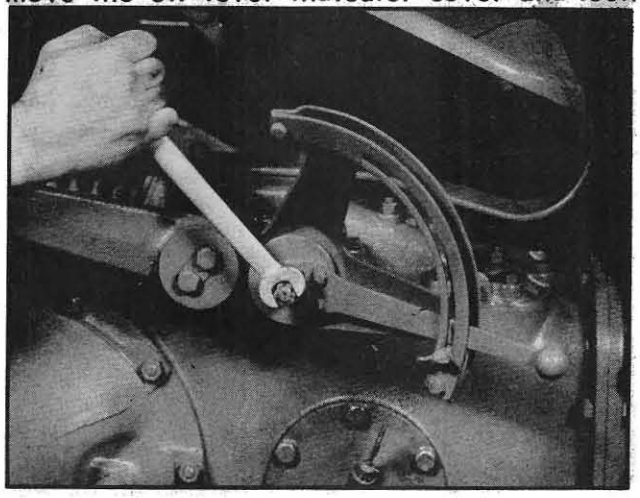


Fig. 293

into the housing with the aid of a light. Leaking from the ram cylinder or the oil tube will be apparent. Leakage from the check valve or from the control valve may not be apparent. The chances are, however, that the relief valve is held open by a bit of dirt lodged under the valve. This dirt may often be blown free by hooking the rear tractor lift links under an immovable object and starting the pump, thereby, overloading the hydraulic system.

If the system will pass the foregoing tests, place 500 pounds on the cross shaft of the plow (300 pounds for a TE-20 tractor) and raise the finger-tip control. If the system will raise the load, the pump pistons and valves, and the relief valve may all be considered satisfactory. However, if this load cannot be raised, look into the housing once again. Oil escaping from the relief valve will probably be apparent, thus indicating a dirty or damaged relief valve.

If a suitable gauge and adapter are available, see Fig. 294, the maximum operating pressure may be checked at this time. The relief valve on the TO-30 and TO-20 pumps is set to relieve at 1900-2300 PSI. The relief valve on the TE-20 pump is set to relieve at 1500-1900 PSI. If the maximum operating pressure of the Hydraulic System is not within these limits, a new relief valve should be installed. Do not attempt to adjust the relief valve, always replace a defective valve with a new one. A relief valve which relieves at too low a pressure will not allow the system to lift its rated capacity, while a relief valve that allows the system to operate at a pressure above the specified limits will definitely cause greater wear on the moving parts and may result in blown gaskets or broken parts in the pump.

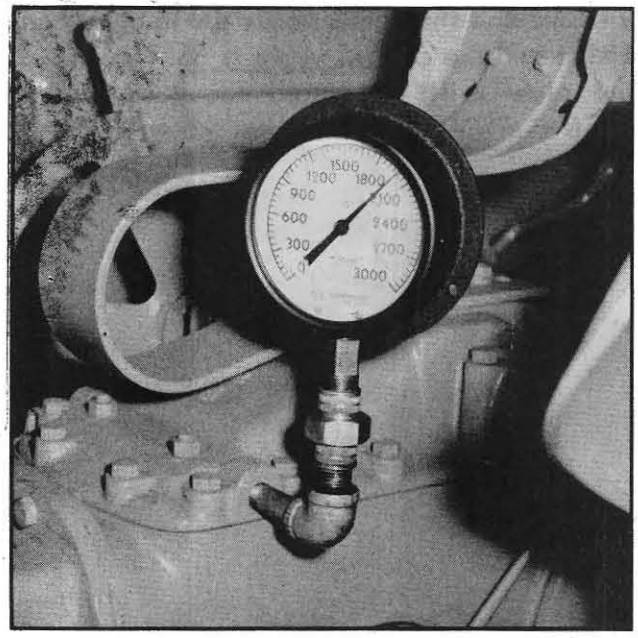


Fig. 294

If making the corrections, indicated by these checks, does not cause the system to give satisfactory results, the internal parts of the pump are probably worn or damaged and it will be necessary to remove the pump.

HYDRAULIC PUMP

The hydraulic pump unit is located in the forward position of the center housing and is driven by the forward splined end of the PTO shaft.

The transmission lubricant is the operating fluid for the hydraulic system.

REMOVAL

To remove the hydraulic pump:

1. Drain the oil from the transmission, hydraulic pump and center housing.
2. Remove the PTO shaft.

Note: After removing the four retaining cap screws, the PTO shaft should slide out easily. If the PTO shaft cannot be removed by hand, this indicates a bent or twisted shaft. Never attempt to remove the PTO shaft by using a puller. Severe damage to the hydraulic pump may result. See page 148 for the proper removal of a damaged PTO shaft.

3. Remove the inspection covers from each side of the center housing.
4. Working through these openings, loos-

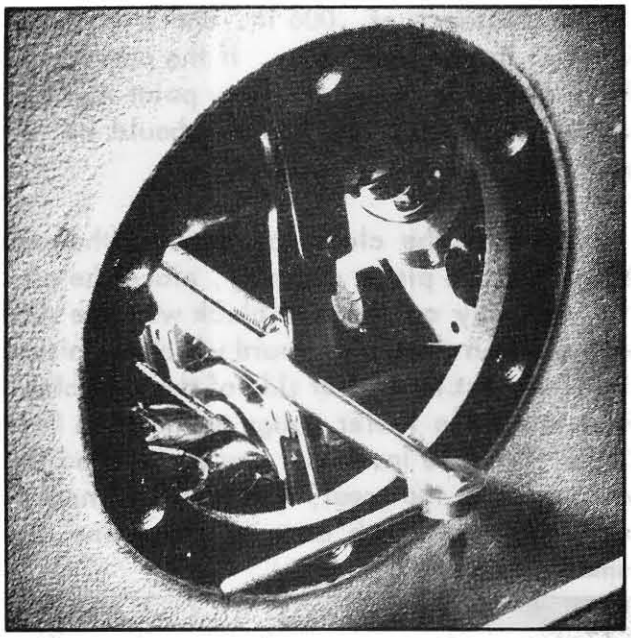


Fig. 295

en the bolts holding the stabilizer to the fork and spread the ends of the control fork sufficiently to remove the control valve cross arms. A tool which will do this job easily is available, see Fig. 295. After the fork is disconnected, push the control valve all the way forward.

5. Remove the cap screws holding the pump base to the center housing and remove the pump by sliding rearward then lowering gently.

DISASSEMBLY

The disassembly and assembly procedure is basically the same for the pumps of the TO-30, TO-20 and TE-20. If the part mentioned in the service outline is not present in a particular pump, proceed to the next step.

1. Remove the control valve assembly.

2. Loosen, but do not remove, the cap screws holding the valve chamber clamp to the top of each pump side plate.

3. Remove the four cap screws from each side of the pump and remove the valve chambers. If necessary, use a soft face hammer to loosen the chambers.

4. Loosen the set screw that positions the oscillator fork and pin assembly. Slide the fork assembly forward as far as possible. Lift the piston drive assembly out of the pump body. Note the positions of the parts.

5. Remove the guide rods. Remove the set screw that locks the oscillator fork and pin assembly in position and remove the fork.

6. Remove bronze bushing from rear of pump body.

7. Remove the safety valve, check valve and shield.

8. If necessary, the control valve bushing can be pressed out of the pump housing by using the special bushing driver and mandrel, SDT-121. Make sure that the pump housing is properly supported and is setting square with the press base, to prevent damage to the pump housing.

9. Disassemble valve chamber sub-assemblies as follows:

a. Remove loosened cap screws and clamp.

b. Remove valves and springs by inverting chambers and tapping lightly on a piece of wood. It may be necessary to use long needle-nose pliers to remove guide rods. The guide sockets may be removed from the bottom of the valve chamber with a sharpened piece of wood dowel or a pencil with the lead broken off. Wedge the tapered wood into the socket and gently pull out socket.

10. Disassemble control valve and stem.

INSPECTION

While the pump is disassembled, all parts should be carefully inspected for signs of wear or other damage. Thoroughly clean and inspect the bearing surfaces of the cam and the cam blocks for evidence of scoring or excessive wear. If the bearing surfaces show any rough or worn areas, the damaged parts should be replaced. If the visual inspection shows the parts to be in good condition, place the cam blocks in the proper position on the cam so that their flat sides will be next to each other and check the clearance between the cam and cam blocks by inserting a feeler gauge as shown in Fig. 296. Check the clearance at a minimum of four places around the diameter of the cam. If it is possible to

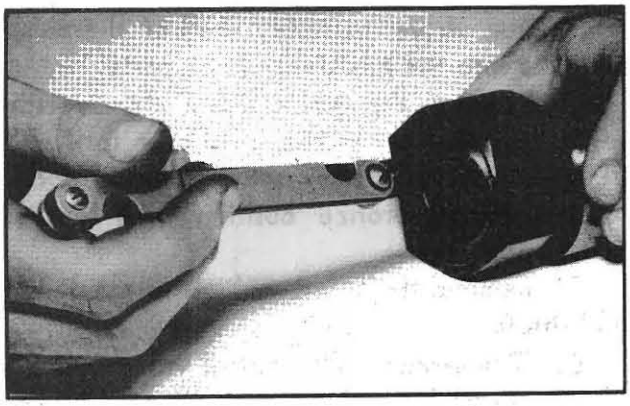


Fig. 296

insert a .010 in. feeler at any point, the clearance between the two parts is too great and it will be necessary to determine how much each part is worn. To do this, proceed as follows:

The cam is finished to an outside diameter of 1.995-1.997 in. and case hardened to a depth of .025-.035 in. Measure the diameter of the cam at several locations with a suitable micrometer, as shown in Fig. 297. Move the micrometer 90 degrees on the cam to determine if the wear has been uniform or if the cam is worn out-of-round. If the diameter of the cam at any point is less than 1.993 in., a new cam should be installed.

Carefully measure the inside diameter of the cam blocks with a telescoping gauge and suitable micrometer as shown in Fig. 298. The cam blocks are finished to an inside diameter of 2.000-2.001 in. This allows a maximum clearance of .006 in. and a minimum of .003 in. on new parts. If the cam blocks have an inside diameter at any point that exceeds 2.005 in., the blocks should be replaced.

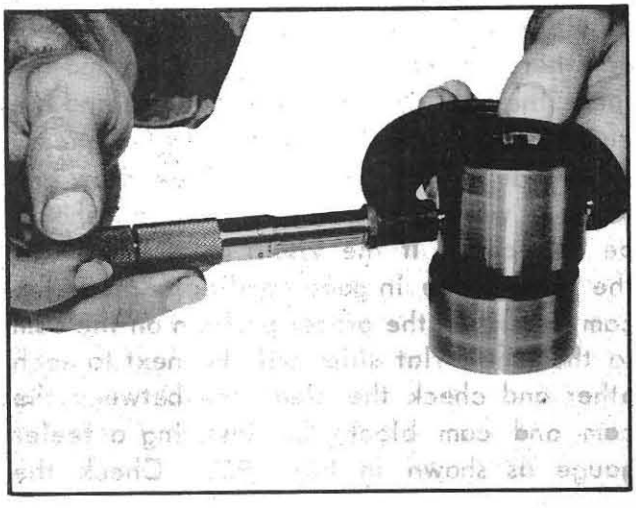


Fig. 297

To check the clearance between the cam block and the piston assembly, place the piston assembly on the cam block with the side of the piston assembly toward which the piston is offset next to the flat side of the cam block and insert the feeler gauge as shown in Fig. 299. If a .010 in. feeler can be inserted the clearance is too great, and it will be necessary to check both parts to determine the amount of wear.

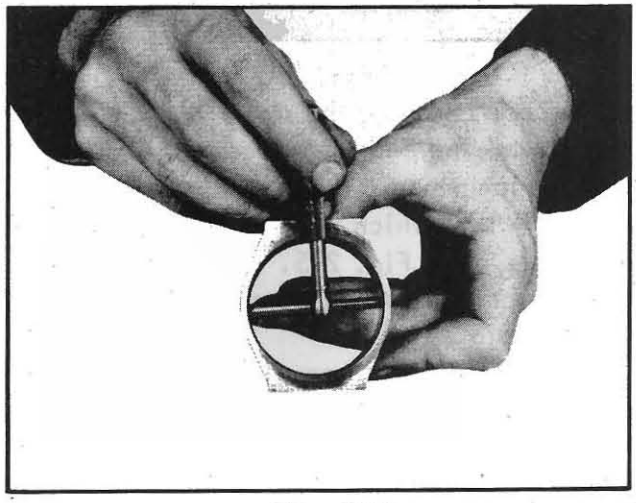


Fig. 298

The parallel faces of the cam block are finished to 2.244-2.247 in. and should be measured with a suitable micrometer as shown in Fig. 300. If the distance between the parallel surfaces is less than 2.242 in., the cam block should be replaced.

The distance between the parallel inside faces of the piston assemblies is 2.249-2.252 in. This allows a maximum clearance of .008 in. and a minimum of .002 in. with new parts. Measure the distance between the parallel surfaces in several places with an inside micrometer, see Fig. 301. If this distance exceeds 2.254 in. at any point, the piston assembly should be replaced. If either the cam block or the piston assembly or both

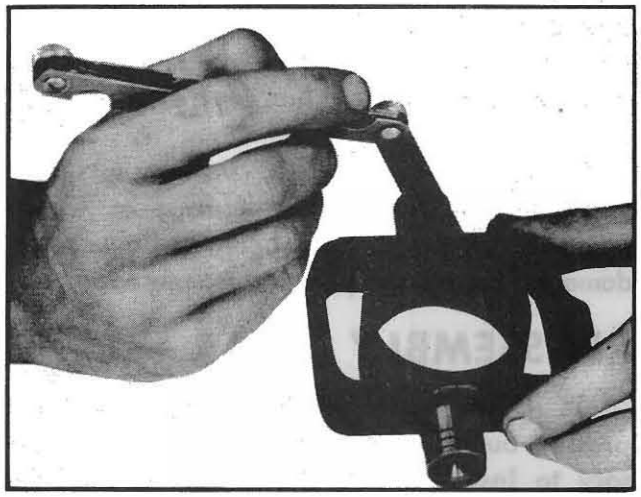


Fig. 299

are replaced, the clearance should again be checked with a feeler gauge.

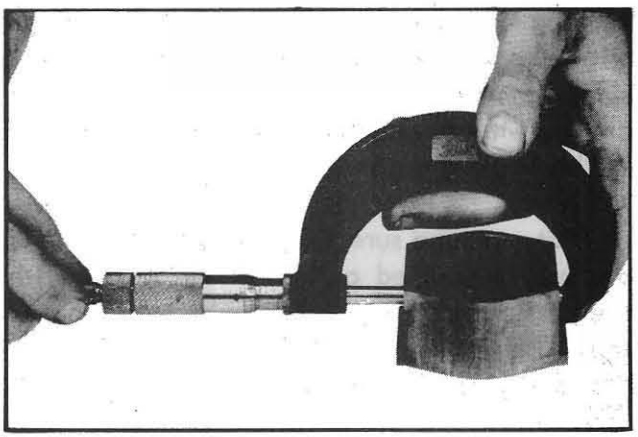


Fig. 300

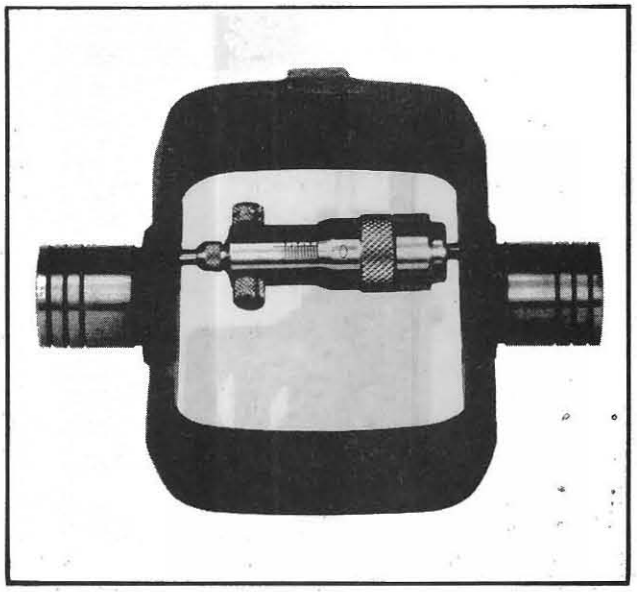


Fig. 301

Fig. 302

The pistons are finished to a diameter of .800-.801 in. and should be measured with a suitable micrometer, as shown in Fig. 302. The pistons should be measured in several places to determine if they have worn either tapered or out-of-round. If the diameter of the piston at any point is less than .799 in., the piston assembly should be replaced.

The cylinder in the valve chamber is finished to an inside diameter of .802-.803 in.

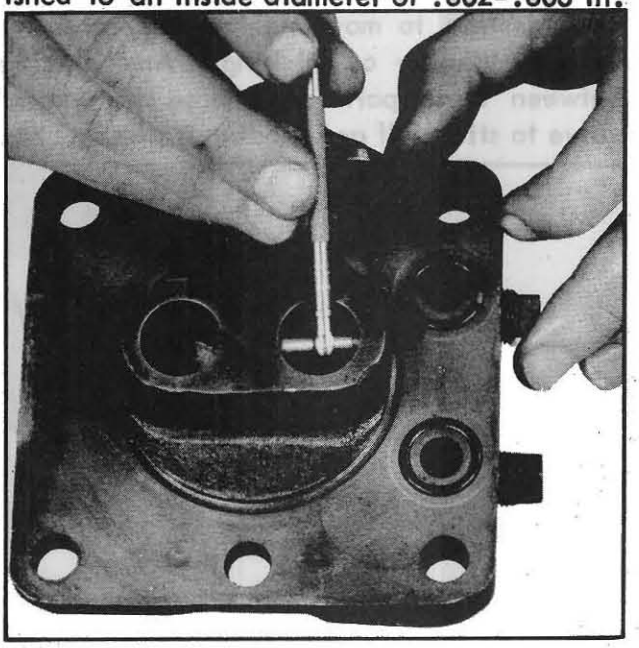


Fig. 303

Measure the inside diameter of the cylinder at several points with a telescoping gauge and a micrometer as shown in Fig. 303. If the diameter of the cylinder at any point should exceed .804 in., the valve chamber should be replaced.

Carefully measure the inside diameter of the bronze bushing with a telescoping gauge as shown in Fig. 304. The bushing is finished with an inside diameter of 1.182-1.183 in. If the bushing is worn so that the inside diameter at any point exceeds 1.184 in., the bushing should be replaced.

Fig. 304

Place the oscillator drive assembly in its proper position in the fork assembly as shown in Fig. 305. Slide the drive assembly back and forth several times and determine if the drive is free to move in the fork assembly without binding or sticking. Any binding between these parts will cause the control valve to stick. If any binding is present, the square end of the drive assembly should be lightly dressed with a fine cut file or emery cloth until the binding has been eliminated.

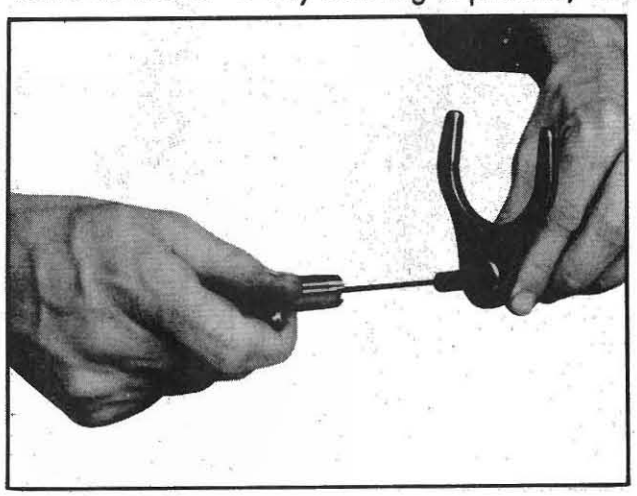


Fig. 305

Check all the valves, valve seats and valve springs for signs of damage or wear. Replace any parts that appear to be worn or damaged before the pump is assembled.

REASSEMBLY

1. If the control valve bushing has been pressed out of pump body, it will be necessary to install a new bushing. Be sure the bored bushing hole in the pump body is clean and free of any scoring or nicks. Lubricate the outside of the bushing lightly with petroleum jelly. Using a special arbor, press the bushing in until the outer end is just flush with the finished surface of the pump. Be sure the pump base is square with the arbor and that the centerline of the two large holes in the bushing is parallel with the pump base.

Note: Make sure that the pump housing is properly supported and is setting square with the press base to prevent damage to the housing. Use the special bushing driver and mandrel and press the bushing in as shown in Fig. 306.

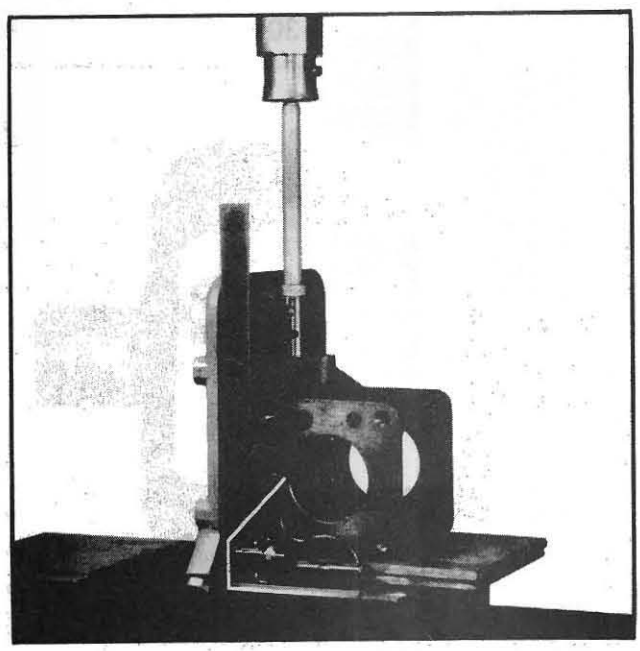


Fig. 306

2. Reassemble valve chamber sub-assembly as follows:

a. Place guide in socket.

b. Assemble to the guide in the order given, the inlet valve, inlet valve spring and outlet valve.

c. Pick up the valve chamber in one hand and the above assembly in the other. With the openings to the valve chamber slightly below horizontal, insert and seat the valve guide socket into the bottom of the valve chamber. Insert other guide assembly in similar manner, see Fig. 307.

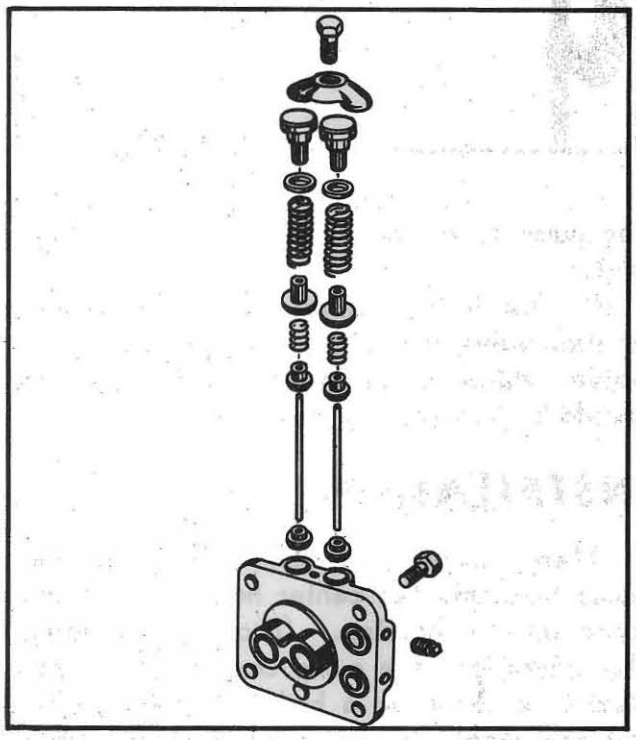


Fig. 307

d. Insert outlet valve spring.

e. Replace caps, clamps and cap screws. Be sure to use a new gasket under the cylinder caps. (Tighten cap screws later).

3. Place the bronze bushing in the pump body so that the flanged end of the bushing is toward the inside of the pump body. Replace the fork and pin assembly and leave the set screw loose, see Fig. 308.

4. Install the guide rods.

5. Reassemble the piston and piston drive assembly.

a. Place the two cam blocks on the cam so that their flat sides will be next to each other, see Fig. 309.

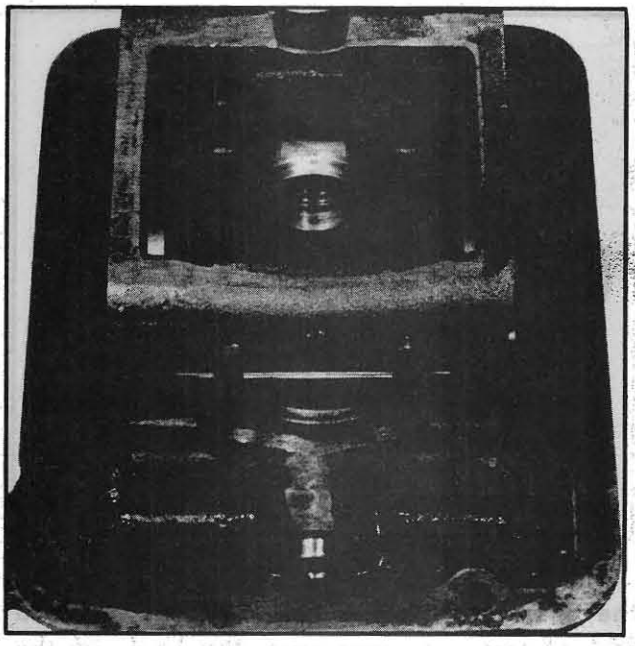


Fig. 308

b. Note that the pistons on the piston assemblies are offset slightly. The side of these assemblies toward which the pistons are offset is placed next to the flat side of the bronze cam blocks.

c. Check the assembly by inserting the two pistons in the two cylinders in one of the valve chambers, if they can be inserted in cylinders, piston assemblies are correctly placed on the cam blocks, see Fig. 310.

6. Note the recess in one end of the cam. The bronze bushing, installed in Step 3, fits into this recess, see Fig. 311. Replace the piston and piston drive assembly in

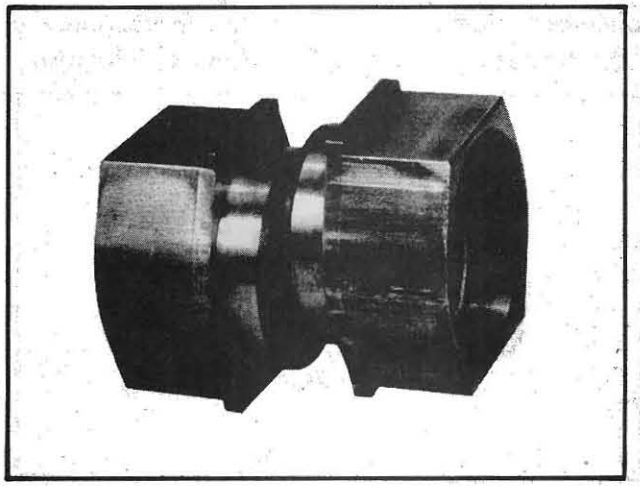


Fig. 309

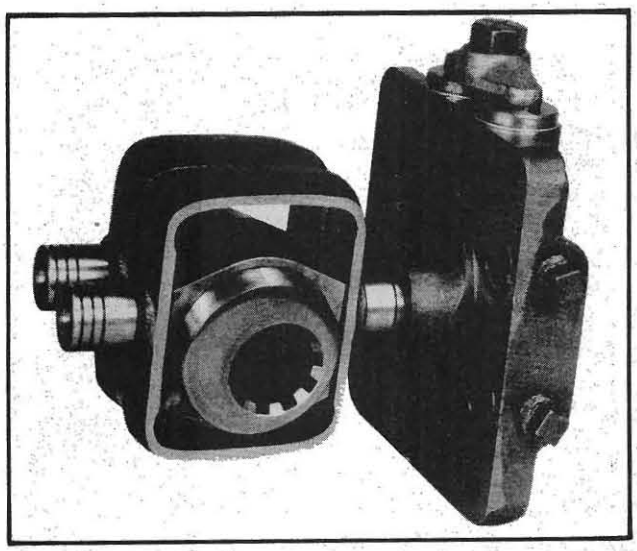


Fig. 310

the pump body being sure that the recessed end of the cam is toward the back of the pump body. Position the fork and pin assembly and tighten the set screw.

7. Hold the assembly in position and replace one of the valve chamber assemblies. Use a new gasket.

8. Replace the other valve chamber assembly and cap screws, tightening to 50-55 pound-feet.

Note: On the TO-30, the longer screws go on through the rear holes or thick side of the side plate.

9. Replace the safety valve and shield. Tighten the safety valve and pipe plugs in the valve chambers securely. Tighten the valve chamber clamp cap screws to 50-55 pound-feet torque. This is easily done by clamping

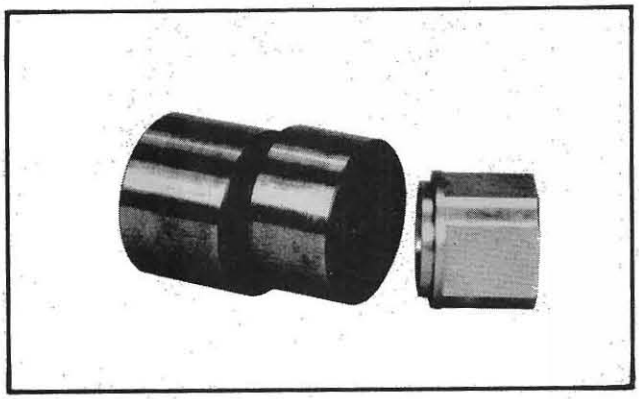


Fig. 311

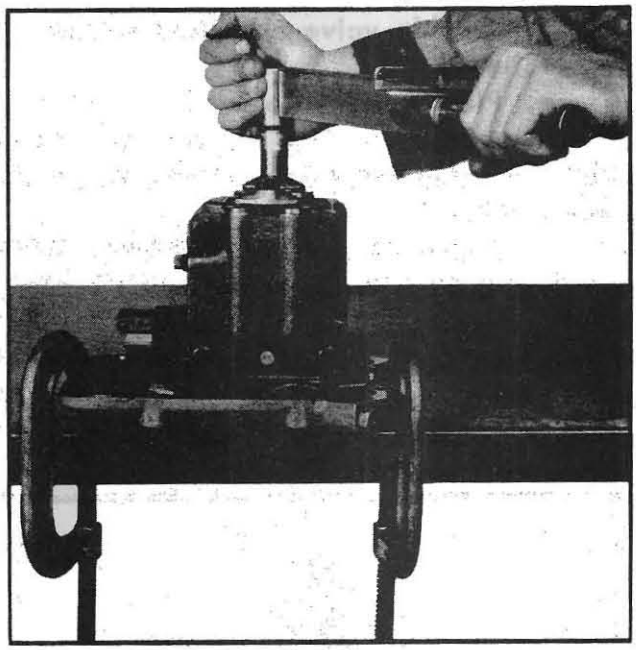


Fig. 312

the pump to a work bench as shown in Fig. 312.

10. Install the control valve. Reassemble control valve and stem. The key inside the valve which connects the oscillator wire should be in a vertical position.

INSTALLATION

Always use a new gasket between the pump base and the center housing. Fit the pump into the housing. (If one man is doing this operation, the pump can be raised and held in position on a hydraulic floor jack). Put cap screws in place finger-tight. Now the PTO shaft is to be installed, using a new gasket. Start tractor engine and operate the pump for a few seconds. This allows the pump to shift slightly and serves to properly align pump splines with those on PTO shaft. Do not operate pump any longer than necessary when there is no oil in system as costly damage may result. Now tighten pump base cap screws to 38-45 pound-feet of torque.

Working through the inspection ports, attach the vertical fork to the control valve cross member. Check to see that the fork legs are properly seated in the stabilizer flanges then tighten the cap screws. Replace the in-

spection plates using new gaskets. Tighten the drain plugs and fill the system with the proper grade of recommended type oil.

MODEL DIFFERENCE

Functionally the Ferguson System in the TO and TE tractors is the same. A difference, however, does exist in the relief valve. The TO systems operate at approximately 2300 PSI while the TE systems are limited to 1900 PSI. Several of the Ferguson System parts were strengthened to withstand this increased pressure and these weaker TE parts should never be used to service TO tractors.

Caution: Never install the TO-638-A relief valve in a TE tractor, (prior to Serial No. 83271), see Fig. 313.

Fig. 313

Valve chamber assemblies are not interchangeable in the two model pumps. Use the TO-621 and TO-622, left and right hand assemblies to service the pumps used in the TO-20 and TE-20 tractors, see Fig. 314. Use the TO-621-A and TO-622-A assemblies to service the TO-30 pump. The component parts of the various assemblies, except the valve chamber and valve chamber to pump housing gaskets, are interchangeable in all assemblies.

Piston assemblies TO-615 are used in all pumps.

The cams for the TO-30 and TE and TO-20

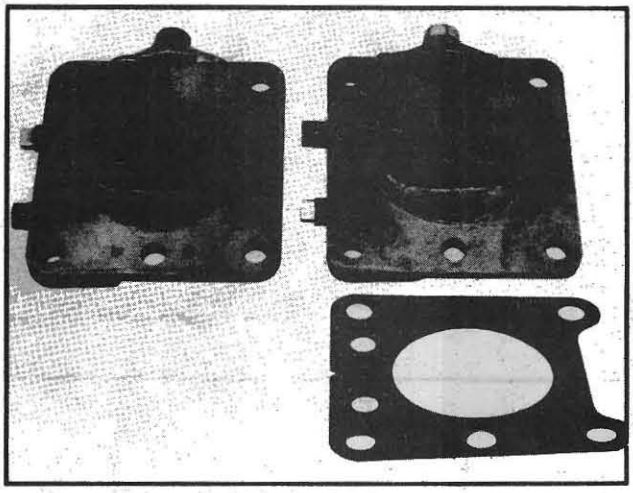


Fig. 314

tractors differ only in the length of one cam. The TO-618-A cam was extended to contact the fork which oscillates the control valve. It is used in the TO-604-A base assembly for use with the oscillating control valve. For tractors (TO-20 and TE-20) not equipped with the oscillating control valve, the TO-618 cam is used with the TO-604 base assembly. Do not attempt to interchange these parts.

Phosphor bronze cam blocks, Part No. TO-612, are now used in production pumps. Four different type cam block materials have been used in the past. These are phosphor bronze, sintered iron, sintered bronze and Parco-Lubrited, however, the phosphor bronze cam blocks are to be used to service all pumps.

The following differences should be noted in the pumps used in the different model tractors, see Fig. 315 and Fig. 317.

1. The vertical control fork used on the TO-30 has a stabilizer which fits over the PTO shaft. This stabilizer is not used on the TE-20 or TO-20.

2. The TO-30 pump makes use of an oscillating control valve. The following parts were added to the pump and will not be found in either the TO-20 or TE-20.

TO-691	Oscillator Drive Assembly
S-10152	Internal Ring
TO-695	Tab Washer
TO-697	Set Screw
TO-688	Fork and Pin Assembly

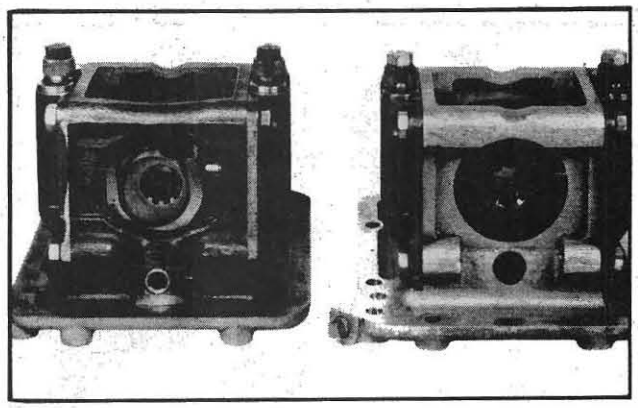


Fig. 315

3. The TO-30 safety valve is provided with a metal baffle which is not used in either the TO-20 or TE-20 models. Two types of baffles have been used. They both serve the same purpose and are shown in Fig. 316. The cup type is preferred since it is less apt to cause interference during assembly.

4. The valve chamber to pump base gaskets used on the TO-30 pump are small O-rings fitted into grooves around the discharge ports. The TO-20 and TE-20 pumps make use of a flat gasket between the valve chamber and pump housing, see Fig.314. Always use new gaskets when assembling the pump.

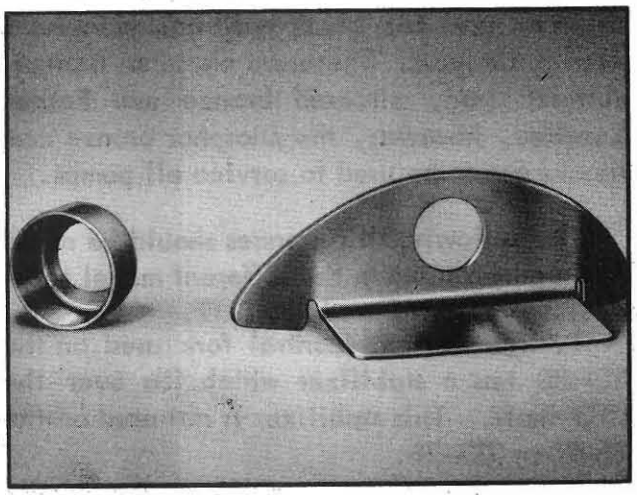


Fig. 316

HYDRAULIC LIFT

The lift assembly can be removed from the tractor without draining the oil, if only the parts of this assembly are to be serviced. It is advisable to lift the rear end of the tractor with a jack or chainfall and allow some of the oil to run forward into the transmission to prevent leaking when the side cover plates are removed.

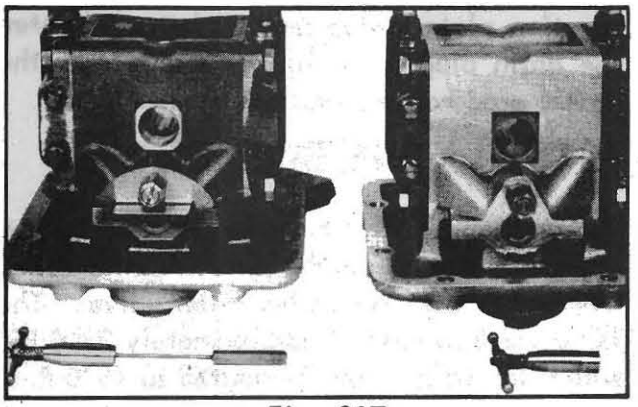


Fig. 317

1. Remove the tractor seat, PTO shifter cover and the oil level indicator cover.

2. Working through these openings, remove the two cap screws retaining the fork stabilizer to the control fork and remove the stabilizer. Spread the control fork and release the lower ends of the fork from the control valve.

3. Disconnect the leveling rods from the lift arms.

4. Remove the clevis pin connecting the hydraulic lift spring control plunger to the hydraulic lift rocker.

5. Remove the cap screws retaining the hydraulic lift cover to the center housing and remove the hydraulic lift and ram assembly.

DISASSEMBLY

1. Remove the four cap screws retaining the lift control quadrant to the lift cover and remove the lift control quadrant assembly.

2. Remove the two cap screws from each end of the hydraulic lift shaft, remove the retaining washers and lift arms and withdraw the shaft.

3. Remove the lift fork retracting spring and the four bolts attaching the ram cylinder to the lift cover and remove the ram cylinder.

4. Remove the cotter pins and clevis pins attaching the hand control fork to the spring control fork and remove the hand control fork. Remove the ram arm and connecting rod

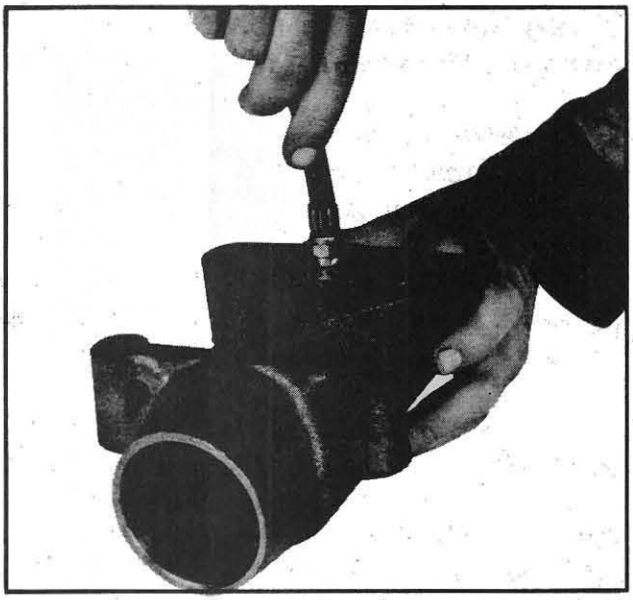


Fig. 318

from the cover.

5. Unscrew the hydraulic lift yoke from the hydraulic lift spring control plunger. Remove the three cap screws from spring seat support and remove the spring, spacer, spring seat, spring seat support, felt seat and plate.

6. Remove the cotter pin and clevis pin holding the spring control fork to the spring plunger and both parts can be removed.

7. The hand control fork can be further disassembled by removing the clevis pins.

8. The hydraulic ram piston may be removed from the cylinder by jarring the assembly on a wood block or by using compressed air to force the piston out, see Fig. 318.

9. The lift control quadrant assembly may be disassembled by removing the cotter pin and slotted nut from the end of the control lever shaft. The lift control friction plate is keyed to the shaft with a woodruff key.

INSPECTION

Even though the ram cylinder may not show leaks when tested as outlined in the preceeding section, it should be checked for wear whenever the lift cover assembly is removed.

Thoroughly clean and inspect the ram cylinder for visible signs of wear or scoring. Replace any cylinder that shows signs of wear. If the cylinder is in good condition, carefully measure the inside diameter with an inside micrometer, see Fig. 319. This should be done at several locations to determine the amount of wear. The new cylinder is finished to an inside diameter of 2.500–2.501 in. If the inside diameter at any point is more than 2.503 in., the cylinder should be replaced.

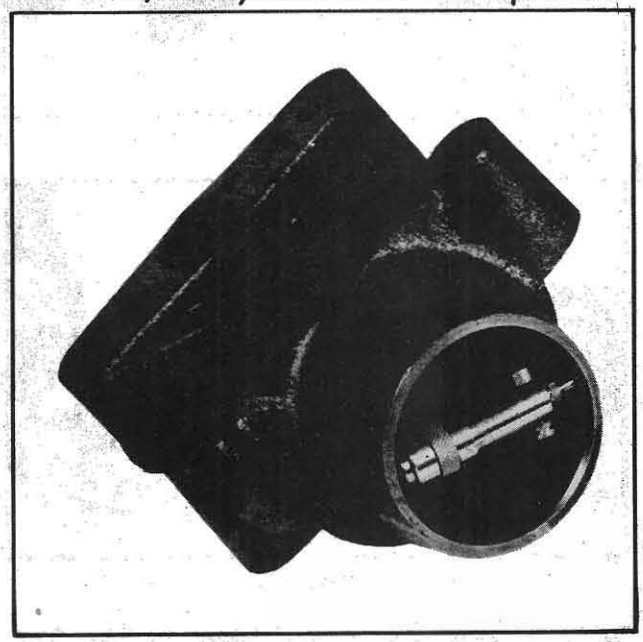


Fig. 319

To determine the amount of wear on the hydraulic piston rings, remove the rings with a piston ring remover, as shown in Fig. 320, and insert the ring in a new cylinder. Use the piston to push the ring down into the cylinder bore to make sure the ring is square in the bore, see Fig. 321. Measure the ring gap

Fig. 320

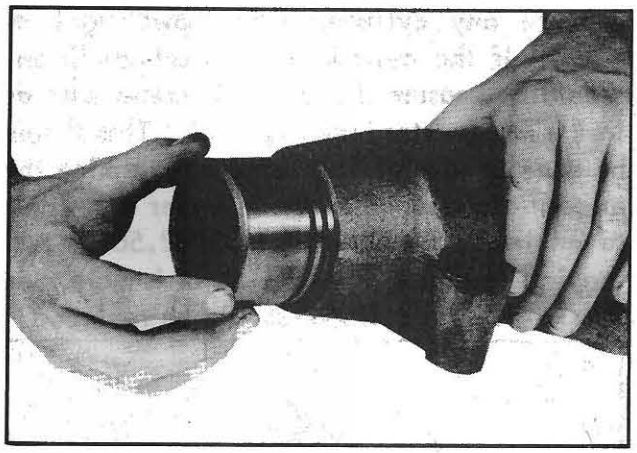


Fig. 321

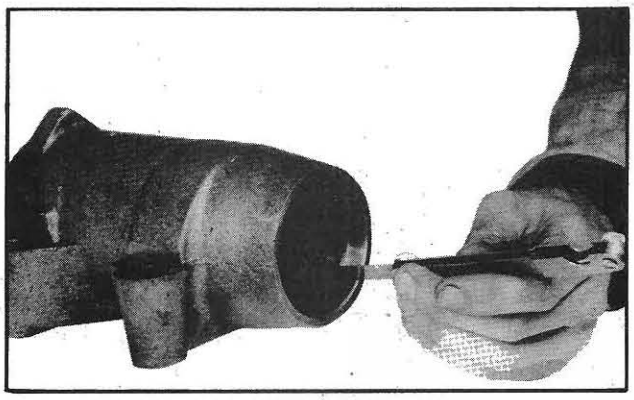


Fig. 322

with a feeler gauge as shown in Fig. 322. The rings are manufactured so that the ring gap is .003-.008 in. when the ring is inserted in a 2.500 in. cylinder. If the gap of the ring when measured in a new cylinder is more than .010 in., the rings should be discarded and replaced. Regardless of the condition of the old rings, it is advisable to use a new set of rings whenever either the cylinder or the piston is replaced with a new one.

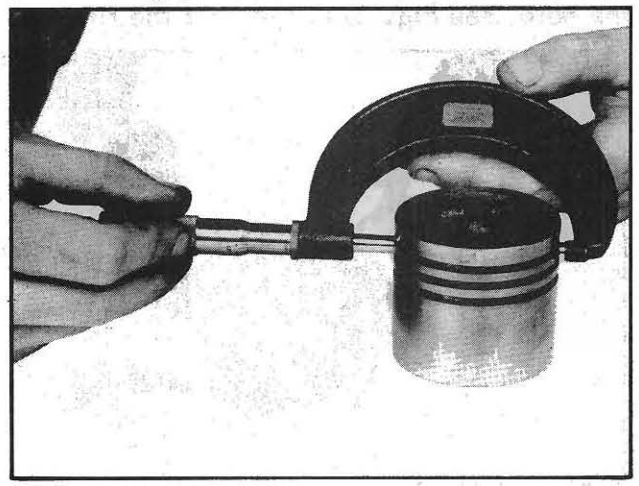


Fig. 323

To determine the amount of wear on the piston, carefully measure the outside diameter at several points with a micrometer, see Fig. 323. The piston is finished to an outside diameter of 2.497-2.498 in. If the diameter of the piston at any point is less than 2.496 in., the piston should be replaced.

The bearing areas of the hydraulic lift shaft are finished to a diameter of 1.996-1.998 in. The diameter of the bearing areas should be checked with a micrometer whenever the unit is disassembled, see Fig. 324. If the diameter at any point becomes less than 1.994 in., the shaft should be replaced.

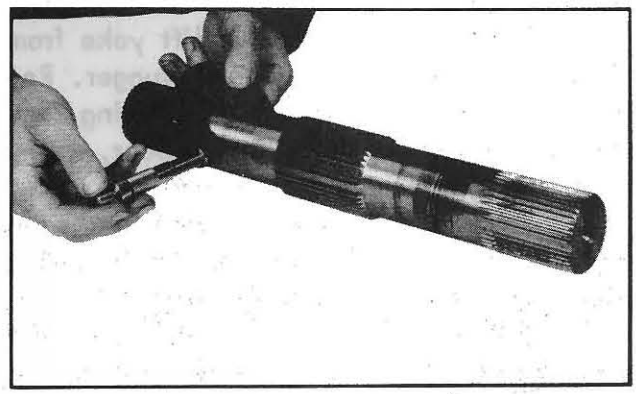


Fig. 324

The hydraulic lift shaft bushings are finished to an inside diameter of 2.001-2.004 in. and an outside diameter of 2.370-2.372 in. Measure both the inside and outside diameter of the bushing, see Figs. 325 and 327. If the outside diameter is less than 2.368 in. or the inside diameter is more than 2.007 in., the bushings should be replaced. Service bushings are available either as one long bushing for each side of the shaft, or two short bushings for each side. Use whichever type bushing is available.

The bushing bore of the hydraulic lift housing is finished to a diameter of 2.374-2.375 in. The inside diameter should be measured with an inside micrometer to determine if any wear has occurred in the bore of

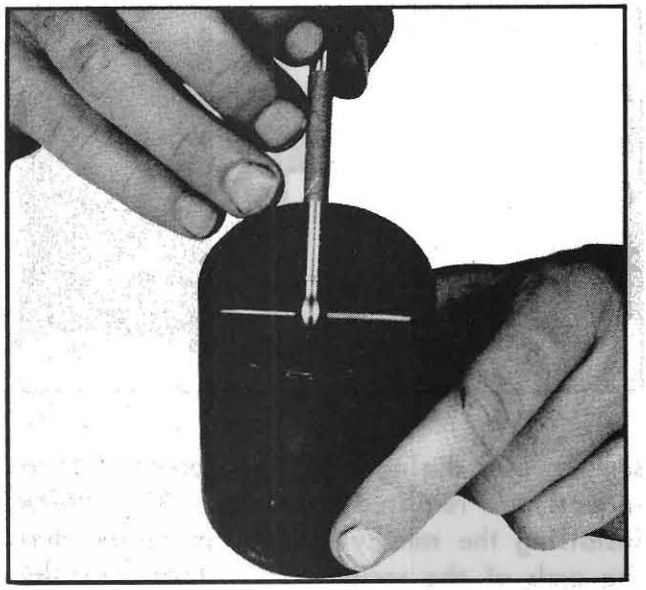


Fig. 325

the housing, see Fig. 326. If the diameter of the bore is more than 2.376 in., the housing is unfit for further use and should be replaced.

Warning: The bushings used on the hydraulic lift shaft are oil impregnated and require no additional lubrication. Coating the bushing, shaft or the bore of the lift cover with oil or grease will only serve to collect dirt and greatly increase the wear on these parts.

Examine the friction disc while the control quadrant is disassembled and install a new one if the old one is cracked or badly worn.

Check the hydraulic lift cover plate, TO-541, to make sure it is in good condition. A slight buckling of this plate will change the fork pivot points and result in a higher trans-

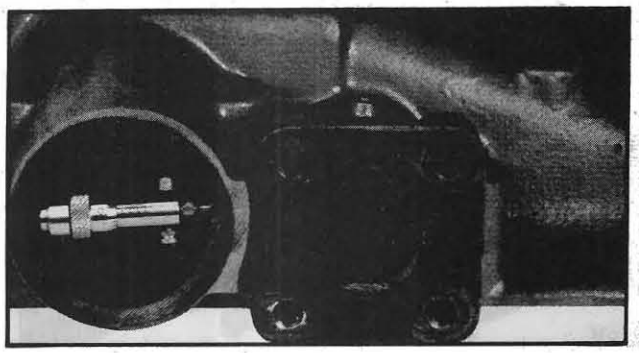


Fig. 326

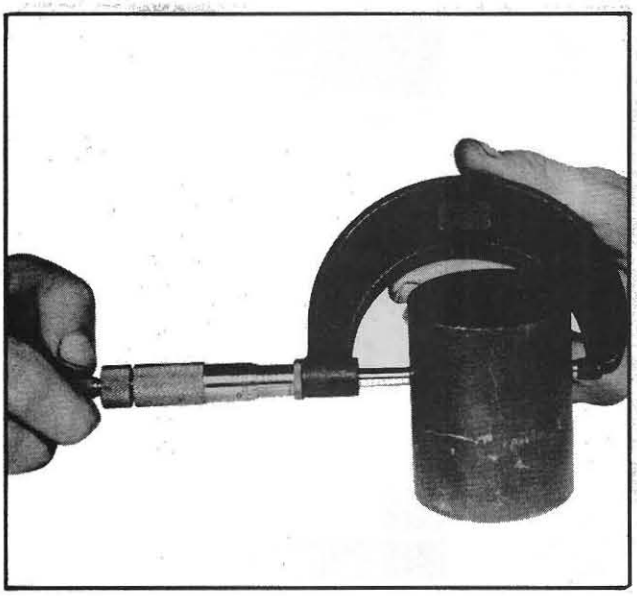


Fig. 327

port shut off position. If there is any indication that this plate is buckled, it should be replaced.

REASSEMBLY

1. Place the lift spring control fork and the control spring plunger in the lift cover, as shown in Fig. 328, and fasten them together with the clevis pin.

2. Replace the ram arm, connecting rod, hydraulic lift shaft and bushings. DO NOT LUBRICATE the shaft or bushings. Note the "Blind" spline that locates the shaft in the ram arm.

3. Place the plate, felt seal, spring seat support, spacer and control spring on the control spring plunger in that order and replace the hydraulic lift yoke. Replace the cap

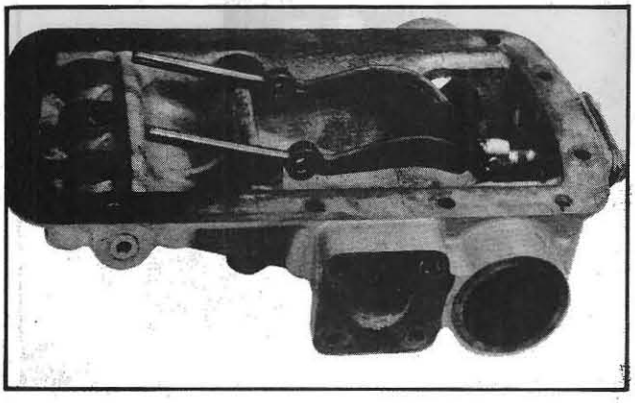


Fig. 328

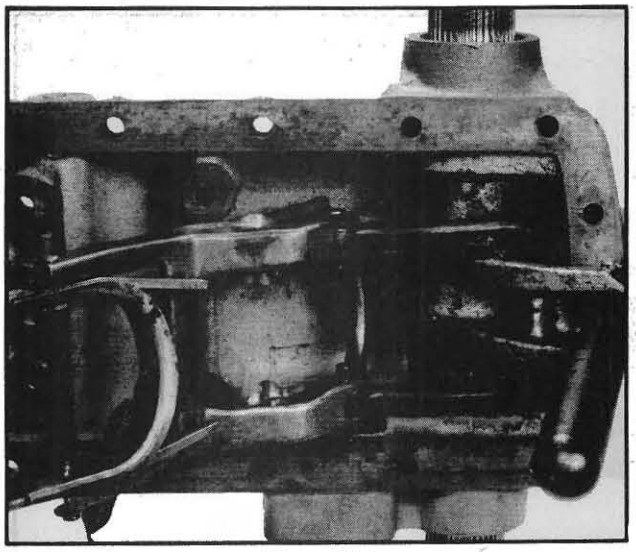


Fig. 329

screws in the spring seat support.

4. Install the hand control fork so the reinforcing plate is toward the rear of the unit, as shown in Fig. 329. Secure it with the clevis pins and cotter pins.

5. Stagger the ring gaps on the piston at least 90 degrees apart. Using a ring compressor, replace the ram piston in the ram cylinder as shown in Fig. 330.

6. Using a new gasket, bolt the ram cylinder in position in the cover. The TO-20 and TE-20 lift cover assemblies use a flat gasket and two spacers between the lift cover and the hydraulic cylinder. The TO-30 assembly uses a single O-ring gasket and no spacers are required, see Fig. 331. When installing the ram cylinder make certain that the ends of the spring control fork enter the holes in the ram cylinder as shown in Fig. 332. Tighten the ram cylinder retaining bolts just snug as it will be much easier to torque these after the assembly is in place on the tractor, see Fig. 333.

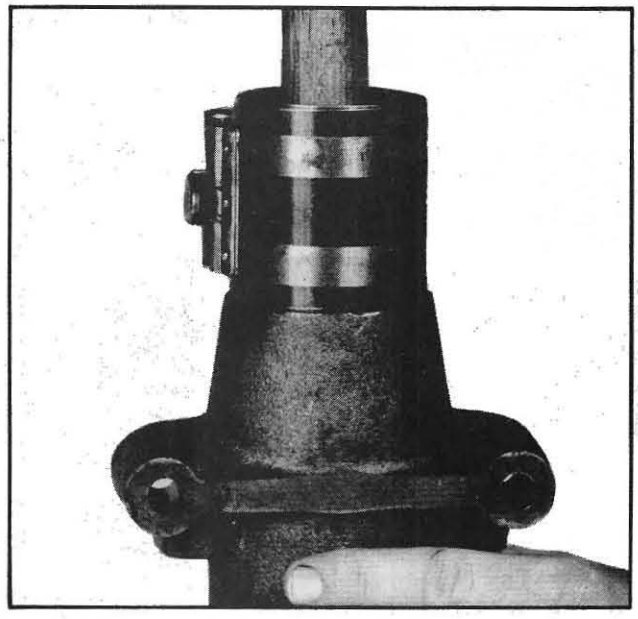


Fig. 330

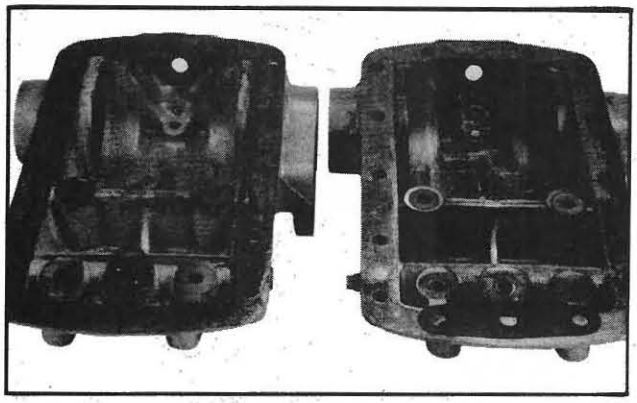


Fig. 331

7. Place the lift arms on the lift shaft, note again the "Blind" spline that locates the lift arms on the lift shaft. The arms are identical and may be installed on either side. Replace the washers, locking clips and cap screws. Tighten the cap screws on one side securely and adjust the other side until the lift arms will just fall of their own weight. Always bend clips over heads of screws to lock them in position.

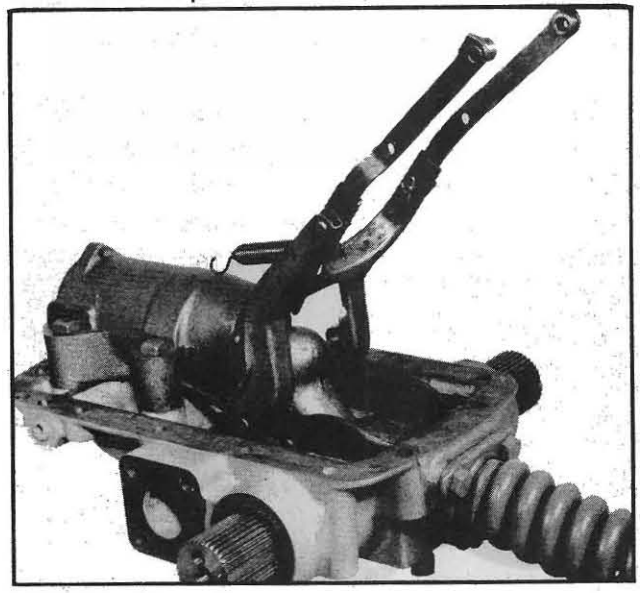


Fig. 332

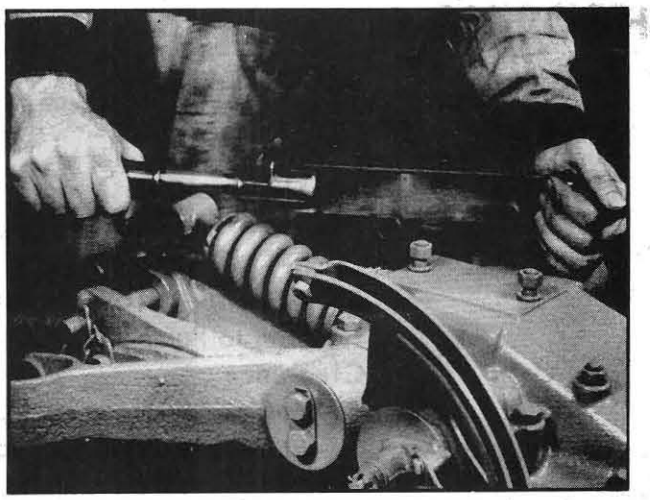


Fig. 333

8. Assemble and install the lift control quadrant, place the quadrant control shaft behind the hand control fork and tighten the retaining cap screws. Install the fork retracting spring.

INSTALLATION

With the hydraulic pump and PTO shaft in place, position a new lift cover to center housing gasket on the center housing and install the lift cover assembly. Working through the side openings, attach the control fork to the pump control valve. Replace the fork stabilizer and tighten the cap screws. Replace the lift cover to center housing cap screws and tighten them down evenly. Using a torque wrench, tighten the cap screws to 38-45 pound-feet. Torque the ram cylinder retaining bolts to 45-50 pound-feet.

Attach the leveling rods to the lift arms and the lift spring control plunger to the lift rocker. Using a new gasket, replace the side cover plates. Replace the drain plugs and fill the system with a straight mineral gear oil, SAE 90 for operating temperatures above 50 degrees or SAE 80 for operating temperatures below 50 degrees F., if the system was drained before starting the work. Adjust the quadrant setting and the control spring as outlined on page 154.

HIGH PRESSURE TUBE

The high pressure oil tube is located at the forward right side of the center housing. It is removed by first removing the lift assembly and PTO shifter cover and working through both openings. It will be necessary to collapse the tube at its mid-section and drive upward until the top end is free. Install a new tube from the top by carefully tapping with a soft face mallet until the upper end is flush with the hydraulic lift cover surface. Pay particular attention to the ends of the new tube when installing it. The top end of the tube is finished to an outside diameter of .505-.507 in. and the bottom end is finished to an outside diameter of .502-.504 in. This lower end has a 45 degree chamfer and this chamfered end should always be installed in the bottom of the center housing. After installing a new tube, flare the ends of the tube slightly by peening with a tool having a 45 degree cone point.

LEVELING BOX

To disassemble the leveling box:

1. Unscrew the right-hand lift rod from the fork by turning the leveling crank.
2. Remove the pin from the upper end of the leveling box and rod.
3. Drive the rivet from the leveling gear and crank, and carefully drive the crank out of the gear and gear box.
4. Drive the shaft through the leveling box, which in turn will drive out the expansion plug allowing the bearing assembly to be removed.

Reassemble in the reverse order.

TROUBLE SHOOTING

TROUBLE	POSSIBLE CAUSE
Implement Will Not Lift	1. PTO Shaft not in Gear 2. Badly Scored or Binding Ram Cylinder 3. Binding Control Valve 4. Binding Pump Side Plate Valves 5. Broken Control Valve Stem 6. Blown Old Type Flat Gasket 7. Relief Valve Spring Very Weak 8. Broken Ram Cylinder 9. Split or Leaky Riser Tube 10. Congealed Oil due to Extreme Cold 11. Control Valve Unhooked from Vertical Fork 12. Loose Cap Screws on Valve Chamber
Implement Will Not Lower	1. Seized Ram due to a Scored or Binding Cylinder 2. Binding Control Valve 3. Cap Screws on Lift Arms too Tight
Slow or Erratic Action	1. Badly Scored or Binding Ram Cylinder 2. Binding Control Valve 3. Broken Control Valve 4. Weak Retraction Spring 5. Leaking Gaskets 6. Side Chamber Valves Binding on Guide Rod 7. Loose or Split Riser Tube 8. Scored Pump Pistons 9. Oil Contains Dirt or Abrasive Substance 10. Valves Assembled Upside Down in Pump Chambers 11. Binding Control Valve Oscillator Drive
Pump Noisy or Knocking	1. Foaming Oil 2. Worn or Broken Pump Cams 3. Improper PTO Shifter Housing to Pump Side Plate Clearance 4. Improperly Aligned Pump 5. Starved Pump due to Improper Quadrant Setting
Implement Jerks When in Raised Position	1. Check Chain Anchors Installed Upside Down 2. Twisted Check Chain 3. Reversed Lower Links 4. Improperly Seated Safety Valve 5. Weak Fork Retractor Spring 6. Leaking Riser Tube
Implement Fails to Lift at Idle Speed	1. Loss of Oil Pressure Between Pump and Ram Cylinder 2. Relief Valve Spring
Implement Lifts But Falls When Pump is Stopped	1. Improperly Seated Relief Valve 2. Scored Ram Cylinder 3. Faulty or Worn Ram Piston Rings 4. Loss of Oil Pressure Between Pump and Ram Cylinder 5. Sticking Control Valve
Implement Will Not Maintain Desired Working Depth	1. Implement Out of Adjustment 2. Dull Tools 3. Quadrant Maladjusted

TROUBLE	POSSIBLE CAUSE
	4. Implement Has too Much Suck 5. Soil Texture Varies 6. Binding Automatic Control Linkage 7. Sticking Control Valve 8. Top Link Improperly Adjusted
PTO Shift Lever Binds or Sticks	1. Drive Shaft to PTO Retainer Assembly (TO-708) Clearance Incorrect 2. Drive Shaft-PTO Shifter Rail (TO-719) Clearance Incorrect. Flashings on the Drive Shaft not Ground to Give Proper Clearance
Pump Does Not Function After Assembly in Tractor	1. Air Lock in Pump in Side Chambers

SPECIFICATIONS

OPERATING PRESSURE	
TO-30 & TO-20	1900-2300 PSI
TE-20	1500-1900 PSI
PUMP	
1500 Engine RPM.	2 gal. per min.
2000 Engine RPM.	2.6 gal. per min.
Cam Blocks	
Inside Dia.	2.000-2.001 in.
Max. Allowable Inside Dia.	2.005 in.
Parallel Face	2.244-2.247 in.
Min. Allowable Parallel Face	2.242 in.
Cam	
Outside Dia.	1.995-1.997 in.
Min. Allowable Dia.	1.993 in.
Bushing	
Inside Dia.	1.182-1.183 in.
Max. Allowable Inside Dia.	1.184 in.
PISTON ASSEMBLIES	
Distance Between Inside Faces	2.249-2.252 in.
Max. Allowable Distance	2.254 in.
VALVE CHAMBER	
Cylinder Dia.	.802-.803 in.
Max. Allowable Dia.	.804 in.
Min. Allowable Dia.	.800-.801 in.
CONTROL VALVE	
Outside Dia.	.5918-.5920 in.
Inside Bushing Dia.	.5929-.5933 in.
Outside Bushing Dia.	1.0011-1.0015 in.
Pump Base Bushing Bore	
Aluminum Base	.999-1.000 in.
Cast Iron Base	.9998-1.0006 in.
RAM CYLINDER	
Inside Dia.	2.4995-2.5010 in.
Max. Allowable Dia.	2.503 in.
Ring Gap (Measured in a 2.500 in. cylinder).	.0025-.0075 in.
Max. Allowable Ring Gap	.010 in.
Ring Width	.123-.124 in.

Piston Dia.	2.497-2.498 in.
Min. Allowable Piston Dia.	2.496 in.
Ring Groove Width	.1255-.1265 in.

HYDRAULIC LIFT SHAFT

Dia. at Bearing Area	1.996-1.998 in.
Min. Allowable Bearing Area Dia.	1.994 in.
Bushing Outside Dia.	2.370-2.372 in.
Min. Allowable Bushing O.D.	2.368 in.
Bushing Inside Dia.	2.001-2.004 in.
Max. Allowable Bushing I.D.	2.007 in.
Bushing Bore in Lift Cover	2.374-2.375 in.
Max. Allowable Bushing Bore Dia.	2.376 in.

TORQUE SPECIFICATIONS

Valve Chamber to Pump Base Cap Screws	50-55 lb. ft.
Valve Chamber Clamp Cap Screws	50-55 lb. ft.
Pump Base to Center Housing Cap Screws	38-45 lb. ft.
Lift Cover to Center Housing Cap Screws	38-45 lb. ft.
Ram Cylinder Retaining Bolts.	45-50 lb. ft.

SERVICE BULLETINS

No.	Date	Subject

NOTES

FRONT AXLE

AND

STEERING

FRONT AXLE & STEERING

The front axle and steering assembly of the Ferguson tractor offers a unique arrangement of a three section front axle, radius rods, steering drag links and steering housing which combined, provide the ultimate in working and driving ease. These components are designed so that a maximum of flexibility, with a minimum amount of adjustment, is attained to meet all field and crop conditions.

FRONT AXLE

The front axle consists of a center section and two outer sections which are bolted to the center section. The front wheel spacing may be varied from 48-80 in. by bolting the outer sections at different positions on the center section and by various wheel arrangements. The center section of the front axle pivots about and is supported by a 1 3/4 in. cadmium plated pivot pin. The pivot pin allows the axle to rock in relation to the tractor as the wheels follow the contour of the ground. This Ferguson Feature also permits a forward and rearward movement of the axle on the pin when the wheel tread spacings are changed, thereby making it possible to change the spacing without the altering of the steering geometry or wheel alignment. Further, the radius rods always remain in the same relative position with the steering drag links since they also move outward, when the outer axle sections are extended, pivoting at the transmission case. With this condition existing, the radius rods always provide maximum support for the front axle assembly.

REMOVAL

The axle, radius rods, drag links and axle support can be easily removed as a unit when it is necessary to work on any component parts. Remove the hood, drain and remove the radiator. Support the engine on a jack or with a chain fall and remove the four bolts attaching the axle support to the engine block. Detach the radius rods from the transmission case and the drag links from the steering arms. To remove the drag link bolt from the steering arm, hold the drag link and strike the steering arm a sharp blow with a hammer as shown in Fig. 334. The assembly may now be wheeled away from the tractor as

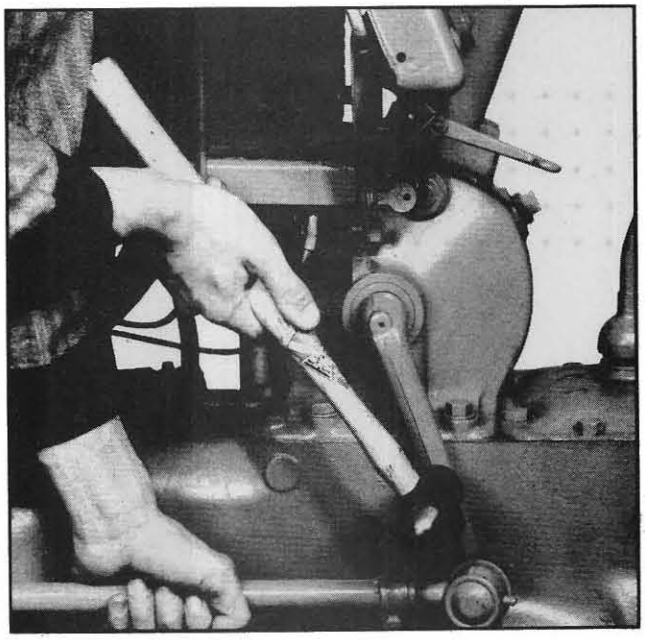


Fig. 334

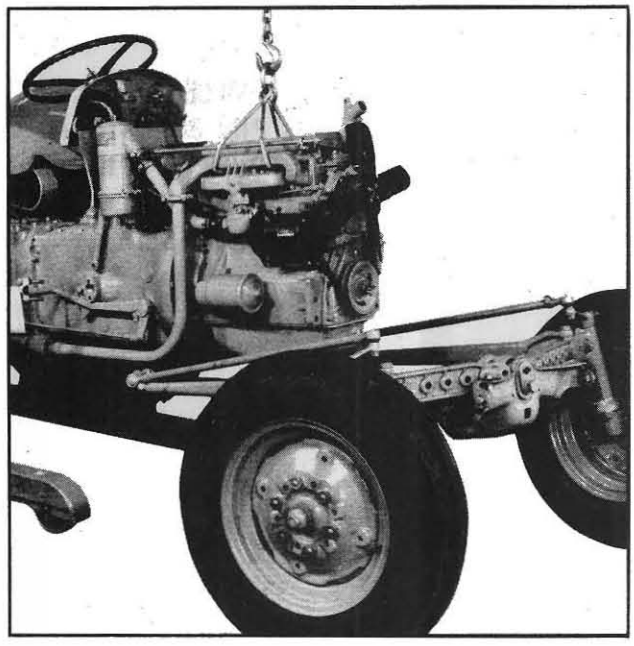


Fig. 335

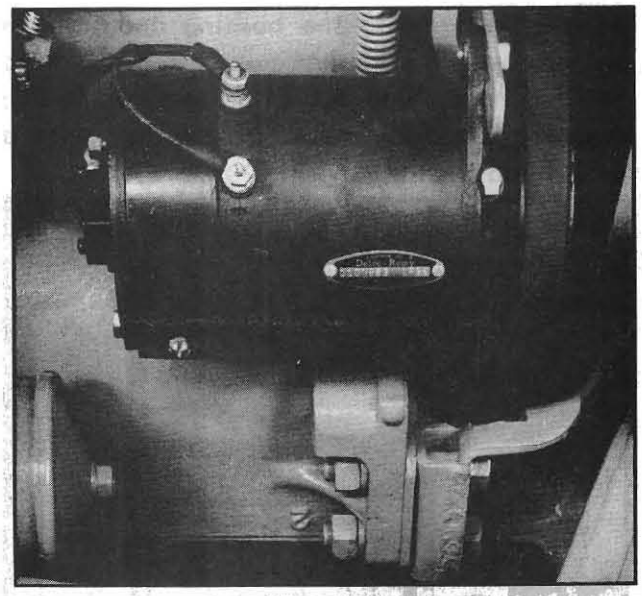


Fig. 336

shown in Fig.335.

Note: A spacer is used between the right side of the axle support and the engine block on the TO-30 tractor, see Fig.336. The generator support bracket used on the TO-20 and TE-20 tractors, Fig.337, eliminates the need for this spacer.

PIVOT PIN & BUSHING

The pivot pin may be removed from the axle support as shown in Fig.338. When the pin becomes worn so that its diameter at any point is less than 1.700 in., it should be renewed. This point on the tractor may occasionally squeak but it should not be oiled as this will cause it to pick up dust and dirt which will hasten wear. It may, however, be dusted with dry powdered graphite or sprayed with DGF while disassembled.

The pivot pin used in the TE-20 and TO-20 tractors between Serial Numbers TO-12432 and TO-13171 is 3 3/4 in. long and has a 17/32 in. hole. On most TO tractors between Serial Numbers TO-31835-TO-40842, the pin had a larger bolt hole to accept a 7/16 x 1 1/4 in. bolt over which a bushing and washer had been fitted. This change was made to reduce the tendency of the axle pin to shear the bolt and work loose. Where trouble is encountered on older TO tractors, the use of this pin and bushing should help. A further change was made on tractors after Serial Number 40380 whereby, a 5/8 in. bolt and bushing was installed. This change requires a pivot pin with a 7/8 in. hole. These parts are all indicated in the Parts Catalog. A split, pre-sized, hardened steel pivot pin bushing is pressed into the center section of

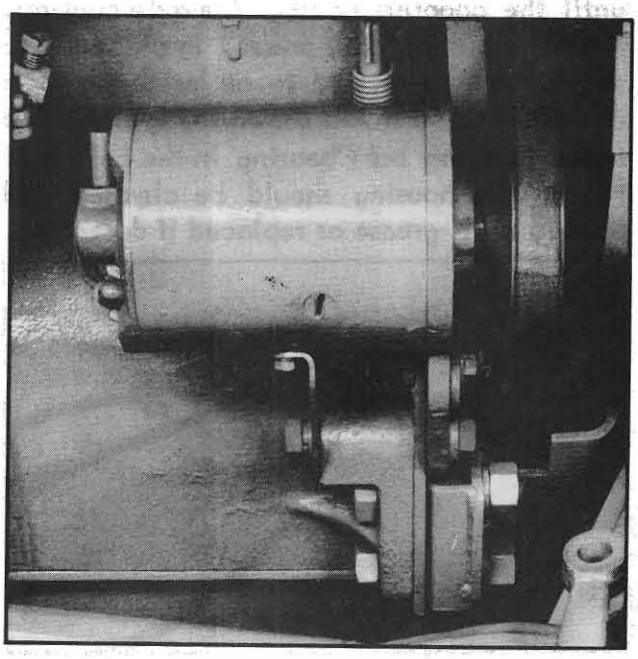


Fig. 337

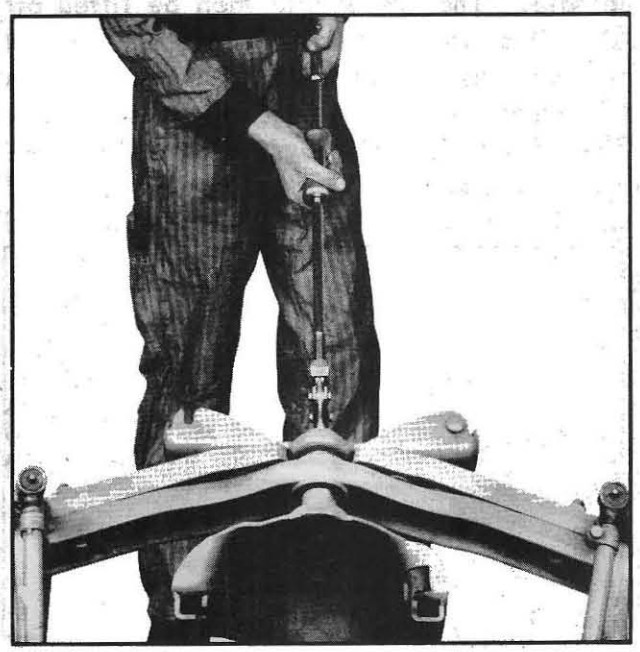


Fig. 338

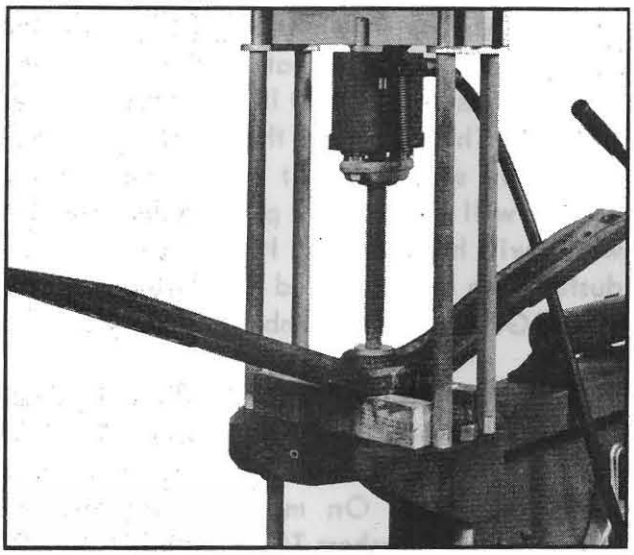


Fig. 339

the axle. When the I.D. of the bushing becomes greater than 1.790 in., it should be pressed out and a new one pressed in, see Fig. 339 using the correct size standard step plate, being careful to get the split side up. Manufacturing clearance between the pin and the bushing is .007-.008 in.

FRONT WHEEL SPINDLE

In order to remove the front wheel spindles, it is first necessary to completely remove the bolt which clamps the spindle arm to the spindle. The arm should then be lifted off (do not drive the spindle down) and the felt seal and key removed. The spindle rotates in two steel backed bushings of the split type. They should be pulled when they have become excessively worn and new ones pressed in. To remove the bushing, screw a threaded bushing puller into the bushing and pull the bushing with a slide hammer as shown in Fig. 340. If the bushing cannot be removed in this manner, carefully split the bushing with a chisel and then remove it.

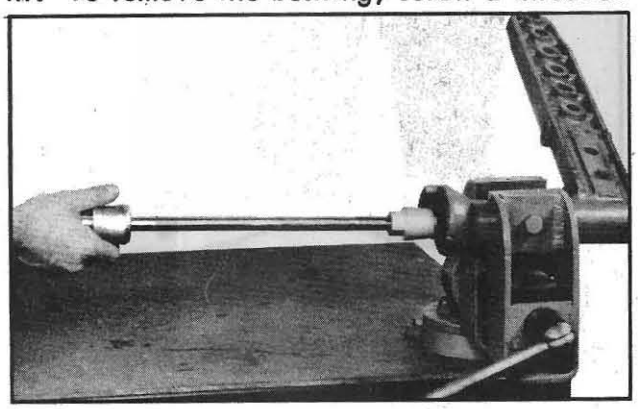


Fig. 340

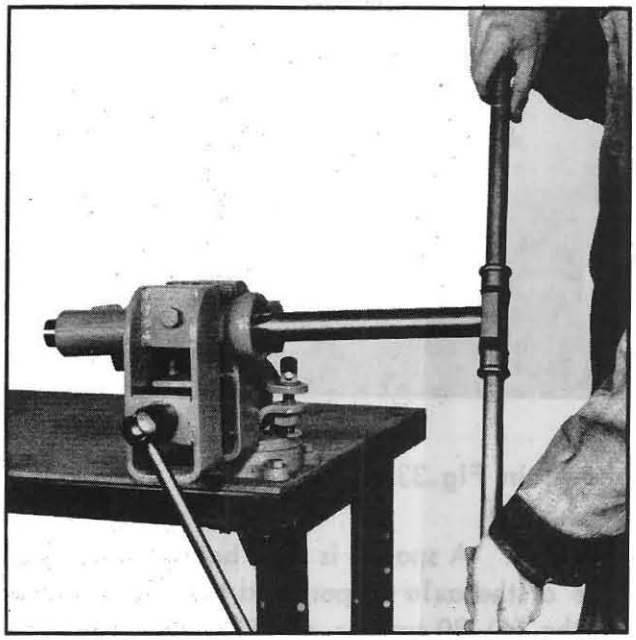


Fig. 341

To replace the spindle bushings, start both bushings into the axle housing and then using the two adapters, SDT-118 and SDT-119, press both bushings in at the same time as shown in Fig. 342. Press both bushings in until the adapters contact the axle housing. After the bushings are pressed in place, they should be line-reamed to an inside diameter of 1.249-1.250 in. as shown in Fig. 341 The thrust-carrying ball bearing in the bottom of the spindle housing should be cleaned and packed with grease or replaced if defective.

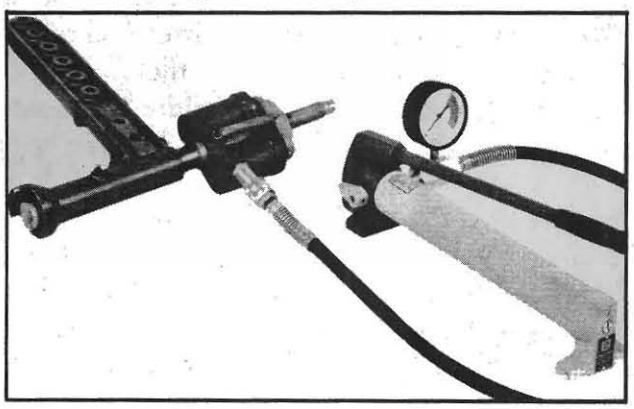


Fig. 342

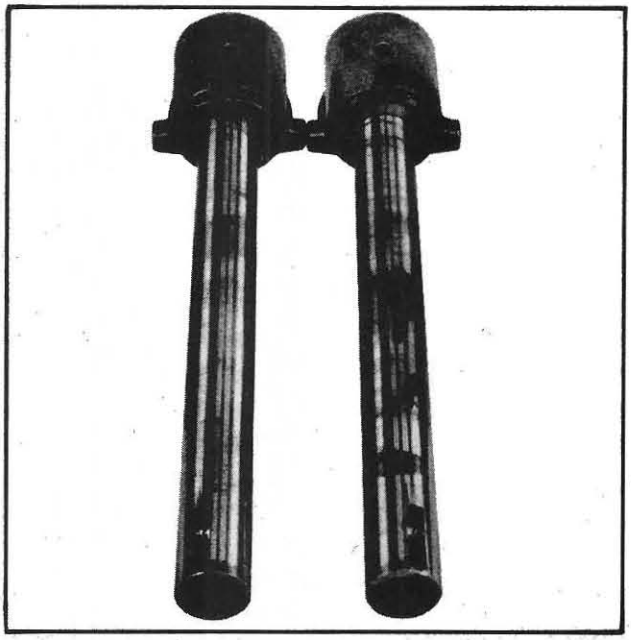


Fig. 343

The spindles are right-hand and left-hand and may be identified by looking at the upper end of the spindle with the axle arm pointing downward. If the keyway is to the right, the spindle is a right-hand piece, if the keyway is to the left, the spindle is a left-hand member, see Fig. 343.

FRONT WHEEL HUB

The front wheel hub rides on two tapered-roller bearings which are protected by an inner dust seal and a hub cap. Whenever the hub is removed, wash it and the bearings in a suitable grease solvent and repack with bearing lubricant. The seal should be inspected and if it shows signs of wear, it should be renewed. To remove the bearing and seal from the spindle, use a bearing splitter and puller as shown in Fig. 344. Check the surface of the spindle on which the seal rides to be sure it is clean and smooth. Polish the area with fine emery cloth and crocus cloth if it is rough. When replacing the seal and bearing, slip the seal in position on the spindle and place the bearing on as far as it will go. The bearing will pull into place when the retaining nut is tightened. The bearing races may be pulled from the hub with a conventional race puller as shown in Fig. 345 and re-

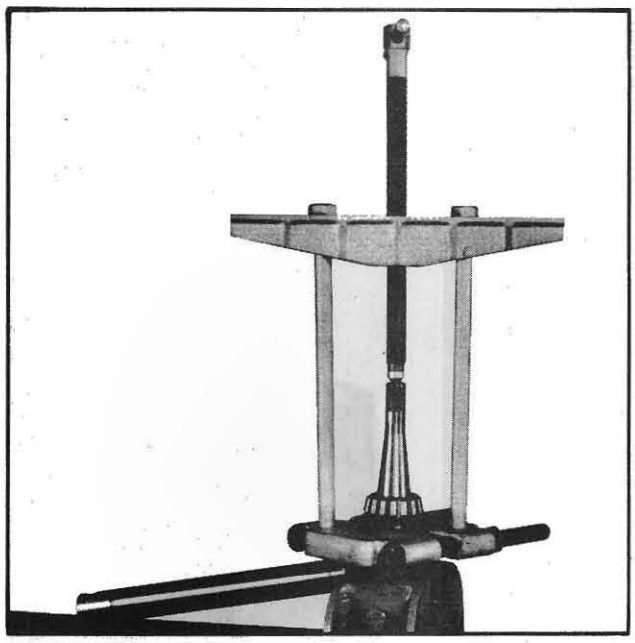


Fig. 344

installed by pressing in with a suitable step-plate as shown in Fig. 346. Adjust the bearings by tightening the nut until a slight drag is felt when the wheel is spun and then backing it off until the cotter pin may be inserted. If the inner bearing and seal were removed, tighten the retaining nut sufficiently to pull the bearing into position before adjusting the bearings.

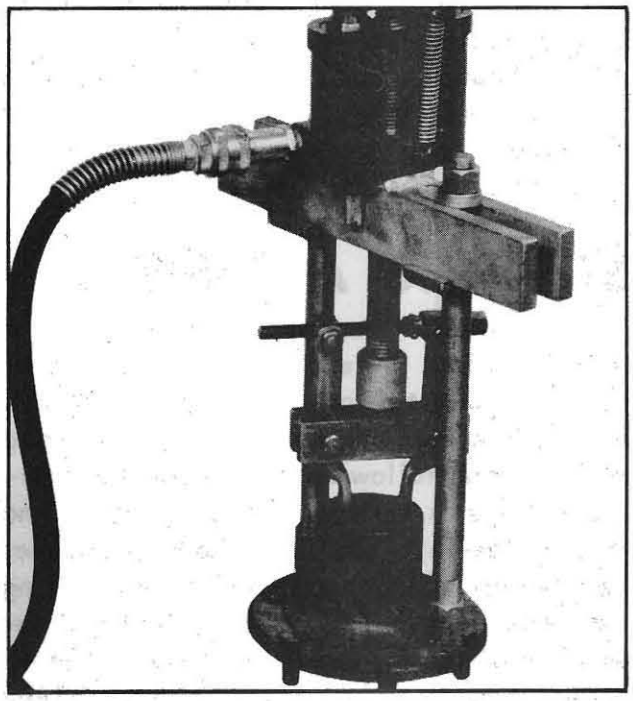


Fig. 345

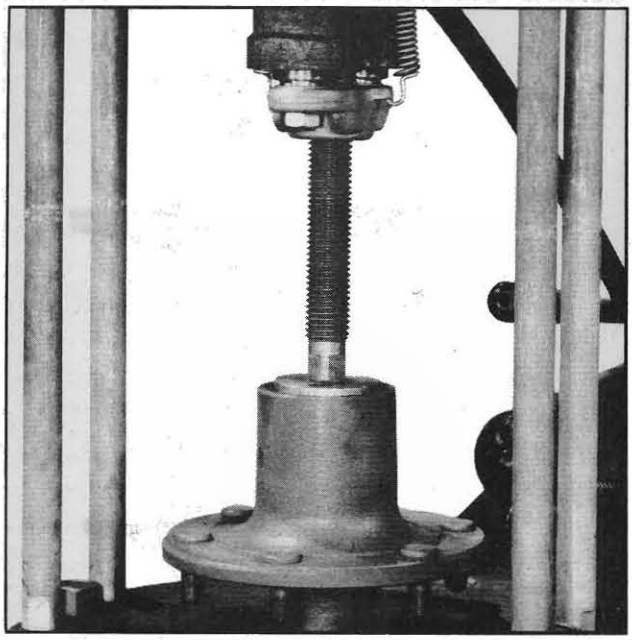


Fig. 346

RADIUS RODS

The rear or ball end of the radius rod is secured in a socket and cap and should be free to pivot at all times. Clearance for the ball in the socket is obtained by the use of shims inserted under the ball cap. These shims can be removed to compensate for wear but enough shims must always be present to permit the ball to move freely as the axle rocks about the pivot pin. This clearance may be checked by jacking up the front of the tractor and rocking the axle about its pivot pin.

STEERING ASSEMBLY

The Ferguson tractors are equipped with two drag links instead of the conventional drag link and tie-rod. This means that both wheels are steered instead of one steering and the other following. The Ferguson steering linkage is easily adjusted for wear and correct toe-in. The lower housing encloses two sectors which are bolted to the steering arms and are driven by a pinion on the lower end of the steering shaft. The mesh between the sectors and the pinion is adjusted by screws which bear against the back of the sectors. An upper housing carries the steering shaft which rotates in tapered-roller bearings.

REMOVAL

The following procedure for removing the steering gear from the tractor is recommended. Remove the hood, battery and gas tank. Disconnect wires from the generator, coil and starter switch so that the assembly is left attached to the instrument panel. Disconnect the oil gauge line from the gauge. Remove the choke rod by disconnecting from the carburetor and withdrawing from the instrument panel. Loosen the U-bolt holding governor linkage to the hand throttle rod. Remove oil cup from air cleaner. Remove rear ends of drag links from steering sector arms. Remove bolts holding steering housing to the transmission case and lift off entire assembly. After the cover plate is removed from the bottom of the housing and the oil is drained, the assembly may be set on the steering wheel as shown in Fig. 347.

DISASSEMBLY

In order to remove the sectors and steering arms, the bolts which clamp the sectors to the arms must be completely removed, making it

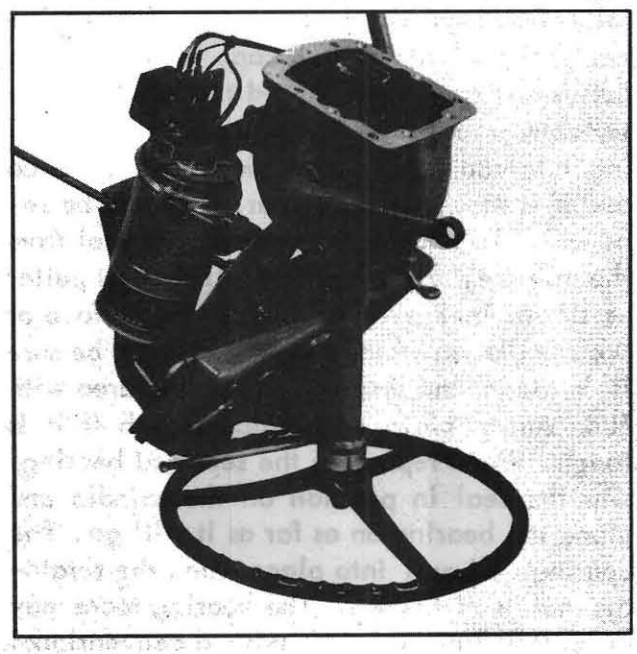


Fig. 347

Fig. 348

possible to pull the arms out of the housing. Note that the steering arms are right-hand and left-hand. On TO tractors, they may be identified by looking at the splined end while holding the arms so that they point down. If the blind spline is to the right, the arm is a right-hand member and if the blind spline is to the left, the arm is a left-hand unit, see Fig.348. On TE tractors, the inner end of the arms are stamped right or left. The sectors are identical and interchangeable. After the sectors and arms are removed, the lower housing should be detached from the upper housing.

Whenever the steering arms are removed, the bushings should be checked for wear and replaced if necessary. The assembled inside diameter of the center bushing should be 1.1275-1.1290 in. while that of the two outside bushings should be 1.3120-1.3135 in. If their diameters at any point exceed these figures by more than .0020 in., the bushings should be replaced. To remove the bushings from the steering gear housing, support the housing in a press, select the proper size mandrel and press the two outside bushings out of the housing as shown in Fig.349. Pressing the bushing out in this manner will remove the oil seal at the same time.

To remove the center bushing, first place the special support, SDT-120, between the center web and the outside of the housing, as shown in Fig.350. Select the proper size standard step plate as shown. The use of this special support eliminates the danger of cracking the center web when pressing the center bushing out or in. The special support

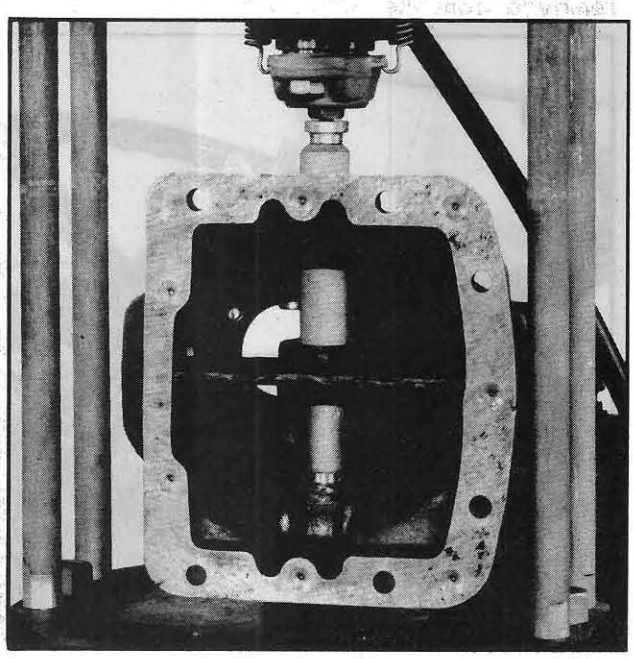


Fig. 349

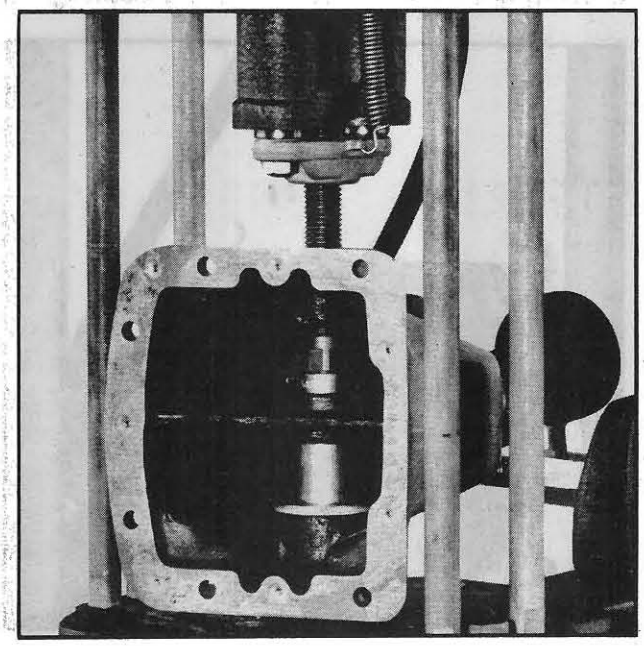


Fig. 350

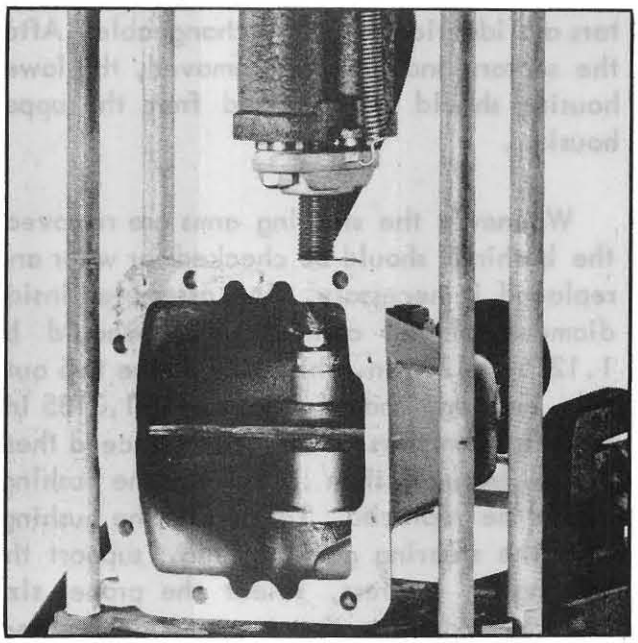


Fig. 351

is adjustable in height and should be adjusted so that it is tight between the center web and the outside of the housing.

To install the new bushings leave the special support in place and press the center bushing in as shown in Fig. 351. Press the bushing in until it is centered in the bore of the center web. Use the proper size standard bushing driver to press the two outer bushings in as shown in Fig. 352. Press the bushings in

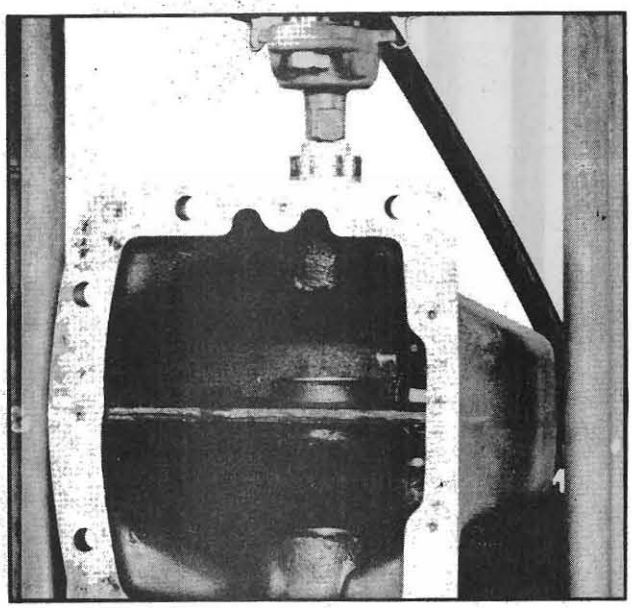


Fig. 352

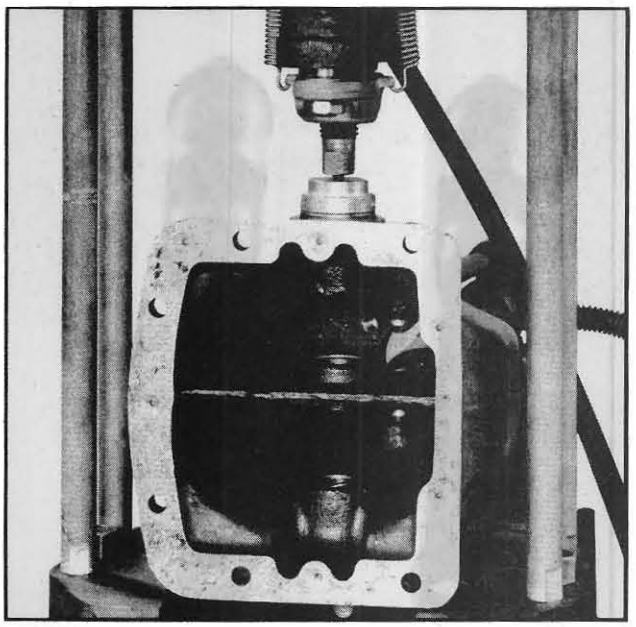


Fig. 353

until they are flush with the inside of the bore in the steering gear housing. Service bushings for the steering gear housing are pre-sized and do not require reaming after installation. To install new oil seals, use a flat step plate as shown in Fig.353. Install the seal with the feathered edge of the seal toward the inside of the housing, and press the seal in until it bottoms in the recess. Never try to reuse an oil seal that has been removed from the housing.

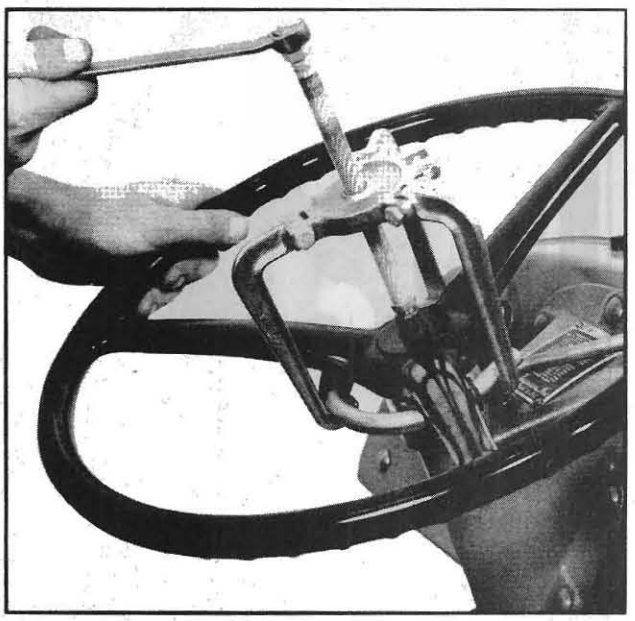


Fig. 354

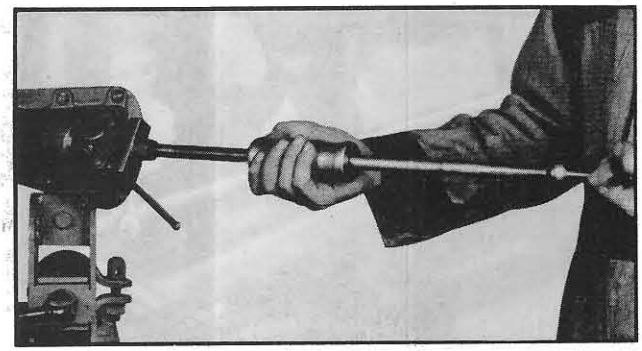


Fig. 355

The upper housing should be removed from the instrument panel before attempting to remove the steering shaft or its bearings. In order to remove the steering shaft, it is necessary to remove the steering wheel dome nut and pull the steering wheel, as shown in Fig. 354. Remove the cap, seal, lock nut, and adjusting nut; the steering shaft may now be withdrawn from the bottom of the housing. If the bearings are to be replaced, the cups may be pulled and replaced as shown in Figs. 355 and 356. The lower cone and roller assembly may be removed from the shaft using a bearing splitter. The bearings should be coated with bearing lubricant and the adjusting nut tightened until a slight drag is felt or until a torque of 1-2 pound-feet is required to turn the shaft. Tighten the lock nuts and lock both nuts with a lock washer.

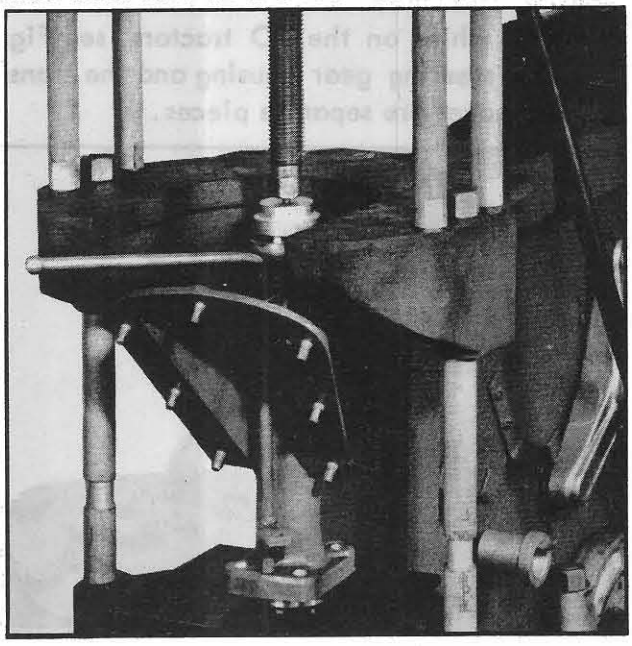


Fig. 356

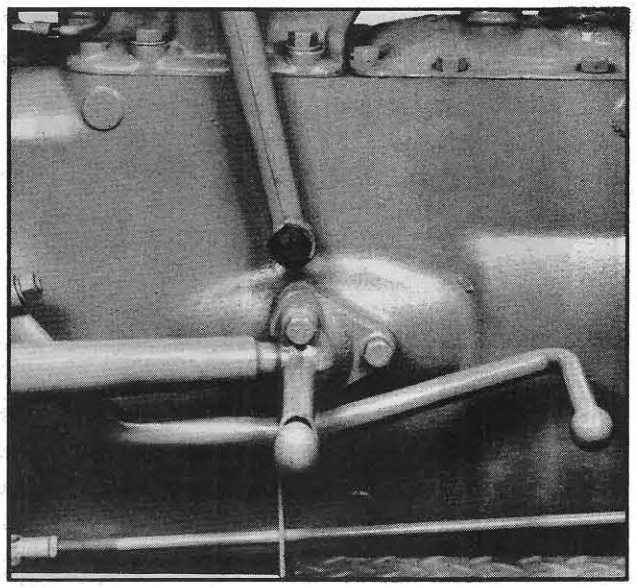


Fig. 357

Complete the reassembly in the reverse order to the disassembly, using a new gasket between the cover plate and cast housing.

The steering gear must be "timed" before the drag links are reconnected. This is done by moving one sector arm completely forward and the other arm completely toward the rear. Move both arms toward each other until the sector gears mesh with the pinion at the same time. If this is properly done, both arms will be directly over the foot rests when the steering wheel is in the straight ahead position as shown in Fig. 357. Reconnect the drag links.

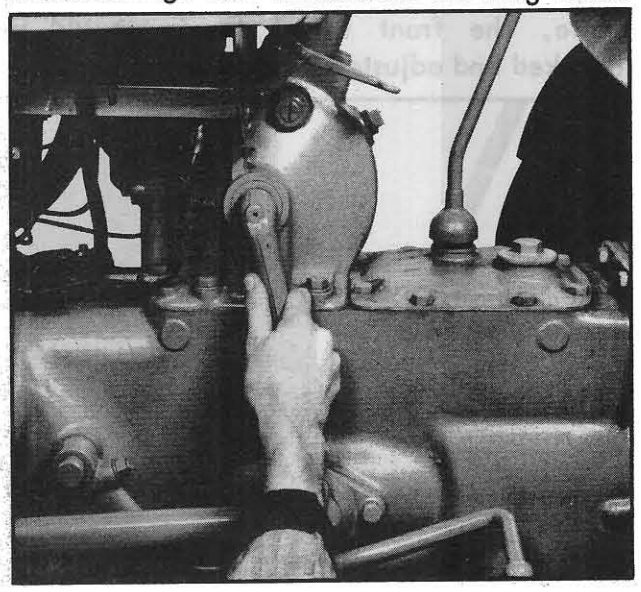


Fig. 358

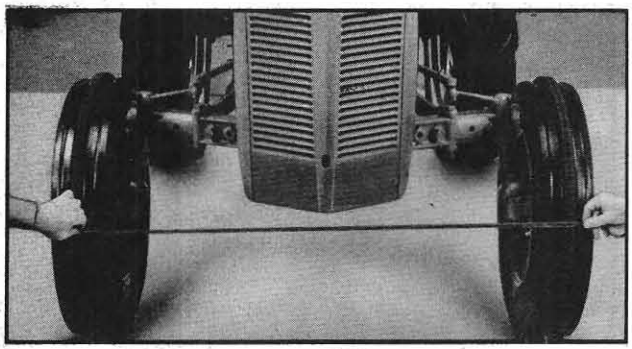


Fig. 359

The adjusting screws on either side of the housing should now be screwed in until the sector gears mesh fully with the pinion. This may be checked by forcing the arm in and out of the housing to see if there is any end play as shown in Fig. 358. Turn the wheels as far as they will go in both directions and make sure that no binding occurs. The lower housing should be filled with transmission oil until the oil just touches the steering arms. The pinion bearings should require no further lubrication if they were cleaned and packed with grease before they were installed.

INSTALLATION

The assembly may be installed by merely reversing the procedure outlined above.

TOE IN

After the reassembly of the tractor is complete, the front wheel toe-in should be checked and adjusted if necessary. To check

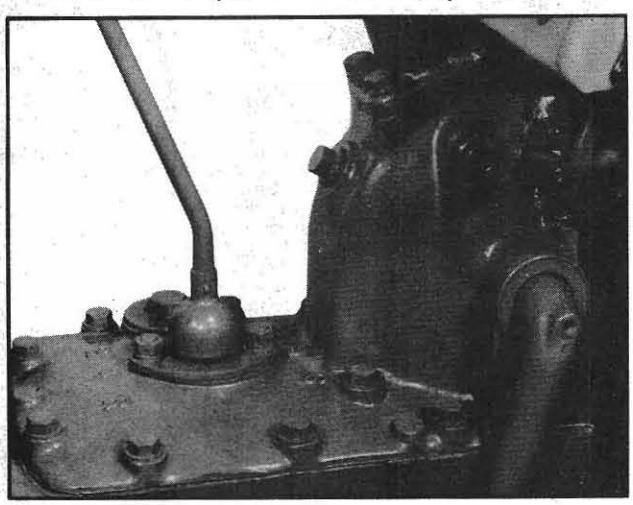


Fig. 360

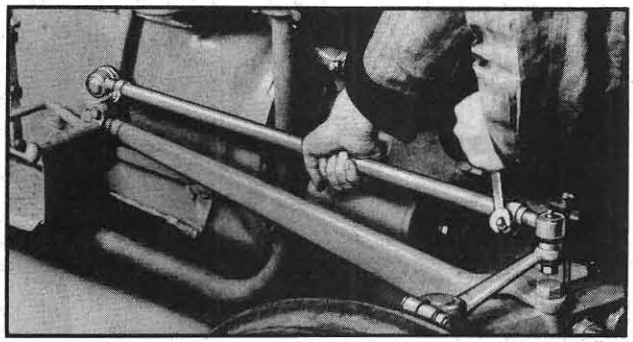


Fig. 361

the toe-in, measure between the tire rib centers at hub height at both front and rear of wheels, as shown in Fig. 359. and note the difference. The measurement at the front of the wheels should be from 0-1/4 in. less than that at the rear.

To adjust the toe-in, loosen the bolts at the front and back of each drag link, and turn in or out as required. After adjusting the toe-in, retighten all clamp bolts securely, see Fig. 361

MODEL DIFFERENCE

The principal difference between the steering gear of the TO tractors and the TE tractors is in the design of the housing. On the TE tractors, see Fig. 360, the steering gear housing also serves as the cover for the transmission, while on the TO tractors, see Fig. 362, the steering gear housing and the transmission cover are separate pieces.

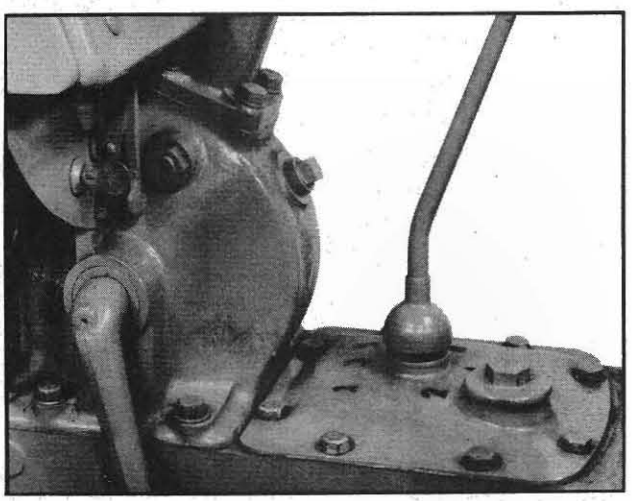


Fig. 362

SPECIFICATIONS

PIVOT PIN	
Original Dia. of Pivot Pin	1.747-1.748 in.
Min. Allowable Dia. of Pin	1.700 in.
Original I.D. of Pivot Pin Bushing	1.7615-1.7675 in.
Max. Allowable Dia. of Bushing	1.790 in.
SPINDLE	
Spindle Bushings-Ream to	1.249-1.250 in.
STEERING HOUSING	
I.D. of Center Steering Housing Bushing	1.1275-1.1290 in.
Max. Allowable Dia.	1.1250 in.
I.D. of Outer Steering Housing Bushings	1.3120-1.3135 in.
Max. Allowable Dia.	1.3100 in.
Toe-In	0-1/4 in.

SERVICE BULLETINS

No.	Date	Subject

NOTES

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NOTES