FORD

1320-1520 AND 1720 TRACTORS

Repair Manual

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FORD NEW HOLLAND, INC.
NEW HOLLAND, PENNSYLVANIA

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FOREWORD

This repair manual provides information for the proper servicing and overhaul of Ford 1320-1520 and 1720 Tractor Models and is an essential publication for all service personnel carrying out repairs and maintenance procedures.

The Manual is divided into twelve PARTS, each sub-divided into Chapters. Each Chapter contains information on general operating principles, detailed inspection and overhaul and, where applicable, trouble shooting, special tools and specifications.

The material contained in this Manual was correct at the time of going to print, but Ford New Holland, Inc. policy is one of continuous improvement and the right to change prices, specifications, equipment or design at anytime without notice is reserved. All data in this Manual is subject to production variations, so overall dimensions and weights should be considered as approximate only and the illustrations do not necessarily depict the unit to standard build specification.

FORD NEW HOLLAND, INC.

PRODUCTION DATE CODES AND SERIAL NUMBERS

The Tractor Identification Plate is located on the left side of the transmission case on the Ford 1320-1520 and 1720 Tractors and is stamped with the following information:

Production Identification Number — Two letter prefix followed by the Tractor Serial Number.

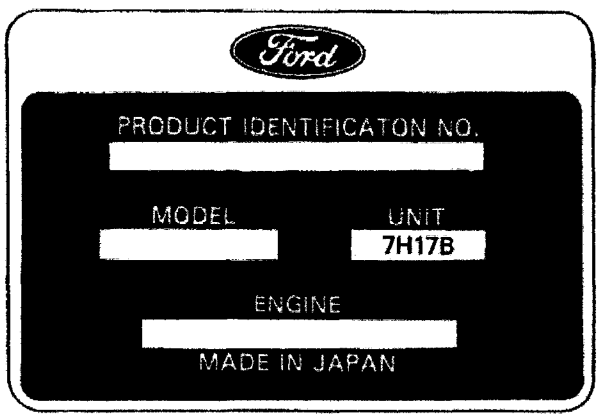
Whenever effecting repair or overhaul the relevant series information should be noted and used when referring to Service Bulletins and/or the Parts Catalog.

Model — Production Model Code

Unit — Production Unit Date Code*

Engine — Serial Number and Engine Production Date Code

TRACTOR SERIES IDENTIFICATION PLATE



First Number YEAR	First Letter MONTH		Second Number DAY OF MONTH	Second Letter PRODUCTION SHIFT
4 — 1984	A—Jan.	G—July	01/28/29/30/31	A—Midnight
5 — 1985	B—Feb.	H—Aug.		B—Day
6 — 1986	C—March	J—Sept.		C—Afternoon
7 — 1987	D—April	K—Oct.		
8 — 1988	E—May	L—Nov.		
	F—June	M—Dec.		

*Example of Production Unit Date Code 7 H 17 B

Year of Final Assembly 1987 — Month of Year August — Day of Month (Seventeen) — Shift Period Day

SAFETY PRECAUTIONS

Practically all service work involves the need to drive the tractor. The Operator's Manual, supplied with each tractor, contains detailed safety precautions relating to driving, operating and servicing that tractor. These precautions are as applicable to the service technician as they are to the operator, and should be read, understood and practiced by all personnel.

Prior to undertaking any maintenance, repair, overhaul, dismantling or re-assembly operations, whether within a workshop facility or out "in the field," consideration should be given to factors that may have an effect upon safety, not only upon the mechanic carrying out the work, but also upon bystanders.

PERSONAL CONSIDERATIONS

- The wrong clothes or carelessness in dress can cause accidents. Check to see that you are suitably clothed.

  Some jobs require special protective equipment.

- **Eye Protection**
  The smallest eye injury may cause loss of vision. Injury can be avoided by wearing eye protection when engaged in chiselling, grinding, discing, welding, painting, etc.

- **Breathing Protection**
  Fumes, dust and paint spray are unpleasant and harmful. These can be avoided by wearing respiratory protection.

- **Hearing Protection**
  Loud noise may damage your hearing and the greater the exposure the worse the damage. If you feel the noise is excessive, wear ear protection.

- **Hand Protection**
  It is advisable to use a protective cream before work to prevent irritation and skin contamination. After work clean your hands with soap and water. Solvents such as white spirit, paraffin, etc., may harm the skin.

- **Foot Protection**
  Substantial or protective footwear with reinforced toe-caps will protect your feet from falling objects. Additionally, oil-resistant soles will help to avoid slipping.

- **Special Clothing**
  For certain work it may be necessary to wear flame or acid-resistant clothing.

- Avoid injury through incorrect handling of components. Make sure you are capable of lifting the object. If in doubt get help.

EQUIPMENT CONSIDERATIONS

- **Machine Guards**
  Before using any machine, check to ensure that the machine guards are in position and serviceable. These guards not only prevent parts of the body or clothing from coming in contact with the moving parts of the machine, but also ward off objects that might fly off the machine and cause injury.

- **Lifting Appliances**
  Always ensure that lifting equipment, such as chains, slings, lifting brackets, hooks and eyes are thoroughly checked before use. If in doubt, select stronger equipment than is necessary.

  Never stand under a suspended load or a raised implement.

- **Compressed Air**
  The pressure from a compressed air line is often as high as 100 psi (6.9 bar) 7 (kgf/cm^2). It is perfectly safe if used correctly. Any misuse may cause injury.

  Never use compressed air to blow dust, filing, dirt, etc., away from your work area unless the correct type of nozzle is fitted.

  Compressed air is not a cleaning agent, it will only move dust, etc., from one place to another. Look around before using an air hose as bystanders may get grit into their eyes, ears or skin.

- **Hand Tools**
  Many cuts, abrasions and injuries are caused by defective tools. Never use the wrong tool for the job, as this generally leads either to some injury, or to a poor job.

  Never use

  — A hammer with a loose head or split handle.
  — Spanners or wrenches with splayed or worn jaws.
  — Spanners or files as hammers; or drills, clevis pins or bolts as punches.

  For removing or replacing hardened pins use a copper or brass drift rather than a hammer.

  For dismantling, overhaul and assembly of major and sub components, always use the Special Service Tools recommended.

  These will reduce the work effort, labor time and the repair cost.

  Always keep tools clean and in good working order.

- **Electricity**
  Electricity has become so familiar in day to day usage that its potentially dangerous properties are often overlooked. Misuse of electrical equipment can endanger life.

  Before using any electrical equipment — particularly portable appliances — make a visual check to make sure that the cable is not worn or frayed and that the plugs, sockets, etc., are intact. Make sure you know where the nearest isolating switch for your equipment is located.

GENERAL CONSIDERATIONS

- **Solvents**
  Use only cleaning fluids and solvents that are known to be safe. Certain types of fluids can cause damage to components such as seals, etc., and can cause skin irritation. Solvents should be checked that they are suitable not only for the cleaning of components and individual parts, but also that they do not the affect personal safety of the user.

- **Housekeeping**
  Many injuries result from tripping or slipping over, or on, objects or material left lying around by a careless worker. Prevent these accidents from occurring. If you notice a hazard, don't ignore it — remove it.

  A clean, hazard-free place of work improves the surroundings and daily environment for everybody.

- **Fire**
  Fire has no respect for persons or property. The destruction that a fire can cause is not always fully realized. Everyone must be constantly on guard.

  — Extinguish matches/cigars/cigarettes, etc., before throwing them away.
  — Work cleanly, disposing of waste material into proper containers.
  — Locate the fire extinguishers and find out how to operate them.
  — Do not panic — warn those near and raise the alarm.
  — Do not allow or use an open flame near the tractor fuel tank, battery or component parts.

- **First Aid**
  In the type of work that mechanics are engaged in, dirt, grease, fine dusts, etc., all settle upon the skin and clothing. If a cut, abrasion or burn is disregarded it may be found that a septic condition has formed within a short time. What appears at first to be trivial could become painful and injurious. It only takes a few minutes to have a fresh cut dressed, but it will take longer if you neglect it. Make sure you know where the First Aid box is located.

- **Cleanliness**
  Cleanliness of the tractor hydraulic system is essential for optimum performance. When carrying out service and repairs plug all hose ends and component connections to prevent dirt entry.

  Clean the exterior of all components before carrying out any form of repair. Dirt and abrasive dust can reduce the efficiency and working life of a component and lead to costly replacement. Use of a high pressure washer or steam cleaner is recommended.

OPERATIONAL CONSIDERATIONS

- Stop the engine, if at all possible, before performing any service.
- Place a warning sign on tractors which, due to service or overhaul, would be dangerous to start. Disconnect the battery leads if leaving such a unit unattended.
- Do not attempt to start the engine while standing beside the tractor or attempt to by-pass the safety start switch.
- Avoid prolonged running of the engine in a closed building or in an area with inadequate ventilation as exhaust fumes are highly toxic.
- Always turn the radiator cap to the first stop, to allow pressure in the system to dissipate when the coolant is hot.
- Never work beneath a tractor which is on soft ground. Always take the unit to an area which has a hard working surface — concrete for preference.
- If it is found necessary to raise the tractor for ease of servicing or repair, make sure that safe and stable supports are installed beneath axle housings, casings, etc., before commencing work.
- Certain repair or overhaul procedures may necessitate "separating the tractor," either at the engine/front transmission or front transmission/rear transmission locations. These operations are simplified by the use of the Tractor Splitting Kit/Stands. Should this equipment not be available, then every consideration must be given to stability, balance and weight of the components, especially if a cab is installed.
- Use footsteps or working platforms when servicing those areas of a tractor that are not within easy reach.
- Before loosening any hoses or tubes connecting implements to remote control valves, etc., switch off the engine, remove all pressure in the lines by operating levers several times. This will remove the danger of personal injury by oil pressure.
- Prior to pressure testing, make sure all hoses and connectors not only of the tractor, but also those of the test equipment, are in good condition and tightly sealed. Pressure readings must be taken with the gauges specified. The correct procedure should be rigidly observed to prevent damage to the system or the equipment, and to eliminate the possibility of personal injury.
- When equipment or implements are required to be attached to the hydraulic linkage, either for testing purposes or for transportation, then "position control" should be used.
- Always lower equipment to the ground when leaving the tractor.
- If high lift attachments are installed on a tractor beware of overhead power, electric or telephone cables when traveling. Drop attachment near to ground level to increase stability and minimize risks.
- Do not park or attempt to service a tractor on an incline. If unavoidable, take extra care and block all wheels.
- Observe recommended precautions as indicated in this Repair Manual when dismantling the air conditioning system as escaping refrigerant can cause frostbite.
- Prior to removing wheels and tires from a tractor, check to determine whether additional ballast (liquid or weights) has been added. Seek assistance and use suitable equipment to support the weight of the wheel assembly.
- When inflating tires beware of over inflation — constantly check the pressure. Overinflation can cause tires to burst and result in personal injury.
- Some components on your tractor, such as gaskets and friction surfaces (brake lining, clutch lining, etc.) may contain asbestos. Breathing asbestos dust is dangerous to your health. You are therefore advised to have any maintenance or repair operation on such components carried out by an authorized Ford New Holland Dealer. If, however, service operations are to be undertaken on parts that contain asbestos, the essential precautions are listed below must be observed.
  - Work out of doors or in a well ventilated area.
  - Dust found on tractor or produced during work on the tractor should be dampened, placed in a sealed container and marked to ensure safe disposal.

— If any cutting, drilling, etc., is attempted on materials containing asbestos, the item should be dampened and only hand tools or low speed power tools used.

- Continuous long term contact with used engine oil may cause skin cancer. Avoid prolonged contact with used engine oil. Wash skin promptly with soap and water.

Safety precautions are very seldom the figment of someone's imagination. They are the result of sad experience, where most likely someone has paid dearly through personal injury.

Heed these precautions and you will protect yourself accordingly. Disregard them and you may duplicate the sad experience of others.

SERVICE TECHNIQUES

A. SERVICE SAFETY

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all equipment as well as the personal safety of the individual doing the work. This Shop Manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools, and parts for servicing equipment, as well as in the skill of the individual doing the work. This Manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this Manual must first establish that he compromises neither his personal safety nor the equipment integrity by his choice of methods, tools or parts.

B. SERVICE TECHNIQUES

Clean the exterior of all components before carrying out any form of repair. Dirt and abrasive dust can reduce the efficient working life of a component and lead to costly replacement.

Time spent on the preparation and cleanliness of working surfaces will pay dividends in making the job easier and safer and will result in overhauled components being more reliable and efficient in operation.

Use cleaning fluids which are known to be safe. Certain types of fluid can cause damage to 'O' rings and cause skin irritation. Solvents should be checked that they are suitable for the cleaning of components and also that they do not risk the personal safety of the user.

Replace 'O' rings, seals or gaskets whenever they are disturbed. Never mix new and old seals or 'O' rings, regardless of condition. Always lubricate new seals and 'O' rings with hydraulic oil before installation.

When replacing component parts use the correct tool for the job.

HOSES AND TUBES

Always replace hoses and tubes if the cone end or the end connections are damaged.

When installing a new hose loosely connect each end and make sure the hose takes up the designed position before tightening the connection. Clamps should be tightened sufficiently to hold the hose without crushing and to prevent chafing.

The hoses are the arteries of the unit, be sure they are in good condition when carrying out repairs or maintenance, otherwise the machine's output and productivity will be affected.

After replacing a hose on a moving component make sure the hose does not foul by moving the component through its complete range of travel.

Be sure any hose which has been installed is not kinked or twisted.

Hose connections which are damaged, dented, crushed or leaking restrict oil flow and the productivity of the components being served. Connectors which show signs of movement from the original swaged position have failed, and will ultimately separate completely.

A hose with a chafed outer cover will allow water entry. Concealed corrosion of the wire reinforcement will subsequently occur along the hose length with resultant hose failure.

Ballooning of the hose indicates an internal leakage due to structural failure. This condition rapidly deteriorates and total hose failure soon occurs.

Kinked, crushed, stretched or deformed hoses generally suffer internal structural damage which can result in oil restriction, a reduction in the speed of operation and ultimate hose failure.

Free-moving, unsupported hoses must never be allowed to touch each other or related working surfaces. This causes chafing which reduces hose life.

PART 1
ENGINE SYSTEMS
MODELS 1320-1520-1720

Chapter 1
ENGINE AND LUBRICATION SYSTEM

Chapter 2
COOLING SYSTEM

Chapter 3
TROUBLE SHOOTING, SPECIFICATIONS AND SPECIAL TOOLS

PART 1
ENGINE SYSTEMS
MODELS 1320-1520-1720

Chapter 1
ENGINE AND LUBRICATION SYSTEM

A. DESCRIPTION AND OPERATION

This chapter describes the engine overhaul and repair procedures of the Models 1320-1520 and 1720 tractors. Repair procedures are essentially the same for all models except as noted in the repair procedures.

The tractors are equipped with three-cylinder in-line engines. They are all four cycle, overhead valve, liquid cooled engines. The engines are identified by a code number cast into the side of the cylinder block.

Engine Identification	Tractor Model	Horsepower
J823	1320	19.0
J843	1520	22.0
N843	1720	26.5

CYLINDER HEAD AND VALVE TRAIN COMPONENTS

The cylinder head incorporates the valve assemblies, rocker arms, rocker shaft, push rods, and lifters.

A swirl chamber located between the injector assembly and the main combustion chamber of the cylinders provides improved starting and greater fuel efficiency. Initial combustion starts in the pre-combustion chamber and as the air-fuel expansion occurs a strong swirl pattern is created in the main combustion chamber for more complete combustion of the air-fuel mixture.

The air intake manifold is separated from the cast aluminum valve cover on all of these engines. The exhaust manifold is bolted to the left hand side of the cylinder head on each of the models.

Cylinder heads have integral valve guides. Standard size valves only are used.

CYLINDER BLOCK ASSEMBLY

The cylinder block assembly contains the pistons, connecting rods, crankshaft, timing gears and engine oil pump.

The crankshaft is supported on four main bearings. The front bearing is positioned in a bore in the front of the block.

The 2nd, 3rd and 4th bearings are split liners located in holders bolted to the block.

The camshaft is supported on two ball bearings located on each end of the block.

PISTON AND CONNECTING RODS

All models utilize a straight connecting rod and a three ring piston.

LUBRICATION SYSTEM
Models — All

The oil pump assembly is located within the injection pump drive gear at the front of the block and below and to the left of the crankshaft as viewed from the front. The oil pump is driven by the crankshaft gear.

Oil is picked up from the sump by the intake tube and drawn into the lower side drilling in the block to the oil pump. Oil from the pump flows through passages in the block, past the relief valve, through the oil filter and returns to the main oil gallery in the area of the drilled bolt located on the side of the block. Oil flow in the main oil gallery extends to the four main bearings. Oil flow to the main bearings passes through drilled passages in the crankshaft to the three connecting rod bearings. The remaining portion of the oil flow is directed through the external tube to the rocker arm assembly. Oil flows from the external tube into a passage in the rocker arm bracket to the rocker shaft.

Oil leakage from clearance between the rocker arms and the shaft overflows in the valve cover and lubricates the valve stems, push rods and tappets.

The relief valve is mounted in the side of the block and intersects the main oil passage. When the oil pressure exceeds the rated pressure, oil is by-passed through the relief valve directly to sump.

The cylinder walls, pistons and piston pins are splash lubricated by the crankshaft.

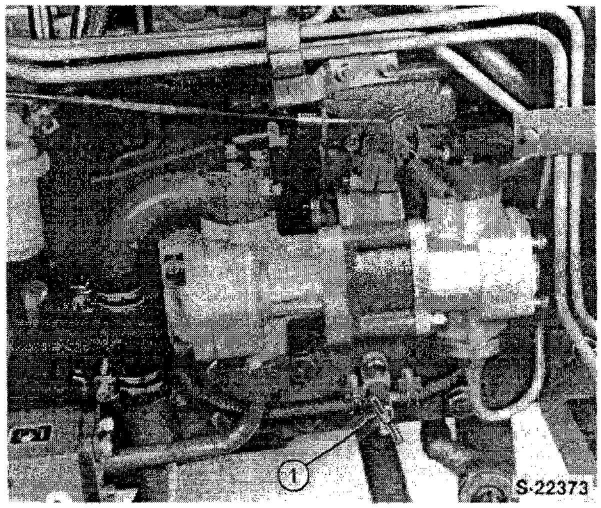


Figure 1
Radiator Drain Cock

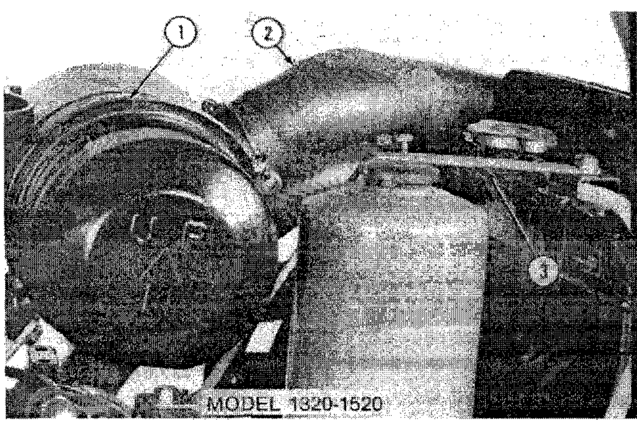
1. Coolant Drain Cock

B. ENGINE OVERHAUL

CYLINDER HEAD AND RELATED COMPONENTS

REMOVAL

1. Drain the radiator assembly, Figure 1.
2. Remove the air cleaner assembly along with the air cleaner hoses, Figure 2.
3. Remove the upper radiator hose from the cylinder head, Figure 2.
4. Remove the exhaust muffler and manifold assembly, Figure 3.



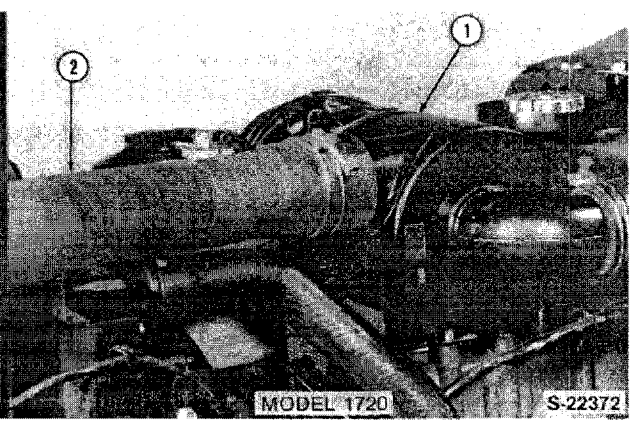


Figure 2
Air Cleaner Removal

1. Air Cleaner Assembly
2. Air Intake Tube
3. Radiator Support Brace (Model 1320/1520)

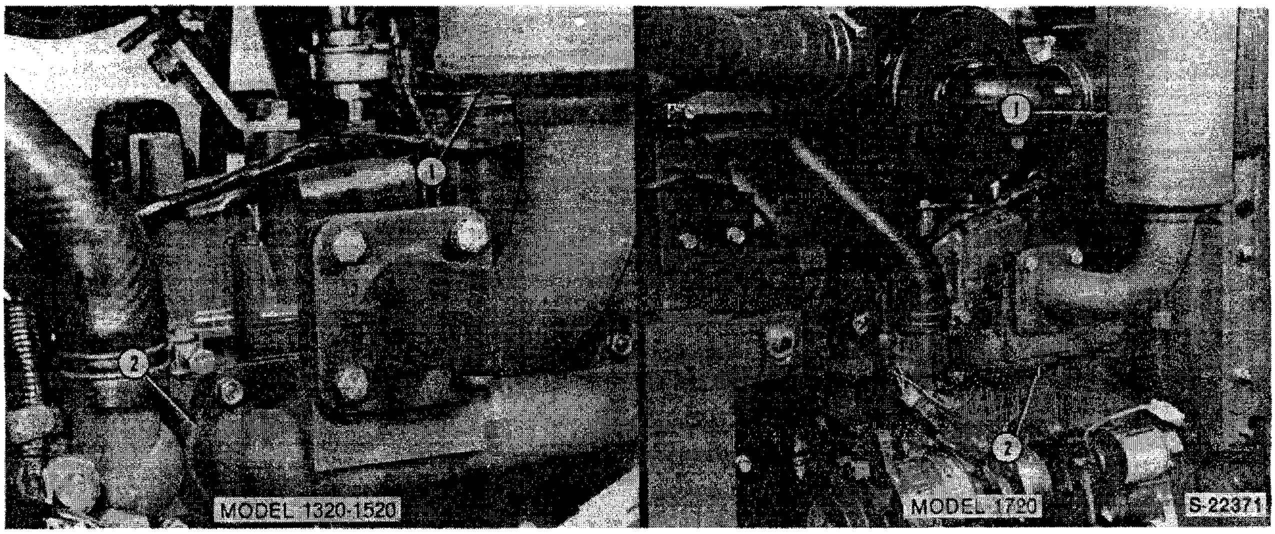


Figure 3
Exhaust Manifold Removal
1. Muffler Assembly
2. Exhaust Manifold

Model 1320-1520

Remove the radiator support brace from the cylinder head, Figure 2.

5. Remove the injection lines and cap all openings, Figure 4.

6. Remove the injector leak-off line (3), Figure 4.

7. Remove the injector assemblies, Figure 4.

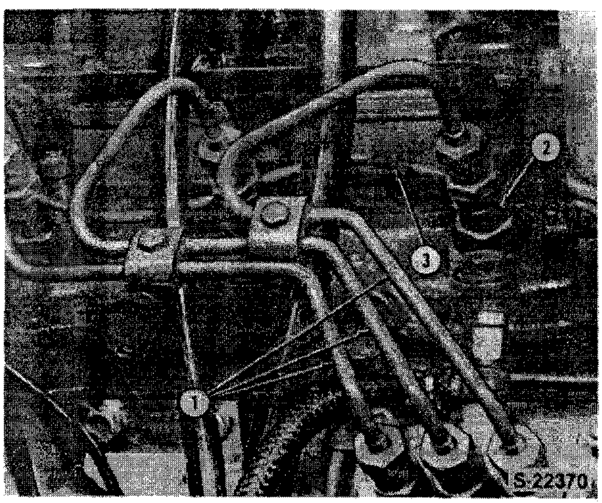


Figure 4
Injector Removal
1. Injection Lines
2. Injector Assembly
3. Injector Leak-off Line

8. Remove the glow plug wire connectors and remove the glow plugs, Figure 5.

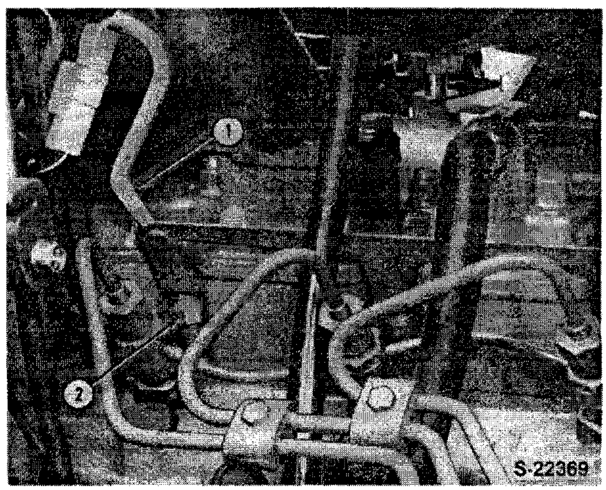


Figure 5
Glow Plug Removal
1. Glow Plug Wire Connector
2. Glow Plug Assembly

9. Remove the temperature sender switch, Figure 6.

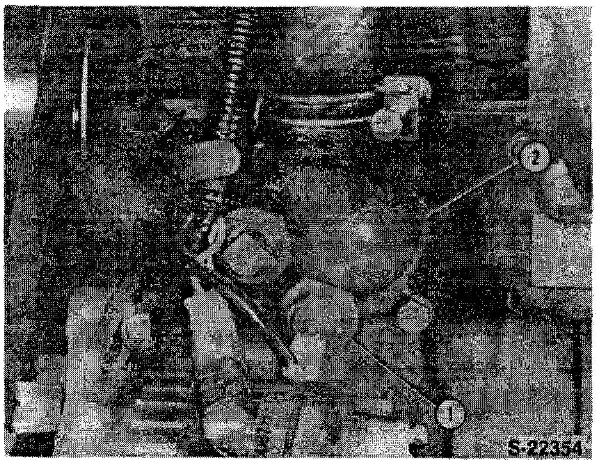


Figure 6
Temperature Sender

1. Sender
2. Coolant Outlet Connector

10. Remove the oil sender switch from the front of the cylinder head, Figure 7.
11. Remove the water pump assembly, Figure 7.
12. Remove the external oil transfer tube bolt from the front of the cylinder head, Figure 8.
13. Remove the air inlet manifold assembly, Figure 9.
14. Remove the valve cover assembly, Figure 10.

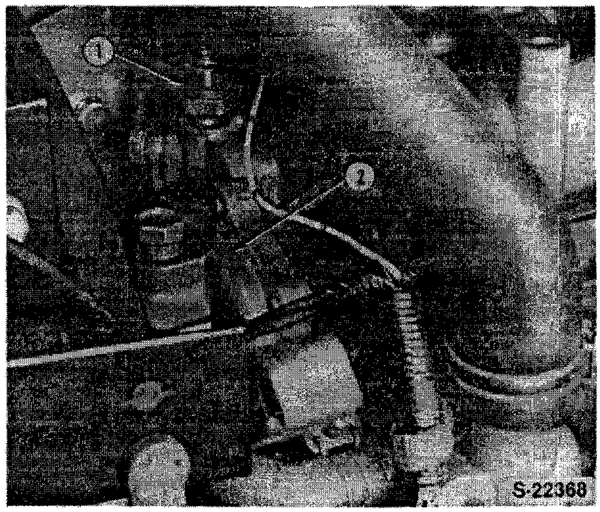


Figure 7
Oil Pressure Switch

1. Switch
2. Water Pump Assembly

15. Remove the valve rocker arm shaft and support as an assembly, Figure 11.

    NOTE: *Alternately loosen the rocker support bolts a turn at a time to prevent distorting the rocker shaft support.*

16. Remove the valve stem caps and push rods, Figure 11.

Figure 8
External Oil Transfer Tube

1. External Tube
2. Banjo Bolt

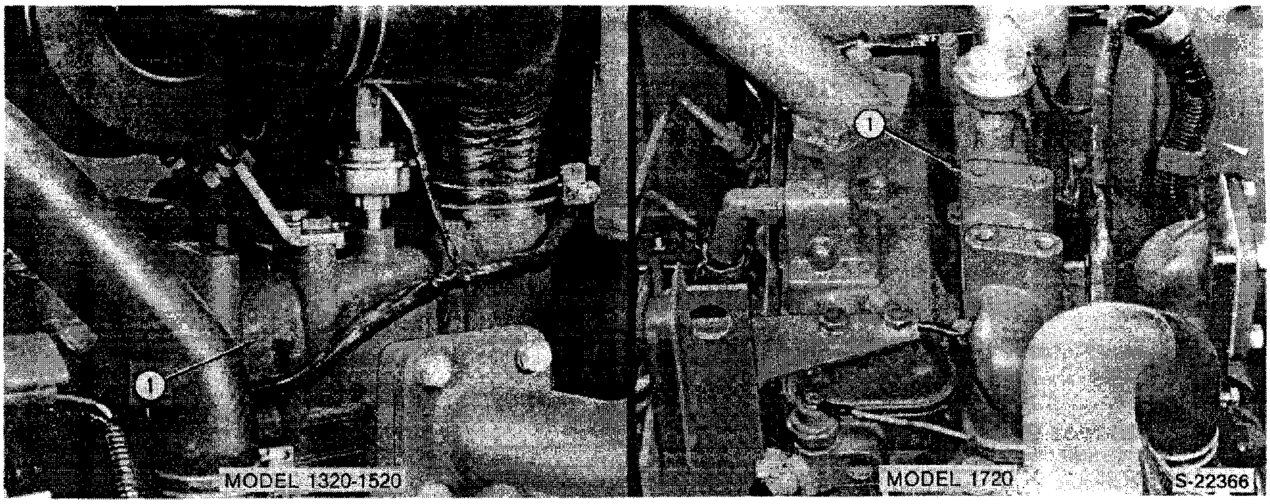


Figure 9
Inlet Manifold
1. Manifold

NOTE: *Keep all valve components in separately marked containers for re-assembly in their original location.*

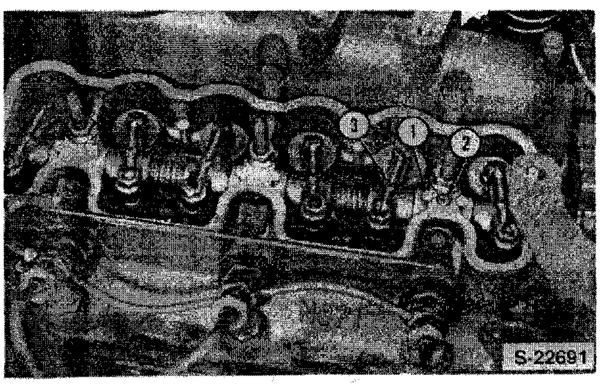


Figure 10
Valve Cover Removal
1. Rocker Shaft Support Bracket
2. Rocker Shaft Set Screw
3. Rocker Arms

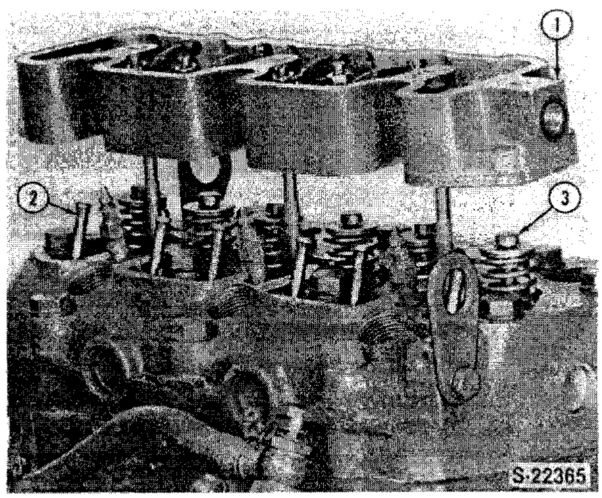


Figure 11
Rocker Arm Assembly – Removal
1. Rocker Arm Support Bracket
2. Push Rod
3. Valve Stem Cap

17. Remove the cylinder head bolts by alternately loosening a half turn at a time to prevent warping the head, Figure 12.

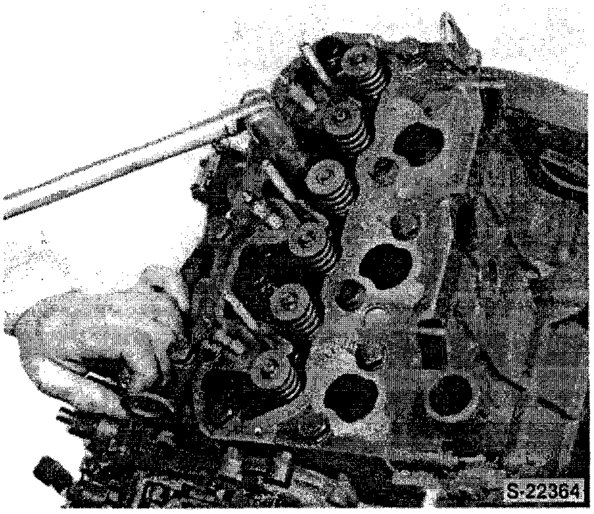


Figure 12
Cylinder Head Removal

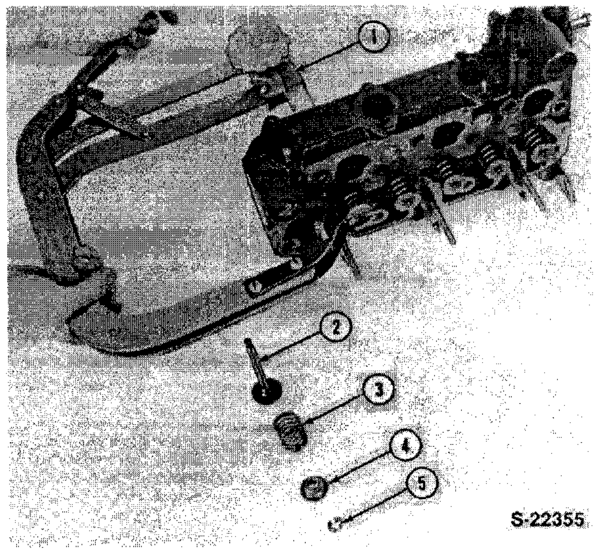


Figure 13
Cylinder Head Valve Removal

1. Valve Spring Compressor
2. Valve
3. Spring
4. Retainer
5. Keepers

DISASSEMBLY

1. Clean the cylinder head and remove any carbon deposits from around the valve heads.
2. Use a valve spring compressor and remove the valve spring retainer locks, spring and spring retainer from the valves, Figure 13.
3. Remove the valves and place the valve components together in separately marked containers for reassembly in their original location.

INSPECTION AND REPAIR

CYLINDER HEAD

1. Clean all carbon deposits from the combustion chamber and valve ports using a wire brush and scraper.
2. Clean all dirt and residue from the gasket surface using care not to scratch or nick the machined surface.
3. Clean the cylinder head in solvent and air dry.
4. Check the head for cracks or damage, Figure 14, in the following areas:

- Valve ports
- Valve seats
- Combustion chamber
- External cracks in the water jackets

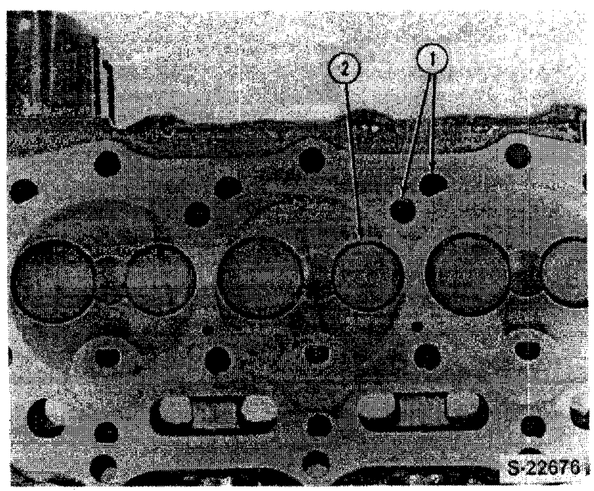


Figure 14
Cylinder Head Inspection

1. Cylinder Head Ports 2. Valve Seat

5. Inspect the gasket surfaces for scratches or nicks which could cause leakage.

6. Examine the core hole plugs for rust or signs of leakage. If a plug shows signs of damaging rust or leakage, replace all the plugs in the head.

7. Use a straight edge and feeler gauge and check the cylinder head for warp length wise, cross wise and diagonally, Figure 15.

   Resurface or replace the head if warpage is greater than 0.005 in. (0.12 mm).

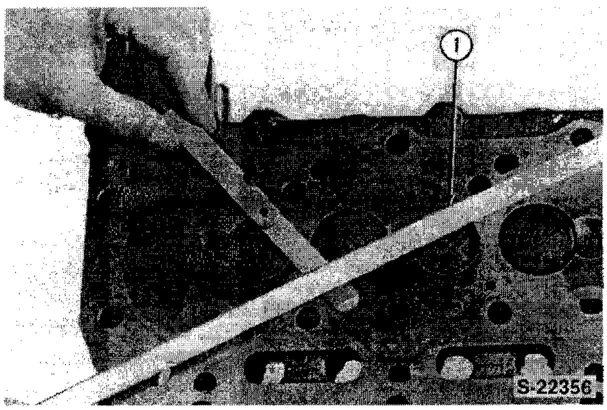


Figure 15
Cylinder Head Flatness Check
1. Straight Edge

VALVE SEATS

Examine the valve seats and reface the seat if damaged.

Valve seat grinding requires that the seat be ground to the correct width and properly positioned as shown in Figure 16.

A valve that extends too deep into the combustion area will result in valve burning and if the valve is recessed too deep into the head it will cause a rapid build-up of carbon deposits.

1. Check the seat for surface defects. Use a 45° stone if necessary to reface. Grind away only enough material to provide a smooth even seat.

2. Check the seat width, Figure 17, if necessary, use a 15° stone to lower the seat contact point and use a 75° stone to raise the seat contact point.

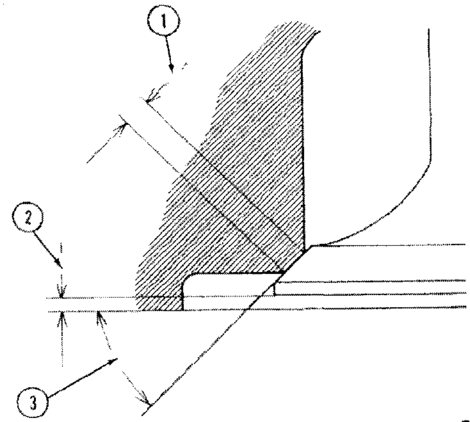


Figure 16
Valve Grinding Checks
1. Correct Valve Seat Width and Location
2. Correct Valve Head Margin
3. 45° Valve Seat Angle

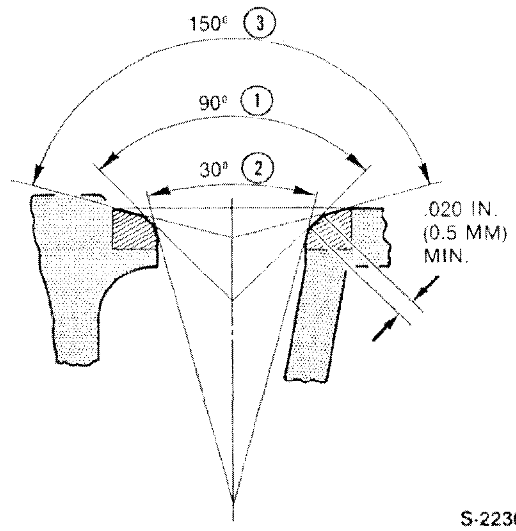


Figure 17
Valve Seat Grinding
1. Seat Angle — 45° Stone
2. Lower Seat Location — 15° Stone
3. Raise Seat Location — 75° Stone

NOTE: *Refacing the seat should always be coordinated with refacing of the valve to assure a compression tight fit.*

VALVES

1. Clean all deposits from the valves using a soft wire brush. Inspect the condition of the valve and discard any that are badly burned, cracked or bent, Figure 18.

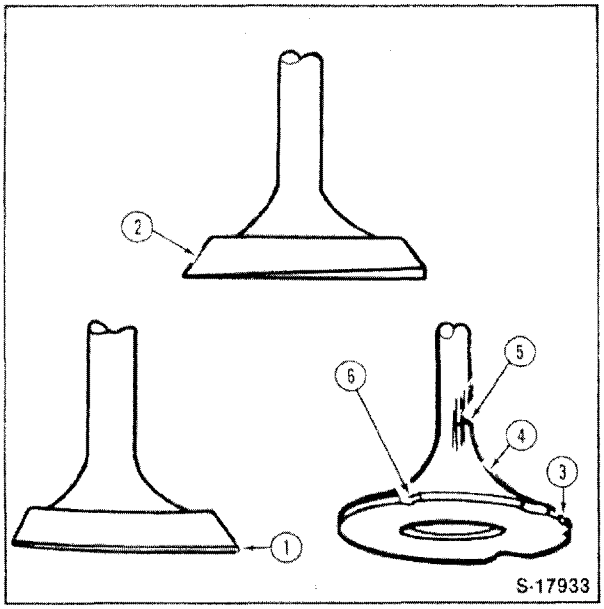


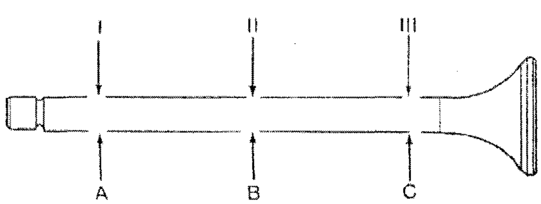
Figure 18
Valve Defect Inspection

1. Margin Too Thin Min. .002 in. (.5 mm)
2. Bent Valve
3. Pitting
4. Indented
5. Wear or Necking
6. Burned

2. Using a micrometer, measure the valve stem at points "A", "B" and "C", Figure 19.

   Replace valve if the stem wear diameter is less than the following dimensions:

	Intake	Exhaust
Ford Model: All	.271 in. (6.89 mm)	.269 in. (6.84 mm)



S-22677

Figure 19
Valve Stem Wear Points

3. If inspection indicates that the valve may be re-used, the valve should be ground as shown, Figure 20.

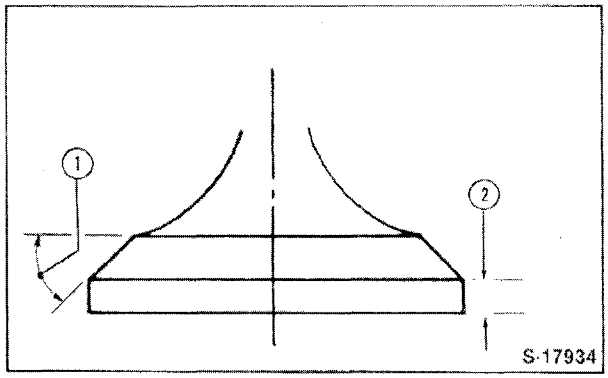


Figure 20
Valve Correctly Ground

1. 45° Angle Seat
2. Minimum Valve Margin

IMPORTANT: *After grinding the valve and seat, check to assure that the seat contacts the center of the valve face. Using Prussian Blue, lightly coat the valve seat, place the valve in position and rotate the valve slightly while holding a light pressure against the valve. If the blue is transferred to the center of the valve face, the contact is correct.*

If Prussian Blue is not available, mark the valve face or seat with a soft lead pencil as shown, Figure 21. Rotate the valve slightly in the seat. The penciled lines will be broken at the seat contact area.

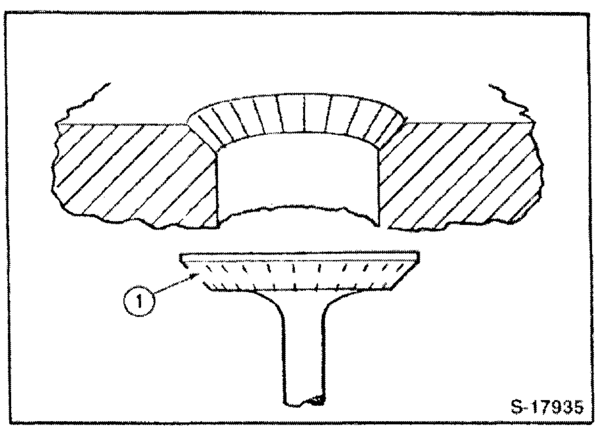


Figure 21
Valve Seat Contact Location

1. Seat

VALVE GUIDES

Thoroughly clean the valve guides before attempting to check internal wear.

1. Using a small hole gauge, measure the valve guide bore at the top and bottom wear points, Figure 22.

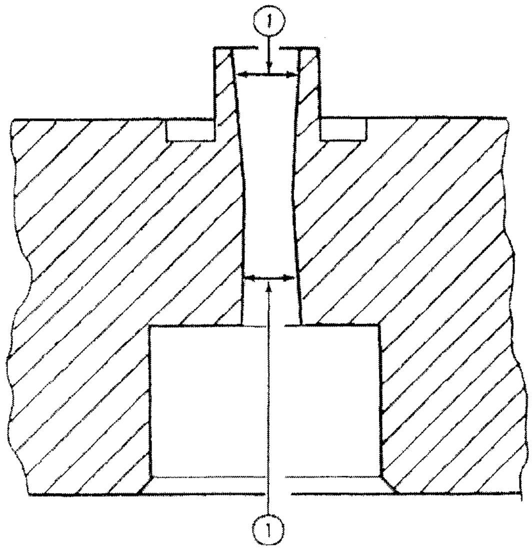


Figure 22
Valve Guide Wear Check
1. Wear Point

2. Determine the stem to guide clearance by subtracting the stem diameter from the valve guide diameter, Figure 23.

   Replace valves if the clearance is more than .0078 in. (0.2 mm).

3. Replace the cylinder head if excessive clearance is determined. See "Specifications," Chapter 3, for wear limits.

VALVE SPRINGS

1. Place the valve springs on a flat surface. Measure the free-length of the spring and squareness, Figure 24.

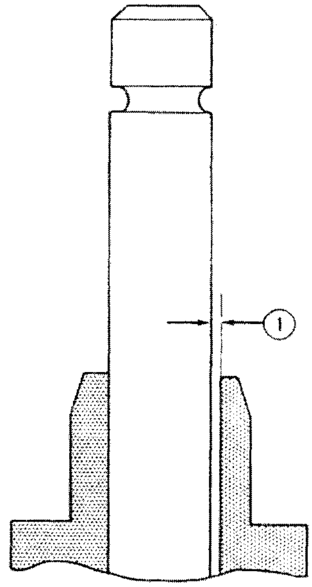


Figure 23
Valve Stem to Guide Clearance Check
1. Clearance

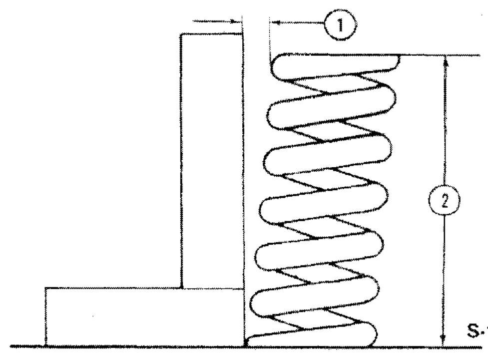


Figure 24
Valve Spring Length and Squareness Check
1. Squareness 2. Free Length

Replace springs that do not meet the following specifications:

	Max. Out of Square	Min. Free-Length
Model: All	.079 in. (2.0 mm)	1.319 in. (33.5 mm)

2. Place the springs in a suitable spring load tester and measure the spring load rating. Replace the springs that do not meet the following load specifications.

Model: All .....28 lbs. (Min.) at 1.2 in. Height (7 kg at 30 mm)

1. Remove the set screw (1), Figure 25.
2. Remove the plug from the rear of the rocker shaft support.
3. Thread a 8 mm bolt into the rear end of the rocker shaft and slowly withdraw the rocker shaft while at the same time removing the rocker arms and springs, Figure 25.

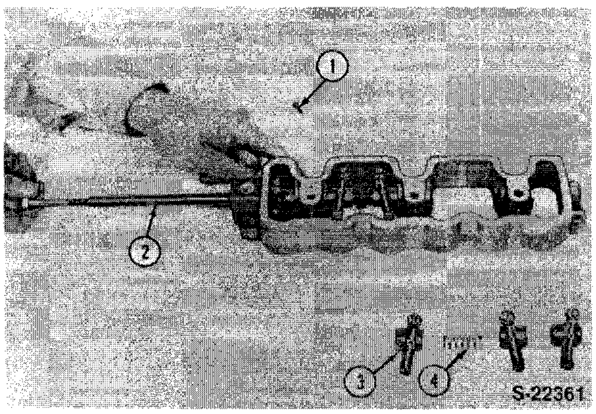


Figure 25
Rocker Arm

1. Screw
2. Rocker Arm Shaft
3. Rocker Arm
4. Spring

NOTE: *A set screw (1), Figure 25, locks the rocker shaft in place in the support. Remove the set screw before attempting to remove the rocker shaft.*

4. Inspect the rocker arms and shaft for wear or damage. Check the adjusting screws for damaged threads or excessive wear.
5. Check the valve stem contact area for pitting or excessive wear. Slight wear patterns may be removed using a fine grit oil stone.
6. Using a micrometer, measure the wear points on the rocker shaft as indicated, Figure 26.

Replace the rocker shaft if the wear at any point exceeds the following diameter:

	Minimum Shaft Diameter
Ford Model: All	.456 in. (11.57)

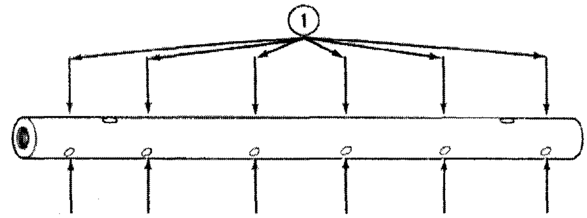


Figure 26
Rocker Shaft Wear Check

1. Wear Points

7. Using a hole gauge, measure the inside bore diameter of the rocker arm, Figure 27.

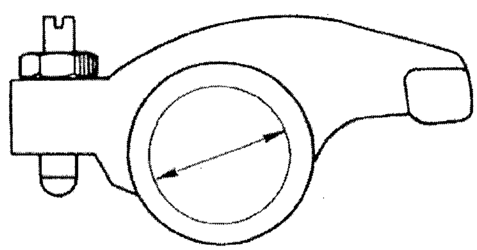


Figure 27
Rocker Arm Wear Check

Replace rocker arms having a bore diameter exceeding the following measurement:

	Minimum Shaft Diameter
Ford Model: All	.456 in. (11.57 mm)

Replace the rocker shaft and/or rocker arm if the rocker arm to shaft clearance exceeds .008 in. (0.2 mm).

PUSH RODS

1. Check all push rods for straightness by rolling on a flat surface. Replace rods which are bent.
2. Inspect the ends of the push rods for excessive wear. If any push rod is worn, the corresponding lifter and rocker arm should also be inspected for excessive wear.

ASSEMBLY

CYLINDER HEAD

1. Insert each valve in the guide from which it was removed and lightly lap the valve to be sure of an even seat around the valve face.

   Remove the valve and remove all traces of lapping compound.

2. Install new intake valve seals on the guides using Tool No. 1587.

3. Using a spring compressor, assemble the valves, springs, retainers and keepers.

INSTALLATION

During assembly, the ultimate engine compression ratio is established by the thickness of the head gasket used. For service replacement, head gaskets of different thickness are available. The correct head gasket must be selected based upon the amount the pistons protrude above the face of the block when at top dead center.

The correct head gasket usage is determined as follows:

1. Position each of the pistons at top dead center and using a dial indicator, determine the distance each piston projects above the face of the block, Figure 28.

   NOTE: *Measure each of the pistons while holding a slight down pressure on the piston. Use the dimension taken from the cylinder which has the greatest projection and select a head gasket as indicated in the following chart.*

   NOTE: *The variation in the amount of protrusion among all pistons must be within .004 in. (0.1 mm).*

2. If removed, install the tappets.

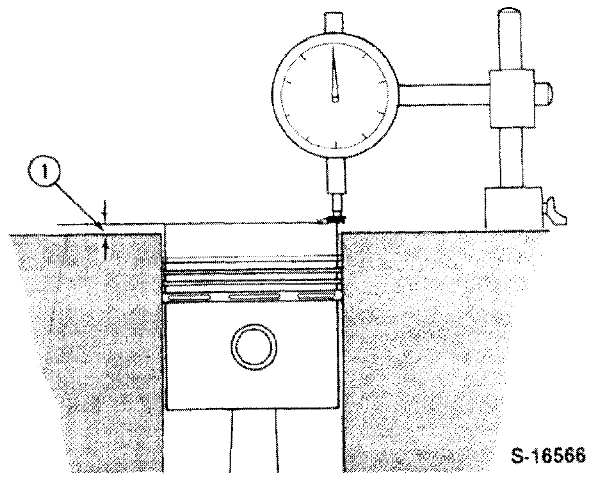


Figure 28
Measuring Piston Height Above Face of Block
1. Dial Indicator

3. Select the proper head gasket and place it on the block with the side marked with the last four digits of part code no. up.

4. Tighten the cylinder head bolts in steps in the sequence as shown, Figure 29. Tighten to the final torque specification.

   Torque Specification . . . . 65-69 lbs. ft (88-94 Nm)

5. Replace the push rods and valve stem caps in their original locations.

6. Install and assemble the rocker shaft components in the support. Install the set screw and end plugs.

7. Install the assembled rocker shaft support onto the head and tighten the bolts to the specified torque.

MODEL	MEASUREMENT VALUE	HEAD GASKET PART CODE NO.	INSTALLED THICKNESS
1320	From (0.5 to 0.6 mm)	111147150	t = 1.2
1520-1720	0.0197-0.0236 in.	111146981	
1320	From (0.6 to 0.7 mm)	111147160	t = 1.3
1520-1720	0.02365-0.0276 in.	111146991	
1320	From (0.7 to 0.8 mm)	111147170	t = 1.4
1520-1720	0.0276-0.0315 in.	111147001	

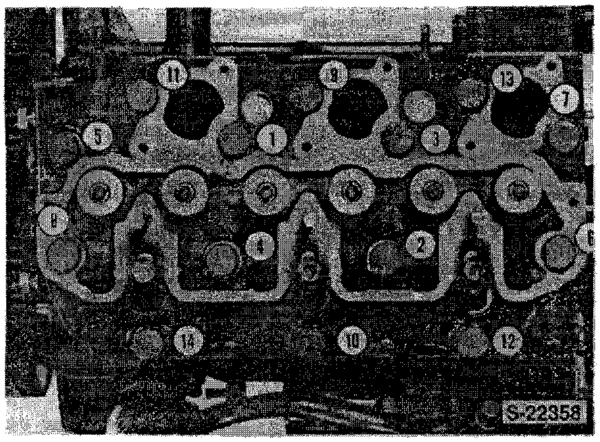


Figure 29
Head Bolt Torquing Sequence

8. Adjust the rocker arm to valve clearance, Figure 30. Be sure the tappet is in its lowest position before making the adjustment. To be sure the tappet is in its lowest position, bring the piston to top dead center on the compression stroke, (both valves closed).

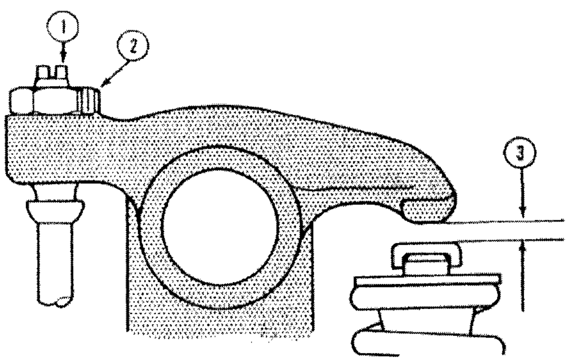


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Figure 30
Valve Clearance Adjustment (Cold)

1. Adjusting Screw
2. Locknut
3. Valve Clearance 0.008 in. 0.2 mm)

With the adjusting screw locknut loosened, turn the adjusting screw to obtain .008 in. (0.2 mm) clearance and tighten the locknut.

ENGINE FRONT COVER, TIMING GEARS AND OIL PUMP

REMOVAL

To remove the front cover assembly, first remove the radiator. See Chapter 2, "Radiator Removal."

COVER REMOVAL

1. Drain the engine crankcase oil.

2. Disconnect the wire (2) and remove the fuel shut-off solenoid (1), Figure 31.

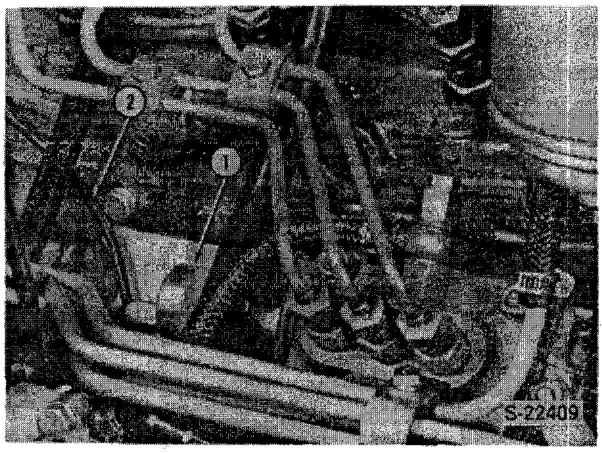


Figure 31
Fuel Shut-Off Solenoid

1. Solenoid
2. Wire

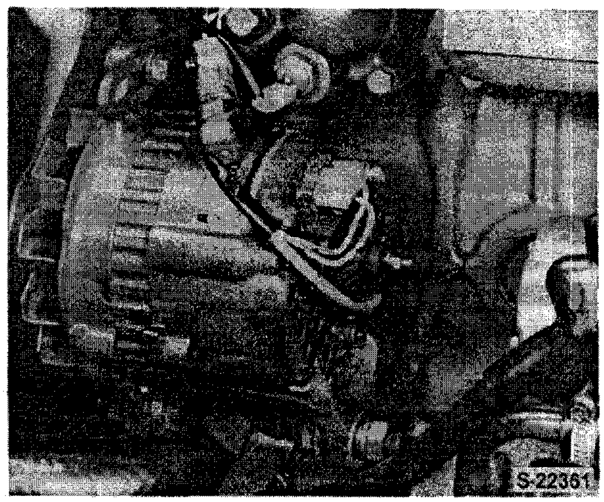
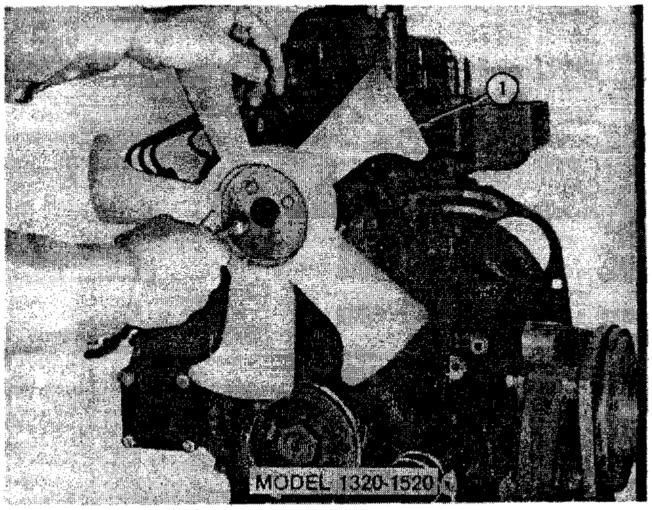


Figure 32
Alternator Removal

3. Remove the alternator assembly, Figure 32.
4. Remove the fan, Figure 33.
   • Remove the water pump assembly, Figure 34.
5. Remove the crankshaft pulley.



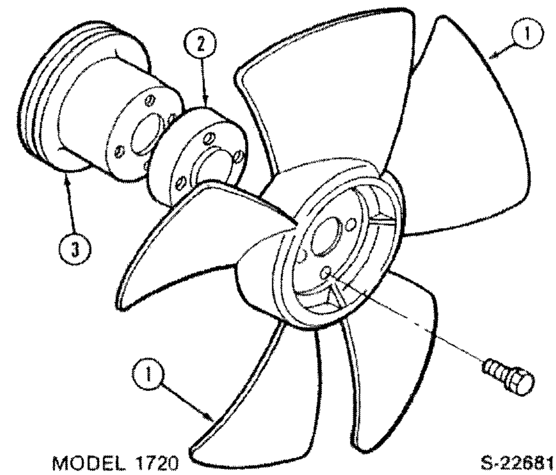


Figure 33
Cooling Fan Removal
1. Fan 2. Holder 3. Pulley

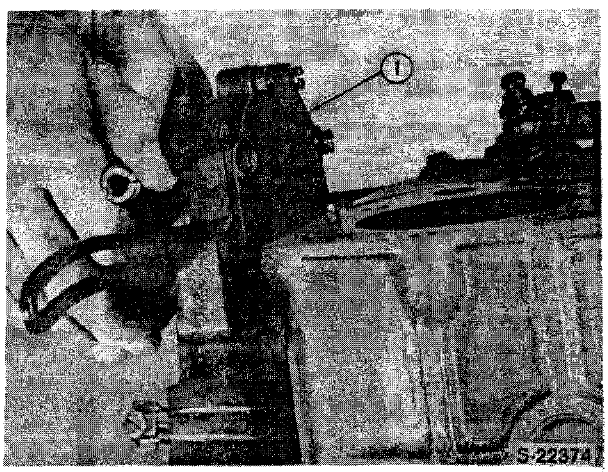


Figure 34
Water Pump Removal
1. Water Pump

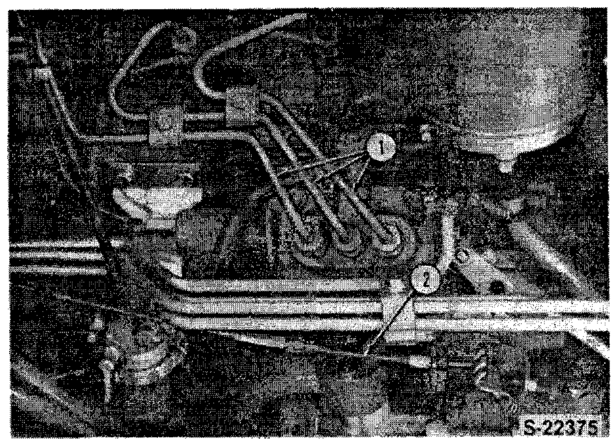


Figure 35
Injection Line Removal
1. Injection Lines 2. Throttle Control Cable

6. Remove the injector lines and cap the openings, Figure 35.

7. Disconnect the throttle control rod at the injection pump, Figure 35.

8. Loosen the injection pump mounting bolts and nuts. Raise the injection pump enough to disconnect the snap pin and separate the governor link from the control rack, Figure 36.

NOTE: *It is not necessary to remove the injection pump.*

9. Remove the suction and pressure tubes from the power steering pump. Cap the lines and pump openings.

10. Remove the nuts and washers that hold the power steering pump to the front cover and remove the pump.

11. Remove the front cover attaching bolts and remove the front cover.

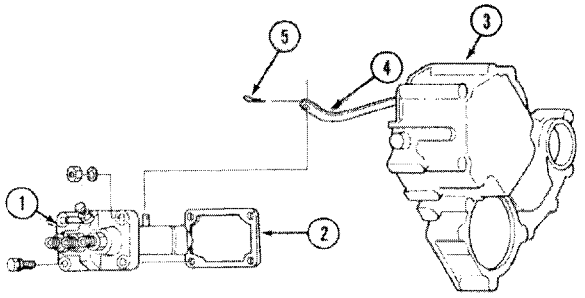


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Figure 36
Timing Gear Cover Removal

1. Injection Pump
2. Shim
3. Cover
4. Governor Link
5. Hair Pin

TIMING GEAR AND OIL PUMP — REMOVAL

CAMSHAFT GEAR

1. Remove the governor assembly, camshaft gear and tachometer drive gear components, Figure 37.

OIL PUMP ASSEMBLY

The oil pump is located inside of the pump drive gear at the front of the engine block, Figure 38.

1. Remove the "E" snap ring and slide the drive gear along with the rotors, cover, spring, shim and collar off the pump shaft as an assembly, Figure 38.

   NOTE: *The oil pump shaft and port block assembly is a press fit in the block, Figure 39. If necessary to remove due to damage, remove the port block and shaft assembly as follows:*

   - Remove the engine front adapter plate.
   - Using a special tool place the collars in the grooves of the port block assembly. Align the set screws of the puller with the counterbores in the collars and tighten. Using a slide hammer as shown, Figure 40, remove the port block assembly.

HYDRAULIC PUMP DRIVE GEAR
Reference — Figure 41

1. Remove the power steering pump. See Part 9.

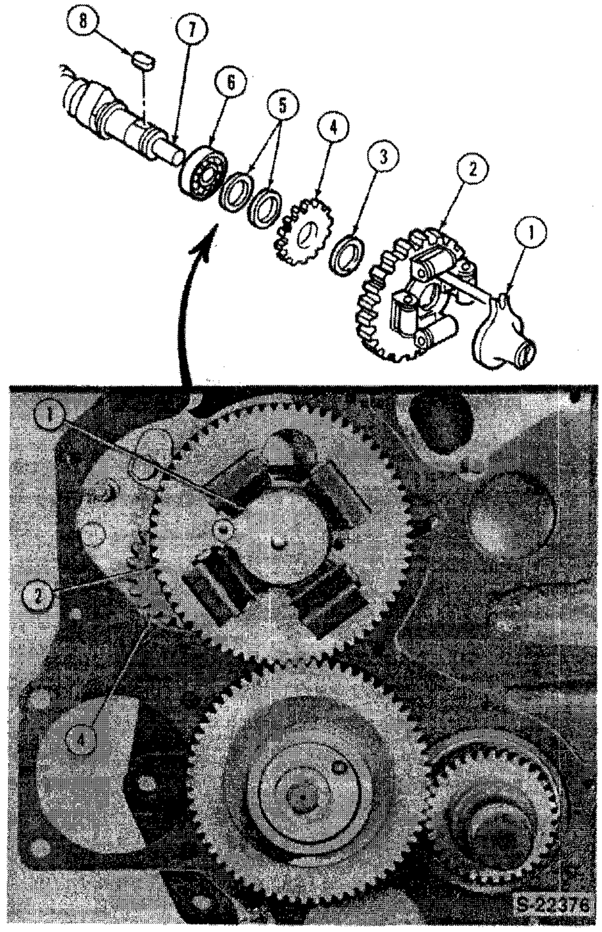

Figure 37
Governor and Camshaft Gear Removal

1. Slider
2. Gear Assembly
3. Spacer
4. Tachometer Drive Gear
5. Spacers
6. Bearing
7. Camshaft
8. Key

2. Remove the hydraulic pump. See Part 8.
3. Remove the drive gear and bearing assembly, Figure 41, from the timing gear cover.

INSPECTION AND REPAIR

TIMING GEARS AND GOVERNOR ASSEMBLY

1. Wash all components in a suitable solvent and air dry.
2. Inspect the governor assembly for excess wear or damage. Replace any components found faulty.

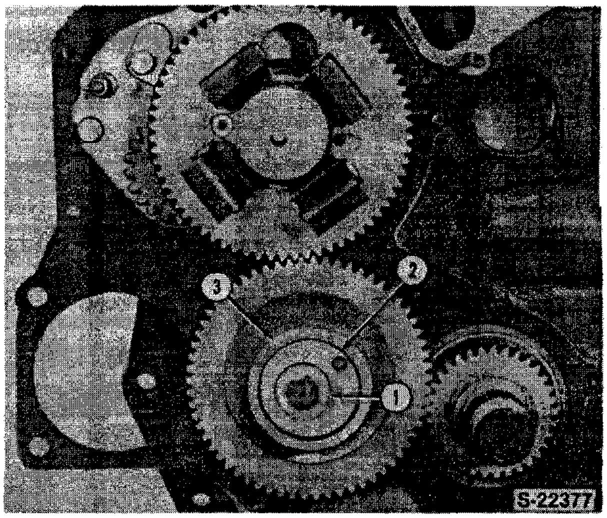

Figure 38
Engine Oil Pump Removal

1. "E" Snap Ring
2. Collar
3. Spring

3. Inspect the timing gear teeth for excess wear, chips, etc.

4. Inspect the camshaft and injection pump drive keys and the key ways for wear.

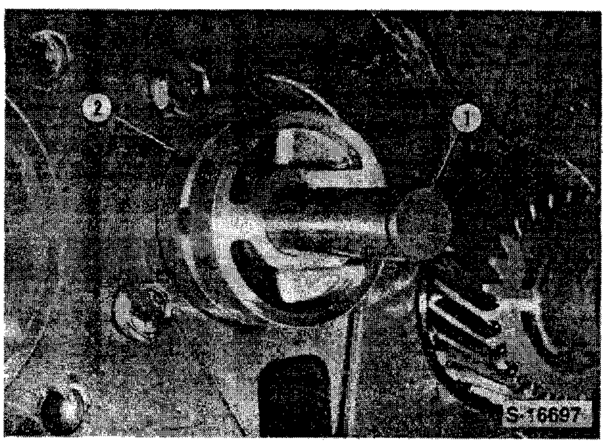

Figure 39
Port Head and Shaft Removal

1. Shaft
2. Port Block

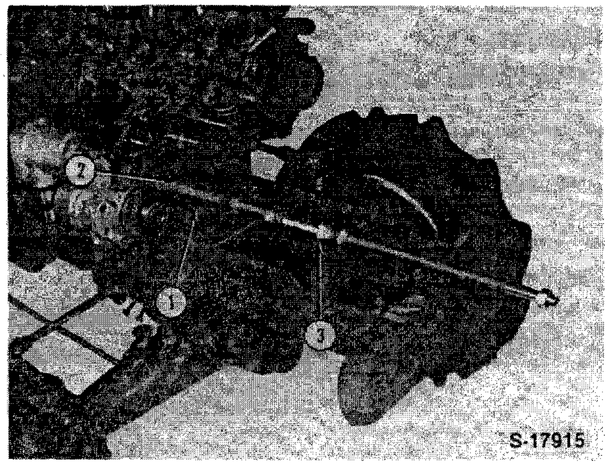

Figure 40
Oil Pump Port Block Removal

1. Puller
2. Set Screws (2)
3. Slide Hammer

OIL PUMP ASSEMBLY

The oil pump consists of the inner and outer rotors, idler gear, port block, shaft and cover, Figure 42.

1. Check for excessive wear on the face of the pump cover and port block, Figure 42.

2. Inspect the pump shaft and rotors for excessive wear or scratches.

3. Measure the rotor to rotor clearance, Figure 43. Replace the components as required, if wear is excessive. See "Specifications," Chapter 3.

INSTALLATION

If the engine oil pump port block assembly was removed, install a new port block assembly as follows:

- Using a special tool insert the threaded guide pins (1) into the cylinder block, Figure 44. Assemble the oil pump shaft to the port block using nut and washer previously removed.

- Insert the port block assembly into the installer and place on the guide pins as shown, Figure 45.

- Use a suitable driver and install the port block assembly as shown, Figure 46. The installer must bottom against the engine block when fully positioned.

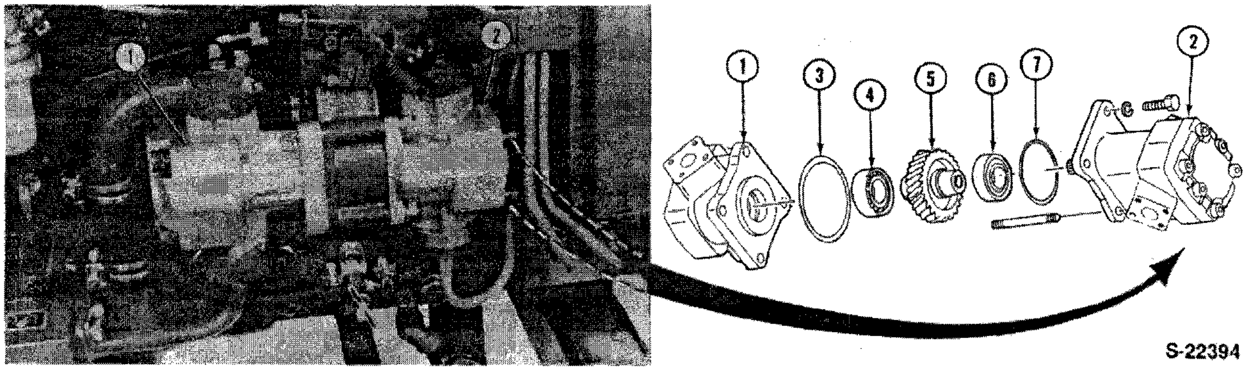

Figure 41
Hydraulic Pump Drive Gear Removal

1. Hydraulic Pump Assembly
2. Power Steering Pump Assembly
3. O-Ring
4. Bearing
5. Drive Gear
6. Bearing
7. O-Ring

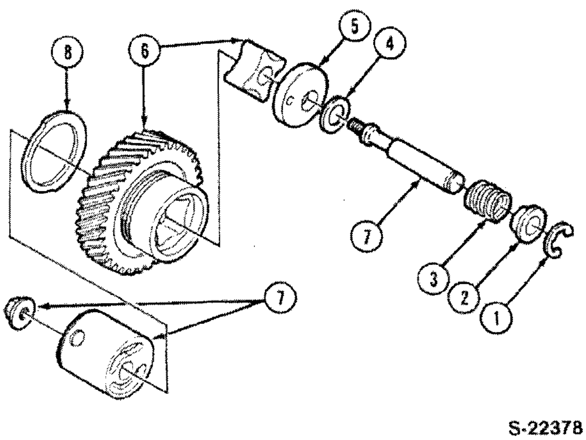

Figure 42
Engine Oil Pump Components — Model 1720

1. "E" Snap Ring
2. Collar
3. Spring
4. Shim
5. Cover
6. Rotor and Gear Assembly
7. Port Block and Shaft Assembly
8. Thrust Washer

1. Install a new gasket and the front adaptor plate to the engine block.
2. Install the tachometer drive shaft and plate, Figure 47.
3. Position the two spacers, tachometer drive gear, camshaft gear, key, flyweight assembly, pins and slider on the camshaft, Figure 48.
4. Assemble the pump drive gear and retaining spring. Position the assembly on the port block, Figure 49. Turn the crankshaft to align the timing marks between the crankshaft and camshaft gears with the injection pump drive gear and install the pump drive gear.
5. Position the oil pump inner rotor on the shaft inside the idler gear and install the cover, shim, spring, collar and "E" snap ring, Figure 42.

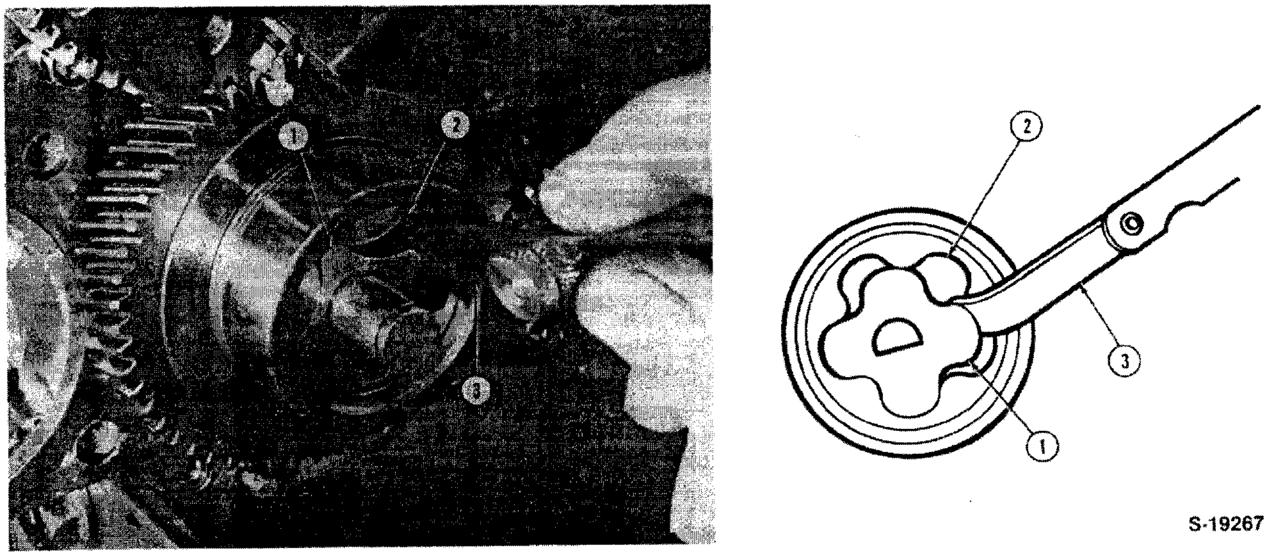

Figure 43
Rotor to Rotor Clearance Check
1. Inner Rotor 2. Outer Rotor 3. Feeler Gauge

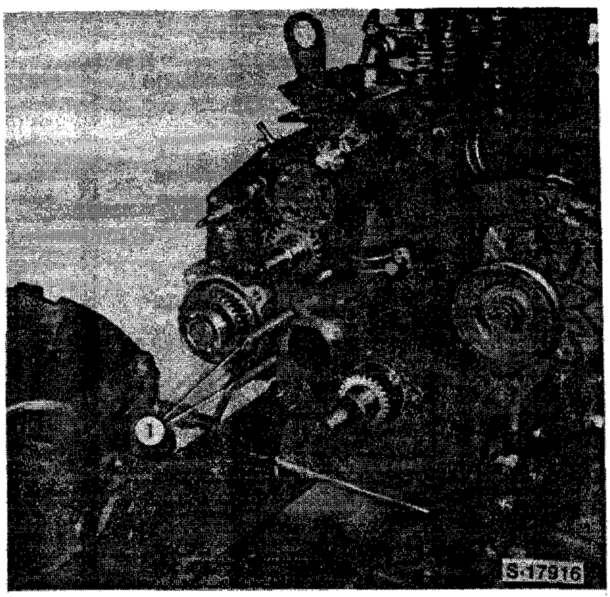

Figure 44
Port Block and Shaft Installation
1. Guide Pins, Tool No. 11044

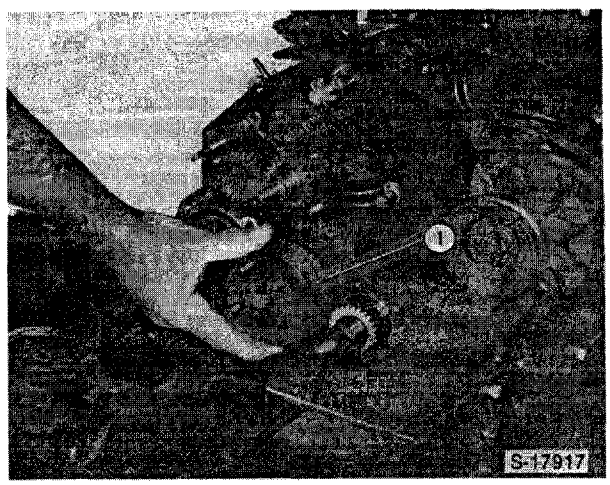

Figure 45
Port Block and Shaft Installation
1. Port Block Installer

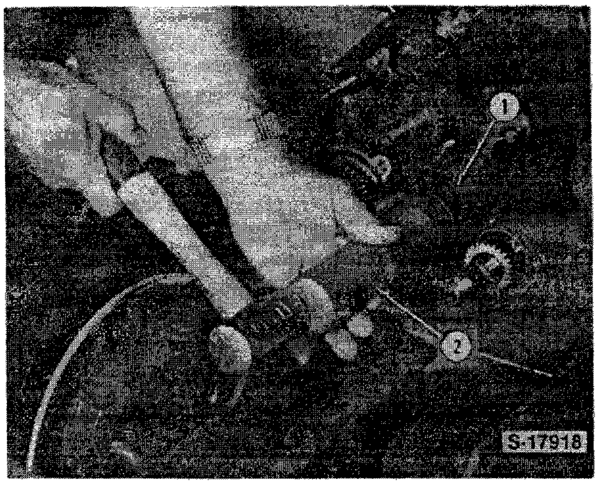

Figure 46
Port Block and Shaft Installation
1. Installer
2. Driver

TIMING GEAR COVER

INSPECTION AND REPAIR

Inspect the governor linkage and replace any worn or damaged parts. See Part 2, Fuel System, Chapter 1 for governor linkage assembly and adjustments.

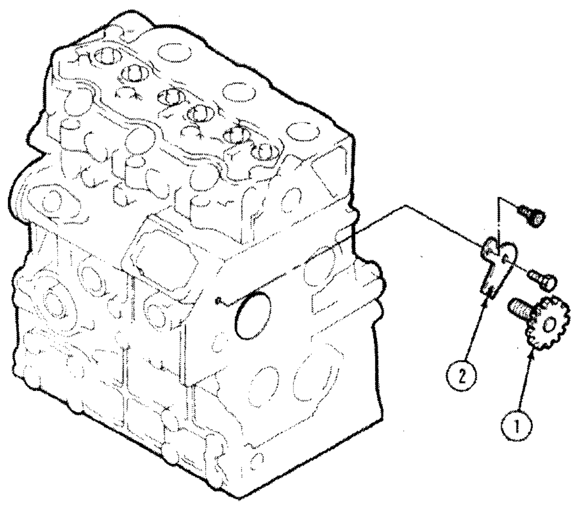

Figure 47
Tachometer Drive Shaft and Plate Installation — Model 1720
1. Tachometer Drive Gear
2. Plate

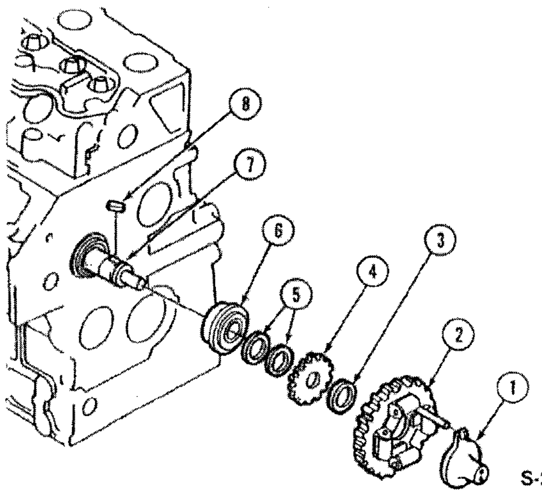

Figure 48
Camshaft Gear and Governor Installation
1. Slider
2. Gear Assembly
3. Spacer
4. Tachometer Drive Gear
5. Spacers
6. Bearing
7. Camshaft
8. Key

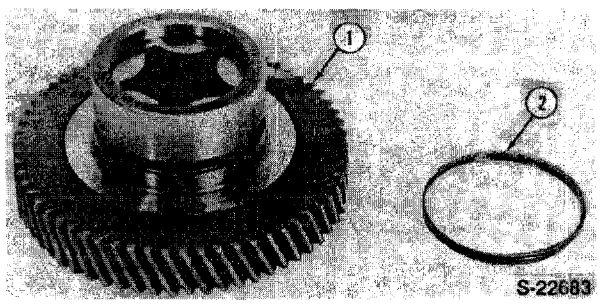

Figure 49
Engine Oil Pump Installation
1. Gear and Housing
2. Spring Retainer 1147

INSTALLATION

1. Install a new timing gear cover gasket and reinstall the timing gear cover following the removal procedure in reverse.

   NOTE: *Be sure the dowel pin in the cover properly aligns with the hole in the oil pump cover, Figure 50.*

CONNECTING RODS, BEARINGS, PISTONS, RINGS AND CYLINDER BLOCK

NOTE: *The pistons and connecting rods can be removed with the engine in the tractor after removal of the cylinder head and oil pan as previously described.*

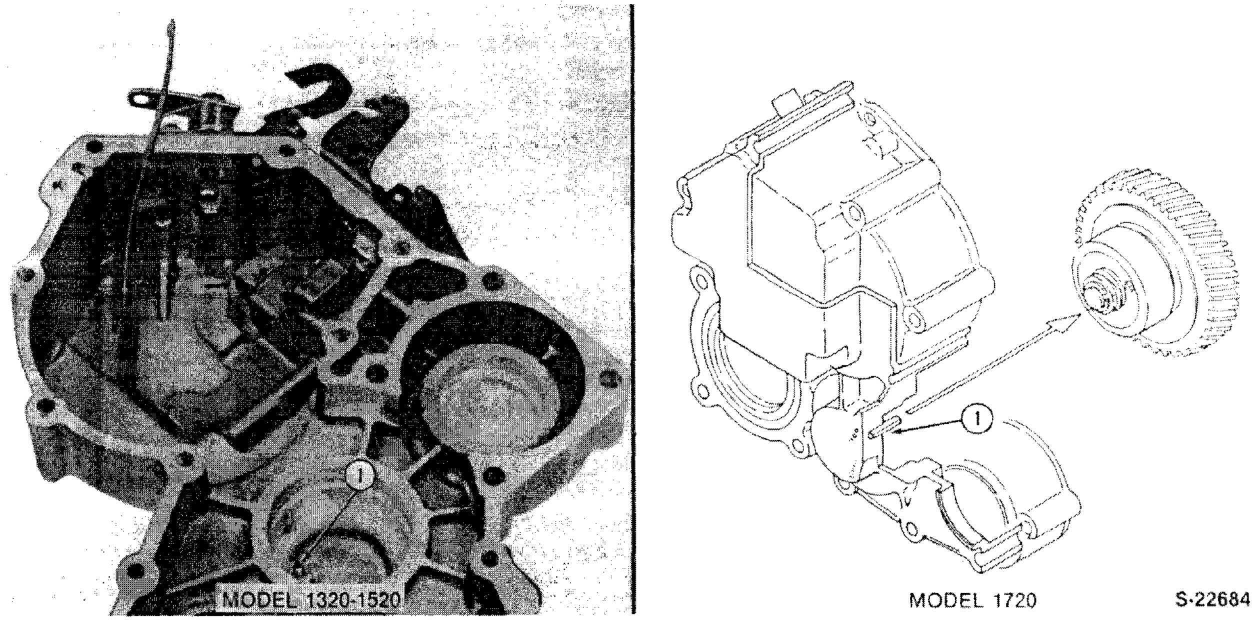

Figure 50
Timing Gear Cover Installation
1. Dowel Pin

DISASSEMBLY

1. Remove the connecting rod caps, Figure 51.

2. If necessary, remove any ridge from the top of the cylinder bores with a suitable ridge reamer. Push the pistons out of the cylinder block.

   NOTE: *Be sure to keep the connecting rod caps and bearing liners with their respective rods for reassembly in their original position.*

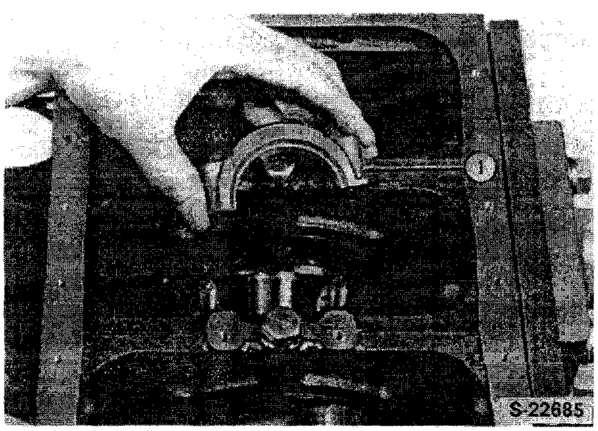

Figure 51
Connecting Rod Removal
1. Rod Cap

3. Use a suitable ring expander to remove the piston rings, Figure 52.

4. Remove the piston pin retainer rings and drive the pin out of the piston, using Tool No. 1585, Figure 53.

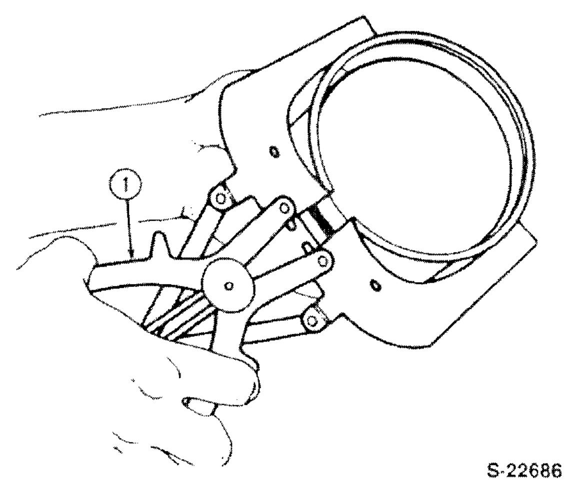

Figure 52
Piston Ring Removal
1. Ring Expander Tool

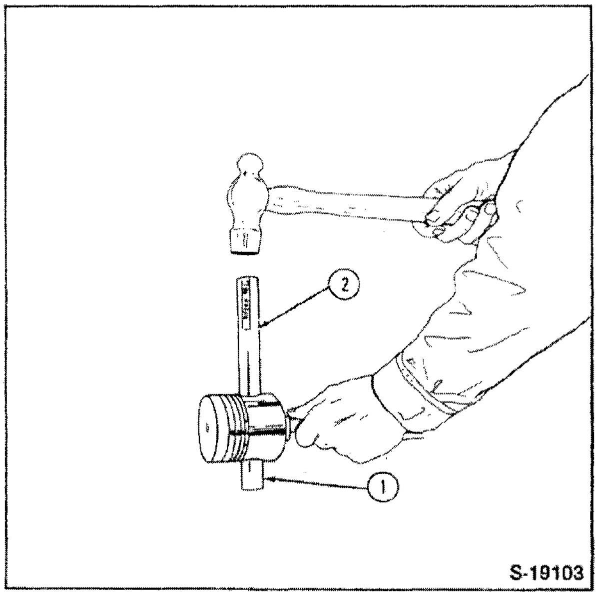

Figure 53
Piston Pin Removal
1. Piston Pin 2. Piston Pin Remover Tool No. 1585

INSPECTION AND REPAIR

Wash the pistons and connection rods in a suitable solvent and air dry.

PISTONS

1. Using a ring groove cleaner, remove the carbon deposits from the ring grooves. Be careful to avoid cutting any metal from either the side or the bottom of the grooves, Figure 54.

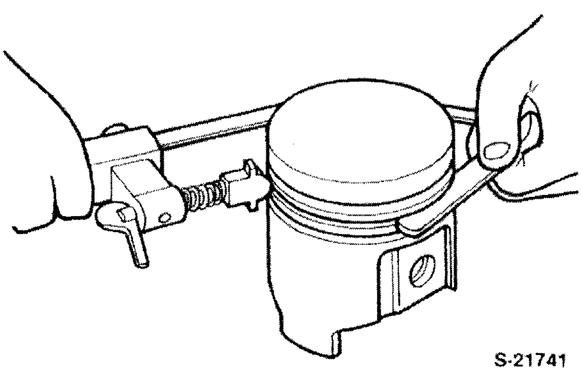

Figure 54
Piston Ring Groove Cleaning

2. Inspect the piston ring lands for excessive wear. Use a new ring and feeler gauge to check the ring side clearance, Figure 55.

   Replace pistons having a ring side clearance exceeding the following dimensions:

	Wear Limit
Compression Ring	.010 in. (0.25 mm)
Oil Control Ring	.006 in. (0.15 mm)

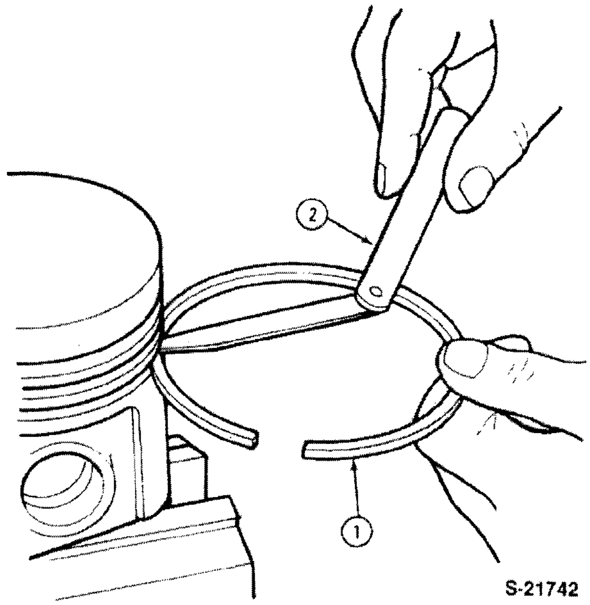

Figure 55
Piston Ring Groove Wear Check
1. Piston Ring (New) 2. Feeler Gauge

3. Using a micrometer, check the piston diameter at 90° from the piston pin bore, Figure 56.

   Replace pistons that are worn to less than the following dimensions:

Model	Piston Diameter Wear Limit
1320	3.2 in. (81.7 mm)
1520	3.3 in. (83.7 mm)
1720	3.3 in. (83.7 mm)

4. Using a small hole gauge and micrometer, measure the piston pin bore and piston pin diameter, Figure 57.

   Replace piston and/or pins that exceed the following wear limits:

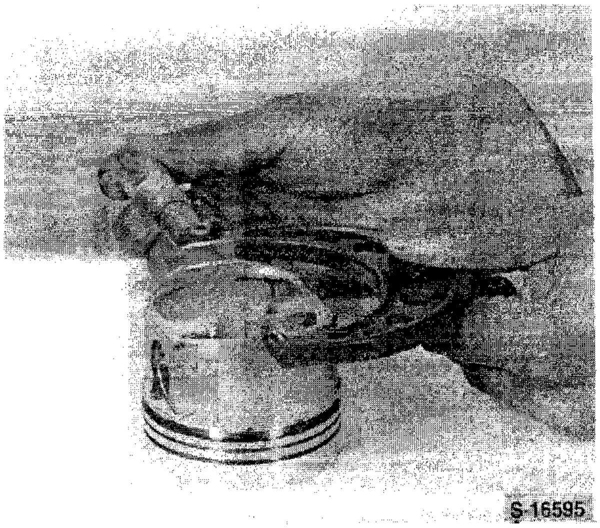

Figure 56
Piston Diameter Wear Check

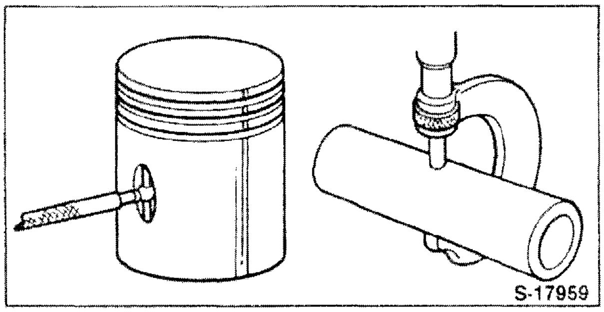

Figure 57
Piston Pin and Bore Wear Check
(Model 1720 Piston Shown)

Model	Piston Pin Bore Diameter	Wear Limit Piston Pin Diameter	Pin to Bore Clearance
1320/ 1520	.984 in. (25.0 mm)	.983 in. (24.98 mm)	0.0008 in. (0.02 mm)
1720	1.102 in. (28.0 mm)	1.101 in. (27.98mm)	.0008 in. (.02 mm)

NOTE: *In some instances the piston pin diameter may be equal or slightly larger than the piston pin bore. This interference fit is normal.*

RINGS

Check the rings in the cylinder bore to determine the end gap clearance as follows:

Position the rings, one at a time, in the cylinder to the lowest point of travel. Use an inverted piston to square the ring in the bore. With a feeler gauge, measure the ring end gap, Figure 58.

NOTE: *The ring is shown at top of its travel in Figure 58 for clarity.*

Replace worn rings with end gap clearance in excess of 0.039 in. (1.0 mm).

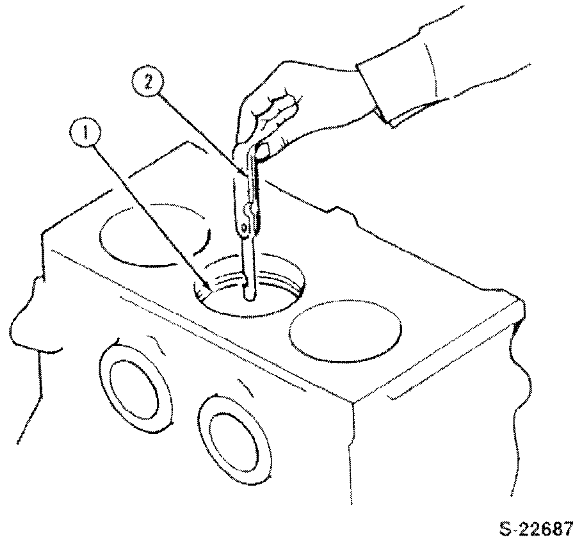

Figure 58
Ring End Gap Clearance Check
1. Piston Ring 2. Feeler Gauge

CONNECTING RODS

1. Check the connecting rods for damage and alignment. Place each rod in an alignment fixture to check for a bent or twisted condition, Figure 59.

   Straighten or replace rods that are bent or twisted more than the following dimensions.

   Max. Bend .... .0059 in. (.15 mm) per 3.94 in. (100 mm)
   Twist .... .0078 in. (.2 mm) per 3.94 in. (100 mm)

2. Using a small hole gauge and micrometer, measure the inside diameter of the connection rod pin bushing, Figure 60.

   Replace bushings measuring more than the following dimensions:

Model	Max. Inside Diameter
1320-1520	.984 in. (25.0 mm)
1720	1.106 in. (28.08 mm)

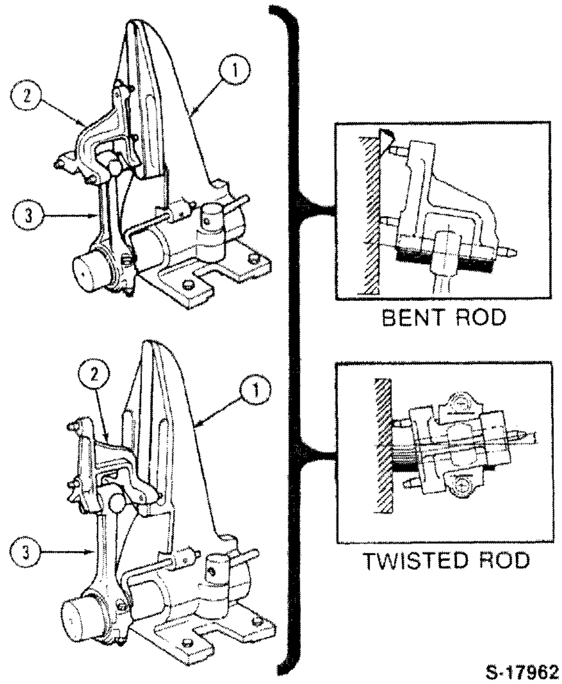

Figure 59
Connecting Rod Alignment Check
1. Alignment Fixture 3. Connecting Rod
2. Gauge

3. Remove and install the connecting rod pin bushings using a suitable driver, Figure 61, and press a new bushing into the rod bore.

4. Ream and hone the bushing to the following finished size:

Model	Pin to Bushing Clearance Std.	Max.
All	.00039-.00098 in. (.010-.25 mm)	.0031 in. (.08 mm)

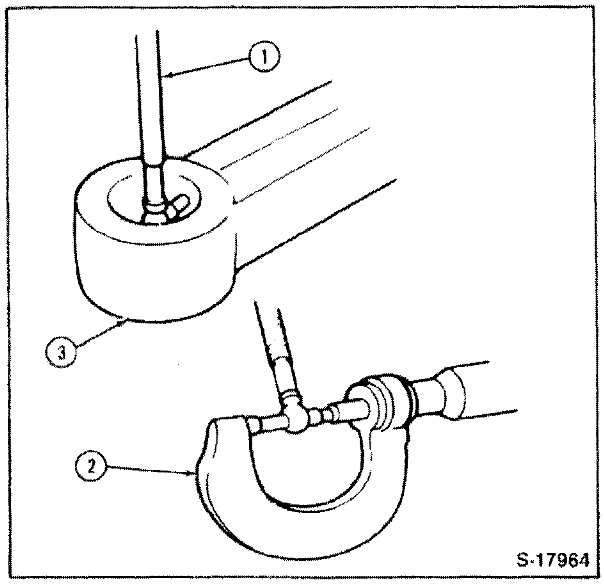

Figure 60
Connecting Rod Bushing Wear Check
1. Hole Gauge 3. Connecting Rod
2. Micrometer

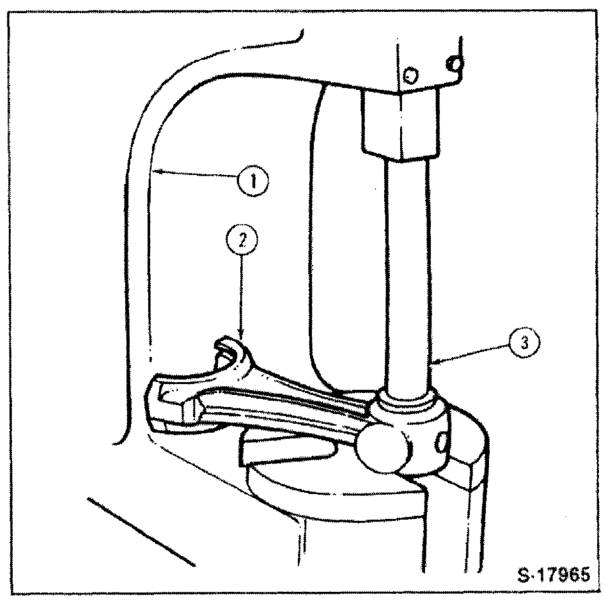

Figure 61
Connecting Rod Bushing Removal and Installation
1. Press 3. Bushing Driver
2. Connecting Rod

5. When installing a new pin bushing, use the hole in the rod as a guide and drill a lube hole in the new bushing, Figure 62.

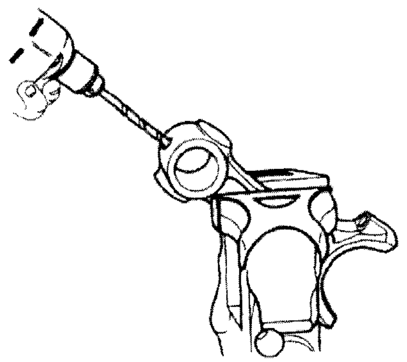

Figure 62
Bushing Lube Hole Drilling

6. Check the connecting rod side clearance on the crankshaft as follows:

   - Install the connecting rod on the crankshaft and torque the bolts to the specified torque.

   - Push the rod from side to side and check the clearance between the connecting rod and crankshaft with a feeler gauge, Figure 63.

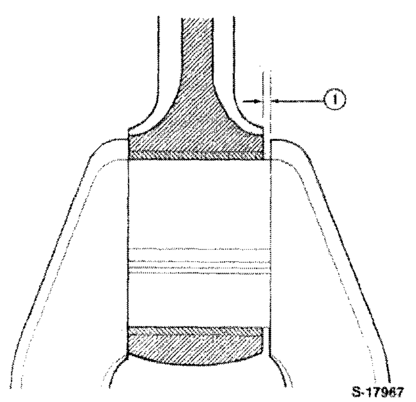

Figure 63
Connecting Rod Side Clearance Check
1. Side Clearance .028 in. (0.7 mm) Max.

Replace the connecting rod if the side clearance is greater than 0.028 in. (0.7 mm).

CYLINDER BLOCK

Check the condition of the cylinder bore, Figure 64, for wear in the following manner.

1. Measure the diameter of cylinder bore in four positions using a suitable bore gauge, Figure 64.

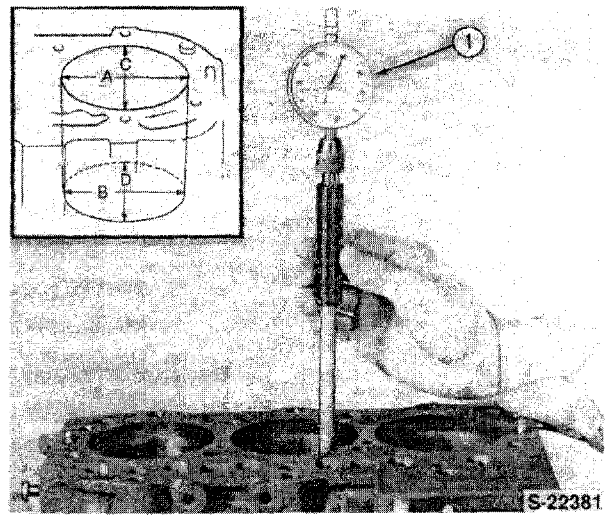

Figure 64
Cylinder Bore Diameter Check
1. Cylinder Bore Gauge

Measurements should be taken as follows:

- In line with the crankshaft at the top of the bore (approximately .39 in. [1.0 mm] Model 1320-1520 and .59 in. [15 mm] Model 1720) below the top of the block.

- At right angles to the crankshaft at the same distance from the top.

- In line with the crankshaft at the bottom of the bore (approximately 3.9 in. [100 mm] Models 1320-1520 and 4.6 in. [117 mm] Model 1720) from the top of the block.

If any of the measurements taken indicate worn or damaged cylinder bores, the cylinders must be bored and oversize pistons installed or replace the block.

Pistons available in .020" (.5 mm) and .040" (1.0 mm) oversize. Measure the new piston. Bore and hone the cylinder to obtain a piston to cylinder wall clearance of:

1320 .... .0034-.004 in. (.086-.100 mm)
1520/1720 .... .0015-.0025 in. (.038-.064 mm)

NOTE: *If the cylinder bore measures:*

1320/1520 .... 3.275 in. (83.19 mm)		*Replace the block.*
1720 .... 3.354 in. (85.19 mm)		

ASSEMBLY

1. Assemble the pistons and connecting rods with the matching marks on the rods on the same side as the trade name "SHIBAURA" embossed on the inside of the piston skirt, Figure 65. Install the piston pin and retaining rings.

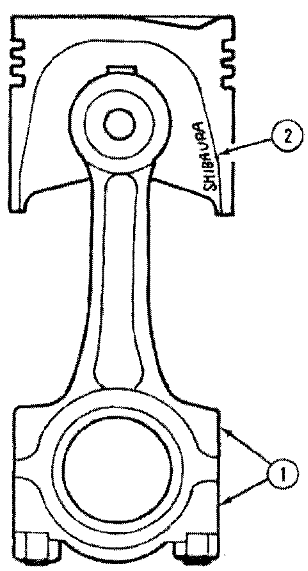

Figure 65
Piston Assembly
1. Matching Marks 2. Trade Name (SHIBAURA)

2. Using a suitable ring expander tool, install the piston rings positioning the ring gaps at approximately 120° from each other, Figure 66. Do not position a ring gap over the piston pin bore.

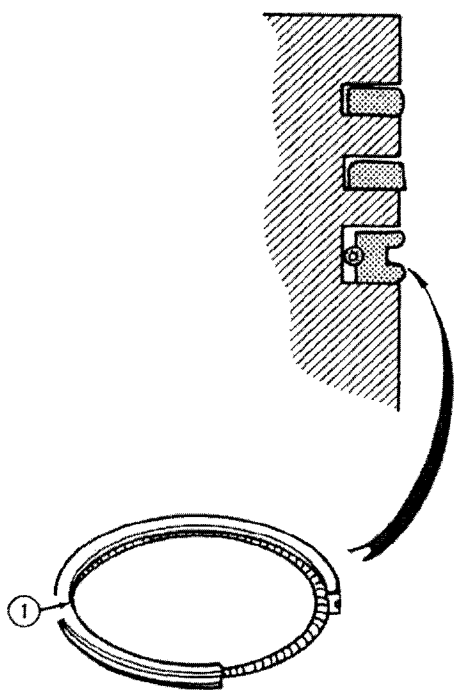

Figure 66
Piston Ring Installation
1. Expander Joint

INSTALLATION

1. Using a suitable ring compressor, install the piston and rod assemblies in their respective cylinder bores. Position the pistons and rod assembly in the block, Figure 67, with the connecting rod number matching marks facing the injection pump side.

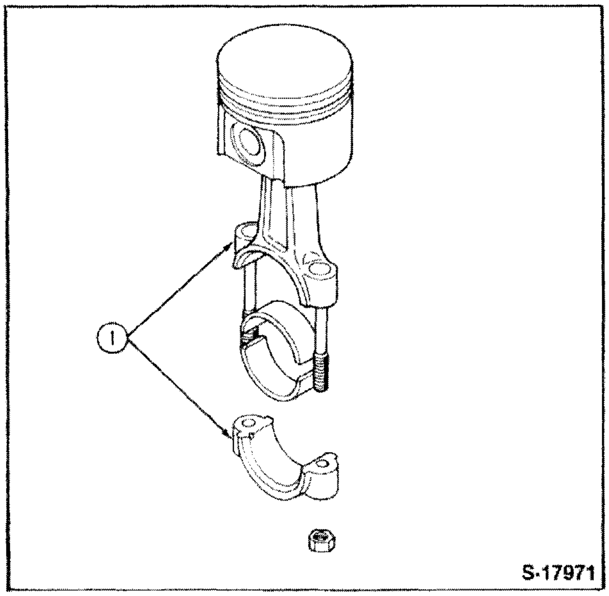

Figure 67
Piston Installation
1. Rod-Number Matching Marks (Facing Injection Pump Side)

2. Using plastigauge, check the connecting rod bearing liner clearance to the crankshaft as follows:
   - Position a piece of plastigauge of the correct size across the full width of the bearing liner at approximately 1/4 inch off center. Install the rod cap and tighten to the specified torque, Figure 68.
   - Remove the rod cap and measure the width of the flattened plastigauge using the plastigauge scale.
   - The width of the widest flattened plastigauge is the minimum clearance and the width of the narrowest plastigauge is the greatest clearance. Select the proper size bearing liners to obtain the correct clearance. See "Specifications," Chapter 3.

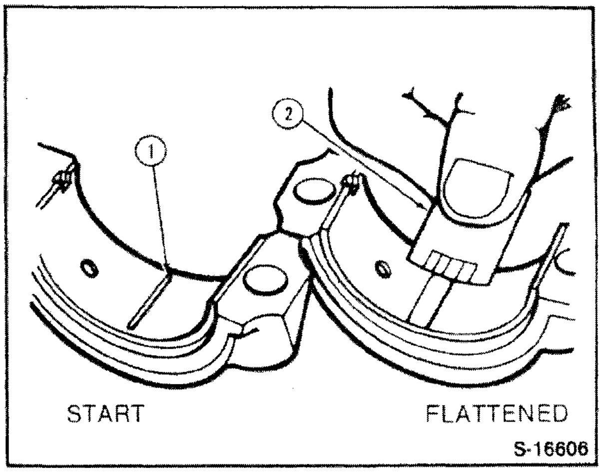

Figure 68
Connecting Rod Bearing Clearance Check
1. Plastigauge 2. Scale

3. Reinstall the bearing caps making sure the rod and cap matching marks are aligned, Figure 67.
4. Tighten the connecting rod bolts to the specified torque. See "Specifications," Chapter 3.

CRANKSHAFT, MAIN BEARINGS, CAMSHAFT AND FLYWHEEL

FLYWHEEL – REMOVAL
Reference – Figure 69

Separate the engine from the transmission, (See Part 12), and remove the clutch assembly.

1. Loosen the flywheel attaching bolts.
2. Using a brass drift and hammer, tap the end of the crankshaft to loosen the flywheel from the shaft.

INSPECTION AND REPAIR

1. Inspect the ring gear for cracked, broken, chipped or worn gear teeth. If found damaged, replace the ring gear.
2. If necessary, remove the starter ring gear using a hammer and chisel to crack the ring gear.

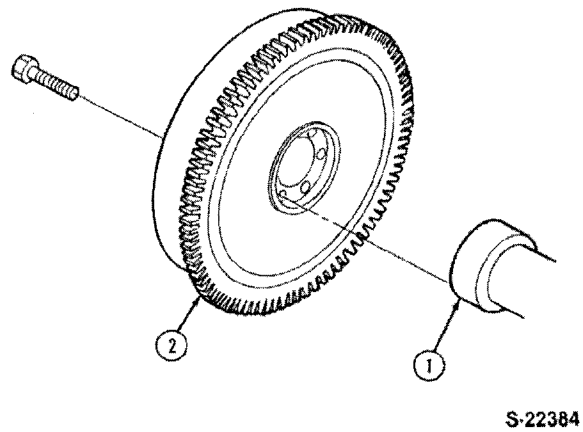

Figure 69
Flywheel Removal
1. Crankshaft 2. Flywheel

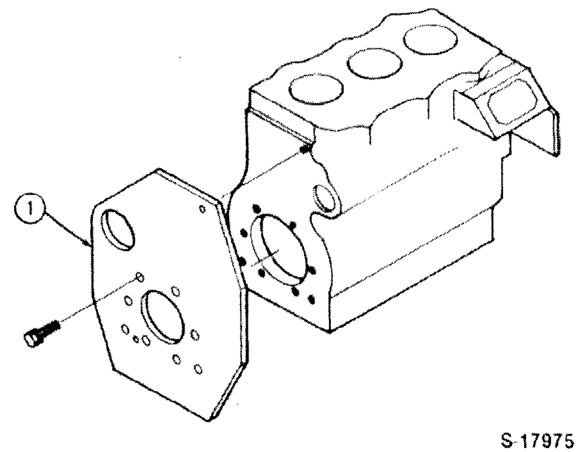

Figure 70
Engine Rear Plate Removal — Model 1720
1. Rear Plate

3. To install a new ring gear, heat the new ring gear to 245-300°F. (120-150°C) from the inside only. Be careful not to overheat the ring gear teeth. Use a temperature sensitive crayon to mark the inside of the ring gear. Quench the ring gear quickly to obtain a good shrink fit onto the flywheel.

INSTALLATION

Installation follows the removal procedure in reverse.

Tighten the flywheel retaining bolts or crankshaft nut to the specified torque. See "Specifications," Chapter 3.

CRANKSHAFT — REMOVAL

1. Remove the engine from the tractor. See "Separating the Tractor," Part 12.

2. Remove the cylinder head assembly, front timing gear cover, clutch, flywheel, pistons and rods as previously described.

   - Remove the rear plate, Figure 70.

   - Remove the crankshaft rear oil seal, Figure 71.

   - Remove the crankshaft bearing holder retaining bolts, Figure 72.

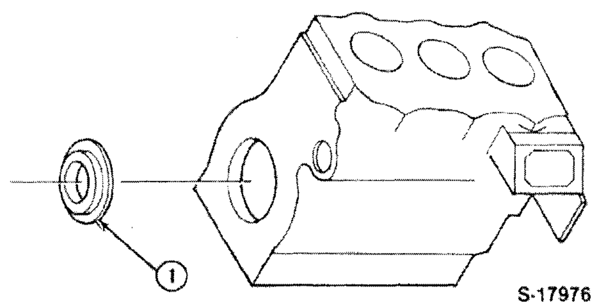

Figure 71
Rear Oil Seal Removal — Model 1720
1. Oil Seal

   - Remove the crankshaft through the rear of the engine.

INSPECTION AND REPAIR

1. Inspect the crankshaft gear teeth for wear or damage and replace if necessary.

2. Using a micrometer, measure the crankshaft journals for size, runout, and taper Figure 73.

3. The amount of taper in a journal is the difference in the measurements taken at points 1 and 2 on a journal, Figure 73.

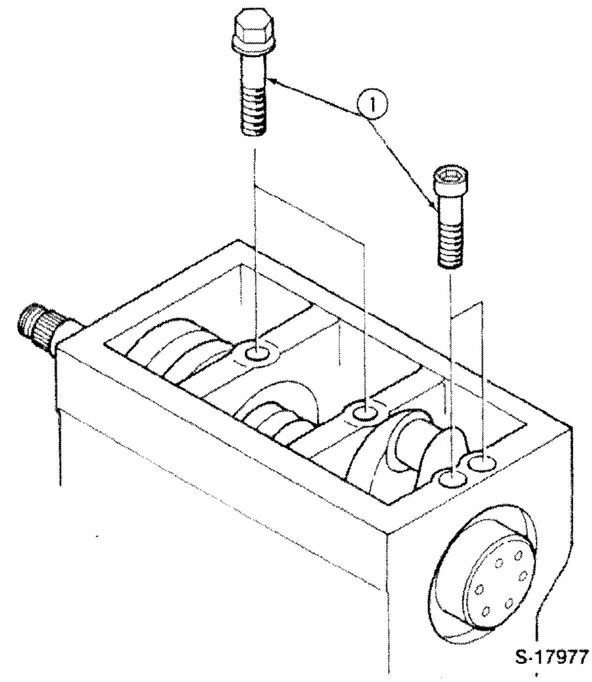

Figure 72
Crankshaft Removal
1. Bearing Holder Bolts

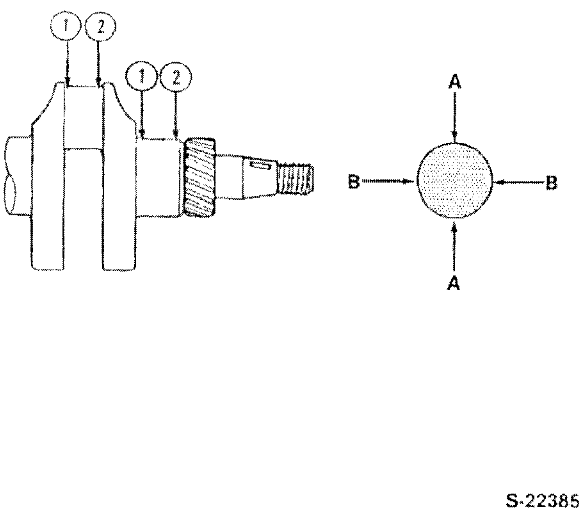

Figure 73
Crankshaft Wear Check

A Taper Readings 1 vs. 2
B Out-of-Round Readings A vs. B

4. The amount of out-of-round in a journal is the difference in the measurements taken at A and B, Figure 73.

   NOTE: *The smallest reading taken at any one of the readings indicates the size of the journal. See "Specifications," Chapter 3, for wear limits and repair recommendations.*

   NOTE: *Undersize bearings are available in 0.010-0.020 in. (0.25-0.50 mm) for both main and crank pin journals. See "Specifications," Chapter 3, for journal wear limits and bearing usage.*

5. Mount the crankshaft in a set of V-blocks and measure the amount of runout, using a dial indicator as shown, Figure 74.

   Straighten or replace crankshafts that exceed runout specifications. See "Specifications," Chapter 3.

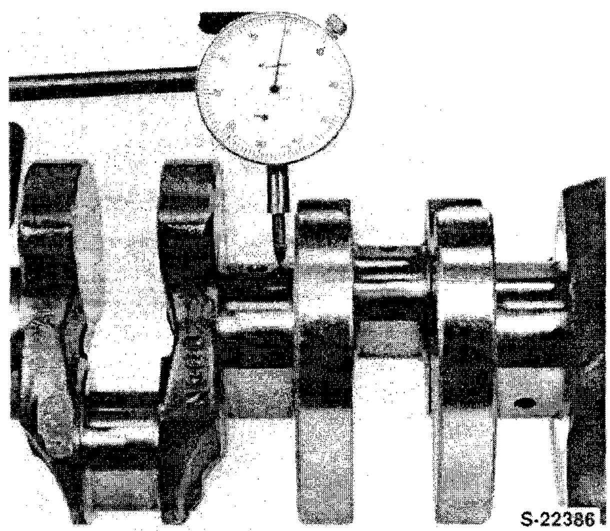

Figure 74
Crankshaft Runout Check

ASSEMBLY

1. Before installing the crankshaft in the block, use a dial indicator to measure the crankshaft bushings for wear and clearance. A full circle bushing is located in the bore in the front of the engine block, Figure 75.

   To determine the bushing clearance, subtract the crankshaft journal diameter from the bushing diameter.

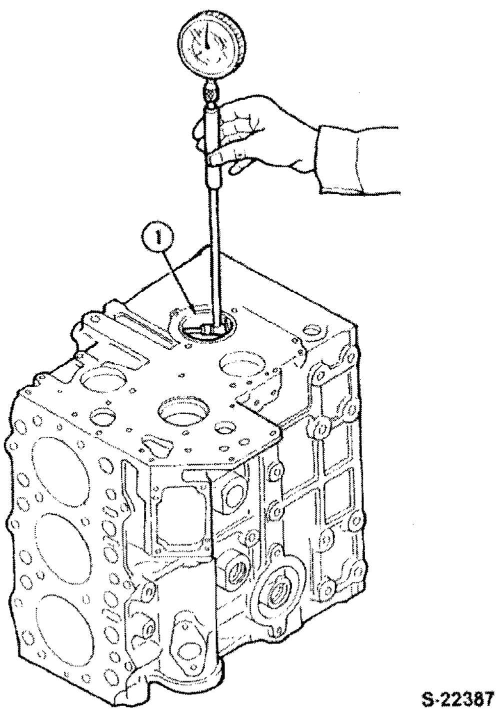

Figure 75
Crankshaft Bushing Wear Check
1. Front Bushing

Replace the bearing or the crankshaft components, or grind the crankshaft and install an oversize bushing as required. See "Specifications," Chapter 3.

2. Check the main crankshaft bearing clearance prior to installing in the engine block.

Position a piece of plastigauge of the correct size across the full width of each bearing liner at approximately 1/4 inch off center, Figure 76.

3. Install the bearing holder and tighten the bolts to the specified torque, Figure 77.

NOTE: *Do not permit the bearing holder to rotate, even the slightest amount.*

4. Remove the bearing holders and measure the width of the flattened plastigauge using the gauge printed on the plastigauge package.

Replace components, or grind the crankshaft to the next oversize bearing as required to obtain the correct clearance. See "Specifications," Chapter 3.

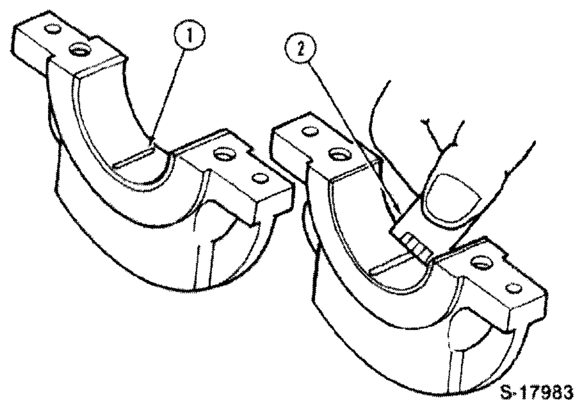

Figure 76
Main Bearing Liner Clearance Check
1. Plastigauge
2. Scale

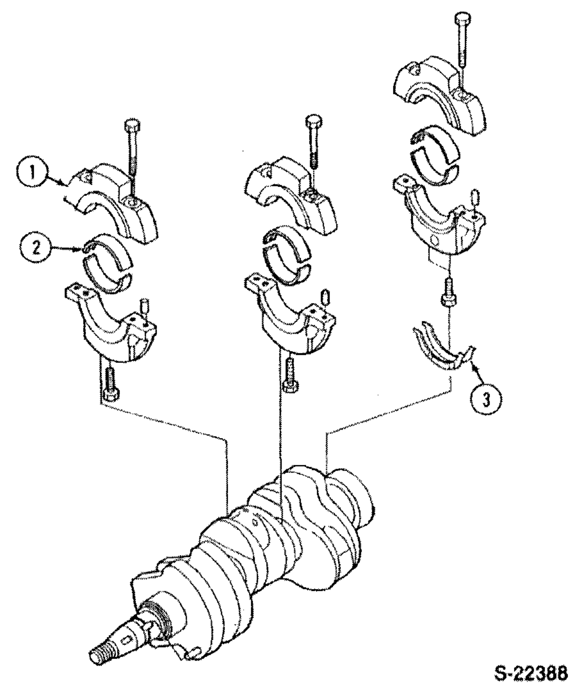

Figure 77
Bearing Holder Installation
1. Holder
2. Main Liner
3. Thrust Bearing

NOTE: *The width of the plastigauge at the widest point establishes the minimum clearance and at the narrowest point the maximum clearance. The difference between the two readings indicates the taper.*

5. Reinstall the bearing holders along with the proper liners and torque the holder bolts to the specified torque. Be sure the bearing holders are correctly positioned on the shaft with the chamfered edge facing forward.

NOTE: *Be sure to install the crankshaft thrust bearings in the holder as shown, Figure 78.*

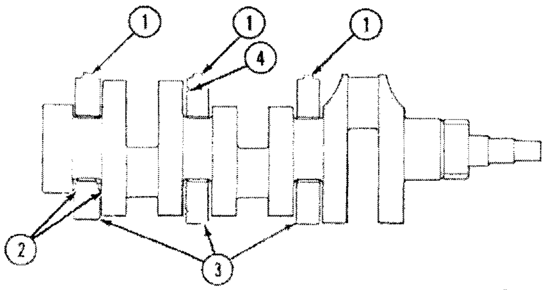

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Figure 78
Main Bearing Holder Installation

1. Bearing Holder
2. Thrust Bearing
3. Holder Chamfer
4. Second Holder Identification Mark

6. Install the crankshaft in the block from the rear. Use care to not damage the front bearing liner when inserting the crankshaft through the bushing.

7. Install the bearing holder bolts and tighten to the specified torque.

8. Using a dial indicator, check the crankshaft end play, Figure 79.

NOTE: *Pry the crankshaft back and forth several times to determine the end play reading.*

Replace the thrust washers if the end play exceeds .019 in. (.5 mm).

If the end play is within the specified limits, complete the assembly as follows:

- Install the oil seal on the crankshaft.
- Using liquid gasket sealer on the rear plate attaching bolts, install the plate and bolts and tighten to the specified torque, Figure 80.

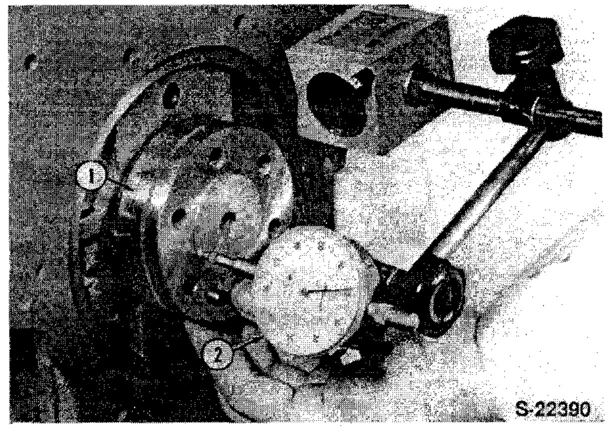

Figure 79
Crankshaft End Play Check

1. Crankshaft
2. Dial Indicator

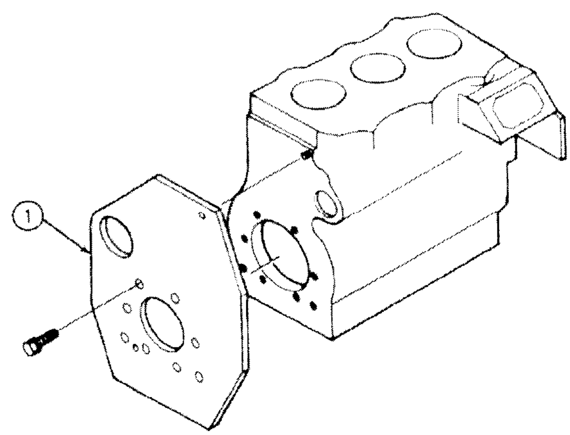

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Figure 80
Engine Rear Plate Installation

1. Rear Plate

CAMSHAFT REMOVAL

1. Remove the radiator assembly, timing gear cover, timing gears and cylinder head as previously described.

2. Remove the valve tappets, Figure 81.

3. Remove the camshaft assembly and tachometer drive shaft and plate assembly as a unit, Figure 82.

4. Remove the engine front plate and gasket, Figure 83.

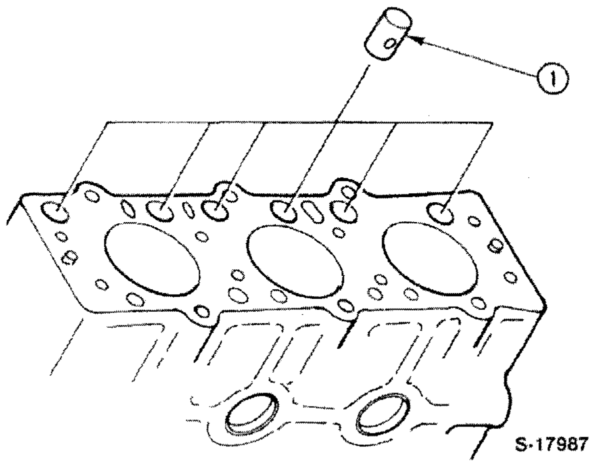

Figure 81
Valve Tappet Removal Model 1720
1. Tappets

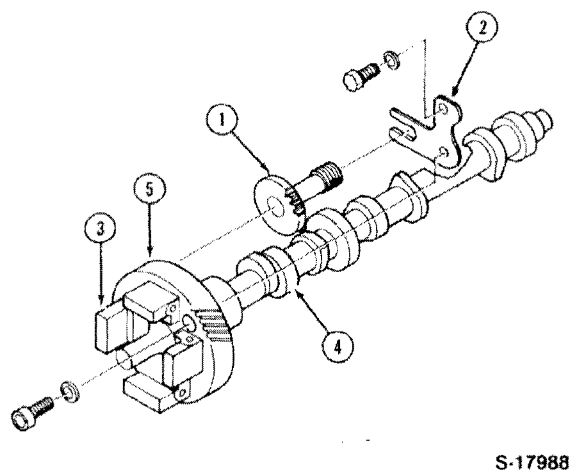

Figure 82
Camshaft Removal — Model 1720

1. Tachometer Drive
2. Plate
3. Governor Flyweight Assembly
4. Camshaft
5. Camshaft Gear

NOTE: *If the camshaft rear bearing is to be removed, separate the engine from the transmission clutch housing and remove the clutch, flywheel and engine rear plate. See "Separating the Tractor," Part 12.*

INSPECTION AND REPAIR

1. Place the camshaft in a set of V-blocks and check the runout using a dial indicator, Figure 84.

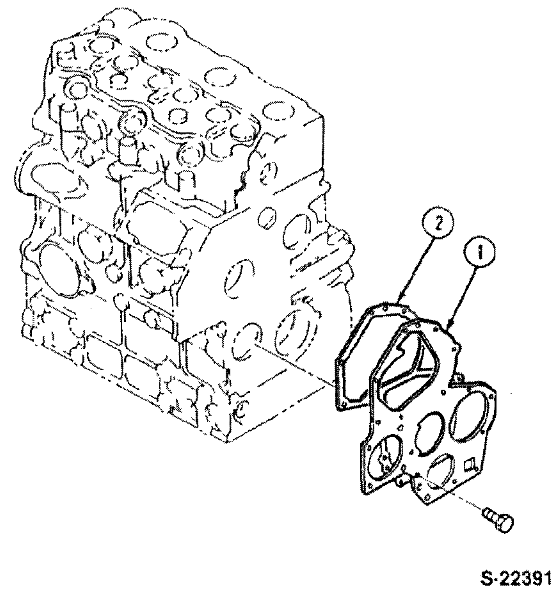

Figure 83
Engine Front Plate Removal
1. Front Plate
2. Gasket

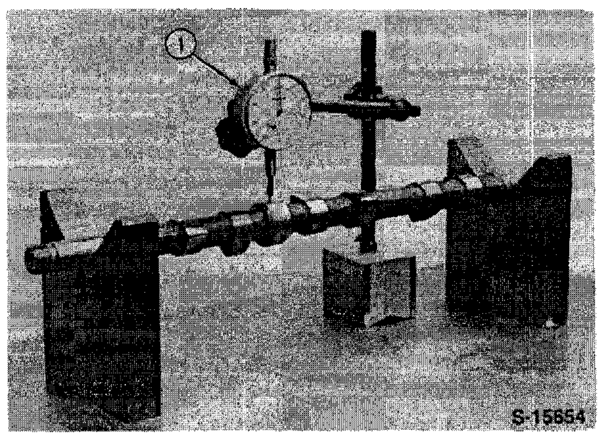

Figure 84
Camshaft Runout Check
1. Dial Indicator

Replace or straighten the camshaft if the runout is greater than .004 (0.1 mm).

2. Using a micrometer, measure the height of the camshaft lobes, Figure 85.

Replace the camshaft if any of the cam lobes are worn to less than the following dimensions:

Valve lobe . . . . 1.326 in. (33.7 mm)
Injection pump lobe . . 1.646 in. (41.8 mm)

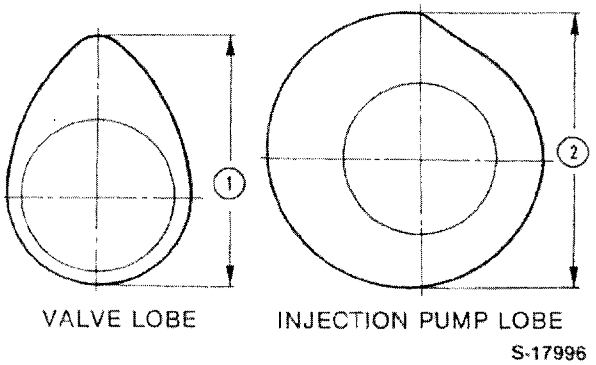

Figure 85
Camshaft Lobe Wear Check
1. Valve Lobe Height 2. Injection Pump Lobe Height

NOTE: *Minor imperfections may be removed using a fine grit oil stone.*

INSTALLATION

Installation generally follows the removal procedure in reverse.

Observe the following during assembly of the camshaft and timing gear components.

1. Install the front plate and gasket.
2. Install the tachometer drive gear and plate, Figure 86.
3. Install the camshaft, tachometer drive gear, camshaft gear and governor components as shown, Figure 87.
4. Install the injection pump drive gear thrust washer and gear assembly, Figure 88.

NOTE: *Be sure to align timing marks of the idler gear with the marks on the crankshaft gear and camshaft gear, Figure 88.*

5. Install the inner rotor, pump cover, shim, spring, collar and "E" snap ring, Figure 89.
6. Install the timing gear cover with a new gasket.

NOTE: *Connect the governor link to the injection pump rack and install the hair pin, Figure 90. Be sure the cover dowel pin is engaged in the oil pump cover on assembly.*

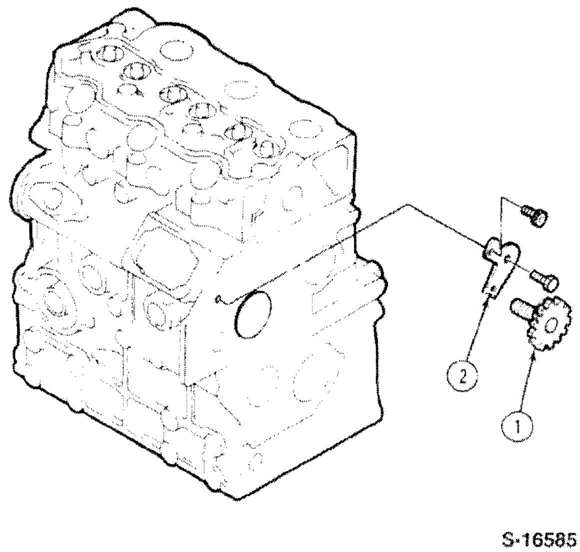

Figure 86
Tachometer Drive Installation
1. Tachometer Drive Gear 2. Plate

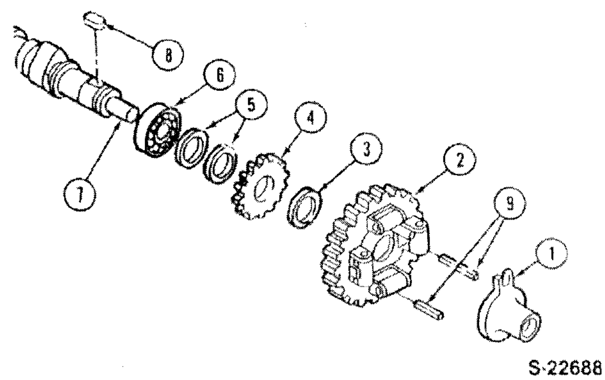

Figure 87
Camshaft and Governor Installation — Model 1720

1. Slider
2. Gear Assembly
3. Spacer
4. Tachometer Drive Gear
5. Spacers
6. Bearing
7. Camshaft
8. Key
9. Pins

IMPORTANT: *Do not turn the crankshaft before installing the timing gear cover to the engine.*

INJECTION PUMP TIMING

See Part 2 for injection pump timing procedure.

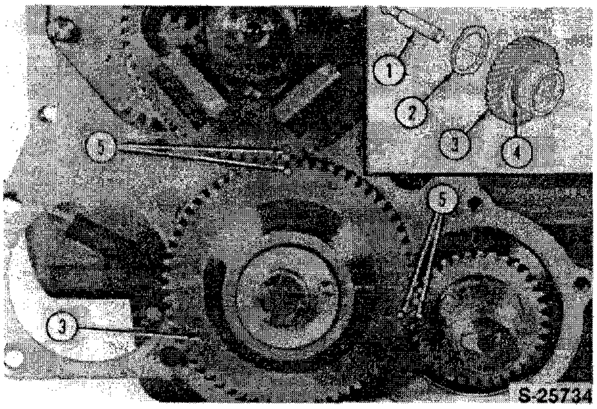

Figure 88
Idler Gear Installation

1. Shaft
2. Thrust Washer
3. Idler Gear Assembly
4. Spring Retainer
5. Timing Marks

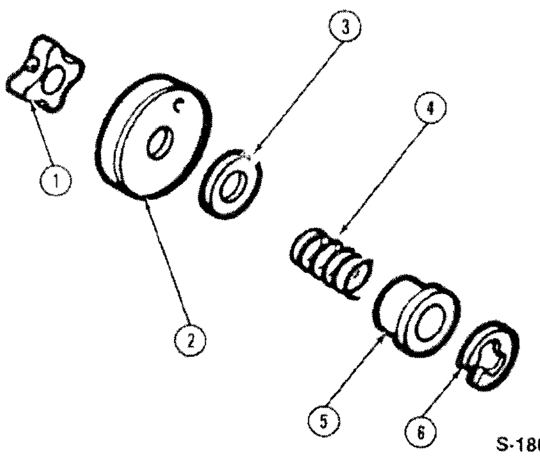

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Figure 89
Engine Oil Pump Assembly — Model 1720

1. Inner Rotor
2. Pump Cover
3. Shim
4. Spring
5. Collar
6. "E" Snap Ring

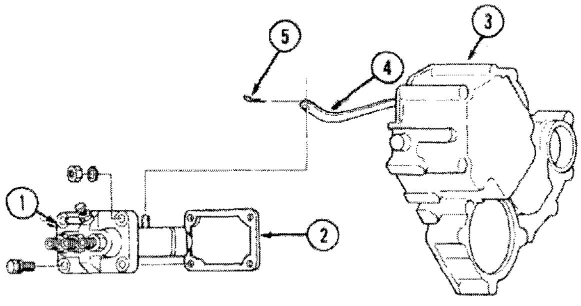

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Figure 90
Timing Gear Cover Installation — Model 1320

1. Injection Pump
2. Shim
3. Cover
4. Governor Link
5. Hair Pin

PART 1
ENGINE SYSTEMS
MODELS 1320-1520-1720

Chapter 2
COOLING SYSTEM

A. DESCRIPTION AND OPERATION

Reference — Figure 91

The cooling system is the recirculating by-pass type with a full length water jacket for each cylinder cast into the block. The coolant is drawn from the bottom of the radiator by the water pump and passes around the cylinders and into the cylinder head.

The thermostat is located in the front of the cylinder head and thermostatically controls the flow of coolant from the engine to the radiator. When the thermostat is closed only a small amount of coolant is permitted to flow through the thermostat by-pass to the radiator to effect a faster warm-up. When the thermostat is open, the coolant flows from the water outlet connection to the top tank of the radiator for maximum cooling.

Cooling occurs as the coolant passes down through the radiator cores which are exposed to the air flow created by the fan as air is sucked through the radiator.

MAINTENANCE

WARNING: *The cooling system operates under pressure which is controlled by the radiator cap. It is dangerous to remove the cap from a hot engine or while the engine is running. Always shut the engine off and allow it to cool before removing the radiator cap. When removing the cap, use a thick cloth to cover the cap and slowly turn the cap to the first stop to allow the pressure to escape before removing the cap completely.*

Clean the cooling system to remove rust, sludge and other foreign material, by using a coolant system cleaning solvent. In severe cases, pressure flushing may be required. A pulsating or reverse flow flushing will more effectively loosen and remove foreign material than a steady flushing in the normal direction of coolant flow. If pressure flushing is to be used, always remove the thermostat and make sure the head bolts are tightened properly.

COOLANT

The coolant is a permanent type ethylene-glycol base antifreeze and should be used all year.

Recommended use of 50/50 mixture of ethylene-glycol antifreeze and pure water provides maximum cooling efficiency for summer use and a winter time freezing protection to -33°F.

NOTE: *Alcohol base coolants are not recommended for use in the tractor engine.*

Drain and flush the cooling system every 12 months and replace the coolant with fresh antifreeze and pure water.

After the coolant has been drained from the radiator and block, flush the system by placing a water hose in the radiator filler neck. With the drain open and the system full of water, start the engine and run it until the water flowing from the drain is clear. Stop the engine and allow the system to drain then replace the coolant with the new 50/50 mixture antifreeze and pure water.

THERMOSTAT

The thermostat is located between the coolant outlet on the engine and the radiator. In this position the thermostat is able to sense the coolant temperature in the engine and regulates the flow of coolant to the radiator. When the engine is cold, only a small amount of coolant flows to the radiator through the thermostat by-pass. As the engine warms up, the thermostat opens to allow sufficient coolant flow to the radiator to maintain a constant engine temperature.

WATER PUMP

The water pump is an impeller attached to a shaft which is belt driven by the engine crankshaft. The impeller circulates coolant by centrifugal force. Coolant entering the pump housing from the radiator through the lower hose is thrown outward against the housing with sufficient force to cause a circulating action.

FAN

A five bladed fan is belt driven by the engine crankshaft and is mounted on the water pump shaft. The fan is positioned behind the radiator to draw air over the radiator cooling fins. To increase and concentrate the volume of air flowing through the radiator, a shroud is positioned around the fan.

RADIATOR

The heat of combustion, absorbed by the coolant as it flows through the engine is transferred to the atmosphere by the radiator. Heat is removed from the coolant as it flows down through the radiator cores to the bottom radiator tank before it is recirculated into the engine.

RADIATOR CAP

The radiator cap acts to pressurize the cooling system as a pressure relief valve and also acts as a vent valve. The pressure valve permits a limited pressure build-up in the cooling system as the coolant heats up. This increased pressure increases the boiling point of the coolant. If excess pressure builds up in the system, the pressure relief valve will open until the pressure returns to the proper level.

When the engine is shut off and the coolant cools, a vacuum condition is created in the system. A vent valve in the radiator cap opens to permit outside air pressure to enter the system when this condition exists.

B. COOLING SYSTEM — OVERHAUL

RADIATOR REMOVAL

1. Drain the radiator and block coolant in a clean container, Figure 92.
   Remove the radiator cap to assist draining.

2. Disconnect the headlight wiring connector, Figure 93.

3. Remove the battery, Figure 93.

4. Remove the hood and side screens, Figure 92.

5. Remove the lower side panels, Figure 92.

6. Remove the air cleaner inlet tube, Figure 93.

7. Remove the radiator top brace, Figure 93.

8. Remove the radiator to drain cock hose from the drain cock, Figure 92.

9. Remove the upper and lower radiator hoses from the radiator.

10. Remove the radiator upper support bolts from the front radiator shell.

11. If equipped with the HST cooler, disconnect the HST cooler lines from the cooler, Figure 93.

12. Remove the radiator screen.

13. Remove the radiator bottom support bolts from the engine frame and remove the radiator assembly, Figure 94.

INSPECTION AND REPAIR

1. Inspect the radiator fins and be sure they are free from obstruction.

2. Check the radiator for signs of coolant leakage and repair as required.

INSTALLATION

Installation of the radiator generally follows the removal procedure in reverse.

On installation, observe the following requirements:

- Refill the radiator with the correct grade and quantity of antifreeze.
- Run the engine for several minutes and check the hose connections for leaks.

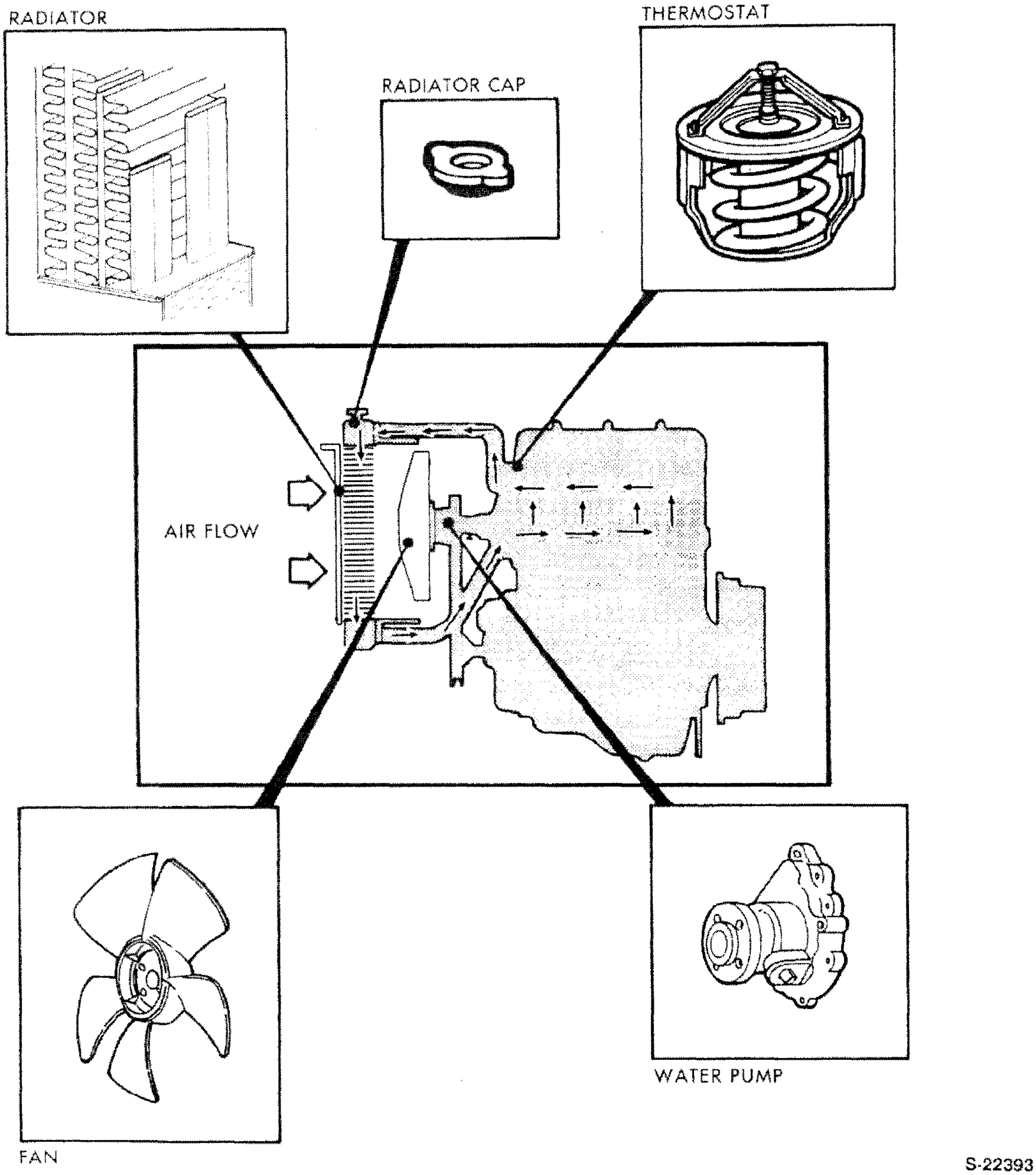

Figure 91
Cooling System Components and Flow Diagram

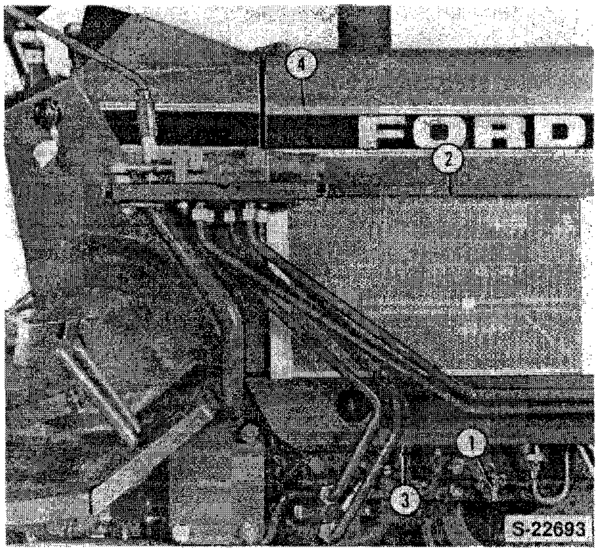

Figure 92
Radiator Coolant Drain

1. Coolant Drain Cock
2. Engine Side Screen
3. Lower Side Panel
4. Hood

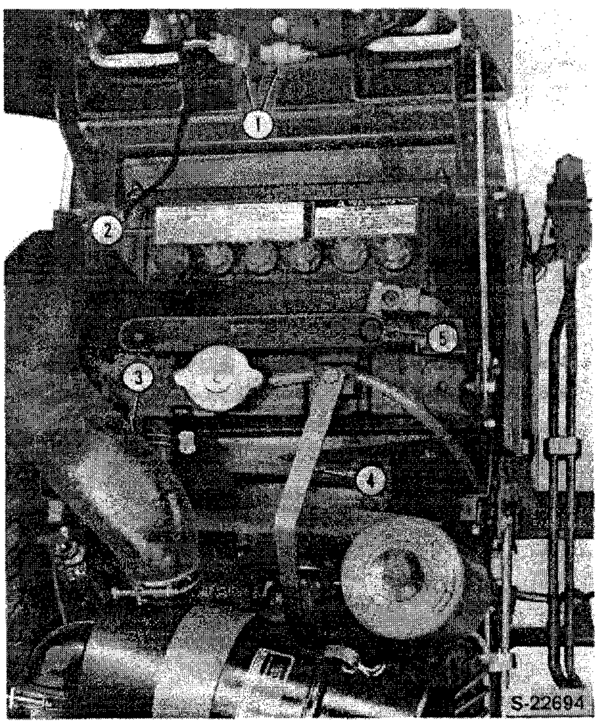

Figure 93
Radiator Removal

1. Headlight Wiring Connectors
2. Battery
3. Air Cleaner Inlet Tube
4. Radiator Top Brace (1320/1520 Only)
5. HST Cooler

WATER PUMP REMOVAL

Remove the radiator assembly as described above.

1. Remove the fan, fan holder, and pulley attaching bolts, Figure 95.
2. Remove the by-pass hose and lower radiator hoses from the water pump, Figure 96.
3. Loosen the alternator mounting bolt and adjusting bracket and remove the drive belt, Figure 97.
4. Remove the water pump and gasket from the engine.
5. Remove the pump mounting plate and gasket, Figure 98.

INSPECTION AND REPAIR

Inspect the water pump for indications of coolant leakage from around the pump shaft. If coolant leakage is observed, or if the water pump is noisy when running, replace the water pump as an assembly.

INSTALLATION

Installation of the water pump generally follows the removal procedures in reverse. On installation, observe the following requirements.

- Install new pump gasket.
- Adjust the alternator drive belt tension to obtain a belt deflection as shown, Figure 99.
- After installation, fill the radiator to the proper level with the correct grade and quantity of antifreeze.
- Start and run the engine for several minutes and check for coolant leaks.

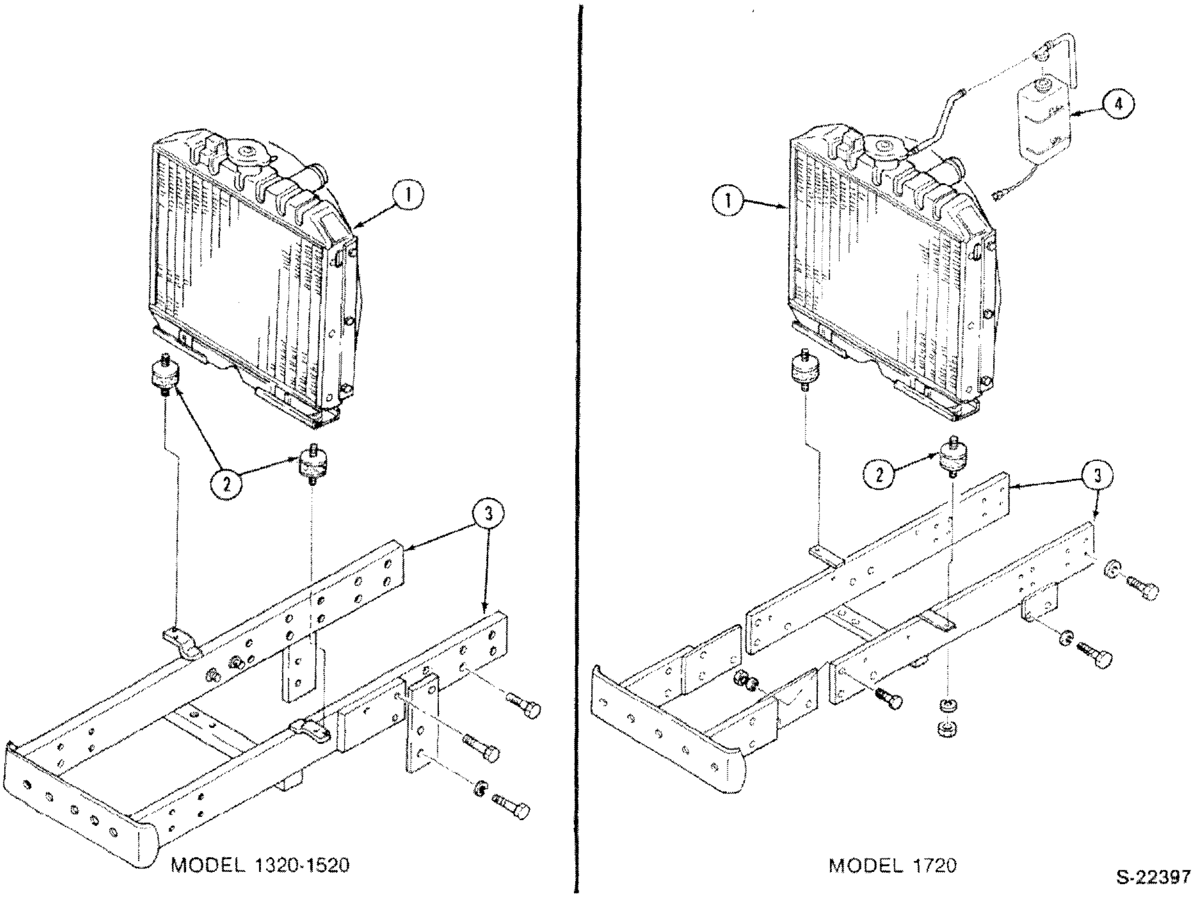

Figure 94
Radiator Removal

1. Radiator
2. Insulators
3. Frame
4. Coolant Reserve Tank (Model 1720)

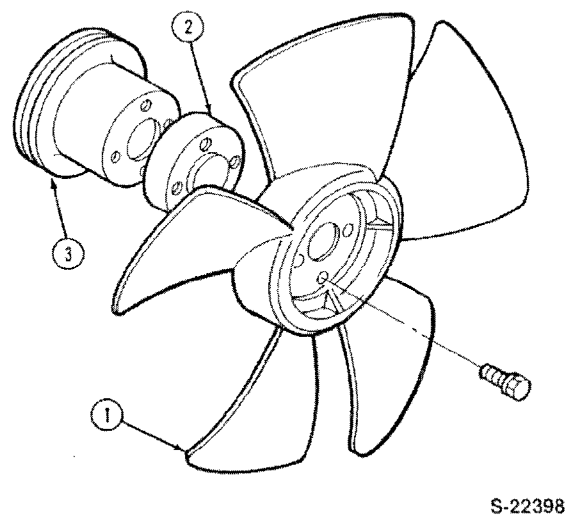

Figure 95
Fan Removal

1. Fan
2. Holder
3. Pulley

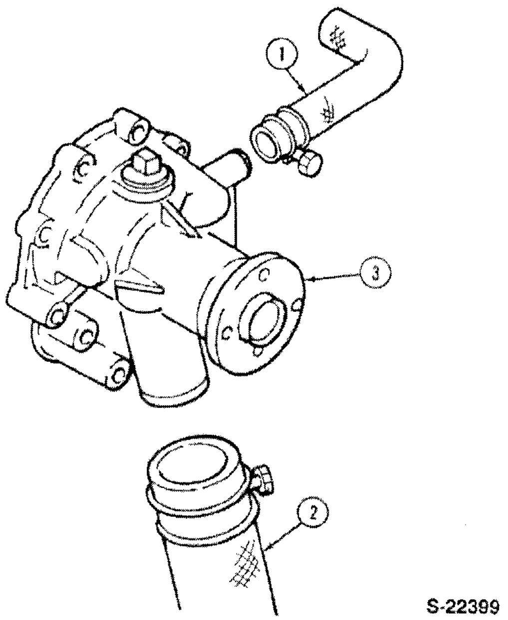

Figure 96
Water Pump Removal
1. Bypass Hose
2. Lower Radiator Hose
3. Water Pump Assembly

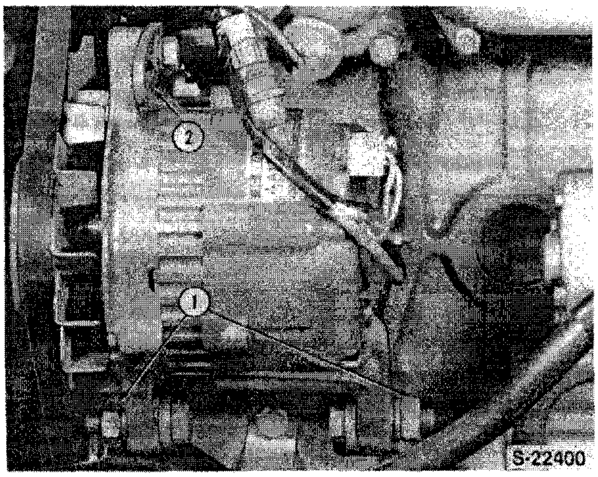

Figure 97
Drive Belt Removal — (Model 1320/1520 shown)
1. Alternator Mounting Bolts
2. Adjusting Bracket

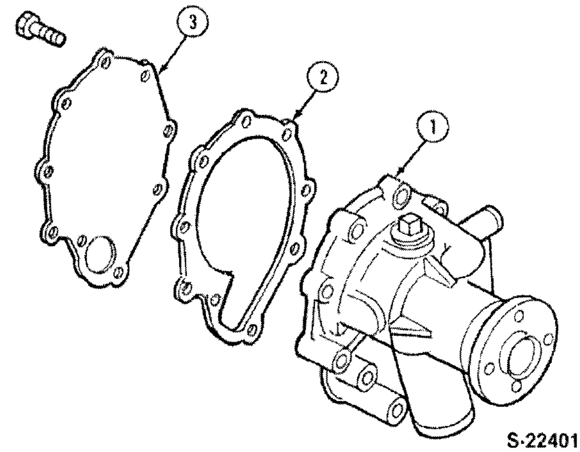

Figure 98
Water Pump and Thermostat Removal
1. Water Pump
2. Gasket
3. Mounting Plate

THERMOSTAT

REMOVAL

1. Remove the radiator cap.
2. Open the radiator drain, Figure 92, and collect the coolant in a clean container.
3. Remove the radiator hose and by-pass hose from thermostat housing, Figure 100.
4. Remove the thermostat housing, thermostat spring and gasket, Figure 101.

INSPECTION AND REPAIR

Place the thermostat in a container filled with a 50/50 mixture of antifreeze and water. Insulate the thermostat from the bottom of the container. Heat the container. Place a high temperature thermometer in the coolant mixture. Use a .003 in. (.07 mm) feeler gauge to determine when the thermostat begins to open, Figure 102.

Note the coolant temperature at which the thermostat starts to open and when it is fully opened.

Thermostat opening temperature:
Start to open . . . . 160°F (71°C)
Fully open . . . . 180°F (82°C)

Replace the thermostat if it fails to open at the specified temperature.

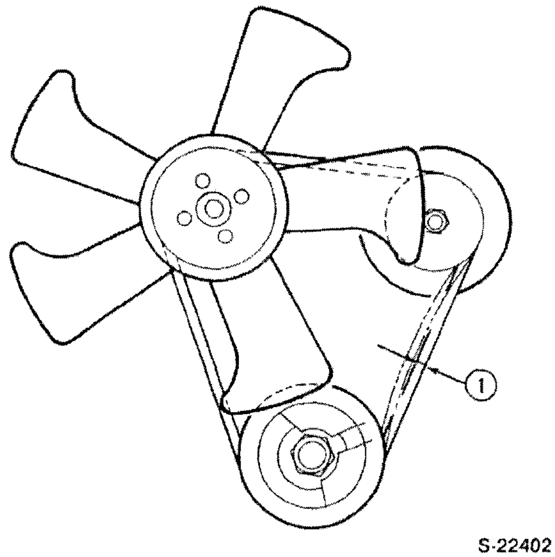

Figure 99
Drive Belt Adjustment
1. Belt Deflection — 0.200 in. (5 mm)

INSTALLATION

Clean the gasket surfaces and install new gaskets as required.

Installation of the thermostat generally follows the removal procedure in reverse.

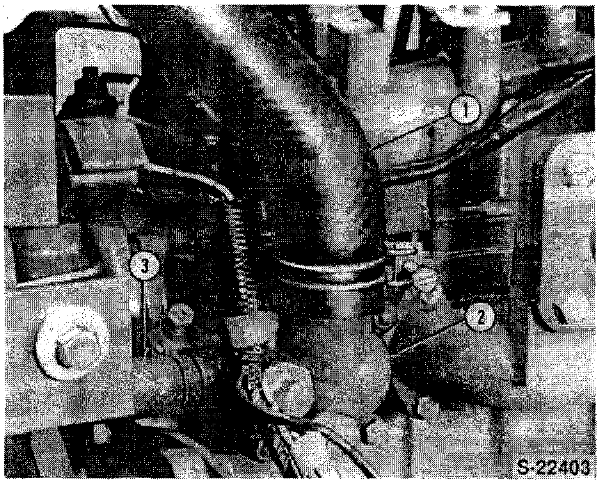

Figure 100
Thermostat Housing Removal
1. Upper Radiator Hose
2. Thermostat Housing
3. By-Pass Hose

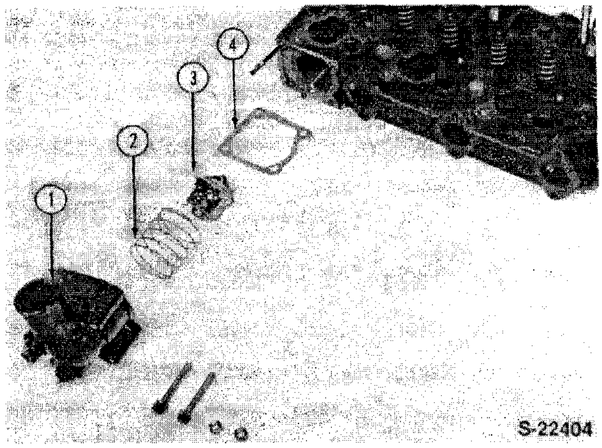

Figure 101
Thermostat Removal
1. Thermostat Housing
2. Spring
3. Thermostat
4. Gasket

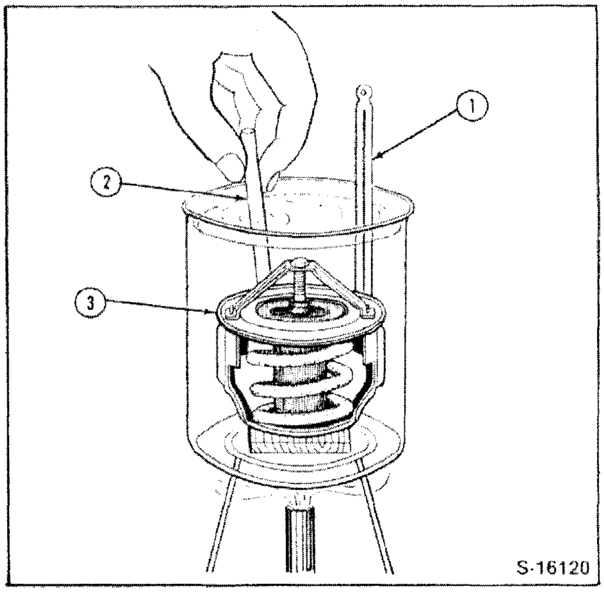

Figure 102
Checking Thermostat Operation
1. Thermometer
2. Feeler Gauge
3. Thermostat

NOTE: *Adjust the alternator belt adjustment to obtain .200 in. (5 mm) deflection with a force of 2.2 lbs (1 kg), Figure 99.*

Fill the radiator to the proper level with the correct grade and quantity of antifreeze mixture.

Start the engine and run for several minutes and check for coolant leaks.

PART 1
ENGINE SYSTEMS
MODELS 1320-1520-1720

Chapter 3
TROUBLE SHOOTING, SPECIFICATIONS AND SPECIAL TOOLS

A. TROUBLE SHOOTING

ENGINE

CONDITION	POSSIBLE CAUSES
Engine Does Not Develop Full Power	1. Clogged air cleaner. 2. Fuel line obstructed. 3. Improper injection timing. 4. Improper nozzle injection pressure and angle. 5. Low cylinder compression. 6. Insufficient fuel injection. 7. Improper valve lash adjustment. 8. Burned, worn or sticking valves. 9. Blown head gasket. 10. Worn or sticking piston rings. 11. Faulty engine stop solenoid.
Engine Will Not Stop	1. Faulty engine stop solenoid. 2. Faulty starter switch.
Low Cylinder Compression	1. Burned, worn or sticking valves. 2. Bent valve stem. 3. Broken or weak valve spring. 4. Blown cylinder head gasket. 5. Worn or sticking piston ring. 6. Scored piston.
Poor Engine Idling	1. Improper injection timing. 2. Air in injection pump. 3. Improper governor adjustment.

A. TROUBLE SHOOTING (continued)

ENGINE (continued)

CONDITION	POSSIBLE CAUSES
Engine Knocks	1. Diluted or thin oil. 2. Insufficient oil supply. 3. Low oil pressure. 4. Worn crankshaft thrust bearing. 5. Excessive flywheel runout. 6. Excessive connecting rod or main bearing clearance. 7. Seized bearing. 8. Clogged oil passages. 9. Bent or twisted connecting rod. 10. Crankshaft journals out-of-round. 11. Excessive piston-to-cylinder bore clearance. 12. Excessive piston ring side clearance. 13. Broken or damaged rings. 14. Excessive piston pin clearance. 15. Seized piston. 16. Piston pin retainer loose or missing. 17. Improper valve lash adjustment. 18. Worn valve lifter. 19. Excessive timing gear backlash.
Low Oil Pressure	1. Engine oil level low. 2. Wrong grade of oil. 3. Clogged oil pump filter. 4. Faulty oil pressure relief valve. 5. Worn oil pump drive shaft or gears, or broken oil pipe. 6. Excessive main or connecting rod bearing clearances.
Oil Pressure Warning Light Fails to Operate	1. Bulb burned out. 2. Oil pressure sensor is faulty. 3. Warning light circuit faulty.
Excessive Oil Consumption	1. Engine oil level too high. 2. Leakage in the cylinder head gasket. 3. Oil loss past the pistons and rings. 4. Worn, broken or sticking piston rings. 5. Clogged return hole of oil ring. 6. Worn valves and/or valve guides or worn seals. 7. Leakage past oil seals and gaskets. 8. External oil leaks from the engine.
Engine Overheats	1. Insufficient amount of coolant in the radiator. 2. Hose connection leaking or collapsed hose. 3. Radiator leakage. 4. Loose, worn, or broken V-belt. 5. Radiator fins bent or clogged. 6. Radiator cap not sealing. 7. Thermostat operating improperly. 8. Insufficient amount of engine oil. 9. Water pump operating improperly. 10. Improper valve clearance. 11. Restriction in the exhaust system. 12. Improperly installed cylinder head gasket. 13. Rust and/or scale clogged water ports. 14. Extended engine idling.

A. TROUBLE SHOOTING (continued)

ENGINE (continued)

CONDITION	POSSIBLE CAUSES
Excessive Fuel Consumption	1. Improper injection timing. 2. Leakage at the injection pipe connectors. 3. Leakage at the fuel shut-off valve. 4. Improperly adjusted nozzle.
Temperature Gauge Fails to Reach Normal Operating Temperature	1. Faulty temperature sender. 2. Faulty thermostat. 3. Faulty temperature gauge.
Excessive Exhaust Smoke	1. Air cleaner dirty or restricted. 2. Excessive fuel delivery.
Engine Does Not Start	1. Faulty starter switch. 2. Insufficient charging or complete discharging of the battery. 3. Lack of fuel. 4. Air mixed in the fuel system. 5. Clogged fuel filter. 6. Irregular or faulty fuel supply. 7. Glow plug not heating. 8. Improper lubricating oil viscosity. 9. Clogged air cleaner. 10. Faulty engine stop solenoid. 11. Disconnected or shorted engine stop solenoid wiring. 12. Burned out fuse.
Engine Stops While Operating	1. Lack of fuel in the fuel tank. 2. Clogged fuel filter. 3. Air mixed in the fuel system. 4. Faulty component. 5. Shorted engine stop solenoid wiring. 6. Burned out fuse.
Undesirable Exhaust (white or pale)	1. Excess engine oil. 2. Improper lubricating oil viscosity. 3. Faulty injection timing.
Undesirable Exhaust Color (black or light grey)	1. Unsuitable fuel. 2. Excess injection. 3. Faulty engine component. 4. Over loading. 5. Clogged air cleaner.

A. TROUBLE SHOOTING (continued)

COOLING SYSTEM

CONDITION	POSSIBLE CAUSES
High Temperature Indication — Overheating	1. Coolant level low. 2. Fan belt loose. 3. Radiator hose(s) collapsed. 4. Radiator blocked to airflow. 5. Faulty radiator cap. 6. Tractor overloaded. 7. Idle speed low. 8. Air trapped in cooling system. 9. Incorrect cooling system component(s) installed. 10. Faulty thermostat. 11. Water pump shaft broken or impeller loose. 12. Radiator tubes clogged. 13. Cooling system clogged. 14. Casting flash in cooling passages. 15. Brakes dragging. 16. Excessive engine friction. 17. Antifreeze concentration too high (Over 68%) 18. Missing air seals. 19. Faulty gauge or sending unit. 20. Loss of coolant flow caused by leakage or foaming.
Low Temperature Indication —	1. Thermostat stuck open. 2. Faulty gauge or sending unit.

NOTE: *Immediately after shutdown, the engine enters a condition known as heat soak. This is caused by the cooling system being inoperative while engine temperature is still high. If coolant temperature rises above boiling point, expansion and pressure may push some coolant out of the radiator overflow tube. If this does not occur frequently, it is considered normal.*

CONDITION	POSSIBLE CAUSES
Coolant Loss — Boil-Over	**Refer to Overheating Causes in addition to the following:** 1. Overfilled cooling system. 2. Quick shutdown after hard (hot) run. 3. Air in system resulting in occasional "burping" of coolant. 4. Insufficient antifreeze in mixture allowing coolant boiling point to be too low. 5. Antifreeze deteriorated because of age or contamination. 6. Leaks due to loose hose clamps, loose nuts, bolts, drain valve, faulty hoses, or defective radiator. 7. Faulty head gasket. 8. Cracked head, manifold or block.
Coolant Entry Into Crankcase or Cylinder	1. Faulty head gasket. 2. Crack in head, manifold or block.
Noise	1. Fan contacting shroud. 2. Loose water pump impeller. 3. Glazed fan belt. 4. Loose fan belt. 5. Rough surface on drive pulley. 6. Water pump bearing worn. 7. Belt alignment.
Temperature Lamp On or Gauge Reads Hot, but Temperature is OK	1. Wrong sending unit. 2. Sending wire shorted to ground.

B. SPECIFICATIONS

GENERAL SPECIFICATIONS

Tractor Model	1320	1520	1720
Engine Model	J823	J843	N843
Number of Cylinders	3	3	3
Bore x Stroke	3.22 x 3.15 in. (82 x 80 mm)	3.31 x 3.15 in. (84 x 80 mm)	3.31 x 3.54 in. (84 x 90 mm)
Displacement	77.2 cu. in.	81.1 cu. in.	91.2 cu. in.
Compression Ratio	22:1	22:1	22.5:1
Rated Speed (rpm)	2500	2500	2500
Muffler	Vertical	Vertical	Vertical
Firing Order	1-2-3	1-2-3	1-2-3
Idle Speed	850 ± 50 rpm	850 ± 50 rpm	850 rpm
Maximum No Load Speed	2650 ± 50 rpm	2650 ± 50 rpm	2700 rpm
Cylinder Arrangement	In-line Vertical	In-line Vertical	In-line Vertical
Valve Arrangement	Overhead	Overhead	Overhead

CYLINDER BLOCK

	1320	1520	1720
Bore			
Standard	3.228-3.229 in. (82-82.019 mm)	3.307-3.308 in. (84-84.019 mm)	3.307-3.308 in. (84.0-84.019 mm)
Maximum	3.276 in. (83.2 mm)	3.354 in. (85.2 mm)	3.354 in. (85.2 mm)
Head Surface Warp			
Standard	.002 in. (.05 mm)	.002 in. (.05 mm)	.002 in. (.05 mm)
Maximum	.005 in. (.12 mm)	.005 in. (.12 mm)	.005 in. (.12 mm)
Re-Bore Size			
.020 oversize	3.236-3.256 in.	3.315-3.334 in.	3.327-3.328 in.
.5 mm	(82.2-82.7 mm)	(84.2-84.7 mm)	(84.5-84.519 mm)
.040 oversize	3.256-3.276 in.	3.334-3.354 in.	3.346-3.347 in.
1.0 mm	(82.7-83.2 mm)	(84.7-85.2 mm)	(85.0-85.019 mm)

CYLINDER HEAD

	1320	1520	1720
Head Warp			
Standard	.002 in. (.05 mm)	.002 in. (.05 mm)	.002 in. (.05 mm)
Maximum	.005 in. (.12 mm)	.005 in. (.12 mm)	.005 in. (.12 mm)
Valve Seat Width			
Standard	0.063-0.071 in. (1.6-1.8 mm)	0.063-0.071 in. (1.6-1.8 mm)	.063-.071 in. (1.6-1.8 mm)
Maximum	.098 in. (2.5 mm)	.098 in. (2.5 mm)	.1 in. 2.5 mm)
Valve Seat Sink			
Standard	.0334-.0453 in. (0.85-1.15 mm)	.0334-.0453 in. (0.85-1.15 mm)	.0334-.0453 in. (.85-1.15 mm)
Maximum	.071 in. (1.8 mm)	.071 in. (1.8 mm)	0.071 in. (1.8 mm)
Valve Angle	45°	45°	45°

B. SPECIFICATIONS (continued)

PISTON	**1320**	**1520**	**1720**
Diameter			
Standard	3.225-3.226 in. (81.913-81.928 mm)	3.303 in. (83.913-83.928 mm)	3.3050-3.3056 in. (83.948-83.963 mm)
Minimum	3.216 in. (81.7 mm)	3.295 in. (83.7 mm)	3.2953 in. (83.7 mm)
Bore Clearance			
Standard	0.0034-0.0041 in. (0.088-0.106 mm)	0.0034-0.0041 in. (0.088-0.106 mm)	.0015-.0025 in. (.038-.064 mm)
Maximum	0.0118 in. (0.3 mm)	0.0118 in. (0.3 mm)	.984 in. (.25 mm)
Piston Pin Bore			
Standard	0.984-0.9843 in. (24.999-25.003 mm)	0.984-0.9843 in. (24.99925.003 mm)	1.1023-1.1025 in. (27.999-28.003 mm)
Maximum	.0985 in. (25.0 mm)	.0985 in. (25.0 mm)	1.1031 in. (28.02 mm)
Piston Pin Clearance			
Standard	0-0.0002 in. (−0.001 + 0.007 mm)	0.0-0.0002 in. (−0.001 + 0.007 mm)	-0.00008 + 0.0003 in. (-0.002 + 0.008 mm)
Maximum	0.0008 in. (0.02 mm)	0.0008 in. (0.02 mm)	0.0008 in. (0.02 mm)
Available Oversizes		0.020 in. & 0.040 in. (0.5 mm & 1.0 mm)	

PISTON PIN	**1320**	**1520**	**1720**
Diameter			
Standard	0.984-0.9843 in. (24.996-25.0 mm)	0.984-0.9843 in. (24.996-25.0 mm)	1.1022-1.1024 in. (27.996-28.0 mm)
Maximum	0.9834 in. (24.98 mm)	0.9834 in. (24.98 mm)	1.1012 in. (27.98 mm)
Pin-to-Bushing Clearance			
Standard	0.00039-0.00098 in. (0.01-0.025 mm)	0.0004-0.001 in. (0.01-0.25 mm)	.0004-.0010 in. (.01-.025 mm)
Maximum	0.0031 in. (0.08)	0.0031 in. (0.08 mm)	.0032 in. (.08 mm)

PISTON RING	**1320**	**1520**	**1720**
End Gap			
1st Compression			
Standard	.008-.014 in. (0.20-0.35 mm)	.008-0.014 (0.2-0.35 mm)	.008-.014 in. (.2-.35 mm)
Maximum	0.03937 in. (1.0 mm)	0.03937 in. (1.0 mm)	.039 in. (1.0 mm)
2nd Compression			
Standard	0.008-0.016 in. (0.20-0.40 mm)	0.008-0.016 in. (0.20-0.40 mm)	.008-.016 in. (.2-.4mm)
Maximum	0.03937 in. (1.0 mm)	0.0397 in. (1.0 mm)	.039 in. (1.0 mm)
Oil			
Standard	0.008-0.016 in. (0.20-0.40 mm)	0.008-0.016 in. (0.20-0.40 mm)	.008-.016 in. (.2-.4 mm)
Maximum	0.03937 in. (1.0 mm)	0.03937 in. (1.0 mm)	.039 in. (1.0 mm)

B. SPECIFICATIONS (continued)

PISTON RING

	1320	1520	1720
Compression Ring to Groove Side Clearance			
1st Compression			
Standard	0.0027-0.0043 in. (0.07-0.11 mm)	0.0027-0.0043 in. (0.07-0.11 mm)	.0028-.0043 in. (.07-.11 mm)
Maximum	0.010 in. (0.25 mm)	0.010 in. (0.25 mm)	.010 in. (.25 mm)
2nd Compression			
Standard	0.0015-0.0031 in. (0.04-0.08 mm)	0.0015-0.0031 in. (0.04-0.08 mm)	.0016-.0031 in. (.04-.08 mm)
Maximum	.010 in. (0.25 mm)	0.010 in. (0.25 mm)	.010 in. (.25 mm)
Oil Ring to Groove Side Clearance			
Standard	.0008-.0024 in. (0.02-0.06 mm)	0.0008-0.0024 in. (0.02-0.06 mm)	.0008-.002 in. (.002-.06 mm)
Maximum	.006 in. (0.15 mm)	0.006 in. (0.15 mm)	.006 in. (.15 mm)
Ring Width			
1st Compression	.079 in. (2.0 mm)	0.079 in. (2.0 mm)	.077-.078 in. (1.97-1.99 mm)
2nd Compression	.059 in. (1.5 mm)	0.059 in. (1.5 mm)	.058-.059 in. (1.47-1.49 mm)
Oil	.157 in. (4.0 mm)	0.157 in. (4.0 mm)	.156-.157 in. 3.97-3.99 mm)

CONNECTING ROD	1320	1520	1720
Rod Twist			
Standard	.003 in. (.08 mm)	.003 in. (.08 mm)	.003 in. (.08 mm)
Maximum	.008 in. (.2 mm)	.008 in. (.2 mm)	.008 in. (.2 mm)
Rod Bend			
Standard	.0020 in. (.05 mm)	.0020 in. (.05 mm)	.002 in. (.05 mm)
Maximum	.0059 in. (.15 mm)	.0060 in. (.15 mm)	.006 in. (.15 mm)
Connecting Rod Side Play			
Standard	.004-.012 in. (.1-.3 mm)	.004-.012 in. (.1-.3 mm)	.004-.012 in. (.1-.3 mm)
Maximum	.028 in. (.7 mm)	.028 in. (.7 mm)	.028 in. (.7 mm)
Crankshaft Bearing Clearance			
Standard	.001-.003 in. (.035-.083 mm)	.001-.003 in. (.035-.085 mm)	.001-.003 in. (.035-.083 mm)
Maximum	.008 in. (.2 mm)	.008 in. (.2 mm)	.008 in. (.2 mm)

B. SPECIFICATIONS (continued)

CRANKSHAFT	1320	1520	1720
Journal Diameter			
Standard	2.281-2.282 in.	2.281-2.282 in.	2.675-2.6759 in.
	(57.957-57.97 mm)	(57.957-57.97 mm)	(67.951-67.97 mm)
Minimum	2.259 in.	2.259 in.	2.654 in.
	(57.4 mm)	(57.4 mm)	(67.4 mm)
Crankpin Diameter			
Standard	1.730-1.731 in.	1.730-1.731 in.	2.0458-2.0463 in.
	(43.964-43.975 mm)	(43.96-43.97 mm)	(51.964-51.975 mm)
Minimum	1.708 in.	1.708 in.	2.0236 in.
	(43.4 mm)	(43.4 mm)	(51.4 mm)
Runout			
Standard	.0012 in.	.0012 in.	.0008 in.
	(.03 mm)	(.03 mm)	(.02 mm)
Maximum	.0023 in.	.0024 in.	.002 in.
	(.06 mm)	(.06 mm)	(.05 mm)
Endplay			
Standard	.0039-.016 in.	.004-0.016 in.	.004-.016 in.
	(0.1-0.4 mm)	(0.1-0.4 mm)	(.1-.4 mm)
Maximum	.019 in.	0.019 in.	.020 in.
	(0.5 mm)	(0.5 mm)	(.5 mm)
Thrust Washer Thickness			
Standard	.116-.118 in.	.116-.118 in.	.116-.118 in.
	(2.95-3.0 mm)	(2.95-3.0 mm)	(2.95-3.00 mm)
Minimum	.110 in.	.110 in.	.110 in.
	(2.8 mm)	(2.8 mm)	(2.8 mm)
Front Main Bearing Diameter			
Standard — ID x OD	2.283 x 2.441 in.	2.283 x 2.441 in.	2.677-2.835 in.
	(58 x 62 mm)	(58 x 62 mm)	(68-72 mm)
Maximum — ID	2.289 in.	2.289 in.	2.683 in.
	(58.14 mm)	58.14 mm)	(68.15 mm)
Journal to Cylinder Block Bearing Clearance			
Standard	.0017-.0045 in.	.0017-.0045 in.	.0017-.0045 in.
	(.044-.116 mm)		(.044-.116 mm)
Maximum	.008 in.	.008 in.	.008 in.
	(.2 mm)	(.2 mm)	(.2 mm)
Main Journal Regrind Size			
.010 undersize	2.271-2.272 in.	2.271-2.272 in.	2.665-2.666 in.
(.25 mm)	(57.707-57.720 mm)	(57.707-57.720 mm)	(67.707-67.720mm)
.020 undersize	2.262-2.263 in.	2.262-2.263 in.	2.656-2.656 in.
	(57.457-57.470 mm)	(57.457-57.470 mm)	(67.457-67.470mm)
Crankpin Regrind Size			
.010 undersize	1.721-1.722 in.	1.721-1.722 in.	2.036-2.037 in.
(.25 mm)	(43.714-43.725 mm)	(43.714-43.725 mm)	(51.714-51.725mm)
.020 undersize	1.711-1.712 in.	1.711-1.712 in.	2.026-2.027 in.
(.50 mm)	(43.464-43.475 mm)	(43.464-43.475 mm)	(51.464-51.475 mm)
Center Bearing to Crankshaft Clearance			
Standard	.0017-.0040 in.	0.0017-.004 in.	.0017-.0040 in.
	(0.044-0.102 mm)	(0.044-0.102 mm)	(.044-.0102 mm)
Maximum	.0079 in.	.0079 in.	0079 in.
	(0.2 mm)	(0.2 mm)	(0.2 mm)

B. SPECIFICATIONS (continued)

CAMSHAFT	1320	1520	1720
Cam Height-Valve			
Standard	1.341-1.343 in. (34.065-34.12 mm)	1.341-1.343 in. (34.065-34.12 mm)	1.3411-1.3433 in. (34.065-34.12 mm)
Minimum	1.327 in. (33.7 mm)	1.327 in. (33.7 mm)	1.3268 in. (33.7 mm)
Bend			
Standard	.001 in. (.03 mm)	.001 in. (.03 mm)	.001 in. (.03 mm)
Maximum	.004 in. (.1 mm)	.004 in. (.1 mm)	.004 in. (.1 mm)
Cam Height-Fuel			
Standard	1.651-1.656 in. (41.94-42.06 mm)	1.651-1.656 in. (41.94-42.06 mm)	1.651-1.656 in. (41.94-42.06 mm)
Minimum	1.646 in. (41.8 mm)	1.646 in. (41.8 mm)	1.646 in. (41.8 mm)

VALVES	1320	1520	1720
Stem Diameter — Intake			
Standard	.2738-.2744 in. (6.955-6.97 mm)	.2738-.2744 in. (6.955-6.97 mm)	.2738-.2744 in. (6.955-6.97 mm)
Minimum	.271 in. (6.89 mm)	.271 in. (6.89 mm)	.271 in. (6.89 mm)
Stem Diameter — Exhaust			
Standard	.273-.274 in. (6.94-6.95 mm)	.273-.274 in. (6.94-6.95 mm)	.273-.274 in. (6.94-6.95 mm)
Minimum	.269 in. (6.84 mm)	.269 in. (6.84 mm)	.269 in. (6.84 mm)
Guide Clearance — Intake			
Standard	.001-.002 in. (.03-.06 mm)	.001-.002 in. (.03-.06 mm)	.001-.002 in. (.03-.06 mm)
Maximum	.008 in. (.2 mm)	.008 in. (.2 mm)	.008 in. (.2 mm)
Guide Clearance — Exhaust			
Standard	.002.003 in. (.04-.065 mm)	.002.003 in. (.04-.065 mm)	.002.003 in. (.05-.075 mm)
Maximum	(.010 in. (.25 mm)	.010 in. (.25 mm)	.010 in. (.25 mm)
Valve Margin			
Standard	.0364-.0423 in. (0.925-1.075 mm)	0.0364-.0423 in. (0.925-1.075 mm)	.0364-.0423 in. (.925-1.075 mm)
Maximum	.0197 in. (0.5 mm)	.0197 in. (0.5 mm)	.020 in. (.5 mm)
Valve Lash	0.008 in. (0.2 mm)	0.008 in. (0.2 mm)	.008 in. (.2 mm)
Valve Spring — Free Height			
Standard	1.378 in. (35 mm)	1.378 in. (35 mm)	1.378 in. (35 mm)
Minimum	1.319 in. (33.5 mm)	1.319 in. (33.5 mm)	1.319 in. (33.5 mm)

B. SPECIFICATIONS (continued)

VALVES (continued)

Valve Spring — Squareness			
Standard	.047 in.	.047 in.	.047 in.
	(1.2 mm)	(1.2 mm)	(1.2 mm)
Maximum	.079 in.	.079 in.	.079 in.
	(2.0 mm)	(2.0 mm)	(2.0 mm)
Valve Spring — Compressed Height			
Standard	17.86 lbs.	17.86 lbs.	17.857 lbs.
	(8.1)@30.4 mm	(8.1 kg)@30.4 mm	(8.1 kg)@30.4 mm
Maximum	15.43 lbs.	15.43 lbs.	15.432 lbs.
	(7 kg)@30.4 mm	(7 kg)@30.4 mm	(7 kg)@30.4 mm
Valve Timing — Intake			
Open Before TDC	10°	10°	16°
Close After BDC	46°	46°	40°
Valve Timing — Exhaust			
Open Before TDC	46°	46°	46°
Close After BDC	16°	16°	10°

PUSH RODS	1320	1520	1720
Length	6.854-6.870 in.	6.854-6.870 in.	7.7086-7.7244 in.
	(174.1-174.5 mm)	(174.1-174.5 mm)	(195.8-196.2 mm)
Diameter	.248 in.	.248 in.	.248 in.
	(6.3 mm)	(6.3 mm)	(6.3 mm)

ROCKER ARM	1320	1520	1720
Shaft Diameter			
Standard	.4587-.4594 in.	.4587-.4594 in.	.459-.4594 in.
	(11.65-11.668 mm)	(11.65-11.668 mm)	(11.65-11.67 mm)
Minimum	.456 in.	.456 in.	.456 in.
	(11.57 mm)	(11.57 mm)	(11.57 mm)
Shaft to Rocker Clearance			
Standard	.00126-.00268 in.	.0013-.0027 in.	.0013-.0027 in.
	(0.032-0.068 mm)	(0.032-0.068 mm)	(.032-.068 mm)
Maximum	.008 in.	.008 in.	.008 in.
	(.2 mm)	(.2 mm)	(.2 mm)

LUBRICATION SYSTEM	1320	1520	1720
Pressure Relief Valve			
Opening Pressure	35-50 psi	35-50 psi	35-50 psi
	(2.4-3.4 bar)	(2.4-3.4 bar)	(2.4-3.4 bar)
Rotor to Vane Clearance			
Standard	.0004-.006 in.	.0004-.006 in.	.0004-.006 in.
	(.01-.15 mm)	(.01-.15 mm)	(.01-.15 mm)
Maximum	.010 in.	.010 in.	.010 in.
	(.25 mm)	(.25 mm)	(.25 mm)
Rotor to Cover Clearance			
Standard	.004-.006 in.	.004-.006 in.	.004-.006 in.
	(0.1-0.15 mm)	(0.1-0.15 mm)	(.1-.15 mm)
Maximum	.008 in.	.008 in.	.008 in.
	(.20 mm)	(.20 mm)	(.20 mm)
Rotor to Case Clearance			
Standard	.006-.009 in.	.006-.009 in.	.006-.009 in.
	(.14-.22 mm)	.14-.22 mm)	(.14-.22 mm)
Maximum	.012 in.	.012 in.	.012 in.
	(.30 mm)	(.30 mm)	(.30 mm)

B. SPECIFICATIONS (continued)

COOLING SYSTEM

Type of system	**Pressurized liquid w/recirculating by-pass**
Water Pump:	
Type	Centrifugal
Drive	V-belt
Belt Deflection (Tension)	7/16 to 9/16 inch (10 to 15 mm) when 20-25 lbs. (9-11 kg) is applied midway between pulleys
Fan Diameter	13.39 in. (340 mm)
Thermostat	
Starts to Open	160ºF. (71ºC.)
Fully Open	185ºF. (85º.)
Radiator Cap Pressure Rating	13 psi (0.9 bar)
Coolant	Ethylene glycol and water in a 50/50 mixture.
Capacity	Liters Qts. U.S. Qts. Imp. 5.6 5.9 4.9

BOLT TORQUE VALUES

Description	1320/1520/1720
Connecting Rod Caps	36.2-39.8 lbs. ft. (49.0-53.9 Nm)
Flywheel Bolts	43.4-50.6 lbs. ft. (59.0-69.0 Nm)
Main Bearing Holders	36.2-39.8 lbs. ft. (49.0-53.9 Nm)
Bearing Holder Retaining Bolts	36.2-39.8 lbs. ft. (49.0-53.9 Nm)
Rear Bearing Cover Plate Retaining Bolts	9.4-12.3 lbs. ft. (12.7-16.7 Nm)
Tachometer Drive Shaft Plate	6.5-9.4 lbs. ft. (8.8-12.7 Nm)
Crankshaft Pulley Nut	202.5-245.9 lbs. ft. (274.4-333.2 Nm)
Oil Pump Relief Valve	43.4-50.6 lbs. ft. (58.8-68.6 Nm)
Front Mounting Bolts	3.62-5.06 lbs. ft. (4.9-6.86 Nm)
Injection Pump Delivery Valve Holder	28.9-32.5 lbs. ft. (39.2-44.1 Nm)
Engine Oil Transfer Tube Banjo Bolts	7.2-9.4 lbs. ft. (9.8-12.7 Nm)
Head Bolts	65.1-68.7 lbs. ft. (88-94 Nm)

METRIC BOLT TORQUE SPECIFICATIONS

Bolt Size	Grade No.	Coarse Thread			Fine Thread		
		Pitch (mm)	Pounds-Feet	Newton-Meters	Pitch (mm)	Pounds-Feet	Newton-Meters
M6	4T	1.0	3.6– 5.1	4.9– 6.9	–	–	–
	7T		6.1– 8.3	8.3– 11.3			
	10T		8.7– 11.6	11.8– 15.7			
M8	4T	1.25	9.4– 12.3	12.7– 16.7	1.0	11.2– 14.8	15.2– 20.1
	7T		16.6– 21.0	22.6– 28.4		19.5– 25.3	26.5– 34.3
	10T		21.0– 26.8	28.4– 36.3		22.4– 29.7	30.4– 40.2
M10	4T	1.5	18.8– 24.6	25.5– 33.3	1.25	21.0– 26.8	28.4– 36.3
	7T		32.5– 41.2	44.1– 55.9		36.2– 46.3	49.0– 62.8
	10T		39.8– 51.4	53.9– 69.6		42.7– 54.2	57.9– 73.5
M12	4T	1.75	27.5– 34.7	37.3– 47.1	1.25	31.8– 40.5	43.1– 54.9
	7T		48.5– 61.5	65.7– 83.4		55.0– 69.4	74.5– 94.1
	10T		68.0– 85.4	92.2–116		73.1– 93.3	99.0–127
M14	4T	2.0	46.3– 59.3	62.8– 80.4	1.5	51.4– 64.4	69.6– 87.3
	7T		76.7– 96.9	104 –131		86.1–109	117 –148
	11T		102 –129	139 –175		108 –137	147 –186
M16	4T	2.0	63.6– 81.0	86.3–110	1.5	67.3– 84.6	91.2–115
	7T		110 –136	149 –184		116 –142	157 –192
	11T		152 –188	206 –255		163 –199	221 –270
M18	4T	2.0	83.9–104	114 –141	1.5	96.9–120	131 –163
	7T		145 –174	196 –235		170 –206	230 –279
	11T		203 –246	275 –333		221 –271	299 –368
M20	4T	2.5	106 –132	144 –179	1.5	127 –156	172 –211
	7T		177 –213	240 –289		203 –246	275 –333
	11T		268 –325	363 –441		293 –358	397 –485

C. SPECIAL TOOLS

	Tool No.
Seal Protector — Timing Gear Cover — Crankshaft	1584
Driver — Piston Pin	1585
Valve Guide Seal — Installer	1587
Socket — 27 mm Special Injector Socket	1588
Adaptor — Compression Test	FNH 00120
Driver Handle — Use With Tools 1585 & 1587	7778
Dial Indicator — (Magnetic Base)	1345
Micrometer	0-1 inch
Micrometer	1-2 inch
Micrometer	2-3 inch
Small Hole Gauge	3/4-1 inch
Cylinder Bore Gauge	2-3 inch
Cylinder Bore Gauge	1-2 inch

D. COMPRESSION TEST AND TOOLS

ENGINE COMPRESSION TEST

Compression test tool kit, Figure 103, is available for testing all 20 Series Tractors. The compression test on all tractors is performed through the glow plug ports. The test adaptor tool is equipped with quick coupler ends for easy installation of the hose and gauge.

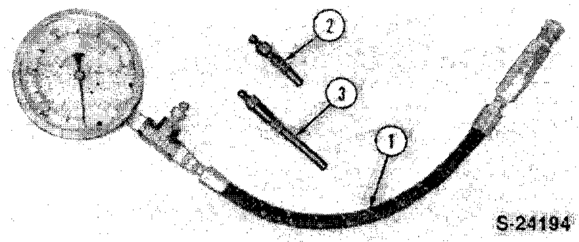

Figure 103
Compression Test Kit

1. Hose, Gauge, Check Valve, Relief Valve and Quick Coupler
2. Adaptor Tool FNH 00120 (1120-1720 Tractors)
3. Adaptor Tool FNH 00121 (1920-2120 Tractors)

The procedures to perform a compression test are as follows:

1. Remove the wire (1), Figure 104, from the fuel pump solenoid.
2. Remove the glow plug electrical wire and wire connectors from the top of the glow plugs.
3. Remove all the glow plugs.

IMPORTANT: *Be sure all the glow plugs are removed before starting the compression tests.*

4. Install the adapter (2), hose and gauge assembly (3) in each port and crank the engine. The gauge should read 427 ± 50 lbs.

   NOTE: *There should not be more than 50 lbs. variation between cylinders.*

5. To install the adaptor tool in all the glow plug ports, it may be necessary to remove some injector fuel lines.

After performing the compression tests, install the glow plugs and electrical connections in reverse order of removal.

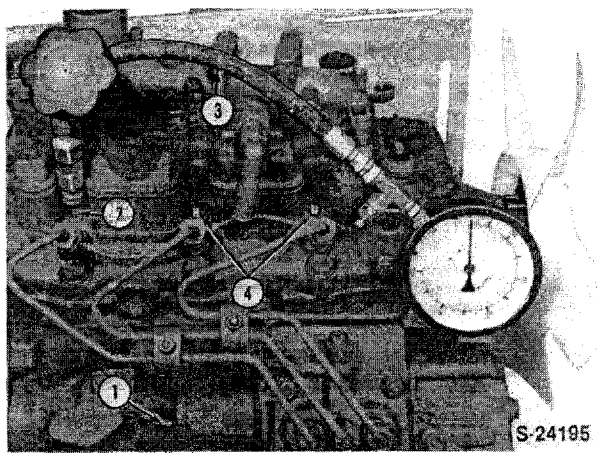

Figure 104
Compression Tools Installed

1. Electrical Wire — Solenoid Removed
2. Adaptor Tool FNH 00120
3. Hose and Gauge Installed
4. Glow Plug Ports (Open)

PART 2
FUEL SYSTEM

Chapter 1
INJECTION PUMP

Chapter 2
INJECTORS

Chapter 3
TROUBLE SHOOTING, SPECIFICATIONS AND SPECIAL TOOLS

PART 2
FUEL SYSTEM

Chapter 1
INJECTION PUMP

A. DESCRIPTION AND OPERATION

The fuel injection pump, Figure 1, is a constant stroke type pump and has one pumping element for each cylinder. The injection pump operates at one-half engine speed.

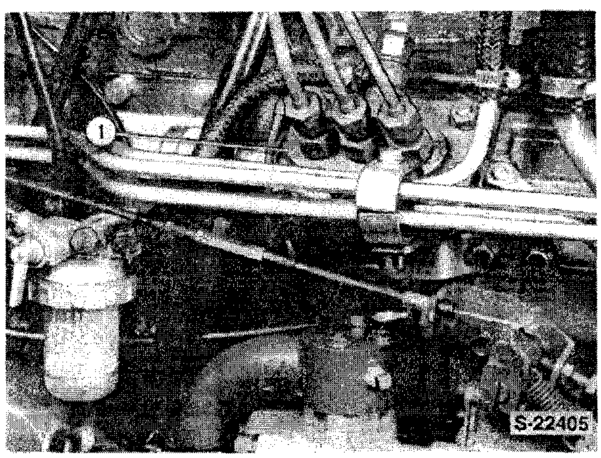

Figure 1
Injection Pump
1. Injection Pump

The pumping elements are operated by cam lobes that are incorporated on the engine valve train camshaft, Figure 2, which is driven by the engine oil pump gear.

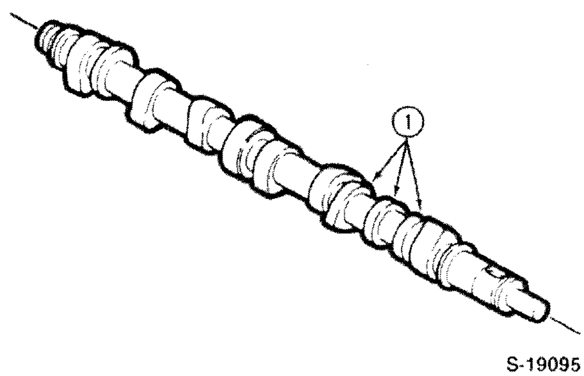

Figure 2
Engine Camshaft
1. Injection Pump Cam Lobes

PUMPING ELEMENTS

The pumping elements, Figure 3, accurately meter and deliver the fuel to the injectors.

Each of the pumping elements consist of a barrel and plunger lapped together to give an accurate fit. Two diametrically opposed drillings in the barrel form fuel inlets and the barrel is splined, with a master spline, for correct location within the pump body, Figure 3.

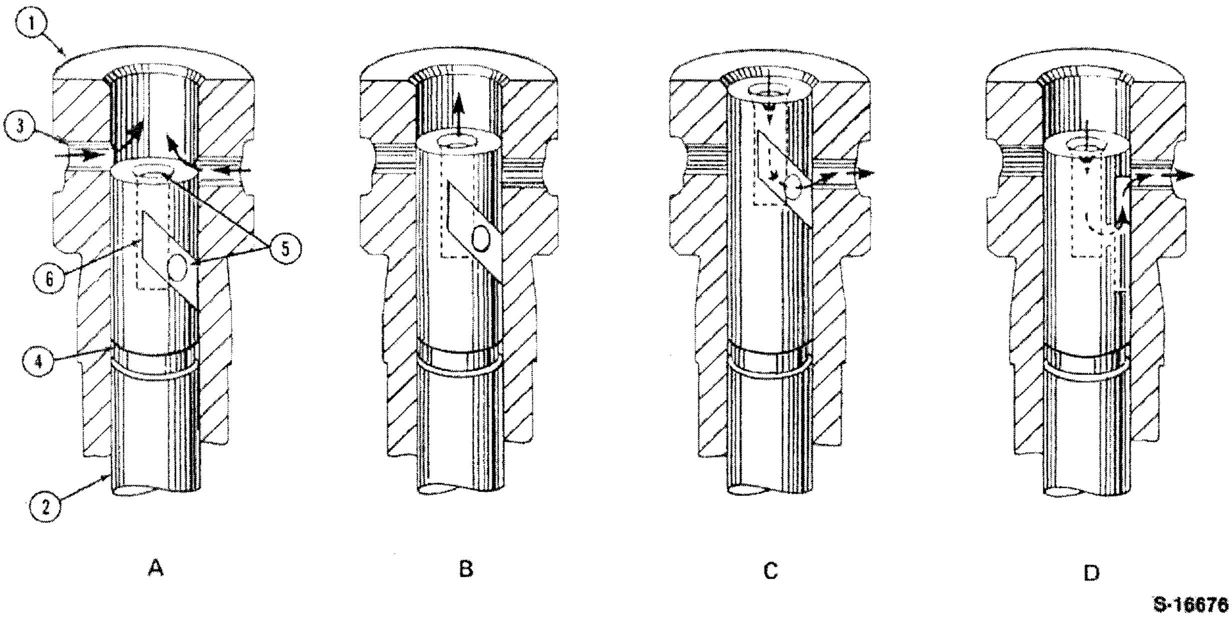

Figure 3
Pumping Element Operation

1. Barrel
2. Plunger
3. Fuel Inlet
4. Annular Groove
5. Fuel Port — Center Drilling
6. Helical Groove

An annular groove is machined around the plunger into which fuel leaking between the barrel and plunger may accumulate. This leakage provides lubrication of the barrel and plunger surfaces.

The plunger also has a fuel port, Figure 3, which terminates in a helical groove machined in the periphery of the plunger. The purpose of the groove is to control the effective pumping stroke of the plunger.

The element operates as follows:

Position A: With the plunger at the bottom of the stroke, fuel flows into the barrel through the two inlet ports to fill the space above the plunger, the center drilling and the helical groove.

Position B: As the plunger rises, the two inlet ports in the barrel are cut off by the plunger and the fuel is trapped. This point is called "spill cut-off" or "point of injection." Further upward movement of the plunger tends to compress the trapped fuel until the delivery valve, which acts as a non-return and unload valve, is lifted from the seat and allows the fuel to pass through the injector line to the injector. The pressure developed lifts the injector needle valve off the seat and injection takes place.

Position C: Injection ceases when the upper edge of the helical groove uncovers the lower edge of the inlet port. The pressurized fuel is allowed to escape back through the drilling to the low pressure area of the inlet port.

This pressure drop causes the injector needle valve to close and injection to cease. After fuel delivery, the plunger continues to the top of the stroke to be returned by a spring for the next cycle.

The effective pumping stroke is the distance between the top of the plunger and the point on the helical groove which uncovers the inlet port.

If the plunger is rotated clockwise so the helical groove now uncovers the inlet port at a lower point on the plunger, the pumping stroke and the amount of fuel injected will be increased.

If the plunger is rotated counterclockwise, the effective pumping stroke and the amount of fuel injected will be reduced. The rotation of the plunger is effected by an arm at the base of the plunger which engages with a fork on the control rod. Movement of the control rod towards the rear of the engine turns the plunger clockwise and increases the fuel flow.

Position D: At this stage the plunger has rotated to a position where the helical groove has reached the bottom of the inlet port before the plunger has risen sufficiently to close both inlet ports.

During the remainder of the plunger stroke the helical groove remains in contact with the inlet port so no pressure is produced and no injection can take place.

This is the "no-delivery" or "stop" position which occurs when the stop lever moves the control rod to the fully forward position.

NOTE: *The plungers have a slot machined across the crown. When the excess fuel device is operated and the control rod is in the maximum fuel position, the slots align with the inlet ports of the barrel to retard inlet port closure and assist easy starting.*

DELIVERY VALVES
Reference — Figure 4

Located above each pumping element is a delivery valve assembly which consists of a piston and stem assembly operating within a cylindrical guide which terminates in a conical seat. The lower part of the stem has four vertical flutes which accurately locate within the guide while permitting fuel to pass. Above the flutes is a piston which is a lapped fit in the bore of the valve guide.

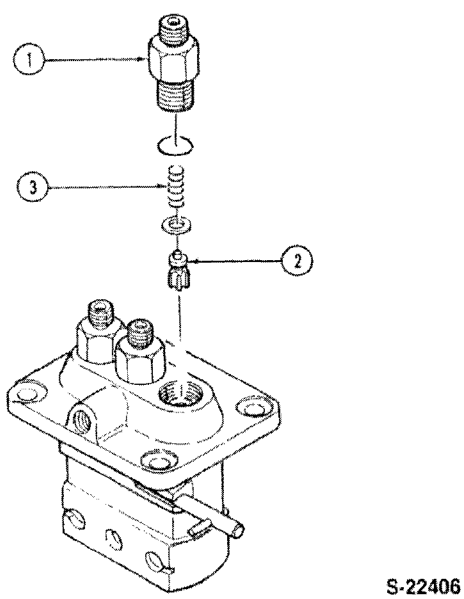

Figure 4
Delivery Valve Assembly

1. Holder
2. Delivery Valve
3. Spring

The delivery valve serves as a non-return valve and also as a means of rapidly reducing the fuel pressure in the injector line when injection ceases. Rapid pressure reduction is required to be sure the injector needle valve "snaps" shut to prevent fuel "dribble," a condition which can cause carbon formation on the injector tip.

The delivery valve operates as follows:

Reference — Figure 5

Position A: The pump plunger is at the bottom of the stroke and the inlet ports are uncovered so the barrel and delivery valve guide are filled with fuel. As the fuel is at low pressure the delivery valve is retained on the seat by the spring.

Position B: The plunger has risen and closed both inlet ports. Injection has now commenced. The fuel pressure lifts the delivery valve off the seat until the piston is clear of the guide which permits fuel to pass to the injector.

Position C: The helical groove has uncovered the inlet port and released the fuel pressure. The delivery valve spring, assisted by the high pressure still existing in the injector line, forces the delivery valve to close rapidly. During closing, the piston portion of the valve returning into the guide increases the volume of the injector line by the volume of this part of the valve. This sudden increase in volume causes a rapid collapse of pressure and allows the injector needle valve to "snap" shut.

B. REMOVAL AND INSTALLATION

REMOVAL
Reference — Figure 6

1. Remove the fuel injection lines and cap all openings.
2. Disconnect the throttle control cable(s) from the pump lever.
3. Disconnect the fuel inlet line from the pump and remove the engine fuel stop solenoid, Figure 6.
4. Remove the injection pump mounting bolts and nuts. Raise the pump and remove the spring pin and separate the governor link from the control rack, Figure 7.

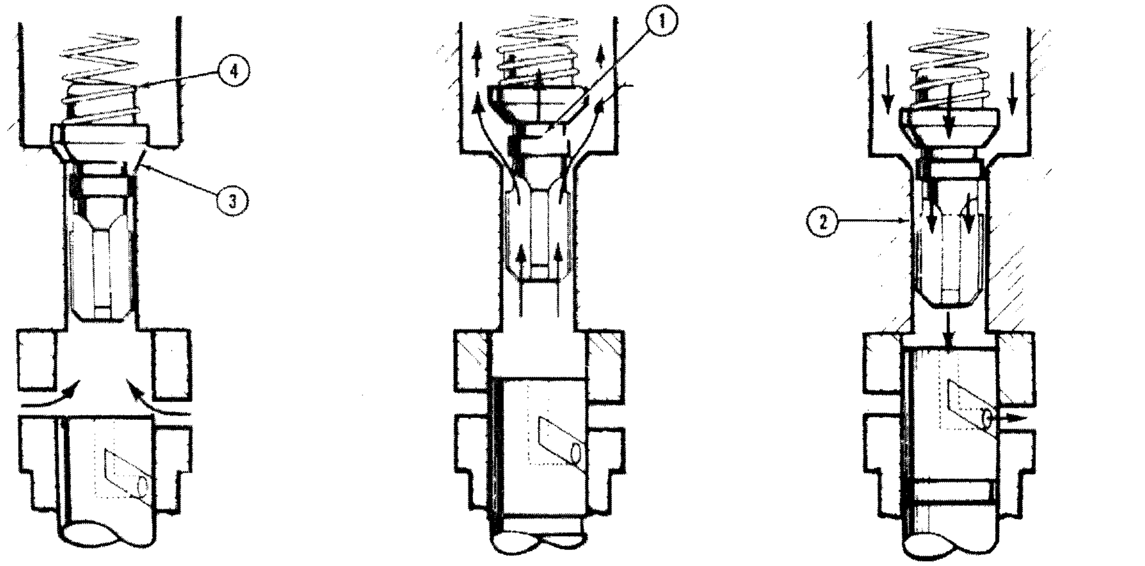

Figure 5
Delivery Valve Operation

A. Valve Closed
B. Valve Open
C. Valve Closing

1. Piston
2. Valve Guide
3. Conical Seat
4. Spring

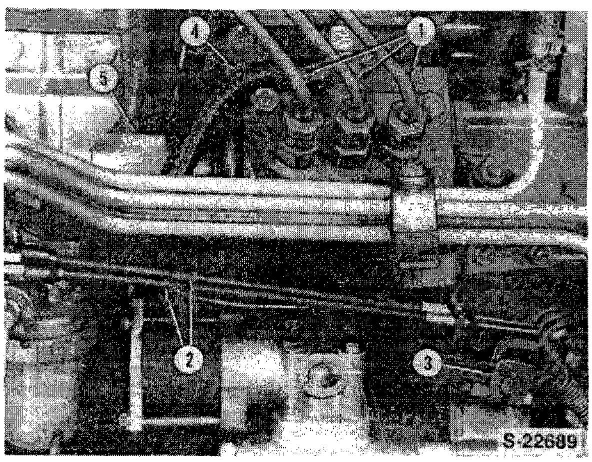

Figure 6
Injection Pump Removal (Model 1720 Shown)

1. Injection Lines
2. Throttle Control Cables
3. Pump Lever
4. Fuel Inlet Line
5. Solenoid

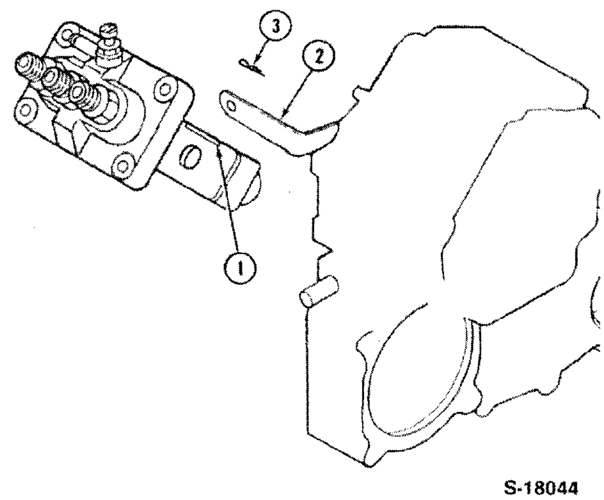

Figure 7
Injection Pump Removal

1. Pump Control Rack
2. Governor Link
3. Spring Pin

5. Remove the injection pump.

   NOTE: *If there are shims between the pump mounting flange and the engine block, carefully remove the shims and retain for reinstallation.*

INJECTION PUMP — REPAIR

If an injection pump is suspected of being faulty, it should be tested and repaired by an authorized Diesel Service Repair Station only.

INSTALLATION

Installation generally follows the removal procedure in reverse. If the pump is being replaced, or if the timing is not known, see "Injection Pump Timing and Governor Adjustments," Section C, this chapter.

Bleed the air from the fuel system. See "Bleeding the Fuel System," page 7.

C. TIMING AND GOVERNOR ADJUSTMENT

INSTALLATION USING ORIGINAL PUMP AND DRIVE COMPONENTS

NOTE: *The engine stop solenoid must be removed before installing the pump.*

1. Position the injection pump in the block using the original shim gasket or a new one of the same thickness, Figure 8.

   Connect the governor link to the pump control rack and secure with the spring pin, Figure 7.

2. Install the pump mounting bolts and tighten to the specified torque. See "Specifications," Chapter 3.

   If necessary to verify correct pump timing, spill time the pump as outlined in "Spill Timing Procedure," this section.

INSTALLING A NEW PUMP OR DRIVE COMPONENT

NOTE: *The engine stop solenoid must be removed before installing the pump.*

(Engine block, camshaft gear, camshaft assembly, idler gear, crankshaft gear, or injection pump.)

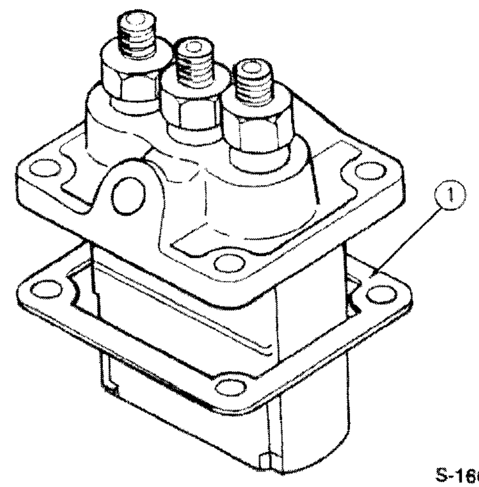

Figure 8
Injection Pump Installation — Model 1720
1. Shim Gasket

1. Position the injection pump in the block using a new shim gasket of 0.012 in. (0.5 mm) thickness, Figure 8.
2. Connect the governor link to the pump control rack and secure with the spring pin, Figure 7.

   NOTE: *Check the control rack for any binding conditions by moving the pump control lever back and forth.*

3. Install the pump mounting bolts and tighten to the specified torque. See "Specifications," Chapter 3.

SPILL-TIMING PROCEDURE

1. Remove the No. 1 delivery valve holder, spring and delivery valve piston, Figure 9.
2. Reinstall the delivery valve spring and holder. Tighten the holder finger tight.
3. Remove the valve rocker cover, Figure 10.
4. Remove the rocker shaft support assembly, Figure 11.
5. Rotate the crankshaft to align the pulley timing mark with the timing pointer, Figure 12.

   NOTE: *No. 1 cylinder must be on compression stroke. (Intake and exhaust valve rocker arms will be loose).*

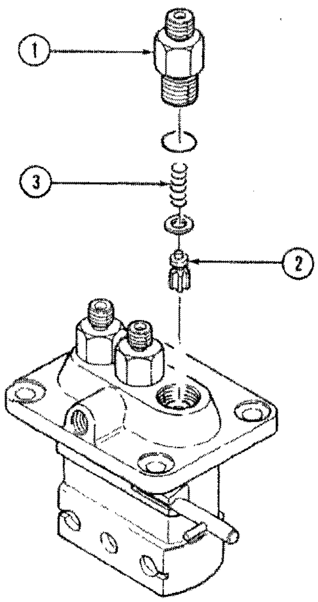

Figure 9
Spill-Timing — Model 1720

1. Delivery Valve Holder
2. Delivery Valve Piston
3. Spring

6. Remove the spring from one of the valves. (No. 1 cylinder).

NOTE: *Use care to not lose the valve step cap during removal, and do not rotate the engine any more than required.*

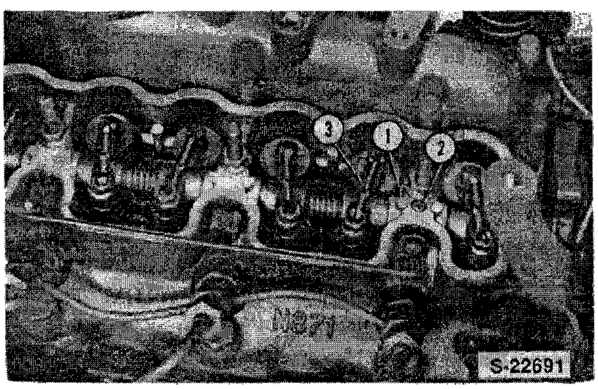

Figure 10
Valve Cover Removal

1. Rocker Shaft Support Bracket
2. Rocker Shaft Set Screw
3. Rocker Arms

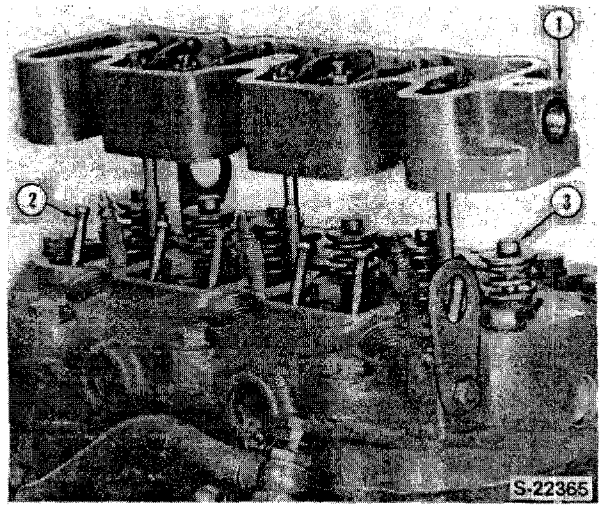

Figure 11
Rocker Arm Assembly Removal

1. Rocker Arm Support Bracket
2. Push Rods
3. Valve Stem and Cap

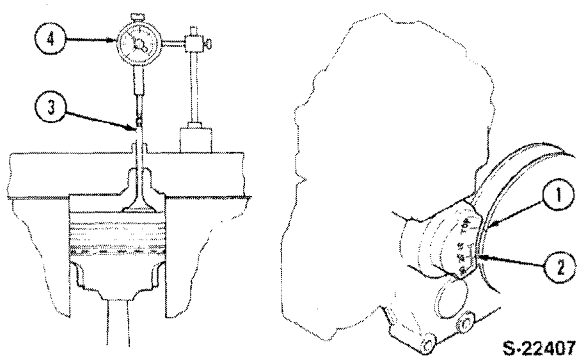

Figure 12
Spill-Timing

1. Crankshaft Pulley Timing Mark
2. Timing Pointer
3. Valve Stem (No. 1 Cyl.)
4. Dial Indicator

7. Gently tap the end of the valve stem to remove loose carbon from the valve head.

8. Using a dial indicator, set up the indicator on the valve stem as shown, Figure 12.

9. Install a temporary fuel supply to the injection pump.

10. Turn the crankshaft clockwise to bring the piston to top-dead-center on compression stroke. (Both intake and exhaust valves closed.)

11. Set the dial indicator to zero.

12. Turn the crankshaft counterclockwise until the dial indicator reads the following piston height.

1320-1520	0.192 in. (4.869 mm)
1720	0.216 in. (5.477 mm)

This will be 25° BTDC.

13. Open the fuel supply and observe fuel flow from No. 1 delivery valve holder.

14. Slowly turn the crankshaft clockwise until the fuel flow stops and observe the dial indicator reading.

Model 1320-1520:

A dial indicator reading of between .149 and .163 in. (3.79-4.14 mm) indicates 22-23° BTDC injection timing and no further adjustment is required.

Model 1720:

A dial indicator reading of between .168 and .183 in. (4.267-4.655) indicates 22-23° BTDC injection timing and no further adjustment is required.

If the timing angle is not correct, use the following chart and adjust the shim thickness as required to obtain the 22-23° injection timing.

NOTE: *To change the injection timing by 1 degree requires changing the gasket thickness by the following amount.*

Model	Approx. Gasket Thickness
1320/1520	0.010 in. (0.25 mm)
1720	0.004 in. (0.1 mm)

Adding shims decreases the angle while subtracting shims increases the angle.

15. Recheck the pump timing after adjusting the shim thickness.

16. Reassemble the delivery valve, spring and holder. Tighten the holder to the specified torque. See "Specifications," Chapter 3.

17. After assembly, check and adjust valve clearances as shown under engine repair.

18. Assemble valve cover.

INJECTION PUMP SHIMS

Shim Thickness	Part Number
.008 in. (.2 mm)	SBA-131437300
.012 in. (.3 mm)	SBA-131437301
.016 in. (.4 mm)	SBA-131437302
.020 in. (.5 mm)	SBA-131437303

BLEEDING THE FUEL SYSTEM

Bleed the fuel system following any of the following conditions.

- If a new fuel filter is installed.
- If the tractor has run out of fuel.
- If any of the fuel lines have been disconnected.
- If the injection pump has been removed.

BLEEDING PROCEDURE

With adequate fuel in the fuel tank and the fuel shut-off valve open, Figure 13:

1. Open the bleed screw on the injection pump, Figure 14, and let the air escape.

Piston Height to Crankshaft Angle BTDC

Angle Deg.	Piston Height Inch (mm)		Angle Deg.	Piston Height Inch (mm)	
	1320-1520	1720		1320-1520	1720
17	.0898 in. (2.283)	.1011 (2.569)	22	.1493 in. (3.793)	.1680 (4.267)
18	.1006 in. (2.556)	.1132 (2.875)	23	.1629 in. (4.138)	.1833 (4.655)
19	.1119 in. (2.842)	.1259 (3.199)	24	.1770 in. (4.496mm)	.1991 (5.058)
20	.1238 in. (3.145)	.1393 (3.539)	25	.1916 in. (4.869mm)	.2156 (5.477)
21	.1362 in. (3.462)	.1533 (3.895)			

2. Set the throttle in the full open position and crank the engine for a few seconds to allow the air to be expelled from the injector lines.

3. If the engine does not start, loosen the injector lines at the injector one at a time while cranking the engine.

4. Be sure all lines and fittings are properly torqued when completed.

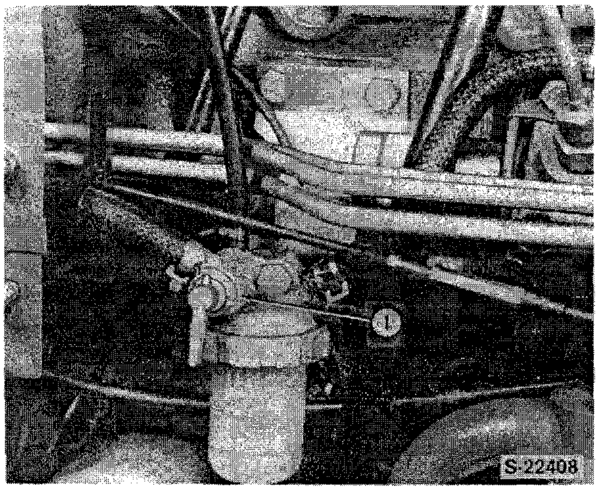

Figure 13
Bleeding the Fuel System
1. Fuel Shut-off Valve

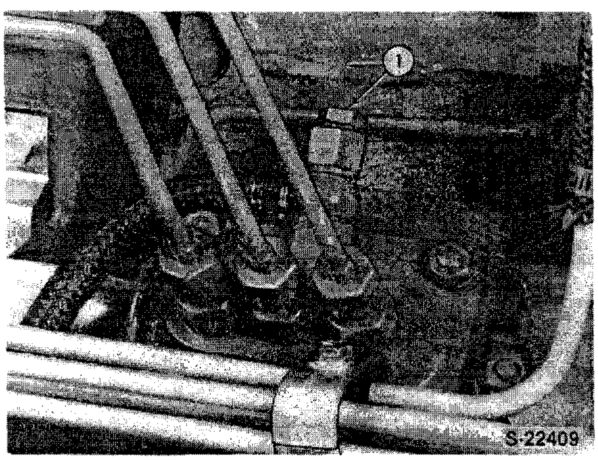

Figure 14
Bleeding the Injection Pump
1. Bleed Screw — Model 1720 Shown

GOVERNOR ASSEMBLY

The governor assembly is mounted on the forward end of the engine camshaft, Figure 15.

If the governor has been disassembled, reassemble in the order as shown, Figure 15.

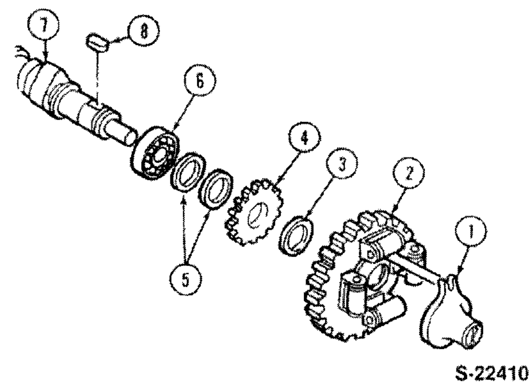

Figure 15
Governor Assembly

1. Slider	5. Spacer
2. Gear Assembly	6. Bearing
3. Spacer	7. Camshaft
4. Tachometer Drive Gear	8. Key

If the governor linkage has been disassembled, reassemble the linkage in the timing gear housing as shown, Figures 16 and 17.

Assemble the governor lever, aligning the slot in the lever with the groove in the governor arm, Figure 18.

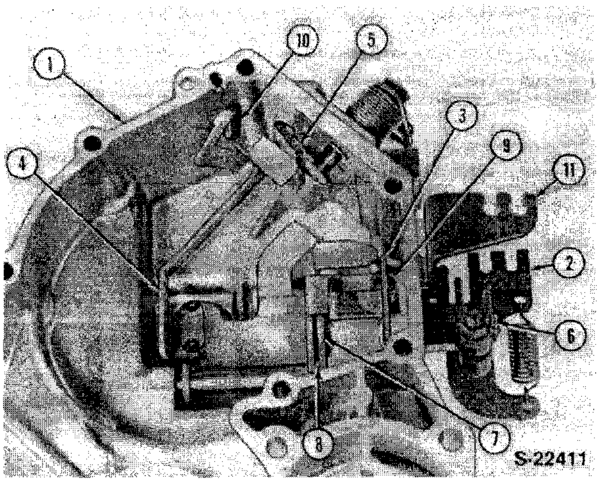

Figure 16
Timing Gear Cover and Governor Linkage Assembly

1. Timing Gear Cover
2. Lever
3. Arm
4. Lever
5. Arm Assembly
6. Shaft
7. Spring Holder
8. Washer
9. Spring
10. Spring
11. Stay

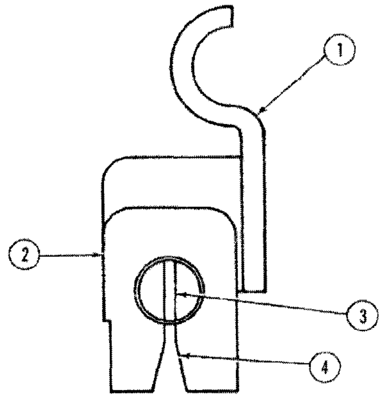

Figure 18
Governor and Adjustment

1. Lever
2. Governor Arm
3. Groove
4. Slot

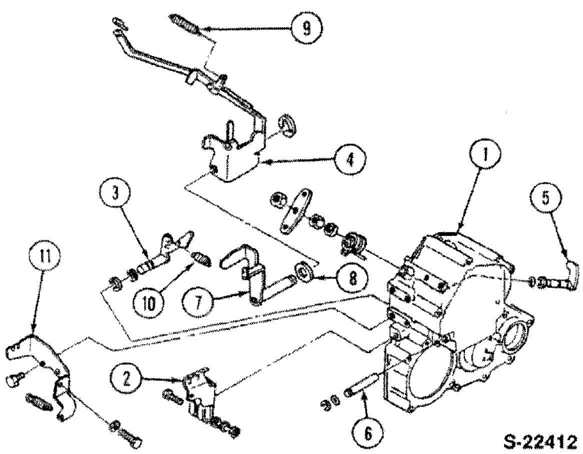

Figure 17
Governor Linkage Components

1. Timing Gear Cover
2. Lever
3. Arm
4. Lever
5. Arm Assembly
6. Shaft
7. Spring Holder
8. Washer
9. Spring
10. Spring
11. Stay

PART 2
FUEL SYSTEM

Chapter 2
INJECTORS

A. DESCRIPTION AND OPERATION

Pintle type injectors are used in all engine applications. The injectors have a .039 in. (1.01 mm) single orifice and are set at 1700 psi (120 kg/cm²), Model 1320-1520 and 2150 psi (150 kg/cm²), Model 1720.

The pressure adjustment is made by adding or deleting shims from the top of the injector pressure adjusting spring. The pintle type injectors have an injection angle of 0°, Models 1320-1520 and 12°, Model 1720. The injection pipes are 0.07 in. (1.8 mm) (Model 1320-1520) and .055 in. (1.4 mm) (Model 1720) in length and are the same length for each cylinder to help keep the injection intervals in time.

The engine injector function is to inject fuel into a pressurized cylinder in a fully atomized condition so as to burn efficiently with a minimum of smoke.

Each injector consists of a nozzle assembly and needle valve assembly, a nozzle holder assembly and injector needle valve regulating spring, Figure 19.

Fuel from the fuel injection pump enters the injector fuel inlet and passes down through a drilling in the nozzle holder and body to the needle valve seat.

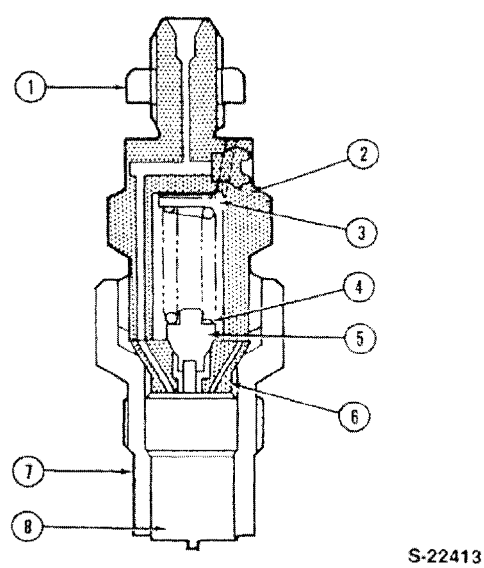

Figure 19
Injector Assembly

1. Nut
2. Body
3. Shim
4. Spring
5. Push Rod
6. Distance Piece
7. Nozzle Nut
8. Nozzle Assembly

The fuel, pressurized by the injection pump, lifts the needle valve off the seat against the action of a spring. The fuel is then forced, in an atomized state, through the .039 in. orifice in the nozzle tip, Figure 20. When the pressure from the injection pump drops, the needle valve snaps back onto the seat under pressure from the spring.

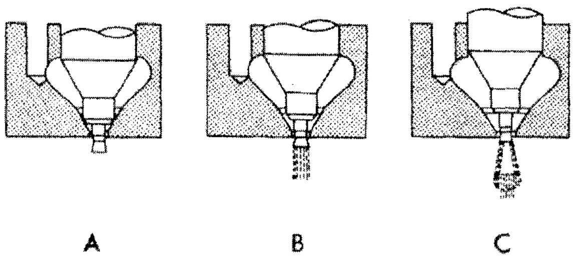

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Figure 20
Injector Nozzle Operation
A. Nozzle Closed
B. Nozzle Initial Opening
C. Nozzle Fully Opened

To provide lubrication of the injector, a small amount of fuel is permitted to leak up between the needle valve and the nozzle body. The excess fuel rises to the top of the injector and returns to the fuel tank via an injector leak-off line.

B. REMOVAL AND INSTALLATION

1. Clean all dirt and oil from the injectors and surrounding areas.
2. Disconnect the fuel lines from the injectors and cap all openings, Figure 21.
3. Remove the injector fuel leak-off line, Figure 21.
4. Remove the injector and seals, Figure 22.

INSTALLATION

Installation of the injector follows the removal procedure in reverse.

Always use new sealing washers on installation.

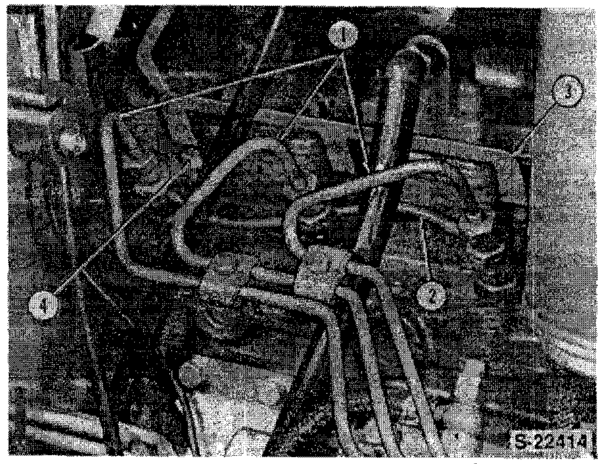

Figure 21
Injector Removal — Model 1720 Shown
1. Fuel Injection Lines
2. Fuel LeakOff Line
3. Glow Plug Connector
4. Glow Plugs

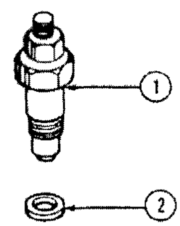

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Figure 22
Injector Assembly Removal
1. Injector Assembly
2. Sealing Washer

Tighten the injector assemblies to the specified torque. See "Specifications," Chapter 3.

C. OVERHAUL

DISASSEMBLY
Reference — Figure 23

1. Loosen and remove the nozzle nut being careful to not drop or otherwise damage the nozzle.
2. Remove the nozzle and needle valve.
3. Clean the nozzle body and needle and check the nozzle for any burn or score marks. Check the needle seat for evidence of fuel leakage or carbon.

Correct fuel leakage at the seat using a polishing stick and polish the seat area.

4. Inspect the upper and lower contact surfaces of the nozzle holder and spacer to assure a clean contact surface.

5. Clean the nozzle spray orifice hole using a .040 in. (1.0 mm) wire in a pin vise.

ASSEMBLY AND ADJUSTMENT

1. Clean and lubricate all parts in clean fuel oil and assemble while still wet.

2. Check and adjust the injector pressure setting.

   Adjust the opening pressure by adding or deleting shims, Figure 23.

   Opening pressure

Model 1320-1520	1700 psi (120 kg/cm^2)
Model 1720	2150 psi (150 kg/cm^2)

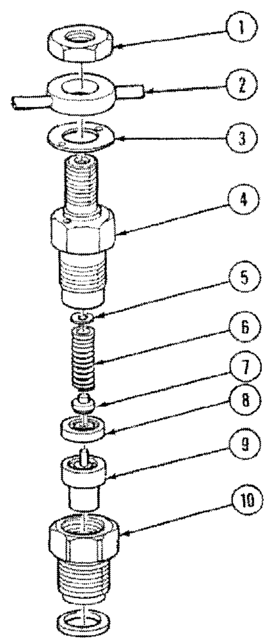

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Figure 23
Injector Assembly Components

1. Nut
2. Leak-Off Line
3. Washer
4. Injector Body
5. Shims
6. Spring
7. Rod
8. Spacer
9. Nozzle Assembly
10. Nozzle Nut

PART 2
FUEL SYSTEM

Chapter 3
TROUBLE SHOOTING, SPECIFICATIONS AND SPECIAL TOOLS

A. TROUBLE SHOOTING

IMPORTANT: *Whenever effecting a repair, the cause of the problem must be investigated and corrected to avoid repeat failures.*

The following tables list problems and their possible causes with recommended remedial action.

DIESEL FUEL SYSTEMS — GENERAL

CONDITION	CAUSE	REMEDY
Fuel not reaching injection pump	1. Fuel shut-off valve closed	1. Check that the fuel shut-off valve at the fuel tank is on the "ON" position
	2. Restricted fuel filters	2. Check and flush the fuel filter clean
	3. Fuel stop solenoid	3. Check fuel stop solenoid — Part 3
	4. Air in system	4. Bleed the fuel system
	5. Fuel leakage	5. Check the fuel lines and connectors for damage
Fuel reaching nozzles but engine will not start	1. Low cranking speed	1. Check the cranking speed
	2. Incorrect throttle adjustment	2. Check the throttle control rod travel
	3. Incorrect pump timing	3. Check the pump timing
	4. Fuel leakage	4. Check the fuel lines and connectors for leakage
	5. Faulty injectors	5. See injector trouble shooting
	6. Low compression	6. Check the engine compression
Engine hard to start	1. Low cranking speed	1. Check the cranking speed
	2. Incorrect pump timing	2. Check the pump timing
	3. Restricted fuel filter	3. Check and flush the fuel filter clean
	4. Contaminated fuel	4. Check for water in the fuel
	5. Low compression	5. Check the engine compression
	6. Air in system	6. Check for air leaks on the suction side of the system

A. TROUBLE SHOOTING (Continued)

DIESEL FUEL SYSTEMS — GENERAL (Continued)

CONDITION	CAUSE	REMEDY
Engine starts and stops	1. Fuel starvation	1. Check and flush clean restricted fuel lines or fuel filter
	2. Contaminated fuel	2. Check for water in the fuel
	3. Restricted air intake	3. Check for restrictions in the air intake
	4. Engine overheating	4. Check cooling system
	5. Air in system	5. Check for air leaks on the suction side of the system
Erratic engine operation (surge, misfiring, poor governor regulation)	1. Fuel leakage	1. Check the injectors lines and connectors for leakage
	2. Fuel starvation	2. Check and flush clean restricted fuel lines or filters
	3. Incorrect pump timing	3. Check the pump timing
	4. Contaminated fuel	4. Check for water in the fuel
	5. Air in system	5. Bleed the fuel system
	6. Faulty or sticking injector nozzles	6. See injector trouble shooting
	7. Incorrect engine timing	7. Check for faulty engine valves
Engine does not develop full power or speed	1. Incorrect throttle adjustment	1. Check for insufficient throttle control movement
	2. Incorrect maximum no-load speed	2. Check maximum no-load speed adjustment
	3. Fuel starvation	3. Check and flush clean restricted fuel lines and filters
	4. Air in system	4. Check for air leaks on the suction side of the system
	5. Incorrect timing	5. Check pump timing
	6. Low compression	6. Check engine compression
	7. Incorrect engine timing	7. Check for improper valve adjustment or faulty valves
Engine emits black smoke	1. Restricted air intake	1. Check for a restricted air intake
	2. Engine overheating	2. Check cooling system
	3. Incorrect timing	3. Check the pump timing
	4. Faulty injectors	4. See injector trouble shooting
	5. Low compression	5. Check the engine compression
	6. Incorrect engine timing	6. Check the engine valves
Pump fails to deliver fuel to all injectors	1. Blocked fuel lines to pump	1. Remove fuel lines and flush or replace
	2. Air in fuel lines to injectors	2. Bleed fuel lines
	3. Control rod seized in "OFF" position	3. Repair or replace control cable

A. TROUBLE SHOOTING (Continued)

DIESEL FUEL SYSTEMS — GENERAL (Continued)

CONDITION	CAUSE	REMEDY
Pump fails to deliver fuel to one injector	1. Air in fuel line to injector 2. Plunger spring broken 3. Plunger seized 4. Delivery valve seized 5. Badly scored plunger and barrel	1. Bleed fuel line 2. Replace spring 3. Repair or replace barrel and plunger assembly 4. Repair or replace delivery valve 5. Replace barrel and plunger assembly
Governor fails to maintain maximum or minimum no-load fuel delivery	1. Control spring broken 2. Governor weights seized 3. Governor weight carrier broken 4. Thrust pad seized 5. Cross-shaft bolt broken or missing 6. Pump link spring broken	1. Replace control spring 2. Repair or replace weight assembly and/or camshaft 3. Replace weight assembly 4. Replace thrust pad and/or camshaft 5. Replace bolt. 6. Replace spring

FUEL INJECTORS

CONDITION	CAUSE	REMEDY
Nozzle does not "buzz" while injecting	1. Needle valve stuck 2. Leakage 3. Nozzle damaged	1. Check needle valve is clean and not binding 2. Check valve seat is not leaking 3. Examine nozzle retaining cap for damage
Nozzle leak-back	1. Needle valve worn 2. Blocked nozzle assembly 3. Loose nozzle retaining nut	1. Replace nozzle assembly 2. Check for carbon or foreign matter on faces of nozzle and nozzle holder. Flush clean or replace 3. Inspect faces and tighten nozzle retaining nut
Nozzle opening pressure incorrect	1. Incorrectly adjusted nozzle retaining nut 2. Damaged nozzle or seized needle valve 3. Blocked nozzle orifice	1. Check adjusting nut for looseness and re-set 2. Replace nozzle assembly 3. Check nozzle orifice for carbon or foreign matter. Flush clean or replace
Nozzle seat leakage	1. Nozzle incorrectly seated 2. Sticking or binding needle valve	1. Check for carbon or foreign matter on faces of nozzle or nozzle holder 2. Repair or replace nozzle assembly

A. TROUBLE SHOOTING (Continued)

FUEL INJECTORS (Continued)

CONDITION	CAUSE	REMEDY
Spray pattern distorted	1. Obstructed needle valve	1. Check for carbon or foreign matter on needle valve tip. Flush clean or replace nozzle assembly
	2. Obstructed needle valve orifice	2. Check for carbon in orifice. Flush clean or replace nozzle assembly
	3. Damaged nozzle or needle valve	3. Replace nozzle assembly

B. SPECIFICATIONS

INJECTION PUMP

Pump Manufacturer Assembly Number	DIESEL KIKI K.K
1720	104294-3120
Type	
All Models	In-line
Timing (Before TDC)	
Model 1320-1520	20-21°
Model 1720	22-23°
Timing (Piston Height at Injection Start BTDC)	
Model 1320-1520	.1238 -.1362 in. (3.145-3.462 mm)
Model 1720	.168-.183 in. (4.267-4.655 mm)
Injection Nozzle	
Nozzle Type	Throttle
Needle Valve Diameter	
Model 1320-1520	.024 in. (.6 mm)
Model 1720	.157 in. (.4mm)
Pintle Diameter	
Model 1320-1520	.039 in. (1 mm)
Model 1720	.039 in. (1 mm)
Injection Pressure	
Model 1320-1520	1706 psi (120 kg/cm^2)
Model 1720	2150 psi (150 kg/cm^2)
Spray Angle	4°
Service Adjustments	
Idle Speed	
1720	850 RPM
Maximum No-Load Speed	
1720	2700 RPM

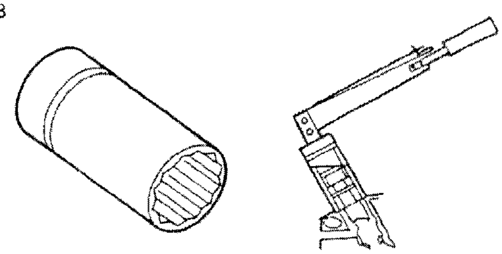
TORQUE SPECIFICATIONS

	1720
Delivery Valve Holder	28.9-32.5 lbs. ft. (39.2-44.1 Nm)
Injector Assembly	43-51 lbs. ft. (59-69 Nm)

C. SPECIAL TOOLS

1588 — Socket, 27 mm
Special Injector

1588



D. FUEL INJECTION PUMP SPECIFICATIONS

FUEL INJECTION PUMP (Field check)

Use the following standards when checking/adjusting or rebuilding the fuel injection pump.

STANDARDS FOR INJECTION PUMP ADJUSTMENT

MODEL OF ENGINE:

J 823	Model 1320
J 843	Model 1520
N 843	Model 1720

PUMP ASSEMBLY ITEM NO. 104294-3120 **SHIBAURA Code No. 131017360**

STANDARDS FOR ADJUSTING THE INJECTION PUMP

1) Rotating direction .... Clockwise when observed from the driving side
2) Nozzle: NPDN4PDN117
3) Nozzle holder: 1051481170
4) Nozzle valve opening pressure:
   Model 1320-1520 .... 1706 ± 71 psi (120 ± 5 kg/cm²)
   Model 1720 .... 2150 ± 71 psi (150 ± 5 kg/cm²)
5) Injection pipe:
   Model 1320-1520 .... .07 in. (1.8 mm) x .236 in. (6 mm) O.D. x 14.5 in. (370 mm) length
   Model 1720 .... .055 in. (1.4 mm) x .236 in. (6 mm) O.D. x 14.5 in. (370 mm) length
6) Oil flowing pressure: .... 2.8 psi (0.2 kg/cm²)
7) Test oil: .... Light oil

PART 3
ELECTRICAL SYSTEM

Chapter 1
WIRING, SWITCHES, GLOW PLUGS AND INSTRUMENTATION

Chapter 2
BATTERY

Chapter 3
STARTING SYSTEMS

Chapter 4
CHARGING SYSTEM

Chapter 5
ENGINE FUEL STOP SOLENOID

Chapter 6
TROUBLE SHOOTING AND SPECIFICATIONS

PART 3
ELECTRICAL SYSTEM

Chapter 1
WIRING, SWITCHES, GLOW PLUGS AND INSTRUMENTATION

A. DESCRIPTION AND OPERATION

WIRING

Reference — Figures 1 and 2

The tractor wiring consists of a front and rear main wiring harness equipped with fool-proof connectors to the sub-wiring harnesses.

SWITCHES

KEY START SWITCH
See Chapter 3, Section E.

NEUTRAL START SWITCHES
See Chapter 3, Section E.

LIGHT SWITCH

The light switch (1), Figure 3, is a dial type switch. 1st position is off, 2nd position (turn the switch clockwise) is high beam, 3rd position is low beam.

FLASHER SWITCH

The flasher warning light switch is combined with the head light switch, Figure 3, and is located on the instrument panel.

COOLANT TEMPERATURE SWITCH

The coolant temperature sender switch, Figure 4, senses coolant overheating, and causes the temperature gauge (5), to register, Figure 3.

OIL PRESSURE SWITCH

The oil pressure sender switch is located on the top front side of the engine, Figure 5. The switch opens under normal oil pressure and closes at low oil pressure to illuminate the warning light (6) on the instrument panel, Figure 3.

The warning light should illuminate when the key switch is turned on and go out when the engine is started. If the light does not go out, check the engine oil level first before checking for a malfunction of the sender switch and engine oil pump.

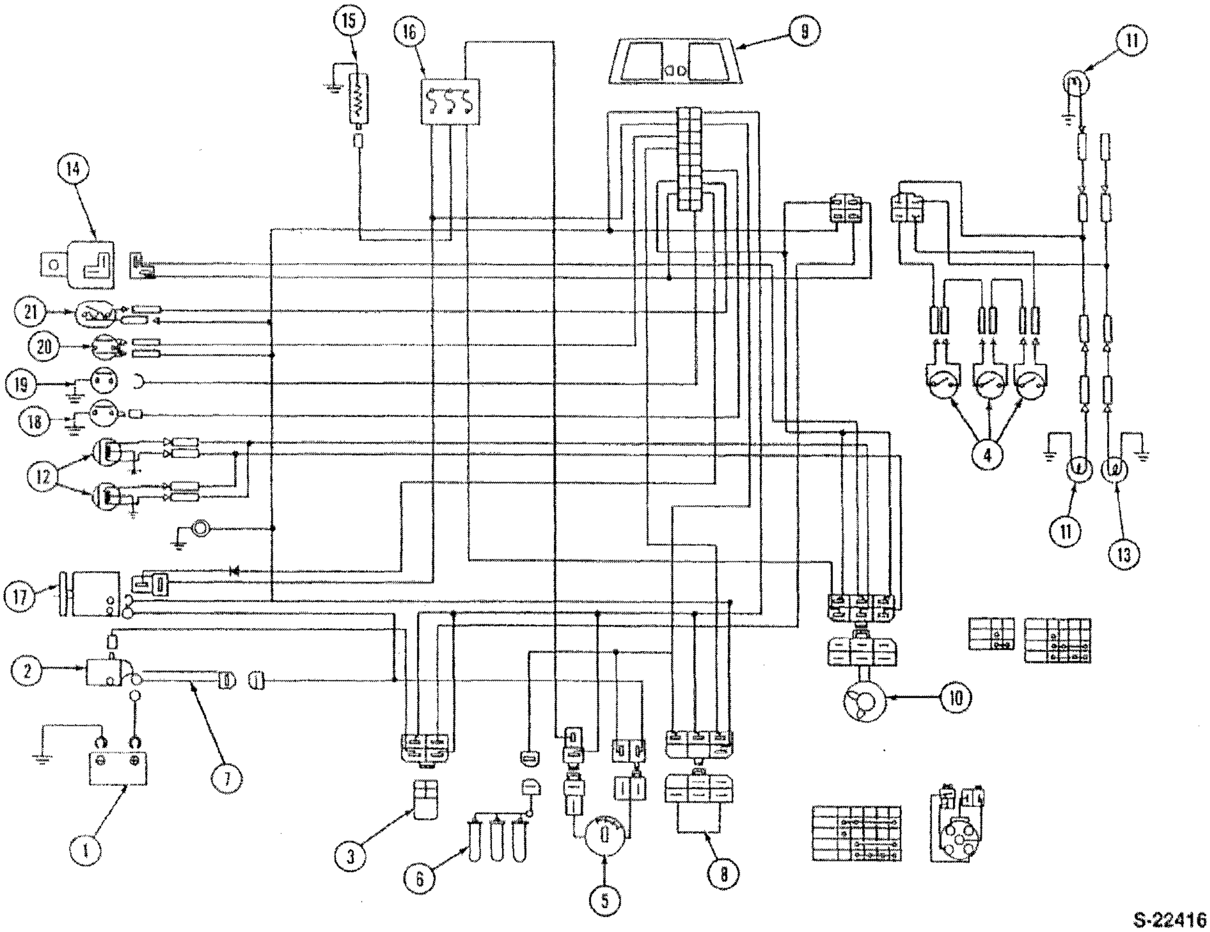


Figure 1
Wiring Diagram — Model 1320-1520

1. Battery
2. Starter Motor
3. Neutral Start Relay
4. Neutral Start Switch
5. Key Start Switch
6. Glow Plugs
7. Fuse Link Wire
8. Quick Start Timer Relay
9. Instrument Warning Lights
10. Combination Switch (Flasher/Headlights)
11. Flasher Warning Lights
12. Headlights
13. Taillight
14. Flasher Unit
15. Engine Stop Solenoid
16. Fuse Box
17. Alternator Assembly
18. Temperature Sender Unit
19. Oil Pressure Sender Unit
20. Air Cleaner Sender Unit
21. Fuel Sender Unit

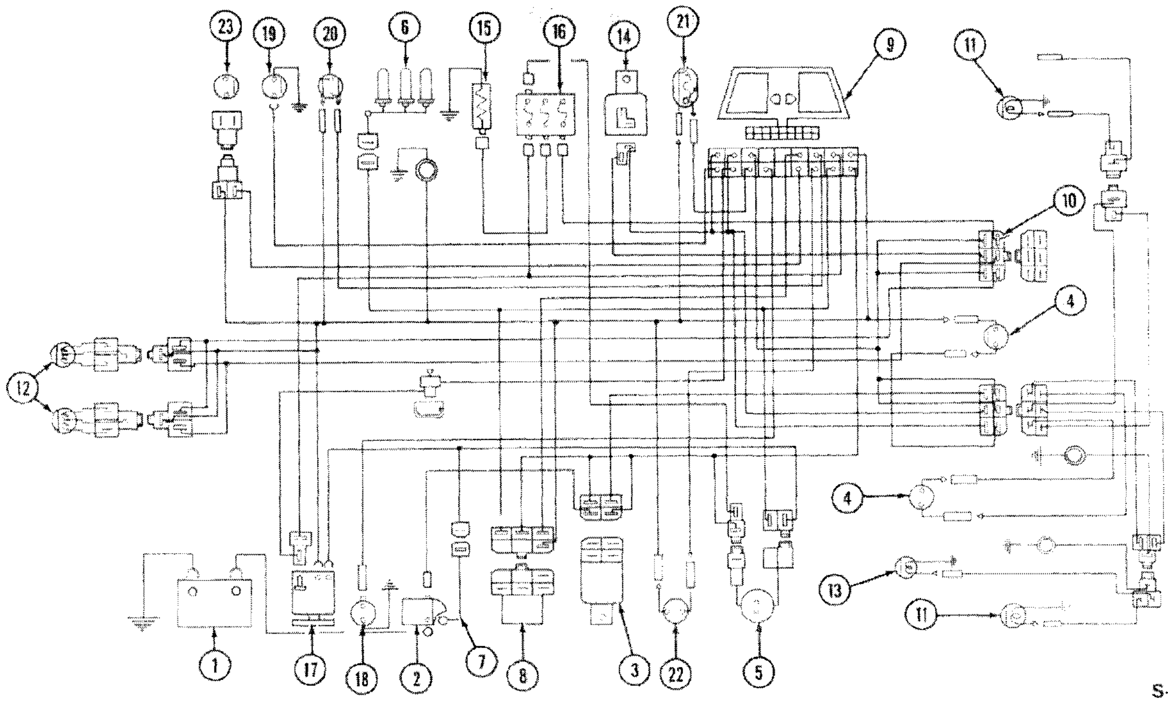


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Figure 2
Wiring Diagram — Model 1720

1. Battery
2. Starter Motor
3. Neutral Start Relay
4. Neutral Start Switch — PC Board
5. Key Start Switch
6. Glow Plugs
7. Fusible Link
8. Quick Start Timer Relay
9. Instrument Warning Lights
10. Combination Switch (Flasher/Headlights)
11. Flasher Warning Lights
12. Headlights
13. Taillight
14. Flasher Unit
15. Engine Stop Solenoid
16. Fuse Box
17. Alternator Assembly
18. Temperature Sender Unit
19. Oil Pressure Sender Unit
20. Air Cleaner Sender Unit
21. Fuel Sender Unit
22. Parking Brake Switch
23. Reserve Tank Sender Unit

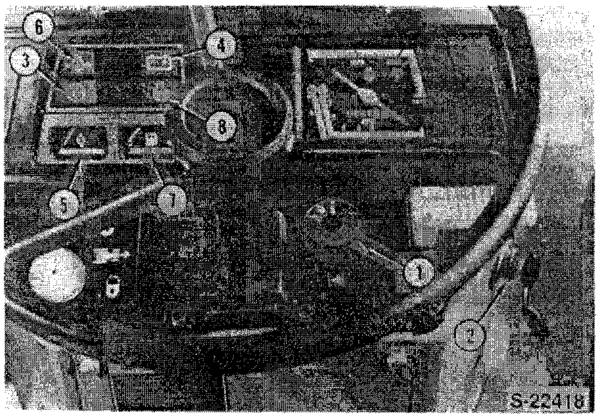

Figure 3
Instrument Panel — Model 1320/1520

1. Combination Switch (Headlight/Flasher)
2. Key Start Switch
3. Air Cleaner Warning Light
4. Alternator Warning Light
5. Coolant Temperature Gauge
6. Engine Oil Pressure Warning Light
7. Fuel Gauge
8. Glow Plug Indicator Light

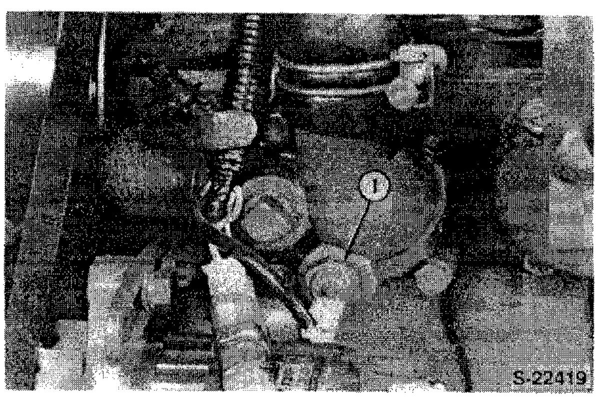

Figure 4
Temperature Sender — Model 1320/1520 Shown

1. Sending Unit

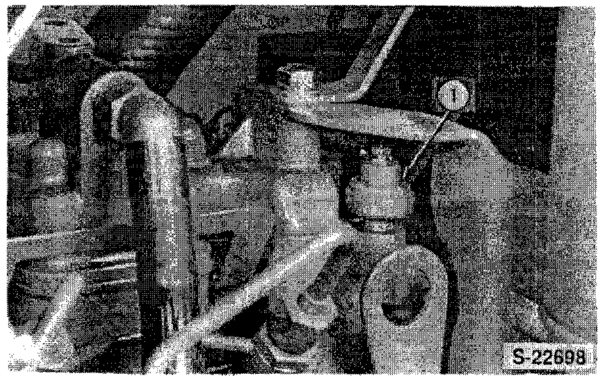

Figure 5
Oil Pressure Sender Unit

1. Sender Unit

GLOW PLUGS

Ultra fast heating glow plugs are used in the models 1320/1520/1720 tractors, Figure 6.

The heating element wire is contained in a stainless steel sheath with the fine heat wire in coil form immersed in sintered magnesium oxide power.

One end of this heat wire is welded to the sheath front tip and the other end is attached to the center electrode.

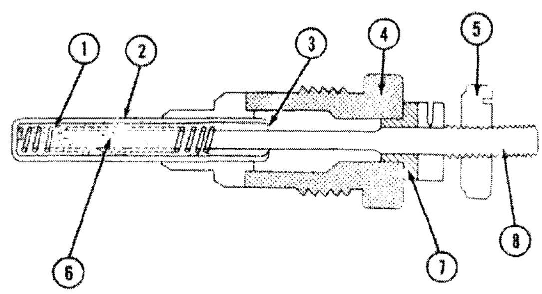

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Figure 6
Glow Plug

1. Heat Wire
2. Sheath
3. Asbestos
4. Body
5. Nut
6. Magnesium Oxide Powder
7. Insulation Bushing
8. Center Electrode

When the key switch is turned to the "HEAT" or "START" positions the element heats up and warms the air in the combustion chambers.

The ignition quick start system is composed of the glow plugs, glow plug indicator lamp and a timer switch.

The glow plugs heat up the combustion chamber air to the starting temperature in 4-5 seconds when the key switch is turned to the "HEAT" position.

WARNING: *Do not disassemble glow plugs. Plugs are sealed and can not be disassembled.*

IMPORTANT: *Never use ether starting fluid in conjunction with the use of the glow plugs as severe damage to the engine may occur.*

FUEL GAUGE SENDER

The fuel level sensor unit (1), Figure 7, is mounted on the top of the fuel tank. The sensor float moves up and down with the fuel level in the tank while changing the resistance in the fuel gauge circuit. The pointer indicates the fuel level in the tank.

The fuel gauge (7), Figure 3, is located on the instrument panel.

Figure 7
Fuel Gauge Sender
1. Sender Assembly

FUSES

The fuse box (1), Figure 8, is located on the forward side of the engine baffle plate.

One fuse protects the headlight circuits and fuel gauge.

One fuse protects the fuel stop solenoid.

One fuse protects the quick start timer and alternator regulator.

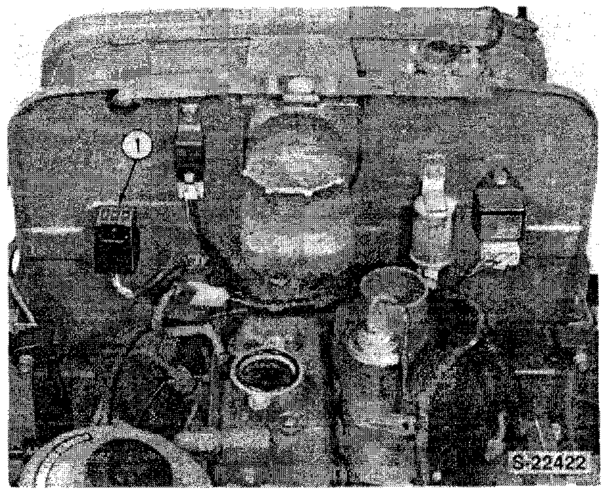

Figure 8
Fuse Box Location
1. Fuse Box

Fuse Link Wire

The fuse link (1), Figure 9, is installed between starter battery terminal and the main wiring harness leading to the alternator/regulator and key start switch.

The fuse link wire protects the main wiring harness from current overloads.

The fuse link should never be by-passed in the event it has blown out. If the fuse link fails, always trouble shoot the electrical system to correct the overload condition before replacing the fuse link.

COOLANT RESERVE TANK— SENSOR SWITCH — Model 1720

On the model 1720 tractor a coolant sender switch is located on the bottom of the coolant reserve tank (1), Figure 10.

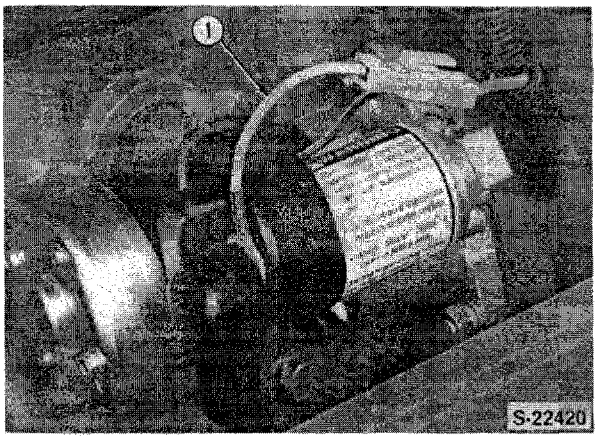

Figure 9
Fuse Link Wire

1. Fuse Link

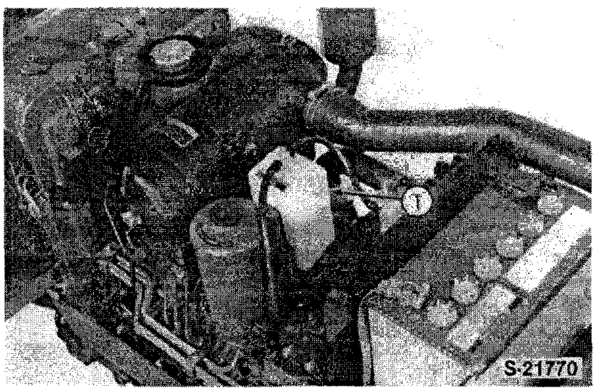

Figure 10
Coolant Reserve Tank Location

1. Reserve Tank

The switch senses low coolant level in the cooling system and causes the warning light to illuminate, Figure 11.

PARKING BRAKE WARNING LIGHT AND SWITCH — Model 1720

On the model 1720 a parking brake switch (1), Figure 12, is used to activate a warning indicator light (10), located on the instrument panel, Figure 11.

The warning light illuminates when the key start switch is turned on when the parking brake is applied.

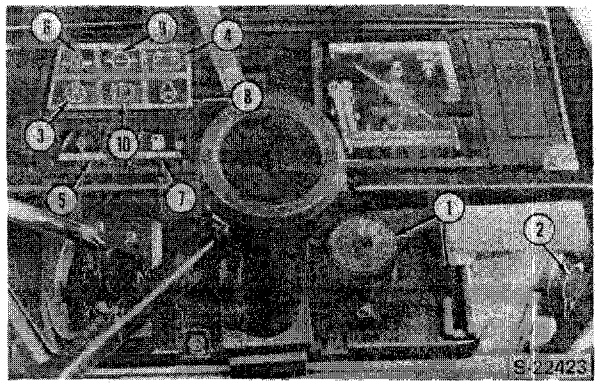

Figure 11
Instrument Panel — Model 1720

1. Combination Switch (Headlight/Flasher)
2. Key Start Switch
3. Air Cleaner Warning Light
4. Alternator Warning Light
5. Coolant Temperature Gauge
6. Engine Oil Pressure Warning Light
7. Fuel Gauge
8. Glow Plug Indicator Light
9. Reserve Tank Coolant Warning Light
10. Parking Brake Light

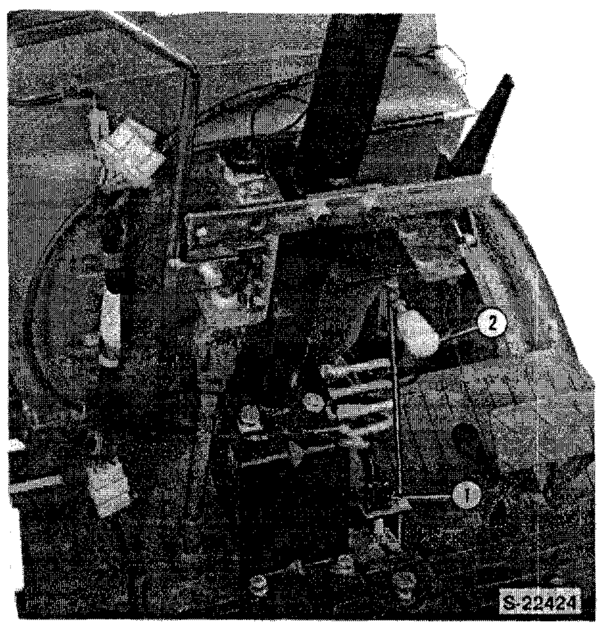

Figure 12
Parking Brake Switch — Model 1720

1. Switch
2. Brake Lever

B. OVERHAUL

GLOW PLUGS

REMOVAL

1. Remove the nut, lock washer and flat washer attaching the parallel connector to the glow plug, Figure 13.

2. If required, remove the wiring terminal from the glow plug.

3. Disconnect the parallel connector from the glow plug.

4. Remove the glow plug from the cylinder head.

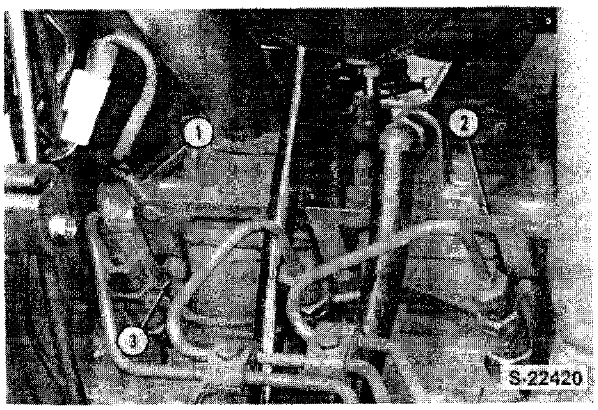

Figure 13
Glow Plug Removal

1. Glow Plug Wire Terminal
2. Parallel Connector
3. Glow Plugs

GLOW PLUG INDICATOR LIGHT

REMOVAL

1. Disconnect the battery negative cable.

2. Remove the instrument panel mounting screws and raise the panel to gain access to the under side.

3. Remove the panel (2), Figure 14.

4. Turn the glow plug indicator light socket (1) counterclockwise and remove it from the panel.

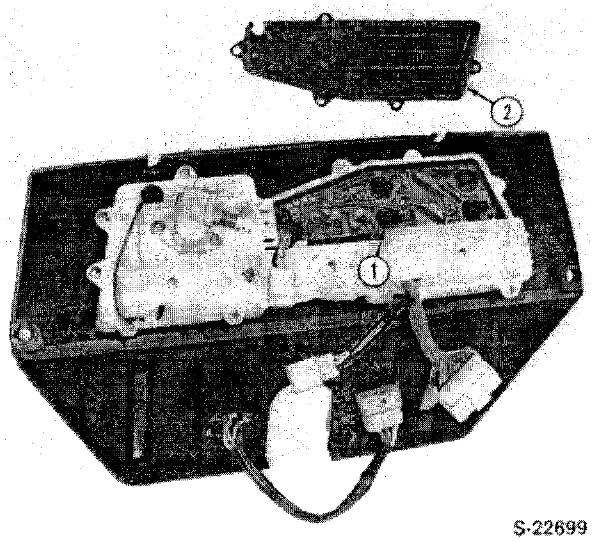

Figure 14
Glow Plug Indicator Lamp Removal

1. Lamp — Glow Plug Indicator
2. Panel Cover

LIGHT SWITCH — REMOVAL

1. Remove the light switch knob (3), Figure 15.

2. Remove the flasher switch lever knob (4).

   NOTE: *These are snap-on type knobs. Using the two screw drivers carefully pry each knob upward to remove.*

3. Unscrew the nut (2), Figure 17, and remove the switch from the bottom side of the instrument panel.

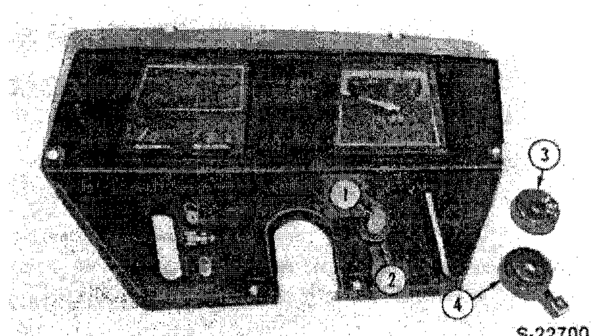

Figure 15
Combination Light and Flasher Switch

1. Switch
2. Nut
3. Knob — Lights
4. Knob — Flasher

TROUBLE SHOOTING

GLOW PLUGS AND CIRCUIT

Disconnect the battery negative cable before performing any of the following ohmmeter tests.

If the glow plugs appear to not be performing properly, perform the following checks.

NOTE: *The key switch supplies electrical power to the glow plugs and to the indicator lamp and timer relay through two separate circuits.*

If the key start switch is inoperative in the "HEAT" position, the indicator lamp, timer relay and glow plugs all will not function.

See Figure 16, wiring diagram.

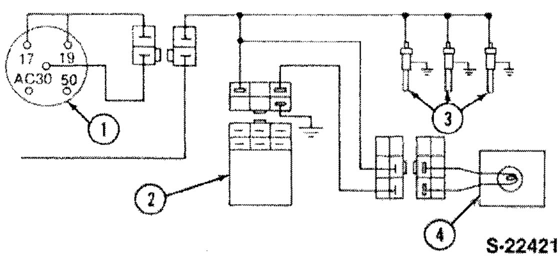

Figure 16
Glow Plug Wiring Circuit
1. Key Switch 3. Glow Plugs
2. Timer Relay Switch 4. Indicator Lamp

If the timer relay malfunctions, it will adversely affect the indicator lamp operation; however, the glow plugs will continue to function normally.

If the glow plugs fail to function, engine starting will be adversely affected; however, the glow plug indicator lamp will function normally.

CIRCUIT CHECK

KEY START SWITCH — HEAT POSITION

Remove the key start switch from the mounting panel, Figure 17.

1. Remove the steering shroud center panel (2), Figure 17.

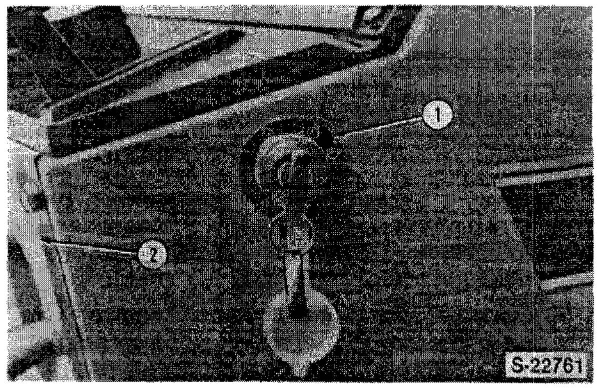

Figure 17
Key Start Switch Removal
1. Key Switch 2. Shroud — Center Panel

2. Remove the retaining nut (4) and remove the switch (1), Figure 18.

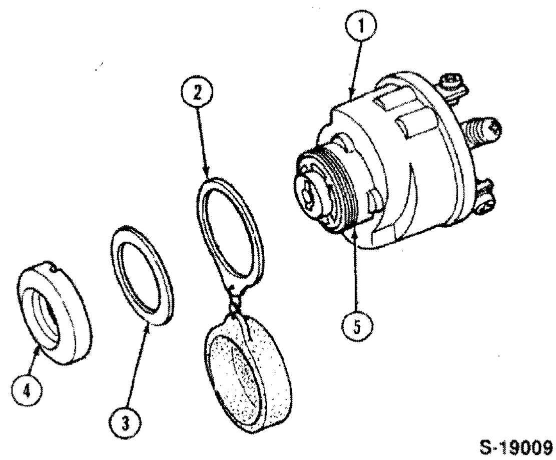

Figure 18
Key Start Switch Removal
1. Switch 4. Retaining Nut
2. Weather Cap 5. Alignment Tab
3. Seal Ring

Reference — Figure 19

1. Connect one ohmmeter lead to the switch terminal marked 19 on the starter switch.

2. Connect the other ohmmeter lead to the switch terminal marked 30. Rotate the key to the "HEAT" position and observe the ohmmeter reading.

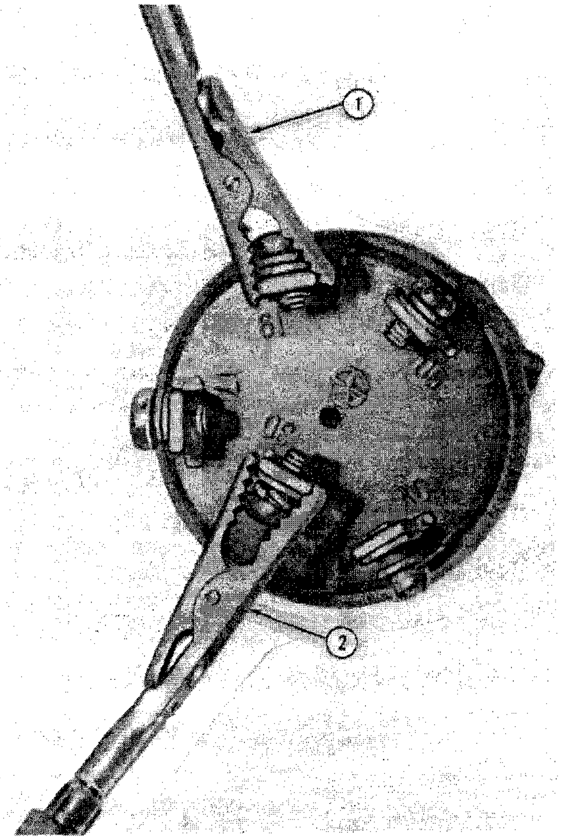

Figure 19
Key Start Switch Heat Position Check
1. Terminal No. 19   2. Terminal No. 30

Test Results

Low or Zero Reading = Good Contacts through switch.

High Reading = Faulty Switch — Replace.

GLOW PLUG CONNECTOR

1. Connect one ohmmeter lead to the glow plug nut.
2. Connect the remaining ohmmeter lead to each of the other glow plug nuts and observe the ohmmeter reading, Figure 20.

Test Results

Low or Zero Resistance = Good Continuity.

High Resistance = Bad Connections — Remove connector and clean connections.

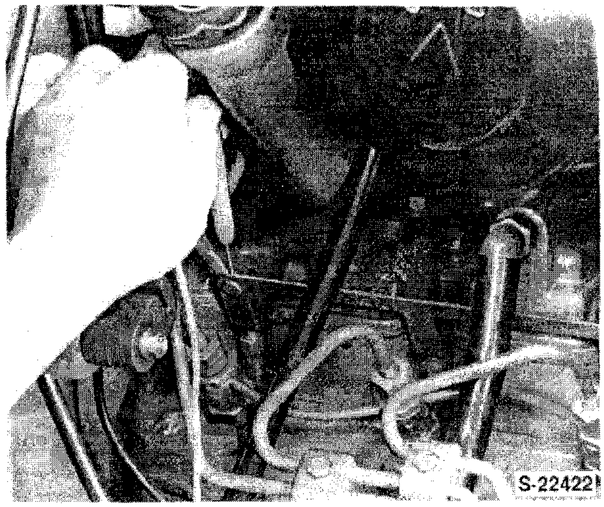

Figure 20
Glow Plug Wiring Check

GLOW PLUGS

Using an ohmmeter, perform continuity and resistance checks on each glow plug as shown, Figure 21. Replace any found to be defective.

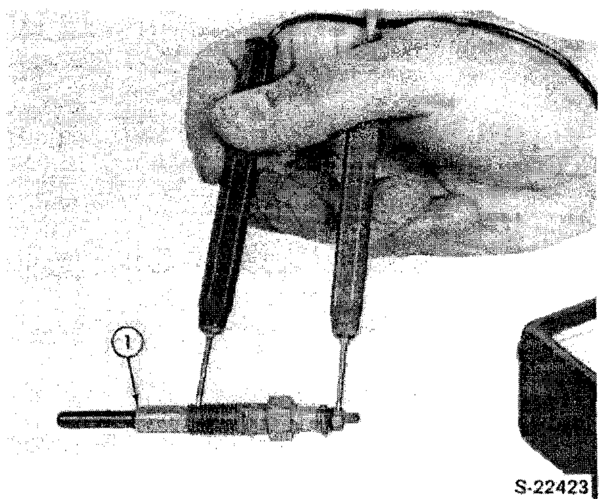

Figure 21
Glow Plug Check
1. Glow Plug

Resistance = 0.8 ohms max.

NOTE: *The 1320/1520/1720 tractor glow plugs are fast acting type and are identified with markings of Y-701 R, or 701 M and have green heat resistant paint applied. Do not inter-change with glow plugs used on prior model tractors.*

CAUTION: *DO NOT DISASSEMBLE GLOW PLUGS BECAUSE THE MAGNESIUM OXIDE INSIDE THE GLOW PLUG IS VERY HAZARDOUS.*

ASSEMBLY

1. Clean the threads on the glow plug and in the cylinder block.
2. Install the glow plug.
3. Install the backing washer.
4. Position the parallel connector over the glow plug.
5. If required, position the wiring terminal on the glow plug.
6. Install the flat washer, lock washer and parallel connector retaining nut.

GLOW PLUG INDICATOR LAMP CIRCUIT

If the indicator lamp is not functioning, remove the instrument panel mounting screws and raise the instrument panel sufficient to remove the circuit board cover, Figure 14.

With the battery connected, use a 12 volt test light connected to the indicator lamp connector strip to make certain the lamp is receiving current when the key start switch is turned to the "HEAT" position.

If there is no current at the test lamp, check the wiring harness for broken wires or loose connections.

If the test light shows that the indicator lamp is receiving current, connect the test light across the terminals and turn the key start switch to the "HEAT" position.

If the test light illuminates for 4-5 seconds and then goes out, replace the indicator lamp.

If the test light does not function properly, replace the timer relay.

PART 3
ELECTRICAL SYSTEM
Chapter 2
BATTERY

A. DESCRIPTION AND OPERATION

SAFETY PRECAUTIONS

WARNING: *Batteries contain SULFURIC ACID. For this reason, numerous safety precautions will be mentioned throughout the manual in the various areas where they are applicable. The principal hazards in servicing batteries occur under charge conditions or when handling acid. The following is a list of safety rules which must be observed when handling or charging batteries:*

1. When mixing battery electrolyte, it is important to pour the concentrated acid into the water and not the water into the acid

2. When working with acid, such as filling batteries, splash-proof goggles should be worn. (Additional protective clothing may be advisable if many batteries are handled.)

3. When adding water or electrolyte, non-metallic containers and/or funnels must be used.

4. Acid must not be stored in excessively warm locations or in direct sunlight.

5. In case of acid contact with skin, eyes, or clothing, FLUSH IMMEDIATELY WITH WATER FOR A MINIMUM OF FIVE MINUTES. Get emergency medical attention for acid burns.

6. Hydrogen and oxygen gases are produced during normal battery operation. This gas mixture can explode if flames or sparks are brought near the battery. Manufacturer's recommendations should be closely followed to hold the charging rate at a limit that prevents rapid generation of hydrogen gas. When charging or using a battery in an enclosed space, always provide adequate ventilation.

7. Exercise care to avoid tools or metallic objects from falling across the battery terminals.

8. Never break a live circuit at the battery terminals. An arc could occur whenever charger leads or booster cable leads are disconnected. Any arc could ignite the accumulated hydrogen gas! Always disconnect the ground cable first at a point away from the battery terminals.

9. Remove cell caps when charging or using jumper cables.

Figure 22
Safety Precautions

DESCRIPTION AND OPERATION

The 12-volt battery, Figure 23, is rated at 72 ampere-hours and is negatively grounded. The battery is constructed with six lead acid cells connected in series. Each cell contains positive and negative plates placed alternately next to each other and separated from each other by a insulated separator plate. If any of the positive plates should make contact with a negative plate within a cell a short will develop and cause irreparable damage to the battery. All positive plates are welded together and all negative plates are welded together. The positive plates and negative plates are connected to an external positive and negative terminal post.

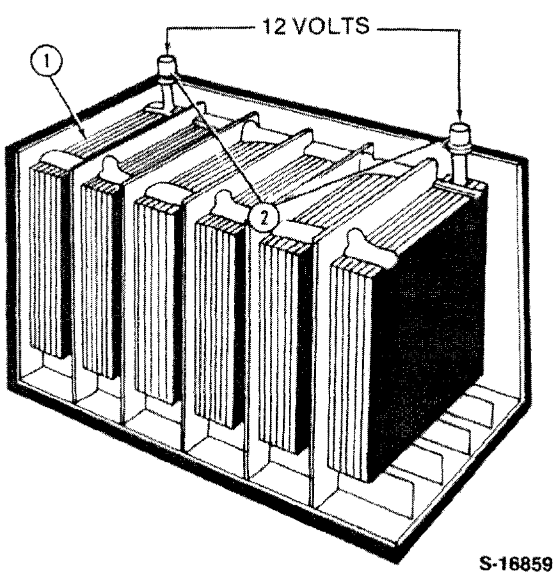

Figure 23
Battery Construction
1. Battery Cells 2. Terminal Posts

When the battery cell is submerged in a liquid electrolyte solution of sulphuric acid, Figure 24, the acid and water combine chemically with the lead peroxide on the positive plates and with the sponge lead on the negative plates causing a transfer of electrons between plates. One plate will lose electrons and become positively charged while the other plate will gain electrons and become negatively charged. When the battery is connected to a lead the surplus electrons at the negative post flow through the circuit to the positive post. The battery is now converting chemical energy to electrical energy.

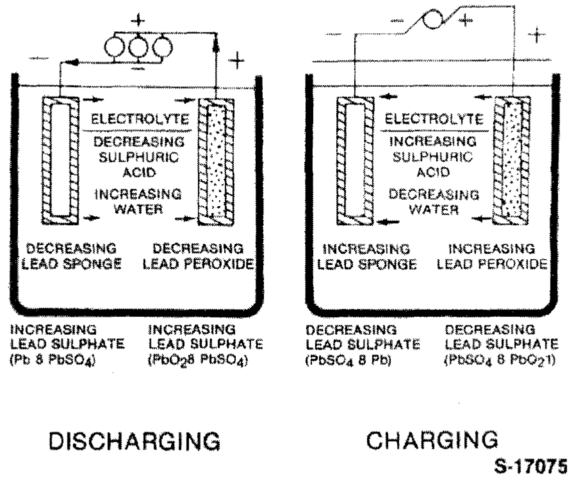

Figure 24
Battery Chemical Action

This process continues until the greater part of the active material on both plates has been converted to lead sulphate, and much of the acid has been reduced to water. When most of the plate surfaces have reacted with the acid the battery will no longer be able to produce current and is therefore discharged.

Recharging is a accomplished by passing a current from an outside source through the battery in the opposite direction to the current flow during discharge. Reversal of the chemical action, by charging, restores the battery to a fully charged condition.

B. MAINTENANCE AND TESTS

REMOVAL

1. Loosen the cable clamps.

2. Use a puller to remove the negative (ground) cable from the battery terminal. Then remove the positive cable.

3. Note the locations of positive and negative terminals so the battery can be properly positioned during installation.

4. Remove the holddowns and battery.

5. Inspect the cables for corrosion and damage. Remove corrosion using a wire brush and soda solution. Replace the cables having damaged or deformed terminals.

6. Inspect the battery tray and holddowns for corrosion. Remove corrosion with a wire brush and soda solution. Paint the exposed bare metal. Replace any damaged components.

7. Clean the outside of the battery case if the original battery is to be installed. Flush the top cover with soda solution to remove acid film. Be careful to prevent soda solution from entering the cells. Remove corrosion from the terminals with a wire brush. Inspect the case for cracks or other damage which could result in a leakage of electrolyte.

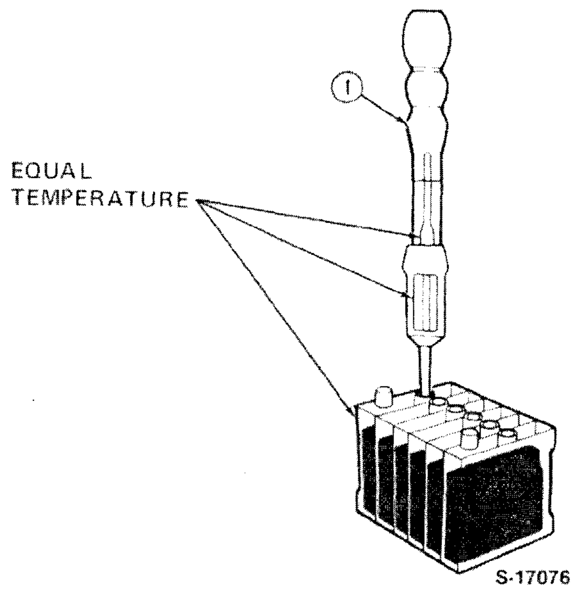

Figure 25
Hydrometer Testing

1. Hydrometer

SPECIFIC GRAVITY – HYDROMETER TEST

The hydrometer test indicates the battery state of charge by measuring the specific gravity of the electrolyte in the battery cells. The specific gravity will vary according to the amount of unused sulphuric acid remaining in solution. The quantity of sulphuric acid in solution determines the battery state of charge.

The hydrometer used for this test should be equipped with a thermometer and the float scale should be graduated to read from 1.160 to 1.320 in graduations of .005 specific gravity. The graduated marking should be accurate within .002, Figure 25.

1. Check the electrolyte level in each cell. Add water to any low cells and charge the battery for ten minutes at twenty amperes to mix the water with the electrolyte.

2. Draw electrolyte in and out of the hydrometer barrel to equalize the temperature of the float and thermometer to that of the acid in the cell, Figure 25.

3. Draw in enough electrolyte to raise the float in the barrel with the bulb fully floating. Do not draw in so much electrolyte that the float is forced against the top of the barrel.

4. With the hydrometer at eye level, read the float scale at the electrolyte level. Hold the hydrometer straight so that the float does not stick to the side of the barrel, Figure 26.

5. Read the specific gravity of each cell.

6. Correct the specific gravity reading for temperature variations, Figure 27.

   a. Add .004 points for each 10° above 80°F.

   b. Subtract .004 points for each 10° below 80°F.

Test Results

1. If the average specific gravity of all cells is above 1.225, but the variation between cells is more than 50 points (.050), the battery is unservicable. Remove the battery for further testing.

2. If the average specific gravity of one or more cells is less than 1.225, recharge the battery as outlined in the slow charging section of this chapter.

3. At the end of the charging period, if the cell variation is more than 50 points (.050), replace the battery.

4. When the specific gravity of all cells is above 1.225 and variation between cells is less than 50 points, the battery must be tested under load.

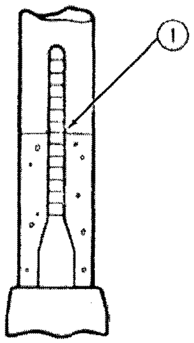

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Figure 26
Hydrometer Reading

CAPACITY TEST

The capacity test is performed to determine if the battery has a discharge capability sufficient to meet the high current demands of the starter motor. The battery is connected to a carbon pile rheostat which can duplicate the high discharge rate the battery experiences during engine cranking. While connected to the simulated load for fifteen seconds, the battery must maintain a voltage of 9.6 volts, To obtain satisfactory results the capacity test should be performed only on a battery which is 100% charged. Never perform this test on a battery which is less than 75% charged (1.230 specific gravity).

1. Connect a carbon pile load tester and voltmeter to the battery.

   a. Make sure the load control knob is in the "OFF" position before making the connection.

   b. Connect the red leads to the battery positive post and the black leads to the battery negative post.

   c. Voltmeter leads must contact the battery posts — not the ammeter leads.

2. Turn the load control knob until the ammeter indicates 200 amp. discharge rate and hold for 15 seconds.

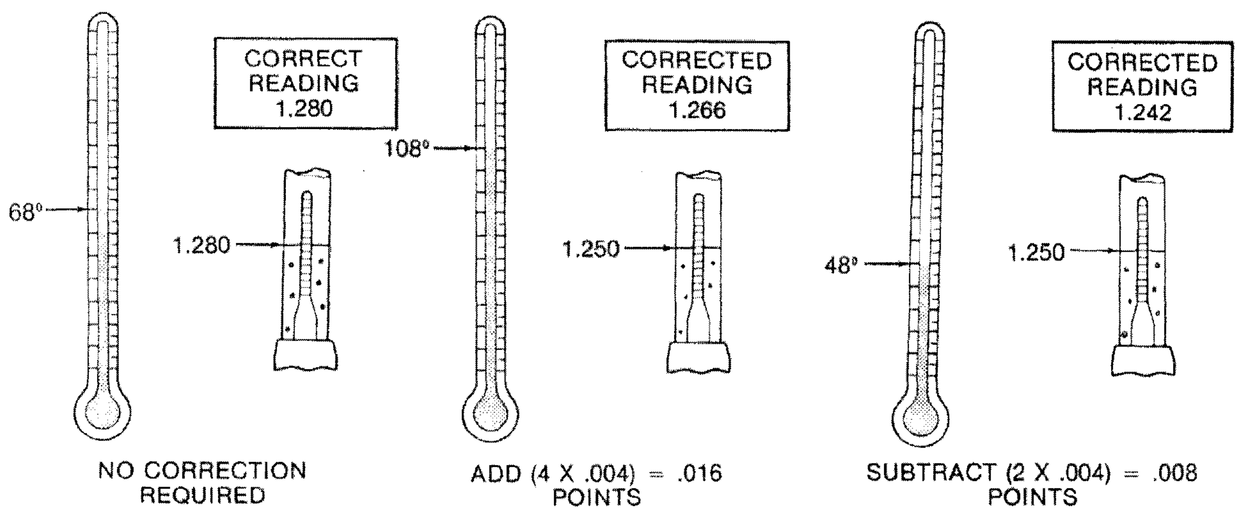

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Figure 27
Hydrometer Reading Temperature Correction

3. At the end of the 15 seconds, observe the voltmeter reading and turn the load control knob to the off position.

Test Results

Battery must maintain above 9.6 volts for the test period.

9.6 volts or above = Good (servicable)

Below 9.6 volts = Perform three minute test charge

THREE MINUTE TEST CHARGE

1. Connect battery charger positive lead to battery positive terminal and negative lead to battery negative terminal. IMPORTANT: Be sure of correct polarity during this test.
2. Turn the battery charger power switch to ON position. Turn the timer switch past three minute mark then back to the three minute mark.
3. Adjust battery charger switch to highest possible rate not exceeding 40 amperes.
4. When timer switch cuts off at the end of the 3 minutes, turn timer switch back to fast charge.
5. Use the 16 volt scale of the battery starter tester and measure total voltage of battery posts while battery is being fast charged, and note the voltmeter reading.

Test Results

Make another capacity test. If capacity test does not meet specifications, replace battery.

If total voltage during charge exceeds 15.5 volts, battery is sulphated and should be cycled and slow-charged until specific gravity reaches 1.270 (See "Slow Charging"). A slow charge is preferrable to bring the battery up to a full charge.

If specific gravity remains constant after testing battery at one hour intervals for three hours, the battery is at its highest state of charge

CURRENT LEAKAGE TEST

The current leakage test is used in a situation where the battery and charging system test is OK yet the battery is continually in a low state of charge. Although an ammeter can be used for this test, it may not be sensitive enough to indicate a small current drain. The voltmeter is preferred because it will indicate battery voltage even if the current drain is as small as a tenth of an amp.

1. Turn off all electrical switches.
2. Disconnect the cable from the battery negative post.
3. Connect the voltmeter between the battery negative cable and the battery negative post.

Test Results

- Voltmeter Reading "0" = OK
- Voltmeter Reading voltage = Proceed to next step

4. Remove one fuse at a time until voltmeter drops to zero.

   NOTE: *If removing the fuses does not cause the voltmeter to drop to zero, disconnect the wires from the electrical accessories (alternator, regulator, etc.) until the needle drops to zero.*

SLOW CHARGING

If time allows, the slow charge method of recharging the battery should be used. A slow charge is the only method to fully charge a battery. A high rate charger can be used to boost the capacity of a battery quickly, but must be followed by a slow charge to bring a battery to full charge.

There are many types of battery charging equipment available. Be sure to follow the instructions of the equipment manufacturer for the necessary preparations and precautions. However, the following items should be observed when slow charging the battery with any type of equipment.

1. If the battery is to remain in the tractor, disconnect the cables at the battery to prevent damage to the electrical system during charging.

2. Thoroughly clean the battery.
3. Make sure the electrolyte is at the proper level.
4. The battery is to be charged at a rate of seven amps.
5. Battery electrolyte temperature must never exceed 125°F (52°C). If this temperature is reached, the battery should be cooled by reducing the charge rate or by disconnecting the battery from the charger.

The average length of time necessary to charge a battery by the slow charge method at the indicated rates is from 12-16 hours, however, when a battery continues to show an increase in specific gravity, battery charge should be continued even if it takes 24 hours or more.

A battery is in a maximum charged condition when all cells are gassing freely and three corrected specific gravity readings, taken at hourly intervals, indicate no increase in specific gravity.

FAST CHARGING

A battery may be charged an any rate which does not cause the electrolyte temperature of any cell to exceed 125°F. (52°C) and which does not cause excessive gassing and loss of electrolyte. This rule does not apply to badly-sulphated batteries. Such batteries should be charged at specified low rates.

A fast charger cannot be expected to fully charge a battery within an hour, but will charge the battery sufficiently so that it may be returned to service. The battery will then be fully charged by the tractor charging system, provided the tractor is operated a sufficient length of time.

The high-rate chargers can inflict irreparable damage on a battery if the safeguards provided by the manufacturer are ignored or circumvented by the operator. Operating instructions of high-rate chargers, as issued by each manufacturer, should be carefully followed.

DRY CHARGE BATTERIES

WARNING: *Before activating a dry charged battery, carefully read the instructions and warnings on the electrolyte carton.*

1. Remove and discard the vent cap seals.
2. Fill each cell with electrolyte until the electrolyte level is at the top of the ring in the bottom of the filler well.

   IMPORTANT: *The electrolyte should be diluted sulphuric acid, sufficiently pure for storage battery use and should preferably be at a temperature between 70°F. (21°C.) and 90°F. (32°C.) In cold climates it may be necessary to place the electrolyte and the battery to be serviced in a warm room until both have attained room temperature.*

3. After the battery is filled, tilt the battery from side to side to release air bubbles. Correct the electrolyte level if necessary.
4. Allow the battery to stand for at least 15 minutes. Absorption of the electrolyte into the plate material may cause the electrolyte level to fall. Correct the electrolyte level if necessary.
5. Check the battery case for leakage to make sure it was not damaged during handling.
6. Install the battery cell vent caps supplied with the battery.

The battery is now ready for installation and can be used to start the engine 15 minutes after filling. If an attempt to start is made and fails, let the battery stand one hour before a further attempt is made.

If facilities exist, it is a useful practice before installing the battery to give a freshening charge for about four hours at a charging rate of one-fifteenth the amp-hour rating of the battery.

Specific Gravity of Electrolyte For Filling Dry and Dry Charged Batteries	
Specific gravity of electrolyte for filling new batteries	1.260-1.270
Specific gravity of electrolyte at end of charge	1.270-1.285
Maximum permissible temperature of electrolyte during charge	125°F. (52°C.)

JUMP STARTING

1. Set the parking brake.
2. Check the battery condition. Do not attempt to jump start if the battery is damaged, if the electrolyte is low, or if the electrolyte is frozen.

3. Use only a 12-volt battery with sufficient capacity for jump starting.

4. Check that all electrical switches are off and that the tractors are not touching one another.

5. Attach the end of one jumper cable to the positive terminal of the booster battery and the other end of the same cable to the positive terminal of the discharged battery.

6. Attach one end of the remaining cable to the negative terminal of the booster battery, and the other end to a solid engine ground at least 12 inches from the battery of the tractor being started — DO NOT CONNECT DIRECTLY TO THE NEGATIVE TERMINAL OF THE DEAD BATTERY.

7. Start the engine of the tractor that is providing the jump start and turn off all electrical switches.

8. Start the engine in the tractor with the discharged battery.

9. Reverse these procedural steps exactly when removing the jumper cables. The first cable to be disconnected should be the negative cable from the ground on the tractor that was being jump started.

MAINTENANCE CHECKS

During scheduled maintenance checks, the battery should be given careful attention. The life of the battery can be extended and service problems related to the battery can be reduced by regularly performing the following maintenance procedure.

1. Visually inspect the battery for damage or incorrect assembly. Repair or replace components as necessary, Figure 28.

2. Inspect the alternator drive belt condition and for proper tension. Replace or tighten the belt if necessary, Figure 29.

3. Check the electrolyte level. Add distilled water if necessary. Do not use well water, Figure 30.

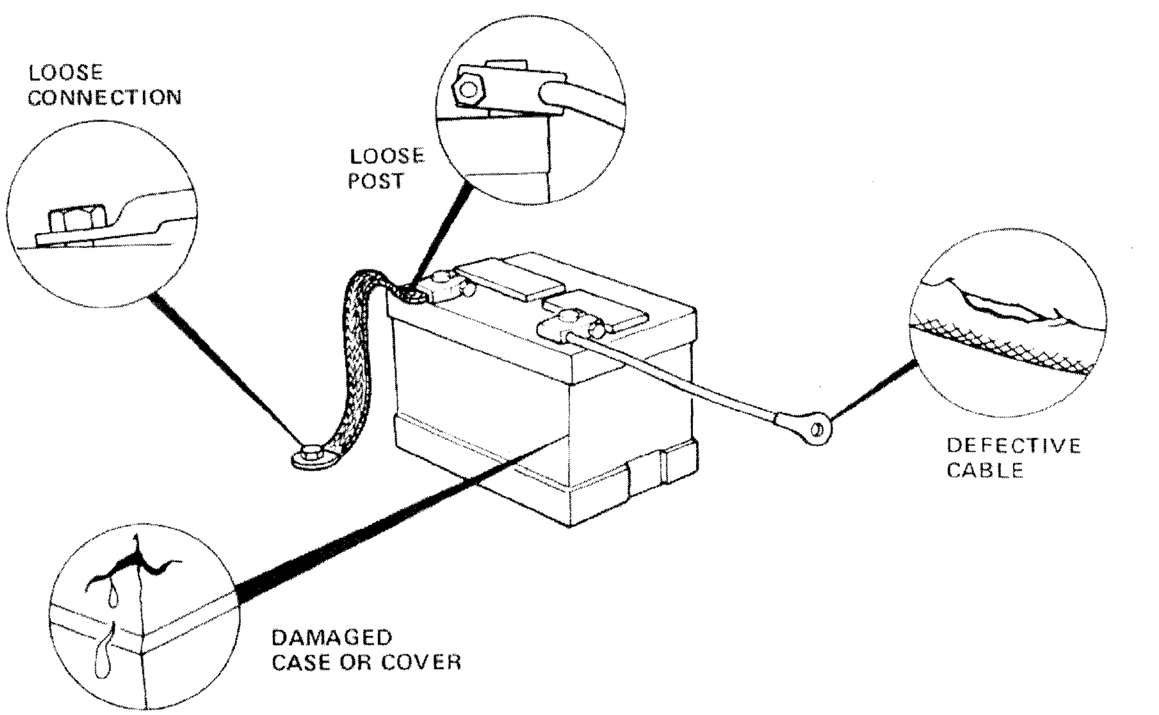
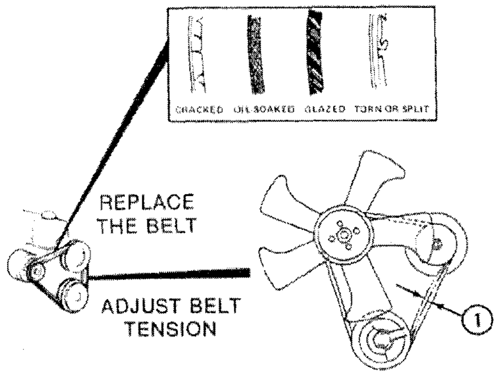


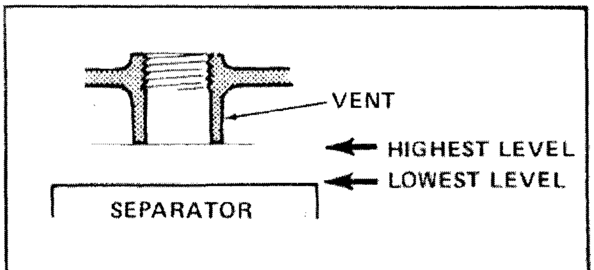
Figure 28
Battery Inspection Checks



S-17080

Figure 29
Alternator Belt Inspection Check

1. Belt Deflection — 0.200 in. (5 mm)



S-17081

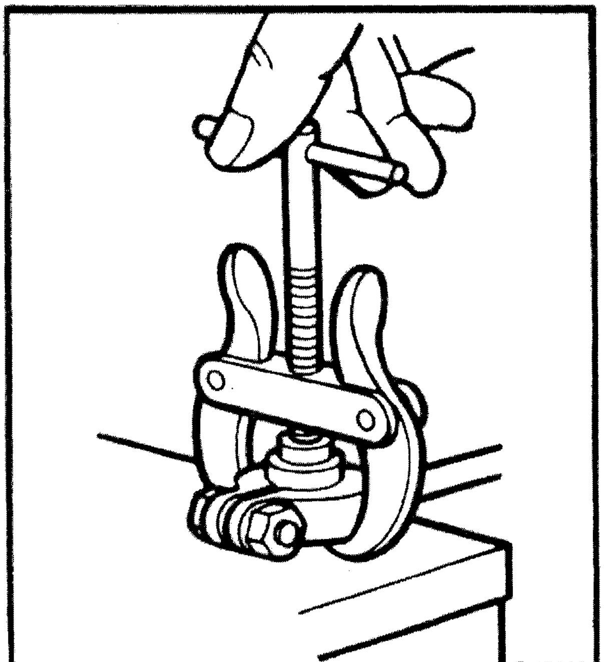
Figure 30
Battery Water Level Check

4. Loosen the cable clamp bolts and remove the cables for cleaning. Use a suitable puller to remove the clamps from the battery post, Figure 31.

5. Clean the battery case and cable terminals using a solution of baking soda and water.

6. Using a wire brush, clean the battery posts and cable terminals. Connect the cables to the battery after cleaning.

7. Clean the ground-to-frame cable connection.



S-17082

Figure 31
Battery Clamp Removal

PART 3
ELECTRICAL SYSTEM

Chapter 3
STARTING SYSTEMS

A. STARTING SYSTEM — DESCRIPTION AND OPERATION

The Ford 1320/1520/1720 starting system consists of a starting motor, a solenoid, a key start switch, a neutral switch, and a relay and heavy duty wiring.

STARTER MOTOR ASSEMBLY

The starting motor is equipped with a reduction gear drive starter, Figure 32. This starting motor is a high speed motor and is equipped with a solenoid operated roller type clutch and a gear reduction unit. A small gear on the armature shaft drives a larger gear mounted in the gear reduction housing. The larger gear, splined to the pinion shaft, drives the pinion gear. This provides greater cranking power and more torque for starting the larger engine.

STARTER SOLENOID

The Solenoid Assembly

The starter solenoid is mounted on top of the starter motor assembly and incorporates two windings, a pull-in winding and a hold-in winding, Figure 33. When the key start switch is turned to the "START" position and the safety switches are in the neurtal position, the solenoid windings become energized. With the solenoid coils energized, the magnetic field attracts the solenoid plunger. The fork attached to the plunger and pinion gear shifts the pinion gear into mesh with the starter ring gear. A set of contact points on the other end of the plunger closes and connects battery current to the starter motor.

Closing the starter motor contacts causes battery voltage to appear at both ends of the solenoid pull-in winding making it ineffective.

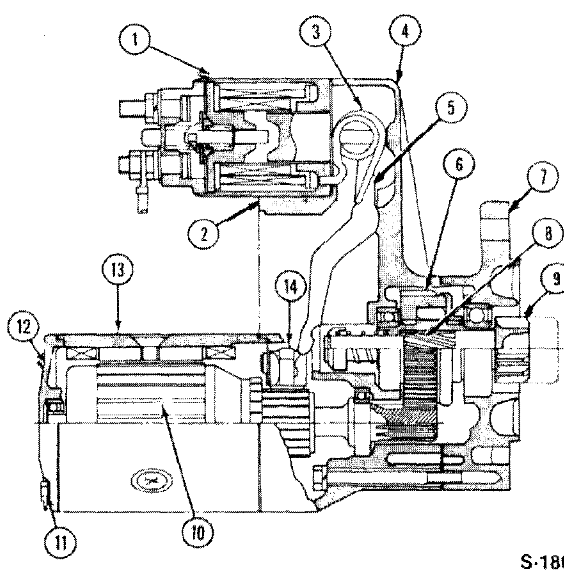


Figure 32
Starter Motor Assembly

1. Magnetic Switch
2. Dust Cover
3. Spring
4. Housing
5. Shift Lever
6. Clutch
7. Gear Case
8. Pinion Shaft
9. Pinion
10. Armature
11. Bolt
12. Rear Cover
13. Yoke
14. Brush Holder

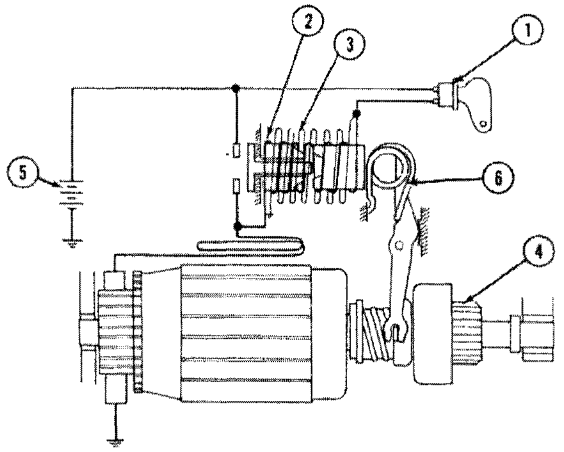


Figure 33
Starter Solenoid Assembly

1. Key Switch
2. Pull-in Winding
3. Hold-in Winding
4. Pinion Gear
5. Battery
6. Spring

The hold-in winding, which is connected to the ground, continues to hold the plunger in the closed position. Cancelling the pull-in coil reduces the solenoid current draw during cranking.

When the key start switch is released, it opens the solenoid circuit and a spring pushes the solenoid plunger out of the housing opening the motor contact points and disengages the pinion from the ring gear.

To prevent the engine from driving the starter motor after the engine is started, the pinion is assembled into an overrunning clutch, Figure 34. The clutch consists of of an outer shell, a cam with tapered notches, spring loaded rollers and a pinion collar which acts as the clutch hub. When the starter motor begins cranking the engine, the rollers move into the narrow ends of the cam tapers where they wedge against the pinion gear collar. With the rollers wedged, the armature rotates the locked assembly through the splined sleeve.

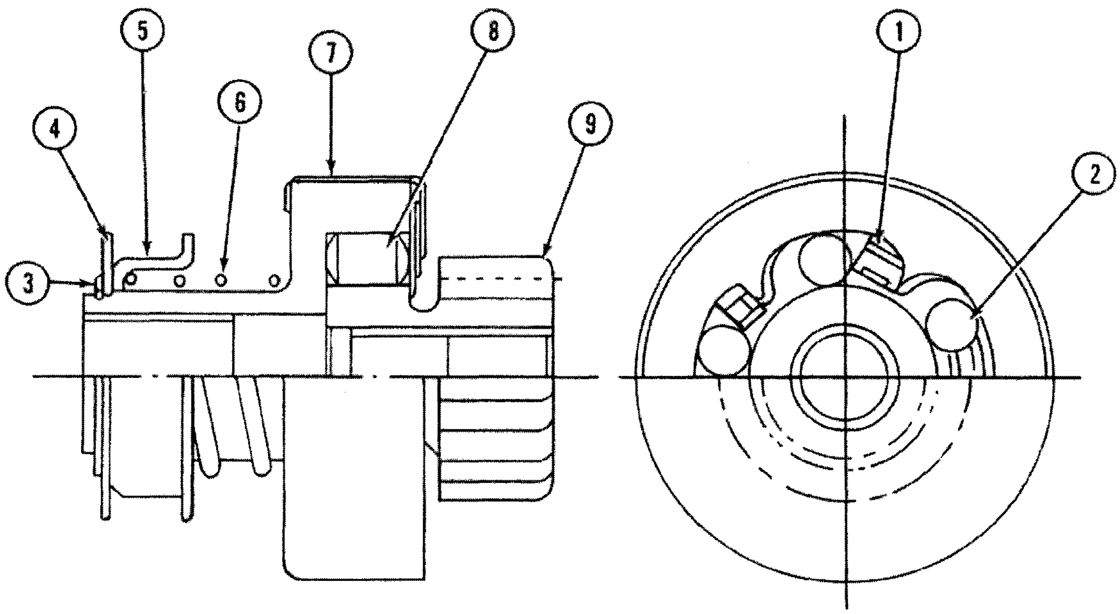


Figure 34
Overrunning Clutch Assembly

1. Spring Roller
2. Roller
3. Snap Ring
4. Sleeve Washer
5. Sleeve
6. Sleeve Spring
7. Clutch Cam
8. Roller
9. Pinion

After the engine starts and before the pinion can disengage the ring gear, the flywheel will cause the ring gear to spin the pinion faster than the armature. The faster moving pinion causes the rollers to move into the wide end of the cam taper unlocking the pinion from the clutch. The unlocking action allows the pinion to turn freely without speeding up the starter motor armature.

The overrunning clutch is serviced as a complete assembly only.

B. STARTING MOTOR — OVERHAUL

REMOVAL

1. Disconnect the negative cable from the battery post.

2. Remove the plastic covers and disconnect the wiring from the starter motor assembly, Figure 35.

3. Remove the starter mounting bolts and withdraw the starter from the clutch housing.

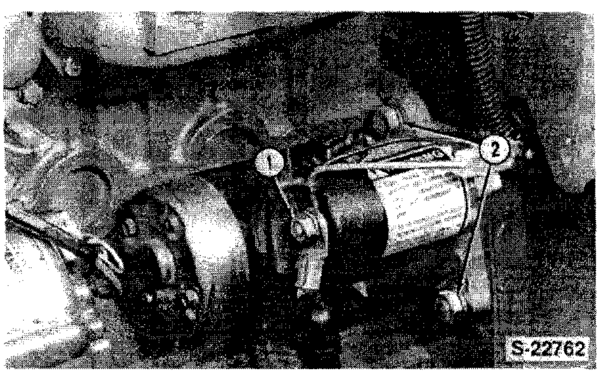


Figure 35
Starter Motor Removal
(Plastic Covers Removed)

1. Solenoid Wiring
2. Starter Mounting Bolt and Nut

DISASSEMBLY

1. Disconnect the field coil strap (1) from the solenoid, Figure 36.

2. Remove the solenoid mounting screws (2) and remove the solenoid (3) from the front housing, Figure 36.

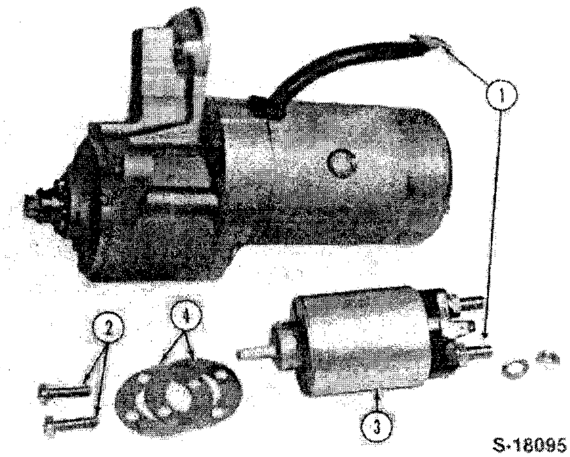


Figure 36
Starter Motor Disassembly

1. Field Coil Strap
2. Solenoid Mounting Screw
3. Solenoid
4. Shims

3. Remove the brush holder retaining screws (2) and through bolts (3). Remove the rear cover (1), Figure 37.

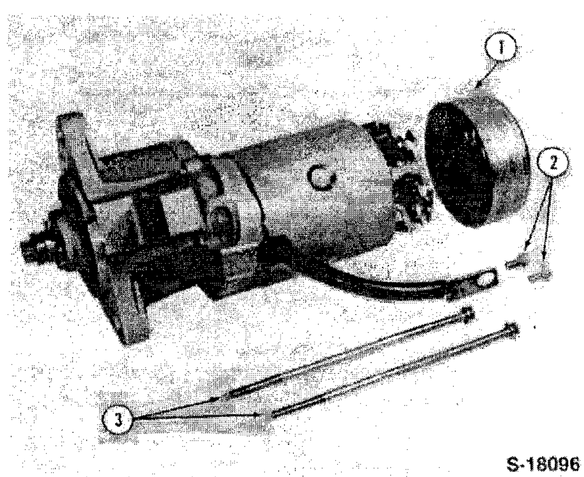


Figure 37
Starter Motor Disassembly — Model 1720

1. Rear Cover
2. Brush Holder Retaining Screws
3. Through Bolts

4. Remove the two positive brushes from their holders and remove the brush holder, Figure 38.

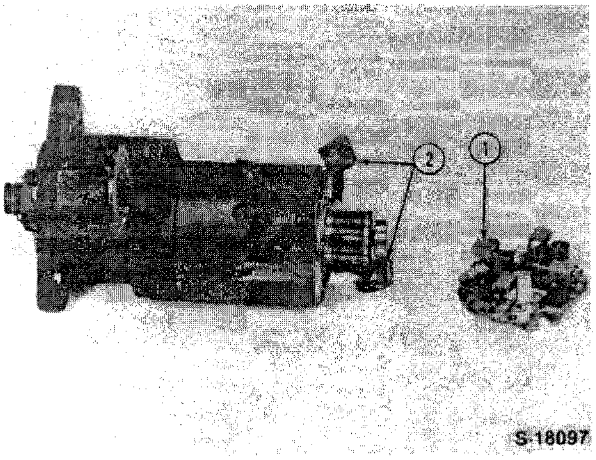


Figure 38
Starter Motor Disassembly
1. Brush Holder 2. Brushes

5. Remove the armature and frame, Figure 39.

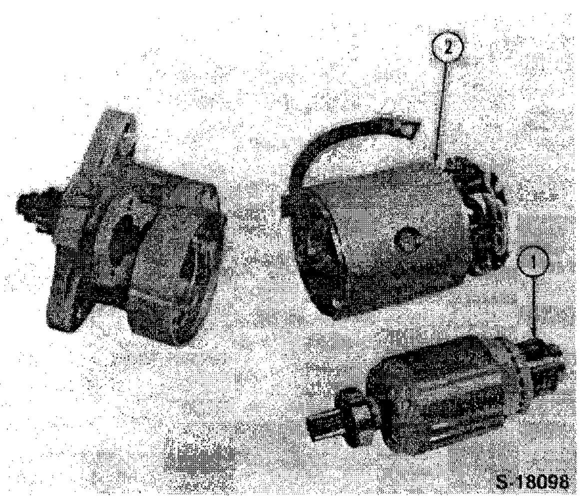


Figure 39
Starter Motor Disassembly
1. Armature Assembly 2. Frame

6. If necessary remove the ball bearings from the armature using a suitable puller, Figure 40.

7. Remove the two screws, cover (1), "C" ring (2) and thrust washer (3), Figure 41.

8. Remove the retaining bolts, center bracket (4) and thrust washers (5), Figure 41.

NOTE: *Thrust washers, item 5, in this location are used to adjust pinion shaft end play.*

9. Using a suitable tool, press the stop ring (12) against the spring tension on the shaft to expose the snap ring (13), Figure 41. Then remove the snap ring, stop ring, pinion gear and spring.

10. Remove the spring guide, spring (7) and lever assembly (8), Figure 41.

11. Remove the reduction gear (6) and pinion shaft from the front bucket.

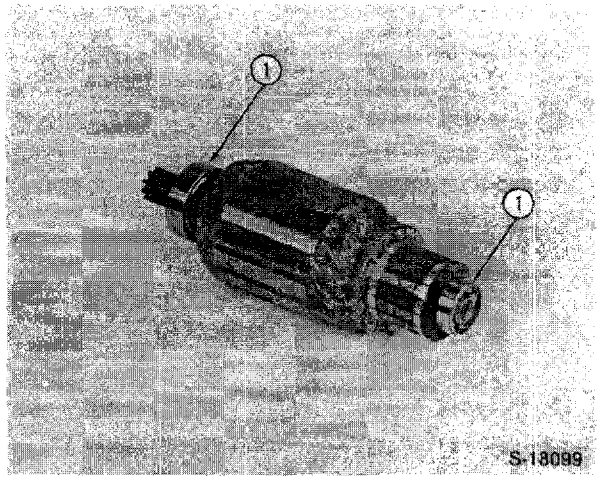


Figure 40
Starter Motor Disassembly
1. Ball Bearings

INSPECTION AND REPAIR

1. Use a shop towel lightly dampened in solvent and low pressure air to clean all starter components.

2. Using fine grit sandpaper, clean the commutator.

   NOTE: *Do not use an emery type abrasive to clean the commutator segments.*

3. Inspect the bushings in the pinion housing and frame end cap. Replace the bushings if scored or if excessive wear is present.

4. Inspect the armature windings for broken or burned insulation and loose connections.

5. Inspect the field coils for burned or broken insulation and loose connections.

6. Inspect the brush holders for broken springs or loose rivets.

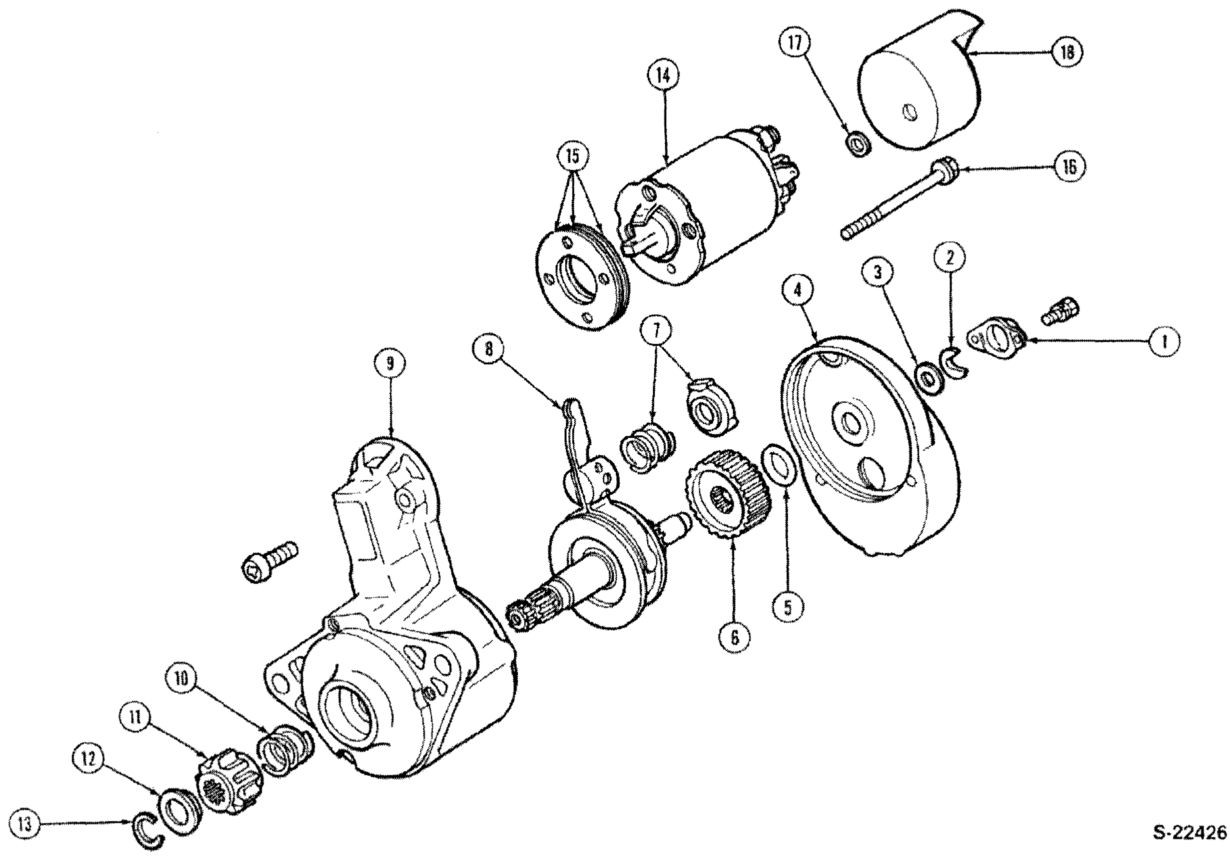


Figure 41
Starter Motor Disassembly

1. Cover	6. Reduction Gear	11. Pinion Gear	15. Shims
2. "C" Snap Ring	7. Spring and Guide	12. Stop Ring	16. Bolts
3. Thrust Washer	8. Lever Assembly	13. Snap Ring	17. Washer
4. Center Bracket	9. Housing	14. Solenoid	18. Cover-Switch
5. Thrust Washer	10. Spring		

7. Inspect the brushes in the holders for sticking or binding conditions.

8. Inspect the commutator for burned spots which indicate an open armature coil.

9. Inspect the bearing in the rear, center and front bracket. Replace the bearing if bearings do not turn smoothly when rotated by hand.

NOTE: *The front bracket must be replaced as an assembly if found faulty.*

10. Measure the brush length, Figure 42. Replace the brushes if they measure less than the following dimensions:

Model	New (A)	Wear Limit (B)
ALL	.710 in. (18 mm)	.433 in. (11 mm)

11. Measure the brush spring tension, Figure 43. Replace the springs if they are not within the following limits.

Model	New	Min. Tension
ALL	3.53-4.85 lbs. (1.6-2.2 kg)	2.86 lbs. (1.3 kg)

12. Measure the commutator diameter, Figure 44. Replace the armature if worn beyond the following specifications.

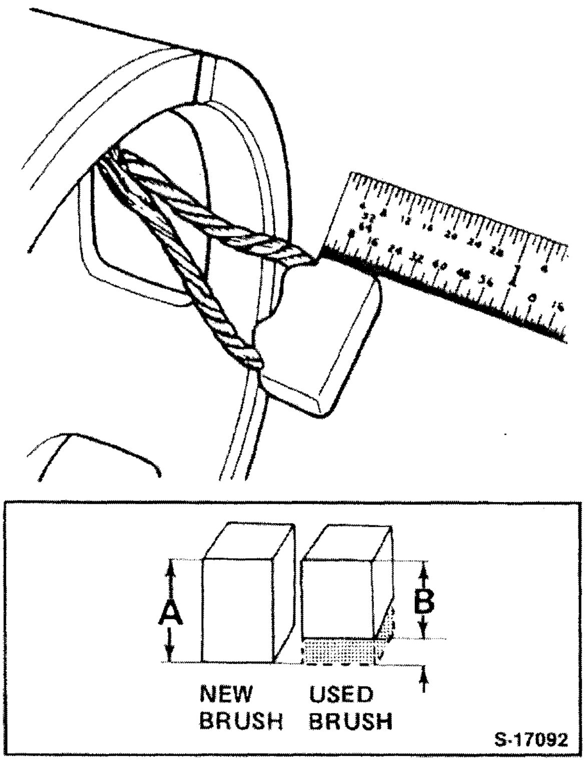


Figure 42
Starter Motor Brush Wear Inspection
1. "A" New Brush Length
2. "B" Used Brush Length

Model	New	Wear Limit
ALL	1.26 in. (32 mm)	1.22 in. (31 mm)

13. Position the armature in V-blocks and measure the commutator runout, Figure 45. If the commutator runout exceeds .020 in. (.5 mm), the commutator may be turned on a lathe.

    NOTE: *Do not reduce the diameter below the minimum diameter specifications.*

14. Measure the distance from the top of the mica insulator to the top of the commutator segment, Figure 46. If the distance is not within specifications the mica can be undercut using a suitable tool. If the insulator cannot be properly undercut, replace the armature.

15. Position the armature in a set of V-blocks and measure the shaft runout, Figure 47. If the shaft runout exceeds .002 in. (0.05 mm) replace the armature.

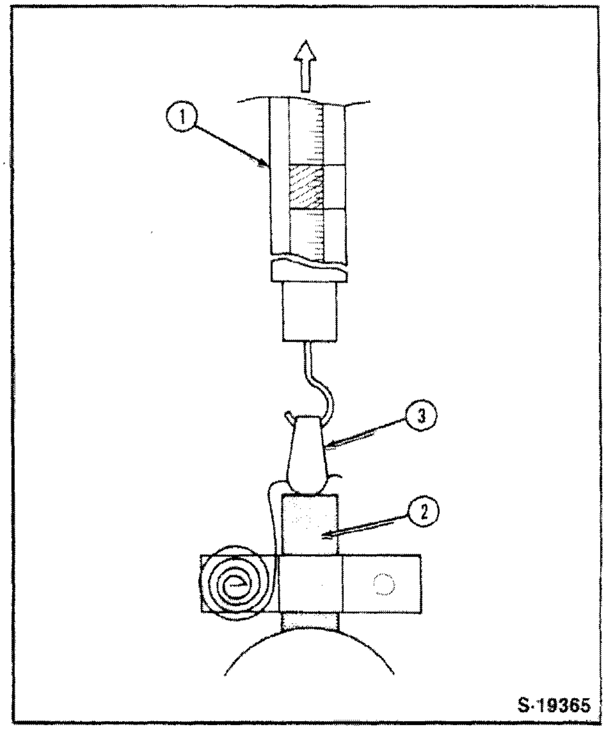


Figure 43
Starter Motor Brush Spring Tension Check
1. Spring Scale
2. Brush
3. Cloth Sling

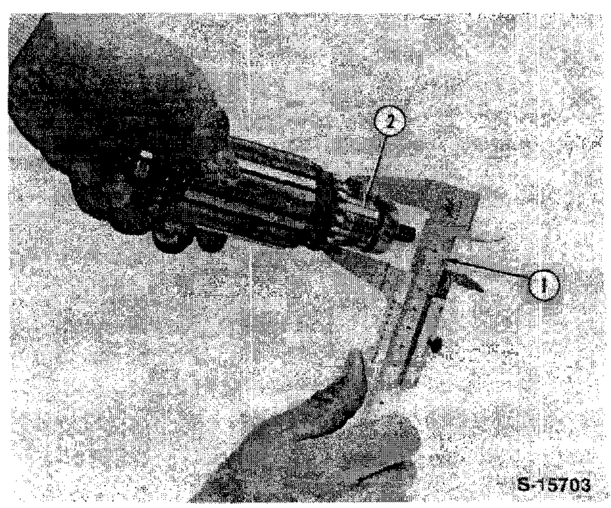


Figure 44
Commutator Wear Check
1. Caliper
2. Commutator Segment

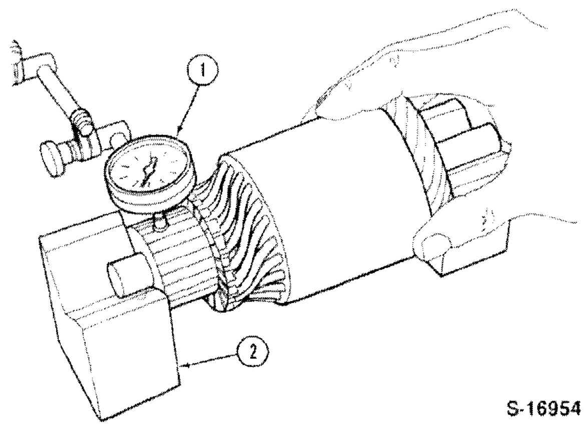


Figure 45
Commutator Runout Check
1. Dial Indicator 2. "V" Blocks

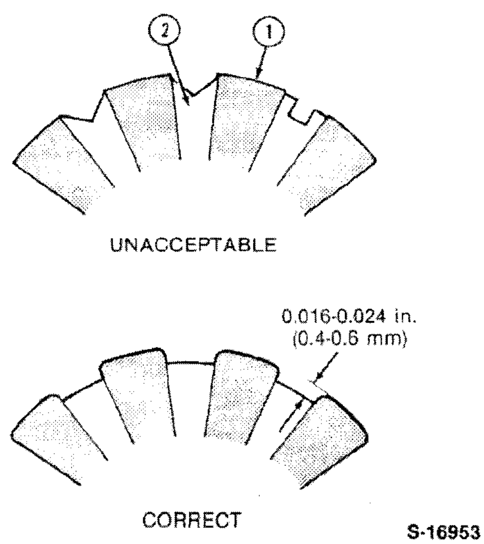


Figure 46
Commutator Insulation Check
1. Commutator Segment 2. Insulator

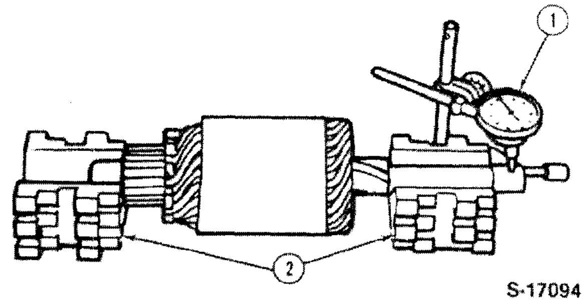


Figure 47
Armature Shaft Runout Check
1. Dial Indicator 2. "V" Blocks

16. Inspect the pinion and ring gear for excessive wear, Figure 48. Replace the pinion assembly and ring gear if they are milled, pitted, or have damaged gear teeth.

ELECTRICAL TESTS

1. Armature Coil Continuity Test

Using an ohmmeter, touch one ohmmeter lead to a commutator segment and the other lead to an adjacent segment and observe the ohmmeter reading, Figure 49.

Repeat the test on each adjacent set of commutator segments, Figure 49.

Test Results

Low resistance reading = Good.

High resistance reading = Faulty armature coil, — Replace.

2. Grounded Armature Coil Test

Using an ohmmeter, touch one ohmmeter lead to the armature shaft and the other ohmmeter lead to each of the commutator segments one at a time and observe the reading, Figure 50.

Test Results

High resistance reading = Good.

Low resistance reading = Grounded armature coil — Replace.

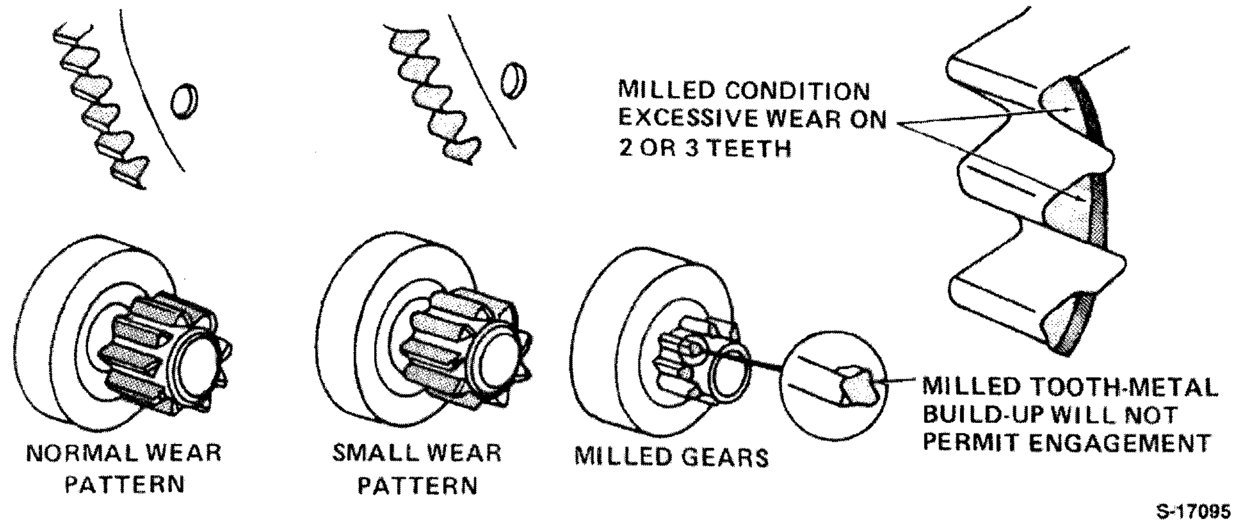


Figure 48
Pinion Gear Wear Check

3. **Brush Holder Ground Test**

Using a ohmmeter, touch one ohmmeter lead to the insulated brush holder and the other ohmmeter lead to the brush holder plate and observe the ohmmeter reading, Figure 51.

Repeat this test on the remaining brush holder.

Test Results

High resistance reading = Good.

Low resistance reading = Grounded brush holder — Replace.

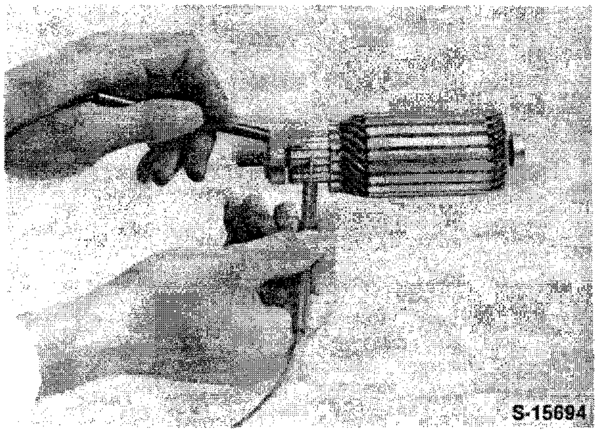


Figure 49
Armature Coil Continuity Check

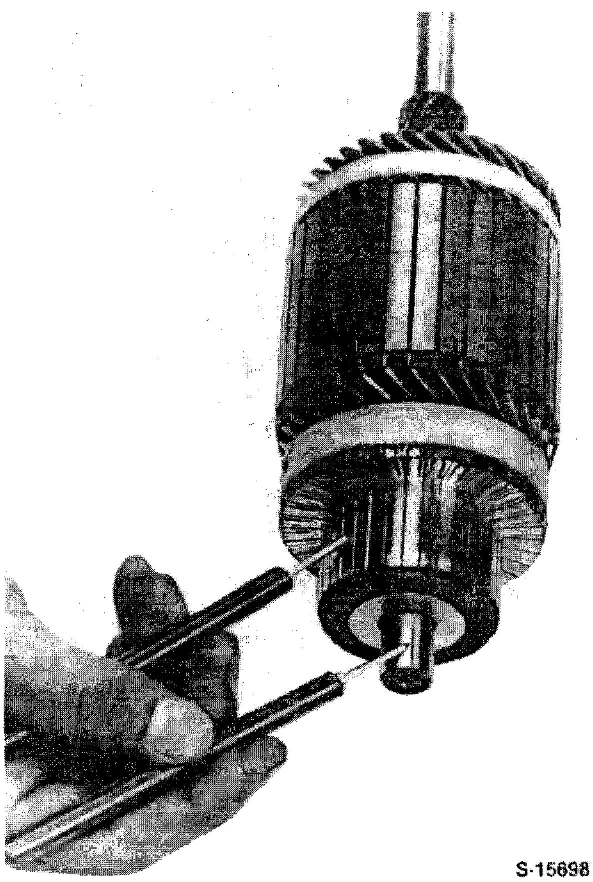


Figure 50
Armature Coil Ground Check

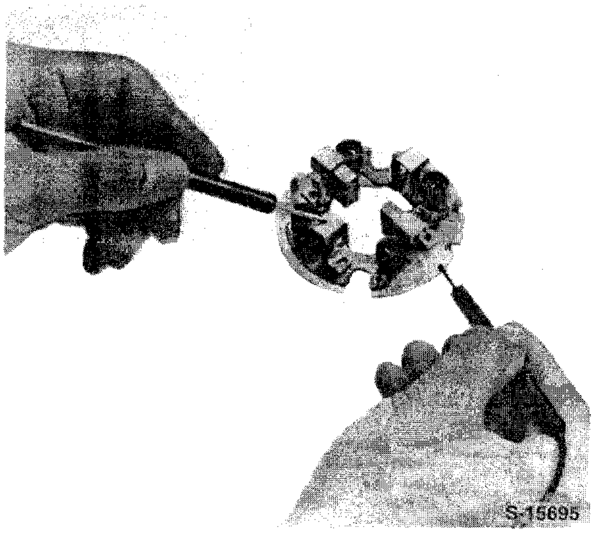


Figure 51
Brush Holder Ground Check

4. **Field Coil Continuity Test**

   Using a ohmmeter, connect one ohmmeter lead to one of the field coil brush connectors and the other ohmmeter lead to the other field coil brush connector and observe the ohmmeter reading, Figure 52.

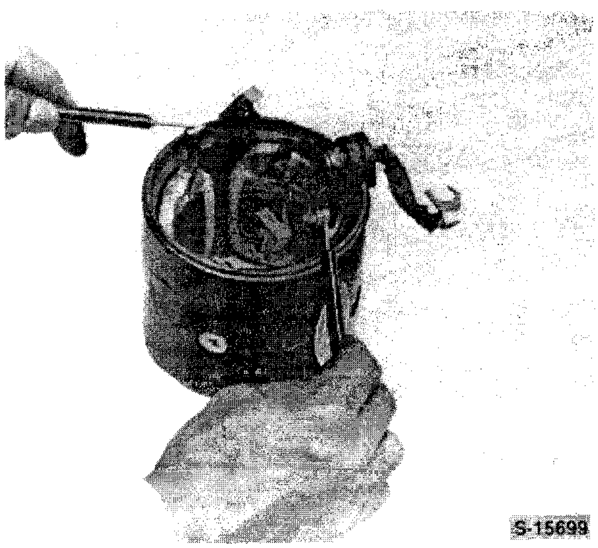


Figure 52
Field Coil Continuity Check

Test Results

Low resistance reading = Good.

High resistance reading = Faulty coil — Replace.

5. **Field Coil Ground Test**

   Using a ohmmeter, connect one ohmmeter lead to one of the field coil brush connectors and the other ohmmeter lead to the starter frame and observe the ohmmeter reading, Figure 53.

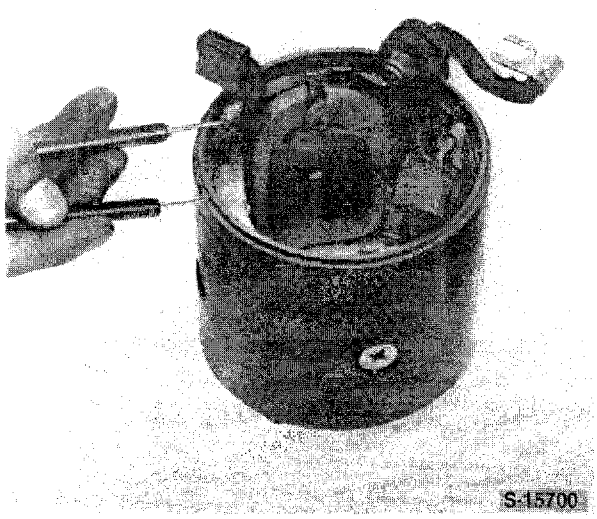


Figure 53
Field Coil Ground Check

Test Results

High resistance reading = Good.

Low resistance reading = Grounded coil — Replace.

6. **Solenoid Pull-In Coil Continuity Test**

   Using an ohmmeter, touch one ohmmeter lead to the solenoid motor terminal and the other ohmmeter lead to the switch terminal and observe the ohmmeter reading, Figure 54.

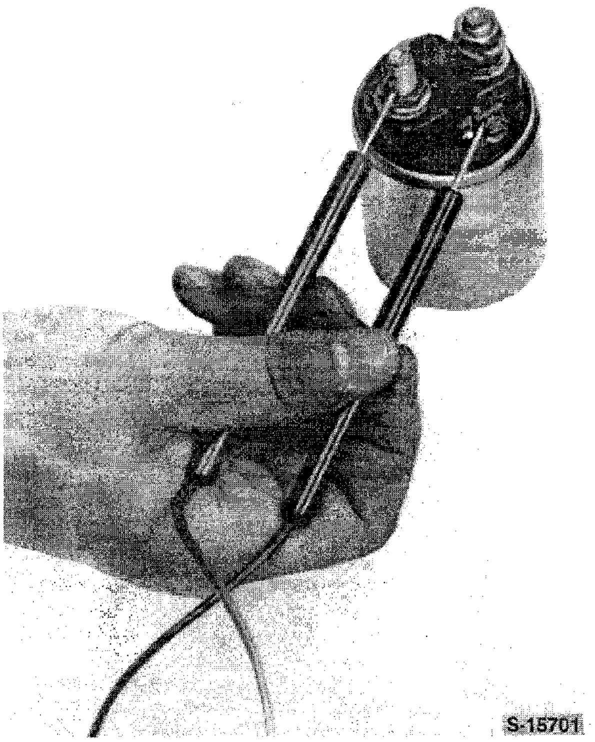


Figure 54
Solenoid Pull-In Coil Continuity Check

Test Results

Low resistance reading = Good.

High resistance reading = Faulty coil — Replace solenoid.

7. **Solenoid Coil — Hold-in Coil Continuity Test**

   Using a ohmmeter, touch one ohmmeter lead to the switch terminal and the other lead to the solenoid housing and observe the ohmmeter reading, Figure 55.

Test Results

Low resistance reading = Good.

High resistance reading = Faulty coil — Replace solenoid

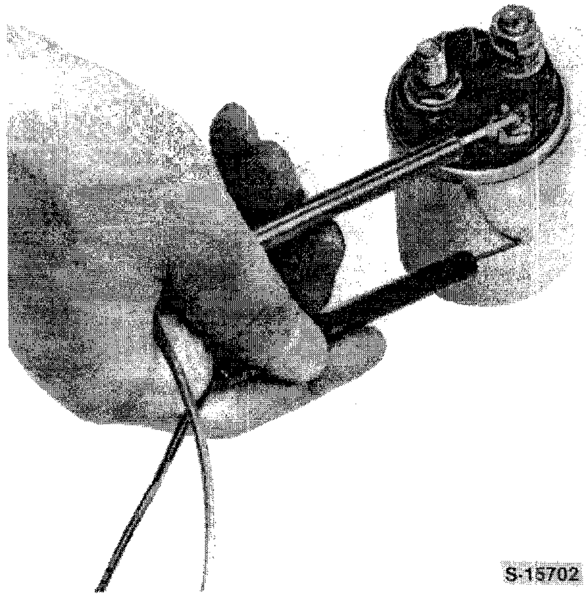


Figure 55
Solenoid Hold-In Coil Continuity Check

ASSEMBLY AND ADJUSTMENTS

Assembly of the starter generally follows the disassembly procedure in reverse, see Figure 56.

PINION CLEARANCE CHECK AND ADJUSTMENT

Bench check the assembled starter as follows:

Reference — Figure 57

1. Remove the field coil wire from the solenoid terminal (1) and insulate the wire from the housing.

   NOTE: *Failure to disconnect and insulate the wire will cause the motor to spin when the battery is connected.*

2. Use a battery and connect a jumper cable from the battery negative terminal to the starter housing, Figure 57.

3. Connect a jumper wire from the battery positive post to the solenoid switch terminal.

4. Connect a jumper wire to the solenoid motor terminal and touch the other end to the starter housing, Figure 57.

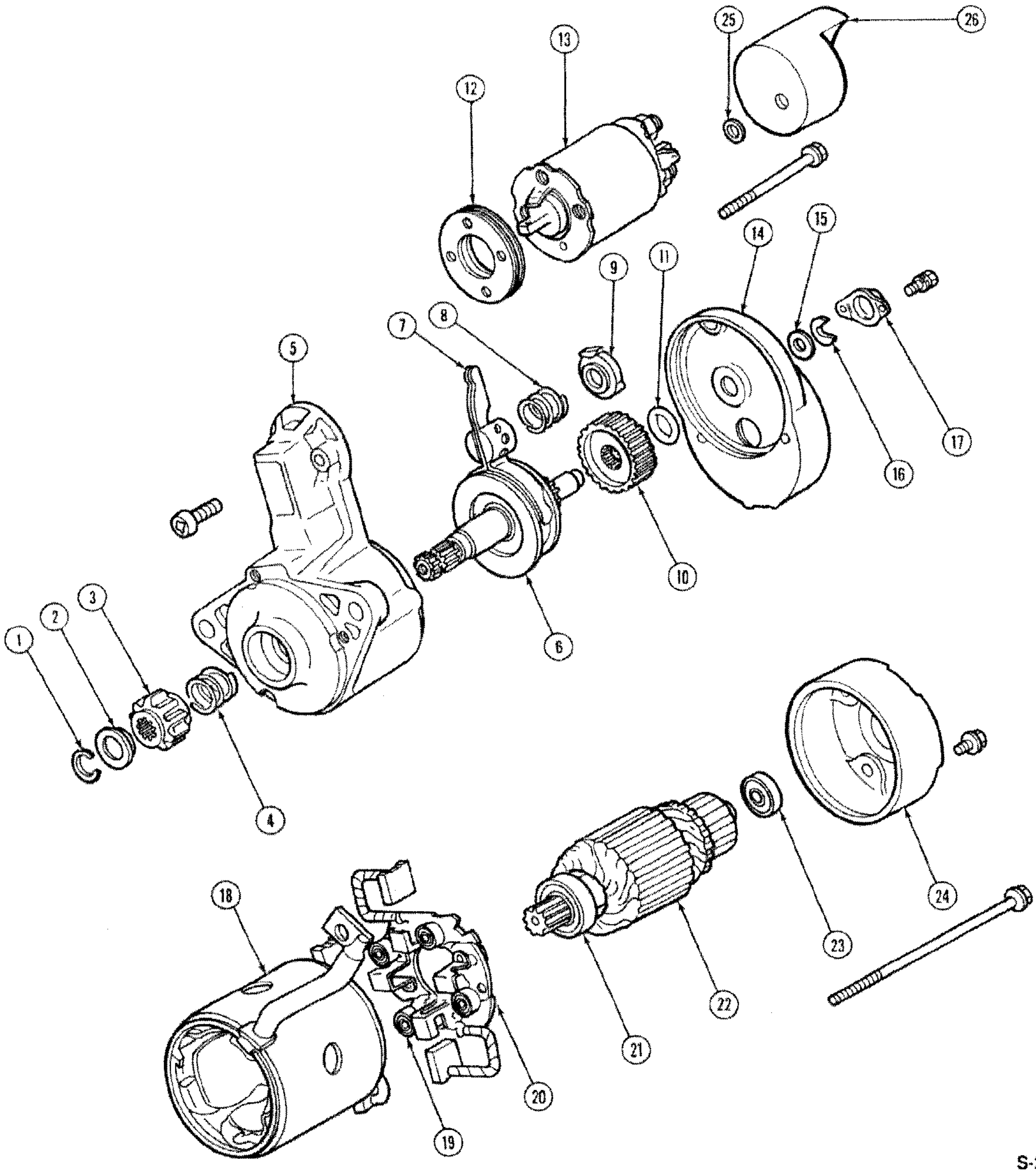


Figure 56
Starter Motor Assembly

1. Snap Ring
2. Stop Ring
3. Pinion Gear
4. Spring
5. Housing
6. Pinion Shaft Assembly
7. Fork
8. Spring
9. Guide
10. Gear
11. Shim
12. Shims
13. Solenoid Coil
14. Center Housing
15. Shim
16. "C" Snap Ring
17. Cover
18. Field and Frame Assembly
19. Brush Assembly
20. Brush Holder Assembly
21. Bearing
22. Armature Assembly
23. Bearing
24. Rear Cover
25. Washer
26. Cover-Switch

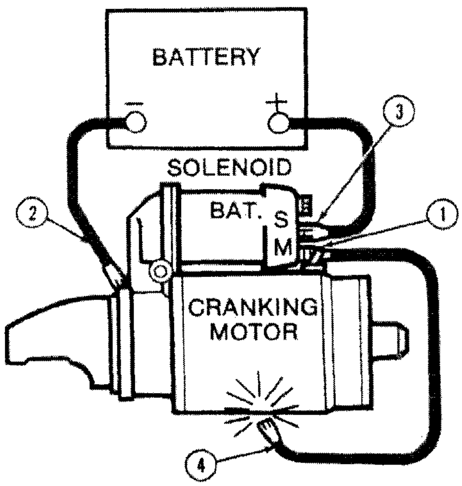


Figure 57
Pinion Clearance Check

1. Solenoid Field Coil Wire
2. Battery Neg. Jumper Wire
3. Battery Pos. Jumper Wire
4. Jumper Wire — Motor Terminal to Housing

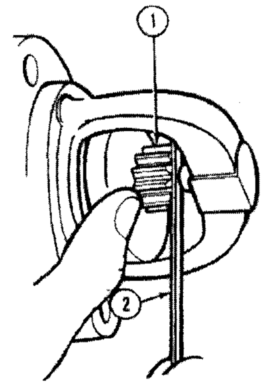


Figure 58
Pinion Gear Clearance Check

1. Pinion Gear

This shifts the pinion into the cranking position where it will remain until the battery is disconnected.

IMPORTANT: *Do not keep the battery connected any longer than necessary as overheating of the solenoid may result.*

5. Push the pinion back to eliminate overtravel, Figure 58, and measure the amount of the pinion shaft movement.

   Pinion clearance should be: . . . . .019 in.-.078 in (.5-2.0 mm)

6. Add or subtract shimss as required as shown in Figure 59 to achieve the required clearance.

   NOTE: *Excessive clearance is an indication of worn shift components. Adding shims decreases the pinion clearance.*

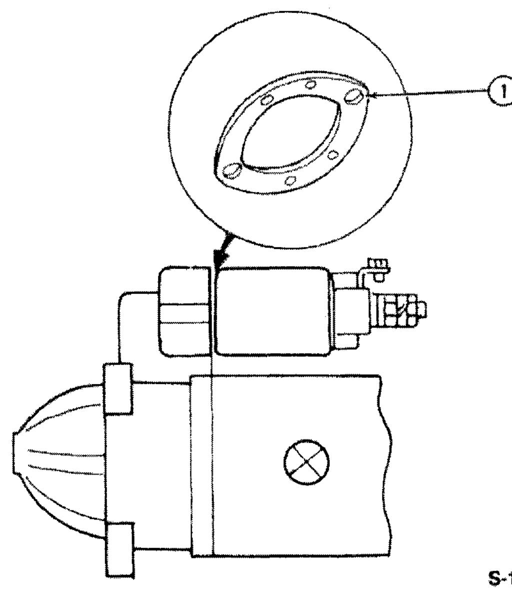


Figure 59
Shim Adjustment

1. Shim Location

C. NEUTRAL START SWITCH — DESCRIPTION AND OPERATION

The tractors are equipped with an advanced design neutral start system.

On the model 1320 and 1520 tractors, the starting circuit can be activated only when the clutch pedal is fully depressed and the PTO control lever(s) is in the neutral position, Figure 60.

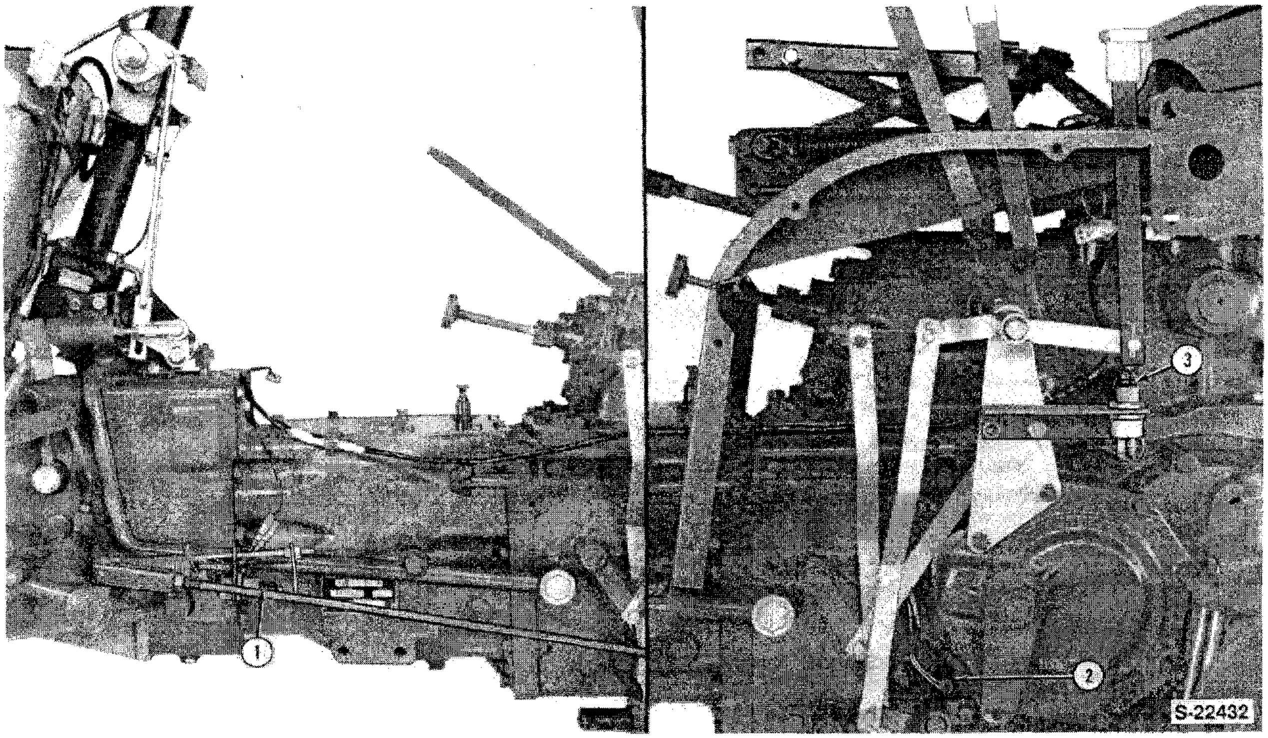


Figure 60
Neutral Start Switches — Model 1320/1520

1. Transmission Neutral Start Switch (Clutch Pedal)
2. Rear PTO Neutral Start Switch
3. Mid-PTO Neutral Start Switch

On the model 1720 tractor, the starting circuit can be activated only when the main transmission gear shift lever and the PTO control lever are in the neutral position, Figure 61.

The switches opens and close the circuit between the key start switch and the fuel stop solenoid relay switch, (1), Figure 62.

The relay switch is located on the baffle plate in front of the fuel tank. The neutral switches are normally open and are closed by positioning the PTO lever and main transmission shift lever in neutral (or by fully depressing the clutch pedal).

If equipped with the shuttle synchromesh transmission, the shuttle shift lever operates the neutral switch instead of the main shift lever. With the switch closed, the relay switch closes when the key start switch is activated in the "START" position and completes the circuit to the starter motor solenoid coil.

If the tractor is equipped with mid-mount PTO, the PTO lever must also be in the neutral position.

D. NEUTRAL START SWITCH — OVERHAUL

Model 1320/1520

TRANSMISSION — NEUTRAL SWITCH REMOVAL

Reference — Figure 63

1. Disconnect the wire connectors.
2. Unscrew the lock-nut and remove the switch assembly.

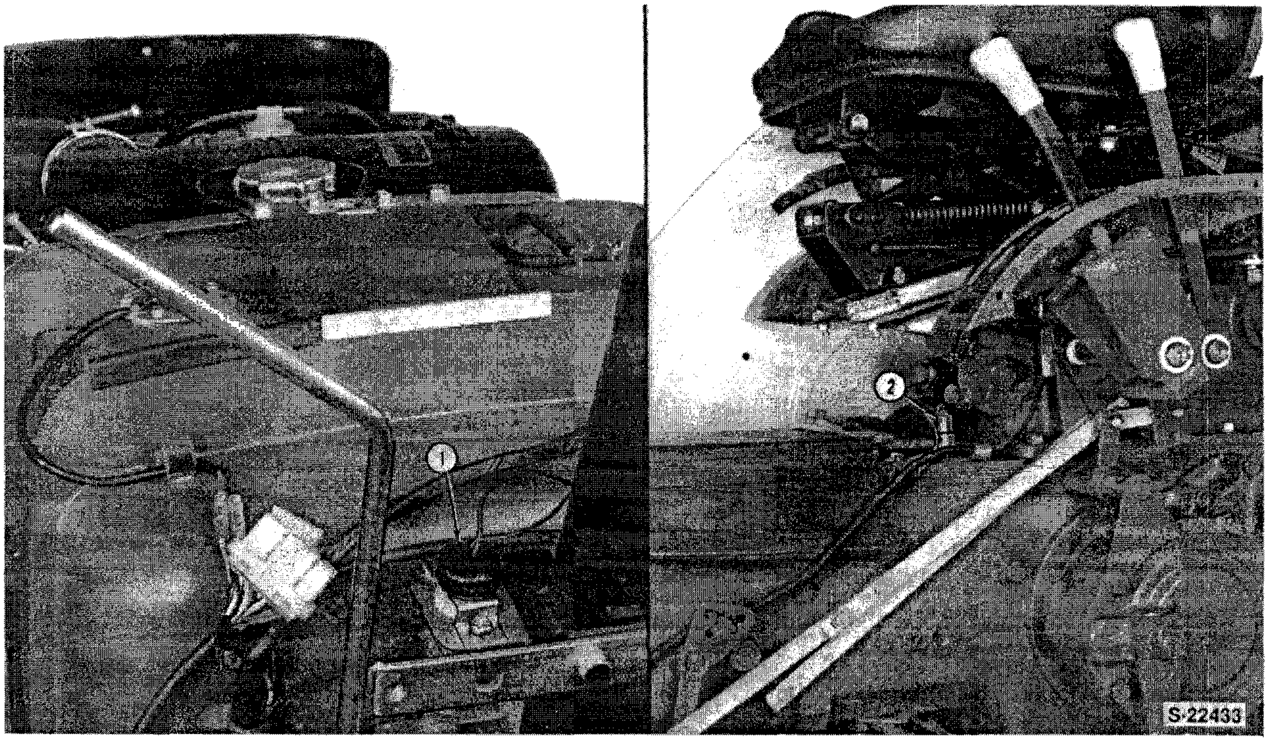


Figure 61
Neutral Start Switches — Model 1720

1. Transmission Neutral Start Switch (Shift Lever)
2. PTO Neutral Start Switch

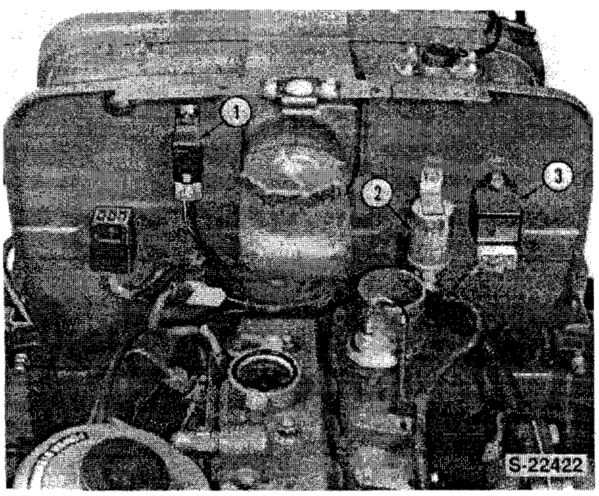


Figure 62
Relay Switches

1. Starting Relay (Fuel Stop Solenoid)
2. Flasher Relay Unit
3. Glow Plug Indicator Lamp Relay

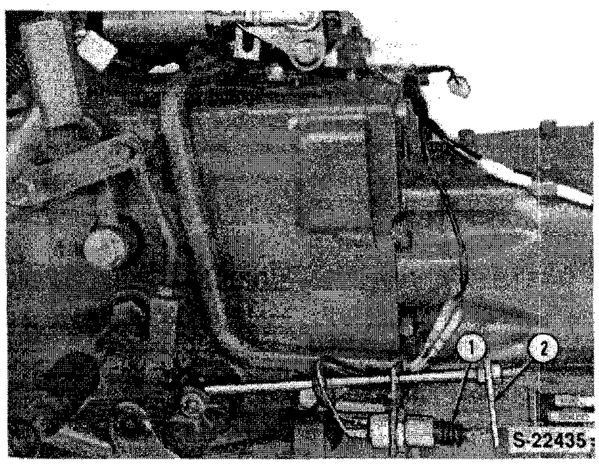


Figure 63
Transmission Neutral Start Switch — Model 1320/1520

1. Switch
2. Activating Lever (Clutch Pedal)

ASSEMBLY

Install the switch assembly and adjust the lock-nuts so that the lock plate (2), Figure 63 opens the switch circuit when the clutch pedal is fully depressed. See ADJUSTMENT AND INSPECTION below.

Model 1720

TRANSMISSION — NEUTRAL SWITCH REMOVAL

Reference — Figure 64

1. Remove the instrument panel mounting screws and raise the instrument panel sufficient to gain access to the switch.

2. Disconnect the wiring connectors to the switch.

3. Remove the two mounting screws (3) and remove the switch assembly.

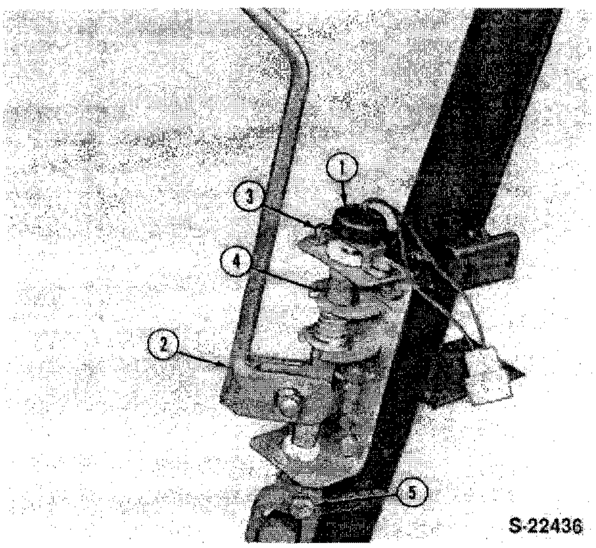


Figure 64
Transmission Safety Start Switch — Model 1720

1. Switch
2. Shift Lever
3. Screws
4. Upper Shaft
5. Clamp Bolt

ASSEMBLY

NOTE: *The neutral switch is a rotary type switch with a small pin that fits into a roll pin groove located in the upper end of the shift lever shaft (4), Figure 64. Moving the shift lever forward and backward from the neutral breaks the contacts in the switch and prevents starting the tractor when in gear.*

Assemble the switch following the disassembly procedure in reverse. On assembly, adjust the switch neutral position. See ADJUSTMENT AND INSPECTION below.

ADJUSTMENT AND INSPECTION

CLUTCH PEDAL SWITCH (Model 1320-1520)

1. Adjust the clutch linkage as outined in Part 4 of this manual.

2. Disconnect the switch wiring terminals.

3. Loosen the locknut.

4. Connect an ohmmeter across the switch terminals.

5. Fully depress the clutch pedal and position the mid PTO shift lever in the neutral position.

6. With the clutch pedal depressed, move the switch forward against the clutch case until the ohmmeter indicates that the switch contacts are closed.

MAIN TRANSMISSION NEUTRAL SWITCH (Model 1720)

1. Disconnect the switch wiring connector.

2. Connect an ohmmeter across the switch terminals. When the main shift lever is moved to the neutral position, the ohmmeter should indicate that the switch contacts are closed. If required, loosen the retaining screws and adjust the switch accordingly.

   NOTE: *If the shift lever shaft (4), Figure 64, has been disassembled or the clamp bolt (5) loosened, it may be necessery to reposition the upper shaft and lever assembly to properly align the shift lever to the neutral position.*

MID-MOUNT AND REAR PTO SWITCH

1. Disconnect the switch wiring connections.

2. Connect the ohmmeter across the switch terminals.

3. Position the PTO lever in neutral position, and the ohmmeter should then indicate that the switch contacts are closed. If required, remove the switch (1), Figure 65, and add or subtract shims as needed.

4. Reconnect the wiring connectors and test the switch for proper operation.

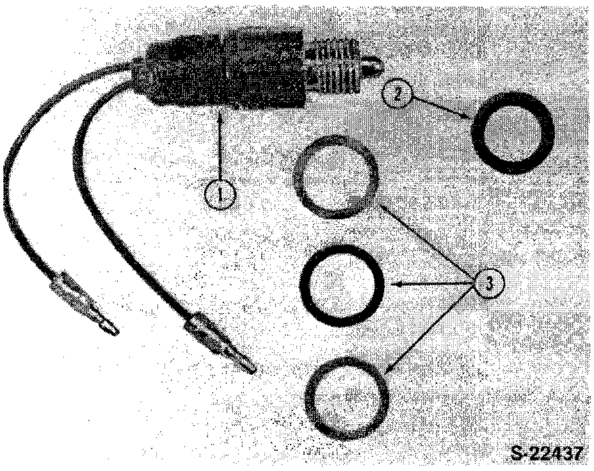


Figure 65
PTO Neutral Start Switch
1. Switch
2. Gasket
3. Shims

RELAY

REMOVAL

1. Disconnect the relay wiring, Figure 62.

2. Remove the relay mounting bolt and remove the relay.

INSPECTION

Check the relay contact switch as follows:

1. Using an ohmmeter, connect the ohmmeter leads to the relay terminals marked 1 and 2 and observe the ohmmeter reading, Figure 66.

Test Results

High resistance reading = Good.

Low resistance reading = Faulty contacts—replace relay.

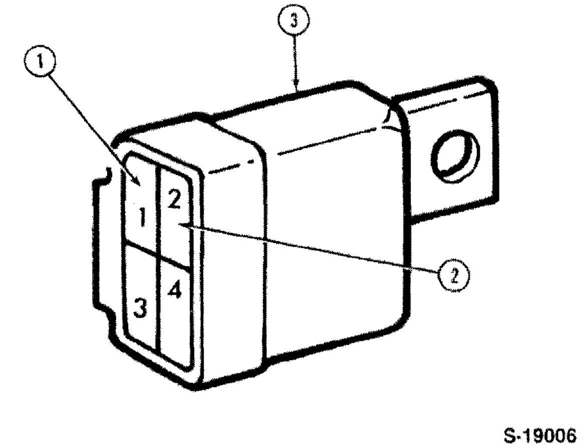


Figure 66
Relay Contact Switch Check
1. To Starter Motor
2. From Key Switch
3. Relay Assembly

If a high resistance reading is observed, use jumper wires and connect the relay to the battery and re-check the contact switch operation as follows:

1. Connect the battery positive lead to the relay terminal marked No. 3 and the negative lead to relay terminal No. 4, Figure 67.

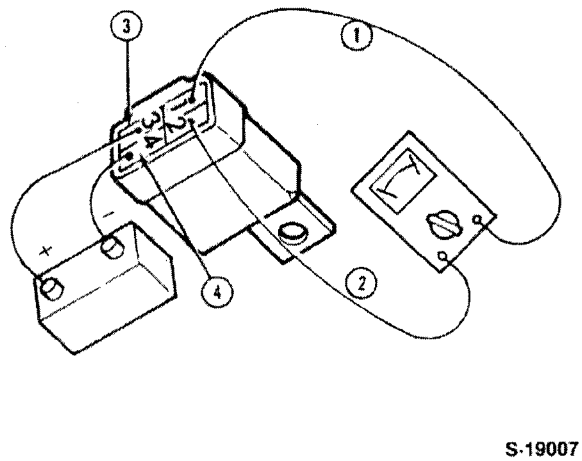


Figure 67
Relay Contact Switch Check
1. Terminal No. 1, Relay Contact
2. Terminal No. 2, Relay Contact
3. Relay Coil from Key Switch
4. Relay Coil to Reed Switch

2. Using the ohmmeter connected across terminals No. 1 and 2, recheck the contact switch operation.

Test Results

Low resistance reading = Good.

High resistance reading = Faulty relay — replace.

INSTALLATION

Installation follows the removal procedure in reverse.

E. KEY START SWITCH — DESCRIPTION AND OPERATION

Reference — Figure 68

The key start switch is located on the instrument panel and has four operating positions.

HEAT Position. In the heat position, the glow plugs are energized and heat the pre-combustion chamber for easier starting in cold weather.

OFF Position. In this position, the circuits are disconnected from the battery current and the key can be removed.

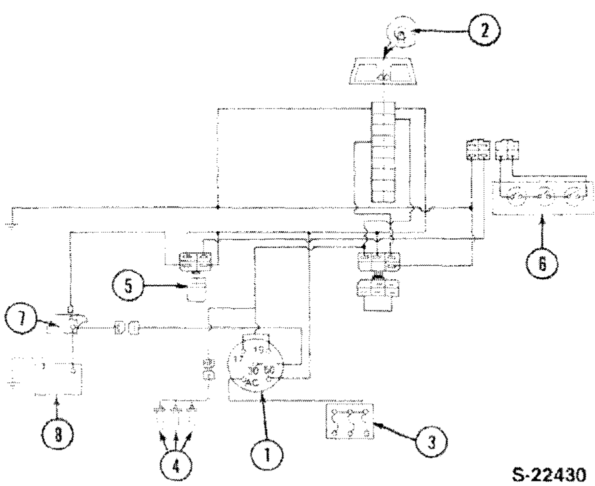


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Figure 68
Key Start Switch Operation

1. Key Switch
2. IQS Indicator Lamp
3. Fuse Box
4. Glow Plugs
5. Start Switch Relay
6. Start Reed Switch
7. Starter Solenoid
8. Battery

ON Position. In the "On" position, battery current is provided to operate the accessories without the engine running.

START Position. The "Start" position activates the starter motor circuit.

To prevent the key from remaining in the "start" or "heat" positions, the switch is spring loaded out of these positions.

The starter switch is not serviceable and must be replaced as an assembly if found faulty.

F. KEY START SWITCH — OVERHAUL

REMOVAL

1. Disconnect the battery negative cable from the battery terminal.

2. Remove the steering shroud center panel (2), Figure 69.

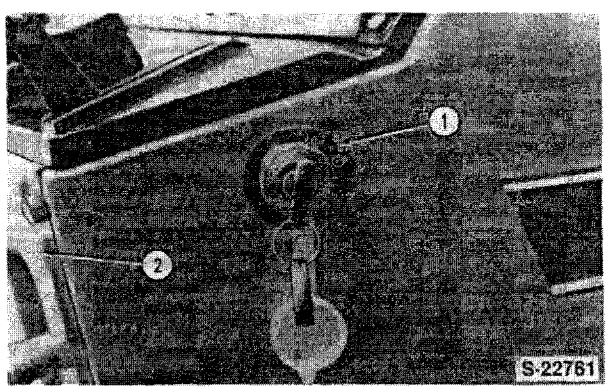

Figure 69
Key Start Switch Removal

1. Key Switch
2. Shroud — Center Panel

3. Remove the retaining nut (4) and remove the switch, Figure 70.

INSTALLATION

Installation of the switch generally follows the removal procedure in reverse.

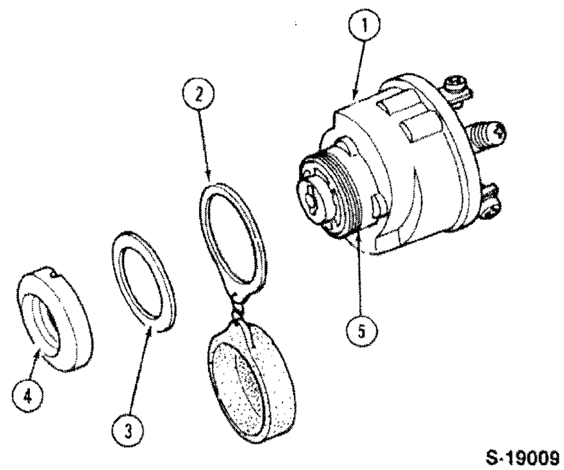

Figure 70
Key Start Switch Removal

1. Switch
2. Weather Cap
3. Seal Ring
4. Retaining Nut
5. Alignment Tab

During installation, observe the following:

1. Connect the wires to the switch as shown, Figures 71 and 72.

2. Position the switch in the instrument panel engaging the tab on the switch with the notch in the instrument panel.

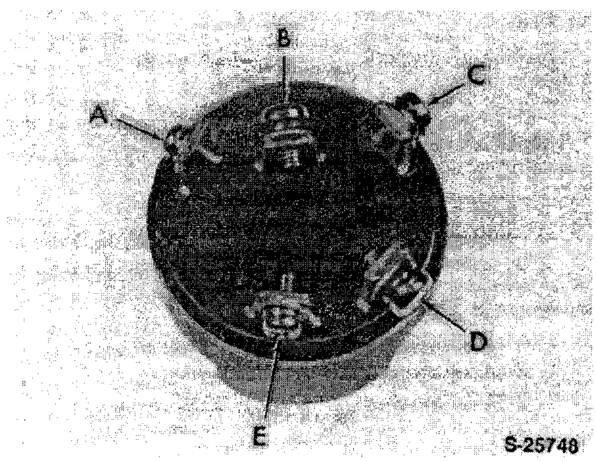

Figure 71
Key Start Switch Installation

A. To Fuse Box (Red/White)
B. To Starter Motor and Alternator (Red)
C. To IQS Timer (Black /White)
D. To IQS Indicator Lamp (Yellow/Black)
E. To Neutral Start Switch Start Relay (Black/Red)

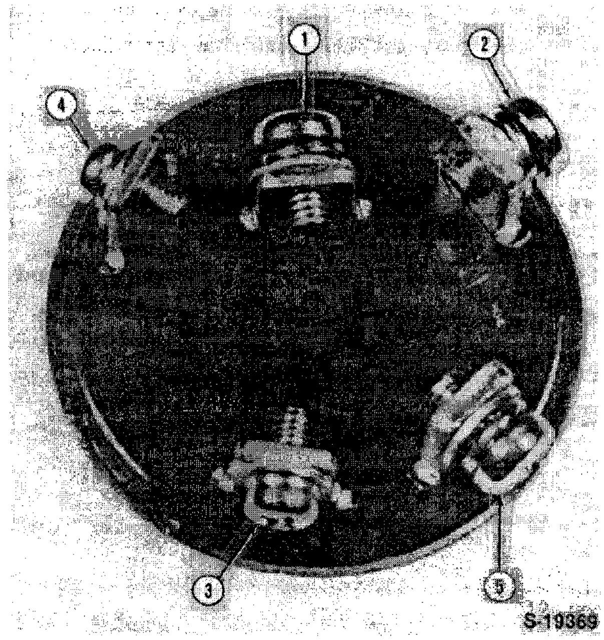

Figure 72
Key Start Switch Terminal Identification

1. Terminal No. 30, Battery
2. Terminal No. 17, Relay Coil Glow Plugs
3. Terminal No. 50, Relay Contact Switch
4. Terminal No. AC, Accessories
5. Terminal No.19, IQS Indicator Lamp

Complete the switch installation and re-connect the battery negative cable.

3. Check the switch for proper operation in all positions.

TROUBLE SHOOTING

If a malfunction is suspected in the key start switch, trouble shoot the switch using the following test procedures.

Disconnect the battery negative cable from the battery terminal.

"START" Position

1. Using a ohmmeter, connect the ohmmeter leads across the switch terminals marked 30 and 50, Figure 72.

2. Turn the switch to the "START" position and observe the ohmmeter reading.

3. Re-connect the ohmmeter leads across the switch terminals marked 30 and 17, Figure 72.

4. Turn the switch to the "Start" position and observe the ohmmeter reading.

Test Results

Low resistance reading = Good.

High resistance reading = Faulty — replace switch.

"ON" POSITION (Accessory Circuit)

1. Connect the ohmmeter leads across the switch terminals marked 30 and AC, Figure 72.

2. Turn the switch to the "On" position and observe the ohmmeter reading.

Test Results

Low resistance reading = Good.

High resistance reading = Faulty — replace switch.

"HEAT" Position

1. Connect ohmmeter leads across the switch terminal marked 30 and 19, Figure 72.

2. Turn the switch to the "HEAT" position and observe ohmmeter reading.

Test Results

Low resistance reading = Good.

High resistance reading = Open circuit — replace switch.

PART 3
ELECTRICAL SYSTEM
Chapter 4
CHARGING SYSTEM

A. DESCRIPTION AND OPERATION

ALTERNATOR

The principal components of the IC alternator are the stator, the rotor, the rectifier assembly, the IC voltage regulator, the front bracket, the rear bracket and the pulley.

The rectifier assembly consists of two heat sinks, one positive and one negative, and a diode trio. The diode trio is used as field supply diode and is connected to the field coil and the terminal L on the alternator.

The built-in IC regulator is a solid state unit and it can only be serviced as an assembly.

The charging circuit and internal connection are shown in Figure 73. The charging system consists of an IC regulator built in the alternator, a battery and connecting wires.

1. As the regulator is incorporated in the alternator, there is no need to provide a wire harness between the alternator and the regulator.
2. The field current flows directly from the diode trio to the field coil without passing through the external circuit. Consequently, there are no voltage drops caused by the key switch or the wiring as with the conventional vibrating-contact regulators mounted spearately from the alternator.

To help the initial voltage build up when the engine is started, the field current is supplied through the indicator lamp from the battery.

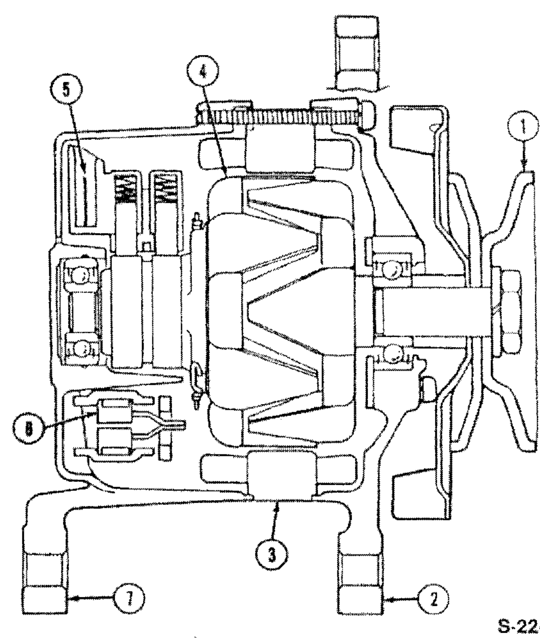

Figure 73
Alternator

1. Pulley
2. Front Bracket
3. Stator Coil
4. Rotor
5. IC Voltage Regulator
6. Rectifier
7. Rear Bracket

3. Principle of IC Regulator

The basic circuit of the IC regulator is shown in Figure 74. The part enclosed by a dotted line represents the IC regulator.

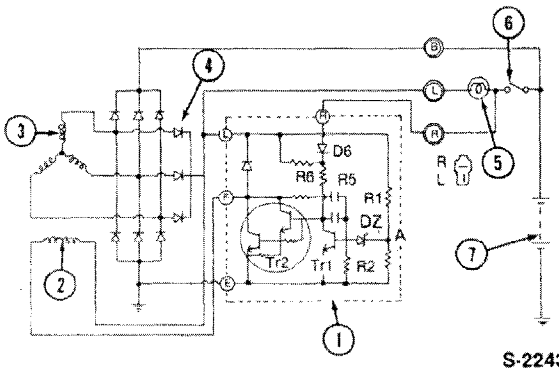

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Figure 74
Regulator/Alternator Wiring

1. IC Regulator
2. Field Coil
3. Stator Coil
4. Diode Trio
5. Indicator Lamp
6. Key Switch
7. Battery

The basic function of the IC regulator is to make the terminal voltage constant by detecting the generated voltage and increasing/decreasing the field current.

As indicated, the regulator consists of two basic sections: a voltage control device and an output device to handle the field current. The voltage control device includes a voltage divider network (R1, R2), a zener diode (DZ) for voltage reference, and a signal amplifying transistor (Tr1). The output device is a darlington type amplifier which is called power transistor (Tr2). The transistor Tr2 is placed in series with the alternator field coil and ground.

The transistor Tr1, as mentioned earlier, senses the generated voltage and turns the transistor Tr2 on and off many times per second most of the time that the engine is in operation. The basic operating principles are explained as follows: (See Figure 74)

1. When the key switch is closed, current from the battery flows through the indicator lamp and resistor R6, which are in parallel, to the field coil. From here it continues to flow on through the field coil to the ground, completing the circuit back to the battery.

2. When the alternator begins to rotate, A.C. voltages are generated in the stator coil. The diodes in the rectifier assembly change the stator A.C. voltages to a D.C. voltage which appears between ground and the terminal B.

   The stator also supplies D.C. field current through the diode trio, the field coil, Tr2 and then through the diodes in the rectifier assembly back to the stator.

3. When the generated voltage is low, no current flows in the zener diode (DZ) since the voltage at point a is lower than the zener voltage.

4. As the speed and voltage increase the voltage at point a also increases until it reaches the limiting valueset by the factory. As the zener diode (DZ) breaks down current flows through R1, DZ and the base-emitter circuit of Tr1 to ground. This renders Tr1 conductive, so that much of the current flows through the collector-emitter circuit of Tr1. This reduces the base current of Tr2 thereby reducing the field current. This means that Tr1 turns on and Tr2 turns off.

5. When the generated voltage decreases, the zener diode (DZ) again turns off and Tr1 also turns off.

   This cycle then repeats many times per second, and the alternator output voltage is, therefore, regulated within a narrow limit.

In other words, the action is similar to the conventional vibrating-contact regulator, in that current to the field coil is varied to limit the output voltage, but in place of the voltage coil and spring system, there is a voltage divider (R1 and R2) and a zener diode.

B. PRELIMINARY CHECKS AND ELECTRICAL TESTS

1. In case of equipment without an ammeter, connect a test ammeter (40A capacity) at the position shown in Figure 75.

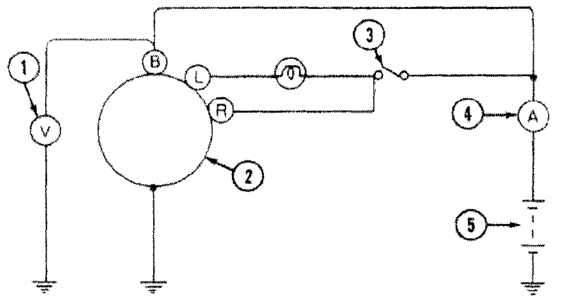

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Figure 75
Electrical Tests

1. Voltmeter
2. Alternator
3. Key Switch
4. Ammeter
5. Battery

If equipment is equipped with an ammeter, use the ammeter on the equipment.

2. Connect a voltmeter between the terminal B of the alternator and the ground.

Comfirm that the reading on the voltmeter indicates the battery voltage.

If the voltmeter reading is zero, the wiring between the terminal B and the battery is faulty.

3. With the test ammeter terminals short-circuited, start the engine.

CAUTION: *In the case where the test ammeter is connected at the position shown in Figure 75, make sure that no starting current is applied to the ammeter when the engine is started.*

4. Remove the short circuit across the test ammeter terminals and increase the engine speed immediately to approx. 2000 rpm. Take the ammeter reading.

5. If the ammeter reading is 5A or less, take the voltmeter reading without changing the engine speed (approx. 2000 rpm). The reading is the adjusting voltage.

6. If the ammeter reading is more than 5A, continue to charge the battery until the reading falls to less than 5A or replace the battery with a fully charged one.

An alternative method is to limit the charging current by connecting a 1/4 (25W) resistor in series with the battery.

If the previous section check is satisfactory, check the output as follows:

1. After opening the battery switch, disconnect the terminal B of the alternator and connect an ammeter (30A capacity) at the position shown in Figure 76.

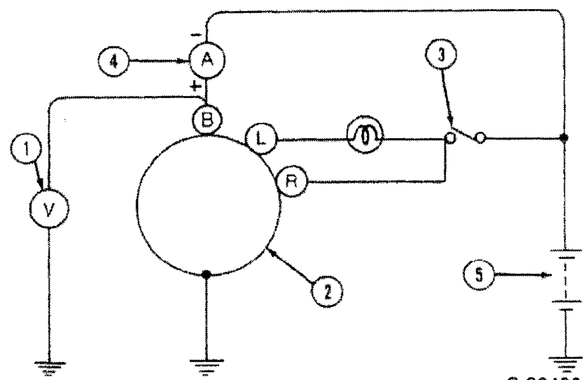

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Figure 76
Electrical Tests

1. Voltmeter
2. Alternator
3. Key Switch
4. Ammeter
5. Battery

2. Connect the voltmeter between the terminal B of the alternator and the ground. Confirm that the voltmeter indicates the battery voltage.
3. Close the key switch.
4. Start the engine and turn on all the lamps. Immediately accelerate the engine to 2000 rpm or more and measure the maximum value indicated on the ammeter.
5. If this value is more than 70% of the nominal output (refer to Section 11 "Service Specifications"), the alternator can be considered as working satisfactorily.

NOTE: *To make the above judgement more accurate, remove the alternator from the engine and check it on a test bench.*

C. OVERHAUL

ALTERNATOR

REMOVAL

1. Disconnect the cable from the battery negative terminal. Observe all safety precautions as outlined in the Battery Chapter.

2. Loosen the alternator mounting bolts and remove the belt from the drive pulley, Figure 77.

3. Disconnect the wiring from the back of the alternator.

4. Remove the alternator mounting bolts and remove the alternator.

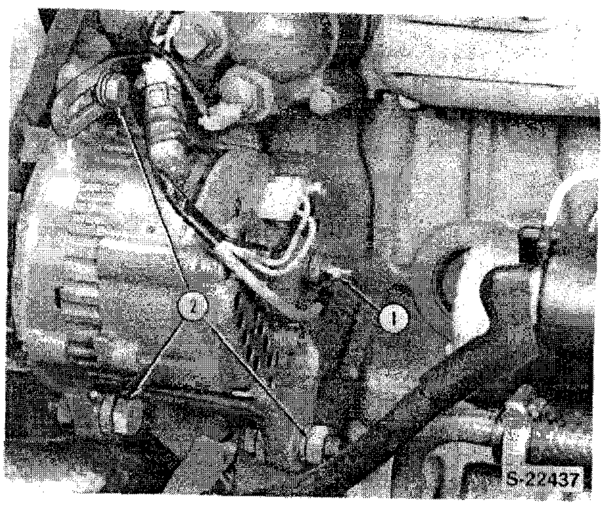


Figure 77
Alternator Removal — (1320/1520 shown)
1. Wiring
2. Mounting Bolts

DISASSEMBLY

1. Mark both brackets and the stator with a scribe mark for assembly, Figure 78.

2. Remove the three through bolts, Figure 79. Pry between the stator and front bracket with blade of a screwdriver. Carefully separate the front bracket, pulley and rotor assembly away from the stator and rear bracket assembly.

NOTE: *If necessary to use a press to remove the bearing, use caution to support the cover close to the bearing boss to prevent damage to the cover assembly.*

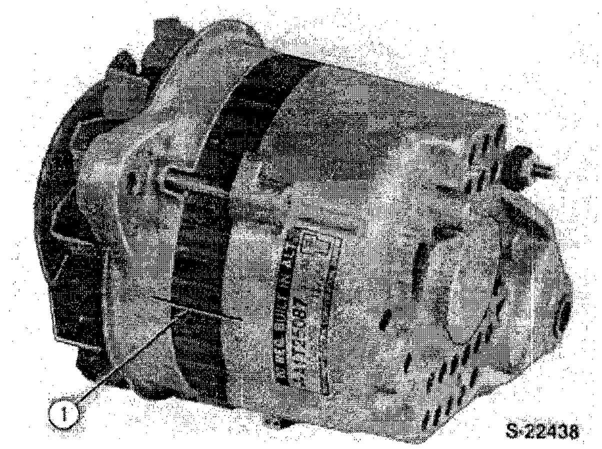


Figure 78
Alternator Disassembly
1. Scribe Mark

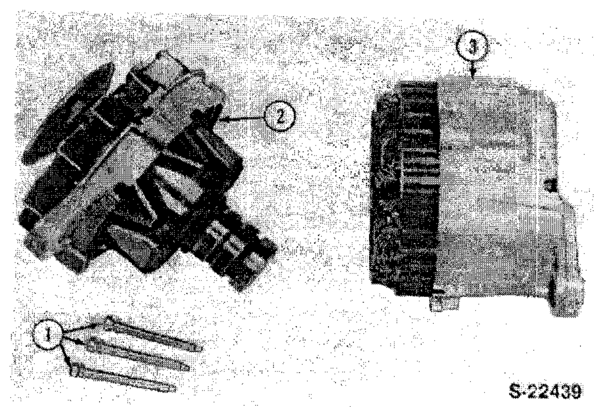


Figure 79
Alternator Disassembly
1. Through Bolts
2. Pulley and Rotor Assembly
3. Housing and Field Assembly

3. Place the rotor in a vise with soft jaws and remove the pulley nut, washer, pulley, fan, spacer, front bracket and two dust seals from the rotor, Figure 80.

4. Unsolder three stator leads and remove the stator, Figure 81.

5. Remove the voltage regulator assembly and rectifier assembly, Figure 82.

6. Remove the three bolts and retainer (3), Figure 83, and remove the ball bearing.

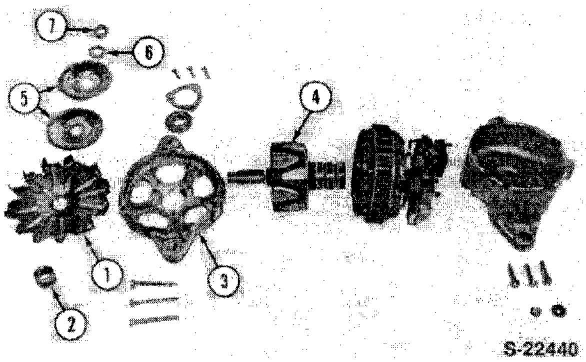


Figure 80
Alternator Disassembly

1. Fan
2. Spacer
3. Cover
4. Rotor
5. Pulley
6. Washer
7. Nut (14 mm)

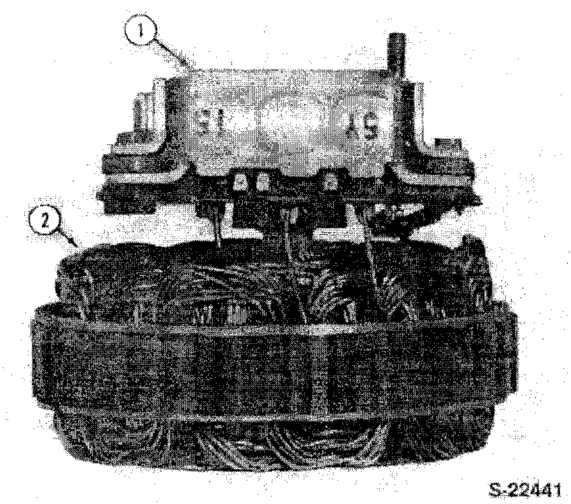


Figure 81
Alternator Disassembly

1. Rectifier Assembly
2. Stator Assembly

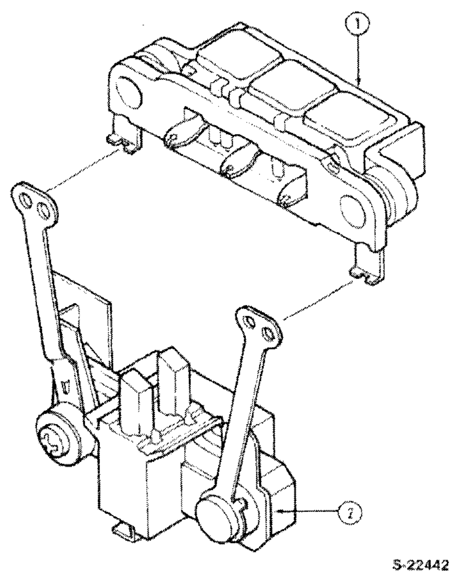


Figure 82
Alternator Disassembly

1. Rectifier Assembly
2. IC Regulator Assembly

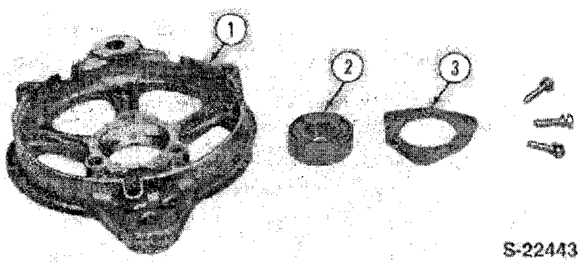


Figure 83
Front Bearing Removal

1. Front Cover
2. Bearing
3. Retainer Plate

COMPONENT INSPECTION

ROTOR ASSEMBLY

Reference – Figure 84

Inspect the rotor assembly for the following conditions:

1. Stripped or damaged threads.

2. Scuffed bearing surfaces indicating the bearing housing spun on the shaft.

3. Scuff marks on the pole fingers, indicating a bent shaft and allowing the rotor to run on the stator frame.

4. Dirty or contaminated rotor slip rings. Clean dirty rings with No. 400 silicone carbide paper.

NOTE: *Do not use emery cloth.*

Polish the slip rings with crocus cloth. Spin the rotor in a lathe or drill press while cleaning to prevent flat spots on the rings.

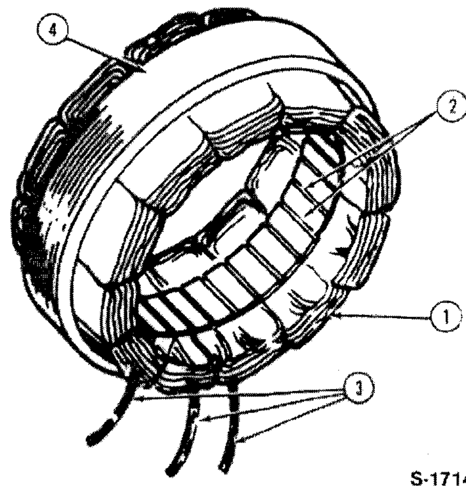


Figure 85
Stator Assembly Inspection
1. Stator Windings
2. Stator Poles
3. Stator Leads
4. Stator Frame

STATOR ASSEMBLY

Reference — Figure 85

Inspect the stator for the following conditions:

1. Burned or discolored stator windings, which indicate an electrical overload or short in the windings.
2. Scuff marks on the inside of the stator frame indicating a bent rotor shaft.
3. A damaged stator frame.
4. Missing, damaged or burned stator lead insulator.

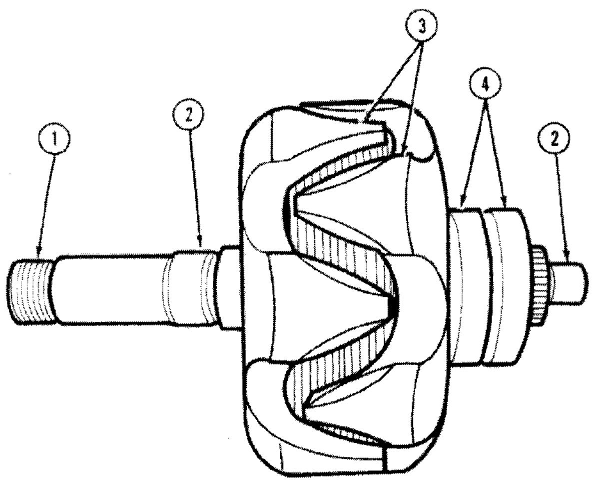


Figure 84
Rotor Assembly Inspection
1. Rotor Shaft Threads
2. Bearing Journals
3. Pole Fingers
4. Slip Rings

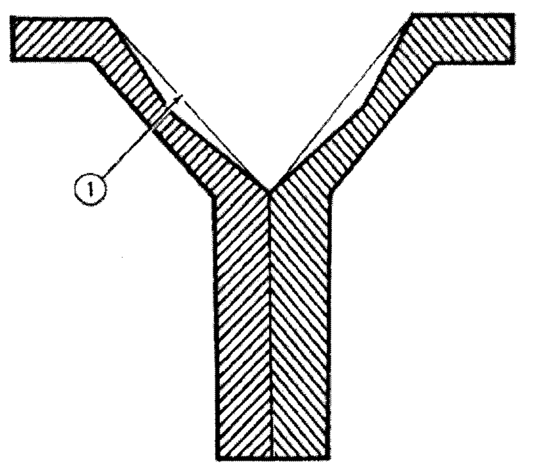


Figure 86
Pulley Inspection
1. Belt Wear Surface

PULLEY

Reference — Figure 86

1. Inspect the pulley for worn, bent or cracked pulley groove.

HOUSING

Reference — Figure 87

Inspect the front and rear housings for the following:

1. Scoring in the bearing bores indicating the bearing was spinning in the housing.

Test Results

Low resistance reading = Good.

High resistance reading = Open stator coil — replace stator.

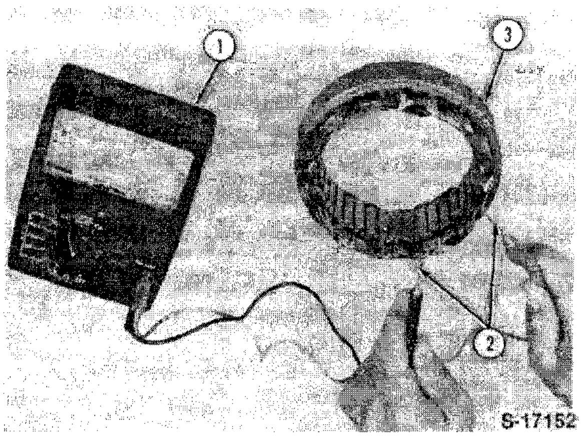


Figure 93
Stator Coil Test (Open Circuit)

1. Ohmmeter
2. Stator Leads
3. Stator Assembly

STATOR — GROUND COIL TEST

Reference — Figure 94

1. Using an ohmmeter, touch one ohmmeter lead to a stator winding and the other ohmmeter lead to the stator frame and observe the ohmmeter reading.

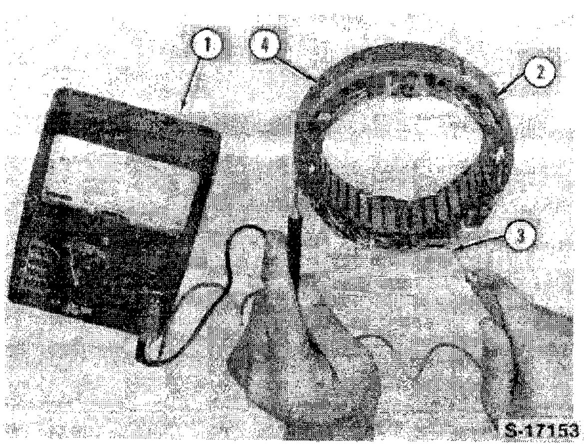


Figure 94
Stator Coil Ground Test

1. Ohmmeter
2. Stator Assembly
3. Stator Lead
4. Stator Frame

Test Results

High resistance reading = Good.

Low resistance reading = Grounded coil — replace stator.

Rectifier Assembly — Test

Positive Heat Sink

Reference — Figure 95

Check for continuity between the positive (+) heat sink and stator coil lead connection terminal with a circuit tester. If there is continuity in both directions, the diode is short-circuited. Replace the rectifier assembly.

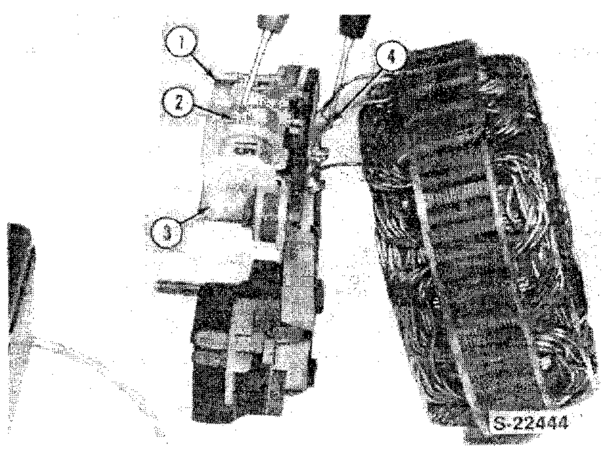


Figure 95
Rectifier Assembly Test

1. Rectifier Assembly
2. Positive Heatsink
3. Negative Heatsink
4. Stator Coil Lead Connection Terminal

Negative Heatsink

Reference — Figure 96

Check for continuity between the negative (−) heat sink and stator coil lead connection terminal. If there is continuity in both directions, the diode is short-circuited. Replace the rectifier assembly.

Diode Trio

Using the circuit tester, check the three small diodes for continuity in both directions. If there is either continuity or an open circuit in both directions, the diode is defective. Replace the rectifier assembly.

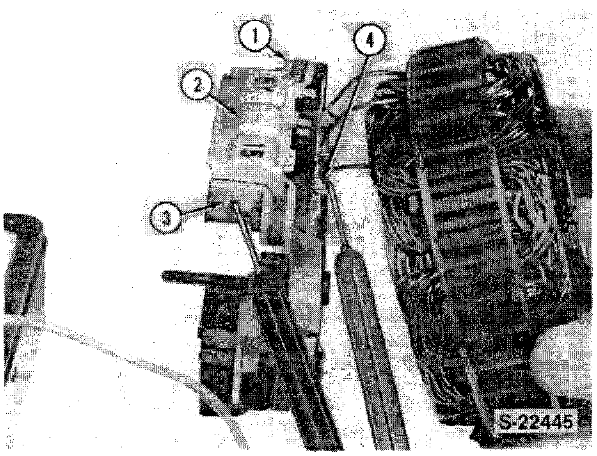


Figure 96
Rectifier Assembly Test

1. Rectifier Assembly
2. Positive Heatsink
3. Negative Heatsink
4. Stator Coil Lead Connection Terminal

ASSEMBLY

Assembly of the alternator generally follows the disassembly procedure in reverse.

On assembly, observe the following:

1. If the rotor shaft bearings were removed, install the bearings using a suitable size driver that contacts the bearing inner race only, Figure 97.

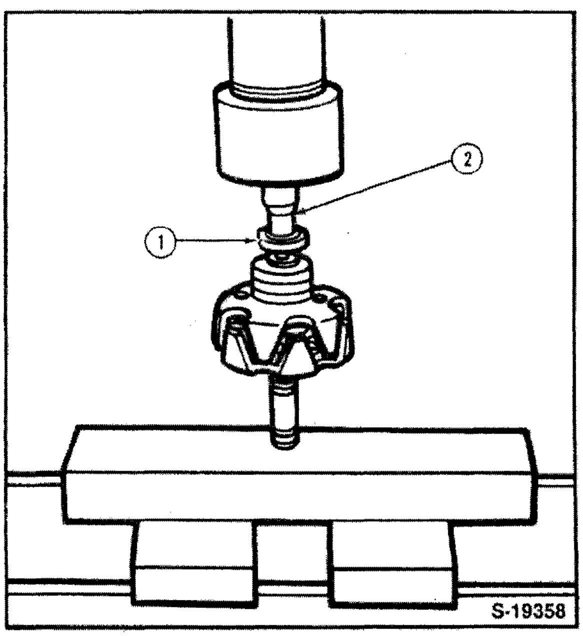


Figure 97
Rotor Bearing Installation

1. Bearing
2. Bearing Driver

2. Solder the stator lead to the rectifier observing the following requirements:

   a. Clean the stator wire leads and rectifier terminals.

   b. Form a firm wire connection between the wire and the terminal post.

   c. Pre-heat the soldering iron and solder the wires using a resin core solder. Hold the rectifier terminal with a needle nose plier just below the joint while soldering. The plier will absorb the heat from the soldering operation and protect the rectifier.

   d. After soldering, quickly cool the connection with a dampened cloth.

3. Check the dust seals on the front bearing as shown in Figure 98.

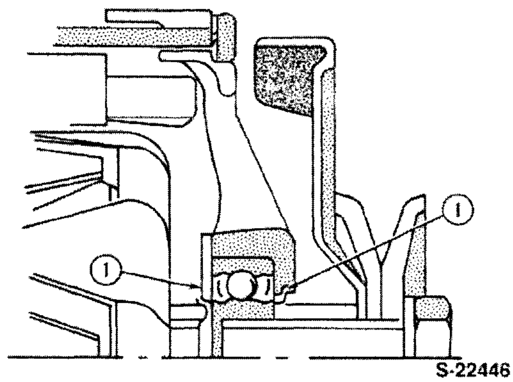


Figure 98
Alternator Assembly Procedure

1. Dust Seal

4. Position the brushes into the brush holder and insert a wire as shown, Figure 99, to hold the brushes in a raised position. Install the rotor to the brush holder and remove the wire.

INSTALLATION

ALTERNATOR

1. Position the alternator on the engine and install the attaching bolts.

2. Connect the wiring to the back of the alternator.

Test Results

Low resistance reading = Good.

High resistance reading = Open stator coil — replace stator.

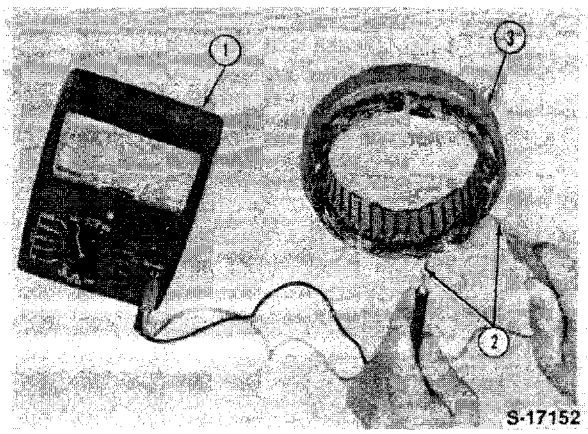


Figure 93
Stator Coil Test (Open Circuit)
1. Ohmmeter
2. Stator Leads
3. Stator Assembly

STATOR — GROUND COIL TEST

Reference — Figure 94

1. Using an ohmmeter, touch one ohmmeter lead to a stator winding and the other ohmmeter lead to the stator frame and observe the ohmmeter reading.

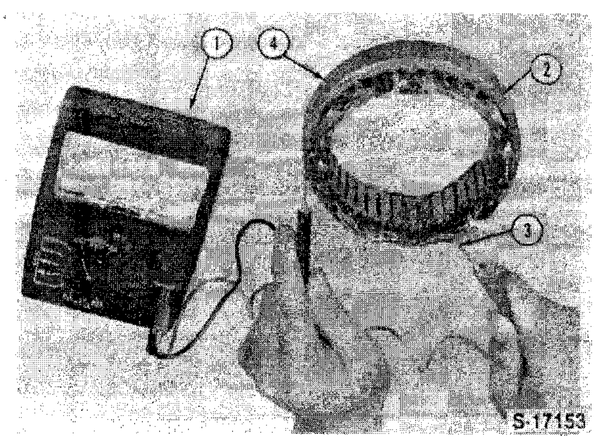


Figure 94
Stator Coil Ground Test
1. Ohmmeter
2. Stator Assembly
3. Stator Lead
4. Stator Frame

Test Results

High resistance reading = Good.

Low resistance reading = Grounded coil — replace stator.

Rectifier Assembly — Test

Positive Heat Sink

Reference — Figure 95

Check for continuity between the positive (+) heat sink and stator coil lead connection terminal with a circuit tester. If there is continuity in both directions, the diode is short-circuited. Replace the rectifier assembly.

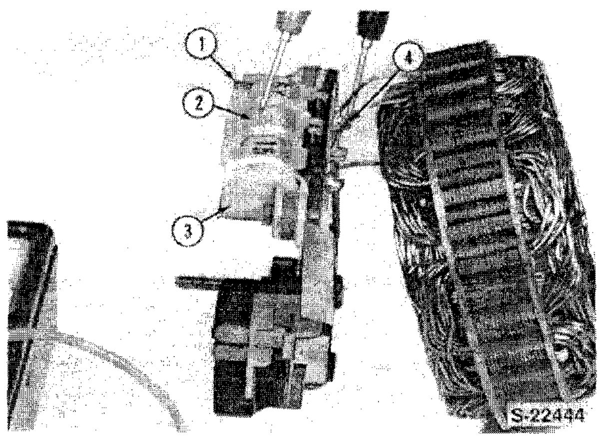


Figure 95
Rectifier Assembly Test
1. Rectifier Assembly
2. Positive Heatsink
3. Negative Heatsink
4. Stator Coil Lead Connection Terminal

Negative Heatsink

Reference — Figure 96

Check for continuity between the negative (-) heat sink and stator coil lead connection terminal. If there is continuity in both directions, the diode is short-circuited. Replace the rectifier assembly.

Diode Trio

Using the circuit tester, check the three small diodes for continuity in both directions. If there is either continuity or an open circuit in both directions, the diode is defective. Replace the rectifier assembly.

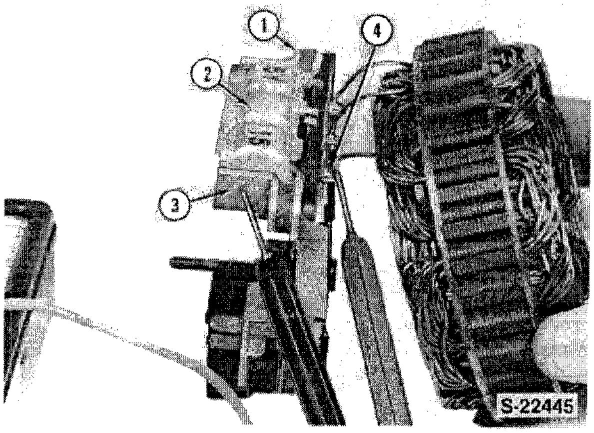


Figure 96
Rectifier Assembly Test

1. Rectifier Assembly
2. Positive Heatsink
3. Negative Heatsink
4. Stator Coil Lead Connection Terminal

ASSEMBLY

Assembly of the alternator generally follows the disassembly procedure in reverse.

On assembly, observe the following:

1. If the rotor shaft bearings were removed, install the bearings using a suitable screwdriver that contacts the bearing inner race only, Figure 97.

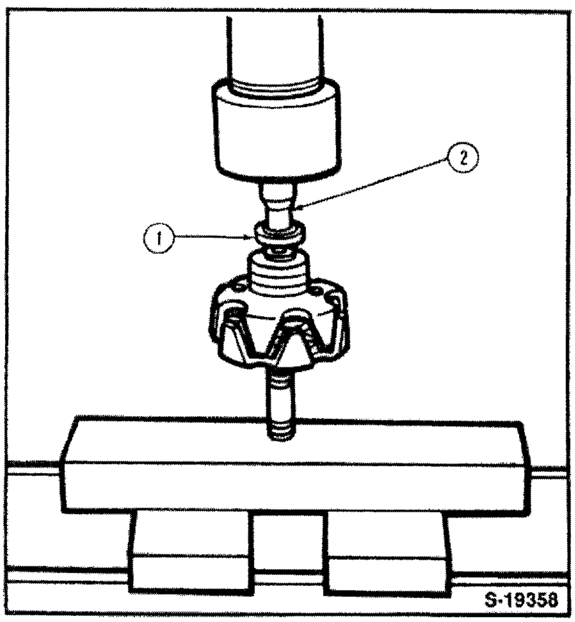


Figure 97
Rotor Bearing Installation

1. Bearing
2. Bearing Driver

2. Solder the stator lead to the rectifier observing the following requirements:

   a. Clean the stator wire leads and rectifier terminals.

   b. Form a firm wire connection between the wire and the terminal post.

   c. Pre-heat the soldering iron and solder the wires using a resin core solder. Hold the rectifier terminal with a needle nose plier just below the joint while soldering. The plier will absorb the heat from the soldering operation and protect the rectifier.

   d. After soldering, quickly cool the connection with a dampened cloth.

3. Install dust seals before and behind the front bearing as shown in Figure 98.

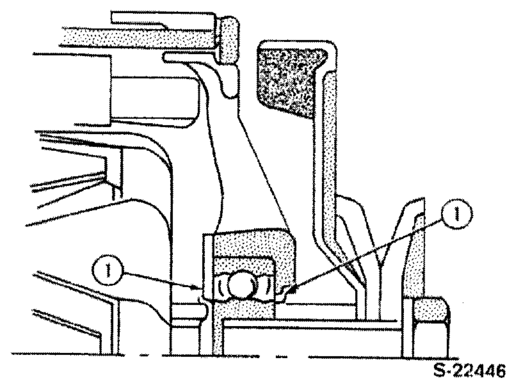


Figure 98
Alternator Assembly Procedure

1. Dust Seal

4. Position the brushes into the brush holder and insert a wire as shown, Figure 99, to hold the brushes in a raised position. Install the rotor to the brush holder and remove the wire.

INSTALLATION

ALTERNATOR

1. Position the alternator on the engine and install the attaching bolts.

2. Connect the wiring to the back of the alternator.

3. Install the drive belt and adjust the belt tension to .19 in. (5 mm) deflection, Figure 100.

4. Connect the battery negative cable to the battery.

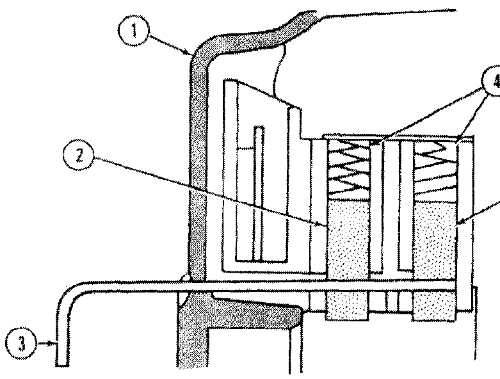


Figure 99
Alternator Assembly Procedure

1. Rectifier Cover
2. Brushes
3. Brush Holder Wire
4. Springs

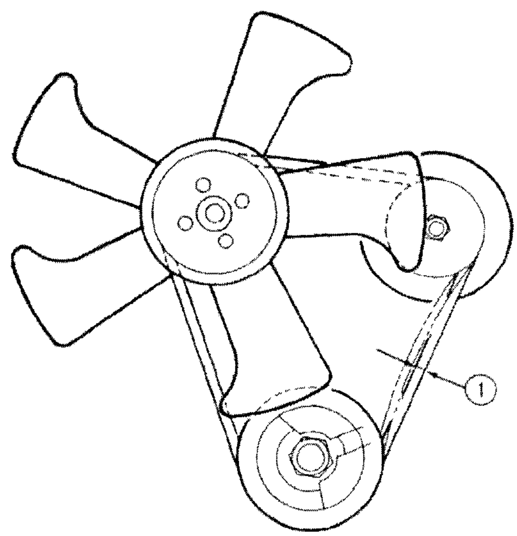


Figure 100
Drive Belt Adjustment

1. Belt Deflection — 0.200 in (5 mm)

PART 3
ELECTRICAL SYSTEM
Chapter 5
ENGINE FUEL STOP SOLENOID

A. DESCRIPTION AND OPERATION

The injection pump is equipped with a fuel stop solenoid (1), Figure 101. The solenoid plunger is spring loaded so that when the solenoid is not energized the plunger pushes the injection pump control rack forward into the closed (shut-off) position. When the solenoid is energized as when the key switch is turned to the "ON" and "START" positions the solenoid plunger is retracted and the governor linkage moves the pump control rack rearward into operating position.

The fuel stop solenoid provides a positive fuel shut-off when the key switch is turned to the "OFF" position or any time power to the solenoid is interrupted.

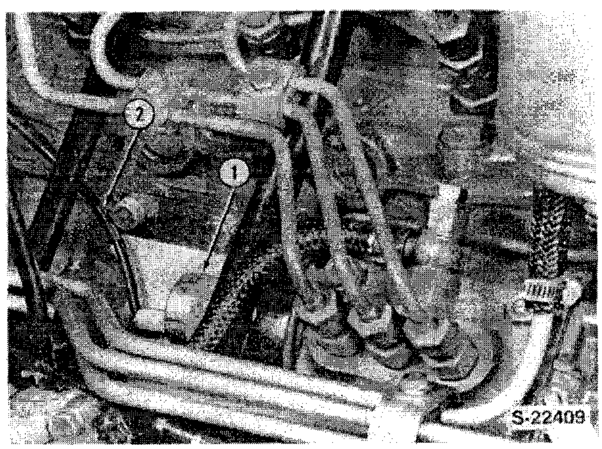


Figure 101
Engine Stop Solenoid
1. Solenoid 2. Wiring

B. OVERHAUL

REMOVAL

Reference — Figure 101

1. Disconnect the wiring of the engine stop solenoid.

2. Using a pair of pliers, remove the solenoid from the injection pump.

INSPECTION

1. With the solenoid de-energized, measure the protrusion distance "A" of the plunger as shown, Figure 102.

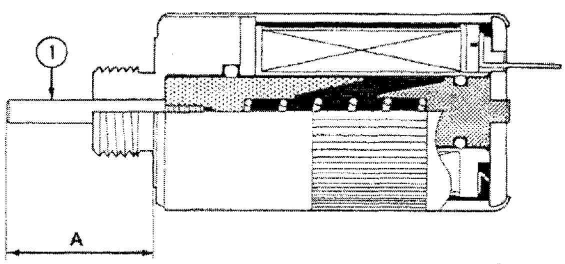


Figure 102
Solenoid Shut-Off Position

1. Plunger Distance
"A" = 1.004-1.04 in
(25.5-26.4 mm)

If the measurement is not within the specified limit replace the solenoid.

PROTRUSION DISTANCE — "A", 1.004-1.04 in. (25.5-26.4 mm)

2. Connect a jumper wire from the solenoid terminal to the battery positive terminal and connect a second jumper from the battery negative terminal to the solenoid body. The solenoid plunger then will retract. Measure the protrusion distance "B", Figure 103.

If the measurement is not within the specified limit replace the solenoid.

PROTRUSION DISTANCE — "B", 0.453-0.571 in. (11.5-14.5 mm)

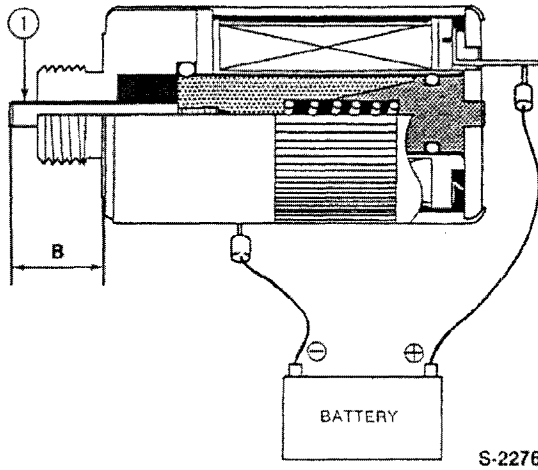


Figure 103
Plunger Retracted Position

1. Plunger Distance
"B" = 0.453-0.571
in. (11.5-14.5 mm)

3. Check the solenoid wiring continuity as follows:

- Disconnect the wiring from the solenoid spade connector.
- Using a voltmeter, touch one voltmeter lead to the wire connector and the other voltmeter lead to a good ground.
- Turn the key switch to the "ON", "START" or "HEAT" position and observe the voltmeter reading.

Test Results

Voltmeter Reading

9.0 or more volts = Good.
8.9 volts or under = Check for short, or open circuit in wiring, faulty battery, or faulty fuse.

ASSEMBLY

Assembly of the engine stop solenoid follows the disassembly procedure in reverse order.

NOTE: *Use a new sealing washer on assembly.*

PART 3
ELECTRICAL SYSTEM
Chapter 6
TROUBLE SHOOTING AND SPECIFICATIONS

A. TROUBLE SHOOTING

CHARGING SYSTEM	
PROBLEM	**POSSIBLE CAUSE**
Battery low in charge or discharged	1. Drive belt slippage. 2. Defective battery. 3. Faulty wiring or connection. 4. Defective regulator. 5. Dirty slip ring or brushes.
Alternator overcharging and battery overheats	1. Defective battery. 2. Defective voltage regulator. 3. Defective alternator.
Low or no output from alternator	1. Drive belt slippage. 2. Faulty wiring or connections. 3. Defective voltage regulator. 4. Defective alternator. 5. Defective rectifier.
Charge indicator lamp dims	1. Faulty wiring or connections. 2. Dirty rotor slip rings or brushes.
Warning light goes out but becomes brighter with increased speed	1. Faulty wiring or connections. 2. Faulty rectifier.

TROUBLE SHOOTING GUIDE

CHARGING SYSTEM	
CONDITION	**CHECKS TO PERFORM**
Charge indicator lamp is "on" with engine running	1. Drive belt tension. 2. Alternator voltage output test. 3. Alternator current output test. 4. Alternator "L" circuit voltage test. 5. Regulator "L" circuit continuity test. 6. Alternator "E" circuit continuity test. 7. Alternator "F" circuit continuity test. 8. Regulator "F" circuit continuity test. 9. Alternator "A" circuit continuity test.
Indicator lamp is "off" when starter switch is "on", but engine is not running.	1. Check indicator lamp bulb. 2. Check fuse. 3. Check wiring continuity between fuse and indicator lamp. 4. Check wiring continuity between lamp and regulator "L" terminal. 5. Check "L" circuit continuity between regulator terminals "L" and "E".

B. SPECIFICATIONS

BATTERY **Amp-Hr. Capacity** **Voltage** **No. of Cells** **Ground Polarity**	 70 12 6 Neg.
STARTER MOTOR **Clutch**	 Overrunning
Current Draw No Load	 130 Amp.
Load	
RPM — No Load Bench Test	4000
Armature Shaft — **Max. Runout**	.002 in. (.05 mm)
Commutator Runout	.002 in. (.05 mm)
Commutator Diameter **Minimum**	1.26 in. (32 mm)
Commutator — Insulation **Min. Depth**	.008 in. (.2 mm)
Brush Min. Length	.433 in. (11 mm)

B. SPECIFICATIONS (Con'd)

ALTERNATOR

Model	MITUBISHI
Rating	35 Amps at 12 Volts Max
Rotor Coil Resistance	3-4 Ohm at 68°F (20°C)
Stator Coil Resistance	.14 Ohm at 68°F (20°C)
Slip Ring — Std. Diameter	1.299 in. (33 mm)
Slip Ring Wear Limit	1.276 in. (32.4 mm)
Brush Length	
Std.	.71 in. (18 mm)
Wear Limit	.315 in. (8 mm)
Drive Belt Tension	.19 in. (5 mm)

PART 4
CLUTCHES

Chapter 1
SINGLE CLUTCH

Chapter 2
DOUBLE CLUTCH
1320-1520

Chapter 3
DOUBLE CLUTCH
1720

Chapter 4
SERVICING CLUTCH RELATED COMPONENTS

Chapter 5
TROUBLE SHOOTING AND SPECIFICATIONS

PART 4
CLUTCHES

Chapter 1
SINGLE CLUTCH

A. DESCRIPTION AND OPERATION

MODEL 1320-1520

A single disc clutch, Figure 1, is standard equipment on the Model 1320-1520 tractors equipped with the 9 x 3 gear transmission, or hydrostatic drive transmission.

MODEL 1720

A single disc clutch, Figure 2, is standard equipment on the Model 1720 tractor equipped with the non-synchromesh 12 x 4 gear transmission.

Reference — Figures 1 and 2

The clutch assembly consists of the clutch pressure plate (1), clutch disc (2), flywheel (3), release bearing (4) and hub assembly.

The clutch disc is a dry organic type assembly, which is mechanically operated. The clutch disc is installed between the flywheel and the pressure plate assembly. The clutch pressure plate is attached to the flywheel with six bolts.

In the engaged position, the spring loaded pressure plate presses the clutch disc into contact with the

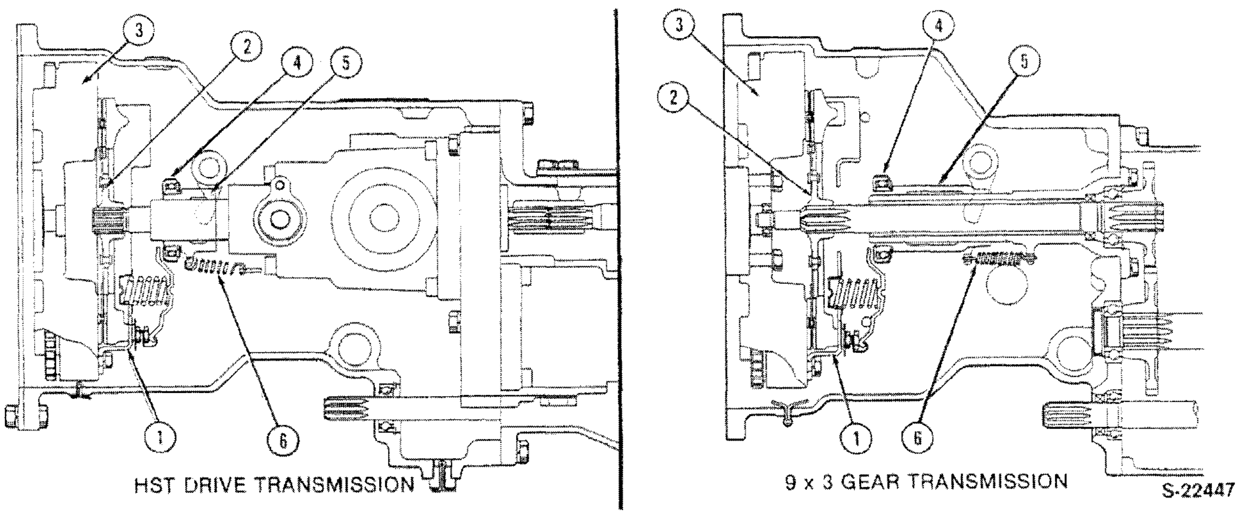


Figure 1
Single Clutch Assembly — Model 1320-1520

1. Clutch Pressure Plate
2. Clutch Disc
3. Flywheel
4. Clutch Release Bearing
5. Hub
6. Return Spring

engine flywheel. The power flow from the engine is transmitted by the friction between the clutch disc linings and the surfaces of the flywheel and the clutch pressure plate.

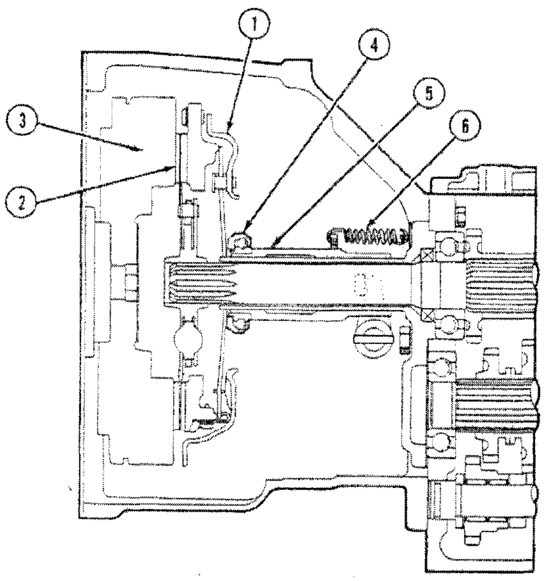


Figure 2
Single Clutch Assembly — Model 1720

1. Clutch Pressure Plate
2. Clutch Disc
3. Flywheel
4. Clutch Release Bearing
5. Hub
6. Return Spring

Reference — Figure 3

The clutch pedal assembly (4) is connected by an adjustable rod (1) to a bellcrank and cross shaft assembly (3) on which a fork is mounted.

The fork engages a sliding release bearing hub assembly. When the clutch pedal is applied, the release bearing comes in contact with the ends of the clutch release levers in the pressure plate. Depressing the clutch pedal causes the cross shaft and fork to move the release bearing forward and depress the pressure plate release levers. This action draws the pressure plate away from the clutch disc releasing the disc from contact with the flywheel.

The friction drive from the engine is then disconnected to enable gear changes to take place.

After a gear change is made and the clutch pedal is released, the release bearing and hub are returned to the free position by a spring attached to a hanger.

The main springs of the pressure plate assembly then reassert pressure on the plate moving it forward to press the clutch disc into contact with the flywheel and re-establish the drive to the transmission.

The release bearing is pre-lubricated and never requires lubrication.

The pressure plate assembly is not repairable and must be replaced as a complete assembly if service is required.

1320/1520:

The release lever height on the 1320 and 1520 is adjustable and should be checked whenever the clutch is removed or a new clutch is installed.

1720:

The release lever height on the 1720 is not adjustable.

B. ADJUSTMENT

FREE-PLAY ADJUSTMENT

The only single clutch adjustment that can be made without using the overhaul procedure is to check the clutch pedal free travel. This is the amount of pedal movement from the fully released position to the point where resistance is first encountered.

1. Remove the cotter pin securing the adjustment rod (1) to the bellcrank, Figure 3.
2. Lengthen or shorten the clevis to obtain .79-1.18 in. (20-30 mm) of free-play in the pedal travel.
3. Reposition the adjustment rod to the bellcrank and secure with a new cotter pin.

C. OVERHAUL

The single clutch is serviced as a complete assembly only. Overhaul of the single clutch is limited to removing the clutch inspection and adjustment of the release lever height.

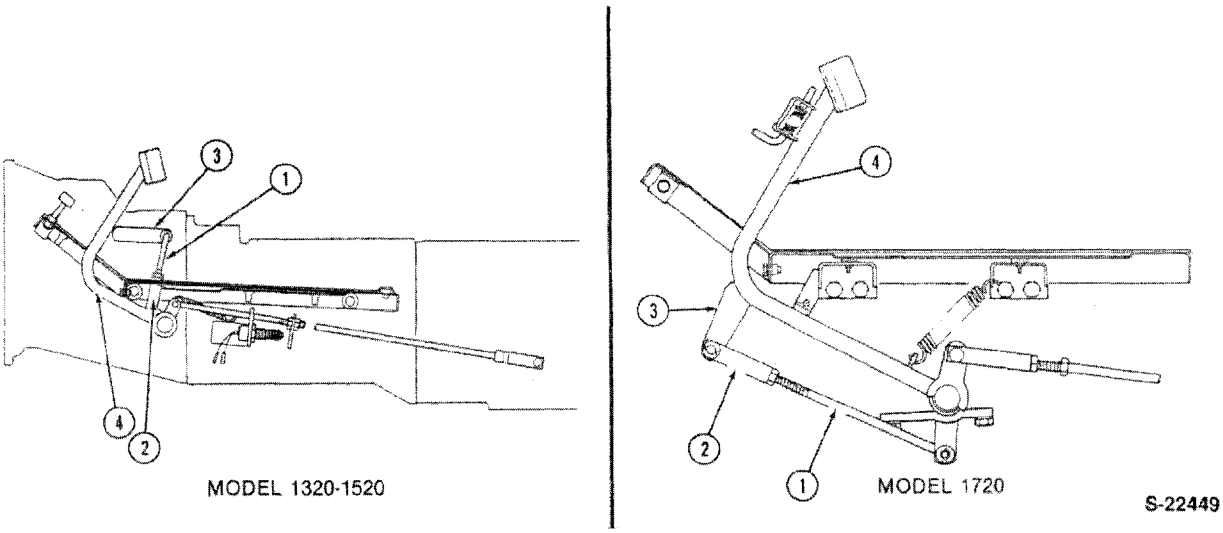


Figure 3
Free-Play Adjustment Rod

1. Adjustment Rod
2. Clevis
3. Cross Shaft Bellcrank
4. Clutch Pedal Assembly

REMOVAL

Reference — Figure 4

1. Separate the tractor between the engine and clutch housing. See Part 12, "Separating the Tractor."

2. Remove the six pressure plate retaining bolts (2) and remove the clutch assembly (1) from the flywheel.

   NOTE: *Loosen the attaching bolts gradually and evenly to prevent distorting the pressure plate assembly.*

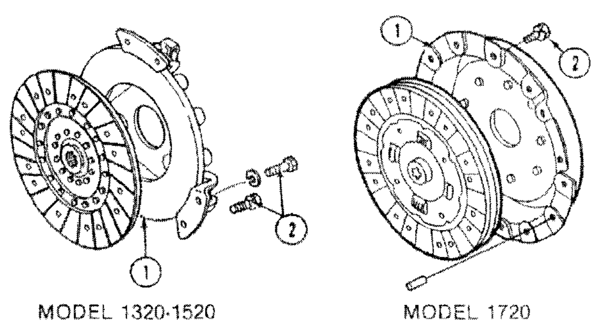


Figure 4
Single Clutch Removal

1. Clutch Assembly
2. Mounting Bolts

INSPECTION

Reference — Figure 5

1. Inspect the pressure plate face for scoring, cracks or overheating. Minor imperfections may be removed by resurfacing the pressure plate face.
2. Inspect the release levers for wear or damage.
3. Inspect the release lever pivot pins and springs for excess wear or damage.

   Replace the pressure plate assembly if damaged.

   Reference — Figure 6

4. Inspect the clutch disc lining for excess wear. Replace the clutch disc if the lining is worn to less than .012 in. (.3 mm) from the top of the rivet head.
5. Inspect the clutch lining for indications of overheating, scoring, or oil impregnation in the lining.
6. Inspect the hub spline for excess wear.
7. Inspect the cushioning springs (3) for signs of wear or damage.

   If any damage to the disc is apparent, replace the clutch disc assembly.

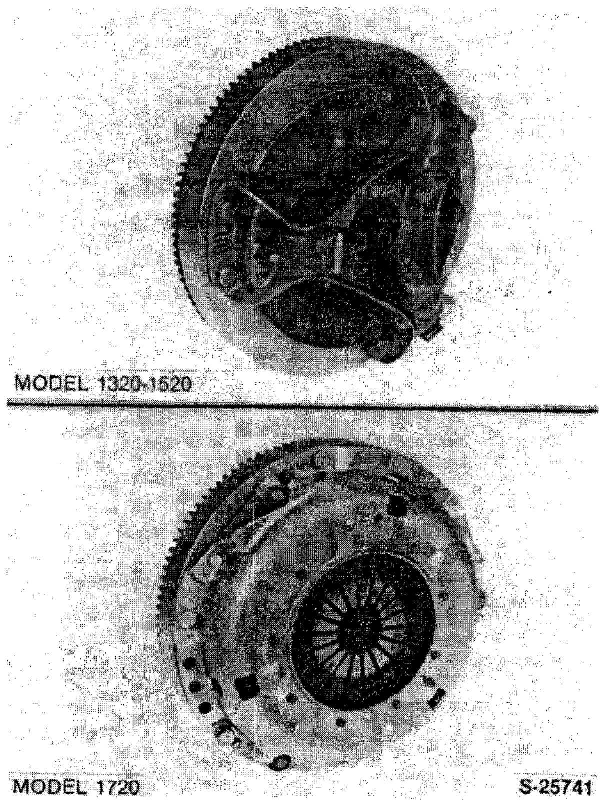


Figure 5
Pressure Plate Assembly — Single Clutch

INSTALLATION

IMPORTANT: *When installing a new pressure plate assembly, the pressure plate friction surface must be wiped clean with a suitable solvent to remove the protective film.*

1. Lightly lubricate the hub splines of the transmission input shaft using a high temperature lubricant.
2. Using the Clutch Alignment Arbor, position the clutch disc and pressure plate on the engine flywheel, Figure 7.
   (Refer to chapter 5 section C)
3. Position the clutch pressure plate on the flywheel and install the six attaching bolts.

   NOTE: *Tighten the attaching bolts evenly to the specified torque. See "Specifications," Chapter 5.*

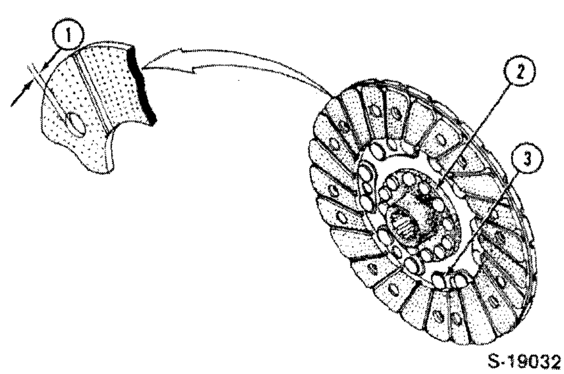


Figure 6
Clutch Disc Assembly

1. Disc Wear Limit 0.12 in. (3. mm)
2. Clutch Hub
3. Cushioning Springs (6)

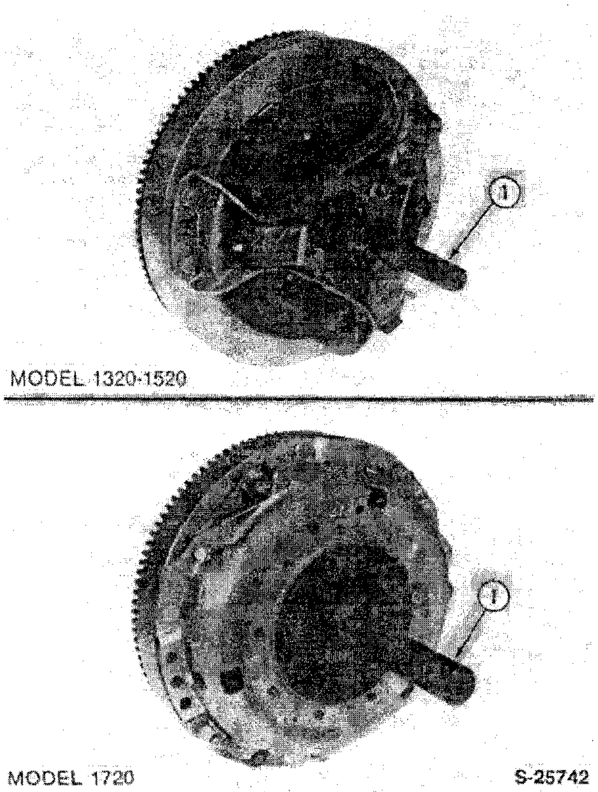


Figure 7
Clutch Installation — Single Clutch
1. Alignment Arbor

RELEASE LEVER HEIGHT ADJUSTMENT: 1320/1520 ONLY

NOTE: *Uneven release lever height may cause improper clutch operation and premature wear of the clutch disc. Always check and adjust the clutch release lever height whenever servicing the clutch or installing a new clutch assembly.*

Reference — Figure 8

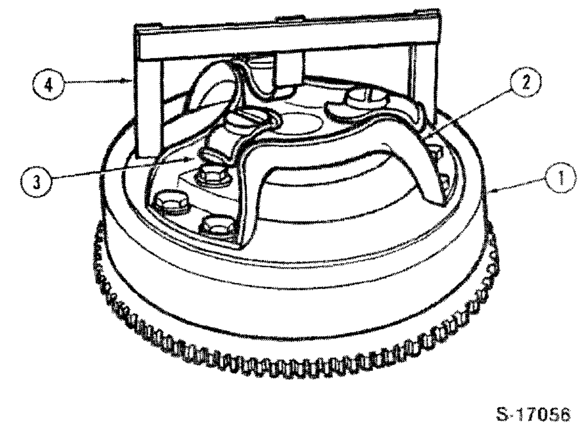


Figure 8
Release Height Adjustment
(Single Clutch)

1. Flywheel
2. Clutch Assembly
3. Retaining Clips
4. Gauge, Tool No. FNH1300

1. Install the clutch disc and pressure plate securely onto the flywheel (1).
2. Remove the retaining clips located over each of the adjuster screws.
3. Using Tool No. FNH 1300 (4) set the outer legs of the tool on the surface of the flywheel and adjust each of the adjusting screws until the release lever just contacts the center leg of the tool.
4. After completing the adjustment, tighten the locknuts securely and reinstall the retainer clips.
5. Depress each of the release levers several times and recheck the lever height for proper adjustment.

PART 4
CLUTCHES

Chapter 2
DOUBLE CLUTCH
1320-1520

A. DESCRIPTION AND OPERATION

The double clutch, Figure 9, is optional equipment on the Model 1320 and 1520 tractors when equipped with the 9 x 3 gear transmission.

The double clutch permits the drive to the transmission to be disconnected from the main transmission to facilitate gear changes without stopping the drive to the PTO.

The double clutch utilizes two 8.5 in. (215 mm) diameter discs. A transmission clutch disc transmits power from the engine to the main transmission input shaft and a second clutch disc transmits power from the engine to the PTO input shaft.

The double clutch is mounted to a recessed flywheel with six bolts.

The double clutch pressure plate release lever height is adjustable and should be checked and adjusted, if required, whenever the clutch is serviced or a new clutch is installed.

B. ADJUSTMENT

FREE-PLAY ADJUSTMENT

The only double clutch adjustment required is to check the clutch pedal free travel. This is the amount of pedal movement from the fully released position to the point where resistance is first encountered.

1. Remove the cotter pin securing the adjustable rod to the bellcrank (3), Figure 3.
2. Lengthen or shorten the clevis to obtain 13/16 - 1-3/16 in. (20-30 mm) of free-play in the pedal travel.
3. Reposition the adjustment rod to the bellcrank and install a new cotter pin.

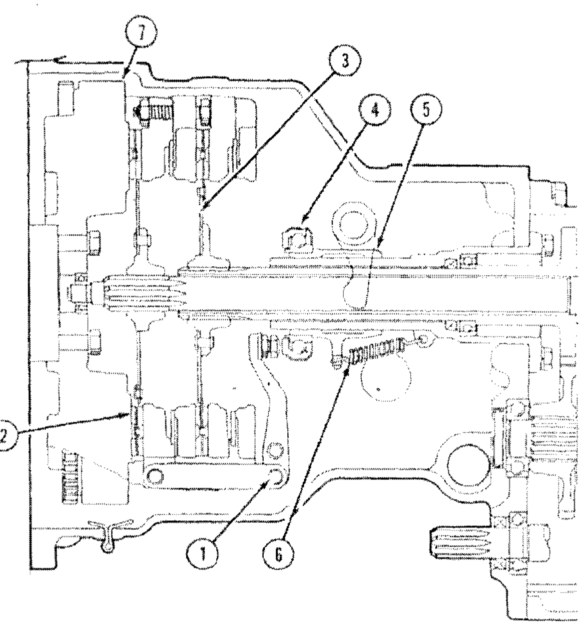


Figure 9
Double Clutch Assembly

1. Pressure Plate Assembly
2. Transmission Clutch Disc
3. PTO Clutch Disc
4. Clutch Release Bearing
5. Hub
6. Return Spring
7. Flywheel

C. OVERHAUL

All parts are serviced individually to overhaul the double clutch assembly.

1. Separate the tractor between the engine and clutch housing. See Part 12, "Separating the Tractor."

2. Remove the six bolts retaining the pressure plate to the flywheel and remove the pressure plate and disc (1), Figure 10.

   NOTE: *Loosen the attaching bolts gradually and evenly to prevent distorting the pressure plate assembly.*

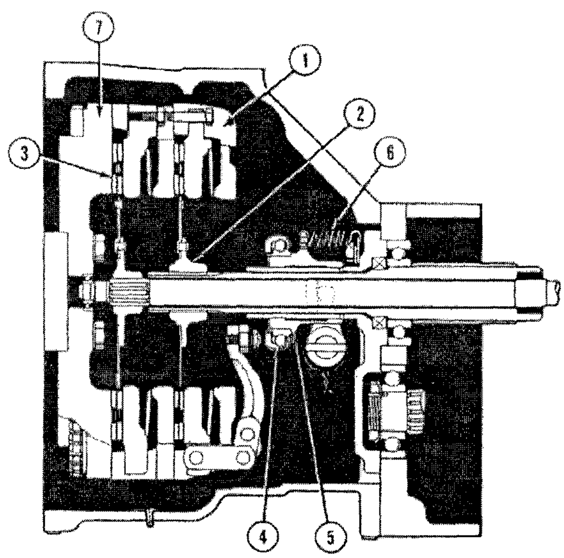


Figure 10
Double Clutch Disassembly

1. Pressure Plate Assembly
2. PTO Clutch Disc
3. Transmission Clutch Disc
4. Clutch Release Bearing
5. Hub
6. Return Spring
7. Flywheel

DISASSEMBLY

1. Loosen the three PTO clutch release adjusting bolts (1), Figure 11, gradually and evenly until the bolts are disengaged from the bottom pressure plate.

2. Remove the three release lever pins (2) from the outer cover and swing the release levers and links (3), Figure 11, out of the way.

3. Complete the disassembly of the remainder of the clutch components.

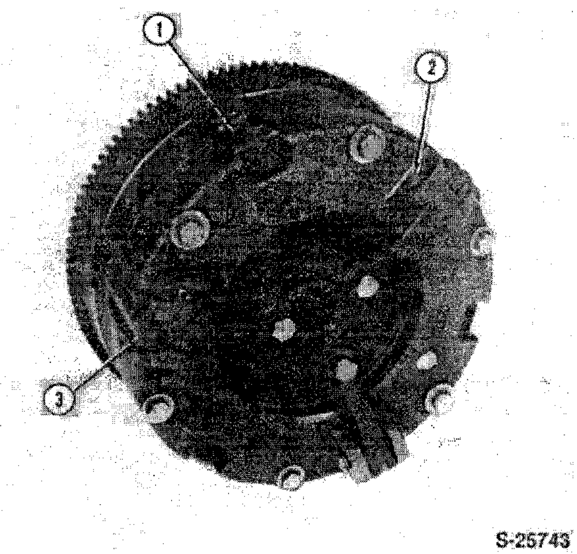


Figure 11
Double Clutch Removal

1. PTO Release Adjusting Bolt (3)
2. Release Lever Pin (3)
3. Release Lever and Link

INSPECTION
Reference — Figure 12

1. Inspect the pressure plate for scoring, cracks or signs of overheating. Minor imperfections may be removed by resurfacing the pressure plate surface.

2. Inspect the release levers (1) for excess wear or damage.

3. Inspect the release lever and link pivot pins for excess wear or damage.

   Replace the needed components if damage is evident.

4. Inspect the clutch disc lining for excess wear. Replace the clutch disc if the lining is worn to less than .012 in. (.3 mm) from the top of the rivet heads, Figure 6.

5. Inspect the clutch linings for indications of overheating, scoring or oil impregnation in the lining.

6. Inspect the hub spline for excess wear.

7. Inspect the cushioning springs for signs of wear or damage.

   If any damage to the disc is apparent, replace the clutch disc assembly.

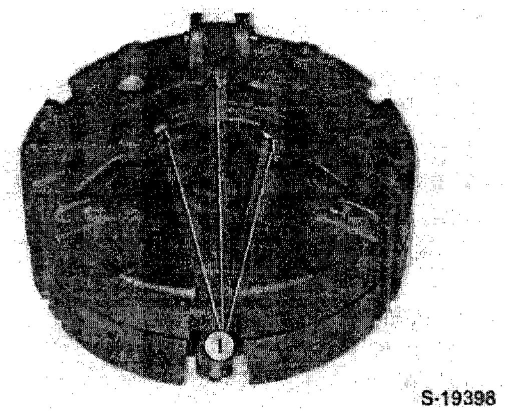


Figure 12
Double Clutch Assembly
1. Release Levers

ASSEMBLY
Reference — Figure 13

Assemble the clutch assembly in the following order:

1. Install one diaphragm spring (dome side away from flywheel) in clutch housing.
2. Install PTO pressure plate in clutch housing.
3. Install PTO clutch disc with long side of hub away from flywheel.
4. Install bottom half of clutch housing.
5. Install one diaphragm spring (dome side away from flywheel) in clutch housing.
6. Install transmission pressure plate in clutch housing.
7. Install release lever link and pin assemblies.
8. Install the three PTO clutch release bolts into the transmission pressure plate (finger tight only).
9. Install transmission clutch disc between the flywheel and pressure plate, long side of hub away from flywheel.
10. Position the clutch pressure plate assembly on the flywheel and install the six mounting bolts, Figure 14.
11. Use alignment arbor FNH 00077 to align clutch disc with flywheel, Figure 14.
12. Tighten the six mounting bolts evenly to 25 lbs. ft. (34 Nm).

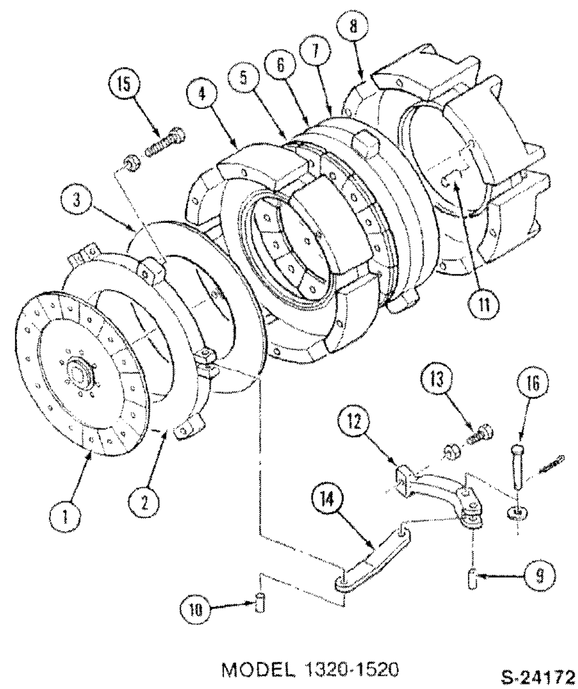


Figure 13
Double Clutch Assembly

1. Clutch Disc Assy.
2. Pressure Plate
3. Diaphragm Spring
4. Clutch Cover — Inner
5. Clutch Disc Assy.
6. Pressure Plate
7. Diaphragm Spring
8. Clutch Cover — Outer
9. Dowel Pin
10. Dowel Pin
11. Pin
12. Release Lever
13. Adjusting Bolt
14. Link
15. Adjusting Bolt
16. Pin

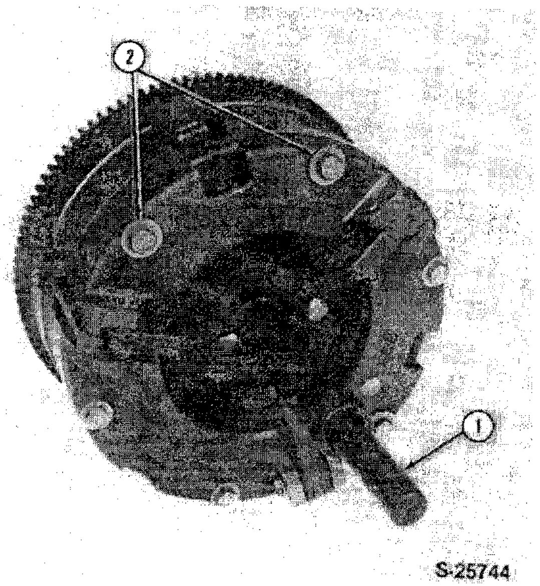


Figure 14
Double Clutch Installation
1. Alignment Arbor 2. Mounting Bolts

DOUBLE CLUTCH ADJUSTMENTS
Reference — Figure 15

NOTE: *The following adjustments are made with the clutch assembly installed on the flywheel.*

1. Install alignment arbor FNH 00077 in clutch assembly until the arbor bottoms out in the pilot bearing.

2. Using a feeler gauge (3) check the PTO clutch release adjusting bolt (4) to pressure plate gap. The gap must be between:

.035-.040 in.	(.9-1.0 mm)	Serial # and below 1320 UE 22253 1520 UH 22475
.055-.060 in.	(1.4-1.5 mm)	Serial # and above 1320 UE 22254 1520 UH 22476

   Readjust the bolt so the gap is within this dimension.

3. Tighten the adjusting bolt locknuts and recheck the gap.

4. Slide swing lever gauge over end of arbor until gauge contacts shoulder on arbor. Swing gauge over each of the height adjusting bolts (2). Adjust each bolt, until the bolt head just touches the swing gauge.

5. Tighten the adjusting bolt locknuts and recheck the settings.

NOTE: *When installing a new pressure plate assembly, the pressure plate friction surface must be wiped clean using a suitable solvent to remove the protective film.*

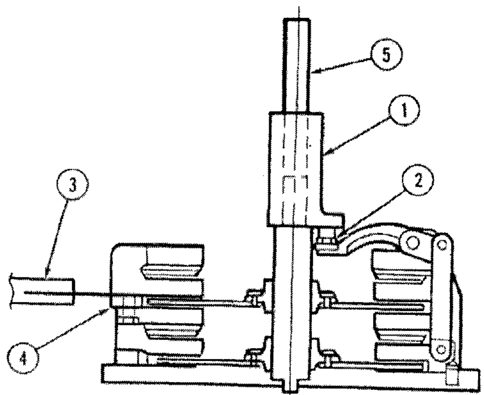


Figure 15
Double Clutch Adjustment — Model 1320-1520
1. Gauge Tool No. 1267
2. Release Lever Adjusting Bolt
3. Feeler Gauge
4. PTO Drive Plate — Adjusting Bolt
5. Alignment Arbor Tool No. FNH 00077

PART 4
CLUTCHES

Chapter 3
DOUBLE CLUTCH
1720

A. DESCRIPTION AND OPERATION

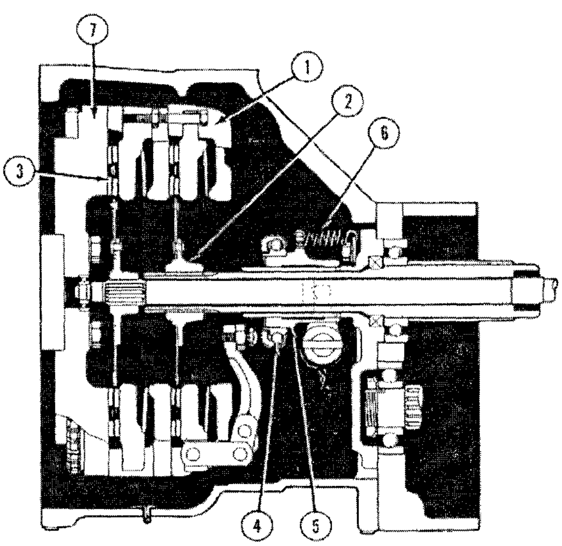
The double clutch, Figure 16, is optional equipment with the 12 x 4 non synchromesh transmission and standard equipment with the 12 x 12 shuttle synchromesh transmission.

The double clutch permits the drive to the transmission to be disconnected from the main transmission to facilitate gear changes without stopping the drive to the PTO.

The double clutch utilizes two 8.9 in. (225 mm) diameter discs. A transmission clutch disc transmits power from the engine to the main transmission input shaft and a second clutch disc transmits power from the engine to the PTO input shaft.

The double clutch is mounted to a recessed flywheel with six bolts.

The double clutch pressure plate release lever height is adjustable and should be checked and adjusted, if required, whenever the clutch is serviced or a new clutch is installed.



MODEL 1720

S-22461

Figure 16
Double Clutch Assembly — Model 1720

1. Pressure Plate Assembly
2. Transmission Clutch Disc
3. PTO Clutch Disc
4. Clutch Release Bearing
5. Hub
6. Return Spring
7. Flywheel

B. ADJUSTMENT

FREE-PLAY ADJUSTMENT

The only double clutch adjustment that can be made without using the overhaul procedure is to check the clutch pedal free travel. This is the amount of pedal movement from the fully released position to the point where resistance is first encountered.

1. Remove the cotter pin securing the adjustable rod to the bellcrank (3), Figure 3.

2. Lengthen or shorten the clevis to obtain 13/16 - 1-3/16 in. (20-30 mm) of free-play in the pedal travel.

3. Reposition the adjustment rod to the bellcrank and install a new cotter pin.

C. OVERHAUL

1. Separate the tractor between the engine and clutch housing. See Part 12, "Separating the Tractor."

2. Remove the six bolts (3) retaining the pressure plate to the flyhweel and remove the pressure plate (2) and disc (4), Figure 17.

   NOTE: *Loosen the attaching bolts gradually and evenly to prevent distorting the pressure plate assembly.*

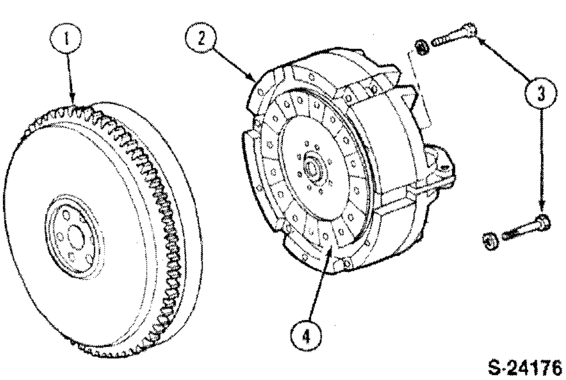


Figure 17
Double Clutch Removal

1. Flywheel
2. Pressure Plate
3. Bolts
4. Clutch Disc

DISASSEMBLY

1. Loosen the three transmission clutch release adjusting bolts (1), Figure 18, gradually and evenly until the bolts are disengaged from the bottom pressure plate.

2. Remove the three release lever pins (2) from the outer cover and swing the release levers and links (3), Figure 18, out of the way.

3. Complete the disassembly of the remainder of the clutch components.

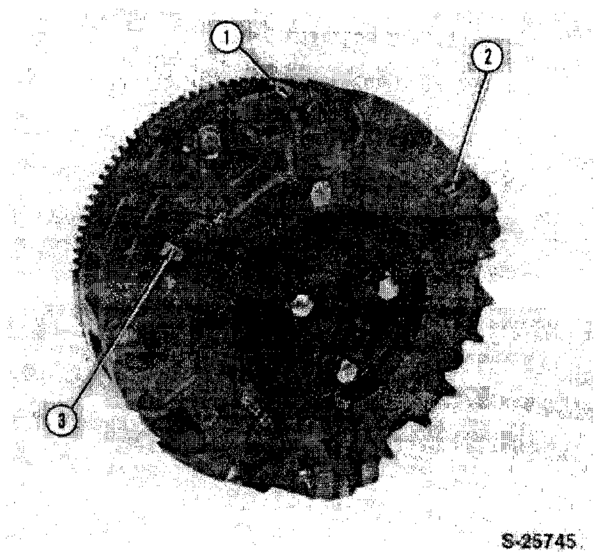


Figure 18
Double Clutch Disassembly

1. Release Adjusting Bolt (3)
2. Release Lever Pin (3)
3. Release Lever and Link

INSPECTION
Reference — Figure 19

1. Inspect the pressure plate for scoring, cracks or signs of overheating. Minor imperfections may be removed by resurfacing the pressure plate surface.

2. Inspect the release levers (12) for excess wear or damage.

3. Inspect the release lever and link pivot pins for excess wear or damage.

   Replace the needed components if damage is evident.

4. Inspect the clutch disc lining for excess wear. Replace the clutch disc if the lining is worn to less than .012 in. (0.3 mm) from the top of the rivet heads, Figure 6.

5. Inspect the clutch linings for indications of overheating, scoring or oil impregnation in the lining.

6. Inspect the hub spline for excess wear.

7. Inspect the cushioning springs for signs of wear or damage.

   If any damage to the disc is apparent, replace the clutch disc assembly.

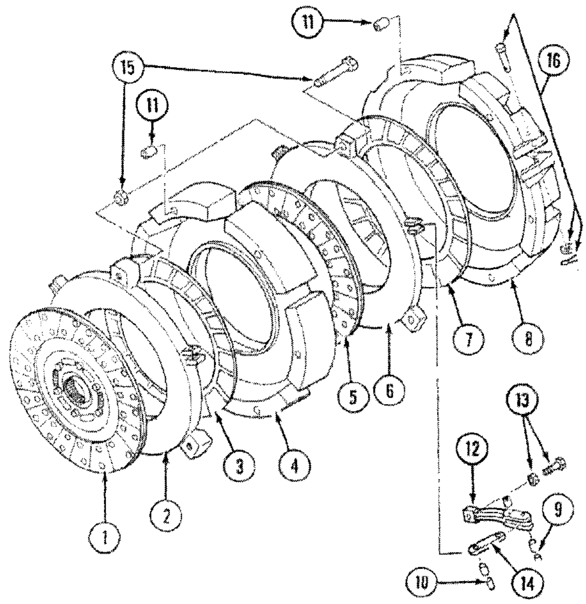


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Figure 19
Double Clutch Assembly

1. Clutch Disc Assy.	9. Dowel Pin
2. Pressure Plate	10. Dowel Pin
3. Diaphragm Spring	11. Pin
4. Clutch Cover – Inner	12. Release Lever
5. Clutch Disc Assy.	13. Adjusting Bolt
6. Pressure Plate	14. Link
7. Diaphragm Spring	15. Adjusting Bolt
8. Clutch Cover – Outer	16. Pin

ASSEMBLY
Reference – Figure 19

Assemble the clutch assembly in the following order:

1. Install one diaphragm spring (dome side away from flywheel) in clutch housing.
2. Install transmission pressure plate in clutch housing.
3. Install transmission clutch disc with long side of hub away from flywheel.
4. Install bottom half of clutch housing.
5. Install one diaphragm spring (dome side away from flywheel) in clutch housing.
6. Install PTO pressure plate in clutch housing.
7. Install release lever link and pin assemblies.
8. Install the three transmission clutch release bolts into the PTO pressure plate (finger tight only).
9. Install PTO clutch disc between the flywheel and pressure plate, long side of hub away from flywheel.
10. Position the clutch pressure plate assembly on the flywheel and install the six mounting bolts.
11. Use alignment arbor #FNH 00078 to align clutch disc with flywheel, Figure 20.
12. Tighten the six mounting bolts evenly to 25 lbs. ft. (34 Nm).

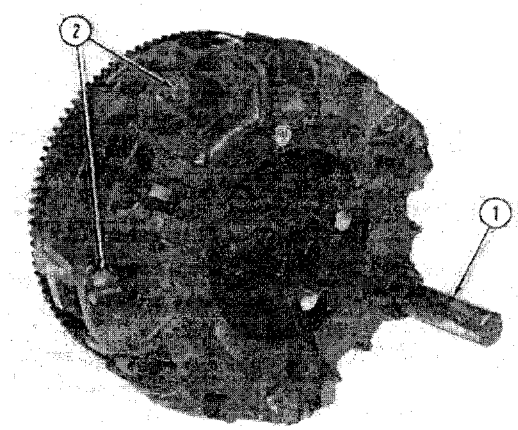

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Figure 20
Double Clutch Installation

1. Alignment Arbor   2. Mounting Bolts

DOUBLE CLUTCH ADJUSTMENTS
Reference — Figure 21

NOTE: *The following adjustments are made with the clutch assembly installed on the flywheel.*

1. Install alignment arbor FNH 00078 in clutch assembly until the arbor bottoms out in the pilot bearing.
2. Use a feeler gauge (3) check the clutch release adjusting bolt (4) to pressure plate gap so the gap is between .060 to .065 in. (1.5-1.6 mm). If not, readjust the bolt so the gap is within this dimension.
3. Tighten the adjusting bolt locknuts and recheck the gap.
4. Slide swing lever gauge over end of arbor until gauge contacts shoulder on arbor. Swing gauge over each of the height adjusting bolts (2). Adjust each bolt, unitl the bolt head just touches the swing gauge.
5. Tighten the adjusting bolt locknuts and recheck the settings.

NOTE: *When installing a new pressure plate assembly. The pressure plate friction surface must be wiped clean using a suitable solvent to remove the protective film.*

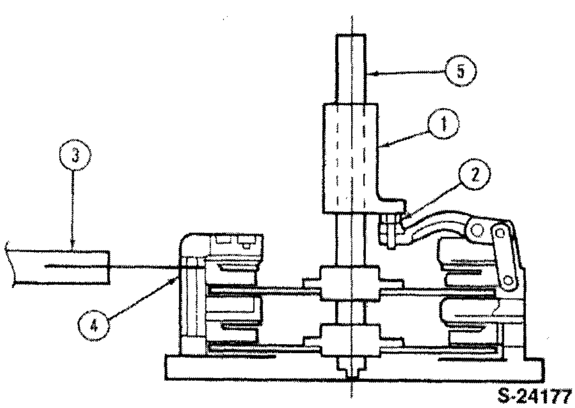

Figure 21
Double Clutch Adjustment — Model 1720

1. Gauge Tool No. FNH 1267
2. Release Lever Adjusting Bolt
3. Feeler Gauge
4. Drive Plate — Adjusting Bolt
5. Alignment Arbor Tool No. FNH 00078

PART 4
CLUTCHES

Chapter 4
SERVICING CLUTCH RELATED COMPONENTS

A. CLUTCH PILOT BEARING — DESCRIPTION AND OVERHAUL

A pre-lubricated ball bearing is installed at the rear of the engine to support the front end of the transmission input shaft. The pilot bearing (2) is located in the flywheel (1), Figure 22.

Whenever the clutch has been removed, inspect the pilot bearing by turning the inner race by hand and observe for abnormal noise, uneven rotation or excessive free-play.

REMOVAL

If any of the above conditions are noted, remove the pilot bearing using a suitable puller.

INSTALLATION

1. Apply a few drops of sealer to the outer race and install the bearing using a suitable size driver.

   Be sure the driver contacts only the outer race so as not to damage the bearing during installation.

B. CLUTCH RELEASE BEARING — DESCRIPTION AND OVERHAUL

Reference — Figures 23 and 24

The clutch release bearing is a pre-lubricated ball bearing (1) and is mounted on the sliding hub (2), which is supported on the front input shaft retainer (9).

A fork (4) mounted on the cross shaft (6) is engaged with the bearing and hub assembly.

On tractors equipped with the single clutch, initial movement of the clutch pedal causes the release bearing to come in contact with the release levers. Further movement of the pedal disengages the clutch and drive to the transmission input shaft and stops the transmission and PTO drive.

On tractors equipped with the double clutch, depressing the clutch pedal approximately half-way disengages the transmission drive, but allows the drive to continue to the PTO. Further movement of the clutch pedal causes the clutch to disengage the drive to the PTO.

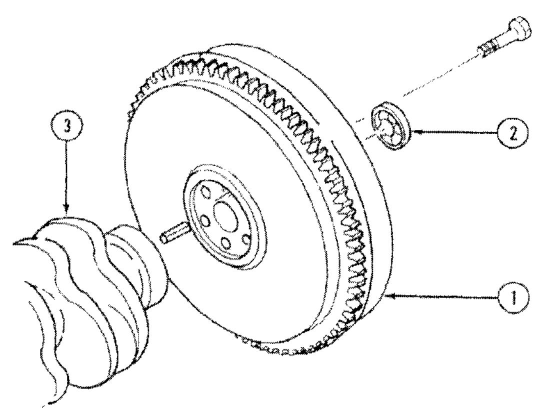

Figure 22
Clutch Pilot Bearing
1. Flywheel
2. Pilot Bearing
3. Crankshaft

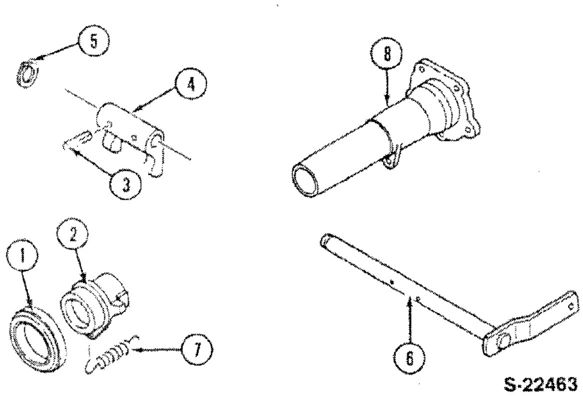

Figure 23
Clutch Release Bearing Overhaul

1. Bearing
2. Hub
3. Pin
4. Fork
5. Snap Ring
6. Cross Shaft
7. Return Spring
8. Support

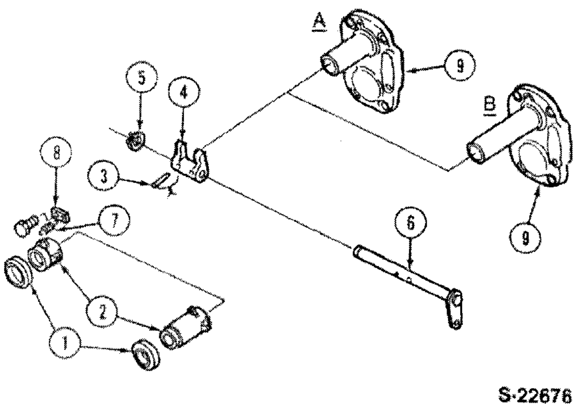

Figure 24
Clutch Release Bearing Overhaul

1. Bearing
2. Hub
3. Pin
4. Fork
5. Snap Ring
6. Cross Shaft
7. Return Spring
8. Spring Hanger
9. Retainer

A. Double Clutch
B. Single Clutch

REMOVAL

1. Separate the tractor between the engine and clutch housing. See "Separating the Tractor," Part 12.
2. Remove the cotter pin and clevis pin and remove the adjustment rod from the clutch release cross shaft.
3. Remove the release bearing and hub return spring and slide the bearing and hub off the support.

OVERHAUL

1. Using a suitable size puller and step plate, remove the bearing from the hub.

INSPECTION

1. Rotate the bearing by hand and observe for the following conditions:
   - Abnormal noise.
   - Uneven rotation when turned slowly by hand.
   - Excessive free-play.
   - Scoring on the inner race.
   - Indications of lubricant leakage at the oil seals.

ASSEMBLY

Reassembly generally follows the removal procedure in reverse.

C. CLUTCH LINKAGE COMPONENTS — OVERHAUL

Separate the tractor between the engine and the clutch housing. See "Separating the Tractor," Part 12.

CLUTCH CROSS SHAFT BUSHINGS

Separate the tractor between the engine and clutch housing. See "Separating the Tractor," Part 12.

1. Remove the cotter pin and clevis pin and remove the adjustment rod from the clutch cross shaft, Figure 25.
2. Remove the snap ring from the right hand end of the cross shaft, Figures 23 and 24.
3. Remove the roll pin from the inner brake pedal and cross shaft, Figure 26.

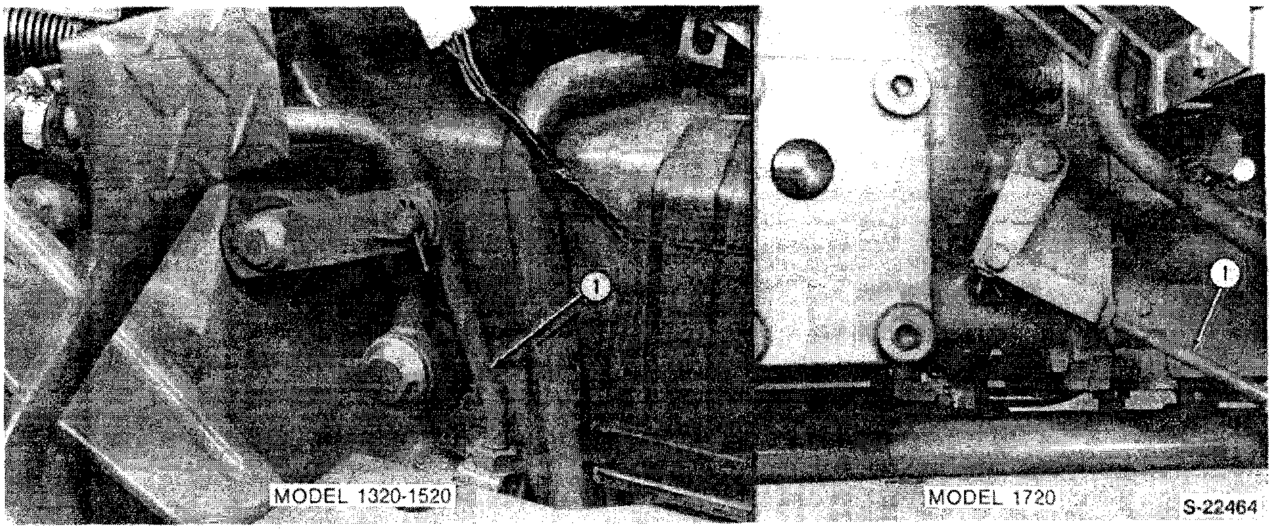

Figure 25
Clutch Release Bearing Removal
1. Adjustment Rod

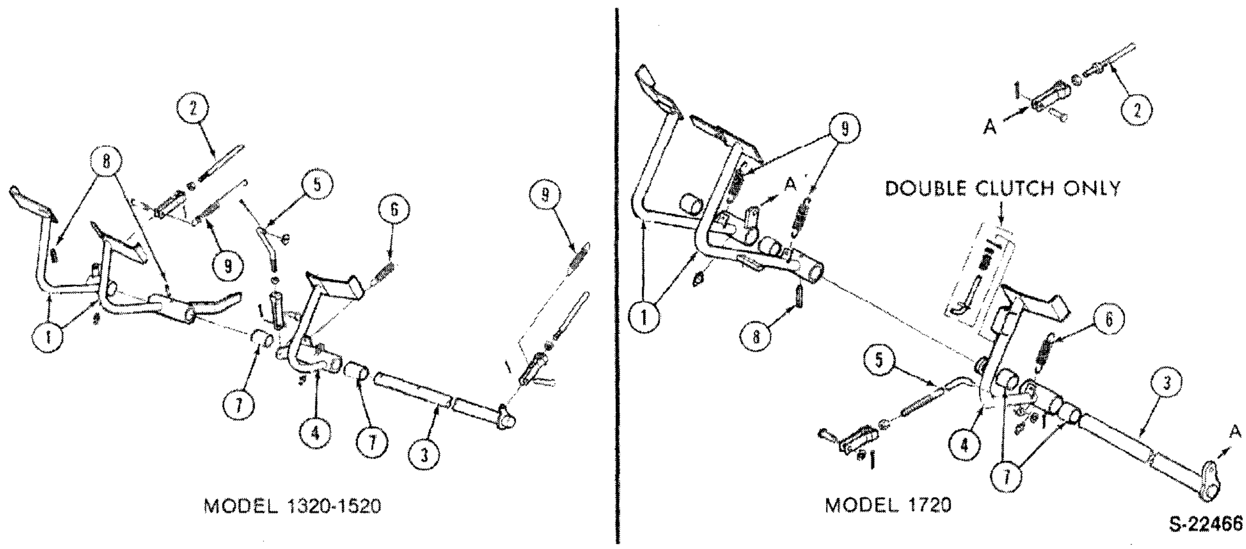

Figure 26
Clutch Pedal Bushing Overhaul

1. Brake Pedal Assembly
2. Brake Actuating Rods
3. Brake Cross Shaft
4. Clutch Pedal
5. Clutch Adjustment Rod
6. Clutch Pedal Return Spring
7. Clutch Pedal Bushings
8. Roll Pins
9. Brake Pedal Return Spring

4. Remove the roll pin from the fork and cross shaft and withdraw the cross shaft from the clutch housing, Figure 26.

5. Use a suitable size driver and remove the bushings (2) from the clutch housing (1), Figure 27.

6. Reinstall new bushings using a suitable driver.

ASSEMBLY

Reassembly of the cross shaft generally follows the removal procedure in reverse.

CLUTCH PEDAL BUSHINGS

REMOVAL

Reference — Figure 26

1. Disconnect the brake actuating rods (2) and brake return springs (18) from the brake cross shaft (3) on both sides of the tractor.
2. Remove the two roll pins (8) from the brake cross shaft.
3. Remove the clutch pedal return spring (6).
4. Remove the cotter pin and clutch adjustment rod (5) from the clutch pedal.
5. Withdraw the brake cross shaft from the support and remove the pedal from the shaft.
6. Using a suitable size driver, remove the bushings (7) from the clutch pedal assembly.
7. Reinstall new bushings using a suitable bushing driver.

ASSEMBLY

Assembly generally follows the removal procedure in reverse.

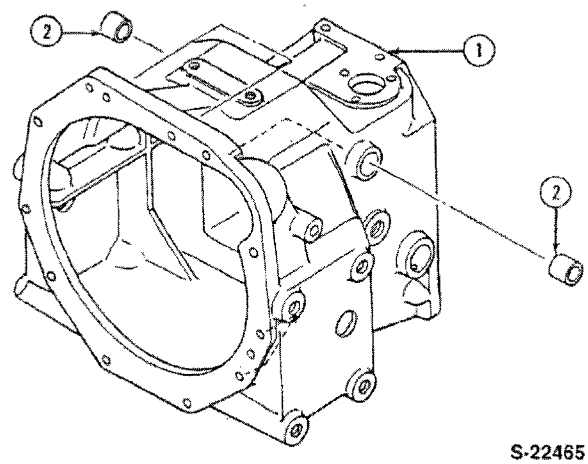

Figure 27
Cross Shaft Bushing Overhaul — 1320/1520 Shown

1. Clutch Housing 2. Bushings

PART 4
CLUTCHES

Chapter 5
TROUBLE SHOOTING AND SPECIFICATIONS

PART 4 — CHAPTER 5

A. TROUBLE SHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
1. Excessive clutch pedal free-play or loss of adjustment reserve.	1. Worn clutch disc	1. Replace disc. Refer to "Clutch Overhaul."
	2. Clutch linkage out of adjustment.	2. Adjust linkage. Refer to "Adjustments."
2. Clutch noisy when free.	1. Defective release bearing.	1. Replace bearing.
	2. Defective clutch pilot bearing.	2. Replace bearing.
3. Clutch slipping.	1. Incorrect pedal free travel.	1. Adjust free travel. Refer to "Adjustments."
	2. Worn disc facings.	2. Replace disc. Refer to "Clutch Overhaul."
	3. Clutch pressure springs weak from overheating.	3. Overhaul or install new clutch assembly. Refer to "Clutch Overhaul."
4. Clutch fails to engage smoothly.	1. Defective clutch disc.	1. Replace disc. Refer to "Clutch Overhaul."
	2. Defective pressure plate assembly.	2. Replace pressure plate assembly. Refer to "Clutch Overhaul."
	3. Worn clutch pilot bearing.	3. Replace bearing.
	4. Defective flywheel.	4. Refer to Part 1, "Engine System" for removal and installation
5. Difficulty in engaging gears.	1. Pedal free travel out of adjustment.	1. Refer to "Adjustments" to adjust the pedal free travel.
	2. Damaged or out of adjustment release levers.	2. Adjust assembly. Refer to "Adjustments."
6. Pedal will not return completely to release position.	1. Broken clutch pedal return spring.	1. Install a new spring.

B. SPECIFICATIONS

	MODEL 1320-1520		MODEL 1720	
ITEM	SINGLE CLUTCH	DOUBLE CLUTCH	SINGLE CLUTCH	DOUBLE CLUTCH
No. of Clutch Plates	1 (2 Facings)	2 (4 Facings)	1 (2 Facings)	2 (4 Facings)
Facing:				
Outside Diameter	8.46 in. (215 mm)	8.46 in. (215 mm)	8.86 in. (225 mm)	8.86 in. (225 mm)
Inside Diameter	5.12 in. (130 mm)	5.90 in. (150 mm)	5.90 in. (150 mm)	5.90 in. (150 mm)
Thickness	0.1259 in. (3.2 mm)	0.1259 in. (3.2 mm)	0.1259 in. (3.2 mm)	0.1259 in. (3.2 mm)
Height of Release Lever	2.3 ± 0.0197 in. (54 ± 0.5 mm)	3.80 ± .0276 in. (96.5 ± 0.7 mm)	1.40 ± .04 in. (35.5 ± 1.0 mm)	4.45 ± .027 in. (113 ± 0.7 mm)
Clearance between driveshaft and clutch disc	.0078-.0137 in. (0.2-0.35 mm)	.0028-.011 in. (0.07-0.27 mm)	.0078-.0137 in. (0.2-0.35 mm)	.0028-.011 in. (0.07-0.27 mm)
Allowable clearance limit	.0236 in. (0.6 mm)	.0236 in. (0.6 mm)	.0236 in. (0.6 mm)	.0236 in. (0.6 mm)
Clearance between driveshaft and clutch disc in the rotational direction	.0019-.0039 in. (0.050-0.1 mm)	.0019-.0039 in. (0.050-0.1 mm)	.0019-.0039 in. (0.050-0.1 mm)	.0019-.0039 in. (0.050-0.1 mm)
Allowable clearance limit	.0098 in. (0.25 mm)	.0098 in. (0.25 mm)	.0098 in. (0.25 mm)	.0098 in. (0.25 mm)
Clearance between retainer and release hub	.0009-.0039 in. (0.025-0.1 mm)	.0009-.0039 in. (0.025-0.1 mm)	.0009-.0039 in. (0.025-0.1 mm)	.0009-.0039 in. (0.025-0.1 mm)
Allowable clearance limit	.0314 in. (0.8 mm)	.0314 in. (0.8 mm)	.0314 in. (0.8 mm)	.0314 in. (0.8 mm)
Length of release hub return spring	1.28 in. (32.5 mm)	1.28 in. (32.5 mm)	1.28 in. (32.5 mm)	1.28 in. (32.5 mm)
Thickness of clutch disc	.34 in. (8.6 mm)	0.32 in. (8.1 mm) Main and PTO	.315 in. (8.0 mm)	.307 in. (7.8 mm) Main and PTO
Allowable limit	.28 in. (7.2 mm)	.28 in. (7.2 mm)	.28 in. (7.2 mm)	.28 in. (7.2 mm)
Depth of clutch disc rivets	.0472 in. (1.2 mm)	.0472 in. (1.2 mm)	.0472 in. (1.2 mm)	.0472 in. (1.2 mm)
Allowable limit	.012 in. (0.3 mm)	.012 in. (0.3 mm)	.012 in. (0.3 mm)	.012 in. (0.3 mm)
Height of release lever from flywheel surface	2.13 in. (54 mm)	3.80 in.* (96.5 mm)	1.40 in. (35.5 mm)	4.45 in.* (4.3 mm)
Allowable limit	2.09-2.16 in. (53.2-54.8 mm)	3.77-3.83 in. (35.8-97.2 mm)	1.36-1.44 in. (34.5-36.5 mm)	4.42-4.48 in. (112.3-113.7 mm)
Deflection of clutch disc	Max. 0.039 in. (1.0 mm)	Max. 0.039 in. (1.0 mm)	Max. 0.039 in. (1.0 mm)	Max. 0.039 in. (1.0 mm)

*Bolt clearance: Standard — .059-.063 in. (1.5-1.6 mm)

ITEM	SINGLE CLUTCH	DOUBLE CLUTCH
No. of Clutch Plates	**1 (2 Facings)**	**2 (4 Facings)**
Standard clutch pedal free-play	.79-1.18 in. (20-30 mm)	.79-1.18 in. (20-30 mm)
Maximum allowable free-play	1.57 in. (40 mm)	1.57 in. (40 mm)

BOLT TORQUES

Flywheel Mounting Bolts . . . . 43.4-51 lbs. ft. (59-69 Nm)
Clutch Mounting Bolts . . . . 16.6-21 lbs. ft. (22.6-28.4 Nm)

C. SPECIAL TOOLS

Gauge — Lever height adjust-single clutch . . . . FNH 1300
Gauge — Lever height adjust-double clutch . . . . FNH 1267
Alignment arbor — 1320/1520 single clutch . . . . FNH 1581
Alignment arbor — 1720 single clutch . . . . FNH 00084
Alignment arbor — 1320/1520 double clutch . . . . FNH 00077
Alignment arbor — 1720 double clutch . . . . FNH 00078

PART 5
TRANSMISSION SYSTEMS

Chapter 1
9 x 3 GEAR TRANSMISSION — MODEL 1320-1520

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PART 5
TRANSMISSION SYSTEMS

Chapter 1
9 x 3 GEAR TRANSMISSION – MODEL 1320-1520

A. DESCRIPTION AND OPERATION

The standard 9 x 3 gear transmission is a three range gearbox with each range having three forward and one reverse speed, for a total of nine forward and three reverse speeds, Figure 1.

Two gearshift levers control the operation of the transmission, Figure 2.

The range selector lever (1), Figure 2, controls operation of the range transmission.

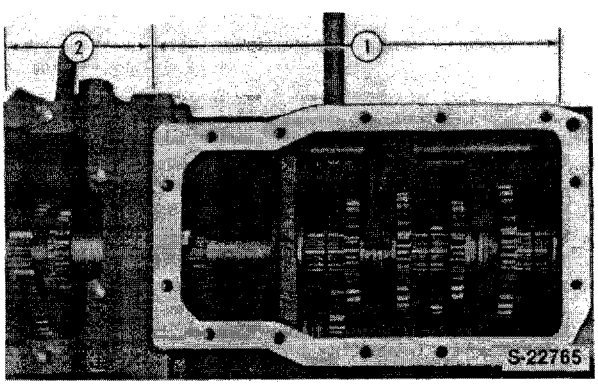

Figure 1
9 x 3 Gear Transmission – Model 1320-1520
1. Main Transmission Gearbox
2. Range Gearbox

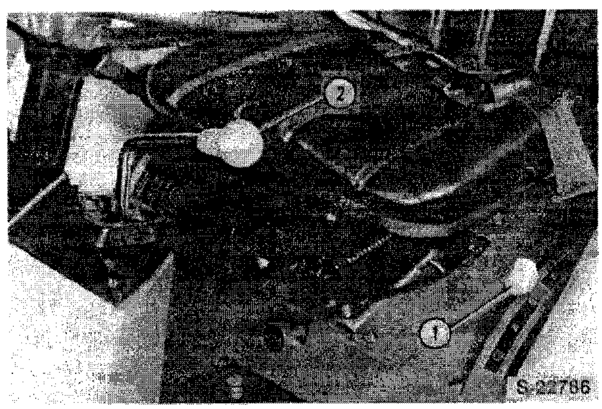

Figure 2
Shift Levers
1. Range Shift Lever
2. Main Shift Lever

The main shift lever (2), Figure 2, controls the three forward and one reverse speeds of the main transmission.

The transmission housing is a part of a common oil reservoir which provides gear lubricant for the differential and transmission and hydraulic system. The oil used is Ford 134B or equivalent.

The oil fill plug (1), Figure 3, is located on the rear of the hydraulic lift cover. The oil level check dipstick (2) is located on the transmission cover.

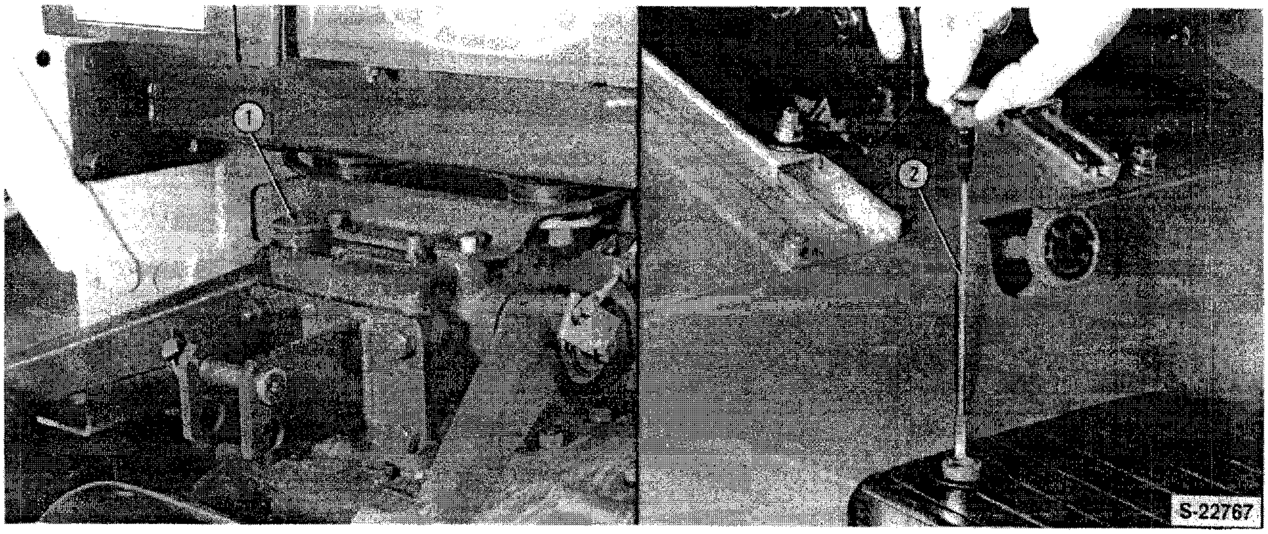

Figure 3
Transmission Hydraulic Rear Axle
Oil Fill and Level Check Location

1. Oil Filler Plug
2. Dipstick

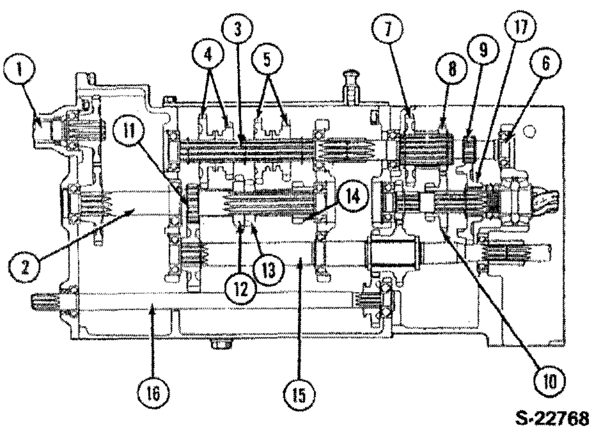

Figure 4
9 x 3 Gear Transmission — Cross-Sectional View and Identification

1. Input Shaft
2. Countershaft
3. Front Main Shaft
4. Sliding Gear (1-3)
5. Sliding Gear (2-R)
6. Rear Main Shaft
7. High Range Gear — Fixed
8. Mid-Range Gear — Fixed
9. Low Range Gear — Fixed
10. Sliding Gear (High, Middle, Low)
11. 1st Gear — Fixed
12. 3rd Gear — Fixed
13. 2nd Gear — Fixed
14. Reverse Gear — Fixed
15. PTO Countershaft
16. 4WD Drive Shaft
17. Low Range Gear — Fixed

A transmission cross-section view with gear identification is shown in Figure 4.

Power flows through the transmission are shown in Figures 5 through 16.

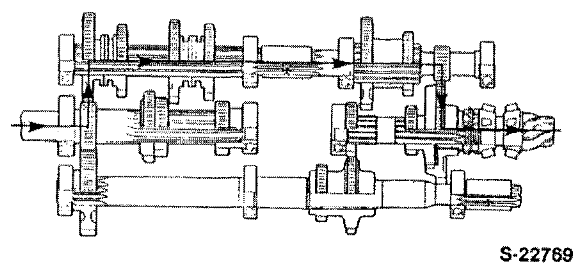

Figure 5
Power Flow — 1st Gear — Low Range

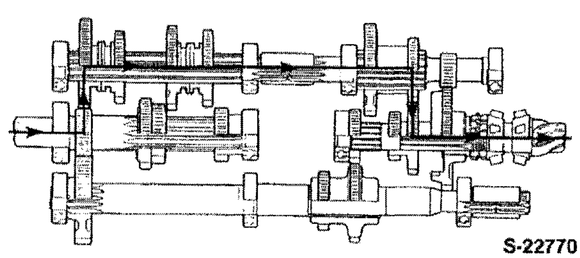

Figure 6
Power Flow — 1st Gear — Mid-Range

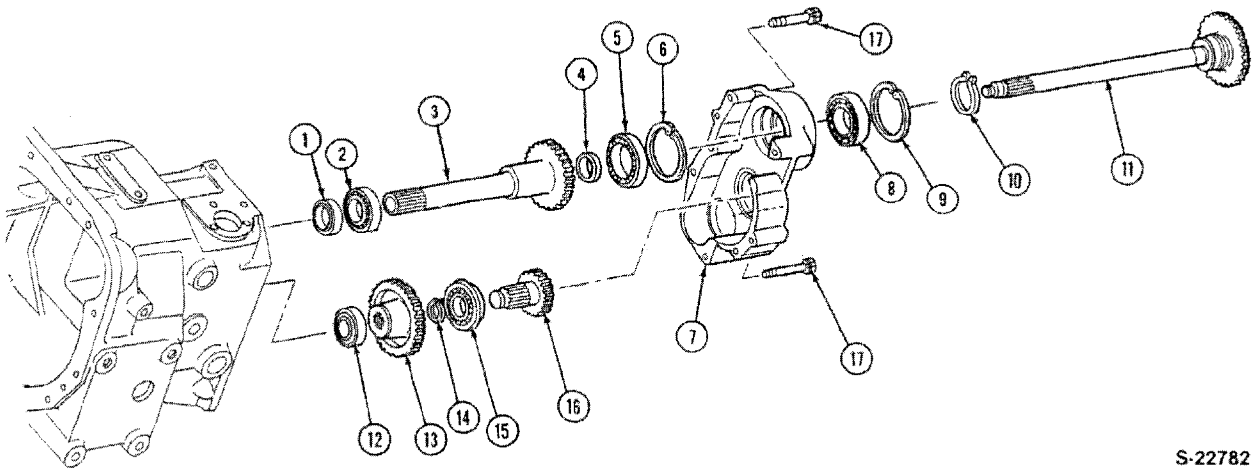

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Figure 18
Input Shaft Removal (Double Clutch)

1. Seal
2. Bearing
3. Input Shaft (PTO)
4. Seal
5. Bearing
6. Snap Ring
7. Case
8. Bearing
9. Snap Ring
10. Snap Ring
11. Input Shaft (Trans.)
12. Bearing
13. Gear
14. Snap Ring
15. Bearing
16. Gear and Shaft Assy.
17. Bolts

2. Remove the snap ring (10) and remove the input shaft (11) from the case.

3. Withdraw the PTO input shaft (3) from the clutch housing.

4. Remove the bearing (12) and gear (13).

5. Remove the snap ring (14) and remove the shaft and gear asembly (16).

NOTE: *On assembly, replace the seals (1) and (4) with new.*

MAIN GEAR SHIFTER ROD — REMOVAL
Reference — Figure 19

1. Remove the upper detent spring (6). Using a small pencil type magnet, remove the detent ball (7), Figure 19.

2. Drive the roll pin (5) out of the shift fork (3), Figure 19.

3. Remove the top shift rod (1), sliding it forward out of the housing. Remove the fork (3) and interlock (balk) pin (8).

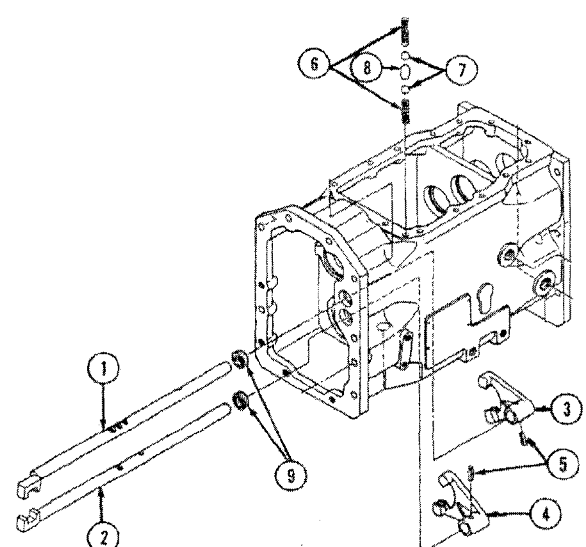

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Figure 19
Main Gear Shift Rod Removal

1. Shifter Rod (2-R)
2. Shifter Rod (1-3)
3. Shifter Fork (2-R)
4. Shifter Fork (1-3)
5. Roll Pin
6. Detent Spring
7. Detent Ball
8. Balk Pin
9. Oil Seals

NOTE: *The lower shift rod must be in neutral position before the upper shift rod can be removed.*

4. Drive the roll pin out of the second shift rod (4) and slide the shift rod forward out of the housing.

   NOTE: *Use care to not lose the detent spring and ball as they will be expelled with considerable force when released by the shift rod.*

5. Remove the lower detent ball (7) and spring (6), Figure 19.

MAIN SHAFT — REMOVAL
Reference — Figure 20

1. Remove the front snap ring (8), Figure 20.
2. Remove the snap rings (3) and (6) from the shaft grooves and place them toward the rear on the shaft.
3. Gently drive the main shaft forward while supporting the gears and snap rings and remove from the case.

REVERSE IDLER — REMOVAL
Reference — Figure 21

1. Remove the front snap ring (1), Figure 21.
2. Gently drive the idler shaft forward while supporting the counter gear and remove from the case.

COUNTERSHAFT — REMOVAL

1. Remove the bearing (1) and gear (2), Figure 22.
2. Remove the bearing retaining snap ring (4), Figure 23.
3. Gently drive the countershaft and front bearing forward and remove the rear bearing (11), fixed gears and spacer (7, 8, 9 and 10), Figure 23, from the shaft.
4. Remove the shaft and front bearing as an assembly from the case.

PTO COUNTERSHAFT — REMOVAL
Reference — Figure 24

1. If equipped with FWD, remove the snap ring (13) and remove the thrust washers, gear set, needle bearings and spacer (9-10-11 and 12), Figure 24.
2. Remove the snap ring (7) from the rear side of the center bearing bore, Figure 24.
3. Gently drive the PTO countershaft rearward.

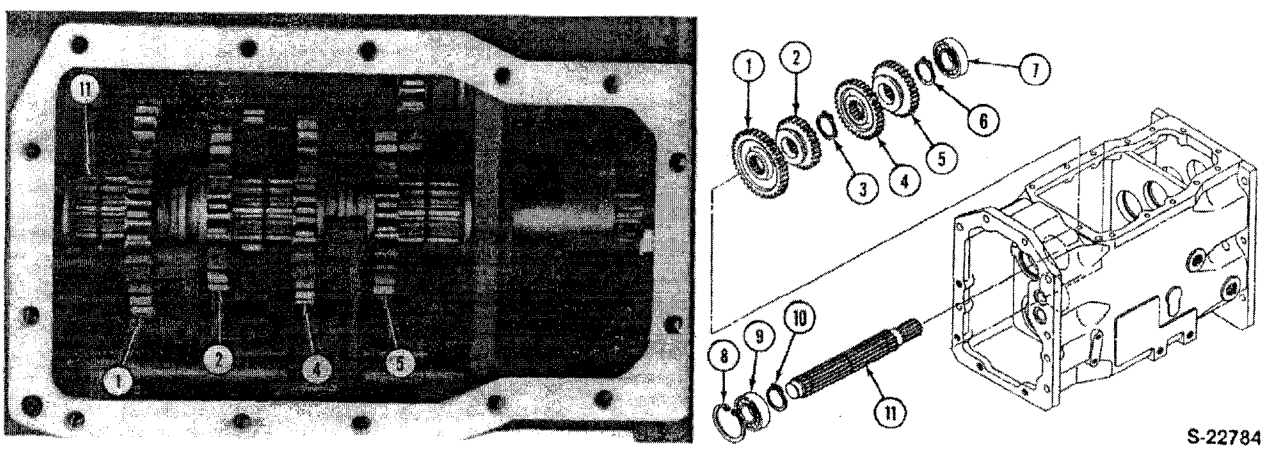

Figure 20
Main Shaft Removal

1. Sliding Gear (1st)
2. Sliding Gear (3rd)
3. Snap Ring
4. Sliding Gear (2nd)
5. Sliding Gear (Rev)
6. Snap Ring
7. Ball Bearing
8. Snap Ring
9. Ball Bearing
10. Snap Ring
11. Main Shaft

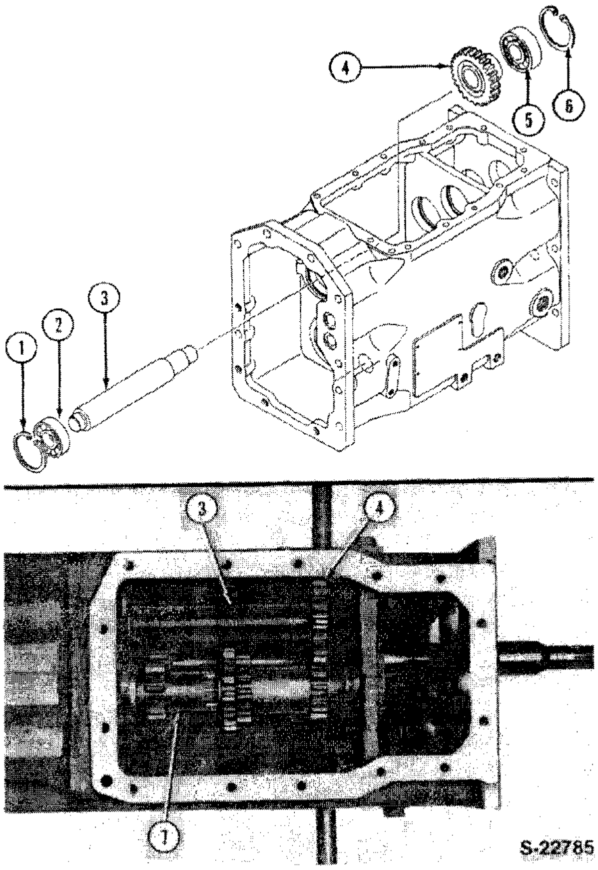

Figure 21
Reverse Idler Removal

1. Snap Ring
2. Ball Bearing
3. Reverse Idler Shaft
4. Counter Gear
5. Ball Bearing
6. Snap Ring
7. Countershaft

4. Remove the bearing (2) and gear (3) from the shaft, Figure 24.

4WD SHIFT ROD — REMOVAL
Reference — Figure 25

1. Drive the roll pin (11), Figure 25, out of the lever (7) and remove the lever.

2. Remove the shift rod (5) from the rear.

   NOTE: *Use care not to lose the detent ball and spring when separating the rod from the fork.*

3. Remove the shift fork (1) and arm (2) from the case.

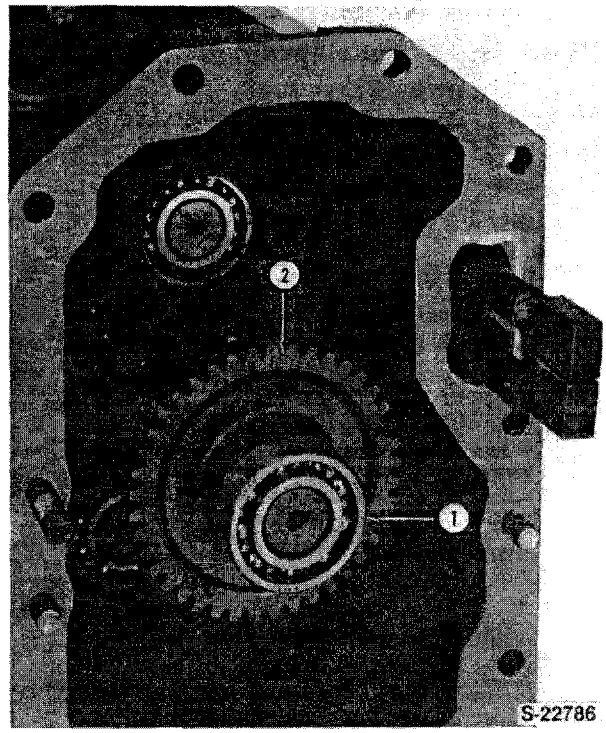

Figure 22
Countershaft Gear Removal

1. Bearing
2. Gear

4WD DRIVE SHAFT — REMOVAL
Reference — Figure 26

1. Gently drive the shaft (3), Figure 26, toward the front while supporting the sliding gear (4) and remove from the case.

2. Remove the seal (1) and bearing (2) from the case.

REAR MAIN SHAFT — REMOVAL
Reference — Figure 27

1. Release the snap ring (3) from the shaft groove and slide it to the rear on the shaft.

2. While sliding the gears (4 and 6) rearward on the shaft, gently drive the main shaft forward removing it from the case. Remove the bearings from the shaft as required.

3. Remove the snap ring (3), gears (4 and 6) and spacer collar (5).

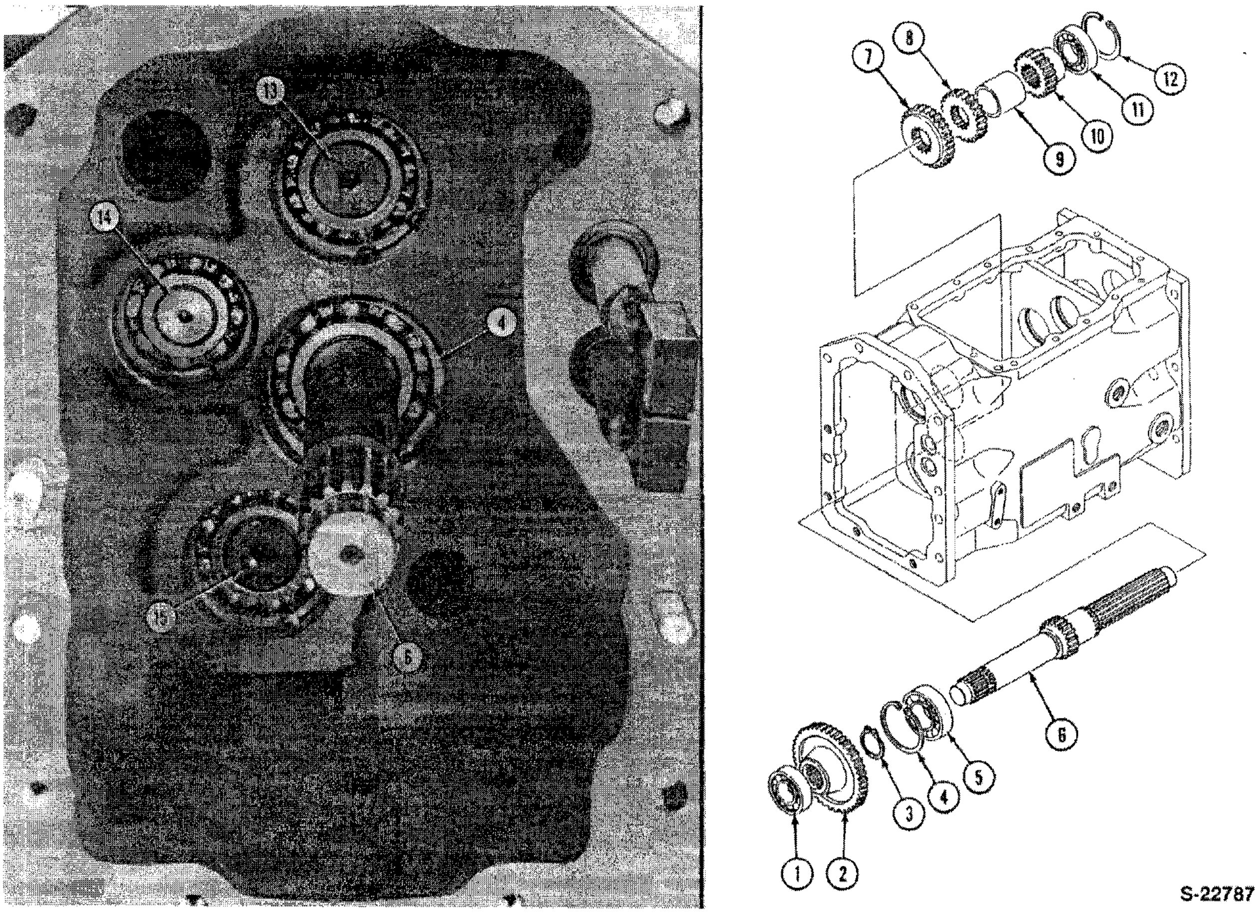

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Figure 23
Countershaft Removal

1. Ball Bearing
2. Gear
3. Snap Ring
4. Snap Ring
5. Ball Bearing
6. Countershaft
7. 3rd Gear — Fixed
8. 2nd Gear — Fixed
9. Collar
10. Reverse Gear — Fixed
11. Ball Bearing
12. Snap Ring
13. Main Shaft
14. Reverse Idler Shaft
15. PTO Countershaft

RANGE GEAR SHIFTER ROD — REMOVAL
Reference — Figure 28

1. Drive the roll pin (10) out of the lever (11) and remove the lever, Figure 28.

2. Pull the shift rod (7) forward and remove it from the front of the case.

   NOTE: *Use care to not loose the detent ball and spring when the rod is separated from the fork.*

3. Remove the shift fork (3).

4. Remove the retaining plate (8) and remove the shifter arm (1).

DRIVE PINION — REMOVAL
Reference — Figure 29

- Remove the differential assembly from the rear axle center housing.

  See "Differential — Rear Axle and Brakes," Part 7 and 12.

1. Straighten the lock washer tabs (15) and loosen the two locknuts (14).

2. Release the snap ring (8) from the shaft groove and slide it forward on the shaft.

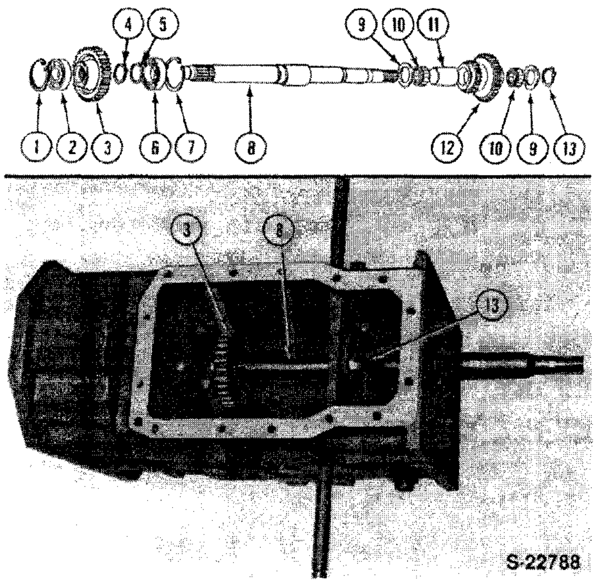


Figure 24
PTO Countershaft Removal

1. Snap Ring
2. Ball Bearing
3. Fixed Gear
4. Snap Ring
5. Snap Ring
6. Bearing
7. Snap Ring
8. Countershaft
9. Thrust Washer (2)
10. Needle Bearings (2)
11. Spacer
12. Gear
13. Snap Ring

3. While moving the pinion gear rearward, remove the bearing (6), gear (7), snap ring (8), sliding gear (9), second snap ring (8), thrust washer (10) and gear and bushing assembly (11), Figure 29.

4. Remove the drive pinion assembly from the rear.

5. Remove the coupling, locknuts, lock washer and bearing (13-16), Figure 29.

INSPECTION

1. Wash all components using a suitable cleaning solvent and air dry.

2. Inspect all bearings for excess wear, score marks, discoloration from overheating, or other damage. Rotate the bearings by hand and check for roughness while slowly rotating the inner and outer races.

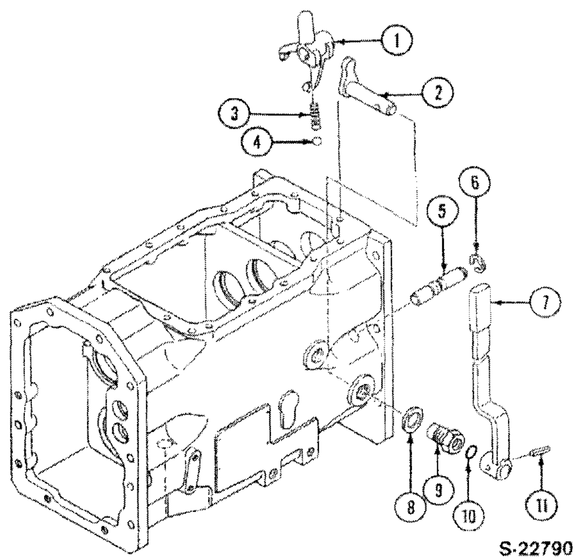


Figure 25
4WD Shift Linkage Removal

1. Shifter Fork
2. Shifter Arm
3. Detent Spring
4. Detent Ball
5. Shifter Rod
6. Snap Ring
7. Change Lever
8. Seal Washer
9. Shift Guide
10. O-Ring
11. Roll Pin

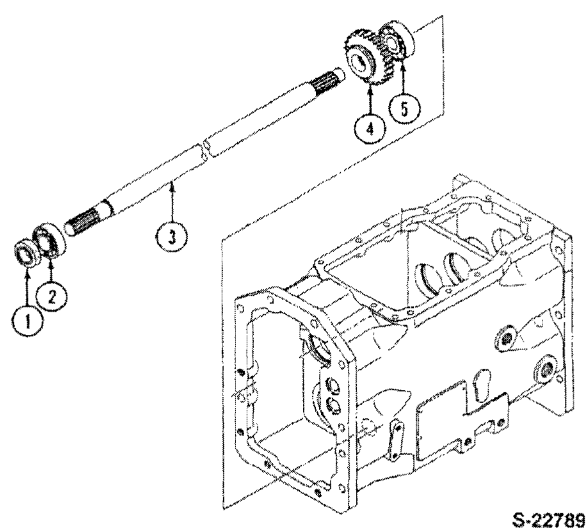
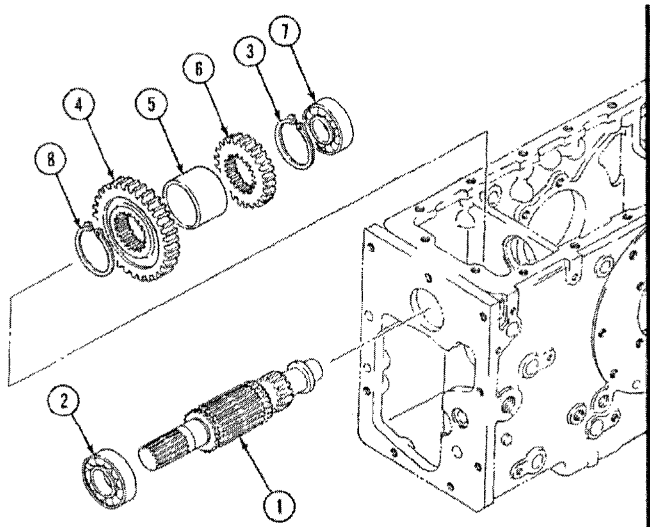


Figure 26
4WD Drive Shaft Removal

1. Oil Seal
2. Ball Bearing
3. 4WD Drive Shaft
4. Slide Gear A
5. Ball Bearing



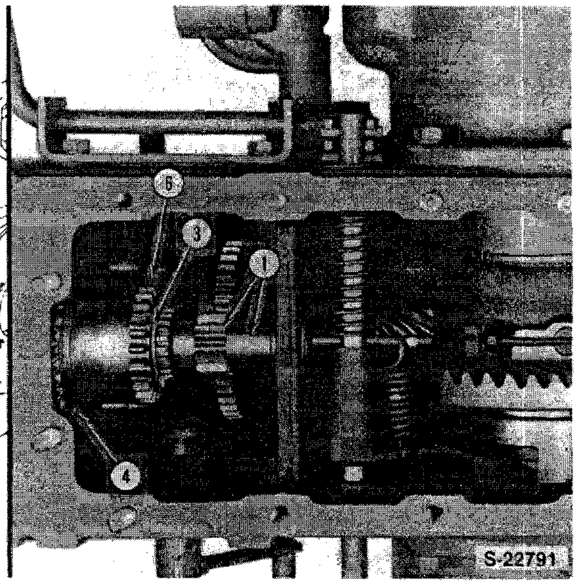


Figure 27
Rear Main Shaft Removal

1. Main Shaft
2. Ball Bearing
3. Snap Ring
4. Fixed Gear (High Range)
5. Collar
6. Fixed Gear (Mid-Range)
7. Ball Bearing
8. Snap Ring

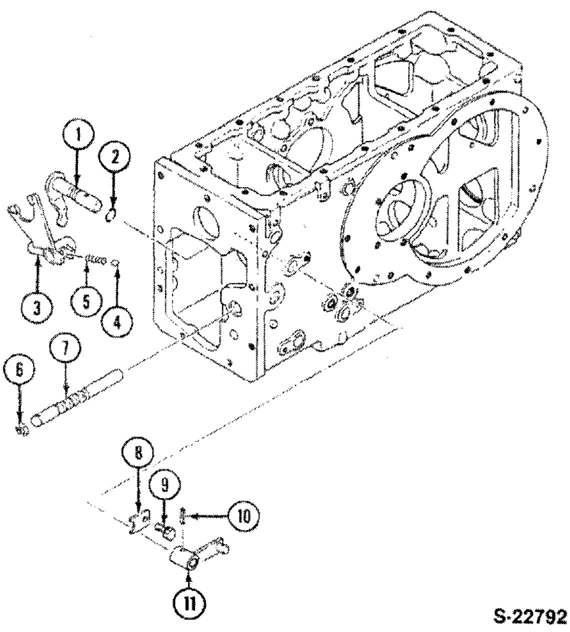


Figure 28
Range Gear Shift Rod Removal

1. Shift Arm
2. O-Ring
3. Shifter Fork
4. Detent Ball
5. Detent Spring
6. Snap Ring
7. Shifter Rod
8. Retaining Plate
9. Bolt
10. Roll Pin
11. Change Lever

3. Lubricate all bearings with a clean lubricant before installation.

4. Inspect the transmission case for cracks, worn bearing bores or other damage.

5. Check the detent springs for wear, chipped or weak spring tension.

6. Inspect the detent balls for excess wear or damage.

7. Inspect the shift rail detent grooves for excess wear.

8. Inspect all gears for excess wear, chipped teeth, or other damage.

9. Inspect the shift forks for excess wear, bending or other damage. See "Wear Specifications," Chapter 3.

ASSEMBLY

1. Lubricate all parts with clean transmission oil prior to assembly.

2. Install new gaskets and seals during assembly.

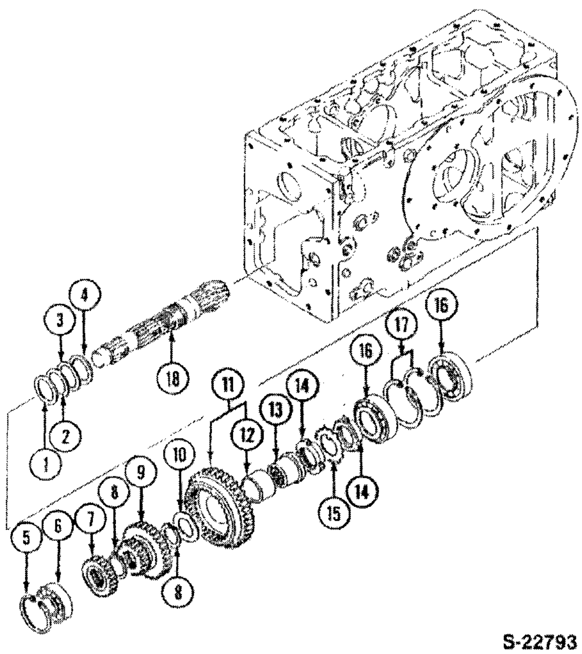


Figure 29
Drive Pinion Removal

1. Shim 0.1T	10. Thrust Washer
2. Shim 0.2T	11. Gear Assy.
3. Shim 0.5T	12. Bushing
4. Thrust Washer	13. Coupling
5. Snap Ring	14. Locknut
6. Ball Bearing	15. Lock Washer
7. Fixed Gear (4WD)	16. Ball Bearing
8. Snap Ring	17. Snap Ring
9. Range Slide Gear	18. Drive Pinion

DRIVE PINION – ASSEMBLY

Install the drive pinion components, Figure 29.

See Part 7, Chapter 1, Section B.

RANGE GEAR SHIFTER ROD – ASSEMBLY
Reference – Figure 28

1. Using a new o-ring, install the shift arm and retaining plate.

2. Install the shift rod and fork with detent ball and spring in place.

3. Position the lever on the shift arm and install the roll pin.

REAR MAIN SHAFT – ASSEMBLY
Reference – Figure 27

1. Install the rear main shaft with the fixed gears, snap rings, spacer and bearings as shown, Figure 27.

4WD DRIVE SHAFT – ASSEMBLY
Reference – Figure 26

1. Install the drive shaft from the front end with the sliding gear and bearings as shown, Figure 26.

2. Using a suitable driver, install the oil seal.

4WD SHIFTER ROD – ASSEMBLY
Reference – Figure 25

1. Install the shifter arm in the transmission.

2. Using a new sealing washer and o-ring install the shift arm guide.

3. Install the shift rod and fork with detent spring and ball as shown, Figure 25.

4. Position the lever on the shifter arm and install the roll pin.

PTO COUNTERSHAFT – ASSEMBLY
Reference – Figure 24

1. Position the PTO countershaft in the case from the rear while positioning the snap rings, thrust washer, gears and bearing on the shaft as shown, Figure 24.

   NOTE: *Counter gear (12) and related components is used with 4WD only.*

COUNTERSHAFT – ASSEMBLY
Reference – Figure 23

1. Install the countershaft from the front end while positioning gears, collar, snap rings, and bearings as shown, Figure 23.

REVERSE IDLER — ASSEMBLY
Reference — Figure 21

1. Install the reverse idler shaft from the front while positioning the gear, bearings and snap ring as shown, Figure 21.

MAIN SHAFT — ASSEMBLY
Reference — Figure 20

1. Install the main shaft from the front while positioning the sliding gears, snap rings and bearings as shown, Figure 20.

MAIN GEAR SHIFTER ROD — ASSEMBLY
Reference — Figure 19

1. Using a suitable driver, install new oil seals (9) in the shift rod case bores.

2. Install the shift rods, forks and detent springs, balls and balk pin as shown, Figure 19.

3. Install the roll pins securing the shift forks to the rods.

C. SHIFT LEVERS

The transmission utilizes two shift levers.

The main transmission shift lever is mounted on the steering column and controls the three forward and one reverse main gear speeds, Figure 30.

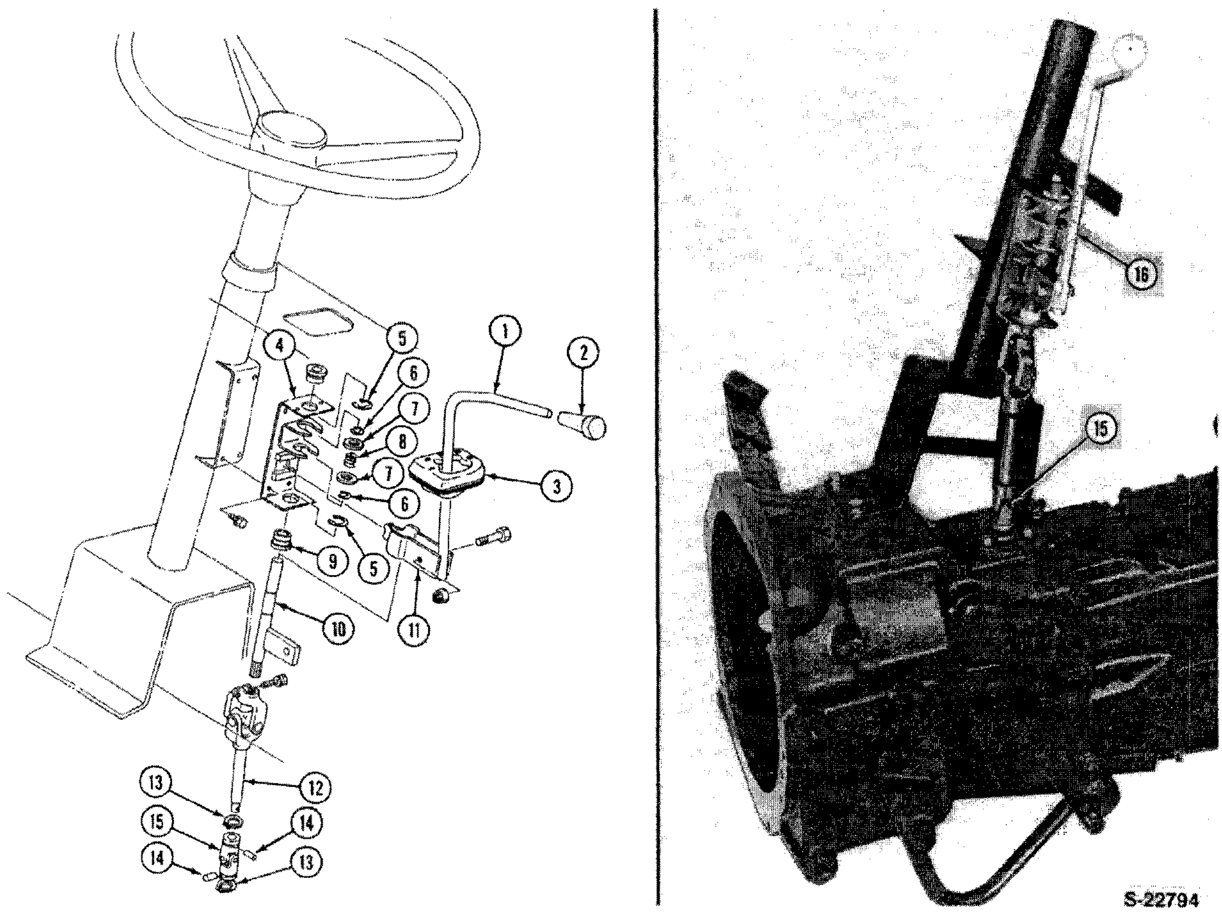


Figure 30
Main Gear Shift Lever Linkage

1. Lever
2. Grip
3. Rubber
4. Holder
5. Snap Ring
6. Snap Ring
7. Washer
8. Spring
9. Bushing
10. Shaft
11. Link Assy.
12. Universal and Shaft Assy.
13. Snap Ring (2)
14. Pin (2)
15. Universal Joint
16. Main Gear Shift Linkage Assy.

The range gear shift lever is located to the left of the operator's seat and controls high, low and mid-range gear ratios of the main transmission.

MAIN TRANSMISSION SHIFT LEVER – OVERHAUL

1. Remove the center steering shroud and the left side shroud panel.
2. Remove the lower snap ring (13), drive the pin (14) out of the universal joint and shaft, Figure 30.
3. Remove the lever bracket (4) from the steering column. Raise the linkage assembly and disconnect the universal joint from the lower lever shaft.
4. Using conventional repair procedures, overhaul the linkage assembly as required.

PART 5
TRANSMISSION SYSTEMS

Chapter 2
HYDROSTATIC TRANSMISSION – MODEL 1320-1520

A. DESCRIPTION AND OPERATION

The hydrostatic transmission consists of a variable displacement piston type hydraulic pump and a fixed displacement piston type motor assembly located in the engine clutch housing. The variable displacement pump is driven by the input shaft connected to the engine flywheel clutch. The pump supplies hydraulic power to the fixed displacement motor, which drives the three range transmission gearbox.

The hydrostatic unit, operated by a foot control pedal, can be advanced in forward-stopped or reverse, Figure 31.

The foot pedal automatically returns to neutral (stopped) position when it is released. The speed is controlled by varying the amount of movement of the pedal from the neutral positon.

The hydraulic unit with the three range gearbox provides a variable speed from 0-2.80 mph in low range, 0-5.28 mph in middle range and 0-11.22 mph in high range, on Model 1320.

On Model 1520 tractor, a variable speed from 0-3.08 mph in low range, 0-6.40 mph in middle range and 0-12.32 mph in high range can be achieved.

When a constant forward speed is desired on level terrain, shifting the speed control lever, Figure 31, to the "set" position will hold the foot pedal in a fixed position and permit the operator to remove his foot from the pedal. When the speed control lever is "released" the foot pedal automatically returns to neutral and the tractor stops.

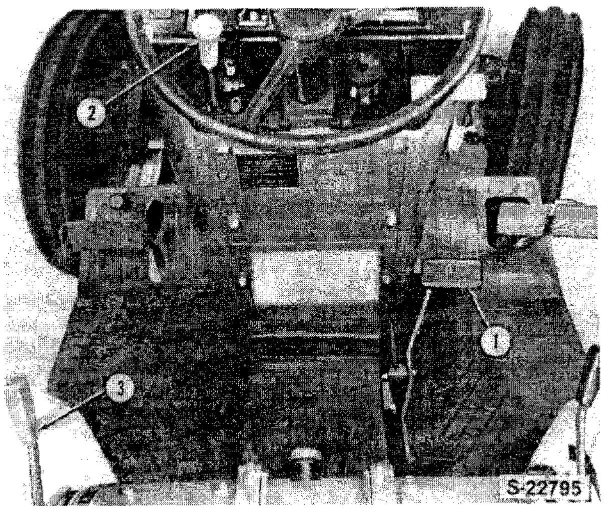


Figure 31
Hydrostatic Transmission

1. Foot Pedal Control
2. Speed Lock Lever
3. Shift Lever, Range Gear

NOTE: *The operator can depress the pedal further from the set position to travel at a faster speed momentarily. The pedal will return to the set position (and speed) when released. The speed control cannot be set in reverse.*

The hydrostatic unit utilizes the oil contained in the rear axle and transmission gearbox common reservoir compartment.

The hydrostatic system, Figure 32, consists of a inlet (suction) filter, hydrostatic transmission unit, oil cooler, final filter and connecting tubing.

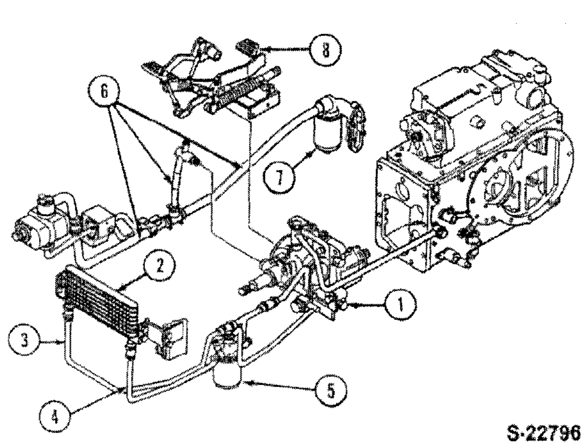


Figure 32
Hydrostatic Transmission — Hydraulic System

1. Hydrostatic Unit
2. Oil Cooler
3. Oil Line to Cooler
4. Oil Line From Cooler
5. Filter
6. Suction Tube
7. Suction Filter
8. Foot Pedal Control

The hydrostatic unit consists of a charge pump, variable displacement piston type pump, fixed displacement piston type motor, high pressure relief valve, two feed valves and neutral valve assemblies, and a charge pump relief valve, Figure 33.

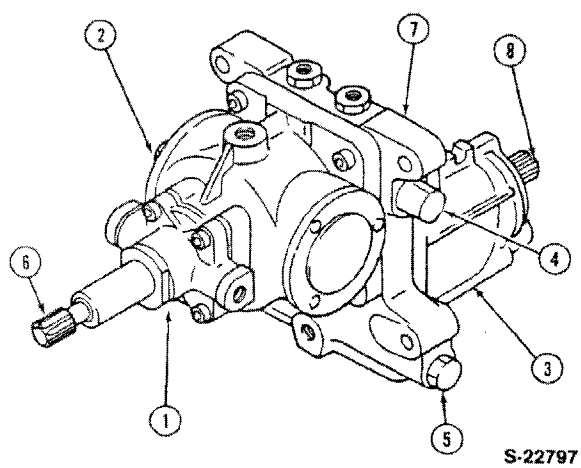


Figure 33
Hydrostatic Unit

1. Charge Pump
2. Piston Type Pump
3. Piston Type Motor
4. High Pressure Relief Valve
5. Feed Valve and Neutral Valve Assy. (2)
6. Input Shaft
7. PTO Drive
8. Transmission Drive

The input shaft, driven by the engine clutch, is splined to the variable displacement piston pump and extends out the rear side of the unit to drive the PTO shaft.

The charge pump, also driven by the input shaft, draws oil from the transmission sump and charges the hydrostatic system with oil under pressure at all times.

High pressure oil supplied by the piston pump drives the motor and powers the transmission assembly.

VARIABLE DISPLACEMENT PUMP — OPERATION
Reference — Figure 34

The pump cylinder block and pistons are splined to the input shaft and rotate with the shaft. In neutral position, the swash plate is in a vertical position and is at a right angle to the pistons and the pistons do not stroke.

When in the neutral position, the displacement in cylinders "A" and "B" are equal and no oil flows through the pump or motor.

When the swash plate is tilted at an angle, Figure 35, oil in the cylinder in position "A" is discharged out through the port in the valve plate as the cylinder is rotated to position "B."

Maximum oil flow is obtained when the swash plate is at the maximum tilt angle.

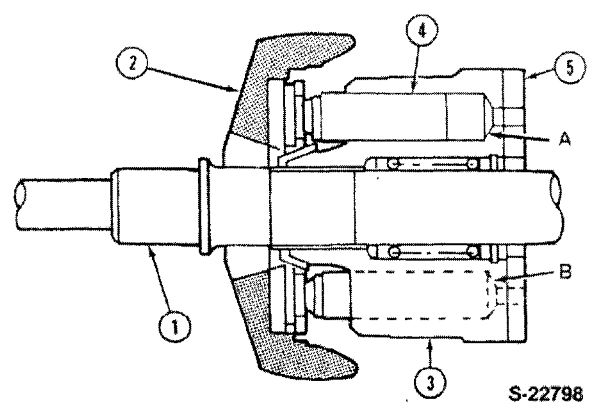


Figure 34
Hydrostatic Pump Operation — Neutral Position

1. Input Shaft
2. Variable Swash Plate
3. Cylinder Block
4. Pistons (4)
5. Valve Port Plate

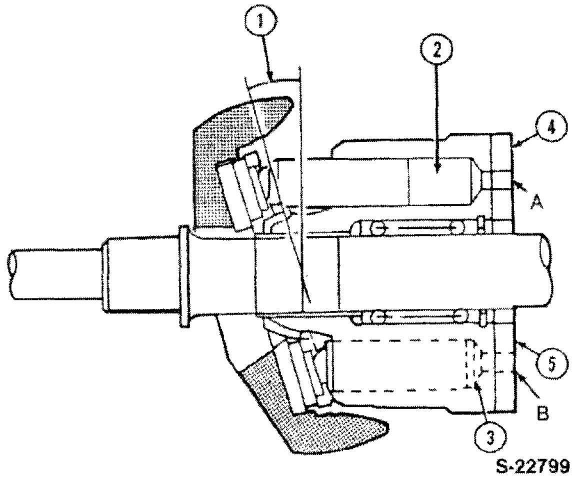


Figure 35
Hydrostatic Pump Operation — Forward Position

1. Swash Plate Angle
2. Suction Stroke
3. Discharge Stroke
4. Valve Port Plate
5. Valve Port

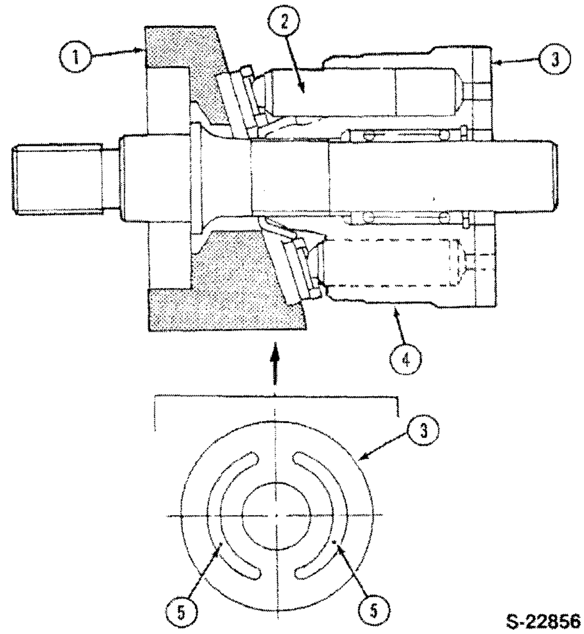


Figure 36
Hydrostatic Motor Operation

1. Fixed Angle Swash Plate
2. Pistons (9)
3. Valve Port Plate
4. Cylinder Block
5. Valve Ports

FIXED DISPLACEMENT MOTOR — OPERATION
Reference — Figure 36

Oil flow from the piston pump enters one of the ports in the valve plate of the motor and exerts a pressure against the end of the pistons in line with the port. Oil pressure on the pistons causes the cylinder block and pistons to rotate. A drive shaft splined to the motor cylinder block then drives the transmission gearbox.

OIL FLOW — NEUTRAL POSITION
Reference — Figure 37

Oil drawn from the transmission reservoir is pressurized by the rotor type charge pump. The oil flows from the charge pump through the cooler and filter to the feed valve and neutral valve assemblies and then returns to sump via the charge pump relief valve.

The charge pump relief valve maintains 61-81 psi pressure to the feed valves "A" and "B" at all times. Oil flow past the feed valves pressurizes the passages "A" and "B" and the pump and motor cylinder blocks.

Because of equal pressures in passages "A" and "B" the motor does not rotate.

The neutral valves are in a normally open position allowing oil flow past the feed valves to return to sump. The neutral valves set at 284 psi remain open until this pressure is exceeded.

OIL FLOW — FORWARD POSITION
Reference — Figure 38

When the foot pedal is shifted slightly forward, the pump swash plate is tilted at a slight angle and a small quantity of oil is discharged from the piston pump into passage "A." This small quantity of oil passes through the neutral valves and returns to sump while causing a slight pressure increase in the "A" circuit.

When the foot pedal is depressed further forward, increased oil flows from the piston pump, through passage "A." Pump pressure on the back side of feed valve 5, Figure 38, closes the feed valve and pressure increases on the neutral valve. At a pressure above 470 psi, the neutral valve closes the return to sump and all oil flow from pump passage "A" flows to the motor, and causes the motor to rotate.

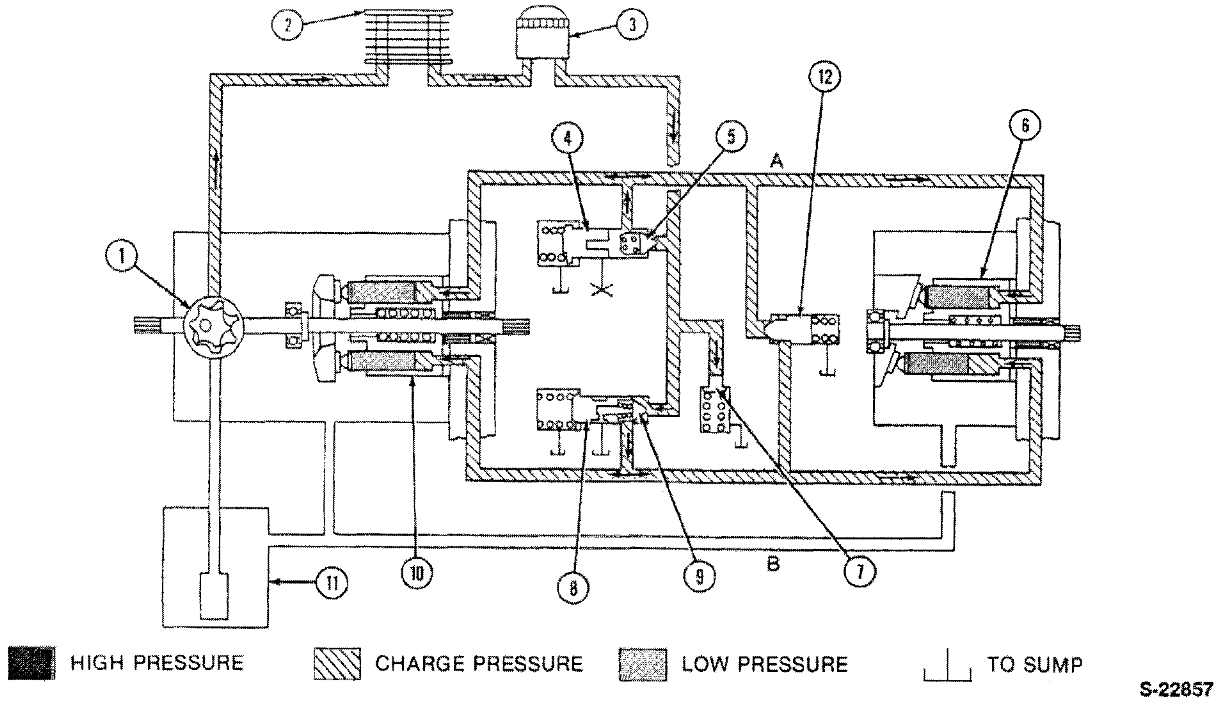


Figure 37
Oil Flow — Neutral Position

1. Charge Pump
2. Cooler
3. Filter
4. Neutral Valve
5. Feed Valve "A"
6. Hydrostatic Motor
7. Charge Pump Relief Valve
8. Neutral Valve
9. Feed Valve "B"
10. Hydrostatic Pump
11. Reservoir
12. High Pressure Relief Valve

Oil discharged from the motor in passage "B" flows back to the pump to complete the cycle.

When oil leakage in the system causes a drop in pressure on the suction passage "B," below 61-81 psi pressure setting, feed valve (8) opens and provides make-up oil from the charge pump.

Surplus oil from the charge pump is returned to sump via the charge pump relief valve (7).

OIL FLOW — REVERSE POSITION
Reference — Figure 39

When the foot pedal is depressed in the reverse position, oil flows from the piston pump into passage "B" to the motor. The neutral valve and feed valve (8) and (9), Figure 39, are closed due to pressure in passage "B." Oil pressure acting on the motor pistons causes the motor to rotate in the reverse direction. Oil discharged from the motor flows back through passage "A" to the pump.

B. OVERHAUL

REMOVAL

1. Drain the transmission oil.
2. Separate the tractor between the engine and clutch housing. See "Separating the Tractor," Part 12.

HYDROSTATIC UNIT — REMOVAL

1. Remove the two test port adaptors (1), Figure 40.
2. Disconnect the HST control rod (1), Figure 41.
3. Remove the clutch housing attaching bolts and remove the clutch housing, Figure 40.
4. Remove the hydrostatic unit retaining bolts and nuts and remove the hydrostatic unit from the transmission case, Figure 42.

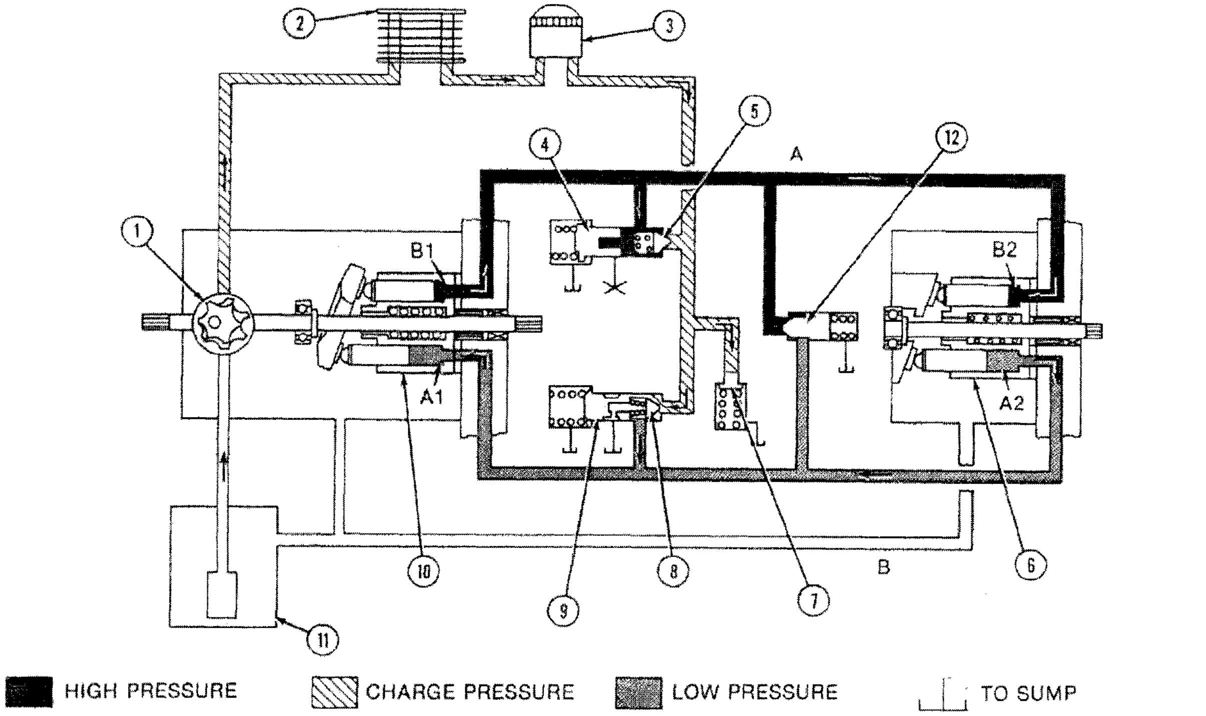


Figure 38
Oil Flow — Forward Position

1. Charge Pump
2. Cooler
3. Filter
4. Neutral Valve
5. Feed Valve "A"
6. Hydrostatic Motor
7. Charge Pump Relief Valve
8. Feed Valve "B"
9. Neutral Valve
10. Hydrostatic Pump
11. Reservoir
12. High Pressure Relief Valve

PRECAUTIONS BEFORE DISASSEMBLY

1. Be sure to thoroughly clean the tractor to remove all dirt and foreign matter from the unit.
2. Plug or cap all hydraulic line openings to prevent foreign particles from entering the system.
3. Drain the oil from the HST unit.
4. Maintain a clean work area so as to not contaminate or damage any of the precision surfaces of the HST components.
5. Handle the HST components with care so as to not scratch or otherwise cause damage to the parts.

HYDROSTATIC PUMP — DISASSEMBLY

1. Remove the four hexagon socket type bolts, Figure 43.
2. Raise the pump housing sufficiently to confirm the position of the valve port plate.

   NOTE: *The valve plate will adhere to either the pump cylinder block surface or to the port block surface. Exercise care in removing the pump to prevent the valve plate from inadvertently being dropped during disassembly.*
3. Remove valve plate, Figure 44.
4. Remove the pump cylinder block and piston assembly, Figure 45.
5. Remove the thrust plate from the swash plate. If it is hard to remove, use a hook type tool to remove the plate, Figure 46.

HYDROSTATIC MOTOR — DISASSEMBLY

1. Remove the four hexagon socket type bolts, Figure 47.

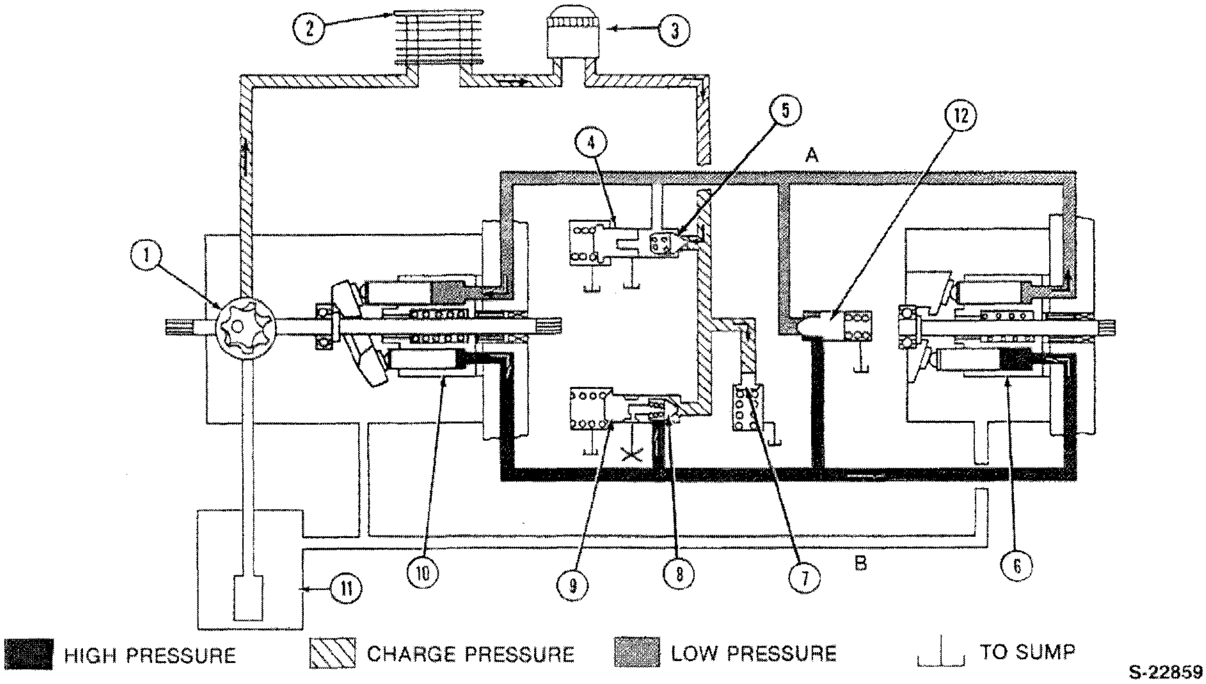


Figure 39
Oil Flow — Reverse Position

1. Charge Pump
2. Cooler
3. Filter
4. Neutral Valve
5. Feed Valve
6. Hydrostatic Motor
7. Charge Pump Relief Valve
8. Feed Valve
9. Neutral Valve
10. Hydrostatic Pump
11. Reservoir
12. High Pressure Relief Valve

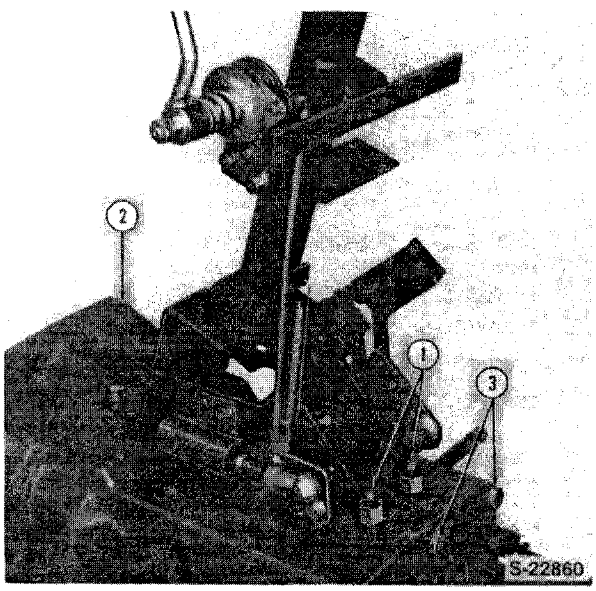


Figure 40
Clutch Housing Removal

1. Adaptors — Pressure Test Ports
2. Clutch Housing
3. Clutch Housing Attaching Bolts

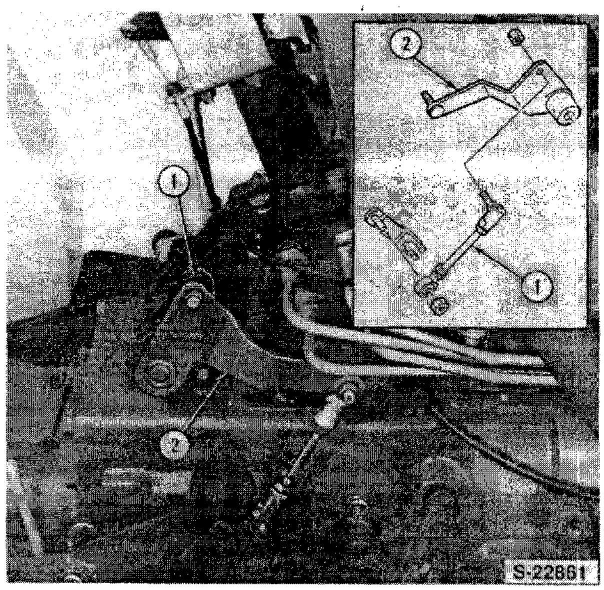


Figure 41
HST Control Rod Removal

1. Rod
2. Shift Link

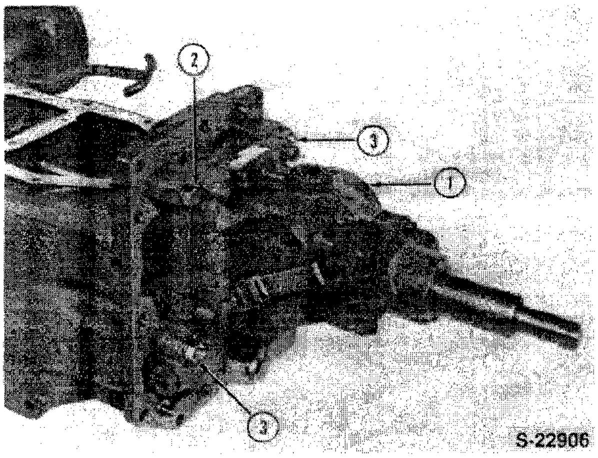


Figure 42
Hydrostatic Unit Removal

1. HST Unit
2. Bolts (2)
3. Stud Nuts (2)

2. Raise the motor housing sufficiently to confirm the location of the valve port plate.

   NOTE: *The valve plate will adhere to either the motor cylinder block surface or the port block surface. Exercise care in removing the pump to prevent the valve plate from inadvertently being dropped during disasembly.*

3. Remove the motor assembly and valve plate, Figure 48.

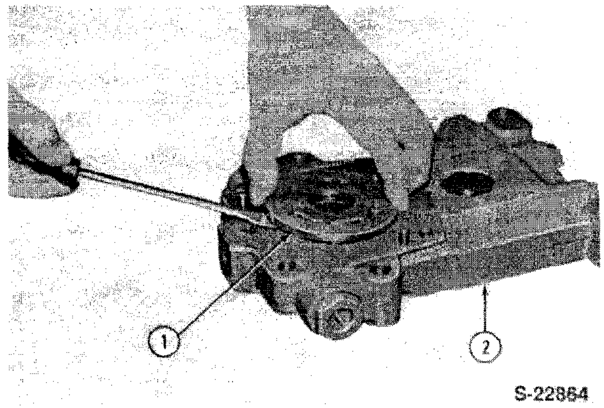


Figure 44
Valve Plate Removal

1. Valve Plate
2. Port Block

4. Remove the motor cylinder block and piston assembly, Figure 49.

5. Remove the thrust plate from the motor housing. If it is hard to remove, use a hook type tool to remove the plate as shown, Figure 46.

HYDROSTATIC MOTOR SHAFT — REMOVAL

1. Remove the three hexagon socket type bolts retaining the cover to the housing and remove the cover, Figure 50.

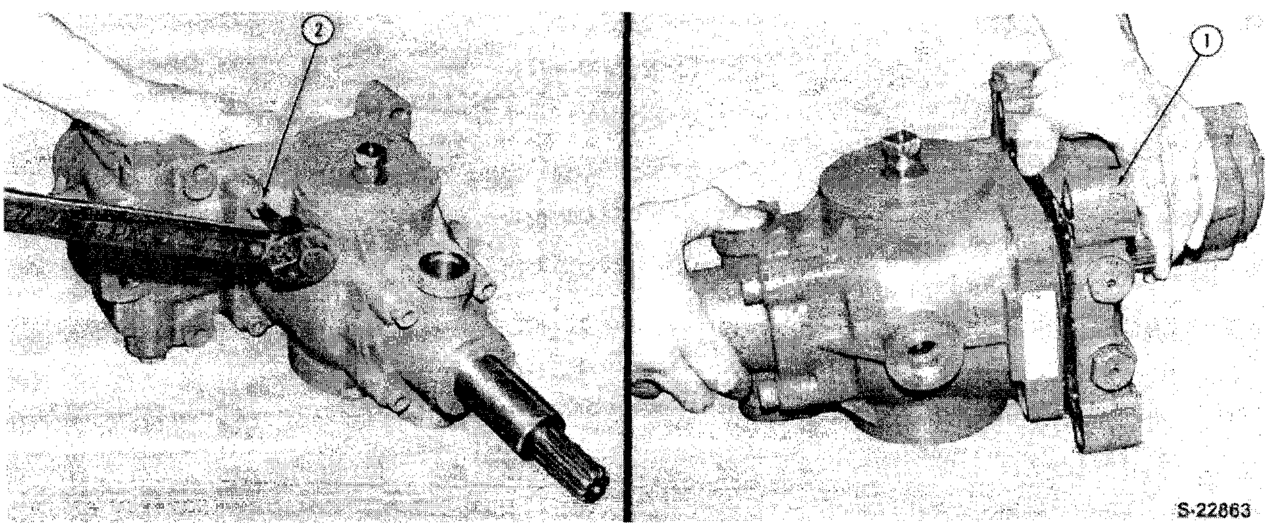


Figure 43
Hydrostatic Disassembly

1. Port Block
2. Socket Head Bolts (4)

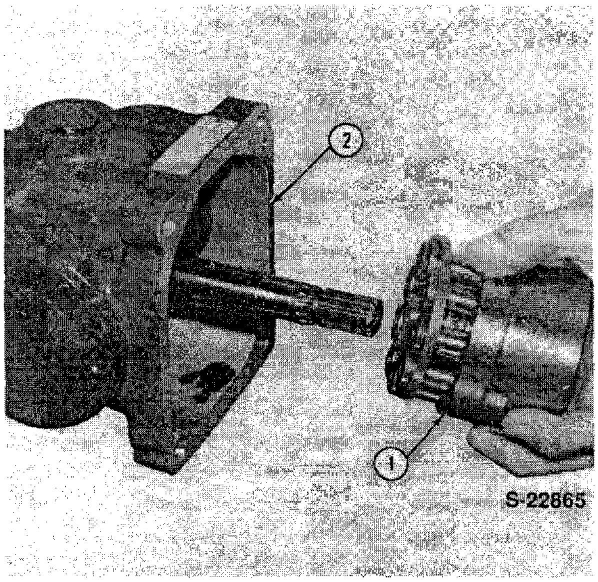


Figure 45
Cylinder Block Assembly — Disassembly
1. Cylinder Block (Pump)
2. Pump Housing

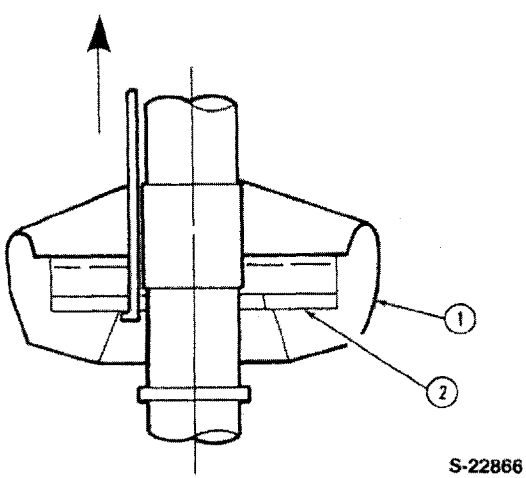


Figure 46
Thrust Plate Removal
1. Swash Plate
2. Thrust Plate

2. Using a soft hammer gently drive the shaft and bearing as an assembly out of the housing, Figure 51.

CHARGE PUMP — REMOVAL

1. Remove the throw-out bearing hub (2), Figure 52.

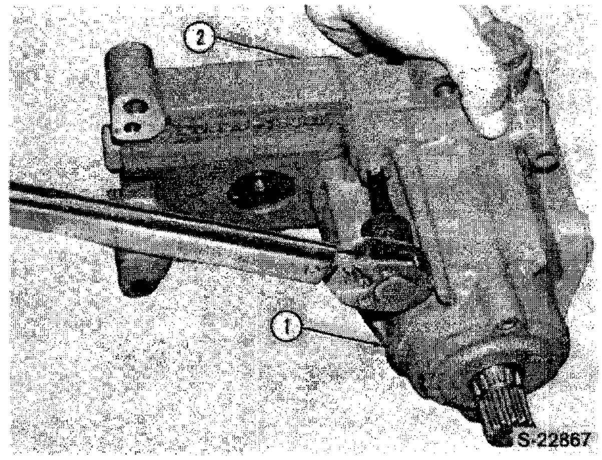


Figure 47
Hydrostatic Motor Housing — Separate
1. Motor Housing
2. Port Block

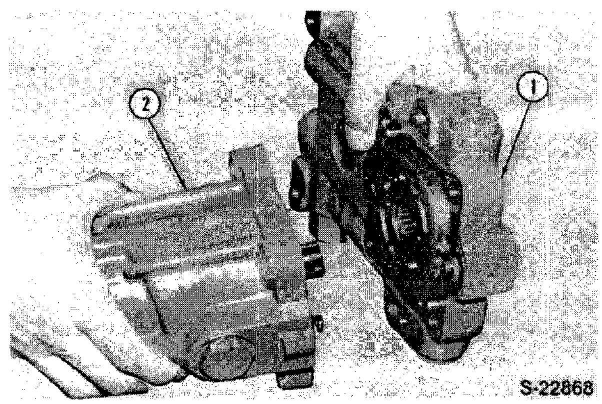


Figure 48
Hydrostatic Motor Housing Disassembly
1. Port Block
2. Motor Housing

2. Remove the four bolts retaining the charge pump to the housing and remove the rotors, wear plate, key and o-rings from the shaft.

NOTE: *Identify the position of the inner and outer rotor so as to assemble in their original position.*

3. Remove the snap ring from the case, drive out the shaft and bearing as an assembly from the front of the case.

SWASH PLATE — REMOVAL

1. Scribe alignment marks on the swash plate covers. Remove the cover screws from each side, Figure 53.

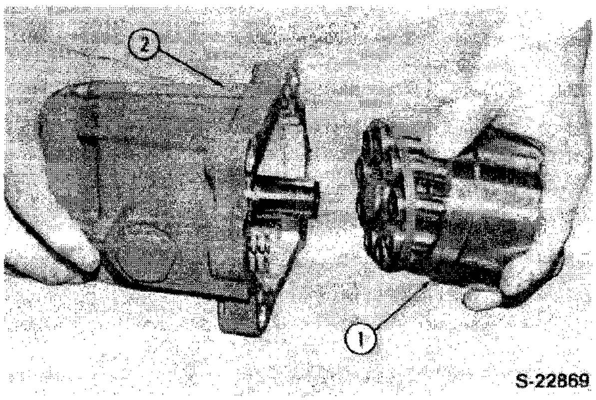


Figure 49
Cylinder Block (Motor) Assembly — Disassembly

1. Cylinder Block (Motor)
2. Pump Housing

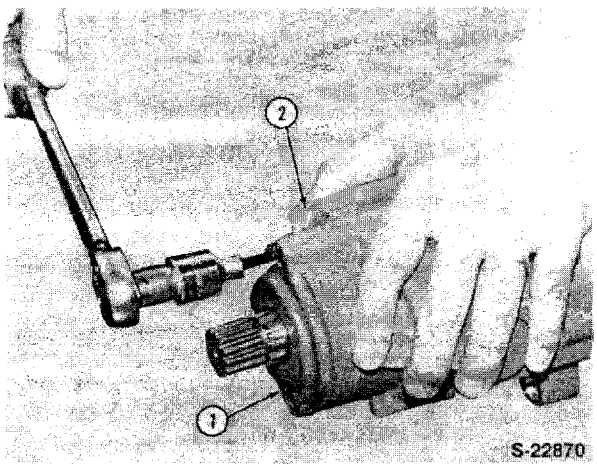


Figure 50
Cover Removal

1. Cover
2. Hydrostatic Motor Housing

2. Gently tap the axial end of the swash plate with a soft hammer and remove the opposite side cover.

3. Gently tap on the exposed trunnion end with a soft hammer and remove the remaining cover.

4. Remove the variable swash plate, Figure 53.

INSPECTION

Inspect the hydrostatic components for the following conditions:

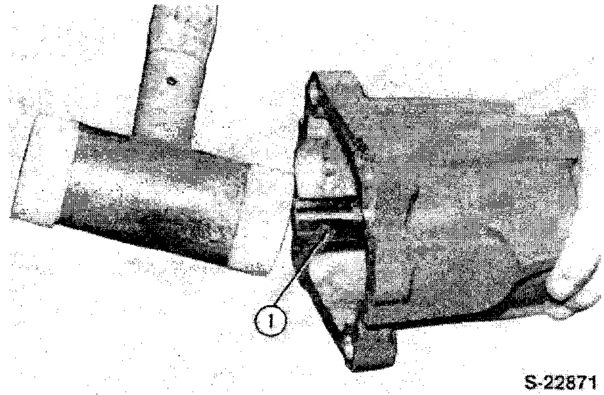


Figure 51
Shaft Removal

1. Shaft

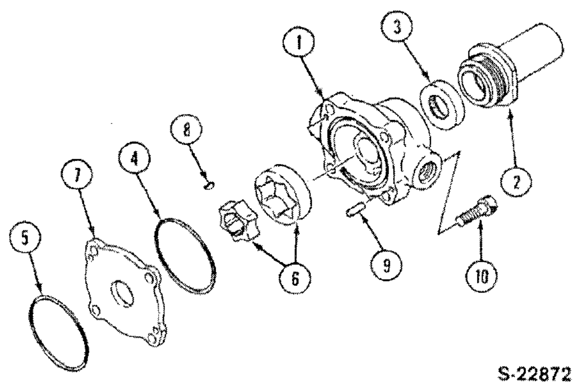


Figure 52
Charge Pump Disassembly

1. Charge Pump Housing
2. Throwout Bearing Hub
3. Seal
4. O-Ring
5. O-Ring
6. Pump Rotors
7. Wear Plate
8. Key
9. Pin
10. Bolt

1. Excessive wear or scored pistons and cylinder bores in the pump and motor block assemblies.

2. Excessive wear or scored cylinder block and valve port plate mating surfaces.

3. Excessive wear or scored charge pump rotor faces and lobes.

4. Excessive wear or scored charge pump body and wear plate surfaces.

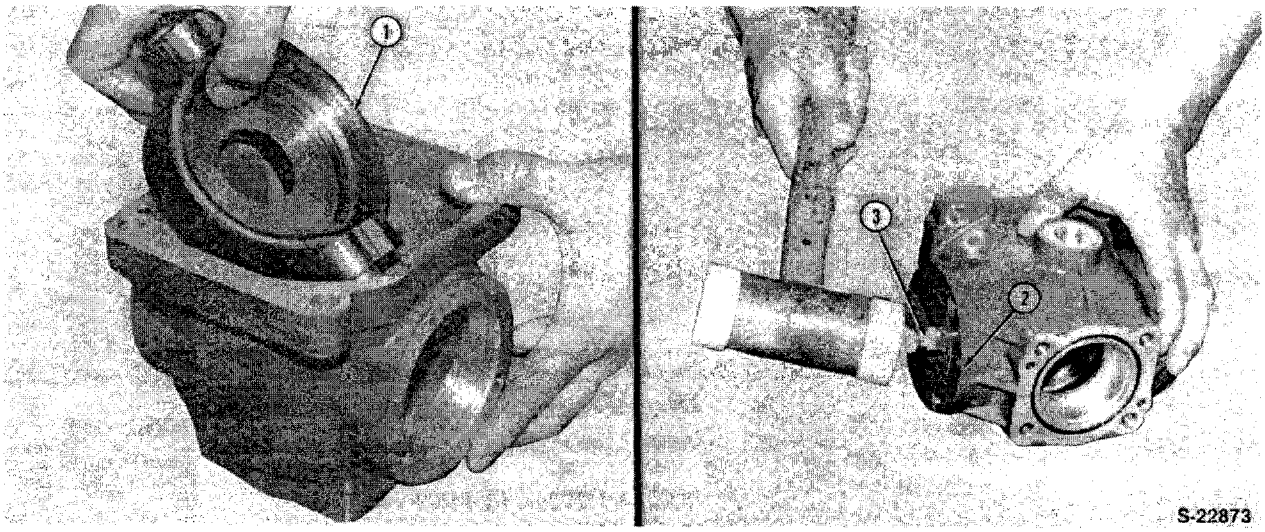


Figure 53
Swash Plate Removal
1. Variable Swash Plate
2. Covers
3. Swash Plate Shaft

5. Check the ball bearings for excessive wear and looseness or uneven rotation when rotated by hand.

6. Inspect the variable swash plate bushings for excessive wear or scoring. Replace the cover and bushing as an assembly if required.

ASSEMBLY

Before assembly, be sure all components are thoroughly cleaned and well lubricated with Ford Oil Part No. 134.

1. Position the variable swash plate into the case, Figure 54.

2. Lubricate the swash plate cover O-rings, seals and bushings and install the covers and retaining screws to the case. Tighten the retaining screws to 2.89 ± 0.29 lbs. ft. (3.92 ± 0.39 Nm) torque.

NOTE: *Be sure to align the cover scribe marks, and install the covers in their original position.*

3. Press the bearing (2) in place on the input shaft (1) and secure with the snap ring (3), Figure 55.

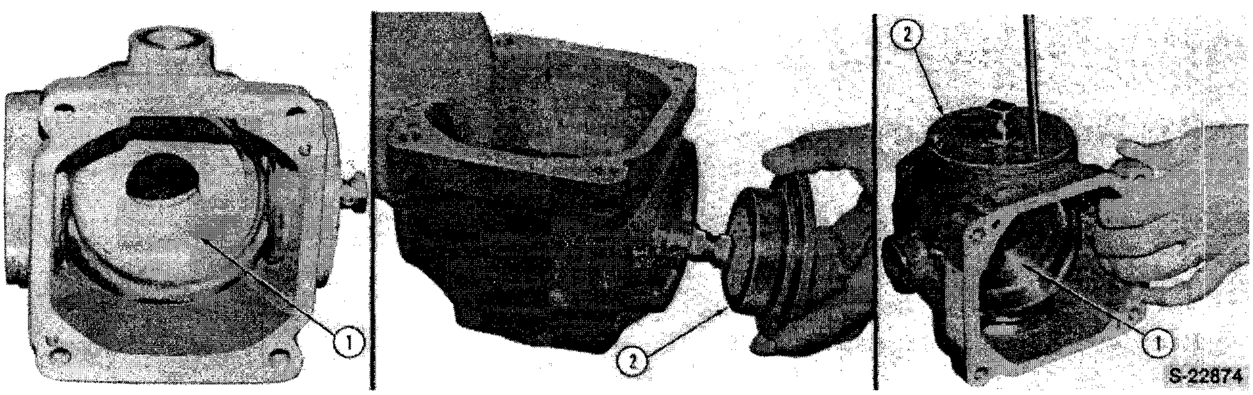


Figure 54
Hydrostatic Assembly
1. Variable Swash Plate
2. Covers

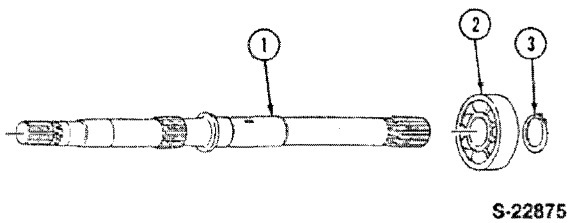


Figure 55
Input Shaft Assembly

1. Input Shaft
2. Bearing
3. Snap Ring

4. Install the input shaft and bearing assembly into the case. Secure with the snap ring (4) in place in the case, Figure 56.

5. Install the dowel pin (10) and o-ring (5) in the hydrostatic pump housing, Figure 56.

6. Install the wear plate (6) to the hydrostatic pump housing.

7. Install the drive key (8) and pump rotor assembly on the input shaft.

8. Press the seal (12), in place in the charge pump housing and install the throw-out bearing hub to the case. Tighten the retaining hub to 43.39 ± 4.39 lbs. ft. (58.80 ± 5.9 Nm).

9. Install the o-ring (7) to the charge pump housing.

10. Install the charge pump sub assembly to the case and tighten the retaining bolts to 13.0 ± 1.3 lbs. ft. (17.6 ± 1.7 Nm), Figure 57.

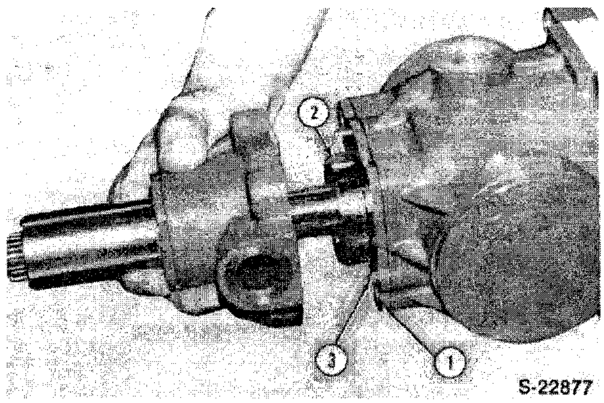


Figure 57
Charge Pump Installation

1. Wear Plate
2. Rotor Assembly
3. Dowel Pin

HST PISTON PUMP CYLINDER BLOCK – ASSEMBLY

1. Assemble the pins and retainer holder to the cylinder block, Figure 58.

2. If removed, assemble the washers (2), spring (3), and snap ring (4) in the cylinder block, Figure 59.

3. Assemble the piston and retainer assembly into the cylinder block, Figure 60.

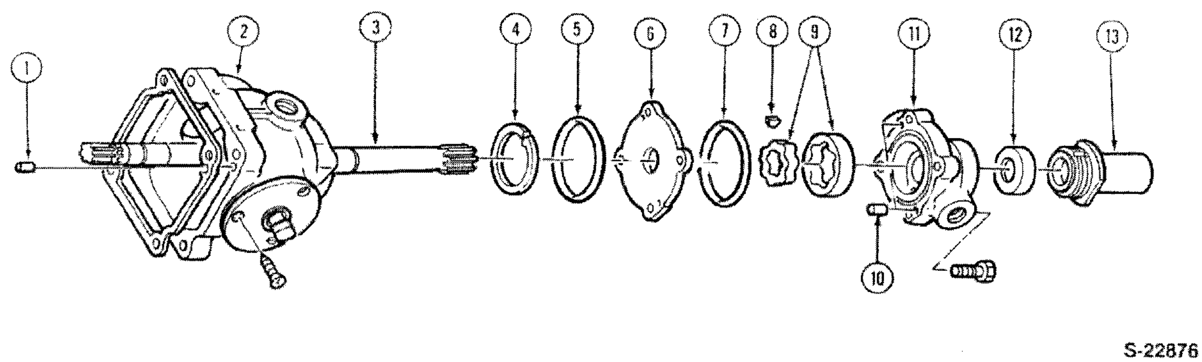


Figure 56
HST Pump and Charge Pump Assembly

1. Dowel Pin
2. HST Pump Housing
3. Input Shaft
4. Snap Ring
5. O-Ring
6. Wear Plate
7. O-Ring
8. Key
9. Rotors
10. Dowel Pin
11. Housing
12. Seal
13. Bearing Hub

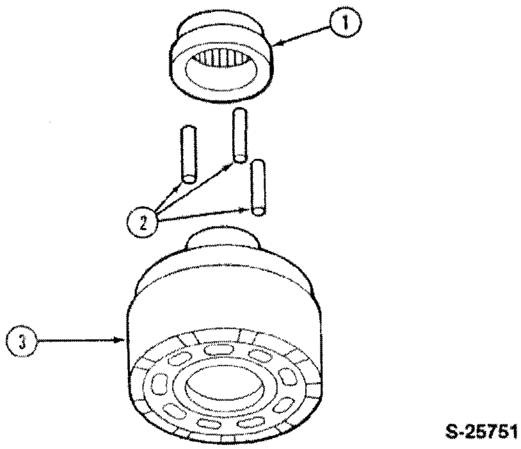


Figure 58
Hydrostatic Pump

1. Retainer
2. Pins
3. Cylinder Block

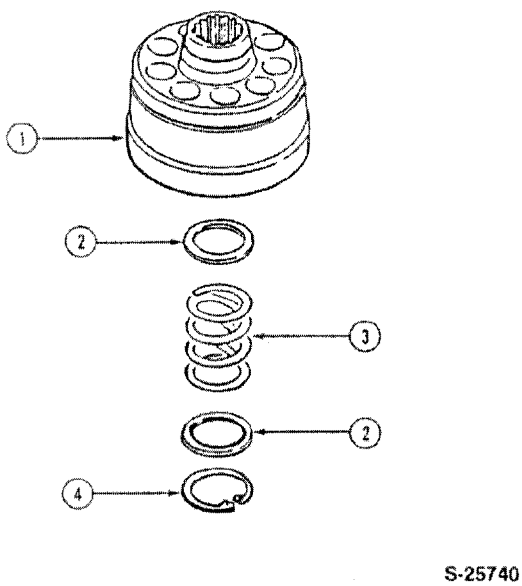


Figure 59
Hydrostatic Pump Assembly

1. Cylinder Block
2. Washers
3. Spring
4. Snap Ring

4. Position the thrust plate in the bottom of the housing in the variable swash plate.

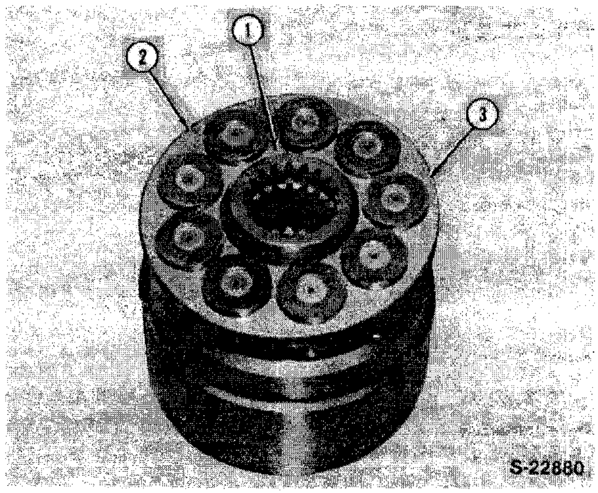


Figure 60
Hydrostatic Pump Installation

1. Retainer Holder
2. Retainer Plate
3. Piston Assy.

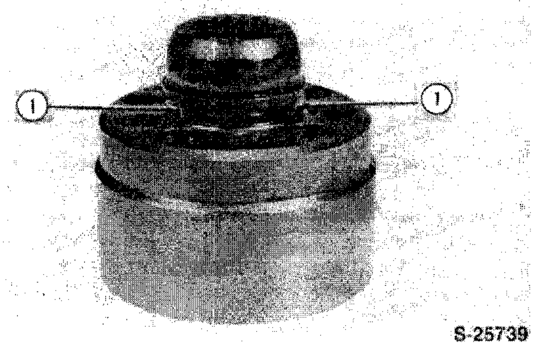


Figure 61
Cylinder Block and Pin Installation

1. Pins

5. Install the assembled pump assembly onto the input shaft, Figure 62.

   NOTE: *Recheck to be sure of correct location.*

HST MOTOR CYLINDER BLOCK — ASSEMBLY

1. If removed, press the bearing (2) onto the drive shaft and secure with the snap ring (4), Figure 63.
2. Install the oil seal (5), and O-ring (3) into the case cover (6), Figure 63.
3. Install the output shaft in the motor housing.

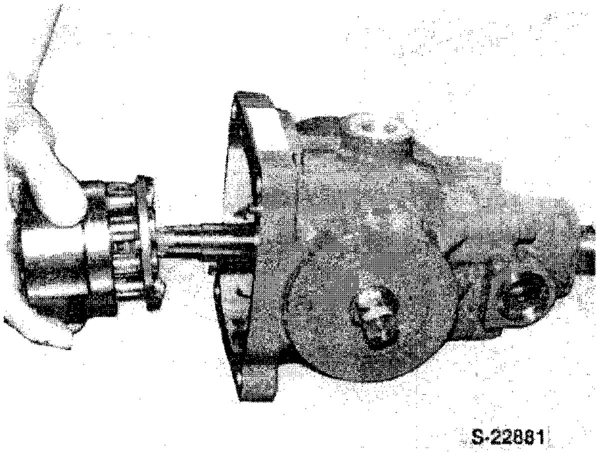


Figure 62
Hydrostatic Pump Installation

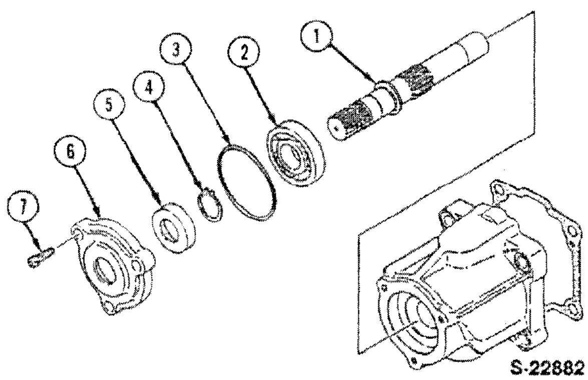


Figure 63
Motor Drive Shaft Installation

1. Motor Drive Shaft
2. Bearing
3. O-Ring
4. Snap Ring
5. Seal
6. Cover
7. Socket Head Bolt

4. Install the cover (6) and tighten the retaining bolts to 3.61 ± 0.36 lbs. ft. (4.9 ± 0.49 Nm) torque.

5. Position the thrust plate (2) in the bottom of the motor housing in the fixed swash plate, Figure 64.

6. Position the assembled motor cylinder block onto the output shaft as shown, Figure 65.

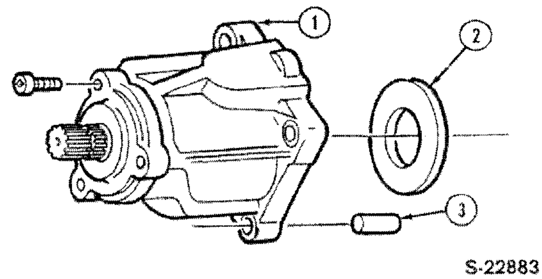


Figure 64
HST Motor Assembly

1. Motor Housing
2. Thrust Plate
3. Dowel Pin

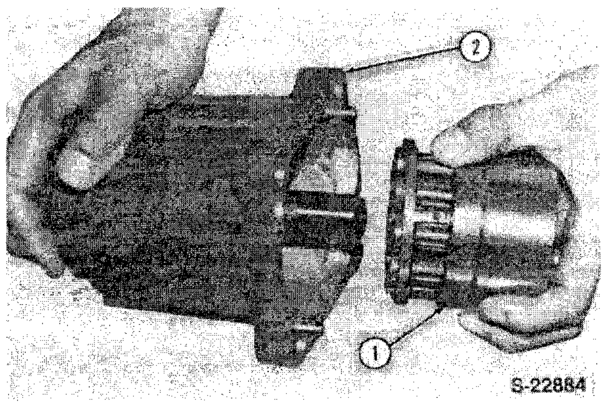


Figure 65
HST Motor Installation

1. Motor Cylinder Block Assy.
2. Motor Housing

PORT BLOCK — ASSEMBLY

NEUTRAL VALVE AND FEED VALVE ASSEMBLY
Reference — Figure 66

Two sets of neutral valves and feed valves are utilized in the hydrostatic transmission unit. One set functions for forward travel and the other for reverse travel.

DISASSEMBLY

1. Remove the neutral valve assembly from the housing.

2. Remove the feed valve spring and poppet.

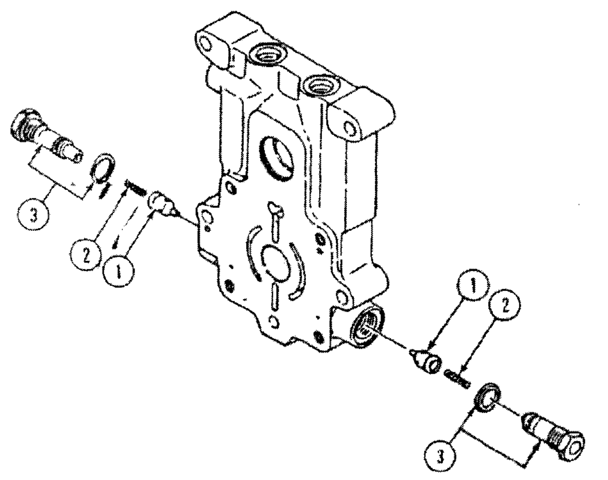


Figure 66
Neutral Valve and Feed Valve Assembly
1. Feed Valve Poppet
2. Feed Valve Spring
3. Neutral Valve Assy.

INSPECTION

1. Inspect the feed valve poppet for excess wear or scoring. Check the poppet in the bore for a sticking or binding condition.

2. Inspect the feed valve spring for wear or damage.

   NOTE: *If the feed valve poppet or spring indicates damage, replace as a kit assembly.*

3. If hydraulic tests indicate faulty neutral valve operation, replace the neutral valve as an assembly.

ASSEMBLY

Install the feed valve spring and poppet onto the end of the neutral valve and install the assembly in the port block. Tighten to the specified torque.

Tightening Torque............27.12 ± 1.80 lbs. ft.
(36.75 ± 2.45 Nm)

CHARGE PUMP RELIEF VALVE
Reference — Figure 67

The charge pump relief valve functions to maintain approximately 61-81 psi of pressure in the oil supply system to the piston pump at all times. Excess oil not required by the piston pump is returned to sump via the charge pump relief valve.

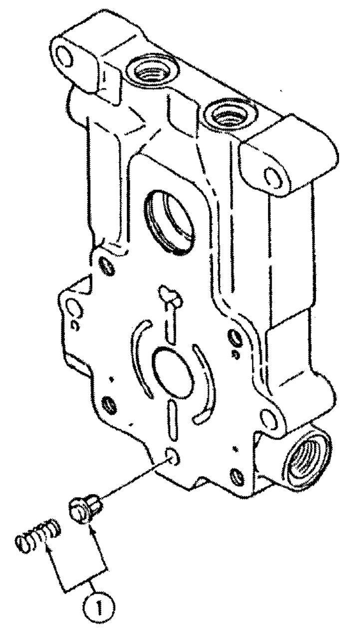


Figure 67
Valve Kit
1. Charge Pump Relief Valve Kit

DISASSEMBLY

1. Remove the spring and valve.

INSPECTION

1. Inspect the valve seat for excess wear or scoring. Check the valve in the bore for a sticking or binding condition.

2. Inspect the valve spring for wear or damage.

   NOTE: *If damage is observed, replace the valve and spring as a kit assembly.*

ASSEMBLY

Assemble the components in the port block.

HIGH PRESSURE RELIEF VALVE
Reference — Figure 68

A single high pressure relief valve assembly is located in the piston pump to motor passages and protects the drive motor from overloads in both forward and reverse directions. See pressure passage circuit, Figure 78.

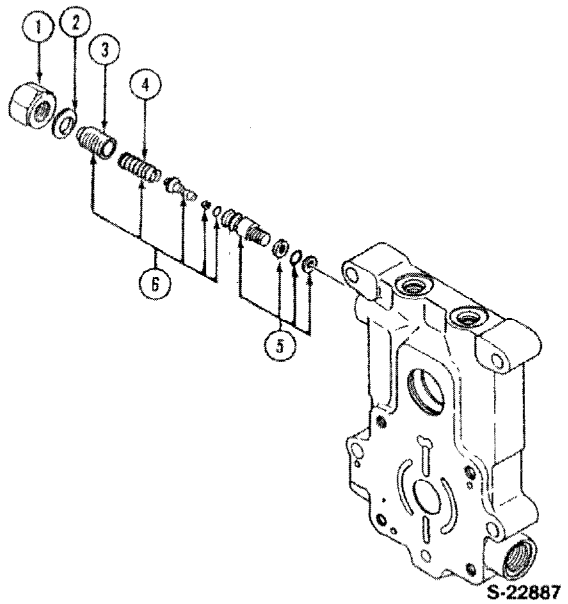


Figure 68
High Pressure Relief Valve

1. Shroud	4. Spring
2. Washer (Seal)	5. Valve Assy.
3. Adjusting Screw	6. Relief Valve Assy.

In forward direction, high pressure oil acts upon the end of the relief valve plunger and in reverse direction, high pressure oil acts upon the shoulder on the relief valve plunger, the high pressure oil passes into the suction side oil passage relieving the pump of overloading.

NOTE: *Assembling relief valve tightening torque.*
47.00 ± 3.6 lbs. ft.
(83.7 ± 4.9 Nm)

HYDROSTATIC PUMP AND PORT BLOCK — ASSEMBLY
Reference — Figure 69

1. Using a straight edge and feeler gauge, measure the depth of the cylinder block surface below the housing end. The clearance should be approximately 0.078 in. (2.0 mm), Figure 69.

   If insufficient clearance is found, disassemble the pump assembly and recheck the thrust plate position and assembling procedures.

2. If removed, install the two dowel pins in the pump housing.

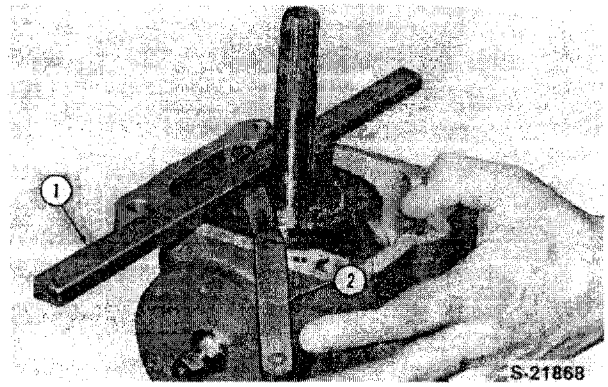


Figure 69
Hydrostatic Pump and Port Block Assembly
1. Straight Edge 2. Feeler Gauge

3. Coat the gasket surface with lithium base grease and position it on the pump housing.

4. Apply lithium base grease to the charge pump relief valve and spring. Install the spring in the pump housing bore and the poppet valve in the port block.

5. Install the port valve with tapered opening onto the port block, Figure 70.

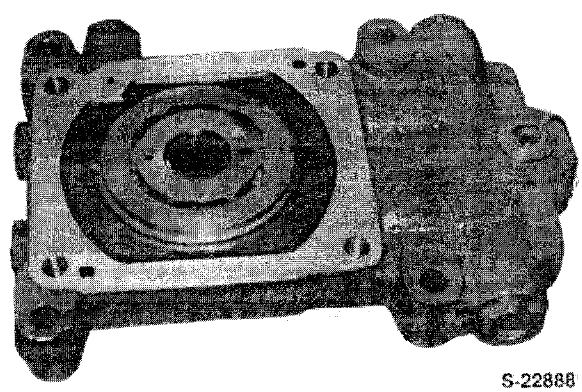


Figure 70
Hydrostatic Pump and Port Block Assembly

6. Install the pump housing assembly to the port block being sure to align the relief valve spring and poppet, Figure 71.

7. Tighten the four socket head type bolts. Be sure that the input shaft rotates freely and then apply final tightening to bolts to specified torque.

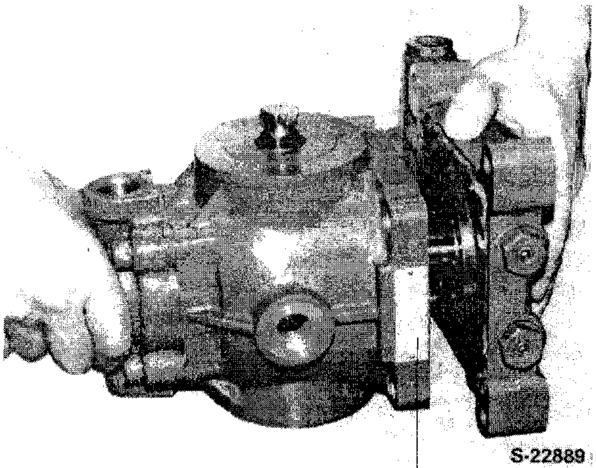


Figure 71
Hydrostatic Pump and Port Block Assembly

Tightening Torque ....25.3 ± 2.5 lbs. ft.
(34.3 ± 3.4 Nm)

MOTOR AND PORT BLOCK — ASSEMBLY

1. Using a straight edge and feeler gauge, measure the depth of the cylinder block surface below the housing end. Clearance should be approximately 0.078 in. (2.0 mm), Figure 72.

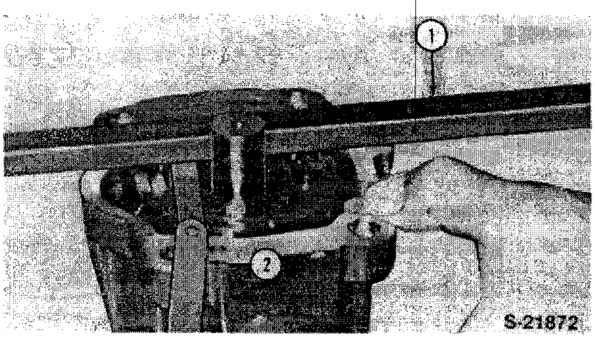


Figure 72
Motor and Port Block Assembly
1. Straight Edge 2. Feeler Gauge

If insufficient clearance is found, disassemble the motor assembly and recheck the position of the thrust plate and assembly procedures.

2. If removed, install the two dowel pins in the motor housing.

3. Coat the surface of the gasket with lithium base grease and position it on the motor housing,.

4. Install the port valve plate onto the port block, Figure 73.

5. Install the assembled motor housing to the port block, Figure 74.

6. Tighten the four socket head type bolts. Be sure the input and output shafts rotate freely and then apply the final tightening to the bolts, Figure 75.

Tightening Torque ....25.3 ± 2.5 lbs. ft.
(34.3 ± 3.4 Nm)

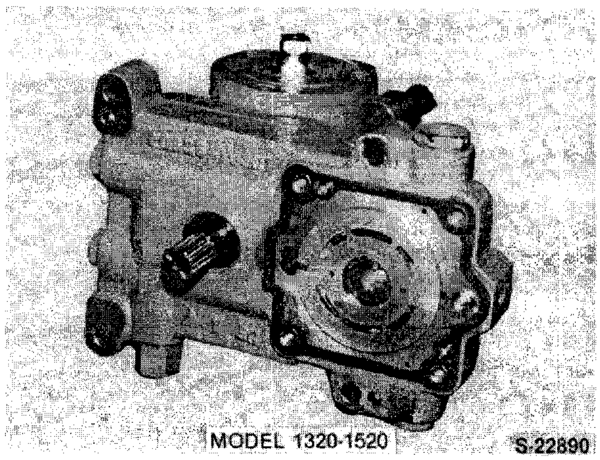


Figure 73
Motor and Port Block Assembly

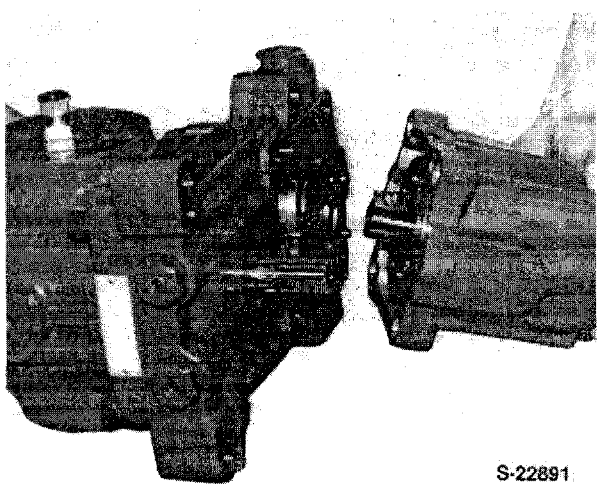


Figure 74
Motor and Port Block Assembly

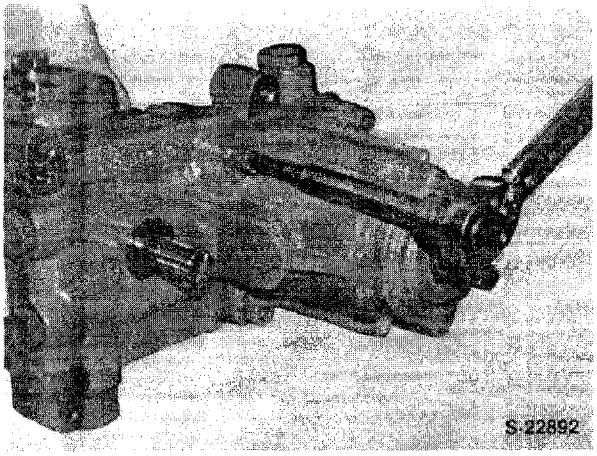


Figure 75
Motor and Port Block Assembly

CHECK VALVE
Reference — Figure 76

A check valve located in the HST filter manifold, Figure 76, protects the cooler from excess pressure due to high oil viscosity or a restriction in the cooler circuit.

DISASSEMBLY

1. Remove the banjo bolt (2), Figure 76, from the cooler return to manifold tube and remove the spring (3) and ball (4) from the manifold.

INSPECTION

1. Inspect the spring and ball for excess wear or damage. Replace faulty components if required.
2. Inspect the ball seat in the pipe. Replace the pipe if required.

ASSEMBLY

Assemble the check valve components as shown in Figure 76.

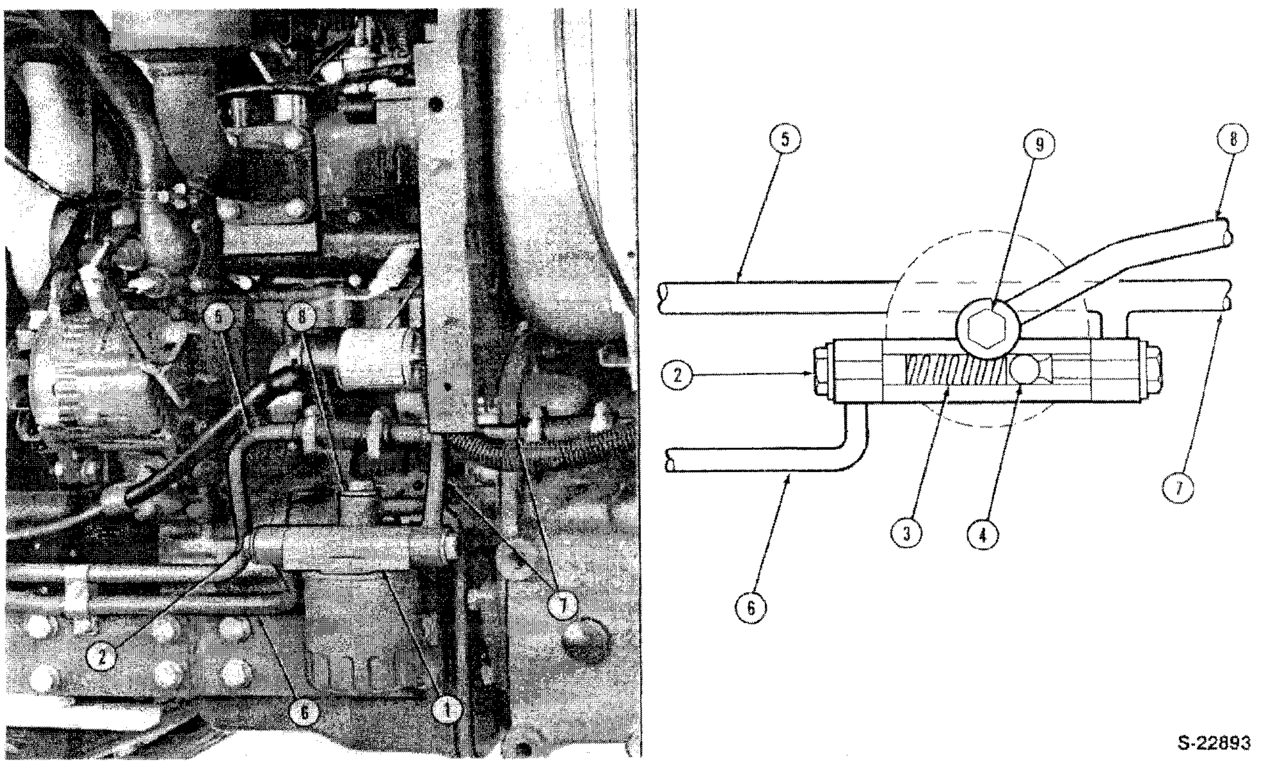


Figure 76
Check Valve and Manifold Assmbly

1. Check Valve Location
2. Banjo Bolt
3. Spring
4. Ball
5. Oil Tube to Cooler
6. Oil Tube from Cooler
7. Oil Tube from HST Charge Pump
8. Oil Tube to HST Unit
9. Banjo Bolt

TROUBLE SHOOTING

PROBLEM	CHECK	POSSIBLE CAUSE	CORRECTIVE ACTION
Transmission fails to operate.	• Input shaft rotation.	• Clutch or input shaft failure.	• Repair or replace.
Erratic operation.	• Transmission oil level.	• Low oil supply.	• Replenish.
Abnormal noise when operated.	• Charge relief valve pressure.	• Low charge pressure.	
		• Clogged strainer. (suction)	• Clean.
		• Oil viscosity high.	• Replace oil.
		• Charge pump defective.	• Replace pump kit.
		• Defective charge pump relief valve.	• Replace valve kit.
		• Defective cylinder block assembly.	• Replace.
Tractor fails to stop at neutral.	• Pedal neutral position.	• Linkage out of adjustment.	• Adjust neutral position.
		• Neutral cannot be adjusted.	• Replace trunnion shaft joint.
		• Defective neutral valve.	• Replace neutral valve.
Oil leakage.	• Charge pump pressure.	• Pressure too high (above 142 psi [10 kg/cm²]).	• Replace charge pump relief valve.
		• Pressure loss in filter excessive.	• Replace filter.
		• Return oil line restricted.	• Repair as needed.
Low power.	• High pressure relief valve setting.	• Low pressure.	• Reset valve pressure.
			• Replace port block kit.
		• Internal leakage.	• Overhaul.
Oil overheating.	• Cooler.	• Dirty Grid.	• Clean.
	• Check valve pressure setting.	• Low pressure setting.	• Shim pressure spring.
		• Oil.	• Incorrect oil.

C. TROUBLE SHOOTING AND ADJUSTMENTS

PRESSURE TESTING AND ADJUSTMENT HIGH PRESSURE RELIEF VALVE TEST

Reference — Figure 77

BEFORE TESTING

Remove the steering shroud center panel to gain access to the test port tubes, Figure 77.

1. Operate the tractor to warm the oil to 80°-120°F (25°-50°C) before performing this hydraulic test.
2. Remove the test port plug, left-hand side, accessible through a hole in the top of the clutch housing.
3. Install Nuday test fitting Tool No. 10617 in the test port. Fitting size is PT 1/8"
4. Install a 0-5000 psi gauge to the test fitting.

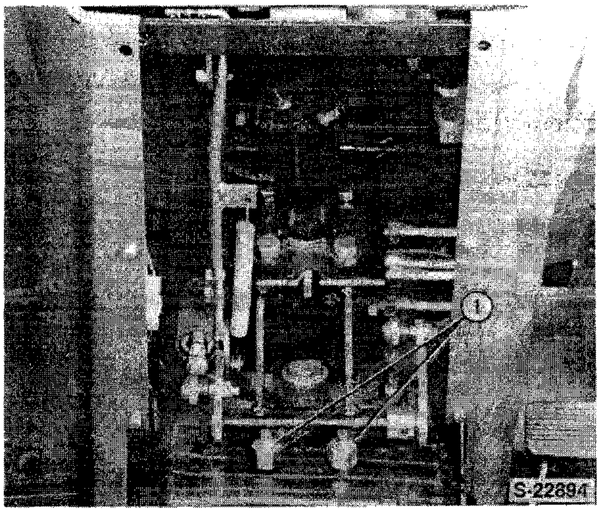


Figure 77
High Pressure Relief Valve Test
1. Test Ports

5. Securely lock the parking brake.

6. Place the range lever in high range.

7. Disengage the clutch and start the engine. Set throttle speed to 2500 rpm.

8. Be sure the transmission foot pedal is in neutral position and then release the clutch pedal.

9. Slowly move the foot pedal in the reverse position to obtain a reading on the pressure gauge. Read the maximum pressure on gauge. Pressure reading should be 3839-4124 psi (270-290 kg/cm²) at 16 litres per minute.

   NOTE: *Read pressure in minimum time to prevent overheating and possible damage to the transmission.*

10. If necessary to adjust the relief valve, separate the tractor and adjust the adjusting screw and then retest the relief valve, Figure 78.

    NOTE: *If the relief valve is faulty, replace the complete port block as an assembly.*

CHARGE PUMP RELIEF VALVE TEST

Operate the tractor to warm the oil to 80°-120°F (25°-50°C) before performing this hydraulic test.

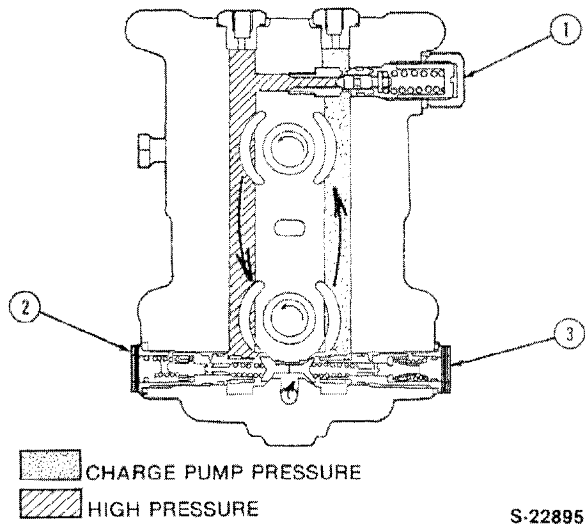


Figure 78
High Pressure Relief Valve Circuit
1. High Pressure Relief Valve
2. Reverse — Neutral Valve
3. Forward — Neutral Valve

1. Remove the banjo bolt (2), Figure 79.

2. Drill and tap a banjo bolt for pressure testing as shown, Figure 80.

3. Install a 0-300 psi gauge to the special banjo bolt.

4. Set the range selector lever in neutral.

5. Set the engine throttle at 2500 rpm and read the pressure gauge.

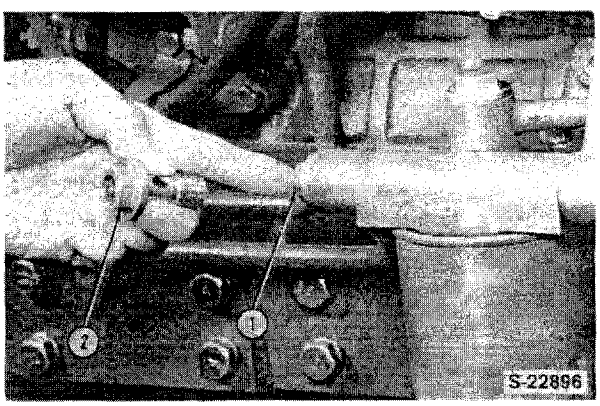


Figure 79
Charge Pump Relief Valve Test
1. Test Port (1/8")
2. Banjo Bolt

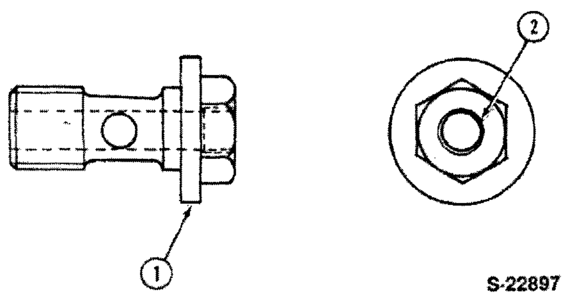


Figure 80
Charge Pump Relief Valve Test

1. Banjo Bolt (for Pressure Test)
2. Drill and Tap — 1/8 in NPT

Pressure Reading . . 61-81 psi (5 ± 0.7 kg/cm²)

NOTE: *If the charge pressure reading is low, check the following:*

- Restricted suction filter.
- Check or replace the charge pump relief valve.
- Check and repair the charge pump.

PART 5
TRANSMISSION SYSTEMS

Chapter 3
HYDROSTATIC TRANSMISSION GEARBOX — MODEL 1320-1520

A. DESCRIPTION AND OPERATION

The hydrostatic transmission gearbox, Figure 81, provides the power flow from the hydrostatic unit for the following functions:

- Three speed gear ratios to the rear axle drive pinion.

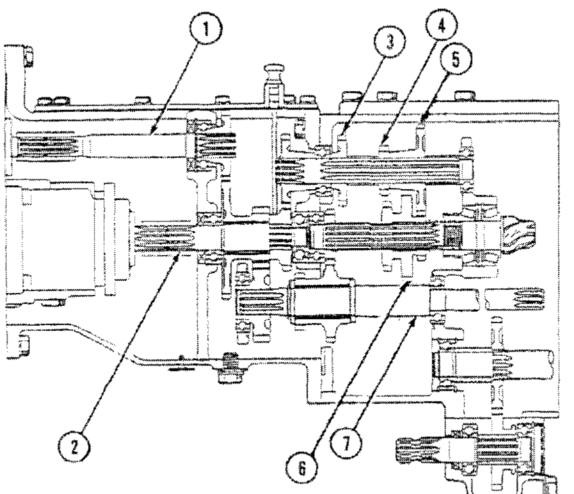


Figure 81
Hydrostatic Transmission Gearbox

1. Input Shaft (PTO)
2. Input Shaft (Trans.)
3. Middle Range Gear
4. Low Range Gear
5. High Range Gear
6. High, Middle, Low Sliding Gear
7. PTO Countershaft

- Power take-off drive through a gear reduction to the rear PTO and mid-power take-off output shafts.
- Front wheel drive when equipped.

The upper hydrostatic shaft (2), Figure 82, provides a direct drive from the engine to the PTO front countershaft (7), Figure 81.

The lower shaft (3), Figure 82, provides hydrostatic motor to drive the rear axle assembly.

Power flows through the gearbox for high, low and mid-range gear speed as shown in Figures 83 through 85.

Power flow to the rear power take-off output shaft is shown in Figure 86.

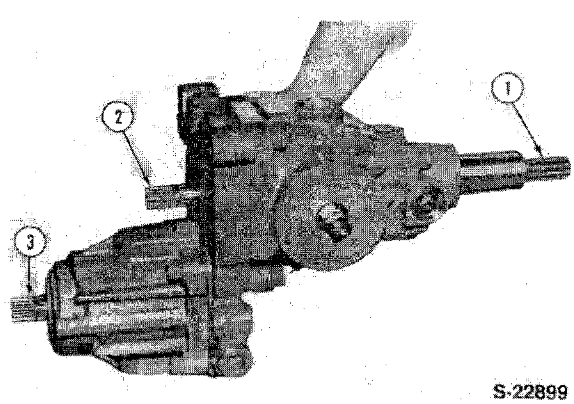


Figure 82

1. Input Shaft
2. PTO Drive
3. Transmission Drive

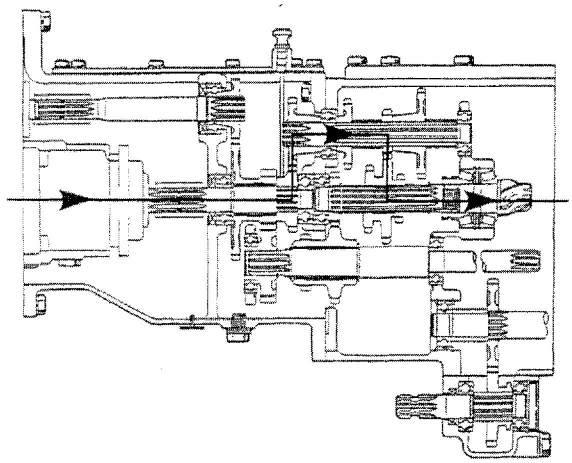


Figure 83
Power Flow — Low Range

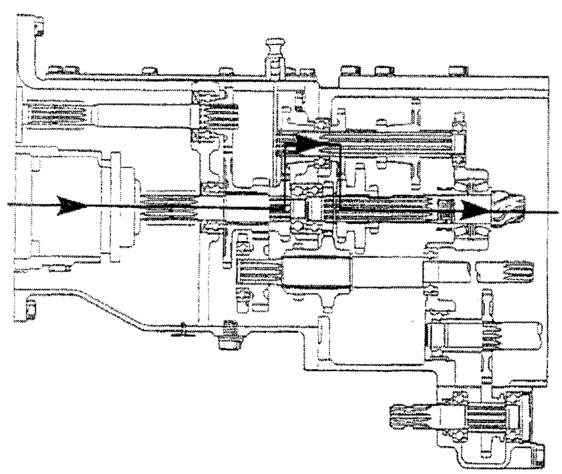


Figure 84
Power Flow — Mid-Range

B. OVERHAUL

REMOVAL

1. Drain the oil from the transmission case.

2. Separate the transmission case from the engine and rear transmission See "Separating the Tractor," Part 12.

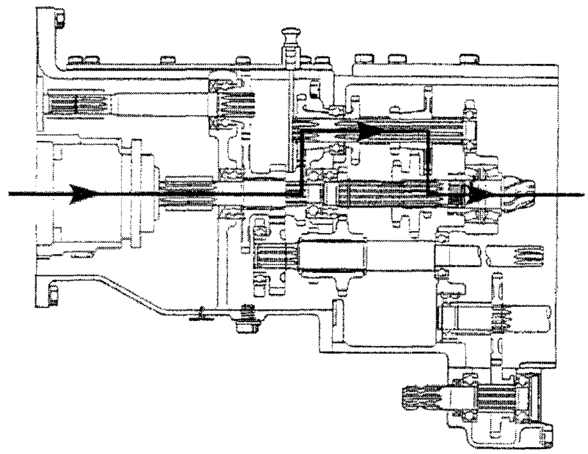


Figure 85
Power Flow — High Range

DISASSEMBLY

1. Remove the two test port adaptors (1), Figure 87.

2. Disconnect the HST control rod (1), Figure 88.

3. Remove the clutch housing attaching bolts and remove the clutch housing, Figure 87.

4. Remove the hydrostatic unit retaining bolts and nuts and remove the hydrostatic unit from the transmission case, Figure 89.

TRANSMISSION CASE — REMOVAL
Reference — Figure 90

1. Remove snap ring (1) and fixed gears (2) from the main shaft, Figure 90.

2. Remove the transmission to rear axle buckle-up bolts. Note that one buckle-up bolt (4), Figure 90, is located inside the case. Remove the transmission case from the rear axle center housing.

PTO INPUT SHAFT — REMOVAL

1. Remove the oil seal (6) from the front of the case, Figure 90.

2. Remove the snap ring (11) and gear (10), Figure 90.

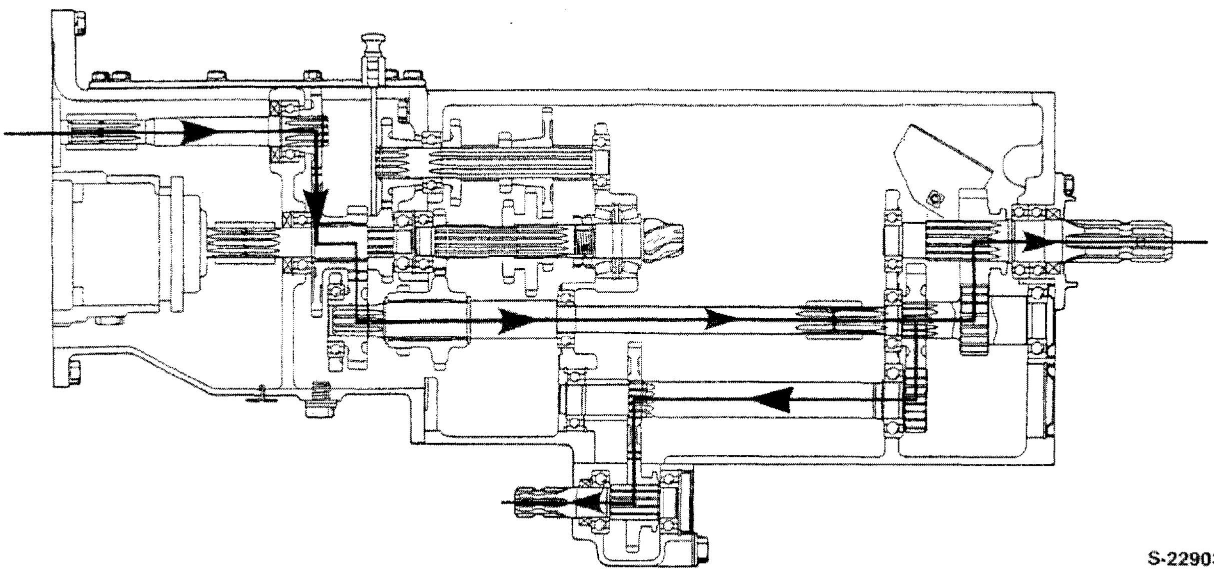


Figure 86
Power Flow — Hydrostatic Transmission — Power Take-Off

3. Remove the bearing retaining ring (8).

4. Gently drive the PTO input shaft (5) forward and remove the shaft and bearing assembly from the case.

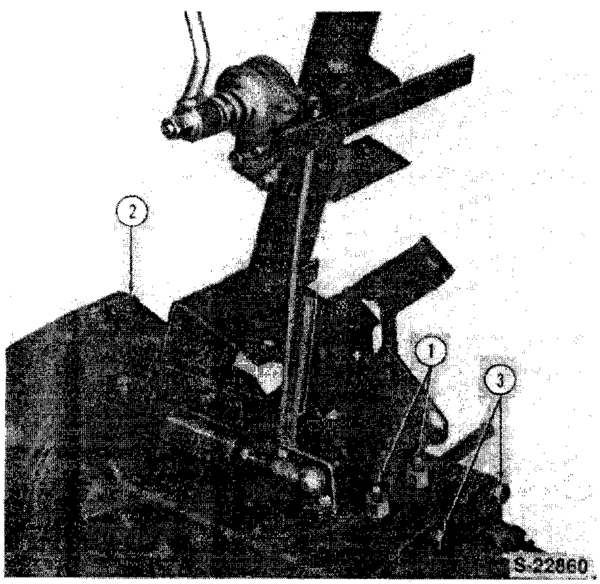


Figure 87
Clutch Housing Removal

1. Adaptors — Pressure Test Ports
2. Clutch Housing
3. Clutch Housing Attaching Bolts

TRANSMISSION INPUT SHAFT — REMOVAL
Reference — Figure 91

1. Remove the input shaft oil seal (1), Figure 91.

2. Remove the bearing retaining snap ring (2).

3. While supporting the gears, slide the input shaft and front bearing out the front of the case.

4. Remove the counter gear (7), needle bearings (6), spacer (8), and fixed gear (9), out through the top of the case.

5. If necessary, use a suitable puller and remove the bearing from the shaft.

4WD SHIFT ROD — REMOVAL
Reference — Figure 92

1. Drive the roll pin (11), Figure 92, out of the lever (7) and remove the lever.

2. Remove the shift rod (5) from the rear.

   NOTE: *Use care to not lose the detent ball and spring when separating the rod from the fork.*

3. Remove the shift fork (1) and arm (2), from the case.

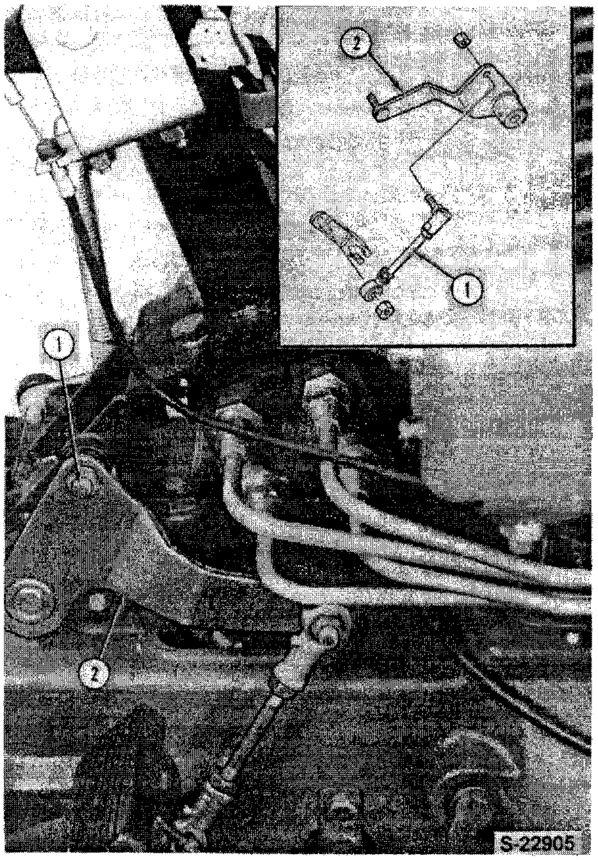


Figure 88
HST Control Rod Removal
1. Rod 2. Shift Link

4WD DRIVE SHAFT — REMOVAL
Reference — Figure 93

1. Remove the seal (4) from the transmission case.
2. Remove the bearing retaining snap ring (5).
3. While supporting the sliding gear (7) pull the 4WD shaft out the front of the case.
4. Remove the sliding gear and rear bearing.

REAR MAIN SHAFT — REMOVAL

1. Gently drive the main shaft forward while removing the rear bearing (7), Figure 94, from the shaft.
2. While supporting the gears and spacers remove the shaft from the front.

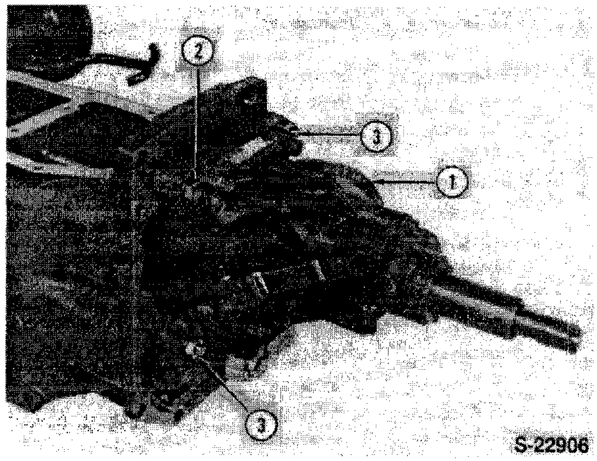


Figure 89
Hydrostatic Unit Removal
1. HST Unit 3. Stud Nuts 2)
2. Bolts (2)

RANGE GEAR SHIFTER ROD — REMOVAL

1. Drive out the roll pin (10) and remove the lever (11) from shift arm, Figure 95.
2. Pull out the shift rod (7) from the front.

   NOTE: *Use care to not loose the dentent spring and ball when the shaft is being separated from the fork.*

3. Remove the fork.
4. Remove the retaining plate (8) and remove the shift arm.

DRIVE PINION SHAFT — REMOVAL
Reference — Figure 96

The rear axle and differential assembly must be removed from the center housing prior to removal of the drive pinion shaft or range gear sliding gears.

See "Differential — Rear Axle and Brakes," Part 7.

1. Pry up the lock washer tabs (7), Figure 96 and loosen the two locknuts (6).
2. Gently drive the pinion rearward while removing the front bearings (1).

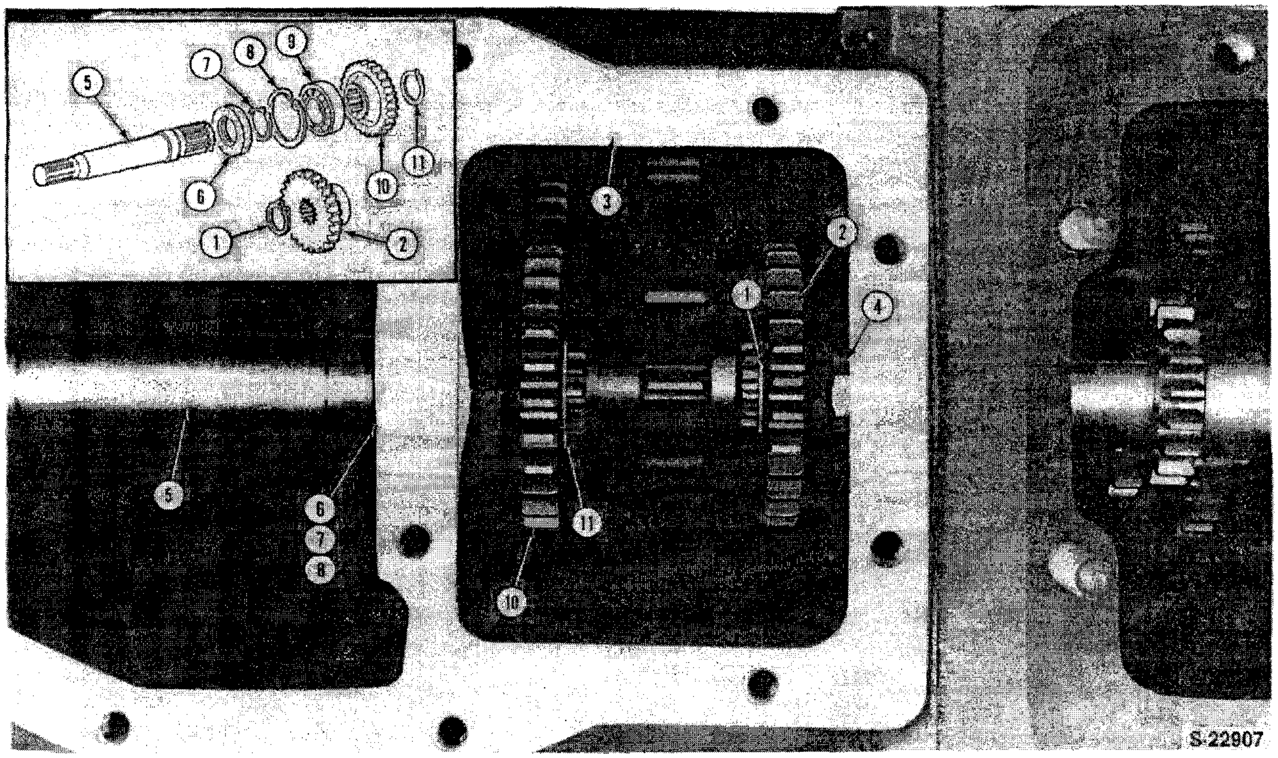


Figure 90
Separating the Transmission Gearbox from Rear Axle Case

1. Snap Ring
2. Drive Gear — Main Shaft
3. Gearbox — Case
4. Bolt
5. PTO Input Shaft
6. Seal
7. Snap Ring
8. Snap Ring
9. Bearing
10. Gear
11. Snap Ring

3. Remove the gear (2), snap ring (3), sliding gear cluster (4), second snap ring (5), locknuts, washer and bearing (9).

4. Remove the pinion shaft shims, thrust washer and rear bearing from the rear of the case.

INSPECTION

1. Inspect the gears for excess wear or damage.

2. Check the bearing for excess or uneven rotation when rotated by hand.

3. Inspect the case for cracks or damage.

4. Inspect the shift rail detent grooves for excess wear.

ASSEMBLY

Assembly generally follows the disassembly procedure in reverse.

DRIVE PINION SHAFT — ASSEMBLY

See Part 7, Chapter 1, Section B.

RANGE GEAR SHIFTER ROD — ASSEMBLY
Reference — Figure 95

1. Install the shift arm and retaining plate.

2. Install the shift rod and fork.

3. Install the change lever and secure with the roll pin.

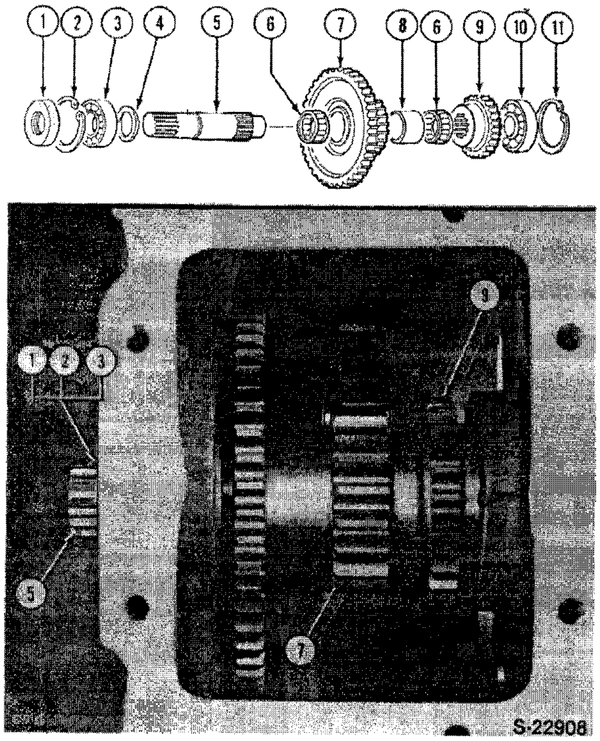


Figure 91
Transmission Input Shaft Removal

1. Oil Seal
2. Snap Ring
3. Bearing
4. Thrust Washer
5. Input Shaft
6. Needle Bearing
7. Cluster Gear
8. Spacer
9. Fixed Gear
10. Bearing
11. Snap Ring

REAR MAIN SHAFT — ASSEMBLY
Reference — Figure 94

1. Install the main shaft and position the fixed gears and spacer collars as shown, Figure 94.
2. Install the fixed gear (2) and snap ring (1) on the front end, Figure 90.

4WD DRIVE SHAFT — ASSEMBLY
Reference — Figure 93

1. Install the 4WD shaft, sliding gear and bearings as shown, Figure 93.

4WD SHIFTER ROD — ASSEMBLY
Reference — Figure 92

1. Install the shifter arm in the transmission case.

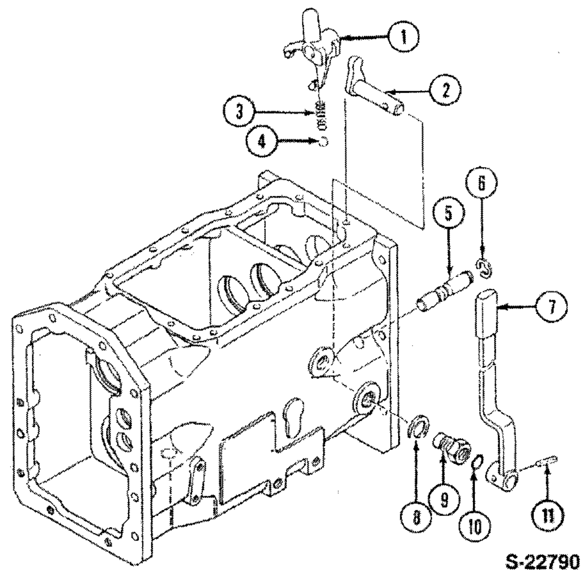


Figure 92
4WD Shift Linkage Removal

1. Shifter Fork
2. Shifter Arm
3. Detent Spring
4. Detent Ball
5. Shifter Rod
6. Snap Ring
7. Change Lever
8. Seal Washer
9. Shift Guide
10. O-Ring
11. Roll Pin

2. Using a new sealing washer and o-ring, install the shift arm guide.
3. Install the shift rod and fork with the detent spring and ball as shown, Figure 92.
4. Position the lever on the shifter arm and secure with the roll pin.

TRANSMISSION INPUT SHAFT — ASSEMBLY
Reference — Figure 91

1. Install the input shaft, gear cluster and fixed gear as shown, Figure 91.
2. Install a new oil seal on the input shaft front end.

PTO INPUT SHAFT — ASSEMBLY
Reference — Figure 90

1. Position the bearing (9) on the shaft and secure with the snap ring (7).

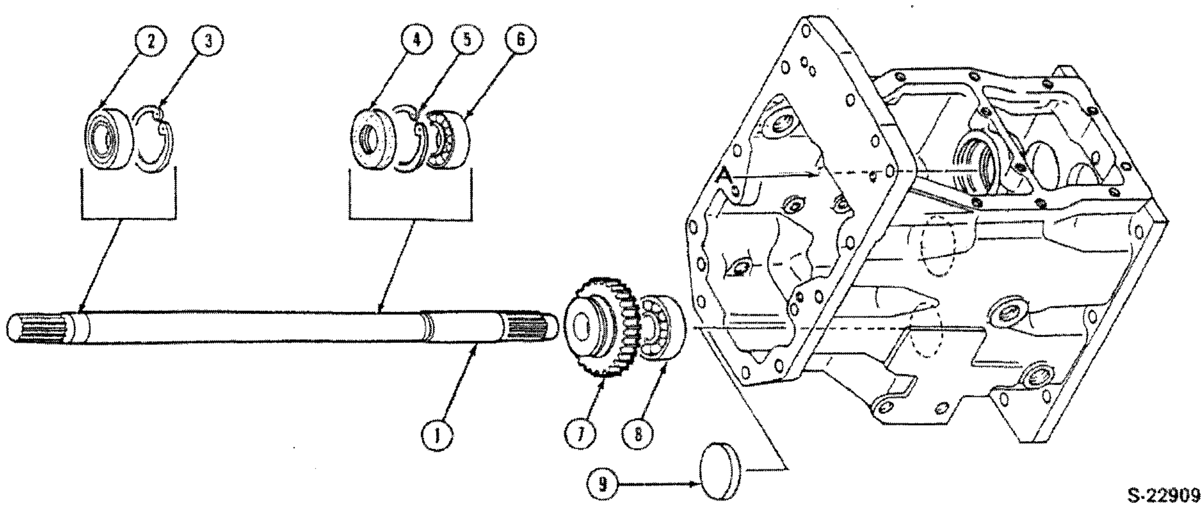


Figure 93
4WD Shaft Removal

1. 4WD Shaft
2. Bearing
3. Snap Ring
4. Seal
5. Snap Ring
6. Bearing
7. Sliding Gear
8. Bearing
9. Sealing Plug (2WD)

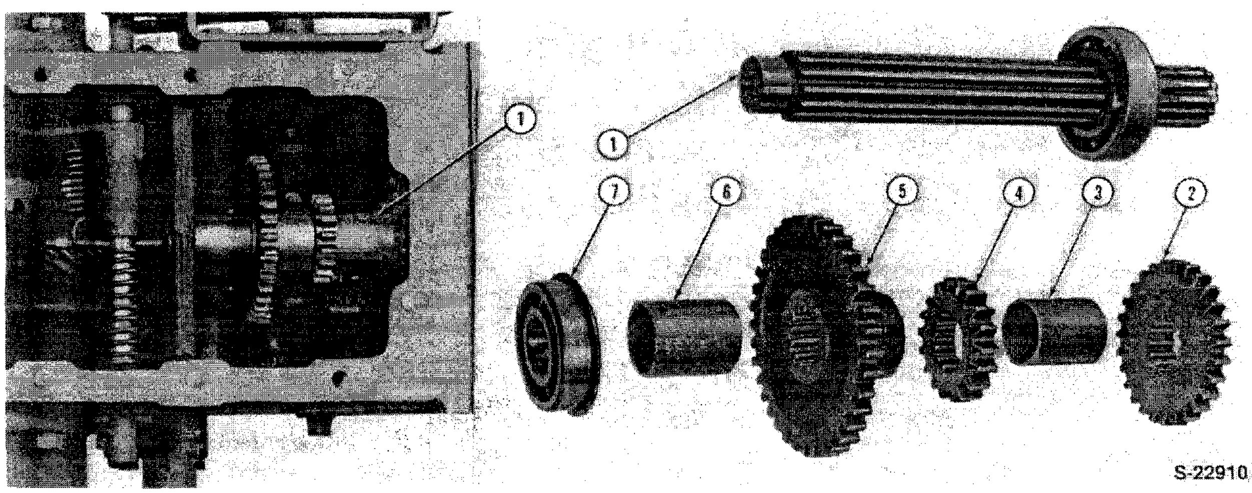


Figure 94
Rear Main Shaft Removal

1. Main Shaft
2. Gear — Mid-Range
3. Spacer
4. Gear — Low Range
5. Gear — High Range
6. Spacer
7. Bearing and Snap Ring Assembly

2. Position the shaft and bearing assembly in the case and install the fixed gear (10) and snap ring (11).
3. Install the snap ring (8) in the case bore.
4. Install a new oil seal.

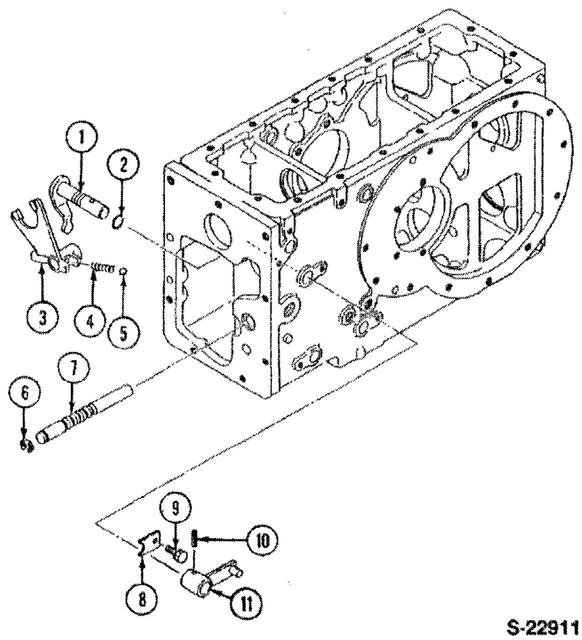


Figure 95
Range Gear Shift Rod and Fork Removal

1. Shift Arm
2. O-Ring
3. Shifter Fork
4. Detent Spring
5. Detent Ball
6. Snap Ring
7. Shifter Rod
8. Plate
9. Bolt
10. Roll Pin
11. Change Lever

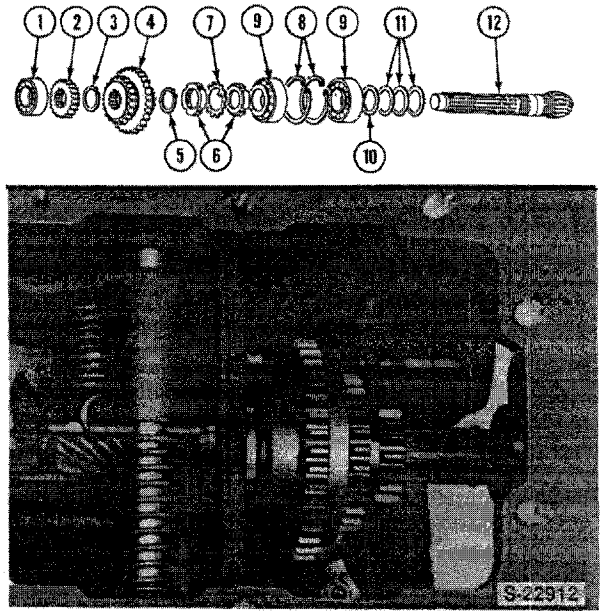


Figure 96
Drive Pinion Removal

1. Bearings
2. Fixed Gear — 4WD
3. Snap Ring
4. Sliding Gear
5. Snap Ring
6. Locknut
7. Lock Washer
8. Snap Rings
9. Bearing
10. Thrust Washer
11. Shims
12. Pinion Gear

PART 5
TRANSMISSION SYSTEMS

Chapter 4
HYDROSTATIC TRANSMISSION — CONTROL LINKAGE — MODEL 1320-1520

A. OVERHAUL AND ADJUSTMENTS

The hydrostatic control linkage consists of a foot pedal control assembly, speed control linkage, a control rod and lever arm, Figure 97.

The linkage is connected to the hydrostatic pump variable swash plate and controls the speed of the hydrostatic unit.

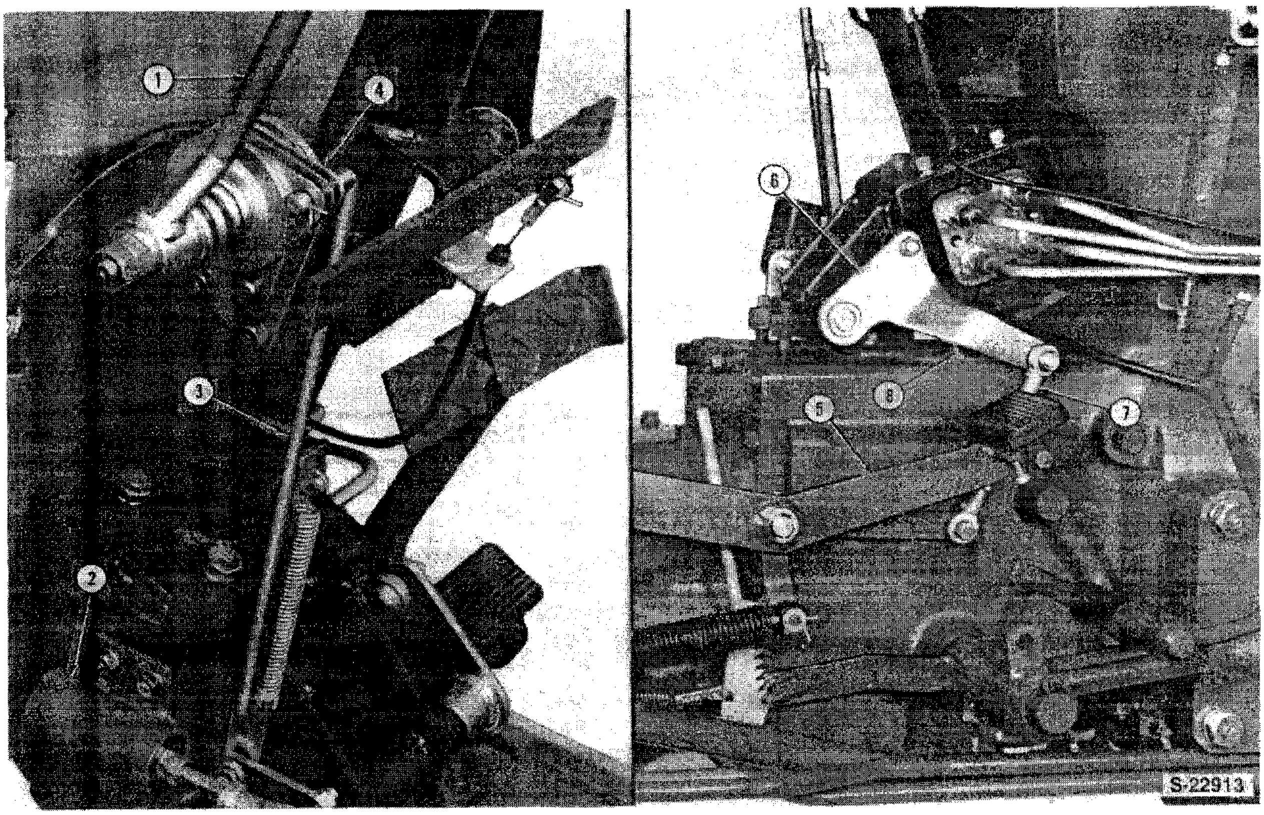


Figure 97
Hydrostatic Control Linkage

1. Speed Control Brake Lever
2. Neutral Control Linkage
3. Brake Control Rod
4. Brake Assy.
5. Foot Pedal Assy.
6. Pivot Linkage
7. Pedal Control Rod
8. Hydrostatic Control Rod

REMOVAL

1. Remove the steering wheel.

2. Remove the retaining screws and remove the instrument panel (1), Figure 98.

3. Remove the shroud center panel (2), Figure 98.

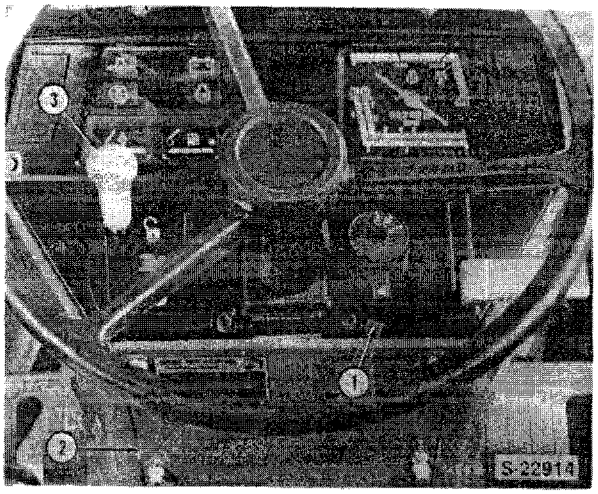


Figure 98
Hydrostatic Control Linkage Removal
1. Instrument Panel
2. Shroud Center Panel
3. Speed Control Brake Lever

4. Remove the spring (4), Figure 99, from the shift arm (3), and brake control rod (2), Figure 99.

5. Remove the cotter pin and washer and separate the control rod (2), from the shift arm (3), Figure 99.

6. Remove the brake mounting bolts from the steering column and remove the speed control lever brake assembly as an assembly, Figure 99.

7. Remove the pedal control rod (4) and HST control rod (5) from the pivot link (6), Figure 100.

8. Remove the neutral control spring assembly (5), Figure 99, and remove the shift arm as an assembly.

9. Remove the damper spring assembly (3) from the mounting bracket, Figure 100.

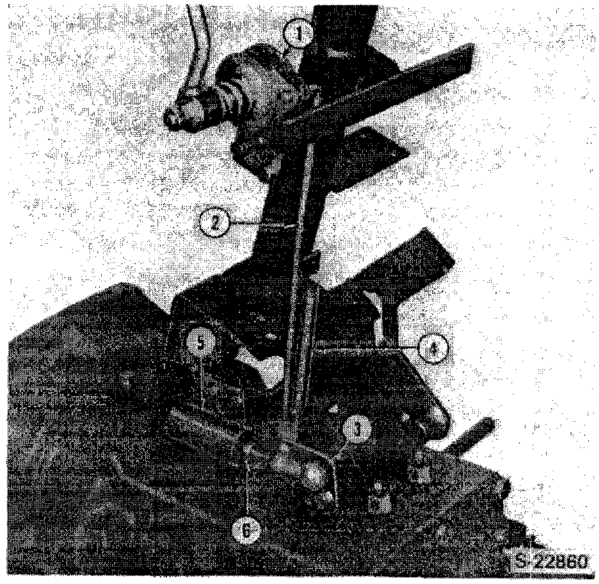


Figure 99
Speed Control Brake Linkage Removal
1. Brake Assembly
2. Brake Control Rod
3. Shift Arm
4. Spring
5. Neutral Control Assembly
6. Locknut

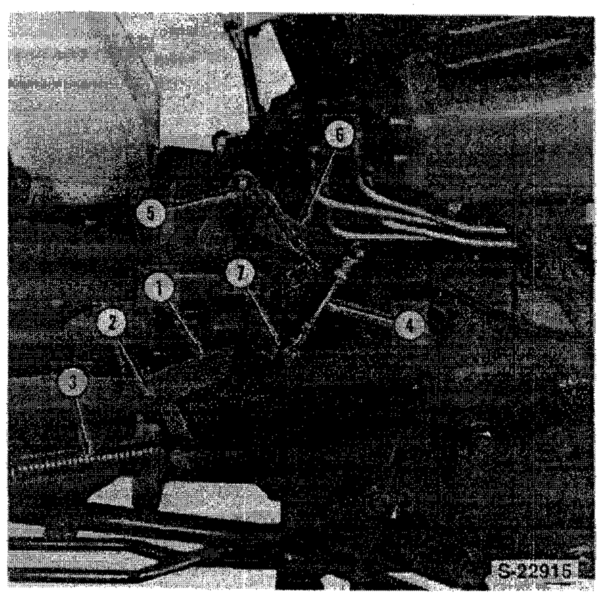


Figure 100
HST Control Linkage Removal
1. Pedal Assembly
2. Snap Ring
3. Damper Assembly
4. Pedal Control Rod
5. HST Control Rod
6. Pivot Link
7. Pedal Stop Bolt

10. Remove the snap ring (2), Figure 100, from the pedal shaft and remove the pedal and damper as an assembly, Figure 100.

ADJUSTMENTS

CONTROL ROD

1. Adjust the length of rod (4) between the HST pedal and shift link to 5.1 in. (129.5 mm), Figure 100, and install it.
2. Adjust the length of the rod (5) between the HST unit and shift link to 5.4 in. (137 mm), Figure 100, and install it.

NEUTRAL ADJUSTMENT

1. Loosen the locknut (6), Figure 99.
2. Start the engine and shift the range lever into low (L) position.
3. Turn the double nut and adjust the neutral spring to obtain the neutral position.
4. Run the engine at 2500 RPM and check the transmission operation to be sure the tractor stops when the foot pedal is released.

   Tighten the locknut on the neutral spring adjustment.

PEDAL STOP

1. With the foot pedal fully depressed in the forward position, adjust the length of the stop bolt (7), Figure 100, to just contact the step plate and then lengthen it by two full turns.
2. Tighten the locknut.

PART 5
TRANSMISSION SYSTEMS

Chapter 5
NON-SYNCHROMESH 12 x 4 GEAR TRANSMISSION — MODEL 1720

A. DESCRIPTION AND OPERATION

The non-synchromesh transmission assembly provides twelve forward and four reverse speeds which are manually selected by two levers.

The transmission is driven by a single disc clutch as standard factory equipment.

A double disc clutch is available as a factory option, providing live power take-off to the transmission drive system.

The transmission has two compartments, Figure 101. The forward compartment contains the main transmission, which provides three forward and one reverse speed. The rear compartment contains the range gears which provide four range speeds for each of the main transmission speed ratios for a total of twelve forward and four reverse speeds.

The main transmission lever (3), Figure 102, controls the three forward and one reverse speed in the main transmission compartment. The range selector lever (1), Figure 102, controls the selection of any of the four range speed gears located in the transmission rear compartment.

The transmission serves as a common oil reservoir which provides the gear lubricant for the differential assembly, transmission and hydraulic system. The oil used is Ford 134B or equivalent.

The oil level dipstick (4) is lcoated on the transmission top cover, Figure 102.

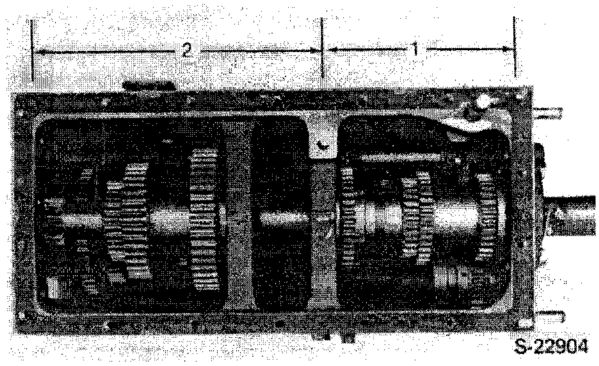


Figure 101
Non-Synchromesh 12 x 4 Gear Transmission
1. Main Transmission Gearbox
2. Range Gear Gearbox

A transmission cross-section view, gear identification and power flows are shown in Figures 103 through 116.

B. OVERHAUL

REMOVAL

1. Drain the transmission and differential oil into a clean container.

2. Remove the transmission case assembly from the tractor. See "Separating the Tractor," Part 12.

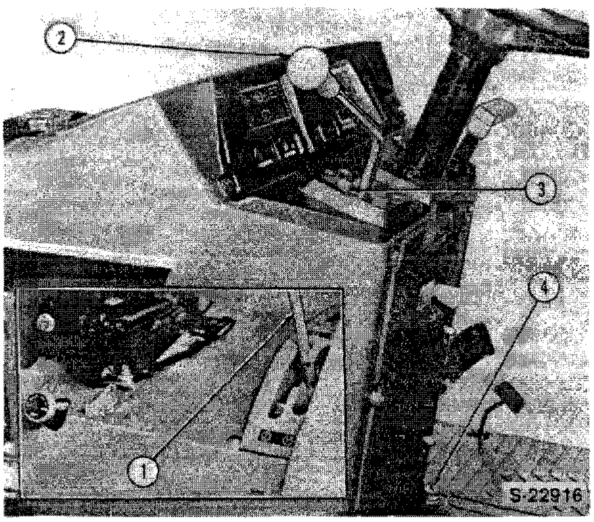


Figure 102
Non-Synchromesh Transmission

1. Range Shift Lever
2. Main Gear Shift Lever
3. Shift Pattern
4. Dipstick

DISASSEMBLY

INPUT SHAFT — REMOVAL

SINGLE CLUTCH — TRANSMISSION
Reference — Figures 117 and 118

1. Remove the retainer (1), Figure 117.

2. Gently drive the input shaft (1), Figure 118, out the front of the case.

3. Remove the fixed gears, collars and bearings, Figure 118.

INPUT SHAFT — REMOVAL

DOUBLE CLUTCH — TRANSMISSION

When equipped with the double clutch, first remove the countershaft as follows.

COUNTERSHAFT — REMOVAL
Reference — Figure 119

1. If not previously removed, remove the PTO shaft (1) from the front.

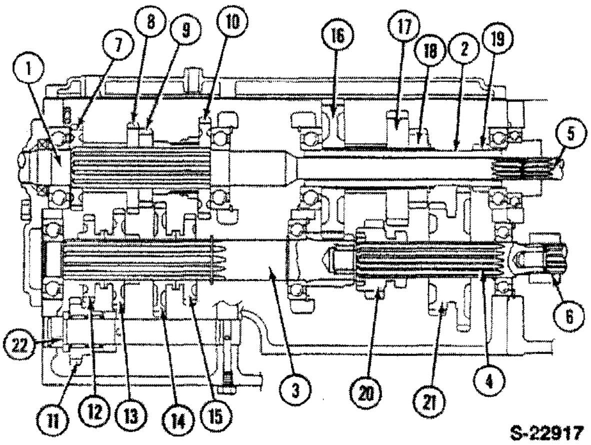


Figure 103
Transmission Cross-Section and Identification

1. Input Shaft
2. Countershaft
3. Main Shaft — Front
4. Main Shaft — Rear
5. PTO Countershaft
6. Drive Pinion
7. Fixed Gear (Rev) (32T)
8. Fixed Gear (2nd) (34T)
9. Fixed Gear (1st) (29T)
10. Fixed Gear (3rd) (38T)
11. Counter Gear (Rev) (25T)
12. Sliding Gear (Rev) (33T)
13. Sliding Gear (2nd) (38T)
14. Sliding Gear (1st) (43T)
15. Sliding Gear (3rd) (34T)
16. Fixed Gear (45T)
17. Fixed Gear (3rd Range) (36T)
18. Fixed Gear (2nd Range) (29T)
19. Countershaft (1st Range) (16T)
20. Sliding Gear (4th-3rd Range) (15-24T)
21. Sliding Gear (2nd-1st Range) (43-55T)
22. Reverse Idler Gear Shaft

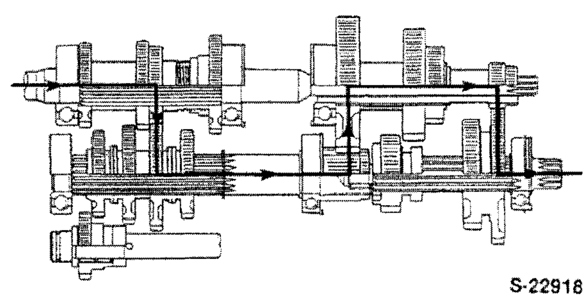
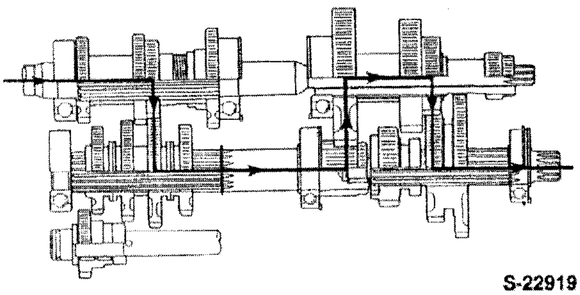


Figure 104
Power Flow — 1st Gear — 1st Range



S-22919

Figure 105
Power Flow — 1st Gear — 2nd Range

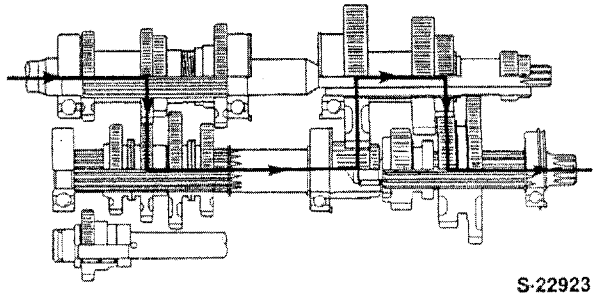


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Figure 109
Power Flow — 2nd Gear — 2nd Range

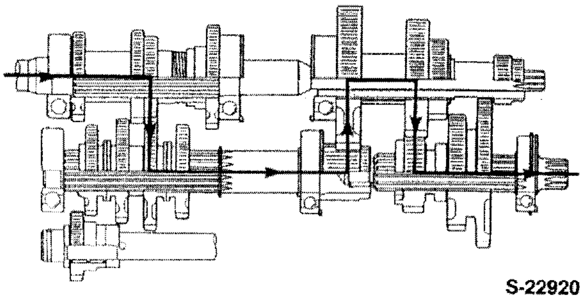

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Figure 106
Power Flow — 1st Gear — 3rd Range

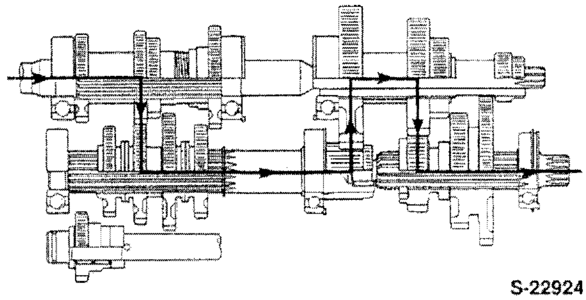

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Figure 110
Power Flow — 2nd Gear — 3rd Range

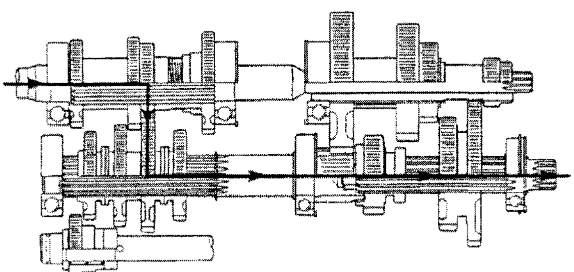

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Figure 107
Power Flow — 1st Gear — 4th Range

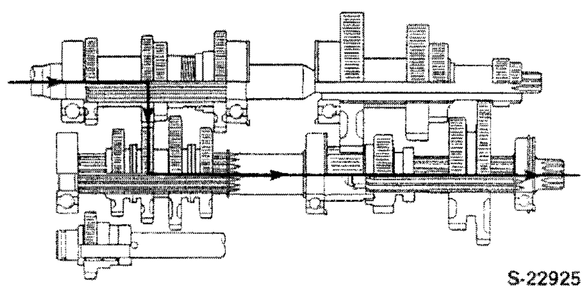

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Figure 111
Power Flow — 2nd Gear — 4th Range

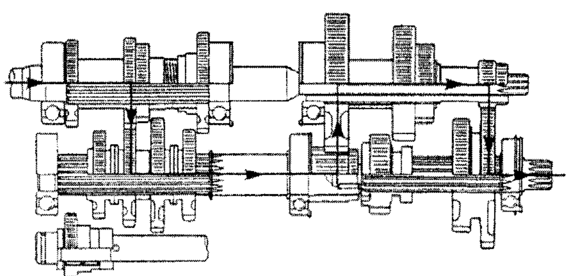

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Figure 108
Power Flow — 2nd Gear — 1st Range

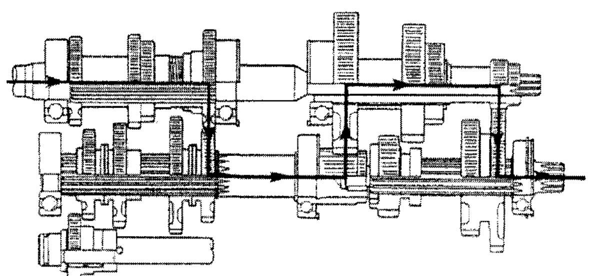

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Figure 112
Power Flow — 3rd Gear — 1st Range

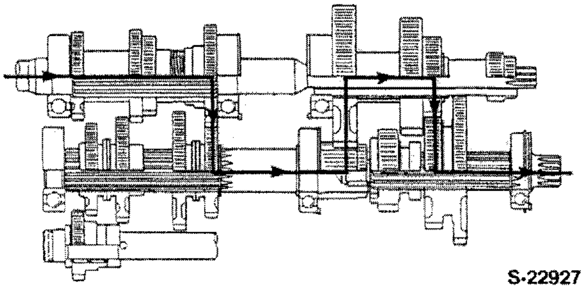

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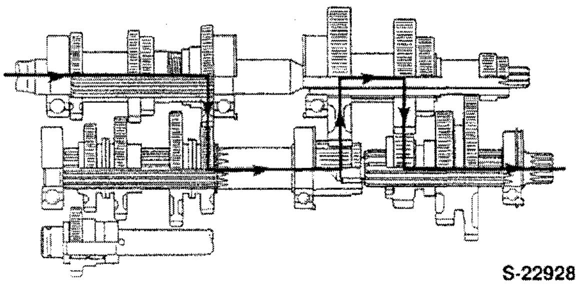
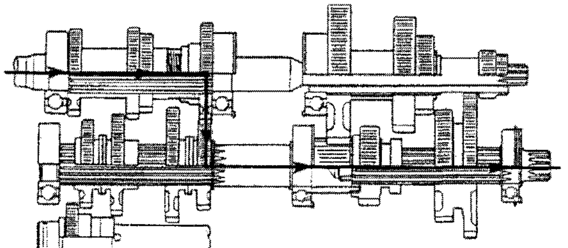
Figure 113
Power Flow — 3rd Gear — 2nd Range



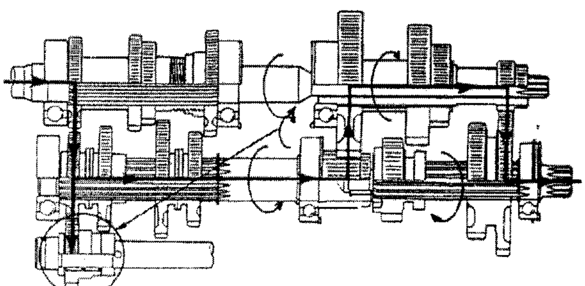
S-22928

Figure 114
Power Flow — 3rd Gear — 3rd Range



S-22929

Figure 115
Power Flow — 3rd Gear — 4th Range



S-22930

Figure 116
Power Flow — Reverse Gear — 1st Range

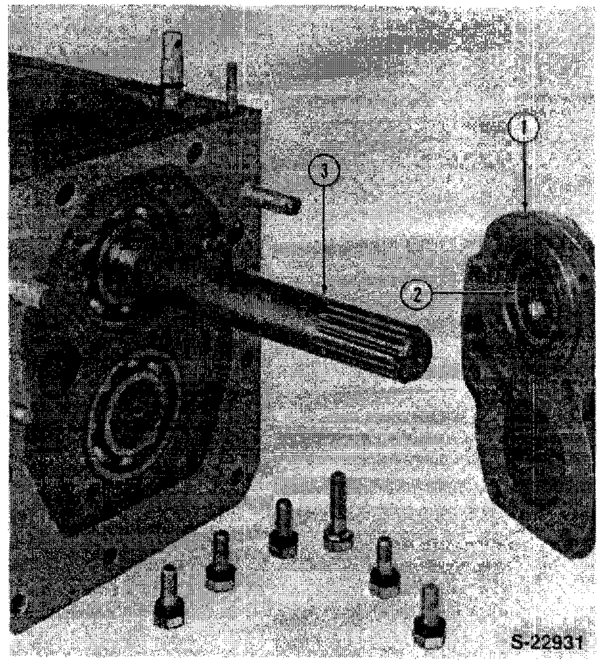


Figure 117
Transmission Disassembly (Single Clutch)
1. Retainer
2. Oil Seal
3. Input Shaft

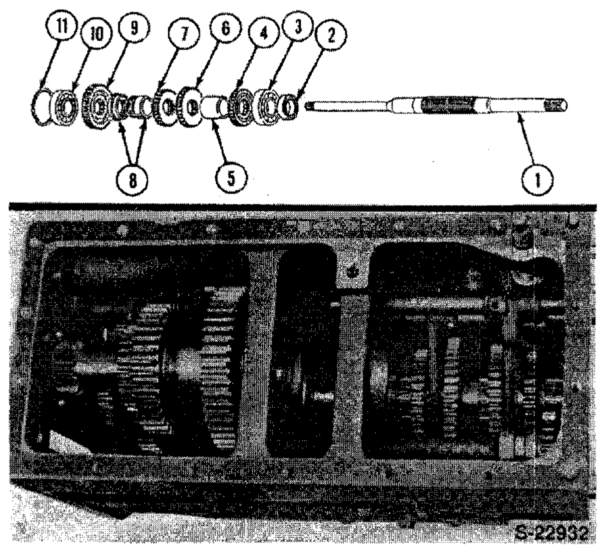


Figure 118
Main Transmission Input Shaft and Fixed Gear Removal (Single Clutch)
1. Input Shaft
2. Seal
3. Bearing
4. Gear (Rev)
5. Spacer
6. Gear (2nd)
7. Gear (1st)
8. Collar
9. Gear (3rd)
10. Bearing
11. Snap Ring

2. Gently drive the countershaft (2) rearward while supporting the fixed gears and collar.

3. Remove the front bearing (8), fixed gears and collar as the shaft is being removed.

4. If required, remove the snap rings from countershaft and housing.

5. Remove the retainer (10), Figure 120.

6. Remove the two bearing retaining snap rings (13), Figure 120, from the two center case webs.

7. While supporting the fixed gears and collars, gently drive the input shaft rearward out of the case.

MAIN SHIFT RAILS AND FORKS — REMOVAL
Reference — Figure 121

1. Drive the roll pin out of the upper shift fork and rail.

2. Remove the detent pin (6), spring (7), and ball (8), Figure 121.

3. Slide the top rail forward and remove the rail and fork from the case.

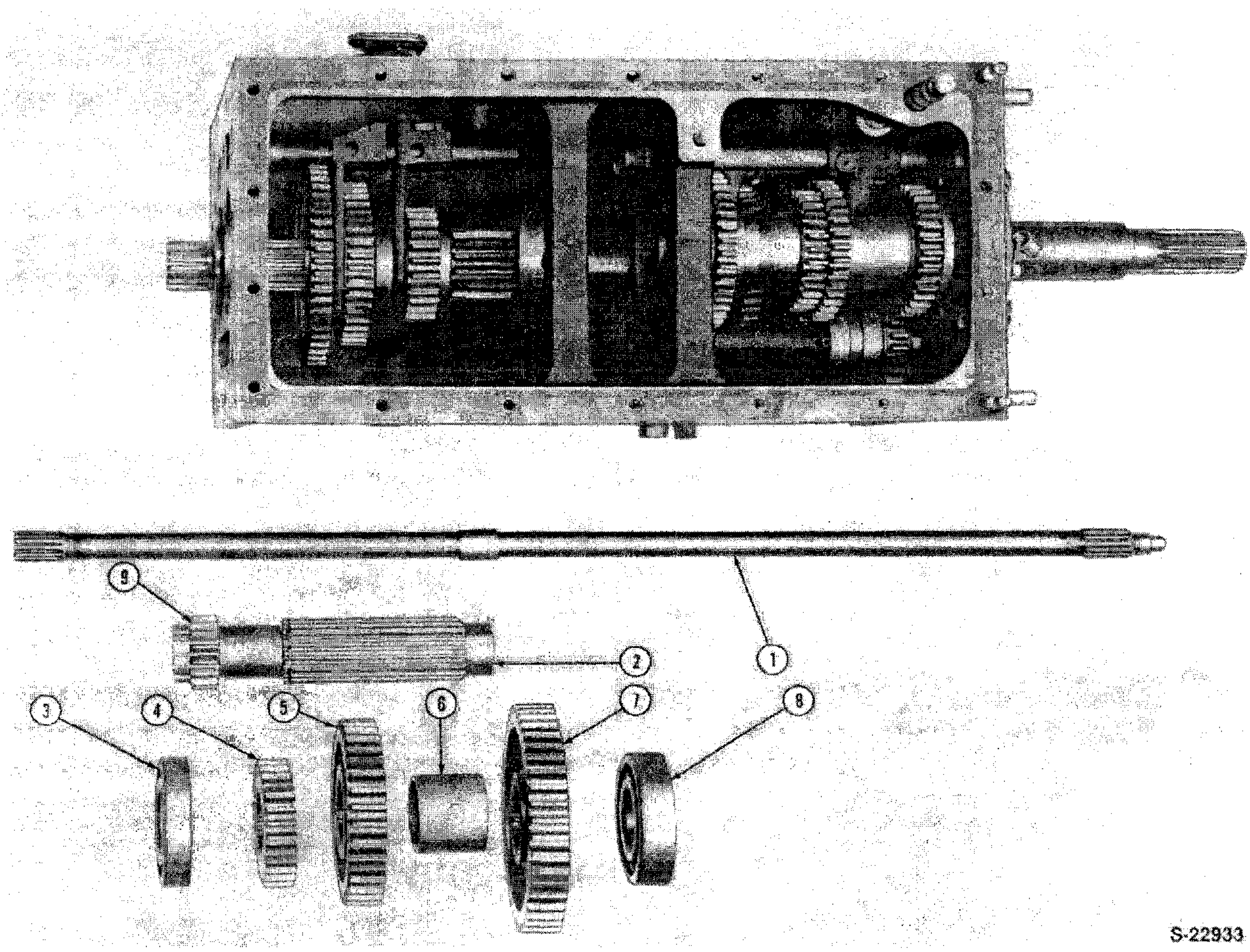


Figure 119
Countershaft Removal (Live PTO Shown)

1. PTO Input Shaft
2. Countershaft
3. Bearing
4. Fixed Gear (2nd Range)
5. Fixed Gear (3rd Range)
6. Spacer
7. Fixed Gear (4th Range)
8. Bearing
9. Gear (1st Range)

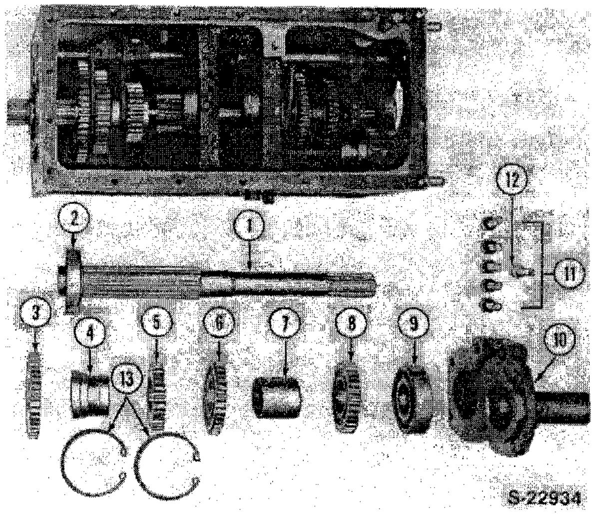


Figure 120
Transmission Input Shaft and Fixed Gear Removal (Double Clutch)

1. Input Shaft
2. Bearing
3. Gear (3rd)
4. Collar
5. Gear (1st)
6. Gear (2nd)
7. Spacer
8. Gear (Rev)
9. Bearing
10. Retainer
11. Retainer Bolts
12. Sealing Washer
13. Snap Rings

NOTE: *The bottom shift rail must be in neutral position before the top rail can be removed.*

4. Using a small pencil type magnet, remove the interlock pin (9) from the detent bore.
5. Drive the roll pin out of the lower shift fork and rail.
6. Drive the roll pin out of the shift boss (10) and rail, Figure 121.
7. Rotate the rail 90° and slide the rail forward out of the case.

NOTE: *Use care to not lose the detent ball and spring as they will be expelled with considerable force when released by the rail.*

8. Remove the plug (5), Figure 122.
9. Remove the roll pin retaining wire (6).
10. Drive the roll pins (4) out of the shift arm (3) and shaft (1), Figure 122, and remove the arm and shaft from the case.

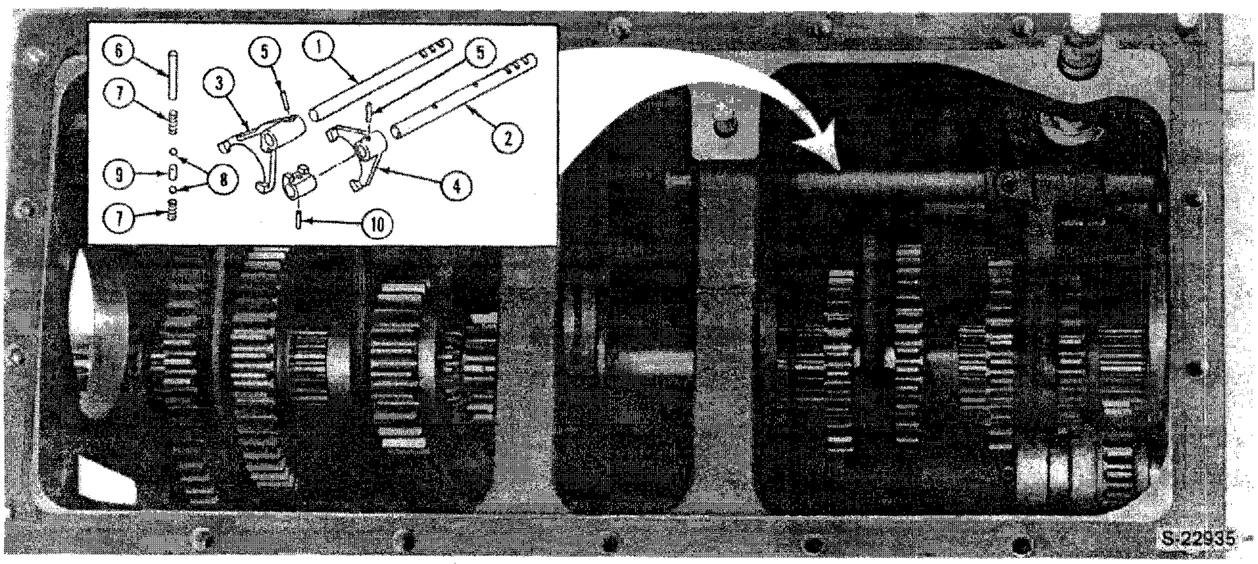


Figure 121
Main Gearshift Rails and Forks Removal

1. Shift Rail (R-2nd)
2. Shift Rail (1st-3rd)
3. Fork (R-2nd)
4. Fork (1st-3rd)
5. Roll Pin (2)
6. Detent Pin
7. Spring (2)
8. Ball (2)
9. Interlock (Balk) Pin
10. Boss

RANGE GEAR SHIFT RAIL AND FORK – REMOVAL
Reference – Figure 123

1. Remove the rail retaining bolt (1), Figure 123.

2. Rotate the rail 1/2 turn and slide the rail rearward out of the case.

   NOTE: *Use care to not lose the detent springs and balls as they will be expelled with considerable force when released by the rail. Cover the shift forks with a shop towel to contain the loose parts.*

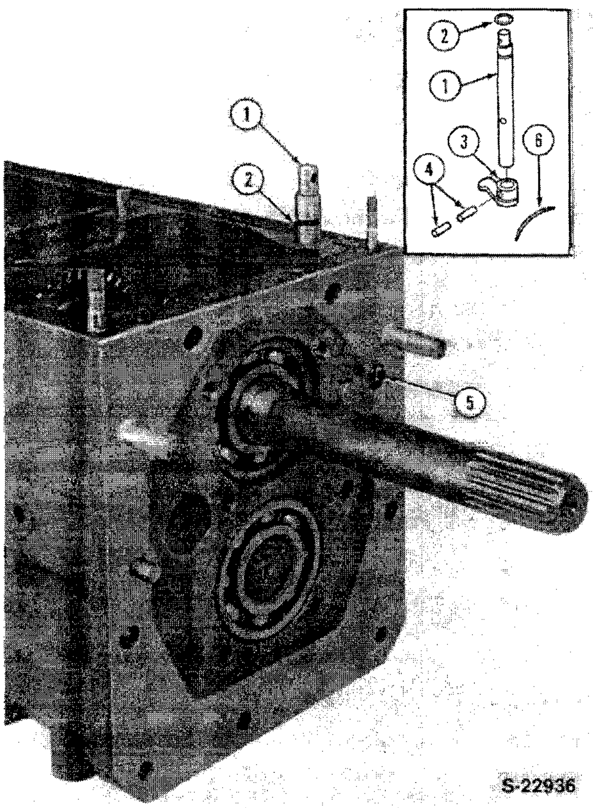


Figure 122
Shift Arm and Shaft Removal

1. Shaft
2. O-Ring
3. Shift Arm
4. Roll Pins
5. Plug
6. Safety Wire

3. Remove the shift forks, detent balls and springs, Figure 123.

4. Remove the retaining plate (8) and remove the shift arms (7) from the case.

REAR MAIN SHAFT – REMOVAL
Reference – Figure 124

1. While supporting the range sliding gears, gently drive the rear main shaft and bearing rearward out of the case.

2. Remove the needle bearing (6) from the rear of the front main shaft.

FRONT MAIN SHAFT – REMOVAL
Reference – Figure 125

NOTE: *The front main shaft may be removed without removing the shift rails and forks.*

1. Remove the rear bearing snap ring (10), Figure 125, from the case.

2. Gently drive the main shaft rearward while supporting the sliding gears and shift forks. Remove the sliding gears and spacer from the main shaft.

3. Remove the reverse idler shaft retaining bolts and slide the reverse idler gear and shaft assembly (11), rearward, as shown, Figure 125.

4. Slide the front main shaft and bearing assembly forward and remove from the case.

REVERSE IDLER SHAFT – REMOVAL
Reference – Figure 126

1. Remove the reverse idler shaft retaining bolt (1) from the case.

2. Drive the roll pin (7) out of the reverse idler shaft.

3. Slide the shaft forward out of the case.

4. Remove the thrust washers, idler gear and needle bearings, Figure 126.

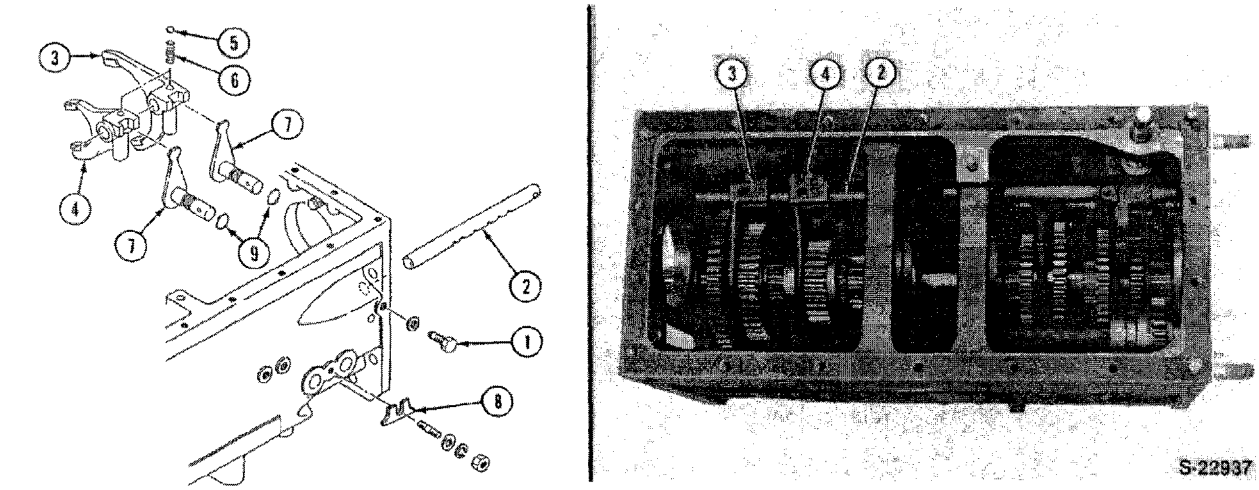


Figure 123
Range Gear Rail and Fork Removal

1. Retaining Bolt
2. Rail
3. Shifter Fork (1st-2nd Range)
4. Shifter Fork (3rd-4th Range)
5. Detent Ball (2)
6. Detent Spring (2)
7. Shift Arm
8. Retaining Plate
9. O-Ring

INSPECTION

1. Wash all components using a suitable cleaning solvent and air dry.

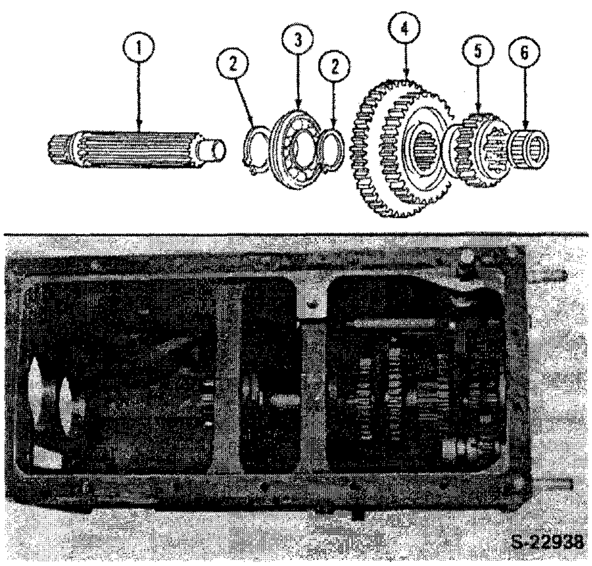


Figure 124
Rear Main Shaft Removal

1. Rear Main Shaft
2. Snap Ring
3. Bearing
4. Sliding Gear (1st-2nd Range)
5. Sliding Gear (3rd-4th Range)
6. Needle Bearing

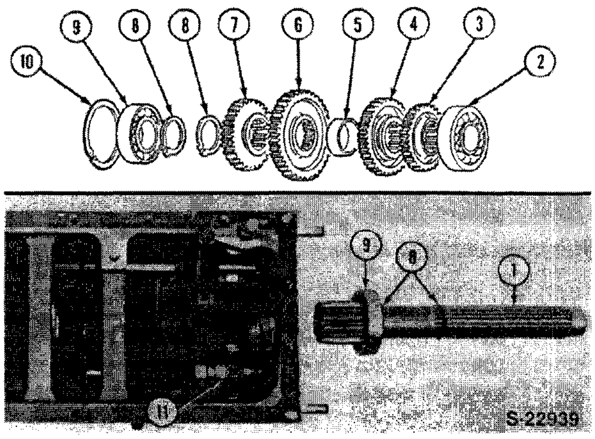


Figure 125
Front Main Shaft Removal

1. Front Main Shaft
2. Bearing
3. Sliding Gear
4. Sliding Gear
5. Spacer
6. Sliding Gear
7. Sliding Gear
8. Snap Ring (2)
9. Bearing
10. Snap Ring
11. Reverse Idler

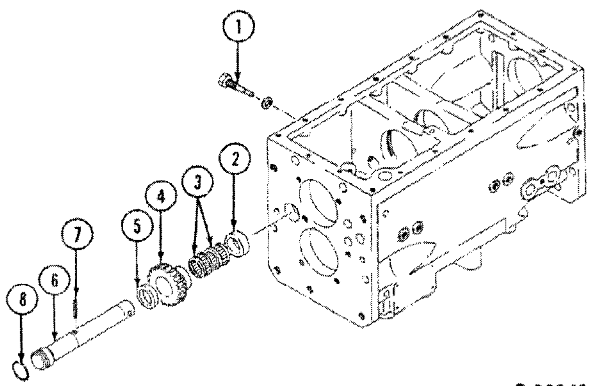


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Figure 126
Reverse Idler Shaft Removal

1. Retaining Bolt	5. Thrust Washer
2. Thrust Washer	6. Idler Shaft
3. Needle Bearing	7. Roll Pin
4. Idler Gear	8. O-Ring

2. Inspect all bearings for excess wear, score marks, discoloration from overheating, or other damage. Rotate the bearings by hand and check for roughness while slowly rotating the inner and outer races.

3. Lubricate all bearings with a clean lubricant before installation.

4. Inspect the transmission case for cracks, worn bearing bores or other damage.

5. Check the detent springs for wear, chipped teeth or weak spring tension.

6. Inspect the detent balls for excess wear or damage.

7. Inspect the shift rail detent grooves for excess wear.

8. Inspect all gears for excess wear, chipped teeth, or other damage.

9. Inspect the shift forks for excess wear, bending or other damage. See "Wear Specifications," Chapter 3.

ASSEMBLY
Reference — Figure 127

1. Lubricate all parts with clean transmission oil prior to assembly into the case.

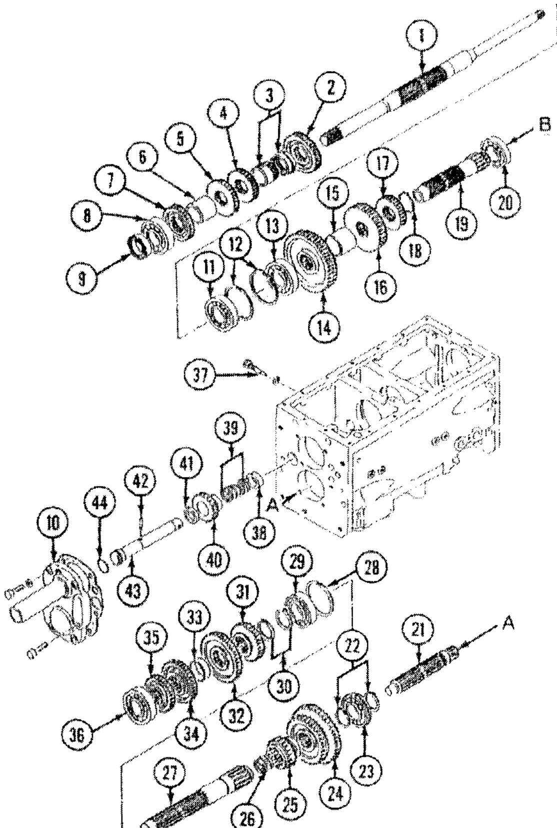

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Figure 127
Non-Synchromesh Transmission Components
(Single Clutch Model Shown)

1. Input Shaft	24. Sliding Gear (2nd-1st Range)
2. Fixed Gear (3rd)	25. Sliding Gear (4th-3rd Range)
3. Collar (Adjustable)	26. Needle Bearing
4. Fixed Gear (1st)	27. Front Main Shaft
5. Fixed Gear (2nd)	28. Snap Ring
6. Collar	29. Bearing
7. Fixed Gear (Rev)	30. Snap Ring
8. Bearing	31. Sliding Gear (3rd)
9. Oil Seal	32. Sliding Gear (1st)
10. Retainer	33. Collar
11. Bearing	34. Sliding Gear (2nd)
12. Snap Ring	35. Sliding Gear (Rev)
13. Bearing	36. Bearing
14. Fixed Gear (4th Range)	37. Retaining Bolt
15. Collar	38. Thrust Washer
16. Fixed Gear (3rd Range)	39. Needle Bearing
17. Fixed Gear (2nd Range)	40. Reverse Idler Gear
18. Snap Ring	41. Thrust Washer
19. Countershaft	42. Roll Pin
20. Bearing	43. Reverse Idler Gear
21. Rear Main Shaft	44. O-Ring
22. Snap Ring	
23. Bearing	

2. Install new gaskets and seals during assembly.

REVERSE IDLER SHAFT — ASSEMBLY
Reference — Figure 126

1. Install the reverse idler shaft through the front of the case, inserting the thrust washers, needle bearing, gear and o-ring.
2. Install the roll pin in the shaft.
3. Align the idler shaft lock bolt counterbore and install the locking bolt using a new sealing washer.

FRONT MAIN SHAFT — ASSEMBLY
Reference — Figure 125

1. Install the rear bearing (9), and two snap rings (8), on the main shaft as shown, Figure 125.
2. Guide the main shaft into the case from the front. Position the rear bearing beyond the case web and then position the sliding gears and spacer on the shaft in the order as shown, Figure 125.
3. Slide the assembled main shaft forward and install the rear bearing retaining ring (10).
4. Install the front bearing (2) in the case.
5. Reinstall the reverse idler gear assembly and install the locking bolt.

REAR MAIN SHAFT — ASSEMBLY
Reference — Figure 124

1. If removed, install the main shaft rear bearing (3) and snap rings (2) onto the main shaft.
2. Install the needle bearing (6) in the front main shaft counterbore.
3. Position the two sliding gears in the bottom of the housing in the order as shown, Figure 124.
4. Install the main shaft from the rear through the gears into the front main shaft.

RANGE GEAR SHIFT RAIL AND FORKS — ASSEMBLY
Reference — Figure 123

1. Install the shift arms from inside of the case using new o-rings.
2. Assemble the shift fork and detent mechanism prior to installing in the housing as follows:
   - Place the fork in a vise with the detent bore facing upward.
   - Place the detent spring and ball in the fork.
   - Position a 3/8 in. straight wall socket in the rod bore and using a suitable size punch compress the detent spring and ball while maintaining hand pressure on the socket. Slide the socket inward to hold the compressed spring and ball in place.
   - Position the assembled fork in the housing and onto the end of the shift rail.
   - While holding the shift fork from moving, strike the end of the shift rail with a light sharp blow with a brass hammer. This will displace the socket while containing the detent mechanism with the shift rail. Assemble the second fork and detent in the same manner.
3. Align the rail lock bolt counterbore with the housing bore and install the locking bolt using a new sealing washer.
4. Install the shift arms locking plate and tighen the nut.

MAIN GEAR SHIFT RAILS AND FORKS
Reference — Figures 121 and 122

1. Install the lower detent spring and ball in the case, Figure 121.
2. Position the 1st-3rd shift fork (4) and boss (10) inside the housing.
3. Install the 1st-3rd shift rail from the front through the fork and boss, Figure 121.
4. Install the roll pins in the fork and boss.

5. Install the shifter shaft (1) in the housing from the top and through the shift arm (3), Figure 122.

6. Install the double roll pin and wire together with a new safety wire.

7. Install the plug (5) in the case.

8. Install the interlock (balk) pin (9), Figure 121.

9. Position the 2nd-Rev fork in the case.

10. Install the 2nd-Rev shift rail in the housing through the fork and install the roll pin.

11. Install the upper detent ball, spring and pin as shown, Figure 121.

COUNTERSHAFT – ASSEMBLY – SINGLE TRANSMISSION

Reference – Figure 128

1. Install the countershaft, gears and bearings as shown, Figure 128.

   NOTE: *When equipped with the double clutch, first install the input shaft in reverse order as described in steps 1 through 7, "Countershaft Removal," Figure 119.*

INPUT SHAFT – ASSEMBLY

Reference – Figures 117 and 118

1. If removed, install the rear snap ring (11) and rear bearing (10), Figure 118.

2. Position the fixed gears and collars in place.

   NOTE: *If new input shaft components parts are used, or if the collar (8) has been upset install a new collar assembly at time of assembly.*

   When a new collar is used, assemble the collar to provide free play on the shaft during assembly. Make final adjustment only after installation of the front retainer assembly.

3. Install the input shaft from the front through the gears and collars.

4. Install the front bearings (3), Figure 118.

5. Install a new seal (2) in the retainer, Figure 117.

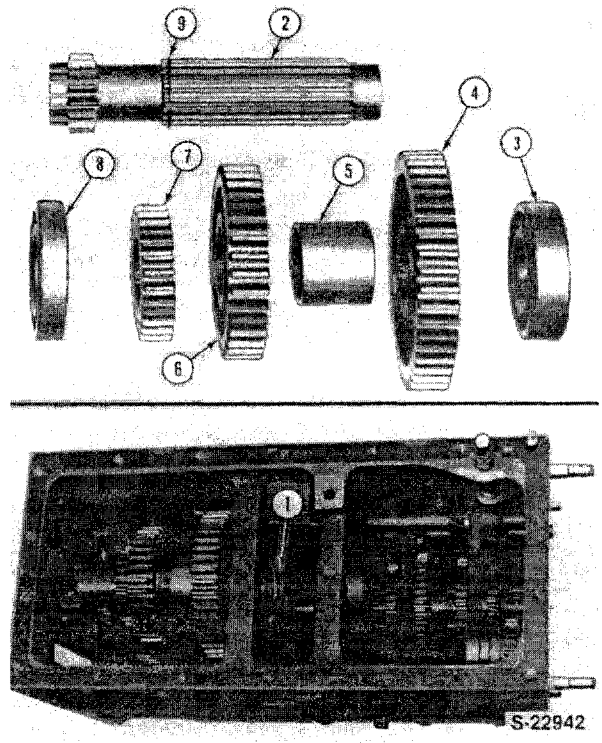


Figure 128
Countershaft Assembly

1. Snap Ring
2. Countershaft
3. Bearing
4. Fixed Gear (4th Range)
5. Spacer
6. Fixed Gear (3rd Range)
7. Fixed Gear (2nd Range)
8. Bearing
9. Snap Ring

6. Using a new gasket, install the retainer and tighten the bolts to the specified torque.

   NOTE: *Use new sealing washers on the retainer mounting bolts.*

COLLAR ADJUSTMENT

Reference – Figure 129

1. Adjust the length of the collar by hand to zero free play of the gears on the shaft. The collar should not be binding nor should it have free play. With proper adjustment, the collar should rotate with medium hand pressure.

2. After adjustment, stake the nut flange into the groove to lock the assembly.

   Never reuse a collar assembly if the staking has been upset.

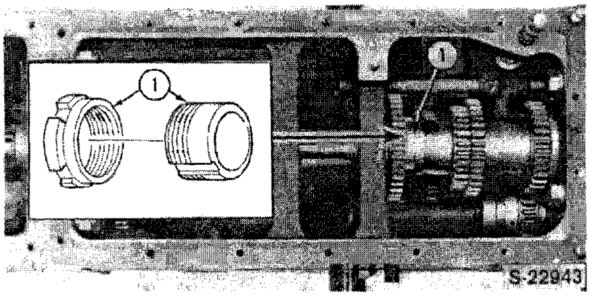


Figure 129
Collar Adjustment

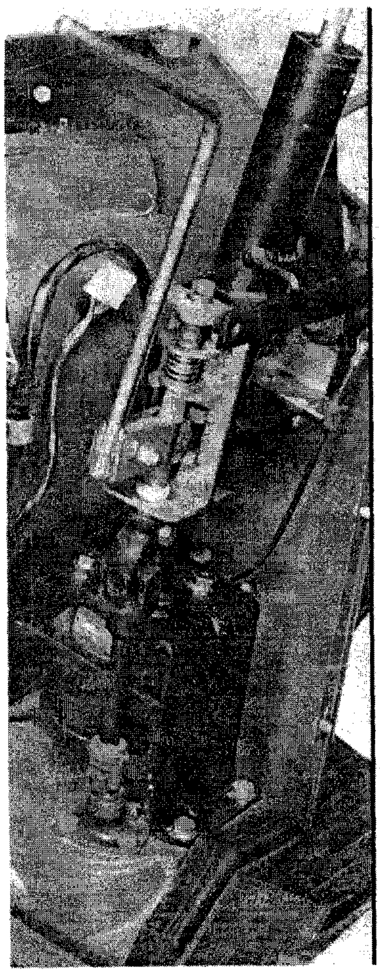
1. Collar

C. SHIFT LEVERS

The non-synchromesh transmission utilizes two control levers.

The main transmission gear shift lever is column mounted, Figure 130. The range gear shift lever is located on the left hand side of the operator seat, Figure 131.

The main shift lever controls the 1st-3rd and Rev-2nd gear shifts. The range shift lever controls the four speeds.



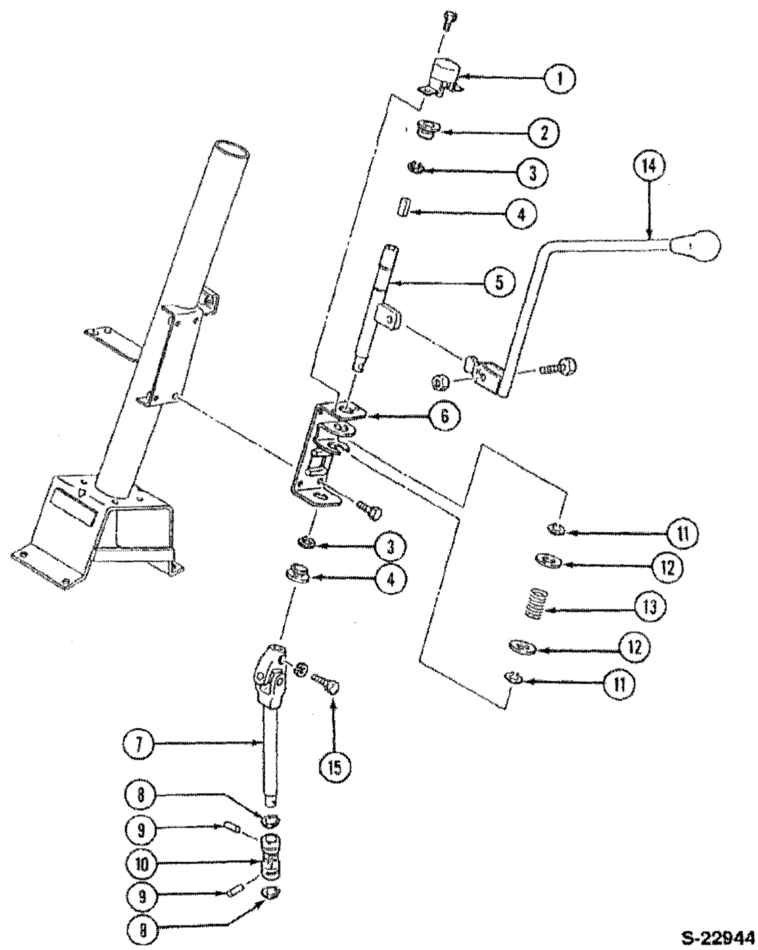


Figure 130
Main Transmission Gearshift Linkage Overhaul

1. Safety Switch
2. Bushing
3. Snap Ring
4. Roll Pin
5. Shift Arm
6. Bracket
7. Link Asembly
8. Snap Ring
9. Pin
10. Joint
11. Snap Ring
12. Washer
13. Spring
14. Change Lever
15. Clamp Bolt

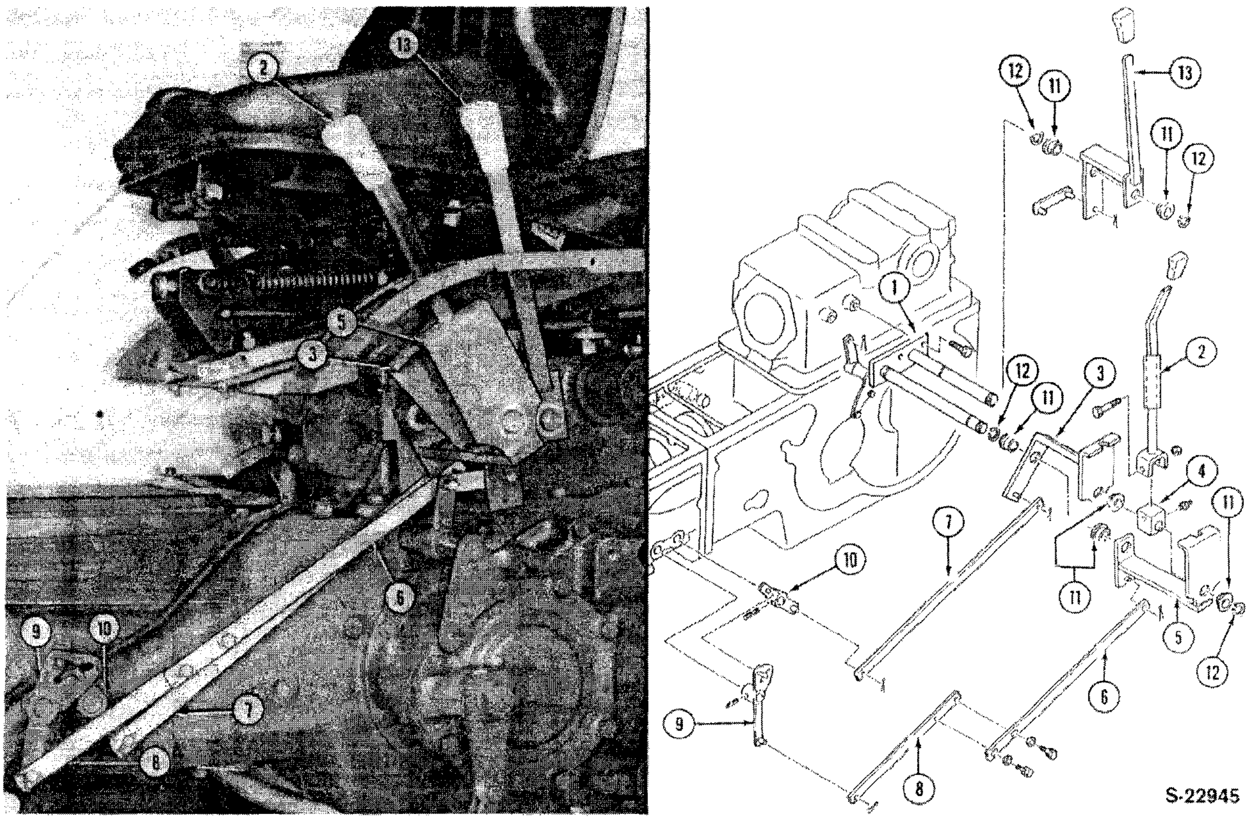


Figure 131
Range Gear Shift Linkage Overhaul

1. Shift Guide
2. Change Lever (Trans.)
3. Shift Arm
4. Boss
5. Shift Arm
6. Shift Plate
7. Shift Plate
8. Shift Plate
9. Change Lever
10. Change Lever
11. Bushing
12. Snap Ring
13. Change Lever (PTO)

Overhaul of the gear shift levers and linkage requires normal repair practices.

On assembly, observe the following requirements:

- With the transmission gears in neutral, assemble the gear shift arm (5) to align the change lever (14) in the neutral position with the guide on the instrument panel.

  Tighten the clamp bolt (15) securely.

- Install the switch (1), Figure 130, being certain to have the small pin on the switch shaft located in the roll pin groove.

- Center the switch assembly in the slotted holes and tighten the mounting screws finger tight. Test the switch operation making sure the switch has continuity when the change lever is in neutral position only. Adjust the switch as required and tighten the mounting screws.

PART 5
TRANSMISSION SYSTEMS

Chapter 6
SYNCHROMESH 12 x 12 SHUTTLE TRANSMISSION — MODEL 1720

A. DESCRIPTION AND OPERATION

The optional synchromesh shuttle transmission assembly, Figure 132, available on the Model 1720 tractor provides 12 forward and 12 reverse speeds which are manually controlled by three shift levers.

The transmission is driven by a double clutch and provides a live power take-off system.

The transmission case contains three compartments, Figure 132. The forward compartment contains the shuttle transmission gears consisting of a forward and reverse synchronizer and are controlled by a column mounted shift lever (1), located on the left hand side of the steering column, Figure 133.

The center compartment contains the main transmission gears consisting of four speed ratios with the two synchronizer gear sets, Figure 132.

These gears are controlled by a column mounted shift lever (2), mounted on the right hand side of the steering column, Figure 133.

The rear compartment contains the range gears, which provides for three range speed ratios for each of the main transmission gear speeds for a total of 12 forward and 12 reverse speeds.

The range gears are not synchronized and are controlled by a lever located at the left hand side of transmission case, Figure 134.

All the shuttle and main transmission gears are in constant mesh, Figure 132, and shifting is accomplished by engaging and disengaging three synchronized assemblies located in the transmission forward and center compartments.

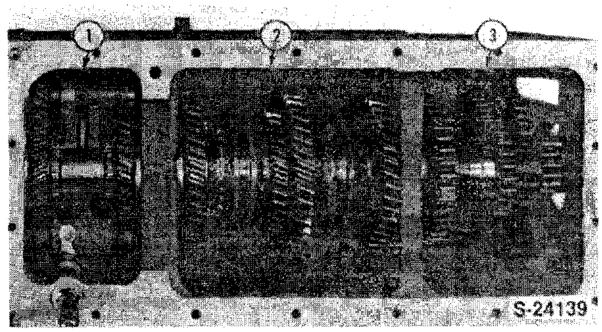


Figure 132
Synchromesh 12 x 12 Shuttle Gear Transmission

1. Shuttle Transmission Gears
2. Main Transmission Gears
3. Range Transmission Gears

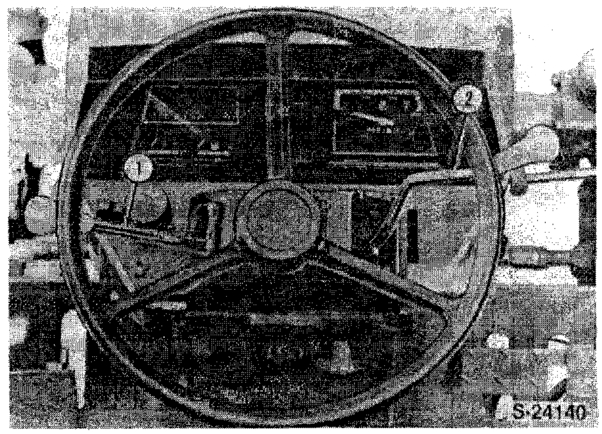


Figure 133
Shuttle Transmission — Main and Shuttle Control Levers

1. Shuttle Shift Lever
2. Main Shift Lever

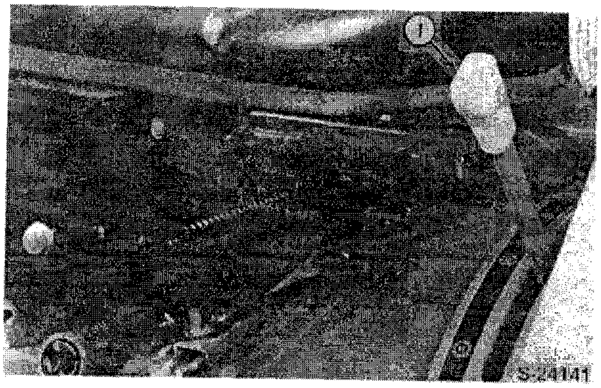


Figure 134
Shuttle Transmission Range Gear Lever
1. Range Shift Lever

The range gears are not synchronized and shifting is accomplished by engaging sliding gears located in the transmission rear compartment.

The transmission housing serves as a common oil reservoir for the final drive assembly, transmission and hydraulic system.

The oil used is Ford 134B or equivalent.

The oil level dipstick is located on the transmission top cover.

B. OVERHAUL

REMOVAL

1. Drain the transmission and differential oil into a clean container. See Operator's Manual.
2. Remove the transmission from the tractor. See "Separating the Tractor," Part 12.
3. Drive the roll pins (6 and 7) out of the upper shift rail shift fork and boss (4 and 5), Figure 135. Remove the detent spring (1) and ball (2), Figure 135.
4. Slide the upper rail rearward out of the case and remove the fork and boss from the case.
5. Remove the interlock (balk) pin (11), Figure 135.

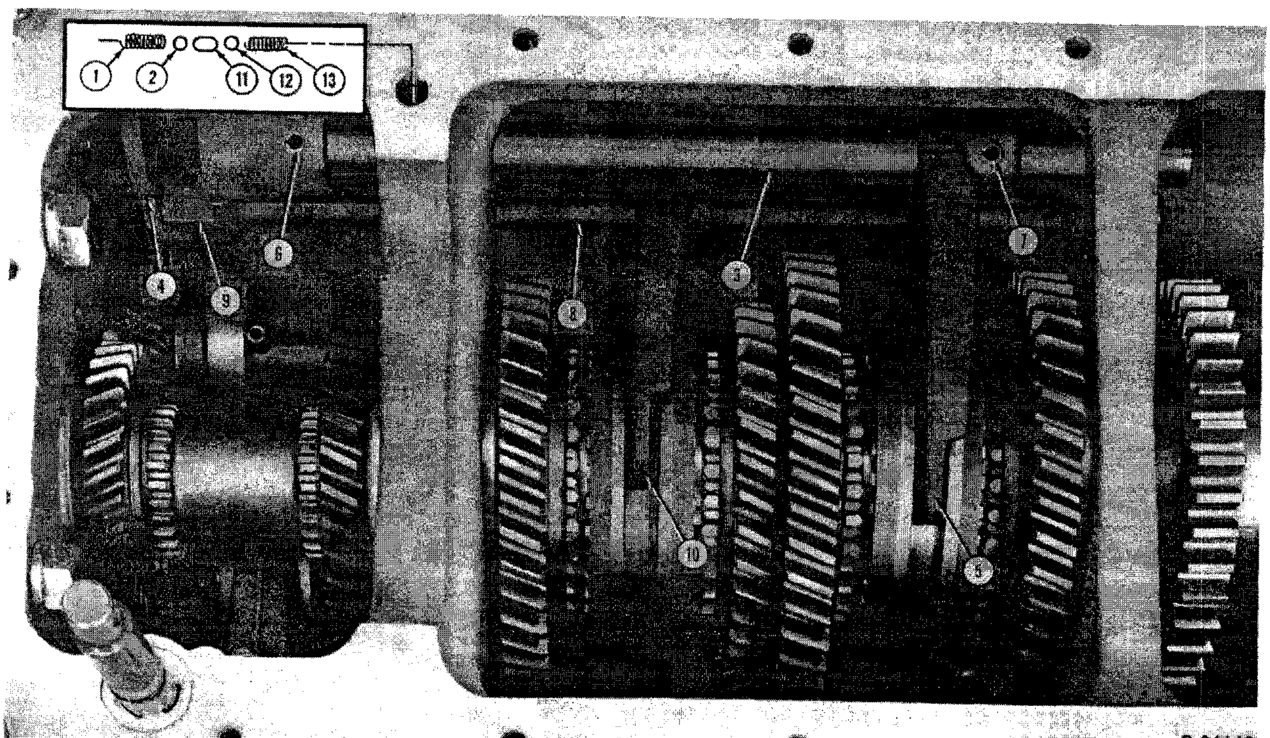


Figure 135
Main Shift Rails and Forks Removal

1. Detent Spring
2. Detent Ball
3. Shift Rail (1st-2nd)
4. Shifter Boss
5. Shifter Fork (1st-2nd-Main)
6. Roll Pin
7. Roll Pin
8. Shift Rail (3rd-4th)
9. Shifter Boss
10. Shifter Fork (3rd-4th-Main)
11. Balk Pin
12. Detent Ball
13. Detent Spring

6. Drive the roll pins out of the lower shaft boss and shift fork (9 and 10), Figure 135.

7. Slide the lower shaft rearward out of the case and remove the fork and boss.

   NOTE: *Use care not to lose the detent ball and spring (12 and 13) when removing the lower shaft as they will be expelled with considerable force when released by the shaft. Place a shop towel over the detent bore to contain the spring and ball while removing the shaft.*

MAIN SHAFT REMOVAL

1. Slide the PTO drive shaft (1) out the rear of the case, Figure 136.

2. Drive the rear bearing (10) out the rear of the case, Figure 136.

3. Drive the main shaft assembly (1) and center bearing (2) rearward, Figure 137.

   NOTE: *The center bearing (2) must be all the way out of the case web as shown in Figure 137. It may be necessary to remove the snap ring (3) from the shaft groove to provide clearance with the large gear on the lower shaft.*

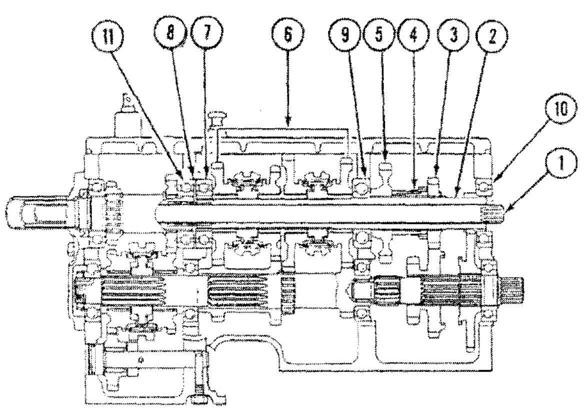


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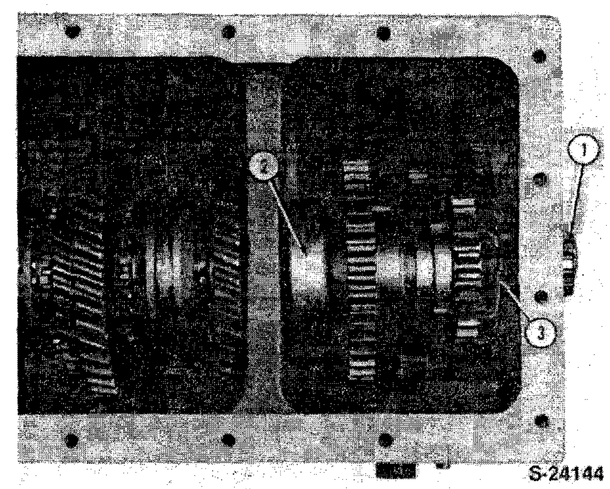
Figure 136
Main Shaft Removal

1. Drive Shaft — PTO
2. Main Shaft
3. Fixed Gear (Middle-Range)
4. Collar
5. Fixed Gear (High-Range)
6. Synchronizer Assembly
7. Bearing
8. Snap Ring
9. Bearing
10. Bearing



S-24144

Figure 137
Main Shaft Removal

1. Main Shaft Assembly
2. Bearing
3. Snap Ring

4. While supporting the main synchronizer gears and fixed range gears, withdraw the main shaft (1), from the case, Figure 138.

5. Remove the fixed range gears (3), spacer (4) and bearing (5), Figure 138.

6. Remove the two synchronizer assemblies (6 and 7), collars (8 and 9) and front bearing (10), Figure 138.

7. Remove the snap ring (8), Figure 136.

   NOTE: *The snap ring (8) is used as a floating spacer between the bearings .*

RANGE SHIFT RAIL AND FORK REMOVAL

1. Remove the retaining bolt (8), Figure 139.

2. Rotate the shift rail 90° and slide the rail rearward.

   NOTE: *The detent spring and ball are located in the fork on the underside of the rail, Figure 140. Use care when removing the rail as the spring and ball will be expelled with considerable force when released. Cover the shift fork with a shop towel to contain the spring and ball while removing the shaft.*

3. Remove the rail and shift fork from the case.

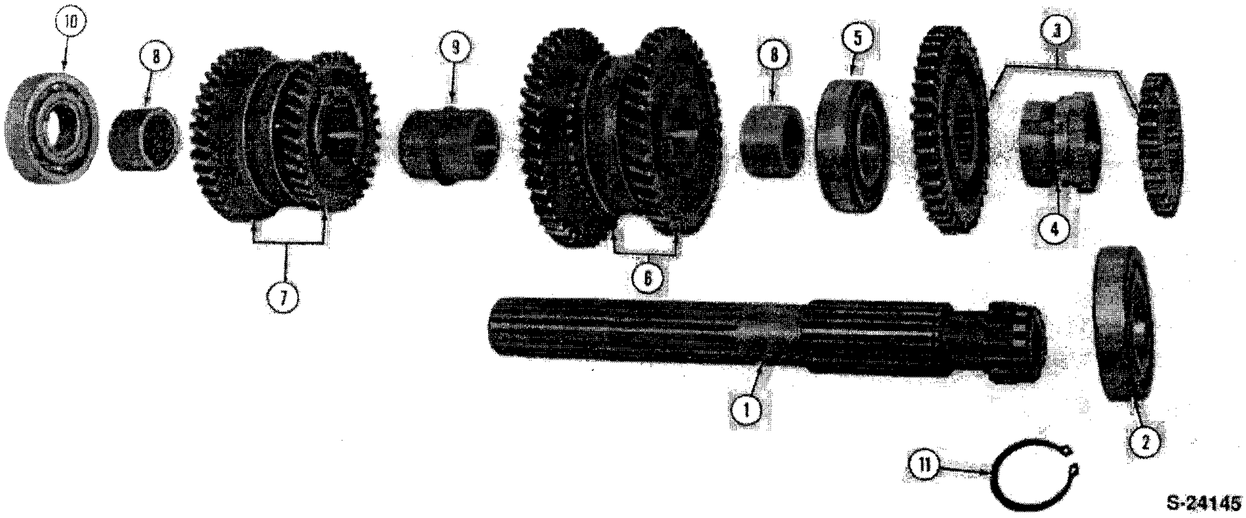


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Figure 138
Main Shaft Removal

1. Main Shaft
2. Rear Bearing
3. Fixed Range Gears
4. Adjustable Spacer
5. Bearing (Center)
6. Synchronizer Assembly (1st-2nd)
7. Synchronizer Assembly (3rd-4th)
8. Collar
9. Collar
10. Bearing Front
11. Snap Ring

4. If required, remove the bolt (7), and plate (6), Figure 139.
5. Remove the shift arm (5) from the inside of the case.

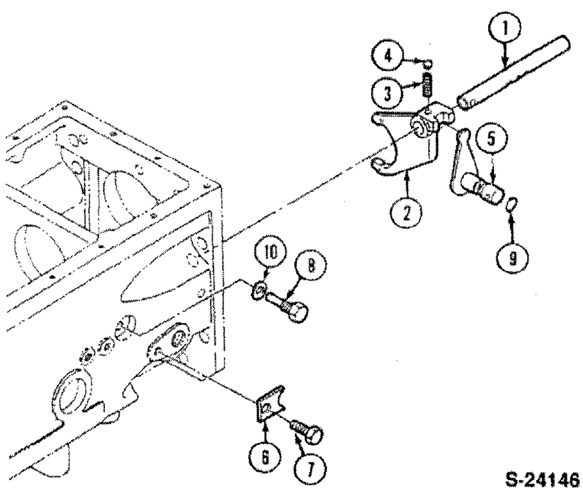

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Figure 139
Range Gear Shift Rail and Fork Removal

1. Shift Rail
2. Fork
3. Detent Spring
4. Detent Ball
5. Shift Arm
6. Plate
7. Bolt
8. Retaining Bolt
9. O-Ring
10. Sealing Washer

RANGE GEAR COUNTERSHAFT REMOVAL

NOTE: *The range gear countershaft may be removed without removing the shift rail and fork from the case.*

1. Slide the snap ring (4) forward on the countershaft, Figure 140.
2. Remove the shift rail retaining bolt (8), Figure 139, to permit sliding the shift fork, rail and sliding gear back and forth easily to prevent binding.
3. Withdraw the countershaft (5), Figure 140, rearward out of the case.
4. Remove the sliding gear (2), countershaft gear (3), snap rings (4 and 5) and rear bearing (6), Figure 141.
5. Remove the needle bearing (7) from inside of the main gear countershaft, Figure 141.

INPUT SHAFT REMOVAL

1. Remove the input shaft retainer (1), Figure 142.

NOTE: *Use care to not lose any shims (if used) on the lower shaft for bearing pre-load.*

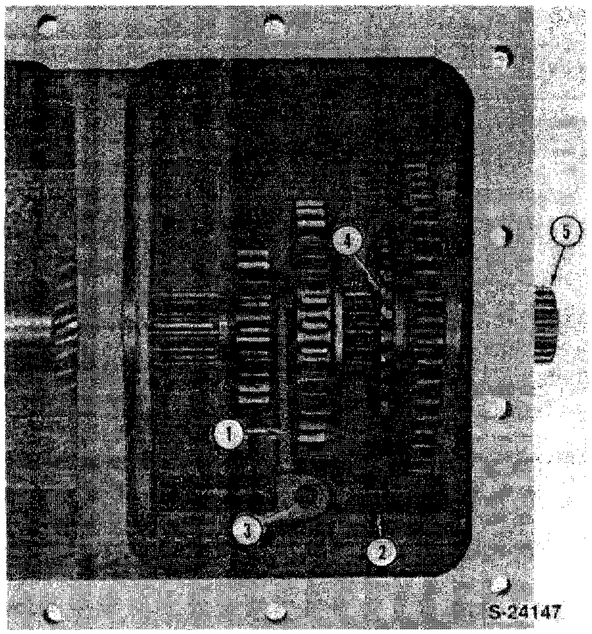

Figure 140
Range Gears, Countershaft, and Shift Rail Removal

1. Shift Fork
2. Shift Rail
3. Detent Bore
4. Snap Ring
5. Countershaft

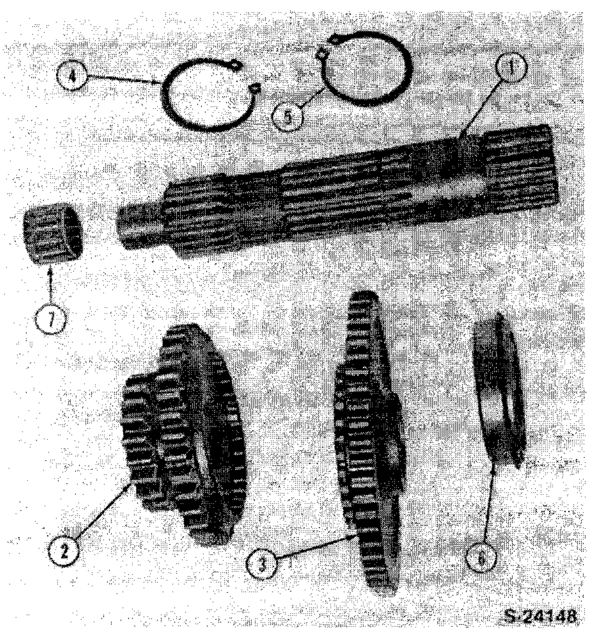

Figure 141
Range Gear Countershaft Removal

1. Countershaft
2. Sliding Gear
3. Countershaft Gear
4. Snap Ring
5. Snap Ring
6. Rear Bearing
7. Needle Bearing

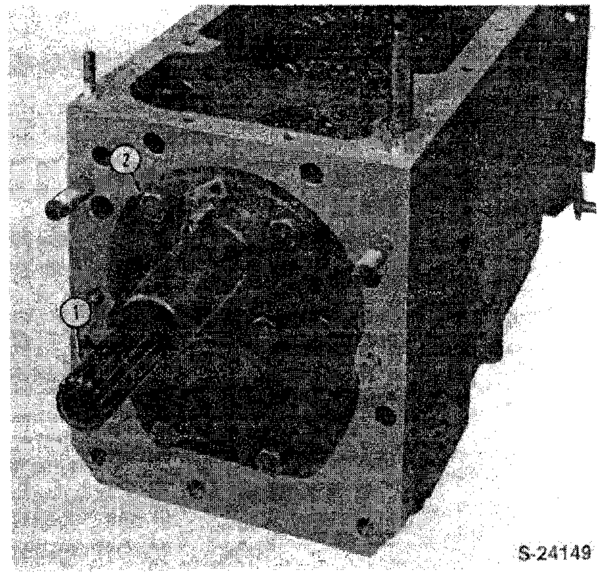

Figure 142
Front Retainer Removal

1. Transmission Input Shaft
2. Retainer

2. Pull the input shaft forward and remove the rear bearing (2) from the shaft.

3. Remove the gear (3), snap rings, (10) and gear (4), Figure 143.

NOTE: *Oil seal (13) is located in the retainer housing for sealing external oil leaks around the outside of the transmission input shaft. A double seal (12) is located inside the rear end of the input shaft for sealing oil leaks between the PTO input shaft and transmission input shaft.*

REVERSE IDLER SHAFT REMOVAL

1. Drive the roll pin (1) out of the shaft, Figure 144.

2. Remove the idler shaft retaining bolt (2), Figure 145.

3. Gently drive the shaft forward out of the case.

4. Remove the thrust washer (6), counter gear (5) and needle bearing (4) from the case, Figure 145.

5. Remove the O-ring (7) from the idler shaft.

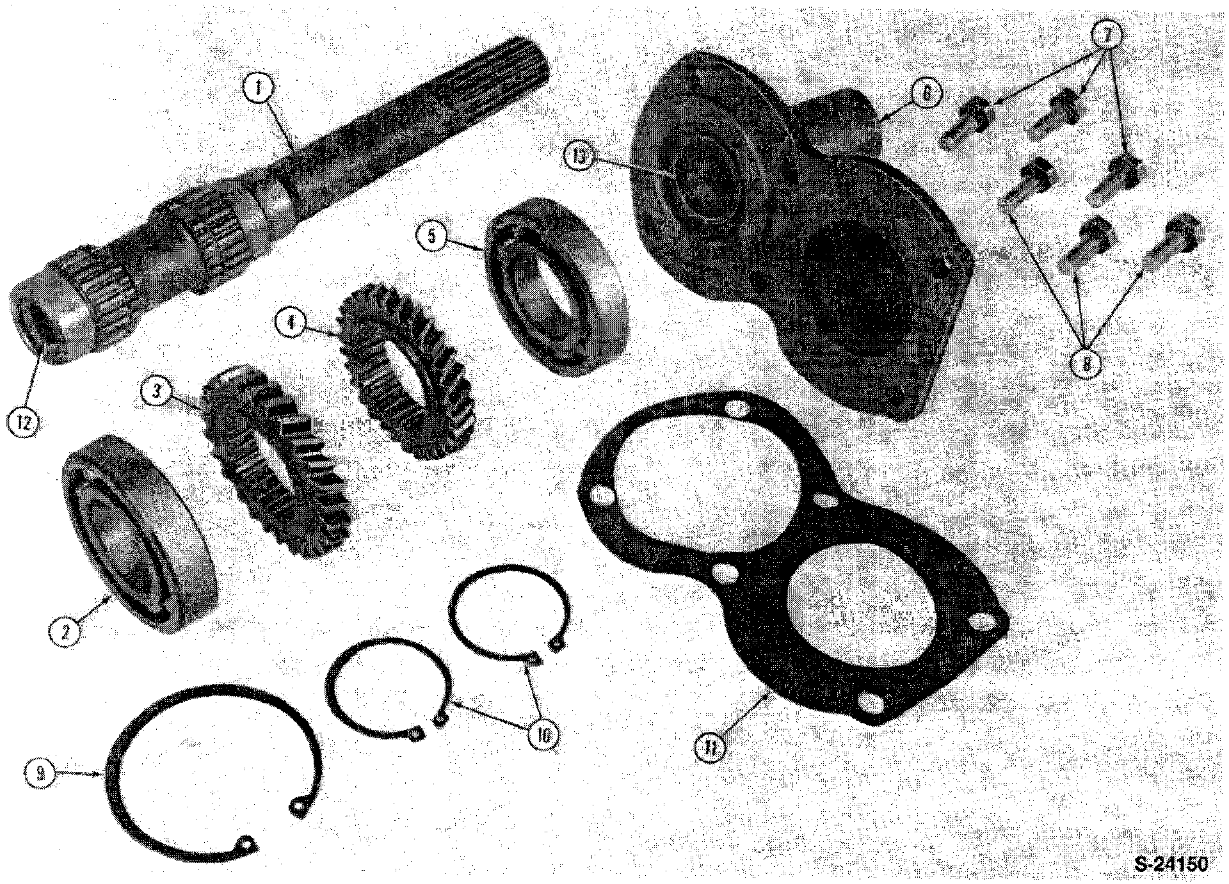

Figure 143
Input Shaft and Retainer Assembly

1. Input Shaft
2. Bearing, Rear
3. Fixed Gear, Forward
4. Fixed Gear, Reverse
5. Bearing, Front
6. Retainer
7. Retainer, Bolts (6)
8. Seals (6)
9. Snap Ring, Rear
10. Snap Ring (2)
11. Gasket
12. Seal, Input Shaft
13. Seal, Retainer

SHUTTLE SHIFT RAIL AND FORK

1. Remove the rubber plug (2), from the access bore at the front of the case, Figure 146.
2. Remove the locking wire (3), Figure 147.
3. Using a small pin punch inserted through the access hole, drive the double roll pin out of the shift arm and shaft (1 and 2), and remove the shaft and arm from the case, Figure 147.
4. Drive the roll pin (4) out of the shift rail, Figure 147.
5. Remove the retaining bolt (6), Figure 148, and slide the shift rail forward out of case.

NOTE: *Use care to not lose the detent spring and ball as they will be expelled with considerable force when released by the shift rail, cover the shift fork with a shop towel to contain the spring and ball while removing the rail from the fork.*

6. Remove the fork (2), detent ball (5) and spring (4), Figure 148.
7. Remove the O-ring (7) from the shift rail.

MAIN COUNTERSHAFT REMOVAL

1. Straighten the lock washer (5), Figure 146, and remove the locknut (4).

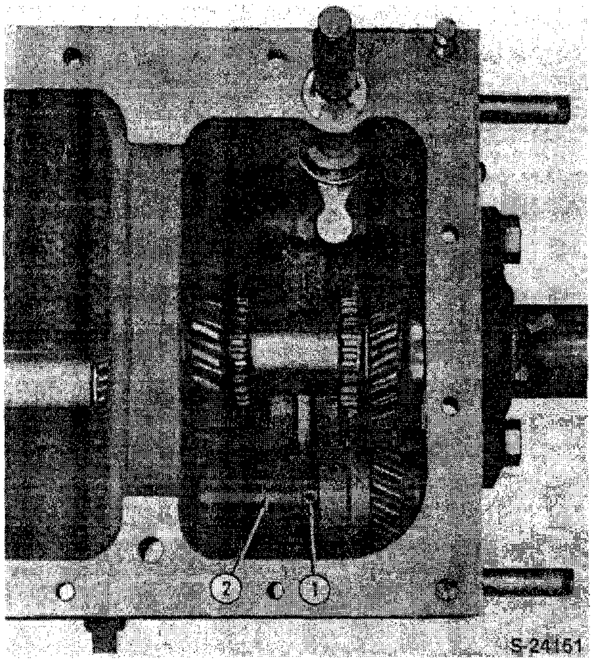

Figure 144
Reverse Idler Shaft Removal
1. Roll Pin
2. Reverse Idler Shaft

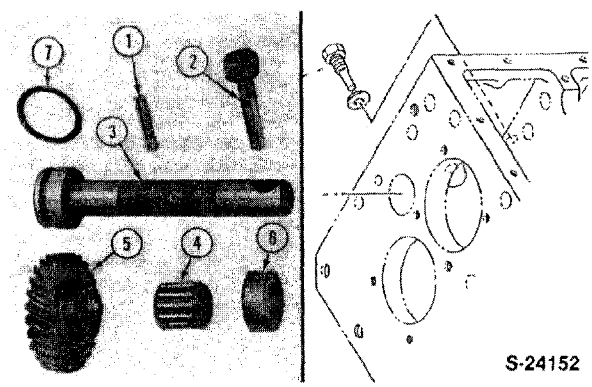

Figure 145
Reverse Idler Shaft Assembly
1. Roll Pin
2. Locking Bolt
3. Reverse Idler Gear Shaft
4. Needle Bearing
5. Counter Gear
6. Thrust Washer
7. O-Ring

2. Remove the snap ring located behind the countershaft rear bearing (6), Figure 147.

3. Gently drive the countershaft rearward while supporting the synchronizer assembly (7) and fixed gear set (8), Figure 147.

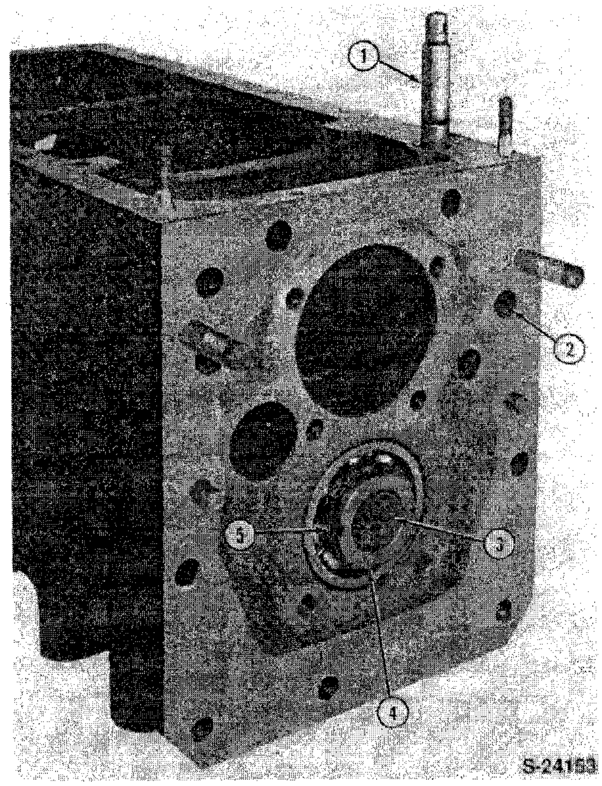

Figure 146
Shuttle Shift Rail Removal
1. Shift Arm Shaft
2. Bore Plug (Access Bore)
3. Main Countershaft
4. Locknut
5. Lock Washer

NOTE: *The countershaft front and center bearing must be removed from the shaft as it is being removed from the case.*

SYNCHRONIZER COUPLER ASSEMBLY

The synchronizer coupler and gear contain matching marks for correct assembly. Locate the matching marks prior to disassembly of the coupler. If no marks are visible, establish matching marks on the gear and coupler.

INSPECTION

1. Wash all components using a suitable cleaning solvent and air dry.

2. Inspect all bearings for excess wear, score marks, discoloration from overheating, or other damage. Rotate the bearings by hand and check for roughness while turning the inner and outer races.

3. Lubricate all bearings with a clean lubricant before assembly.

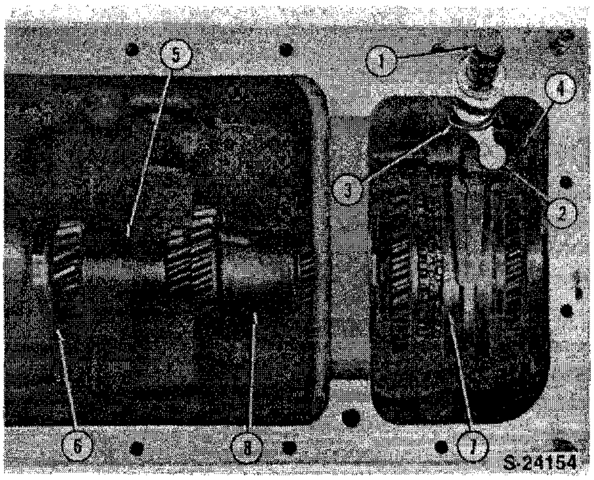

Figure 147
Main Countershaft and Shuttle Shift Shaft and Arm Removal

1. Shift Shaft
2. Shift Arm
3. Locking Wire
4. Roll Pin
5. Main Countershaft
6. Bearing — Countershaft, Rear
7. Synchronizer Assembly
8. Fixed Gear Set

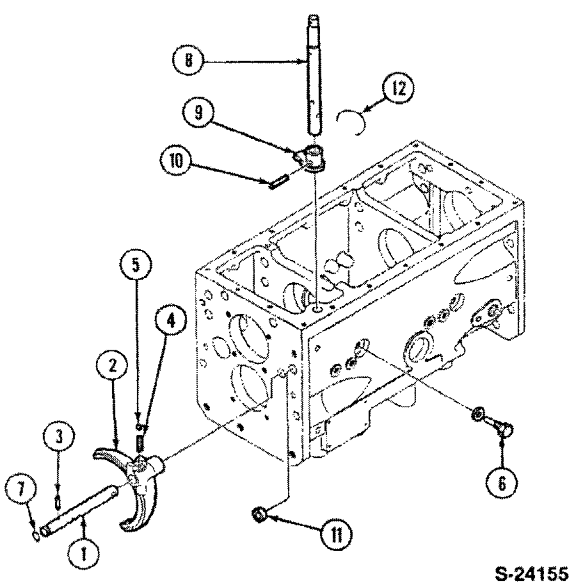

Figure 148
Shuttle Shift Rail and Fork Removal

1. Shift Rail
2. Fork
3. Roll Pin
4. Detent Spring
5. Detent Ball
6. Retaining bolt
7. O-Ring
8. Shaft-Shift Arm
9. Shift Arm
10. Roll Pin
11. Plug
12. Locking Wire

4. Inspect the transmission case for cracks, worn bearing bores or other damage.
5. Check the detent springs for wear, chipped or weak spring tension.
6. Inspect the detent balls for wear or other damage.
7. Inspect the shift rail detent grooves for excess wear.
8. Inspect the gears for excess wear, chipped gear teeth, or other damage.
9. Inspect the shift forks for excess wear, bent forks, or other damage. See "Specifications," Chapter 8.
10. Inspect the synchronizer components for excess wear or other damage, Figure 149. Measure the cone wear between the synchronizer ring and gear, Figure 150. See "Wear Limit Specifications," Chapter 8.
11. Using a feeler gauge, measure the side clearance between the shift fork and the sliding collar, Figure 151. See "Side Clearance Wear Limit Specifications," Chapter 8.

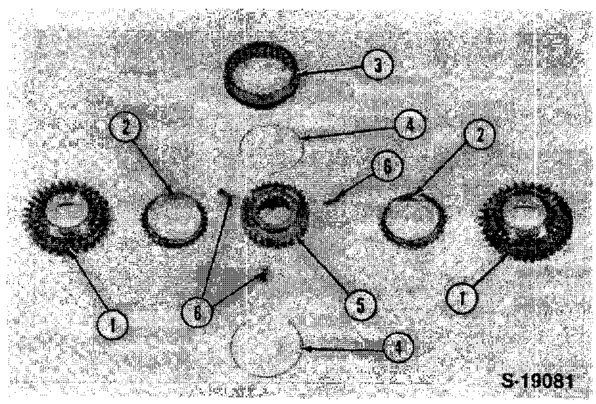

Figure 149
Synchronizer Assembly

1. Synchronizer Gear
2. Synchronizer Ring
3. Sliding Collar
4. Spring
5. Hub
6. Key

ASSEMBLY

MAIN COUNTERSHAFT ASSEMBLY

1. Assemble the synchronizer gear, keys, coupling and retainer rings, Figure 152.

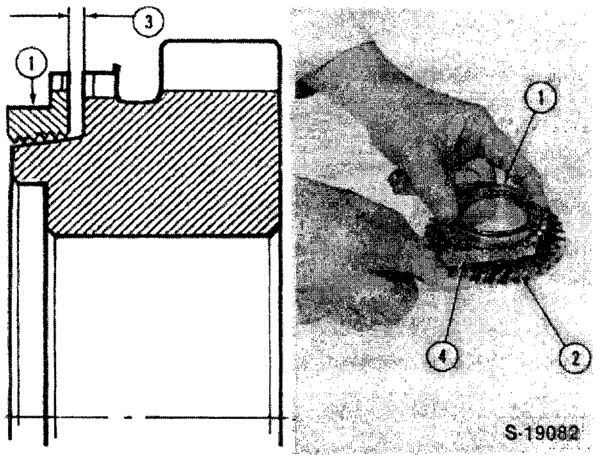

Figure 150
Synchronizer Wear Check

1. Synchronizer Ring
2. Synchronizer Gear
3. Clearance .060 in. (1.5 mm)
4. Feeler Gauge

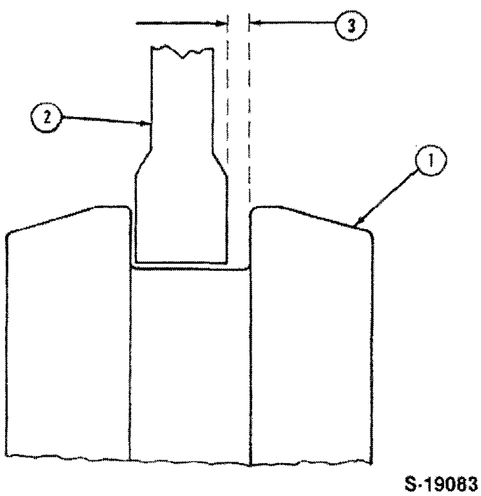

Figure 151
Synchronizer Fork Clearance Check

1. Sliding Collar
2. Shift Fork
3. Clearance .008-.016 in. (.2-.4 mm) Max. .039 in. (1.0 mm)

NOTE: *On assembly, be sure to align the coupling and gear matching marks made on disassembly.*

2. Assemble the synchronizer rings (2), counter gears (1 and 4), to the synchronizer gear assembly, Figure 153.
3. Place the synchronizer gear (9), counter gears (8 and 10) in the bottom of the case as an assembly, Figure 154.

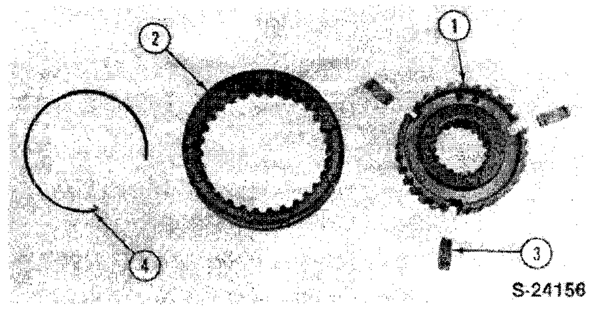

Figure 152
Synchronizer Gear Assembly

1. Gear
2. Coupling (Sliding)
3. Keys (3)
4. Retaining Rings (2)

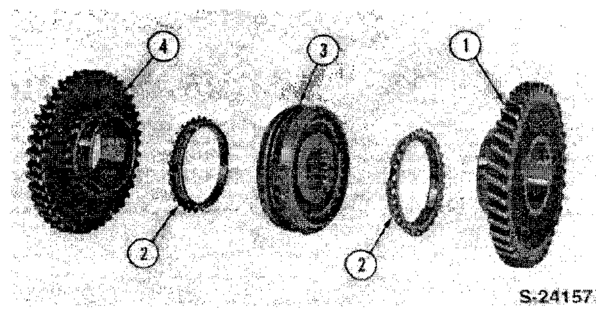

Figure 153
Synchronizer Assembly

1. Counter Gear (Forward)
2. Synchronizer Ring
3. Gear Assembly
4. Counter Gear (Reverse)

4. Position the needle bearings (7) and collars (6) in the synchronizer assembly through the case countershaft openings on each side.
5. Place the counter gear (4) and bearing (5) in the bottom of the housing.
6. While supporting the counter gears, bearing and synchronizer assembly, insert the main countershaft from the rear through the fixed gears, bearing and synchronizer assembly, Figure 154.
7. Install the rear bearing (2), and snap ring (3), Figure 154.
8. Install the front bearing (11), thrust washer (12), lock washer (13) and locknut (14), Figure 154.
9. Tighten the locknut and bend the tabs of the lock washer to prevent loosening.

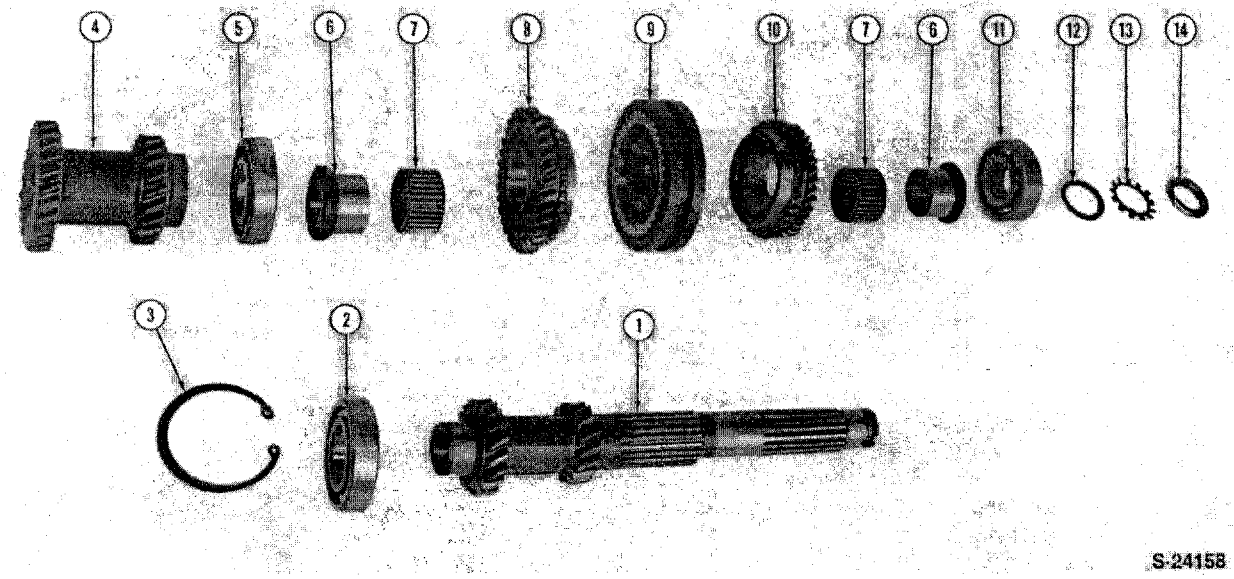

Figure 154
Main Countershaft Assembly

1. Main Countershaft
2. Bearing (6207)
3. Snap Ring
4. Fixed Counter Gear
5. Bearing (6207)
6. Collar
7. Needle Bearing
8. Counter Gear
9. Gear Assemby
10. Counter Gear
11. Bearing (6303)
12. Thrust Washer
13. Lock Washer
14. Locknut

SHUTTLE SHIFT RAIL AND FORK ASSEMBLY

Reference — Figure 155

1. Position the detent spring (4) and ball (5) in the fork (2).
2. Position the fork in place.
3. While compressing the detent ball and spring, install the shift rail (1) from the front through the fork using a new O-ring (7).
4. Install the roll pin (3) in the rail.
5. Align the shift rail lock bolt counterbore and install the the locking bolt (6) using a new sealing washer.
6. Position the shift arm (9) in place, and install the shaft (8) from the top of the case through the shift arm.
7. Install the double roll pins (10), in the shift arm.
8. Install a new lock wire (12) through the roll pin to prevent the roll pins from working out.
9. Install the plug (11) in the front of the case.

REVERSE IDLER GEAR SHAFT ASSEMBLY

Reference — Figure 156

1. Position the reverse idler gear (5) and bearing assembly (4) and thrust washer (6) in place.

   NOTE: *Install the oil groove side of the thrust washer face toward the idler gear.*

2. Install a new O-ring (7), on the front of the shaft.
3. Insert the idler shaft (3), from the front through the gear (5), needle bearing (4) and thrust washer (6).
4. Install the roll pin (1) in the shaft to secure the thrust washer and gear in place.
5. Align the shaft lock bolt counterbore and install the locking bolt (2), using a new sealing washer.

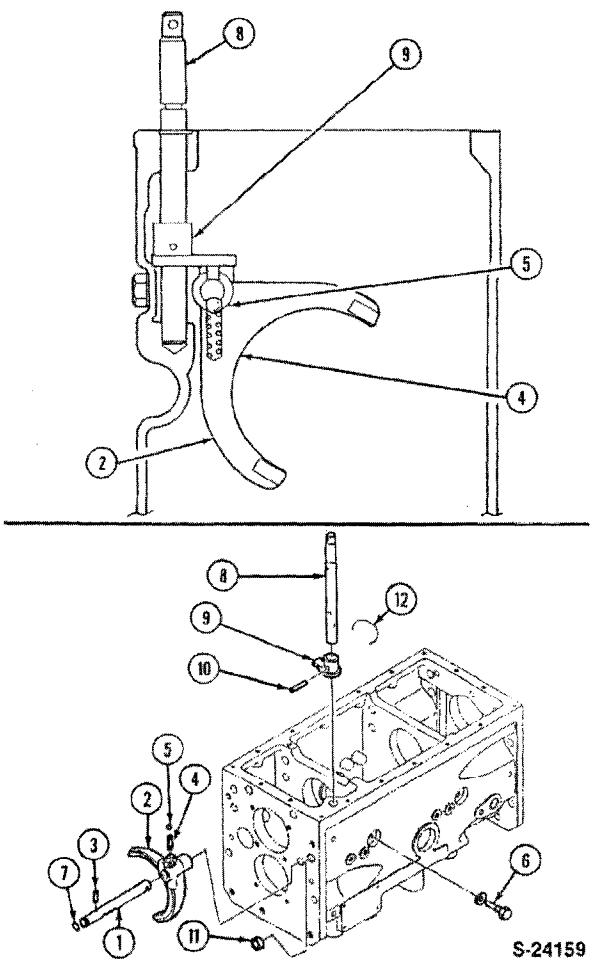

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Figure 155
Shuttle Shift Fork and Rail Assembly

1. Shift Rail	7. O-Ring
2. Fork	8. Shaft — Shift Arm
3. Roll Pin	9. Shift Arm
4. Detent Spring	10. Roll Pin
5. Detent Ball	11. Plug
6. Retaining bolt	12. Locking Wire

INPUT SHAFT ASSEMBLY
Reference — Figure 157

1. Using a suitable size installer, install a new oil seal (12), in the input shaft.

2. If removed, install the snap ring (9) in the case web.

3. Insert the input shaft into the front of the case and position the gear (4) and the two snap rings (10) on the shaft.

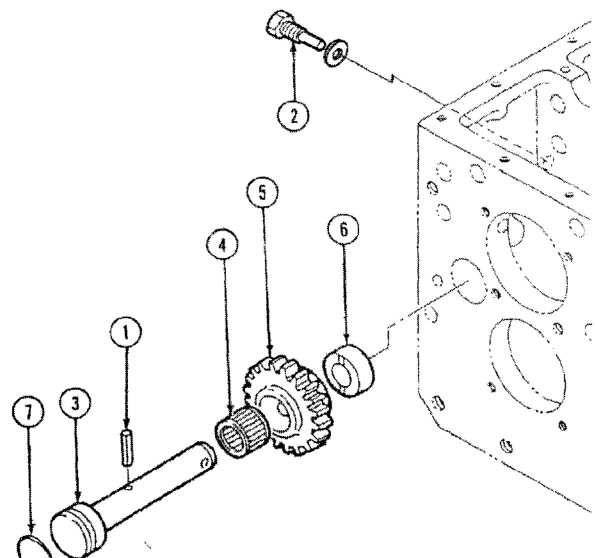

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Figure 156
Reverse Idler Gear Shaft Assembly

1. Roll Pin	4. Needle Bearing
2. Locking Bolt	5. Counter Gear
3. Reverse Idler Gear Shaft	6. Thrust Washer
	7. O-Ring

4. Position the gear (3) and bearing (2) on the shaft and install the two snap rings (10) in their shaft grooves.

5. Position the assembled shaft all the way into the case and install the gear (4) and front bearing (5) on the forward end of the shaft.

6. Using a suitable size installer, install a new oil seal (13) in the retainer housing.

7. With the main countershaft positioned fully rearward, determine the position of the main countershaft front bearing in relation to the front face of the transmission case. Add or subtract shims (3), Figure 158, as required to obtain zero end float of the main countershaft assembly. Shims are available in .003, .008 and .020 in (0.1, 0.2 and 0.5 mm) sizes.

8. Using a new gasket, install the retainer assembly on the front of the case.

NOTE: *Use new seal washers (8) on the retainer mounting bolts, Figure 157.*

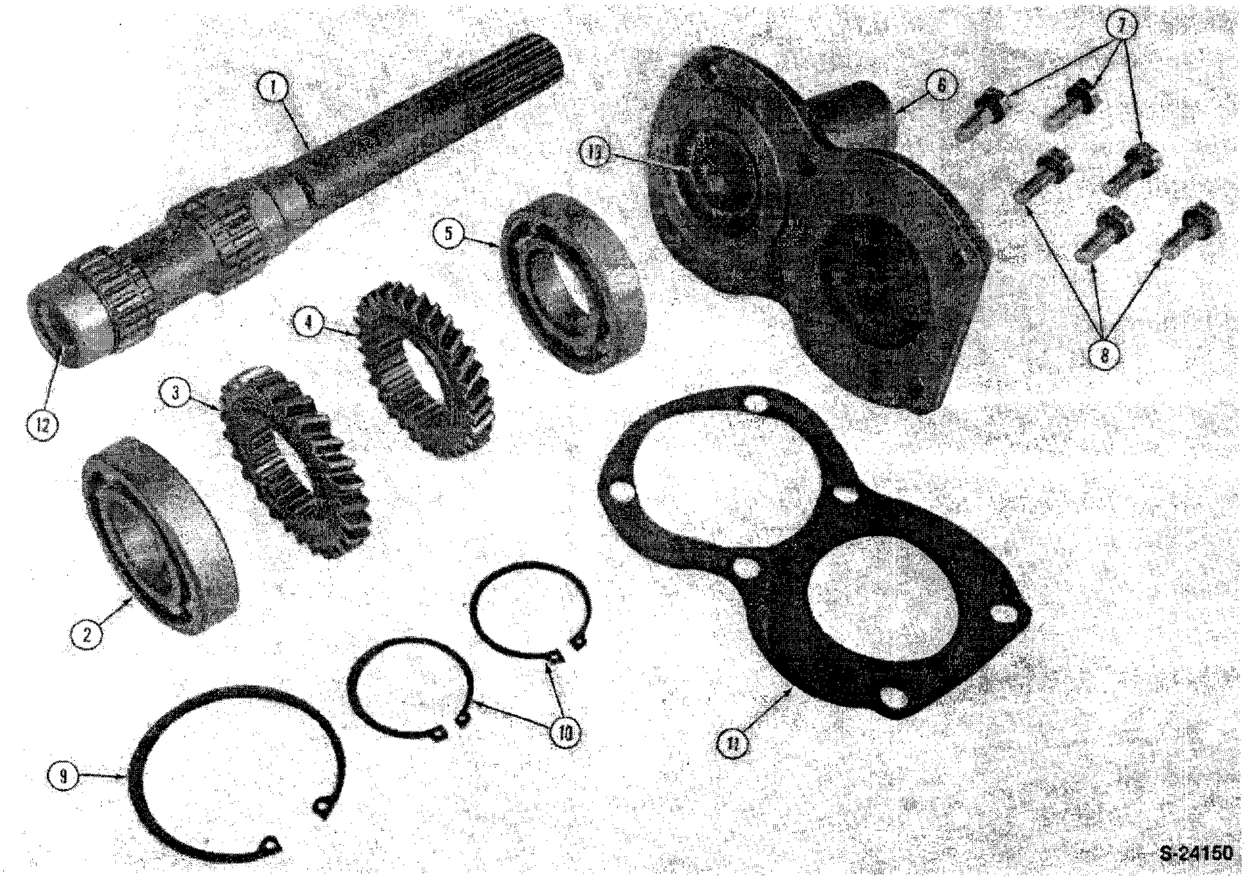

Figure 157
Input Shaft Assembly

1. Input Shaft
2. Bearing, Rear
3. Fixed Gear, Forward
4. Fixed Ger, Reverse
5. Bearing, Front
6. Retainer
7. Retainer, Bolts (6)
8. Seals (6)
9. Snap Ring, Rear
10. Snap Ring (2)
11. Gasket
12. Seal, Input Shaft
13. Seal, Retainer

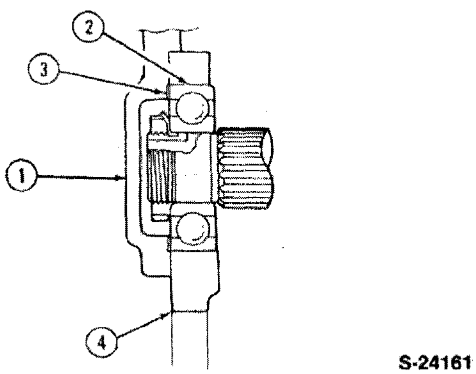

Figure 158
Main Countershaft End Float Adjustment

1. Retainer Assembly
2. Bearing
3. Shims
4. Transmission Case

RANGE COUNTERSHAFT ASSEMBLY
Reference — Figure 159

1. Position the range sliding gear (4), counter gear (3) and snap ring (6), in the bottom of the transmission housing.

2. Install the needle bearing (5), in the rear of the main countershaft.

3. Insert the countershaft from the rear through the gears (3 and 4), snap ring (6), and into the main countershaft.

4. Secure the counter gear with the snap ring (6).

5. If removed, install the rear bearing (2) and snap ring (7).

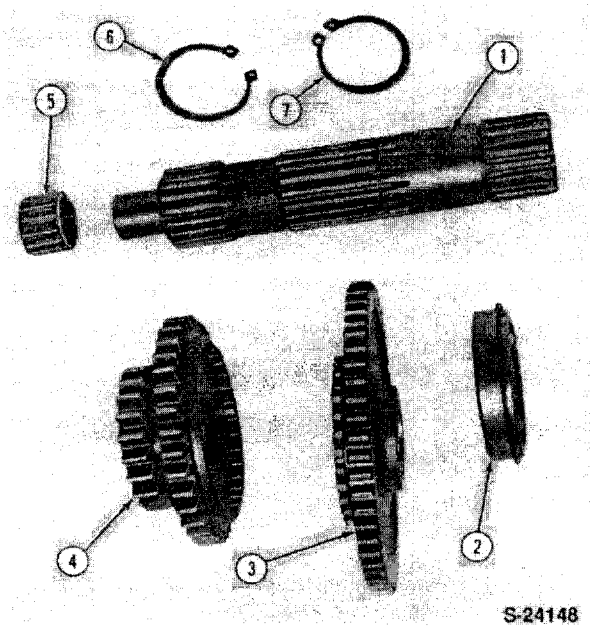

Figure 159
Range Countershaft Assembly

1. Countershaft, Range Gear
2. Bearing
3. Counter Gear
4. Sliding Gear
5. Needle Bearing
6. Snap Ring
7. Snap Ring

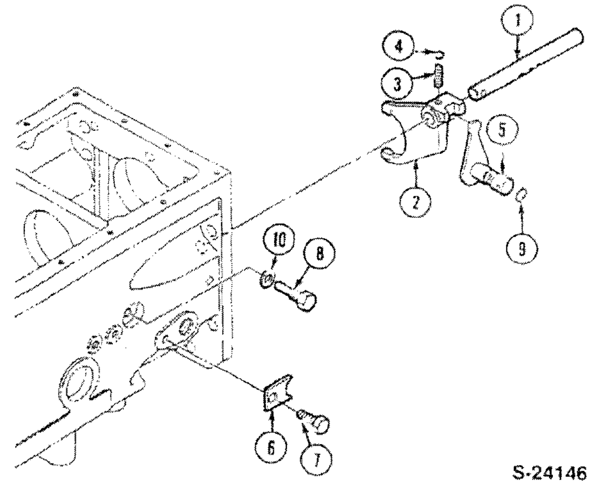

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Figure 160
Range Gear Shift Fork and Rail Assembly

1. Shift Rail
2. Fork
3. Detent Spring
4. Detent Ball
5. Shift Arm
6. Plate
7. Bolt
8. Retaining Bolt
9. O-Ring
10. Sealing Washer

RANGE SHIFT RAIL AND FORK ASSEMBLY
Reference — Figure 160

1. Install the shift arm (5) from inward of the case.
2. Install the detent spring (3) and ball (4) in the fork (2).
3. Position the fork in place.
4. While compressing the detent spring and ball, insert the rail from the rear through the fork.
5. Align the shift rail lock bolt counterbore and install retaining bolt (8) using a new sealing washer (10).
6. Install the plate (6) and bolt (7) to secure the shift arm.

MAIN SHAFT ASSEMBLY

1. Position the snap ring (1) in the housing as shown, Figure 161.

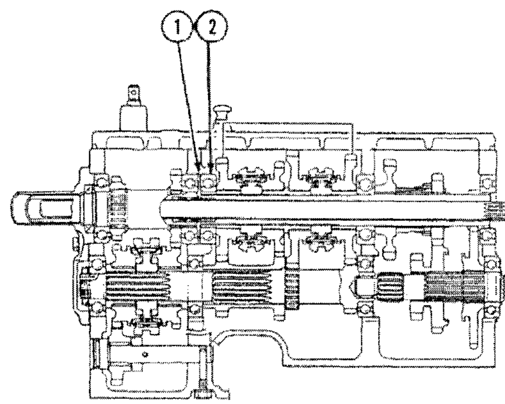

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Figure 161
Mainshaft Assembly

1. Snap Ring
2. Bearing

NOTE: *The snap ring (1) is used as a spacer only and is not positioned in a groove.*

2. Position the bearing (2) in the housing in place as shown, Figure 161.
3. Assemble the synchronizer gear, keys, coupling and retaining rings, Figure 162.

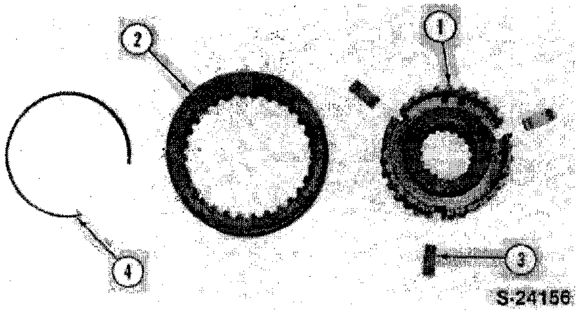

Figure 162
Synchronizer Gear Assembly

1. Gear
2. Coupling, Sliding
3. Keys (3)
4. Retaining Rings (2)

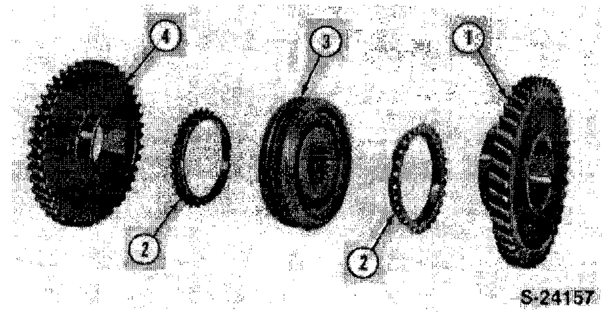

Figure 163
Synchronizer Assembly

1. Counter Gear (Forward)
2. Synchronizer Ring
3. Gear Assembly
4. Counter Gear (Reverse)

NOTE: *On assembly, be sure to align the coupling and gear matching marks made on disassembly.*

4. Assemble the synchronizer rings (2), counter gears (1 and 4) to the synchronizer gear assembly, Figure 163.

5. Position the fixed gears (3), collar (4), center bearing (5), and the two synchronizers (6 and 7) in place in the bottom of the housing.

6. Position the snap ring (11), Figure 164 on the shaft as shown, (6) Figure 165.

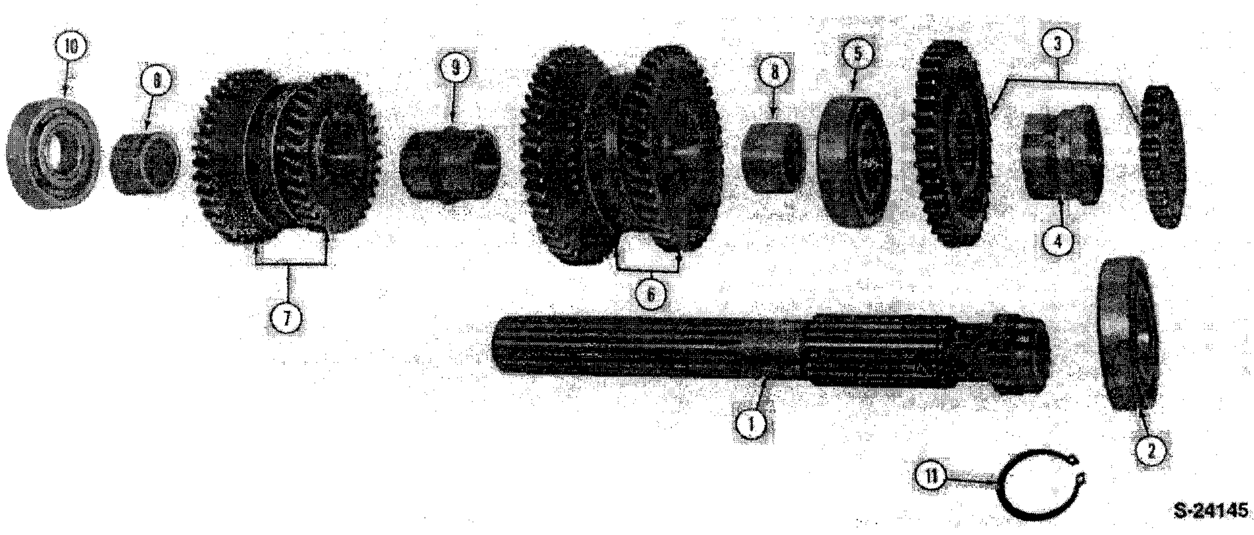

Figure 164
Main Shaft Assembly

1. Main Shaft
2. Rear Bearing
3. Fixed Range Gears
4. Adjustable Spacer
5. Bearing, Center
6. Synchronizer Assembly (1st-2nd)
7. Synchronizer Assembly (3rd-4th)
8. Collar
9. Collar
10. Bearing, Front
11. Snap Ring

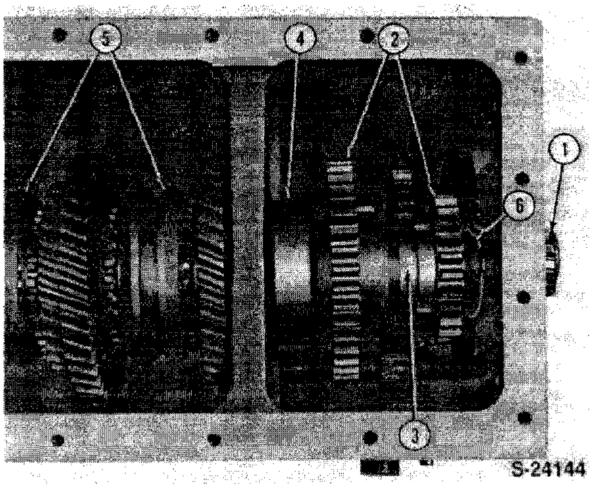

Figure 165
Main Shaft Assembly

1. Main Shaft
2. Fixed Gears
3. Adjustable Collar
4. Center Bearing
5. Synchronizer Assembly
6. Snap Ring

7. Insert the main shaft from the rear through the fixed gears, collar, center bearing and synchronizer assemblies and into the front bearing, Figure 165.

   NOTE: *The center bearing must remain loose on the shaft and not permitted to enter the case bore until the main shaft rear gear teeth are clear of the rear fixed range gear, as shown, Figure 165.*

8. Install the rear bearing (2), Figure 164.
9. Install the snap ring (11) in the shaft groove, Figure 164.
10. Insert the PTO drive shaft from the rear, through the main shaft and transmission input shaft.

   NOTE: *During installation of the PTO drive shaft, use care to not damage the oil seals in the input shaft.*

MAIN SHAFT END FLOAT ADJUSTMENT

If any of the main shaft components have been replaced, a new adjustable collar (3), Figure 165, must be used and the main shaft end float clearance checked and adjusted. To perform this check, the transmission case must be buckled up to the rear axle center housing.

1. Rotate the adjustment collar (1), Figure 166, to extend by hand until the end float clearance is zero and there is no pre-load on the shaft bearings.
2. After adjustment, bend the tab of the collar (nut) to prevent loosening.

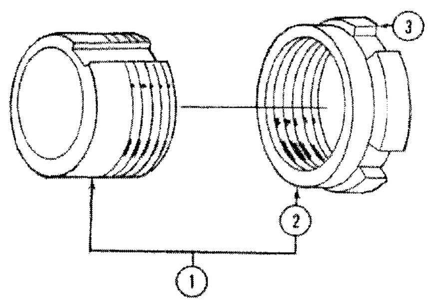

Figure 166
Adjustable Collar

1. Collar
2. Nut
3. Tub

MAIN SHIFT RAILS AND FORKS ASSEMBLY
Reference — Figures 167 and 168

1. Install the detent spring (13) and ball (12) in place as shown, Figure 168.
2. Position the fork (10) and boss (9) in the transmission case.
3. Insert the shift rail (8) from the front through the fork and boss.
4. Drive the roll pins (6 and 7) in to secure the fork and boss.
5. Position the shift rail (8) in neutral, and install the balk pin (11).
6. Position the fork (5) and boss (4), and insert the shift rail (3) from the front through the fork and boss.
7. Drive the roll pins in to secure the fork and boss.
8. Install the detent ball (2), spring (1) and plug (14).

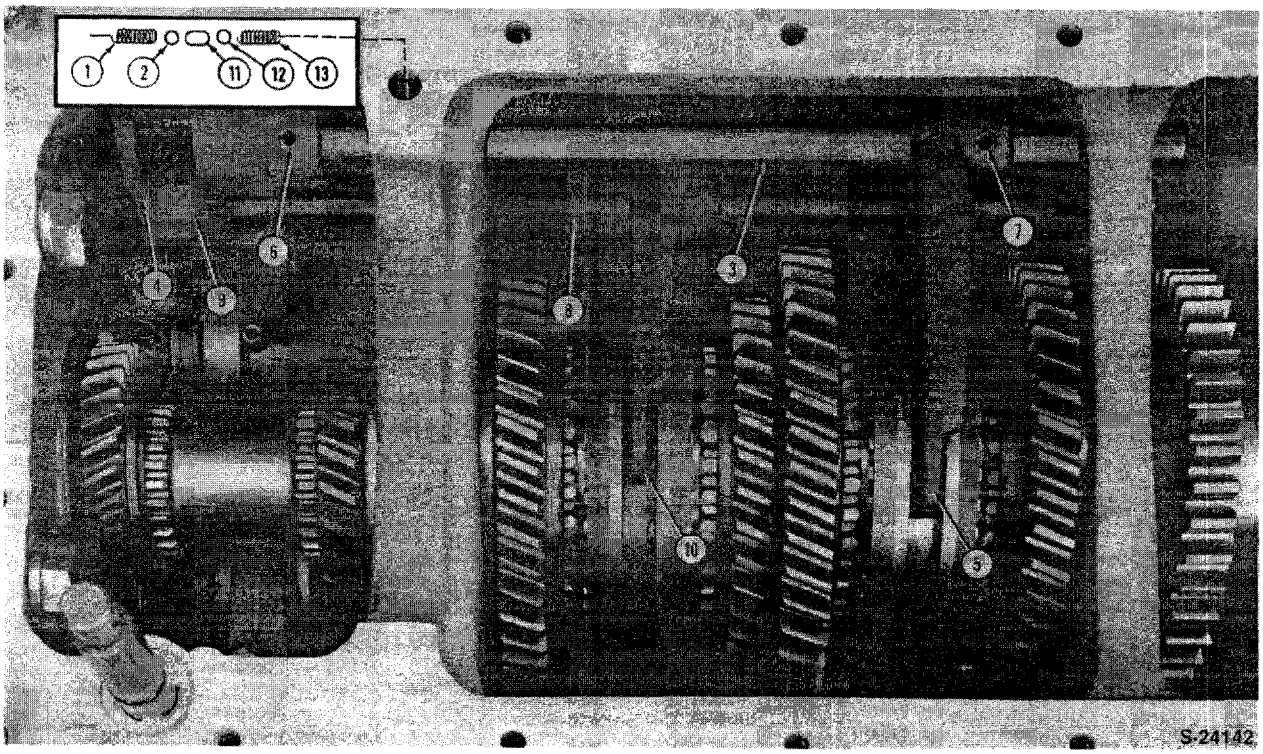

Figure 167
Main Shift Rails and Forks Assembly

1. Detent Spring
2. Detent Ball
3. Shift Rail (1st-2nd)
4. Shifter Boss
5. Shifter Fork (1st-2nd-Main)
6. Roll Pin
7. Roll Pin
8. Shift Rail (3rd-4th)
9. Shifter Boss
10. Shifter Fork (3rd-4th-Main)
11. Balk Pin
12. Detent Ball
13. Detent Spring

C. SHIFT LINKAGE OVERHAUL

Reference — Figures 169, 170, 171 and 172

The synchromesh shuttle transmission utilizes column mounted shift levers to control the four main gear speeds and the forward and reverse shuttle.

The main transmission control lever, Figure 169, is mounted on the right side of the steering column.

The shuttle control lever, Figure 170, is mounted on the left side of the steering column,

The control levers and linkage can be removed and disassembled using normal repair procedures. All of the linkage components, Figure 171, are serviced separately and may be replaced as needed.

The range gear shift lever is mounted on the left side of the tractor adjacent to the operators seat. The lever and linkage, Figure 172, are serviced individually as required using normal repair procedures.

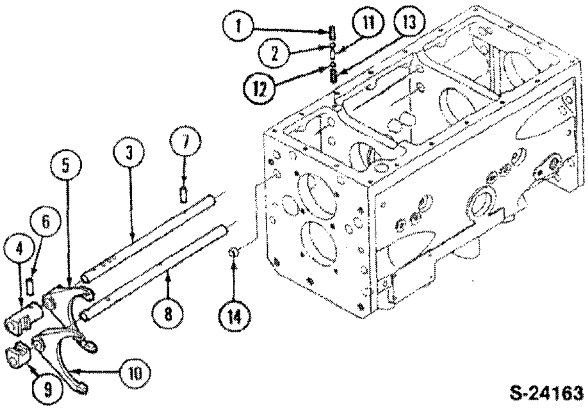

Figure 168
Main Shift Rails and Forks Assembly

1. Detent Spring
2. Detent Ball
3. Shift Rail (1st-2nd)
4. Shifter Boss
5. Shift Fork (1st-2nd-Main)
6. Roll Pin
7. Roll Pin
8. Shift Rail (3rd-4th)
9. Shifter Boss
10. Shift Fork (3rd-4th-Main)
11. Balk Pin
12. Detent Ball
13. Detent Spring
14. Rubber Plug

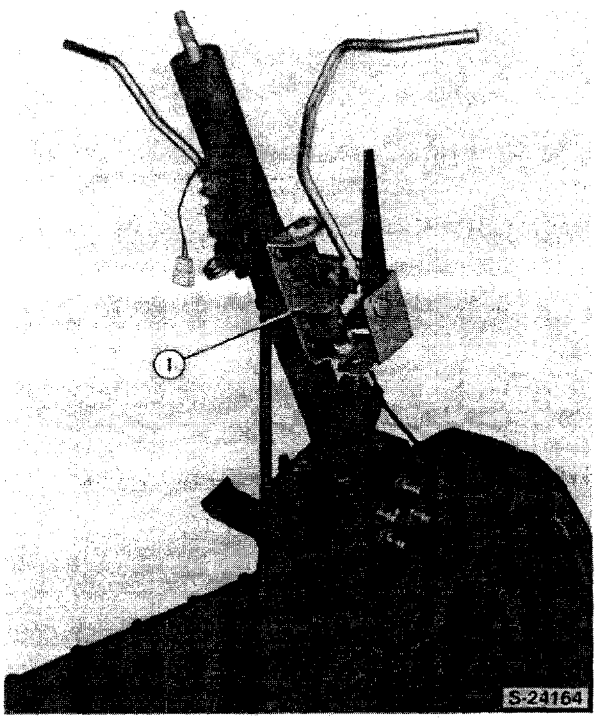

Figure 169
Main Shift Lever and Linkage

1. Main Gear Shift Linkage

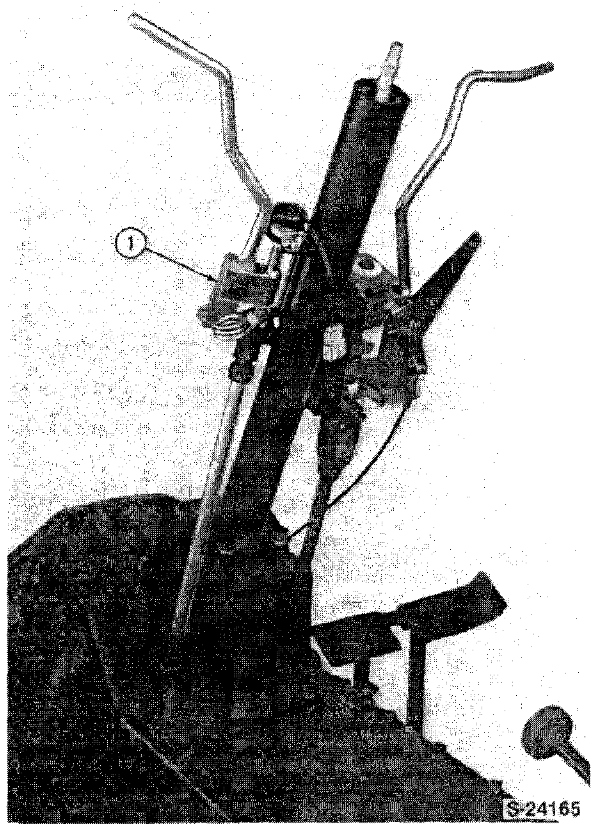

Figure 170
Shuttle Shift Lever and Linkage

1. Shuttle Gear Shift Linkage

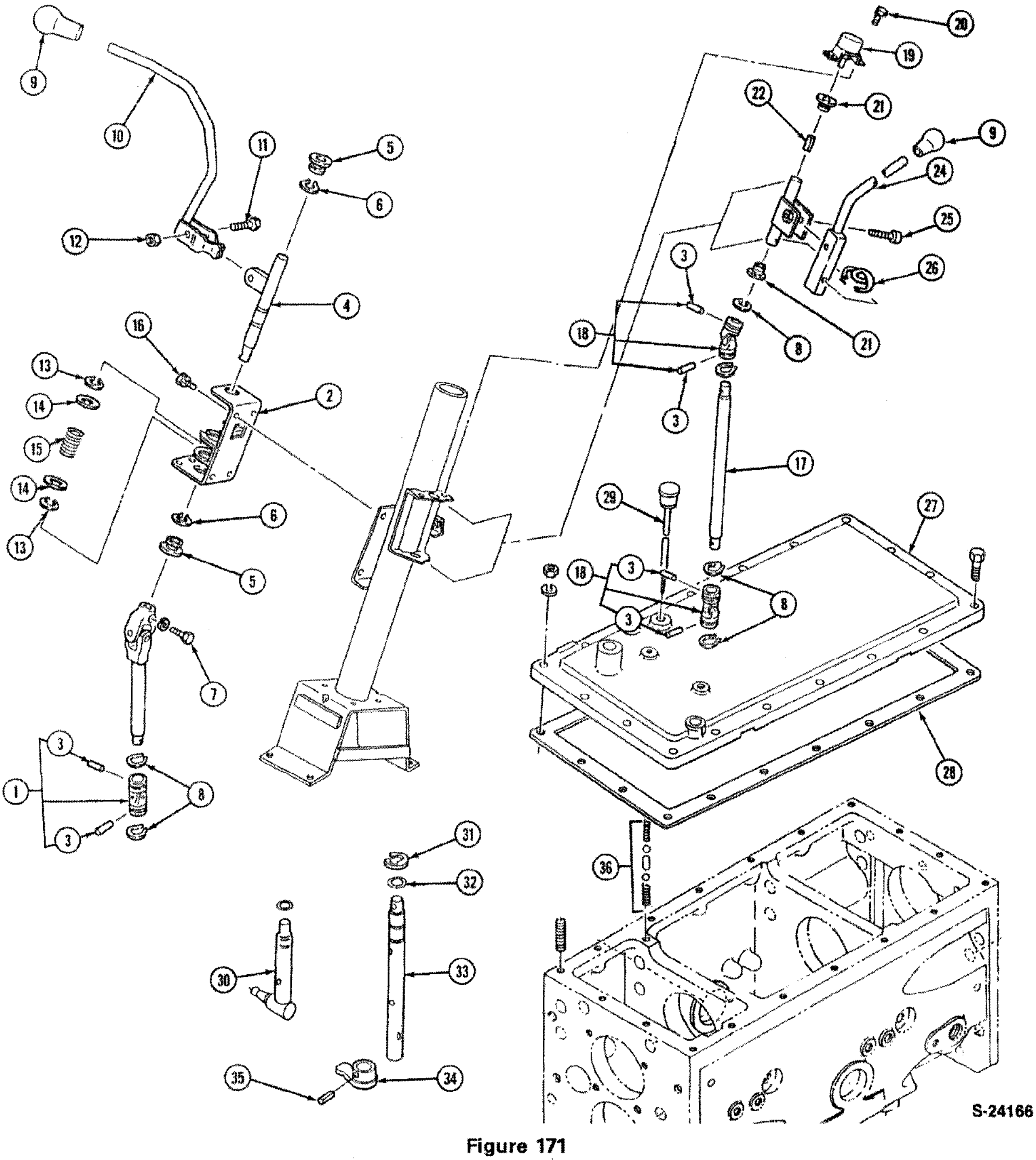

Figure 171
Synchromesh 12 x 12 Shuttle Transmission Shift Linkage Components

Figure 171
Synchromesh 12 x 12 Shuttle Transmission Shift Linkage Components (Cont'd.)

1. Link Assembly — Main
2. Holder
3. Pin
4. Shift Arm
5. Bushing
6. Snap Ring
7. Bolt Tightening Torque: 26.8-31.3 lbs. ft. (36.3-42.0 Nm)
8. Snap Ring
9. Grip
10. Change Lever — Main
11. Bolt
12. U-Nut
13. Snap Ring
14. Washer
15. Spring
16. Bolt
17. Shift Link — Shuttle
18. Joint
19. Switch — Neutral Start
20. Bolt
21. Bushing
22. Roll Pin
23. Shift Arm
24. Change Lever — Shuttle
25. Bolt
26. Spring
27. Transmission Case Top Cover
28. Gasket
29. Dipstick — Oil Level
30. Shift Arm — Main
31. "C" Clip Ring
32. O-Ring
33. Shaft — Shift Arm
34. Shift Arm
35. Roll Pin
36. Detent Assembly

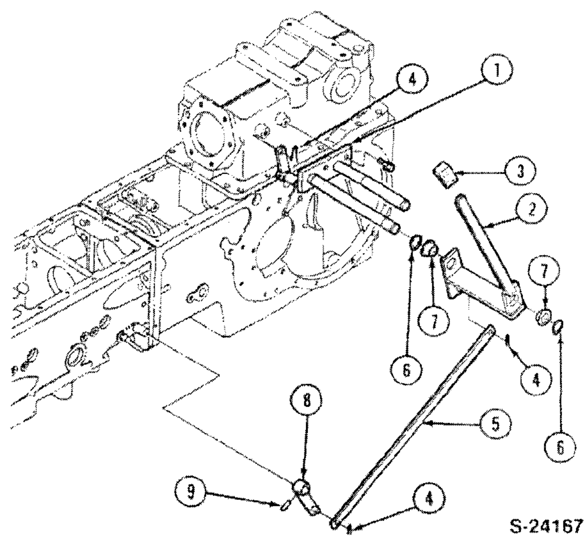

Figure 172
Range Shift Lever Linkage Assembly

1. Shift Guide
2. Change Lever — Range
3. Grip
4. Cotter Pin
5. Shift Plate
6. Snap Ring
7. Bushing
8. Change Lever
9. Roll Pin

PART 5
TRANSMISSION SYSTEMS

Chapter 7
CREEPER GEAR OPTION — MODEL 1720

A. DESCRIPTION AND OPERATION

The creeper reduction gear is available as a factory installed option on the Model 1720 tractor equipped with either the standard gear or shuttle synchromesh gear transmission.

The creeper gear option provides a 12.3:1 speed reduction to the main transmission and provides an additional 12 forward and 4 reverse speeds.

Tractors equipped with the creeper gear option have a total of 24 forward and 8 reverse gear speeds on the standard gear transmission.

On the shuttle synchromesh gear transmission, the crreper gear option provides an additional 12 forward and 12 reverse speeds. Tractors equipped with the creeper option have a total of 24 forward and 24 reverse gear speeds.

See Figures 173 and 174 for ground speed charts for each transmission type.

GROUND SPEED CHARTS
NON-SYNCHROMESH TRANSMISSION

STANDARD TRANSMISSION

REAR TIRE SIZE			11.2-24		12.4-24	
GEAR	RANGE SHIFT	MAIN SHIFT	mph	kph	mph	kph
1	1	1	0.744	1.197	0.779	1.254
2		2	0.987	1.588	1.033	1.663
3		3	1.232	1.984	1.291	2.078
4	2	1	1.724	2.775	1.806	2.907
5		2	2.288	3.682	2.396	3.856
6		3	2.858	4.599	2.993	4.817
7	3	1	3.836	6.173	4.017	6.465
8		2	5.089	8.190	5.330	8.578
9		3	6.357	10.730	6.658	10.715
10	4	1	7.672	12.346	8.035	12.931
11		2	10.178	16.380	10.660	17.155
12		3	12.714	20.461	13.316	21.430
1	1	R	1.069	1.721	1.120	1.803
2	2		2.479	3.990	2.597	4.179
3	3		5.515	8.876	5.776	9.296
4	4		11.031	17.752	11.553	18.593

*Engine Speed 2500 rpm

CREEPER GEAR OPTION

REAR TIRE SIZE			11.2-24		12.4-24	
GEAR	RANGE SHIFT	MAIN SHIFT	mph	kph	mph	kph
1	1	1	0.060	0.097	0.063	0.102
2		2	0.080	0.129	0.084	0.135
3		3	0.100	0.161	0.105	0.169
4	2	1	0.140	0.225	0.146	0.236
5		2	0.186	0.299	0.194	0.313
6		3	0.232	0.374	0.243	0.391
7	3	1	0.312	0.502	0.326	0.526
8		2	0.414	0.666	0.433	0.697
9		3	0.517	0.832	0.541	0.871
10	4	1	0.624	1.004	0.653	1.051
11		2	0.827	1.332	0.867	1.395
12		3	1.034	1.664	1.083	1.743
1	1	R	0.087	0.140	0.091	0.146
2	2		0.201	0.324	0.211	0.340
3	3		0.448	0.722	0.469	0.756
4	4		0.897	1.444	0.939	1.512

*Engine Speed 2500 rpm

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Figure 173

GROUND SPEED CHARTS
SYNCHROMESH SHUTTLE TRANSMISSION

			FORWARD				REVERSE			
REAR TIRE SIZE			11.2-24		12.4-24		11.2-24		12.4-24	
GEAR	RANGE SHIFT	MAIN SHIFT	mph	kph	mph	kph	mph	kph	mph	kph
1	1	1	0.832	1.339	0.871	1.403	0.933	1.501	0.977	1.572
2		2	1.060	1.707	1.111	1.788	1.189	1.913	1.245	2.004
3		3	1.325	2.133	1.388	2.234	1.485	2.390	1.555	3.504
4		4	1.750	2.817	1.833	2.950	1.962	3.157	2.055	3.307
5	2	1	2.259	3.636	2.366	3.808	2.532	4.075	2.652	4.268
6		2	2.879	4.634	3.015	4.853	3.227	5.194	3.380	5.440
7		3	3.597	5.789	3.767	6.063	4.032	6.489	4.223	6.796
8		4	4.751	7.647	4.976	8.009	5.326	8.571	5.578	8.977
9	3	1	5.874	9.454	6.152	9.902	6.584	10.597	6.891	11.099
10		2	7.486	12.048	7.841	12.619	8.391	13.505	8.789	14.144
11		3	9.353	15.052	9.796	15.765	10.483	16.872	10.980	17.670
12		4	12.354	19.882	12.939	20.823	13.847	22.285	14.503	23.340

*Engine Speed 2500 rpm

STANDARD TRANSMISSION

			FORWARD				REVERSE			
REAR TIRE SIZE			11.2-24		12.4-24		11.2-24		12.4-24	
GEAR	RANGE SHIFT	MAIN SHIFT	mph	kph	mph	kph	mph	kph	mph	kph
1	1	1	0.067	0.109	0.070	0.114	0.075	0.122	0.079	0.128
2		2	0.086	0.138	0.090	0.145	0.096	0.155	0.101	0.163
3		3	0.107	0.173	0.112	0.181	0.120	0.194	0.126	0.203
4		4	0.142	0.229	0.149	0.340	0.159	0.256	0.167	0.269
5	2	1	0.183	0.295	0.192	0.309	0.206	0.331	0.215	0.347
6		2	0.234	0.377	0.245	0.394	0.262	0.422	0.275	0.442
7		3	0.292	0.471	0.306	0.493	0.328	0.527	0.343	0.552
8		4	0.386	0.622	0.404	0.651	0.433	0.697	0.453	0.730
9	3	1	0.477	0.769	0.500	0.805	0.535	0.862	0.561	0.902
10		2	0.609	0.980	0.637	1.026	0.682	1.098	0.714	1.150
11		3	0.760	1.224	0.796	1.282	0.852	1.372	0.893	1.437
12		4	1.004	1.617	1.052	1.693	1.126	1.812	1.179	1.898

*Engine Speed 2500 rpm

CREEPER GEAR OPTION

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Figure 174
Creeper Gear Option

The creeper gear consists of a sliding gear (2), Figure 175, mounted on the drive pinion shaft and one idler gear mounted on the PTO countershaft.

When the creeper control lever is moved to the standard gear position (down), the shifter fork is moved forward and couples the sliding gear (2) directly to the transmission main shaft (1). This couples the main shaft to the drive pinion to provide standard drive.

When the creeper control lever is moved to the creeper engaged position (up), the sliding gear is moved rearward engaging the countershaft gear (16).

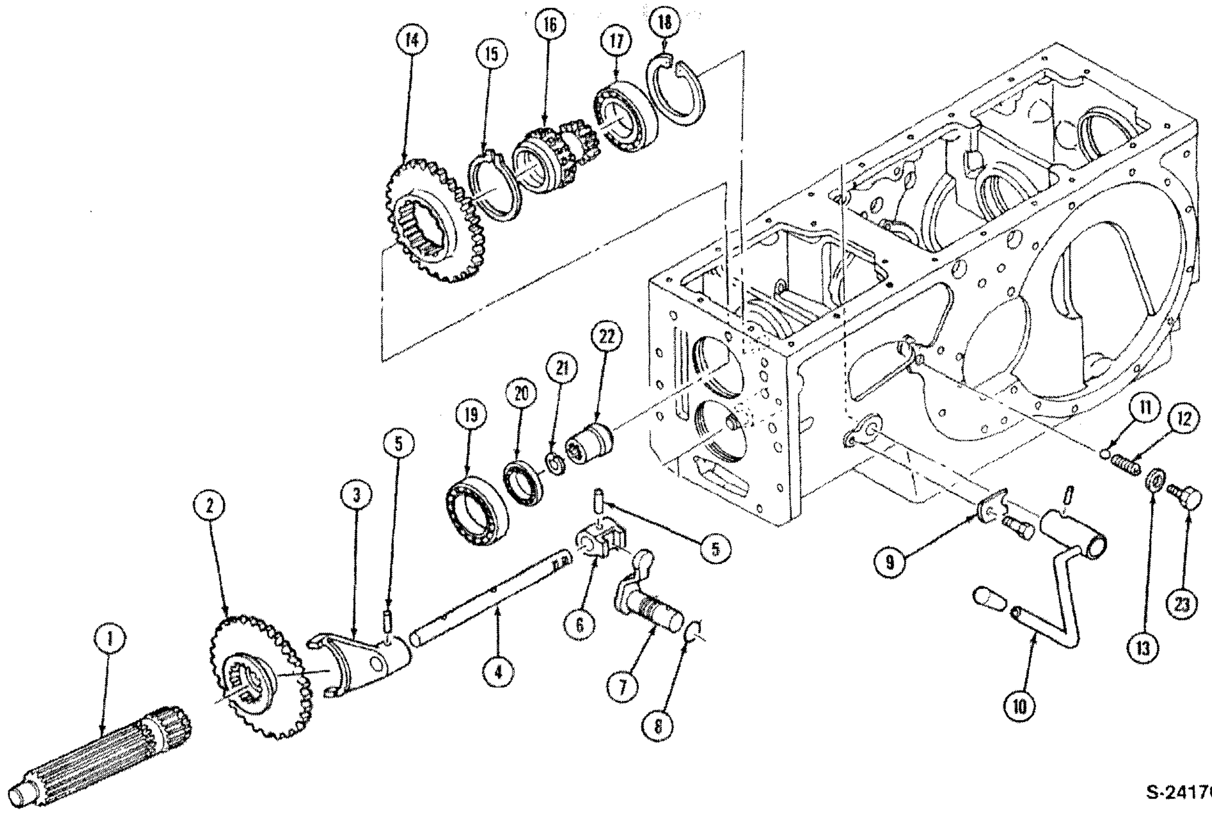

Figure 175
Creeper Gear Overhaul

1. Rear Main Shaft
2. Sliding Gear
3. Fork
4. Shift Rail
5. Roll Pin
6. Boss
7. Shift Arm
8. O-Ring
9. Plate
10. Shift Lever
11. Detent Ball
12. Detent Spring
13. Seal Washer
14. Idler Gear
15. Snap Ring
16. Counter Gear
17. Bearing
18. Snap Ring
19. Bearing
20. Bearing
21. Snap Ring
22. Coupler
23. Bolt

Power then flows from the transmission main shaft (1) to the idler gear (14), to the countershaft gear (16) to the sliding gear (2), which is splined to the drive pinion shaft, thus reducing speed at the final drive.

B.OVERHAUL

REMOVAL

Separate the tractor between the transmission and rear axle center housing. See "Separating the Tractor," Part 12.

DISASSEMBLY

Reference — Figure 175

1. Remove the PTO coupler (22) and inner bearing from the forward end of the PTO countershaft.

2. Remove the transmission top cover.

3. Remove the snap ring (15) from the groove and slide the idler gear (14) rearward.

4. Gently drive the PTO countershaft forward and remove it from the center housing. Remove the idler gear and snap ring from the top of the housing.

5. Remove the sliding gear (2) from the drive pinion shaft.

SHIFT RAIL AND FORK REMOVAL
Reference — Figure 175

1. Remove the detent retaining bolt and remove the detent spring and ball (11 and 12).
2. Drive the roll pin out of the shift lever (10) and remove the lever.
3. Drive the roll pins out of the shift fork (3) and shifter boss (6).
4. Slide the shift rail forward and remove the fork and boss from the housing.
5. Remove the shift arm retaining plate (9) and remove the shift arm (7) from the housing.

INSPECTION

1. Clean all components in a suitable solvent and air dry.
2. Inspect the gears for excess wear or damage.
3. Check the bearings for excess wear or damage by slowly rotating the bearings by hand.
4. Inspect the shift rail for worn detent gears.
5. Inspect the detent ball and spring for excess wear or damage.
6. Inspect the shift fork for excess wear or the pads for bent fingers.

ASSEMBLY
Reference — Figure 175

Assembly of the creeper gear components generally follows the disassembly procedure in reverse order.

1. Install the sliding gear (2) onto the pinion shaft.
2. If removed, install the rear bearing (17) and snap ring (18).
3. Position the idler gear (14) and snap ring (15) and insert the countershaft through the idler gear and snap ring from the front.
4. Secure the idler gear with snap ring.
5. Install the top cover of the rear axle center housing.
6. Install the PTO coupler (22) with inner bearing from the front into the PTO countershaft.
7. Install the shift arm from inside using a new O-ring and install the shift arm retaining plate (9).
8. Position the fork and boss in place.
9. Install the shift rail through the fork and boss from the front and drive the roll pin into the fork and boss.
10. Install the shift lever and drive the roll pin into the shift lever.
11. Install the detent ball, spring and retaining bolt.
12. Complete the assembly of the tractor. See "Separating the Tractor," Part 12.

PART 5
TRANSMISSION SYSTEMS

Chapter 8
TROUBLE SHOOTING AND SPECIFICATIONS

A. TROUBLE SHOOTING

CONDITION	CAUSE	REMEDY
Gear oil leakage	(1) Excessive gear oil	Adjust the oil amount to the specified level on the oil dipstick.
	(2) Loosened bolts	Retighten.
	(3) Worn oil seal or O-ring	Replace the oil seal or O-ring.
	(4) Defective gasket	Replace gasket.
	(5) Cracked transmission housing	Replace the transmission housing.
Abnormal sound	(1) Worn bearing	Inspect and replace.
	(2) Excessive gear backlash	Adjust or replace.
	(3) Worn gears	Replace.
	(4) Gears improperly engaged	Adjust or replace.
	(5) Oil level low	Fill as required.
Gears not engaged	(1) Damaged shift lever	Replace.
	(2) Bent or damaged shifter fork or shifter rod	Correct or replace.
	(3) Clutch is not disengaged	Refer to Chapter 2 in this Part.
Gears disengaged	(1) Damaged spring	Replace.
	(2) Worn detent groove ball on the shifter rod	Replace the shifter rod.
	(3) Uneven gear wear	Replace.
	(4) Shifter rod detent ball worn	Replace.
Gears not disengaged	(1) Bent shifter rod	Correct or replace.
	(2) Foreign matter locked in gears	Remove the foreign matter.
	(3) Dragging clutch	Replace the clutch.

B. SPECIFICATIONS

9 x 3 GEAR TRANSMISSION
MODEL 1320-1520

Gear Backlash	.0016-.0063 in. (0.04-0.16 mm)
Wear Limit	.0236 in. (0.6 mm)
Clearance Between Slide Gear and Shifter Fork	.008-.016 in. (0.2-0.4 mm)
Wear Limit	.0394 in. (1.0 mm)
Clearance Between Shifter Rod and Housing Bearing	.00118-.0039 in. (0.03-0.1 mm)
Wear Limit	.0018 in. (0.3 mm)

HYDROSTATIC TRANSMISSION
MODEL 1320-1520

Type	HVFD - 23C 23-M3
Theoretical displacement of the pump	0-1.41 cu. in./rev. (0-23.4 cc/rev.)
Theoretical displacement of the motor	1.41 cu. in./rev. (23.4 cc/rev.)
Theoretical displacement of the charge pump	.38 cu. in./rev. (6.2 cc/rev.)
Maximum input speed	2700 rpm
High pressure relief valve	3981 psi (274 bars)
Output Speed	2510 rpm - at 2133 psi (147 bars)
Output Torque	59 lbs. ft. (79 Nm) at (274 bars), 3981 psi
Charge pump relief valve	61-81 psi (4.2-5.5 bars) at 2500 rpm
Swash plate tilt angle (pump)	0-18 degree
Swash plate tilt angle (motor)	18 degree
Operating moment	Max. 13 lbs. ft. (17.6 Nm) N = 1000 260 rpm hp = 50 200 kg/cm²

NON-SYNCHROMESH 12 x 4 GEAR TRANSMISSION
MODEL 1720

Gear Backlash	.0016-.0063 in. (0.04-0.16 mm)
Allowable Backlash	.0236 in. (0.6 mm)
Clearance Between Slide Gear and Shifter Fork	.008-.016 in. (0.2-0.4 mm)
Allowable Clearance Limit	.0394 in. (1.0 mm)
Clearance Between Shifter Rod and Housing Bearing	.00118-.0039 in. (0.03-0.1 mm)
Allowable Clearance Limit	.0118 in. (0.3 mm)

SYNCHROMESH 12 x 12 SHUTTLE TRANSMISSION
MODEL 1720

Gear Backlash	.0016-.0063 in. (.04-.16 mm)
Allowable Backlash	.0236 in. (0.6 mm)
Clearance Between Slide Gear and Shifter Fork	.008-.016 in. (0.2-0.4 mm)
Allowable Clearance Limit	.039 in. (1.0 mm)
Clearance Between Synchronizer Ring and Gear	.059 in. (1.5 mm)
Allowable Clearance Limit	.031 in. (0.8 mm)

BOLT TORQUES

Hydrostatic Transmission Cover Screws .... 1.4-1.9 lbs. ft. (2-2.5 Nm)
Charge Pump Housing Bolts .... 12-14 lbs. ft.)16-19 Nm)
Hydrostatic Transmission Port Block Retaining Bolts .... 23-28 lbs. ft. (31-38 Nm)

GENERAL

BOLT TORQUE SPECIFICATIONS

Bolt Size	Grade No.	Coarse Thread			Fine Thread		
		Pitch (mm)	Pounds-Feet	Newton-Meters	Pitch (mm)	Pounds-Feet	Newton-Meters
M6	4T	1.0	3.6-5.1	4.9-6.9	—	—	—
	7T		6.1-8.3	8.3-11.3			
	10T		8.7-11.6	11.8-15.7			
M8	4T	1.25	9.4-12.3	12.7-16.7	1.0	11.2-14.8	15.2-20.1
	7T		16.6-21.0	22.6-28.4		19.5-25.3	26.5-34.3
	10T		21.0-26.8	28.4-36.3		22.4-29.7	30.4-40.2
M10	4T	1.5	18.8-24.6	25.5-33.3	1.25	21.0-26.8	28.4-36.3
	7T		32.5-41.2	44.1-55.9		36.2-46.3	49.0-62.8
	10T		39.8-51.4	53.9-69.9		42.7-54.2	57.9-73.5
M12	4T	1.75	27.5-34.7	37.3-47.1	1.25	31.8-40.5	43.1-54.9
	7T		48.5-61.5	65.7-83.4		55.0-69.4	74.5-94.1
	10T		68.0-85.4	92.9-116		73.1-93.3	99.0-127
M14	4T	2.0	46.3-59.3	62.8-80.4	1.5	51.4-64.4	69.6 87.3
	7T		76.7-96.9	104-131		86.1-109	117-148
	11T		102-129	139-175		108-137	147-186
M16	4T	2.0	63.6-81.0	86.3-110	1.5	67.3-84.6	91.3-115
	7T		110-136	149-184		116-142	157-192
	11T		152-188	206-255		163-199	221-270
M18	4T	2.0	83.9-104	114-141	1.5	95.9-120	313-163
	7T		145-174	196-235		170-206	131-279
	11T		203-246	275-333		221-271	299-368
M20	4T	2.5	106-132	144-179	1.5	127-156	172-211
	7T		177-213	240-289		203-246	275-333
	11T		268-325	363-441		293-358	397-485

PART 6
POWER TAKE-OFF SYSTEMS

Chapter 1
POWER TAKE-OFF SYSTEMS
MODEL 1320-1520

Chapter 2
MID-MOUNT POWER TAKE-OFF
MODEL 1320-1520

Chapter 3
POWER TAKE-OFF SYSTEMS
MODEL 1720

Chapter 4
SPECIFICATIONS

PART 6
POWER TAKE-OFF SYSTEMS

Chapter 1
POWER TAKE-OFF SYSTEMS

A. TRANSMISSION DRIVE POWER TAKE-OFF — DESCRIPTION AND OPERATION

9 x 3 GEAR TRANSMISSION — SINGLE CLUTCH

The model 1320-1520 tractors equipped with the 9 x 3 gear transmission has a single clutch 540 rpm transmission drive power take-off system.

The PTO is driven from the flywheel clutch and transmission input shaft. A gear on the input shaft is in constant mesh with the splined gear (2) on the transmission countershaft (3), Figure 1.

The transmission countershaft is in constant mesh with the gear (4) on the front PTO countershaft and drives the countershafts (5, 11, and 8), Figure 1.

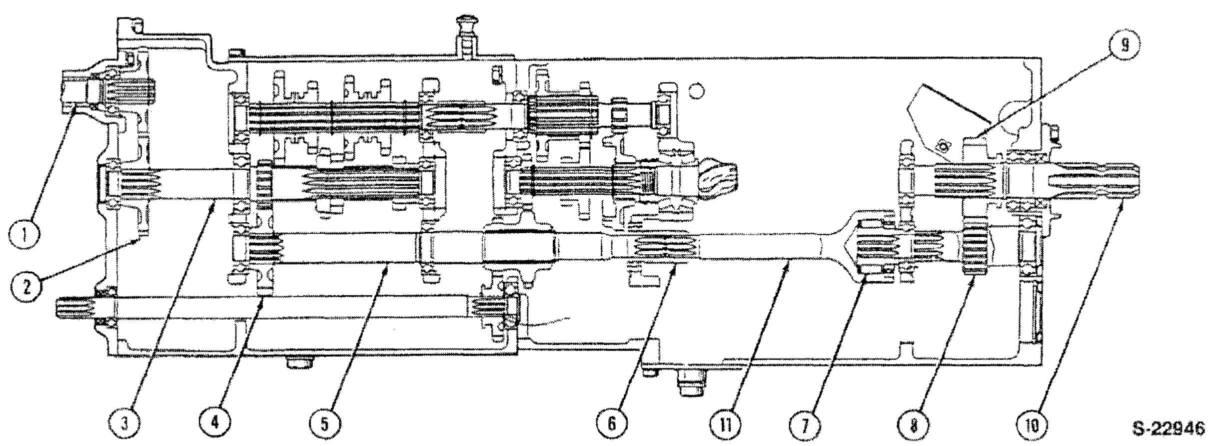

Figure 1
Power Take-Off Drive — 9 x 3 Transmission — Single Clutch

1. Input Shaft
2. Transmission Countershaft Gear
3. Transmission Countershaft
4. PTO Countershaft Gear
5. Front PTO Countershaft
6. Coupling
7. One-Way Clutch
8. PTO Rear Countershaft
9. PTO Sliding Gear
10. PTO Output Shaft
11. Center PTO Countershaft

A sliding gear (9) on the PTO output shaft engages and disengages the rear PTO countershaft.

A one-way clutch (7), Figure 1, is utilized on the 9 x 3 gear transmission.

The one-way clutch assembly provides a positive drive in one direction only and free wheels in the opposite direction. The one-way clutch prevents the power take-off equipment from transmitting power back into the PTO driveline with possible damage to the tractor.

NOTE: *Tractors equipped with the double clutch (Live PTO) and hydrostatic transmissions do not have a one-way clutch in the drive line.*

The one-way clutch, Figure 2, consists of an inner and outer race and a one-way bearing. The inner race is splined to the rear PTO countershaft and the outer race is an integral part of the center PTO countershaft.

When power is transmitted to the PTO countershaft, the one-way bearing locks up and drives the PTO rear countershaft.

In operation, when the transmission clutch is being disengaged, the momentum of the PTO equipment will cause the output shaft to continue to rotate and will cause the one-way clutch inner race to rotate faster than the center PTO countershaft and the one-way bearing will free wheel.

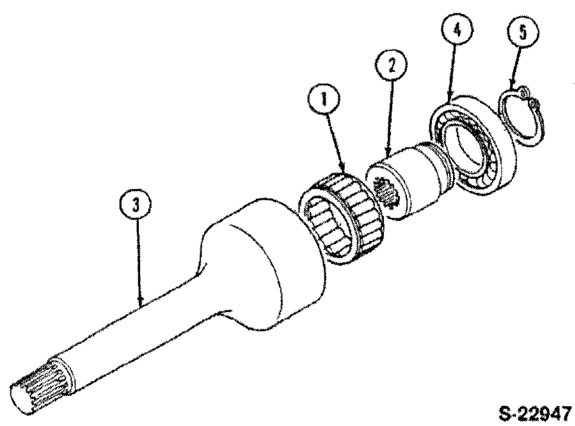

Figure 2
One-Way Clutch

1. One-Way Bearing
2. Inner Race
3. Outer Race (Center PTO Countershaft)
4. Ball Bearing
5. Snap Ring

The transmission drive power take-off can be operated only while the transmission clutch and PTO selector lever are in the engaged position. To engage the PTO, fully depress the clutch pedal and then engage the PTO selector lever. Release the clutch pedal and the PTO shaft will start to rotate. To disengage the PTO, fully depress the clutch pedal and push the PTO selector lever forward (down).

B. LIVE POWER TAKE-OFF — DESCRIPTION AND OPERATION

The live power take-off is optional equipment on the Models 1320 and 1520 tractors equiped with the standard 9 x 3 gear transmission.

The power take-off drive, Figure 3, is taken from a second clutch disc on the flywheel clutch through a separate power take-off input shaft. The power take-off input shaft incorporates a gear which is in constant mesh with the PTO upper countershaft gear.

The PTO upper countershaft is in constant mesh with the front PTO countershaft gear.

The front PTO countershaft extends out the rear of the transmission assembly and is splined by a coupling to the center PTO countershaft.

The center PTO countershaft is splined by a coupling to the PTO rear countershaft.

A sliding gear on the PTO output shaft engages and disengages the PTO rear countershaft.

NOTE: *When the clutch pedal is depressed half way to facilitate gear changes, the PTO drive is maintained without interruption. Depressing the clutch pedal fully will stop the power take-off. To disengage the PTO, the clutch pedal must be fully depressed and the selector lever moved fully forward (down).*

C. POWER TAKE-OFF DRIVE — HYDROSTATIC TRANSMISSION — DESCRIPTION AND OPERATION

On the hydrostatic transmission, the power is taken from the flywheel clutch and is transmitted by a direct shaft through the hydrostatic unit to the transmission gear box, Figure 4. Power flows through a set of reduction gears in the gear box to a countershaft in the rear axle center housing, Figure 5.

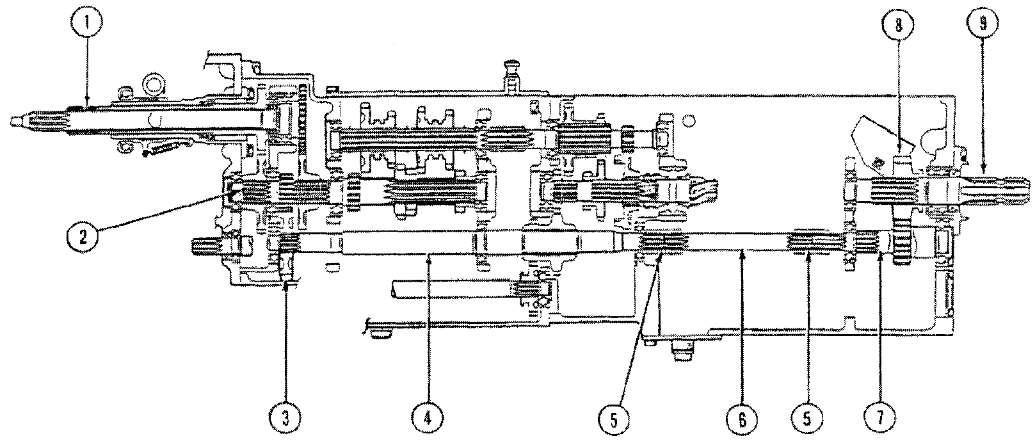

Figure 3
Power Take-Off Drive — 9 x 3 Transmission, Live PTO

1. PTO — Input Shaft
2. PTO Upper Countershaft
3. Front PTO Countershaft Gear
4. Front PTO Countershaft
5. Coupling
6. Middle PTO countershaft
7. Rear PTO Countershaft
8. Sliding Gear
9. Output Shaft

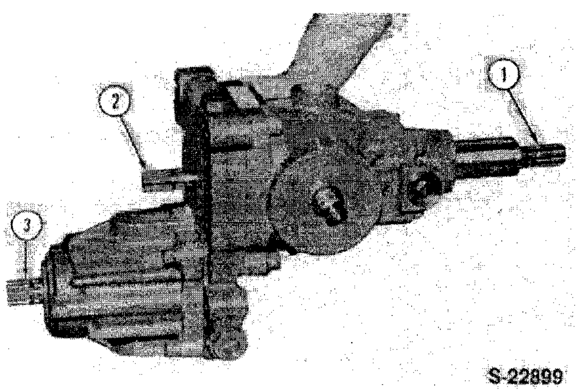

Figure 4
Hydrostatic Transmission PTO

1. Input Shaft
2. PTO Drive
3. Transmission Drive

The power take-off can be operated only while the transmission clutch and PTO selector levers are in the engaged position. To engage the PTO, fully depress the clutch pedal and then engage the PTO selector lever. Release the clutch pedal and the PTO shaft will start to rotate. To disengage the PTO, fully depress the clutch pedal and push the PTO selector lever forward (down).

D. POWER TAKE-OFF — OVERHAUL

REMOVAL

Separate the tractor between the transmission and the rear axle center housing. See "SEPARATING THE TRACTOR" PART 12.

POWER TAKE-OFF OUTPUT SHAFT — REMOVAL

Reference — Figure 6

1. Remove the bracket (12).
2. Remove the four rear cover retaining bolts and remove the cover and seal assembly (9).
3. Drive the output shaft out the rear while supporting the sliding gear.
4. Remove the sliding gear through the top of the case.

POWER TAKE-OFF CENTER COUNTERSHAFT — REMOVAL

Reference — Figure 7

1. Slide the center countershaft forward and remove it out the top of the case.

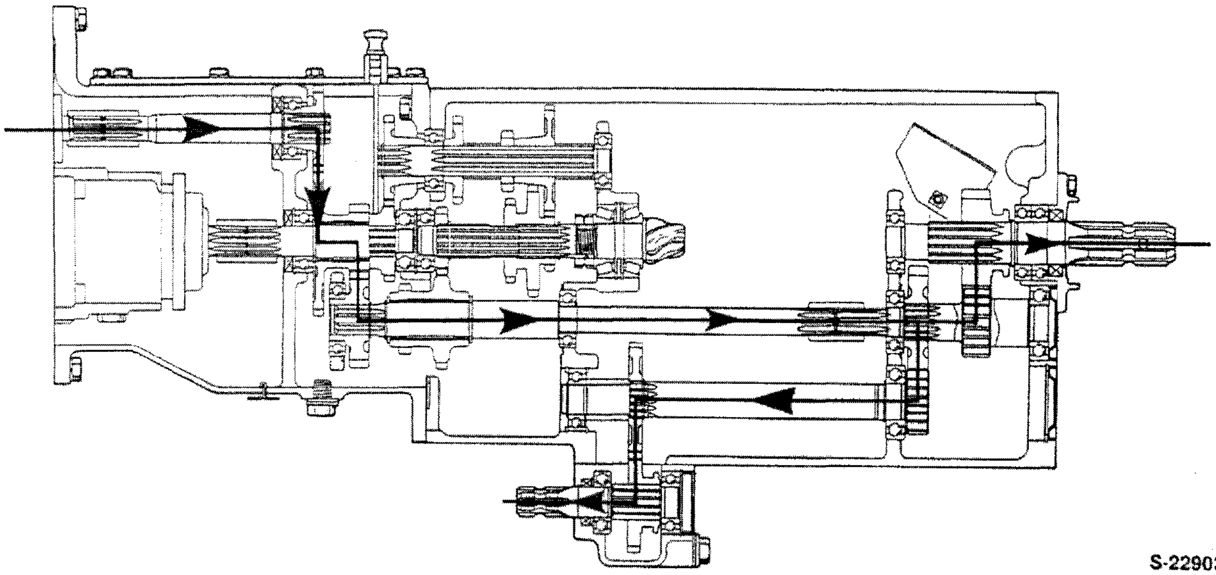

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Figure 5
Power Flow — Hydrostatic Transmission
— Power Take-Off

NOTE: *If equipped with the one-way clutch, the PTO center countershaft consists of the one-way bearing, outer race and inner race, Figure 7.*

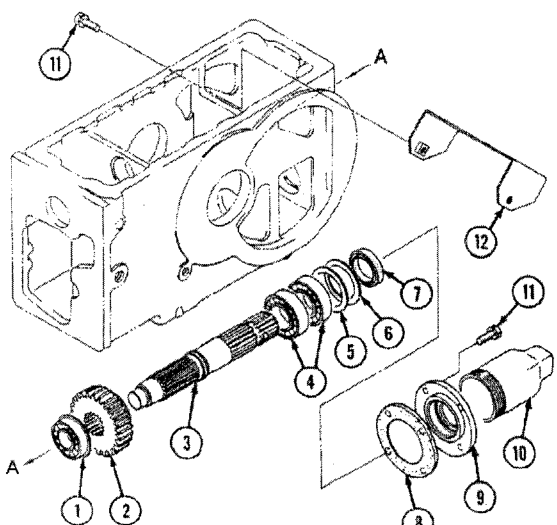

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Figure 6
Power Take-Off Output Shaft Removal

1. Ball Bearing
2. Sliding Gear
3. PTO OUtput Shaft
4. Ball Bearing
5. Shim 0.2
6. Shim 0.5
7. Oil Seal
8. Gasket
9. Cover
10. Cap
11. Bolt
12. Bracket

POWER TAKE-OFF REAR COUNTERSHAFT — REMOVAL

1. Remove the rear countershaft sealing cover (6), Figure 8.
2. Gently drive the countershaft (4) rearward and remove the fixed gear (2).
3. Remove the countershaft (4) out the rear of the case.

DISASSEMBLY (ONE-WAY CLUTCH)

Reference — Figure 7

1.Remove the snap ring, (8).

2.Pull the ball bearing (7) and inner race (6) out.

3.Remove the one-way bearing, (5).

POWER TAKE-OFF FRONT COUNTERSHAFT — REMOVAL

SEE "TRANSMISSION SYSTEMS", PART 5, SECTION "B."

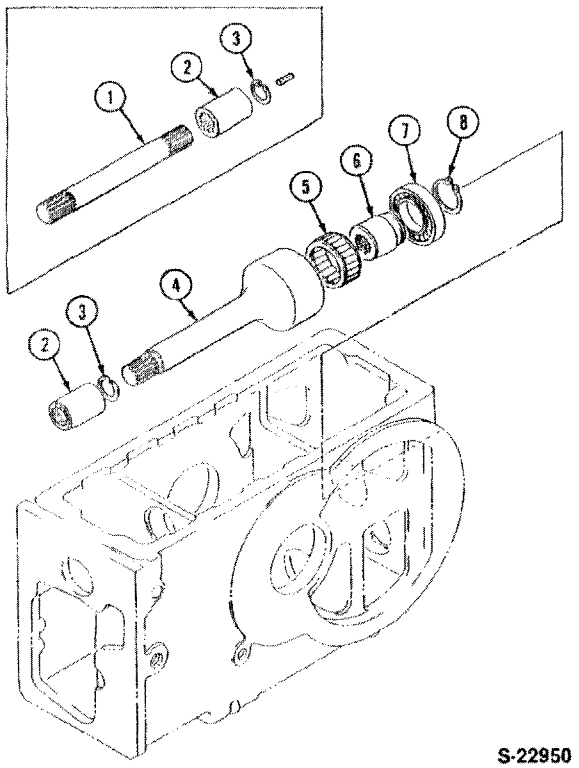

Figure 7
Power Take-Off Center Countershaft Removal

1. PTO Center Countershaft
2. Coupling
3. Snap Ring
4. PTO Center Countershaft (Outer Race)
5. One-Way Bearing
6. Coupling (Inner Race)
7. Ball Bearing
8. Snap Ring

POWER TAKE-OFF SHIFTER — REMOVAL

Reference — Figure 9 and 10

1. Remove the link (1), Figure 9.
2. Drive the roll pin (4) out of the change lever (7) and remove the lever, Figure 10.
3. Remove the retaining plate (9) and remove the shift arm (1), Figure 10.
4. Remove PTO safety switch (14), washer (15) and pin (16).
5. Remove the bolt (10) and remove the detent spring and ball.

NOTE: *Use care to not lose the detent spring as it will be expelled with considerable force when the bolt is removed.*

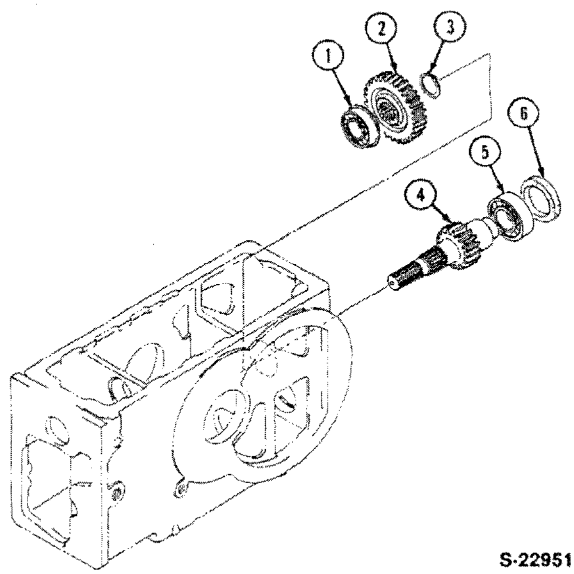

Figure 8
Power Take-Off Rear Countershaft Removal

1. Ball Bearing
2. Fixed Gear
3. Snap Ring
4. PTO Rear Countershaft
5. Ball Bearing
6. Oil Seal

6. Drive out the roll pin and remove the boss (3) from the shift rail.
7. Drive the roll pin out of the shift fork and remove the fork.
8. Slide the shift rail out of the front of the case.

INSPECTION

1. Clean all components in a suitable solvent and air dry.
2. Inspect the gears for excess wear or damage.
3. Check the bearings for excess wear or damage by slowly rotating the bearings by hand.
4. Inspect the shift rail for worn grooves.
5. Inspect the detent spring and ball for excess wear or damage.

ASSEMBLY

Assembly of the one-way clutch follows the disassembly procedure in reverse.

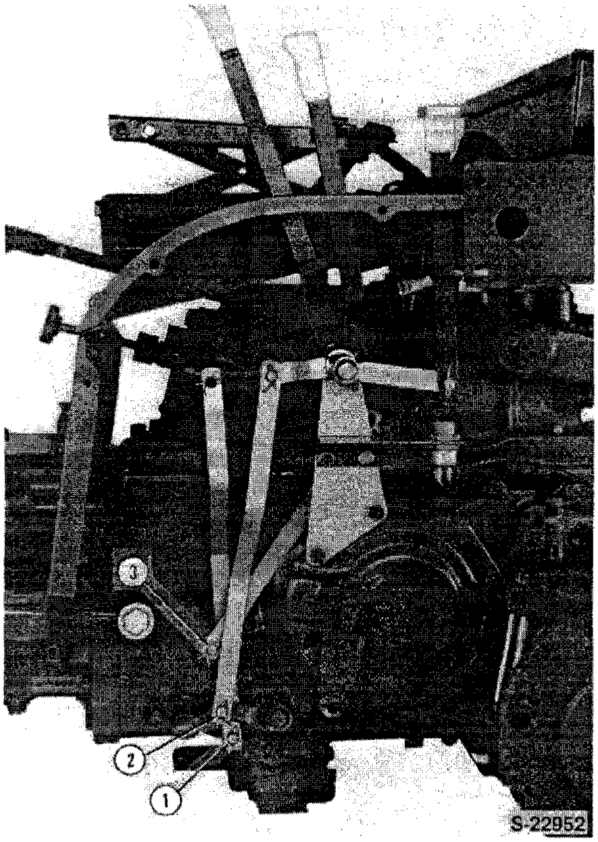

Figure 9
Power Take-Off Shift Linkage Removal

1. Link, Rear PTO
2. Link, Mid-PTO
3. Link, Range Gear Shift

NOTE: *On assembly, be sure the one-way bearing locks up when the PTO countershaft is rotated counter-clockwise (as viewed from the rear) against the inner race and will rotate freely when turned clockwise.*

POWER TAKE-OFF CENTER AND REAR COUNTERSHAFT — ASSEMBLY

Reference — Figures 7 and 8

1. While supporting the center countershaft, install the rear countershaft from the rear.
2. Position the splined gear on the rear countershaft.
3. Press the bearing and the sealing cover into the case.

POWER TAKE-OFF OUTPUT SHAFT — ASSEMBLY

Reference — Figure 6

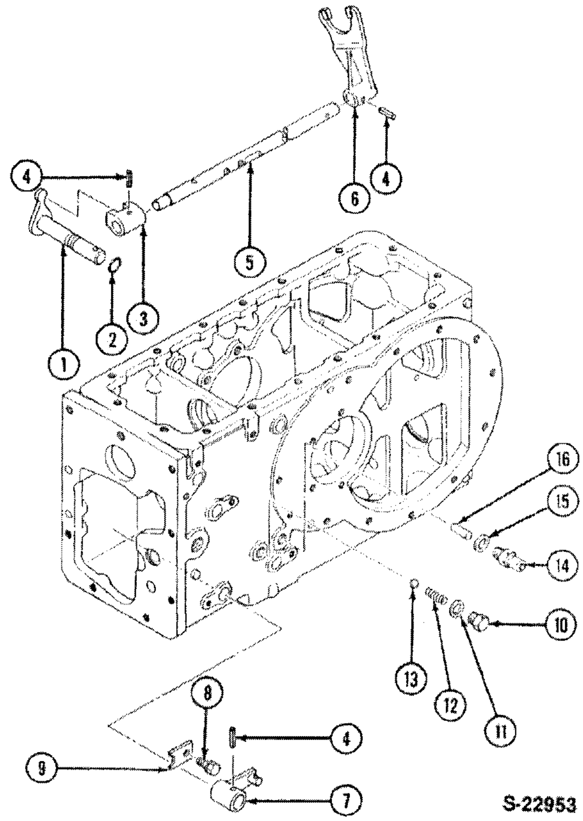

Figure 10
Power Take-Off Shift Rail Removal

1. Shift Arm	9. Plate
2. O-Ring	10. Bolt
3. Shifter Boss	11. Seal Washer
4. Roll Pin	12. Detent Spring
5. Shifter Rod	13. Detent Ball
6. Shifter Fork	14. PTO Safety Switch
7. Change Lever	15. Seal Washer
8. Bolt	16. Pin

1. While supporting the sliding gear, install the output shaft from the rear.
2. Using a suitable driver, install the oil seal in the case.
3. Install the seal cover.

POWER TAKE-OFF SHIFTER — ASSEMBLY

Reference — Figure 10

1. Install the shift arm and fix the plate.
2. Install the shifter rod. Position the shifter fork and shifter boss.
3. Fix the change lever with roll pin.

PART 6
POWER TAKE-OFF SYSTEMS

Chapter 2
MID-MOUNT POWER TAKE-OFF
MODEL 1320-1520

A. DESCRIPTION AND OPERATION

The mid-mount power take-off is standard equipment on the Models 1320 and 1520 tractors equipped with the Hydrostatic transmission and is available as a dealer installed option on the 9 x 3 gear transmission.

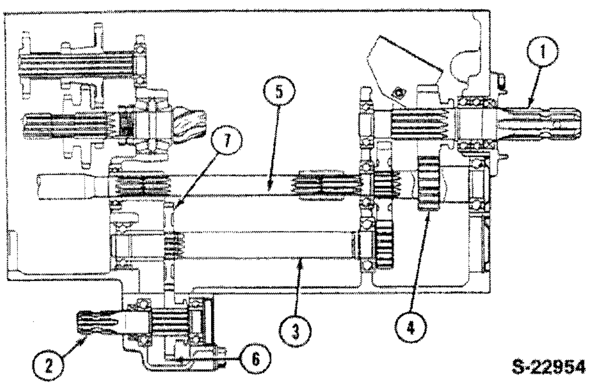

Figure 11
Mid-Mount Power Take-Off

1. Rear PTO Output Shaft
2. Mid-Mount PTO Output Shaft
3. Mid-Mount PTO Countershaft
4. PTO Rear Countershaft
5. PTO Middle Countershaft
6. Mid-Mount PTO Sliding Gear
7. Fixing Gear — Mid-PTO

The mid-mount PTO countershaft, Figure 11, incorporates a gear which is in constant mesh with the PTO countershaft.

A sliding gear on the mid-mount PTO output shaft engages and disengages the mid-mount PTO countershaft gear.

The mid-mount PTO gear box assembly, Figure 12, is installed by removing a plate located on the underside of the rear axle center housing. The gear box bolts to the underside of the center housing.

B. OVERHAUL

- Remove the PTO output shaft. See Chapter 1, Figure 6.
- Remove the PTO center countershaft. See Chapter 1, Figure 7.
- Remove the rear countershaft. See Chapter 1, Figure 8.
- Remove the mid-mount PTO gear box (1), Figure 15.

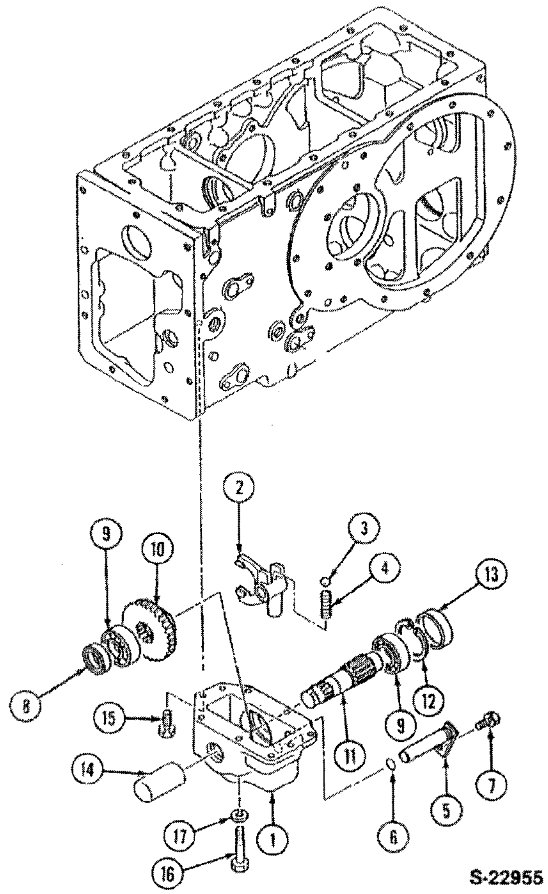

Figure 12
Mid-Mount PTO Gear Box Disassembly

1. Mid-Mount PTO Gear Case
2. Shifter Fork
3. Detent Ball
4. Detent Spring
5. Shift Rail
6. O-Ring
7. Bolt
8. Oil Seal
9. Ball Bearing
10. Sliding Gear
11. Mid-Mount PTO Output Shaft
12. Snap Ring
13. Sealing Plug
14. Cup
15. Bolt
16. Bolt
17. Spring Washer

MID-MOUNT PTO COUNTERSHAFT — REMOVAL

Reference — Figure 13

1. Remove the sealing cover (11) and snap ring (10) from the rear of the case, Figure 13.
2. Remove the snap ring (9) from the front end of the countershaft (1).
3. Gently drive the countershaft rearward and remove the shaft and rear bearing as an assembly out the rear of the case.
4. Remove the fixed gear (4) and spacer (5) from the bottom of the case.
5. If required, remove the snap rings (6 and 8) and remove the bearing (7) from the case.

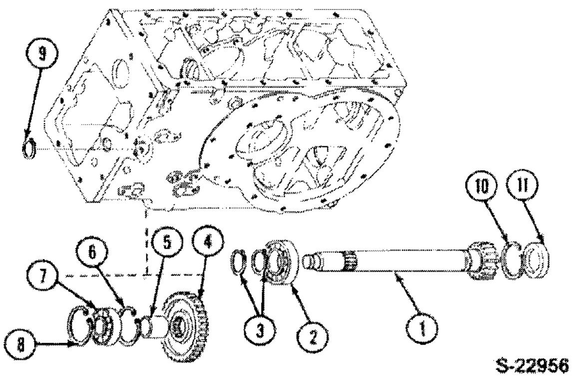

Figure 13
Mid-Mount PTO Countershaft Removal

1. Countershaft
2. Bearing
3. Snap Ring
4. Fixed Gear
5. Spacer
6. Snap Ring
7. Bearing
8. Snap Ring
9. Snap Ring
10. Snap Ring
11. Sealing Cover

MID-MOUNT PTO SHIFTER ARM — REMOVAL

Reference — Figure 14

1. Remove the link (2), Figure 9, from the change lever.
2. Drive the roll pin out of the change lever (1), Figure 14, and remove the lever.
3. Remove the plate (4), and remove the shift arm from inside the case.

MID-MOUNT PTO GEAR BOX — REMOVAL

Reference — Figure 15

1. Remove the gear box retaining bolts and remove the gear box from the underside of the center housing.

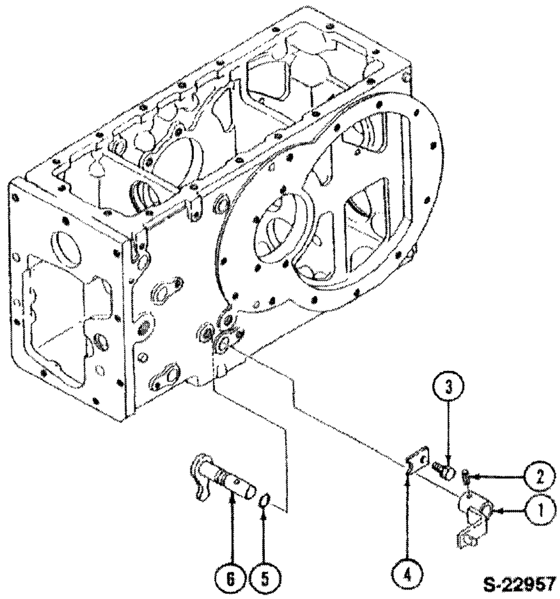

Figure 14
Mid-Mount PTO Shifter Arm Removal

1. Change Lever
2. Roll Pin
3. Bolt
4. Plate
5. O-Ring
6. Shift Arm

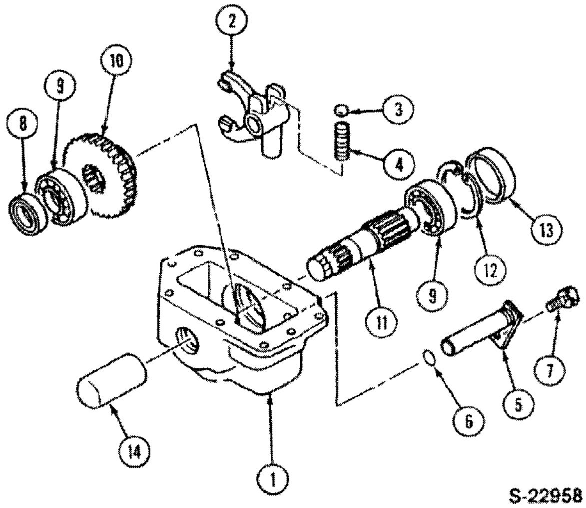

Figure 15
Mid-Mount PTO Gear Box Disassembly

1. Mid-Mount PTO Gear Box
2. Shifter Fork
3. Detent ball
4. Detent Spring
5. Shift Rail
6. O-Ring
7. Bolt
8. Oil Seal
9. Ball Bearing
10. Sliding Gear
11. Mid-Mount PTO Output Shaft
12. Snap Ring
13. Sealing Plug
14. Cup

NOTE: *Two dowel pins locate the gear box to the center housing. Use care in removing the gear box to not damage the castings.*

MID-MOUNT PTO GEAR BOX — DISASSEMBLY

Reference — Figure 15

MID-MOUNT PTO GEAR SHIFTER — REMOVAL

1. Remove the shift rail retaining bolt (7).
2. Pull shift rail (5) out the rear of the case.

   NOTE: *Use care to not lose the detent spring and ball as they will be expelled with considerable force when released by the shift rail.*

3. Remove the shift fork (2).

MID-MOUNT PTO OUTPUT SHAFT — REMOVAL

Reference — Figure 15

1. Pry out the sealing plugs (13 and 14).
2. Remove the snap ring (12).
3. Drive the PTO output shaft (11), out the rear.
4. Remove the sliding gear (10).
5. If required, remove the bearing (9) from the case.

   NOTE: *As the sealing plugs are always damaged during removal, replace with new on assembly.*

INSPECTION

1. Clean all damaged parts in a suitable solvent and air dry.
2. Inspect all parts for excessive wear or damage.

3. Check the bearings for uneven rotation when turned by hand.

4. Inspect the shift rail grooves for excess wear.

5. Inspect the detent spring for wear or damage.

ASSEMBLY

MID-MOUNT PTO GEAR BOX — ASSEMBLY

Reassembly of the gear box generally follows the disassembly procedure in reverse.

ASSEMBLY

MID-MOUNT PTO SHIFT ARM — ASSEMBLY

Reference — Figure 15.

1. Install the shift arm and fix the plate.

2. Install the change lever and roll pin, Figure 14.

MID-MOUNT PTO COUNTERSHAFT — ASSEMBLY

Reference — Figure 13

1. Install the countershaft and position the sliding gear, collar and snap ring.

2. Install the snap ring at front end.

3. Install a new sealing cover.

REAR PTO COMPONENTS — ASSEMBLY

PTO REAR COUNTERSHAFT —

See Part 6, Chapter 1, Figure 8

PTO CENTER COUNTERSHAFT —

See Part 6, Chapter 1, Figure 7

PTO OUTPUT SHAFT —

See Part 6, Chapter 1, Figure 6

PART 6
POWER TAKE-OFF SYSTEMS

Chapter 3
POWER TAKE-OFF SYSTEMS
MODEL 1720

A. TRANSMISSION DRIVE POWER TAKE-OFF SYSTEM — DESCRIPTION AND OPERATION

The standard 540 rpm power take-off is available on the 1720 tractor equipped with non-synchromesh 12 x 4 gear transmission. The PTO drive is taken from the flywheel drive clutch and transmission input shaft, Figure 16.

The input shaft extends out the rear of the transmission and is splined by a coupling to the PTO counter shaft.

A sliding gear (3) on the PTO output shaft (5) engages and disengages the PTO countershaft (2).

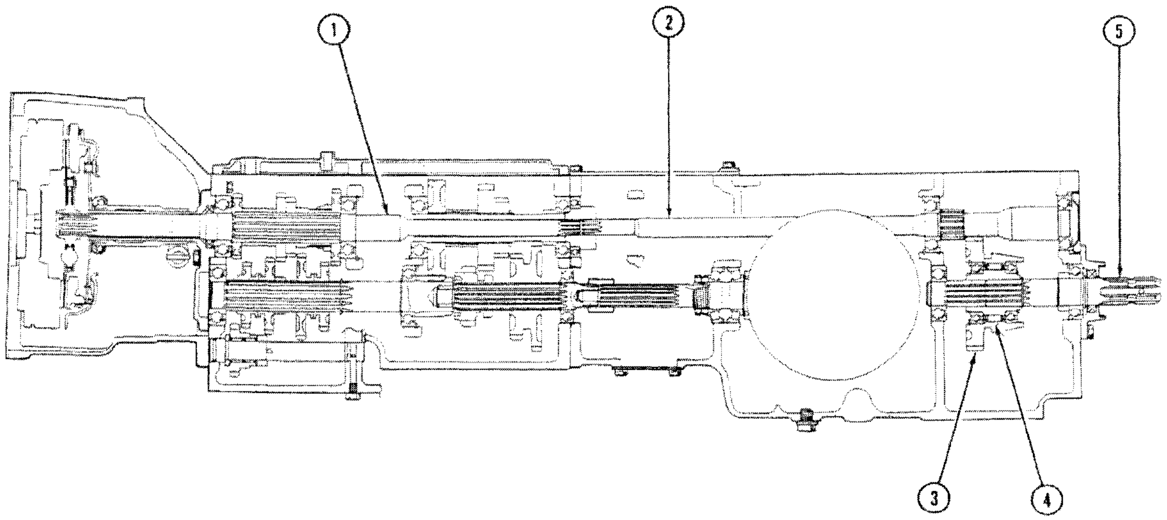

Figure 16
Power Take-Off Drive 12 x 4 Trans and Trans 540 PTO

1. Input Shaft
2. PTO Countershaft
3. PTO Sliding Gear
4. One-Way Clutch
5. PTO Output Shaft

The one-way clutch (4) assembly provides a positive drive in one direction only and free wheels in the opposite direction. The one-way clutch prevents the power take-off equipment from transmitting power back into the PTO driveline with possible damage to the tractor.

The one-way clutch, Figure 17, consists of an inner and outer race and a one-way bearing. The inner race (6) is splined to the PTO output shaft and the outer race (7) is an integral part of the PTO sliding gear.

In operation, when the transmission clutch is being disengaged, the momentum of the PTO equipment will cause the output shaft to continue to rotate and will cause the one-way clutch inner race to rotate faster than the sliding gear and engaged countershaft. Then the one-way bearing will free wheel.

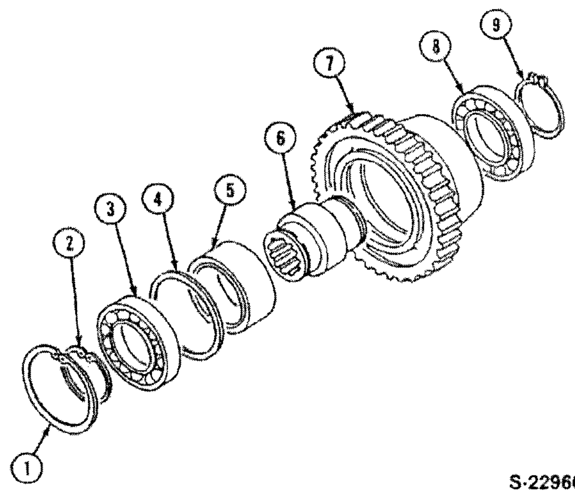

Figure 17
One-Way Clutch

1. Snap Ring
2. Snap Ring
3. Bearing
4. Spacer
5. One-Way Bearing
6. Inner Race
7. Outer Race (PTO Sliding Gear)
8. Bearing
9. Snap Ring

B. LIVE POWER TAKE-OFF DESCRIPTION AND OPERATION

Live power take-off is standard equipment on model 1720 tractors equipped with the shuttle-synchromesh 12 x 12 gear transmission, and is optional equipment with the non-synchromesh 12 x 4 gear transmission.

The power take-off drive (1) is taken from the front disk (2) in the double clutch, Figure 18.

The power take-off control lever (1), Figure 19, is located on the left hand side of the rear axle center housing.

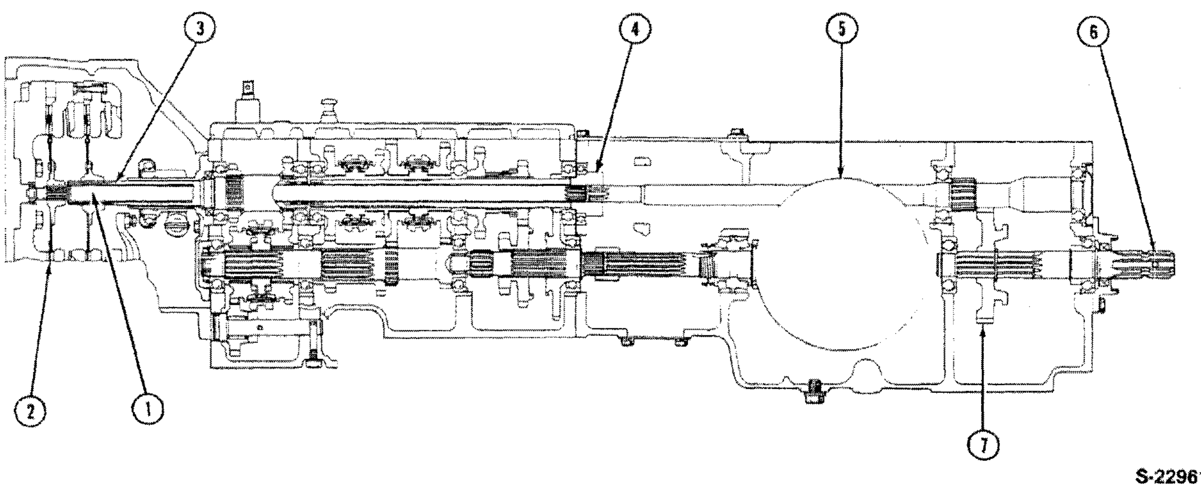

Figure 18
Power Take-Off Drive — Shuttle Synchromesh 12 x 12 Trans and Live PTO

1. PTO Input Shaft
2. PTO Clutch Disc
3. Transmission Input Shaft
4. Coupling
5. PTO Countershaft
6. PTO Output Shaft
7. PTO Sliding Gear

The power take-off is engaged and disengaged when the clutch pedal is fully depressed. Releasing the clutch pedal approximately half way engages the PTO drive while the transmission clutch is still disengaged. This permits engaging PTO driven equipment and bringing it up to operating speed before engaging the transmission drive. The input shaft extends out the rear of the transmission and is splined by a coupling to the PTO countershaft, Figure 18. A sliding gear on the PTO output shaft engages and disengages the PTO countershaft.

NOTE: *The two speed PTO is optional equipment with live power take-off model, Figure 20.*

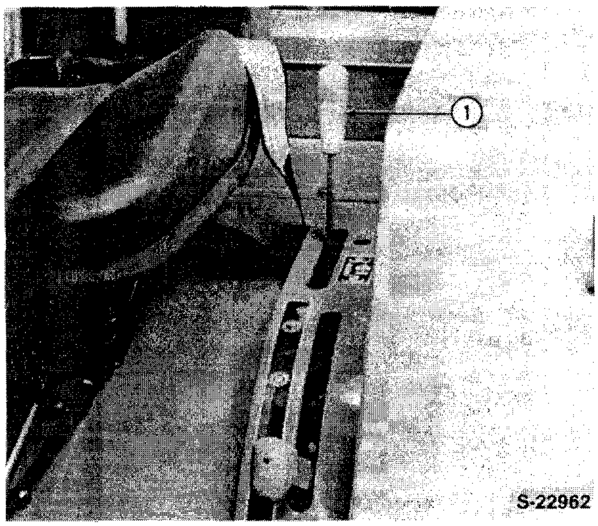

Figure 19
PTO Control Lever Location
1. Control Lever

C. POWER TAKE-OFF SYSTEM OVERHAUL

REMOVAL

Remove the hydraulic lift cover and separate the tractor between the transmission and rear axle center housing. See "Separating the Tractor" Part 12.

COUNTERSHAFT – REMOVAL

Reference – Figure 21

1. Remove the PTO output shaft retainer assembly (4), Figure 21.
2. Gently drive the countershaft (1) with the bearing (3) and seal cover (2) and remove it from the housing.
3. Slide the coupling (6) and bearing (7) forward and remove them from the housing.
4. If required, remove the snap ring (9) and bearing (8).

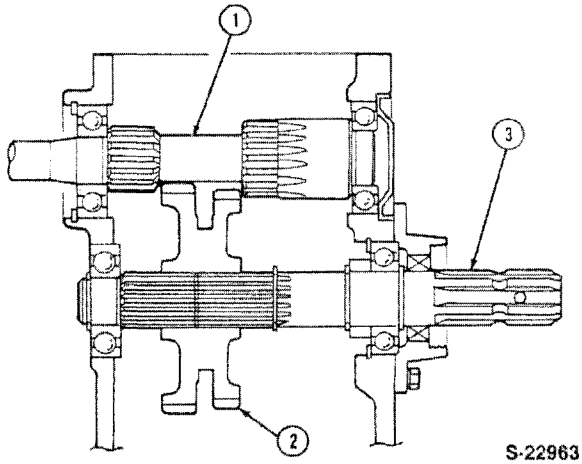

Figure 20
Two Speed PTO (Option)
1. PTO Countershaft
2. Sliding Gear
3. PTO Output Shaft

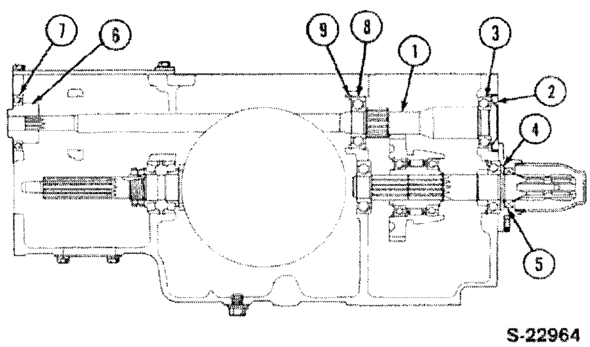

Figure 21
Transmission Power Take-Off
1. PTO Countershaft
2. Seal Cover
3. Bearing
4. Seal Retainer
5. Oil Seal
6. Coupling
7. Bearing
8. Bearing
9. Snap Ring

OUTPUT SHAFT — REMOVAL

Reference — Figure 22

1. Remove the output shaft front snap ring (1).
2. While supporting the sliding gear, gently drive the output shaft rearward and remove them from the housing.
3. Remove the snap ring (6), collar (7) and bearing (5) forward from the output shaft.
4. If required, remove the bearing (2) from the housing.

POWER TAKE-OFF LEVER, AND SHIFTER — REMOVAL

Reference — Figure 23

1. Drive the roll pin out of the change lever (1), and separate it from the shift arm.
2. If not previously removed, remove the cover from the top of the rear axle center housing.
3. Drive the roll pins out of the shifter fork (4), boss (5) and protrusion (6), and remove the fork and protrusion.
4. While supporting the shifter rail, gently drive the rail rearward removing the sealing plug (11) and rail from the rear of the case.
5. Remove the shift arm (2) from the inside of the case.

   NOTE: *Use care not to lose the detent ball and spring. See Figure 23 for detent location.*

INSPECTION

1. Clean all components in a suitable solvent and air dry.
2. Inspect the gears for excess wear or damage.
3. Check the bearing for excess wear, or damage by slowly rotating by hand.
4. Inspect the shift rail for worn grooves.
5. Inspect the detent spring and ball for excess wear or damage.

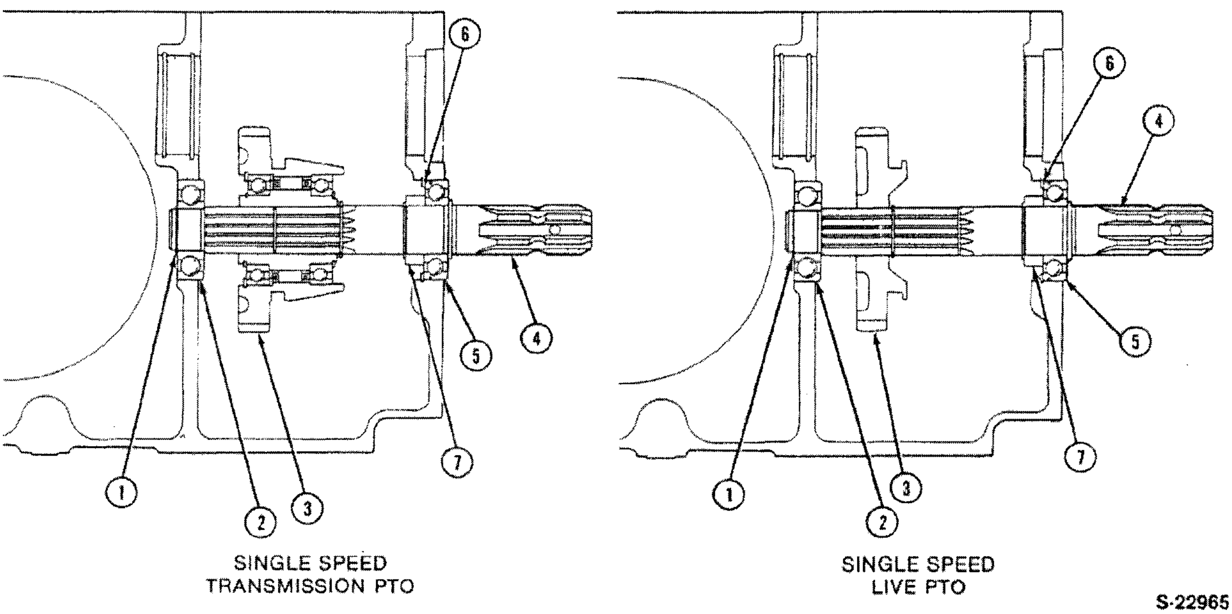

Figure 22
Output Shaft Removal

1. Snap Ring
2. Bearing
3. Sliding Gear
4. PTO Output Shaft
5. Bearing
6. Snap Ring
7. Collar

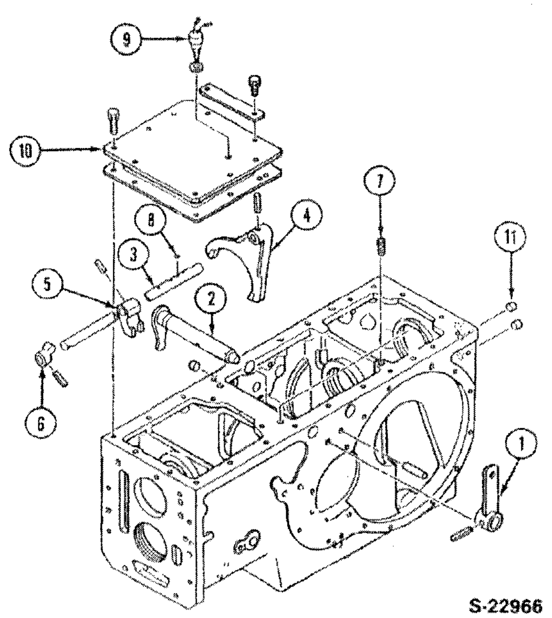

Figure 23
Power Take-Off Shift Rail Removal

1. Change Lever
2. Shift Arm
3. Shift Rail
4. Shifter Fork
5. Shifter Boss
6. Protrusion (for Safety Switch)
7. Detent Spring
8. Detent ball
9. Switch — Safety Neutral
10. Top Cover
11. Sealing Plug

ASSEMBLY

POWER TAKE-OFF LEVER AND SHIFTER — ASSEMBLY

Reference — Figure 23

1. Install the shift arm from inside of the housing.
2. Position the shifter fork, boss and protrusion in place.
3. Insert the shift rail from the rear through the shifter fork, boss and protrusion, and install the roll pins to secure them.
4. Install the top cover, if removed, and install the safety switch (9) on the top cover.
5. Install the change lever into the shift arm, and drive the roll pin to secure the change lever.

OUTPUT SHAFT — ASSEMBLY

Reference — Figure 24

1. If removed, install the bearing (2) in the housing.
2. Install the bearing (7), collar (5) and snap ring to the output shaft (8).
3. Position the sliding gear (3) and insert the output shaft from the rear through the sliding gear.
4. Install the front snap ring (1) to the output shaft.

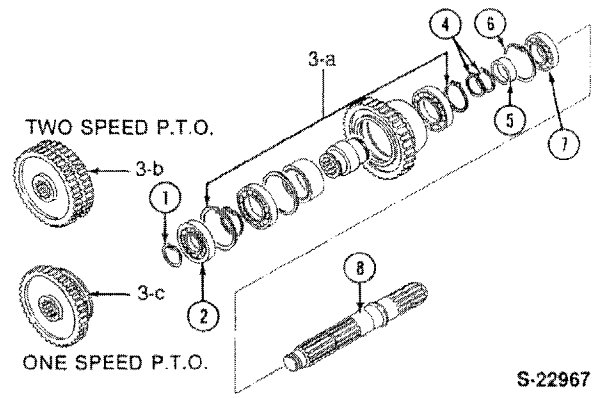

Figure 24
Output Shaft Assembly

1. Snap Ring
2. Bearing
3-a. Sliding Gear — One-Way Clutch
3-b. Sliding Gear — two-speed
3-c. Sliding Gear — one-speed
4. Snap Ring (2)
5. Spacer Collar
6. Snap Ring
7. Bearing
8. Shaft

COUNTERSHAFT — ASSEMBLY

Reference — Figure 25

1. If removed, install the bearing (8) and snap ring (9) on the coupler (6).
2. Install the coupling (6) and bearing (7) and insert the countershaft (1) from the rear into the coupling.

   NOTE: *If removed, install the snap ring (10) inside the coupling (6).*

3. Install the rear bearing (6) and seal cover (2) in the case.

4. Install a new seal (5) in the output shaft retainer (4) and install the retainer assembly using a new gasket.

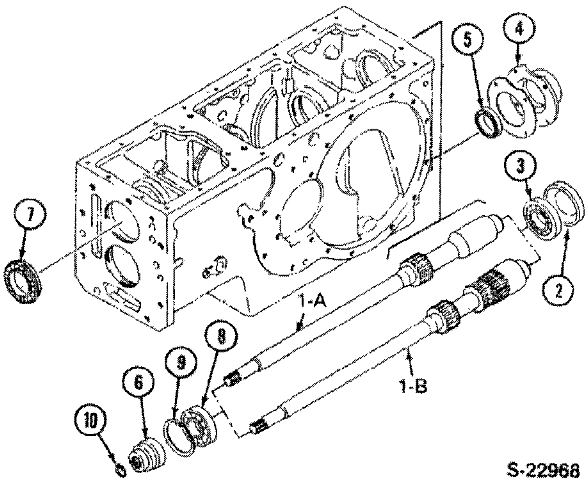

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Figure 25
PTO Countershaft Assembly

1-a. PTO Countershaft — one-speed
1-b. PTO Countershaft — two-speed
2. Seal Cover
3. Bearing
4. Seal Retainer
5. Oil Seal
6. Coupling
7. Bearing
8. Bearing
9. Snap Ring
10. Snap Ring

PART 6
POWER TAKE-OFF SYSTEMS

Chapter 4
SPECIFICATIONS

BOLT TORQUE SPECIFICATIONS

Bolt size	Grade No.	Coarse Thread			Fine Thread		
		Pitch (mm)	Pounds-Feet	Newton-Meters	Pitch (mm)	Pounds-Feet	Newton-Meters
M6	4T	1.0	3.6- 5.1	4.9- 6.9	–	–	–
	7T		6.1- 8.3	8.3-11.3			
	10T		8.7-11.6	11.8-15.7			
M8	4T		9.4-12.3	12.7-16.7	1.0	11.2-14.8	15.2-20.1
	7T		16.6-21.0	22.6-28.4		19.5-25.3	26.5-34.3
	10T		21.0-26.8	28.4-36.3		22.4-29.7	30.4-40.2

PART 7
DIFFERENTIAL , REAR AXLE AND BRAKES

Chapter 1
DIFFERENTIAL, REAR AXLE AND BRAKES

Chapter 2
SPECIFICATIONS

PART 7
DIFFERENTIAL, REAR AXLE AND BRAKES

Chapter 1
DIFFERENTIAL, REAR AXLE AND BRAKES

A. DESCRIPTION AND OPERATION

DIFFERENTIAL ASSEMBLY

The differential assembly, Figures 1 and 2, consists of the drive pinion, ring gear, axle side gears, differential case, differential pinion gears and differential lock.

If equipped, the pinion gear also contains the front wheel drive gear, Figure 3.

If equipped with creeper gear on the model 1720, the pinion gear contains the creeper gear drive gear, Figure 4.

The front wheel drive control lever is located on the right side of the rear axle center housing and the creeper gear control lever is located on the left side of the center housing, Figure 5.

DIFFERENTIAL LOCK
Reference — Figure 6

A differential lock is provided to lock the differential system so that both rear wheels rotate when power is provided by the transmission even though one wheel may lose traction.

The differential lock control lever is foot operated. The pedal lever is located on the right side of the differential housing on the gear transmission and on the left side on the HST transmission.

Depressing the pedal rotates the shaft and actuating pin, causing the fork to move toward the differential assembly and at the same time compressing the return spring. This action causes the coupling to move toward the differential.

On the model 1320/1520, lugs on the differential lock clutch indexes with mating lugs on the ring gear when applied to lock the differential assembly.

On the model 1720, pins on the differential lock clutch index with holes in the differential case housing and differential side gear to lock the differential assembly when applied.

When the pedal is released, the return spring moves the fork outward to disengage the clutch.

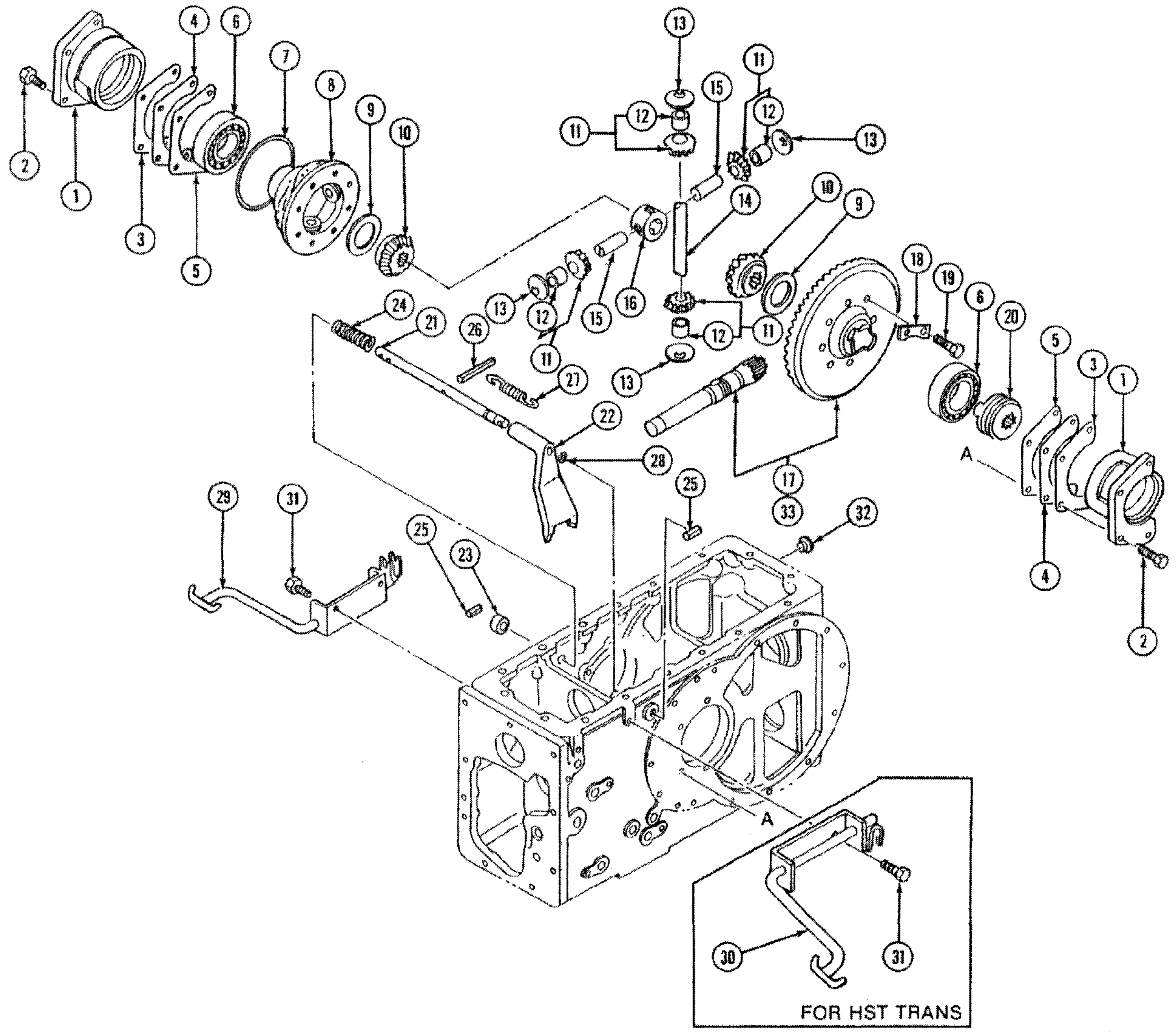

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Figure 1
Differential and Differential Lock Components

1. Bearing Carrier
2. Bolt
3. Shim 0.5
4. Shim 0.3
5. Shim 0.1
6. Ball Bearing
7. Clip
8. Differential Housing
9. Thrust Washer
10. Differential Gear
11. Gear Assembly
12. Bushing
13. Thrust Washer
14. Pinion Shaft
15. Pinion Shaft
16. Joint
17. Ring Gear Assembly
18. Lock Plate
19. Bolt
20. Differential Lock Clutch
21. Differential Lock Shaft
22. Differential Lock Fork
23. Oil Seal
24. Spring
25. Roll Pin
26. Roll Pin
27. Spring
28. O-Ring
29. Differential Lock Pedal
30. Differential Lock Pedal (HST)
31. Bolt
32. Blank Plug
33. Ring Gear Assembly (HST)

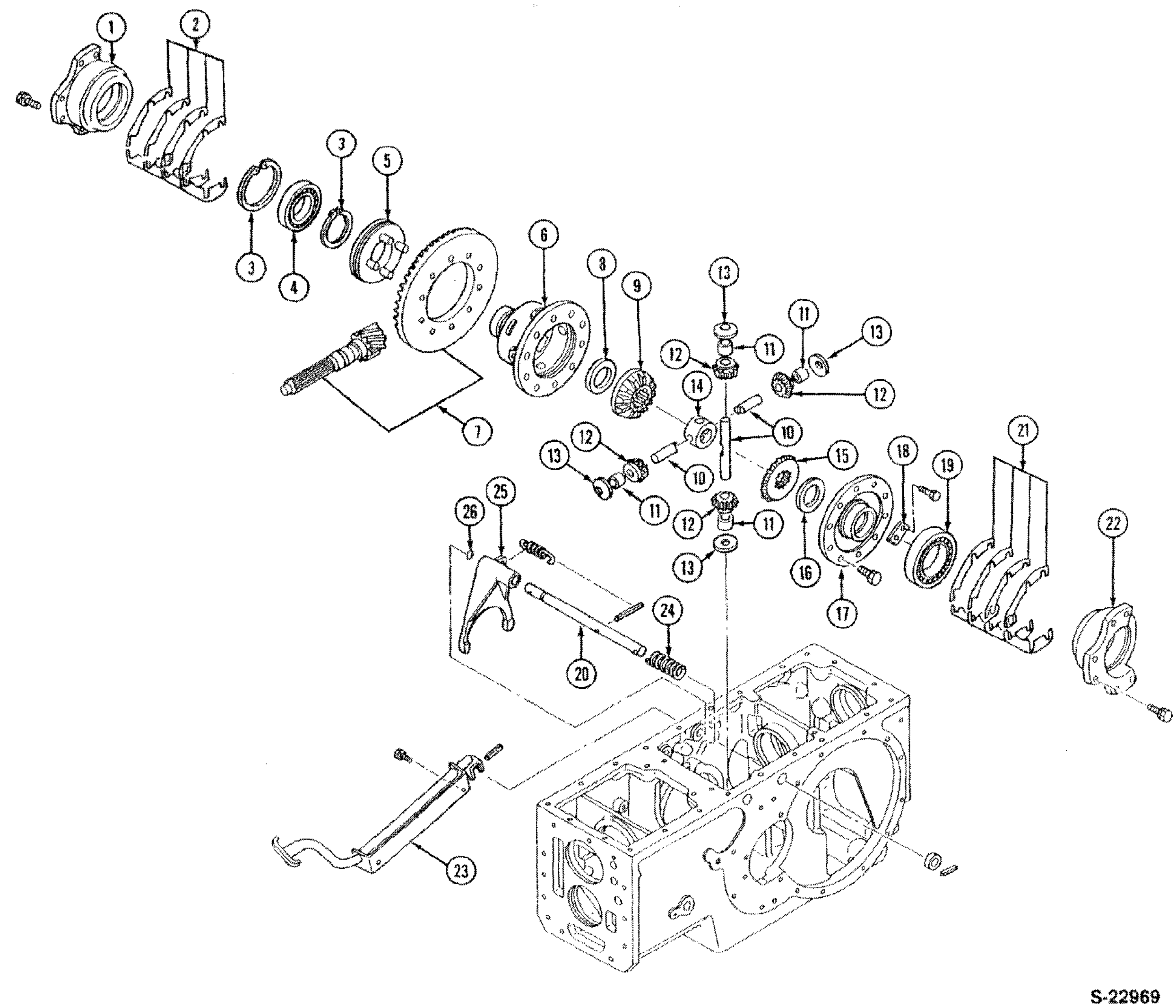


Figure 2
Differential and Differential Lock Components

1. Carrier
2. Shim
3. Snap Ring
4. Bearing
5. Differential Lock Clutch
6. Differential Gear Case
7. Ring Gear and Pinion Assembly
8. Thrust Washer
9. Side Gear
10. Differential Pinion Shaft
11. Bushing
12. Pinion Gear
13. Thrust Washer
14. Joint
15. Side Gear
16. Thrust Washer
17. Differential Gear Case End Plate
18. Lock Plate
19. Bearing
20. Differential Lock Shaft
21. Shim
22. Carrier
23. Differential Lock Pedal
24. Return Spring
25. Differential Lock Fork
26. O-Ring

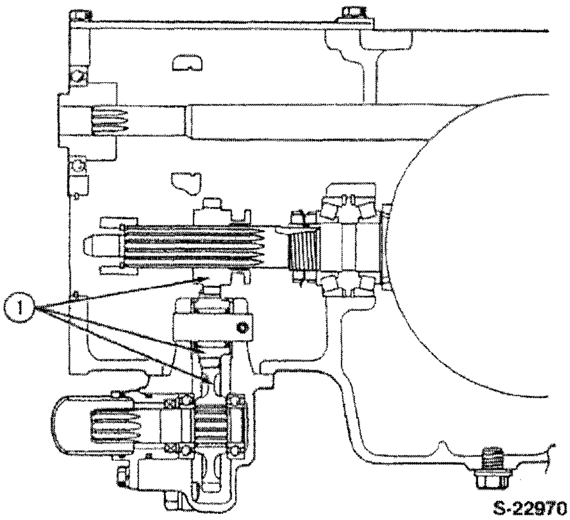


Figure 3
Front Wheel Drive Gears
1. FWD Gears

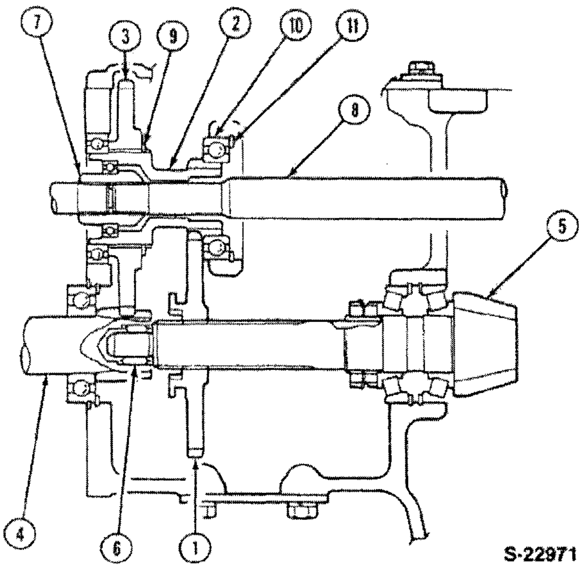


Figure 4
Creeper Gear (Option) Model 1720

1. Sliding Gear
2. Counter Gear
3. Idler Gear
4. Rear Main Shaft
5. Pinion Shaft
6. Needle Bearing
7. Coupler
8. PTO Countershaft
9. Snap Ring
10. Bearing
11. Snap Ring

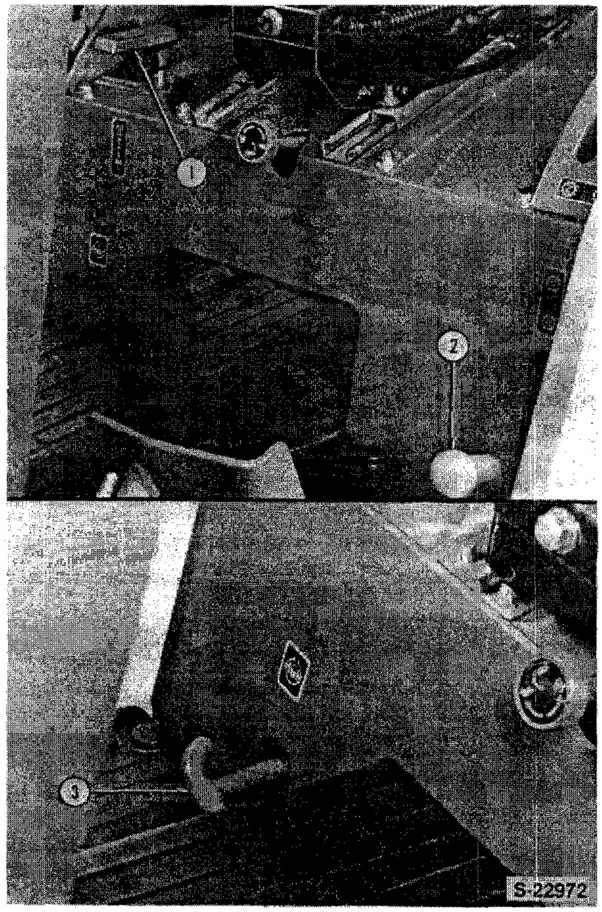


Figure 5
FWD, Creeper Gear and Differential Lock Control Lever — Model 1720

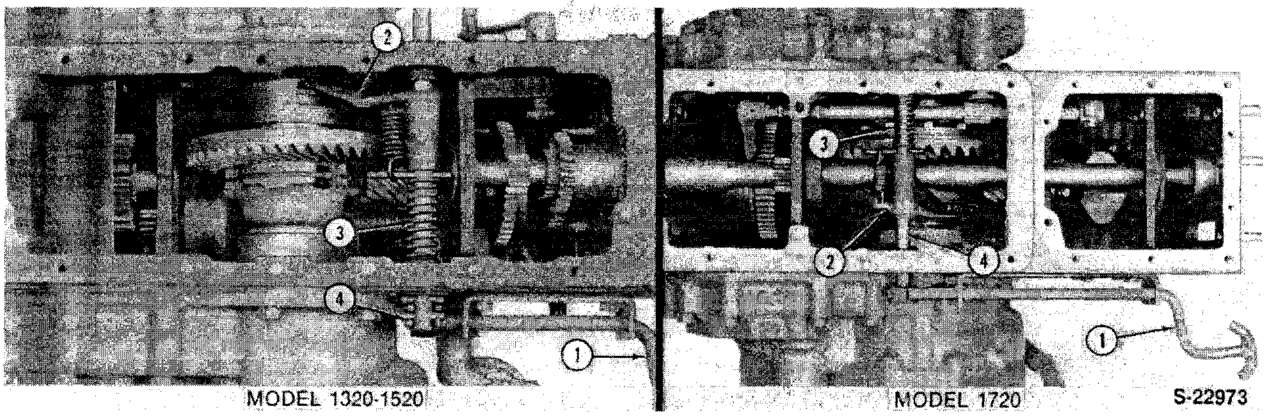
1. FWD Control Lever
2. Creeper Gear Control Lever
3. Differential Lock Control Lever

REAR AXLE AND BRAKES

The rear axle is a double reduction type using the conventional ring gear and pinion for the primary reduction and a final drive pinion and gear for the secondary reduction.

The axle housing enclose the brake discs and stators, Figure 7. The rear axle and differential components are lubricated by the common oil reservoir.

Power is transmitted by the transmission to the differential drive pinion and ring gear. The ring gear is bolted to the differential case which contains the differential pinions and axle side gears, Figure 8.

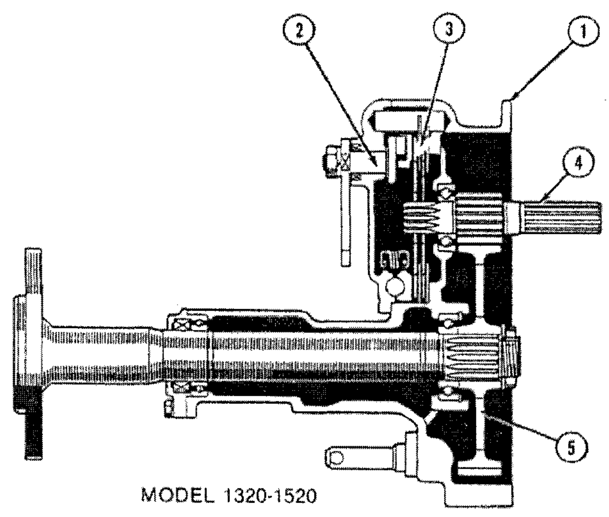


9x3 Gear Transmisson
Model 1320-1520

12x4 Gear Transmission
Model 1720

Figure 6
Differential Lock

1. Control Pedal Lever
2. Differential Lock Fork
3. Return Spring
4. Differential Lock Shaft



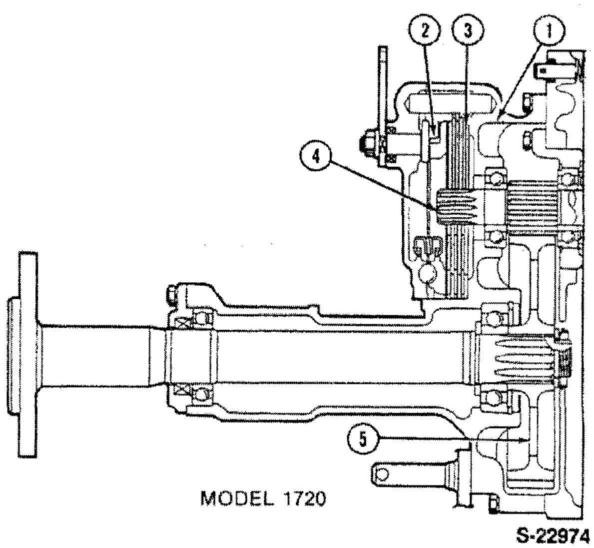


Figure 7
Rear Axle and Brake

1. Axle Housing
2. Actuator
3. Brake Discs and Stators
4. Final Pinion
5. Final Gear

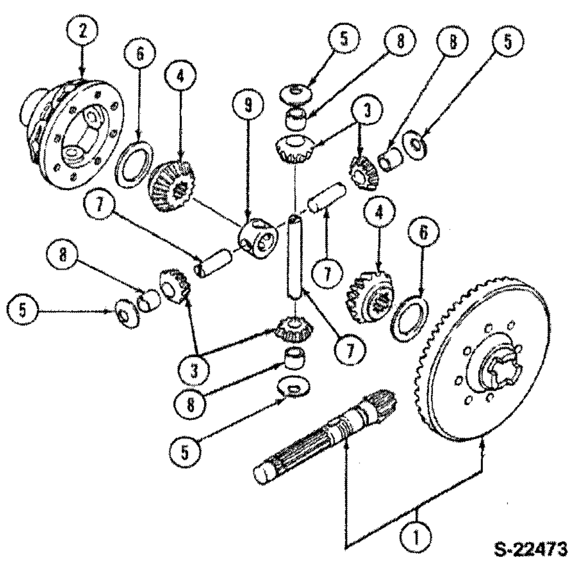


Figure 8
Differential Ring Gear and Pinion (Model 1320/1520 Shown)

1. Pinion and Ring Gear Assembly
2. Differential Case
3. Differential Pinions
4. Differential Axle Side Gears
5. Thrust Washers (4)
6. Thrust Washers (2)
7. Pinion Shaft
8. Bushing (4)
9. Joint

As the differential case rotates, the four differential pinion gears rotate and drive the two axle side gears, Figure 8.

The final drive pinions are splined to the side gears and mesh with the final drive gears. As the final drive pinions rotate with the differential assembly, power is transmitted to the final drive gears and rear axles.

The axle housings support the axle shafts and bearings and provide an enclosure for the brakes, Figure 7.

The axles must be pressed out of the housings to service the bearings and oil seal.

BRAKES
Reference — Figure 9

The brakes are wet disc type and are mechanically actuated. The brakes are located in the outside of the differential housing and are enclosed in the upper portion of the axle housing. The brakes are sealed against dust and moisture entry by the cover.

The brake discs are splined to the final drive pinion and turn at the same speed as the differential assembly.

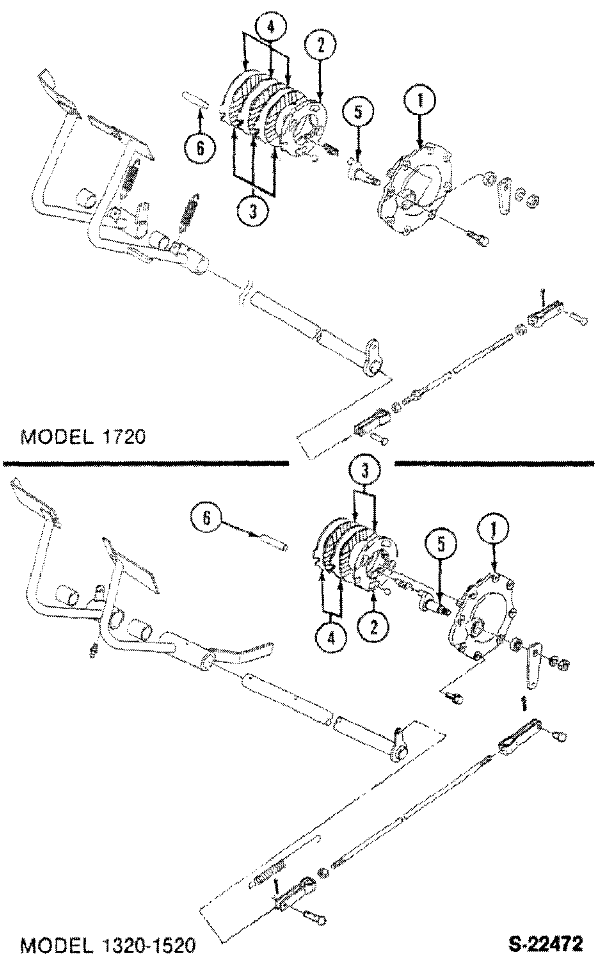


Figure 9
Brake Components

1. Brake Cover
2. Actuator
3. Brake Discs
4. Stators
5. Brake Actuating Cam
6. Pin

Depressing the brake pedal operates the actuator through the brake rod, brake lever, and rod and causes the two actuator plates to expand outward. These actuators press against the rotating brake disc to perform the braking action.

When the brakes are released, the pedal return spring pulls the lever back to its original position and allows the actuator return spring to pull the actuator back.

A parking brake is provided to hold the brakes in a locked position. The control holds the pawl in a locked position on the inside brake pedal only, Figure 10.

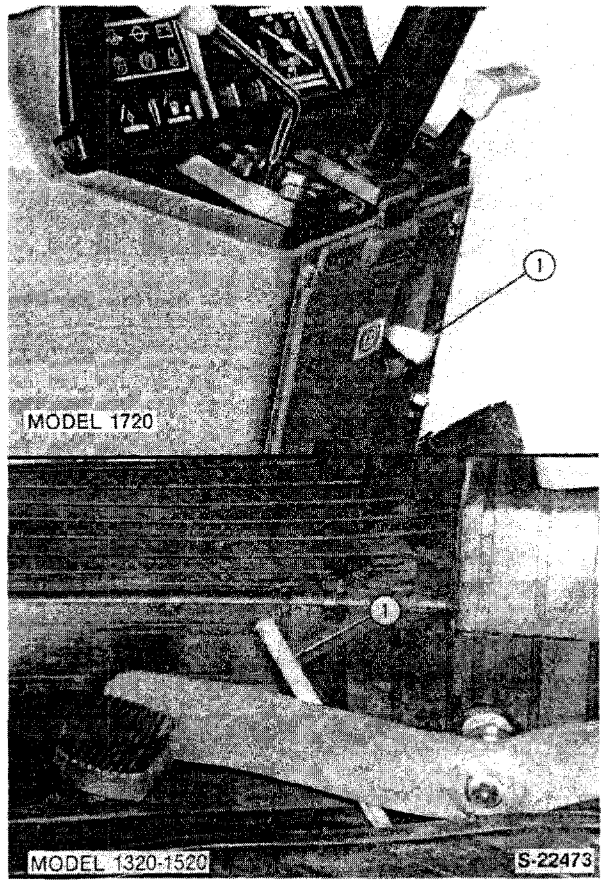


Figure 10
Parking Brake Lever

1. Parking Brake Lever

B. OVERHAUL

DIFFERENTIAL ASSEMBLY

REMOVAL

The differential gear assembly may be removed without removing the center housing from the tractor. To do so, remove both of the rear axle housings and the hydraulic lift cover and related components.

1. Remove the rear wheels and fenders.

2. Drain the oil from the combined transmission, rear axle and hydraulic reservoir system.

3. Remove the lower lift links.

4. Disconnect the brake control rod from the brake cover lever, Figure 11.

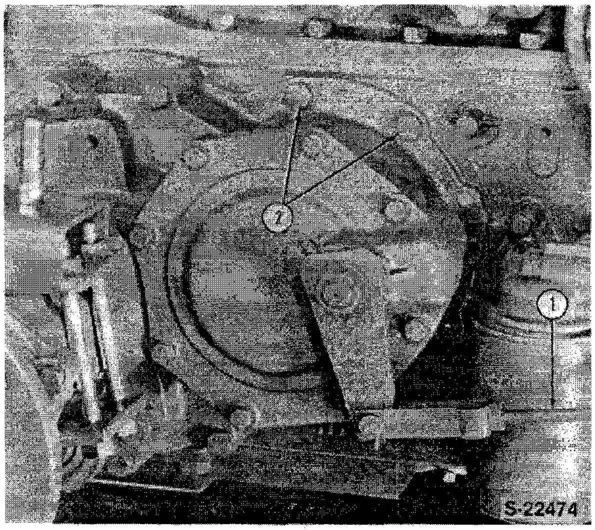


Figure 11
Rear Axle Removal
1. Brake Control Rod 2. Axle Housing Retaining Bolts

5. Attach a suitable overhead lifting device to the rear axle assembly, Figure 12, and remove the axle housing retaining bolts.

6. Carefully move the axle assembly out and away from the tractor.

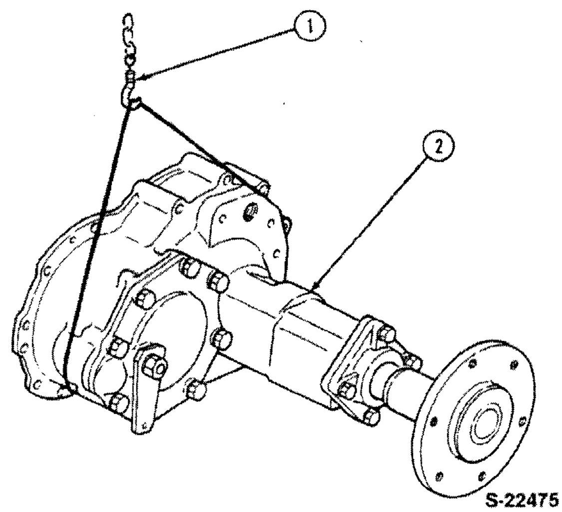


Figure 12
Rear Axle Removal
1. Hoist 2. Rear Axle Assembly

WARNING: *The axle housing is difficult to balance. Exercise care during removal to avoid personal injury.*

7. Remove the opposite axle assembly in the same manner.

8. Remove the right and left hand differential bearing carrier, Figure 13. Note the number and thickness of the shims located between the bearing carrier and housing on each side for ease of assembly.

9. Remove the differential assembly from the top.

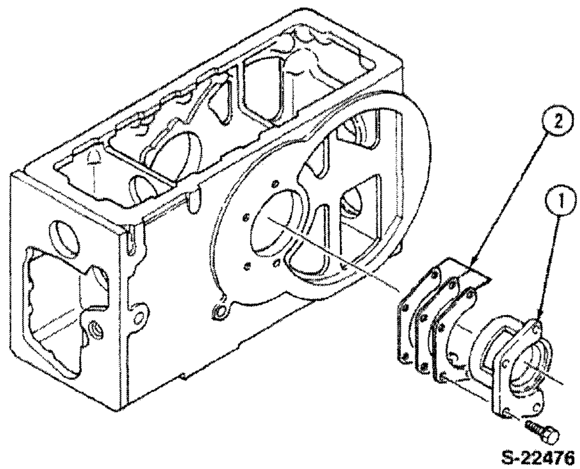


Figure 13
Differential Assembly Removal (Model 1320/1520 Shown)
1. Differential Bearing Carrier 2. Shims

PINION REMOVAL

When the differential drive pinion is to be removed, the rear axle center housing must be separated from the transmission to permit the pinion bearing pre-load adjustment on assembly. See "Separating the Tractor" Part 12.

If not previously removed, remove the cover from the top of the rear axle center housing.

DISASSEMBLY
Reference — Figure 14

TWO WHEEL DRIVE MODEL

1. Straighten the lock washer tabs, Figure 14.

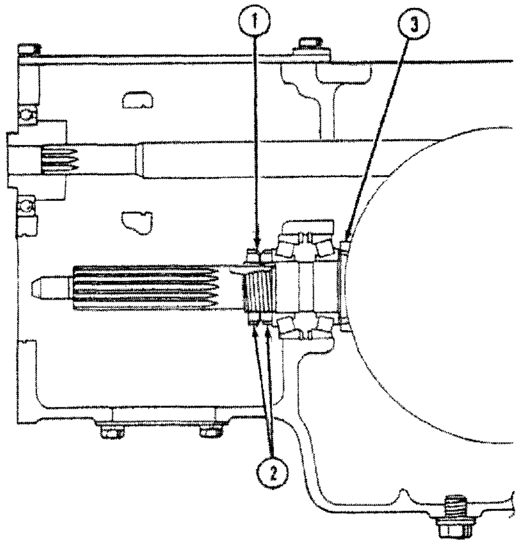


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Figure 14
Pinion Removal — Two Wheel Drive Model Shown

1. Lock Washer
2. Lock Nut
3. Drive Pinion

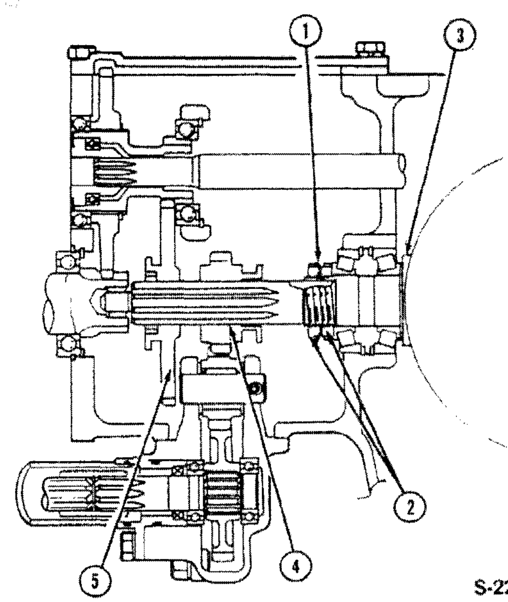

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Figure 15
Pinion Removal — Four Wheel Drive and Creeper Gear Option Shown

1. Lock Washer
2. Lock Nut
3. Drive Pinion
4. Sliding Gear-4WD
5. Sliding Gear-Creeper

2. Remove the two pinion lock nuts and slide the pinion out toward the rear, Figure 14.

FOUR WHEEL DRIVE AND/OR CREEPER GEAR MODEL
Reference — Figure 15.

(See "Transmission System" Part 5, "Creeper Gear Option" Chapter 7.)

1. Straighten the lock washer tabs.
2. Remove the two lock nuts.
3. While holding the sliding gears (4), (5), nuts and washer, slide the pinion out toward the rear.
4. Remove the sliding gears, nuts and washer from the top.

DISASSEMBLY
Reference — Figures 16 and 17

1. Remove the differential gear case end plate bolts.
2. Separate the end plate from the differential housing.
3. Remove the axle side gear and thrust washer.
4. Remove the differential pinion shaft, thrust washers and pinion gears.
5. Remove the remaining axle side gears and thrust washers.

INSPECTION

1. Inspect gear teeth for excessive wear or damage.
2. Measure the thickness of the differential gear thrust washers. Replace washers that exceed the minimum thickness. See "Specifications," Chapter 2.
3. Inspect the differential pinion shaft and gears for excessive wear. See "Specifications," Chapter 2.

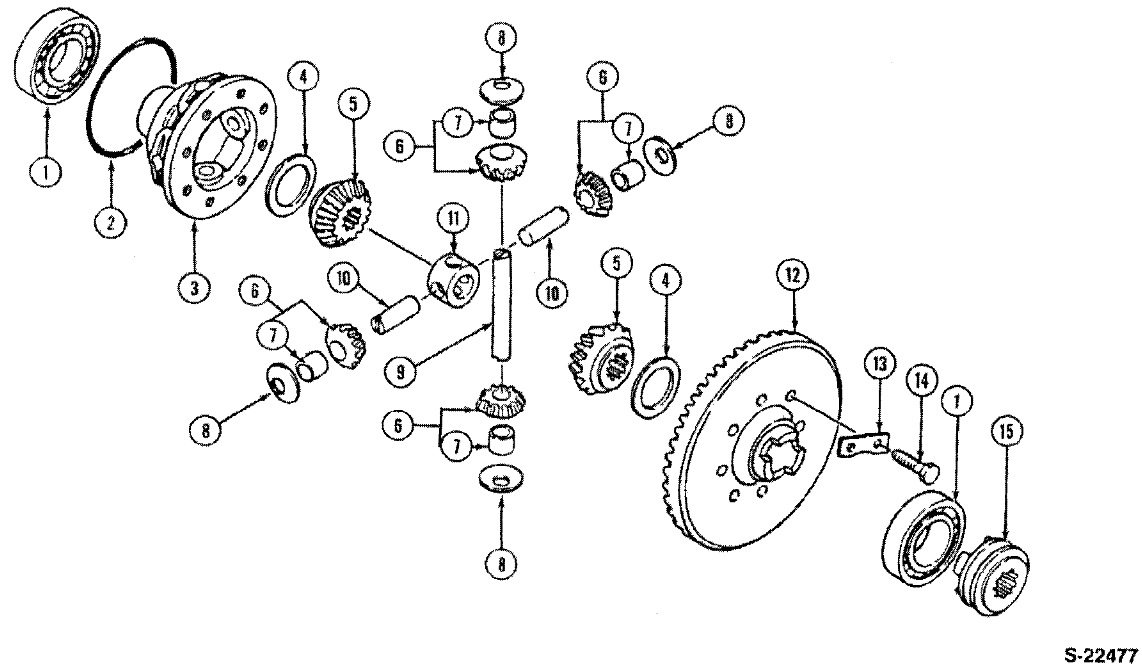


Figure 16
Differential Disassembly — Model 1320/1520

1. Ball Bearing
2. Retaining Ring
3. Differential Housing
4. Thrust Washer
5. Differential Side Gears (2)
6. Pinion Gears (4)
7. Bushing
8. Thrust Washer
9. Pinion Shaft
10. Pinion Shaft
11. Joint
12. Ring Gear
13. Locking Tab
14. Bolt
15. Differential Lock Clutch

4. Inspect the drive pinion to ring gear tooth wear pattern. See "Specifications," Chapter 2, for wear indications and shimming adjustments.

5. Inspect the bearings for excessive wear or binding when rotated by hand.

ASSEMBLY

NOTE: *When the drive pinion and ring gear are reused, assemble using the same shims as removed. When the drive pinion and ring gear are replaced, adjust the shims as described below. The ring gear and pinion are serviced only as a matched set and must be replaced together.*

If the drive pinion and ring gear are replaced:

The drive pinion and ring gear are identified by an assembly number which is stamped into the end of the drive pinion gear and on the circumference of the ring gear, Figure 18. In addition, a "Value of Error" number is also stamped into the end of the pinion gear, Figure 18. This number is prefixed with a (+) or (−) to indicate the amount of error from zero adjustment. If the value of error is greater on the new pinion than on the old pinion, additional shims will be required. If the value of error is less on the new pinion than on the old pinion, the number of shims must be decreased.

Example:

Replaced pinion .... −0.2 mm
New pinion .... +0.0 mm
(−0.2) − +0) = −0.2 mm
Decrease the shims by 0.2 mm (0.008 in.)

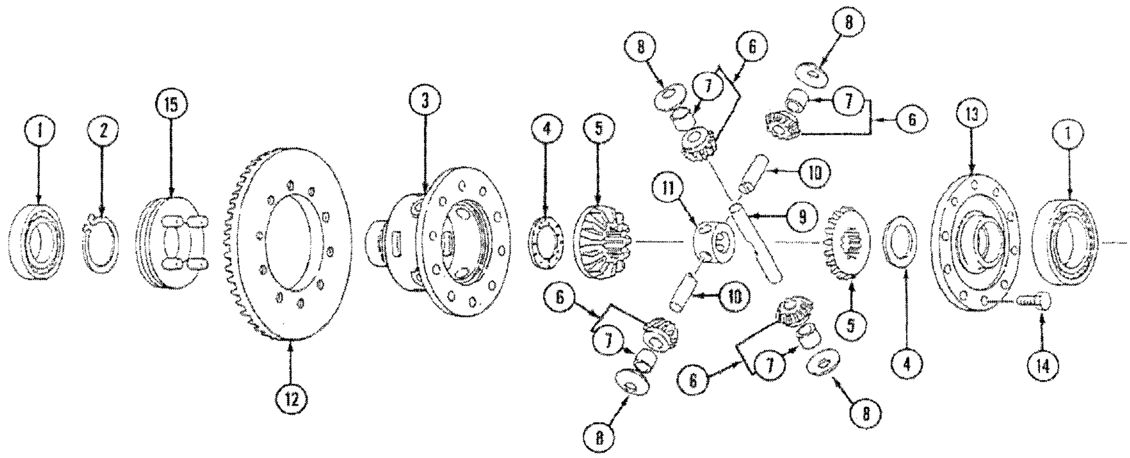


Figure 17
Differential Disassembly — Model 1720

1. Ball Bearing
2. Snap Ring
3. Differential Housing
4. Thrust Washer
5. Differential — Side Gears (2)
6. Pinion Gears (4)
7. Bushing
8. Thrust Washer
9. Pinion Shaft
10. Pinion Shaft
11. Joint
12. Ring Gear
13. Differential Gear Case End Plate
14. Bolt
15. Differential Lock Clutch

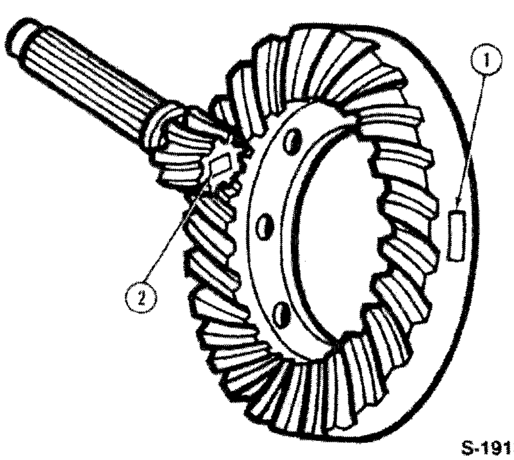


Figure 18
Ring Gear and Pinion Tolerance Identification
1. Assembly Number
2. Tolerance "Value of Error" Number

1. Assemble the differential pinion shaft, pinion gears, thrust washers and side gears as shown, Figures 16 or 17, as required.

2. Install the ring gear and end plate. Using new bolts and locking tabs, tighten to the specified torque.

3. Bend the tabs to secure the bolts.

4. If removed, install the two drive pinion bearing snap rings in the housing, Figures 19 and 20.

5. Assemble the thrust washer, shims and pinion shaft rear bearing on the shaft, Figures 19 and 20. Insert the pinion shaft into the housing from the rear while installing the front bearing, lock nuts, lock washer and 4WD sliding gear as shown, Figure 19.

NOTE: *If equipped with creeper gear option, also assemble the creeper sliding gear on the pinion shaft. See "Transmission Systems" Part 5, "Creeper Gear Option" Chapter 7.*

6. Adjust the pinion bearing preload using a strong cord wrapped around the pinion shaft and a pull scale, Figure 21. Tighten the pinion nut to obtain the specified pounds of constant pull to rotate the pinion assembly.

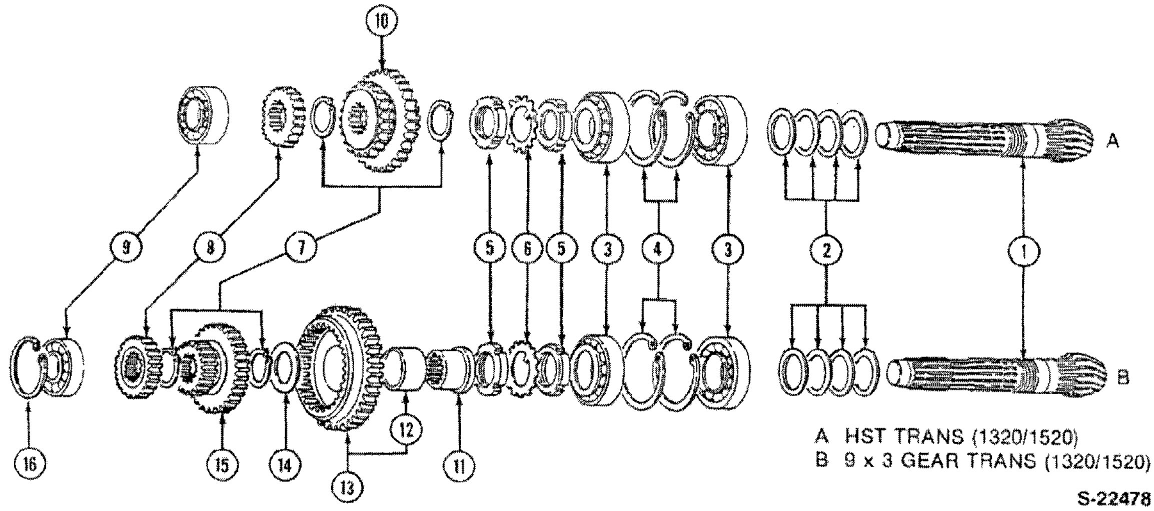


Figure 19
Pinion Gear Assembly — Model 1320/1520

1. Pinion Gear
2. Shims
3. Ball Bearing
4. Snap Ring
5. Lock Nut
6. Lock Washer
7. Snap Ring
8. Fixing Gear
9. Ball Bearing
10. Range Sliding Gear
11. Coupling
12. Bushing
13. Gear Assembly
14. Thrust Washer
15. Range Sliding Gear
16. Snap Ring

Tighten the locknut and lock with the locking washer tabs.

Pinion Bearing Preload	Constant Pull
New Bearings	28.6-37.5 lbs. (13-17 kg)
Original Bearings	14.3-18.8 lbs. (6.5-8.5 kg)

NOTE: *Turn drive pinion several times by hand before performing pull scale test.*

7. Position the differential assembly in the housing and install the right and left hand bearing carriers, Figure 22.

NOTE: *When installing the original components, use the same quantity and thickness shims on each side as removed during disassembly.*

If new differential components are used, adjust the backlash and ring gear contact patterns as follows:

Place a dial indicator gauge at a right angle to the top of a ring gear tooth, Figure 23.

Rock the ring gear back and forth and observe the dial indicator reading.

Adjust the shims to obtain the correct backlash. See "Specifications," Chapter 2.

Using prussian blue on the pinion gear teeth, rotate the pinion gear and check the gear tooth pattern. Adjust the differential and pinion shims to obtain the correct tooth contact. See "Specifications", Chapter 2.

8. Complete the assembly and installation following the disassembly and removal procedure in reverse.

REAR AXLE AND BRAKES

DISASSEMBLY — REAR AXLE

Remove the rear axle assembly as described under "Differential Assembly — Removal", this chapter.

1. Remove the lock nut and washer from the axle shaft, Figure 24.
2. Remove the final reduction gear (3), Figure 24.
3. Remove the seal retainer bolts and remove the retainer from the axle housing, Figure 24.

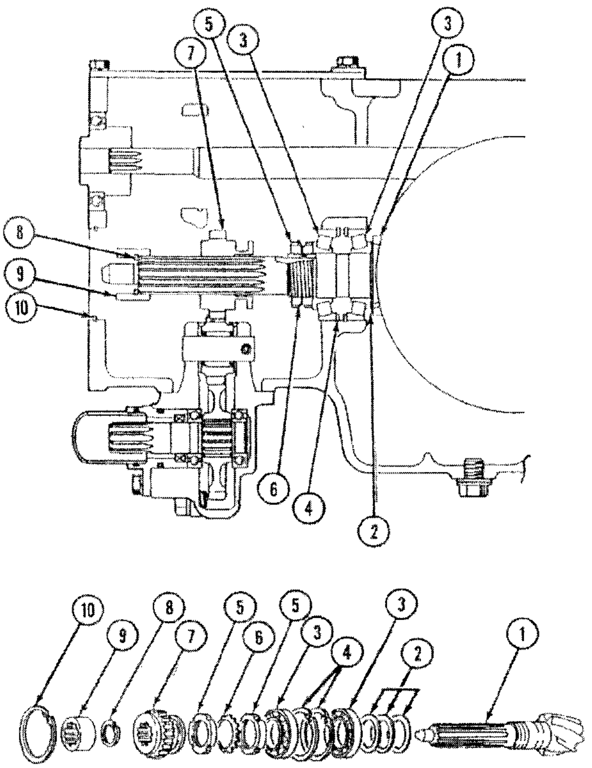


Figure 20
Pinion Gear Assembly — FWD Model Shown
Model 1720

1. Pinion Gear
2. Shims
3. Ball Bearing
4. Snap Ring
5. Lock Nut
6. Lock Washer
7. 4WD Sliding Gear
8. Snap Ring
9. Collar
10. Snap Ring

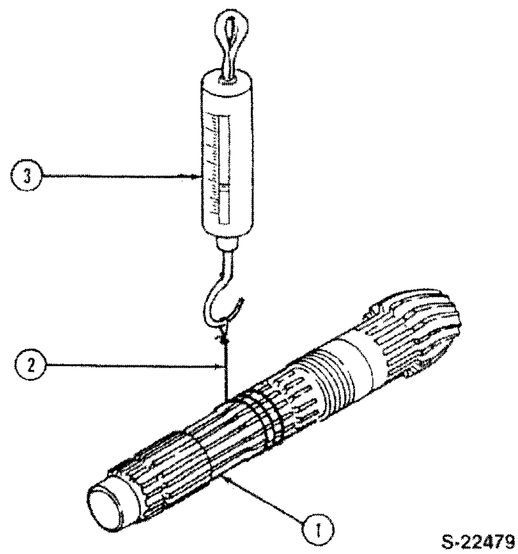


Figure 21
Pinion Preload Adjustment

1. Pinion Shaft
2. String
3. Pull Scale

4. Drive the axle shaft outward and remove from the axle housing.

INSPECTION

Clean the axle components in a suitable solvent and air dry.

1. Inspect the bearings for excess wear or damage.

2. Inspect the final reduction gear teeth for excess wear or damage.

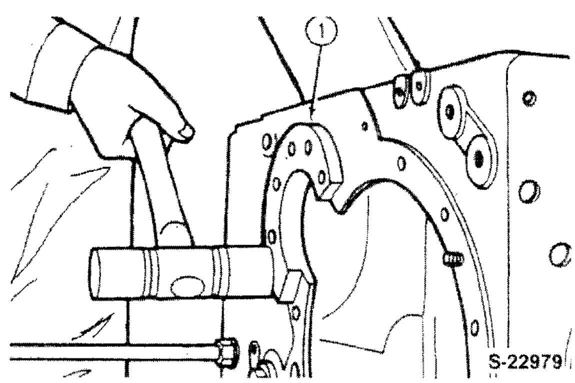


Figure 22
Differential Assembly

1. Bearing Carrier

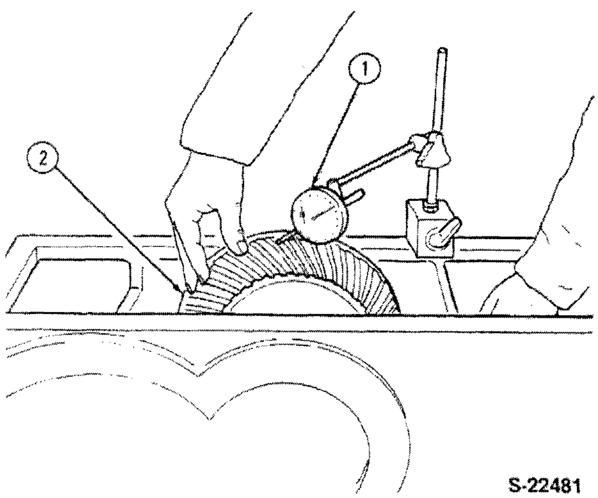


Figure 23
Ring Gear and Pinion Backlash Check
1. Dial Indicator 2. Ring Gear

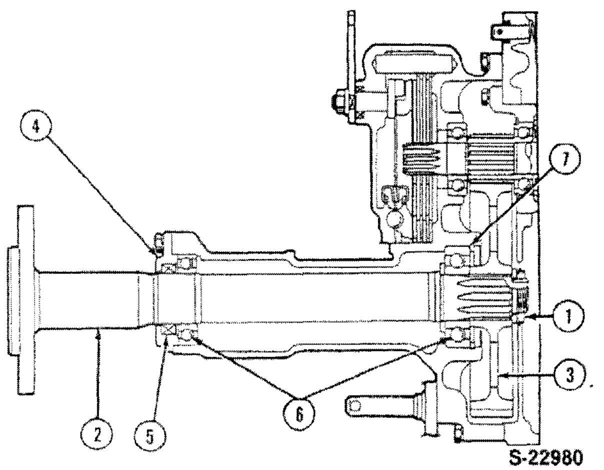


Figure 24
Rear Axle Shaft Removal
1. Lock Nut and Washer
2. Axle Shaft
3. Final Gear
4. Seal Retainer
5. Seal
6. Bearing (2)
7. Snap Ring

ASSEMBLY

1. If removed, install the two axle support bearings (6) and reinstall the inner bearing snap ring (7), Figure 24.

2. Install a new oil seal (5) in the retainer housing, Figure 24.

3. Position the seal retainer on the axle shaft and gently drive the axle into the housing, using care to not damage the oil seal.

4. Position the seal retainer on the housing and install the retaining bolts.

5. Complete the assembly, following the removal procedure in reverse.

BRAKES AND FINAL PINION

DISASSEMBLY

NOTE: *The brakes may be serviced without removing the axle housing from the differential center housing assembly.*

The axle housing must be removed to service the final drive pinion.

1. Disconnect the brake rod clevis at the brake cover lever, Figure 25.

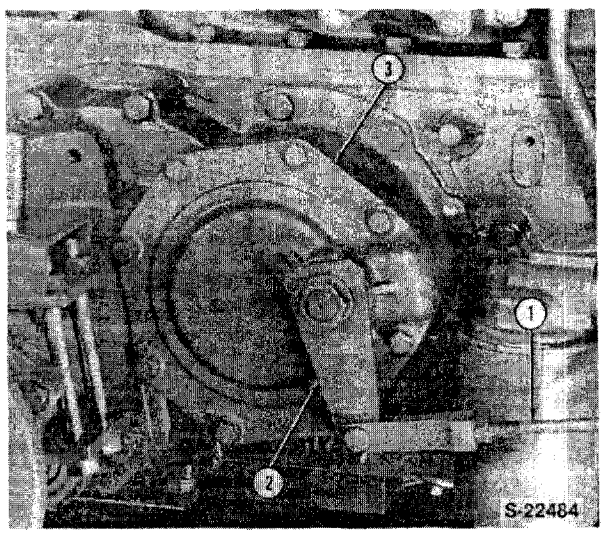


Figure 25
Brake and Final Pinion Disassembly
1. Brake Control Rod
2. Brake Actuating Lever
3. Brake Cover Assembly

2. Remove the brake cover bolts, Figure 26.

   Remove the cover assembly, discs and stators, Figure 26.

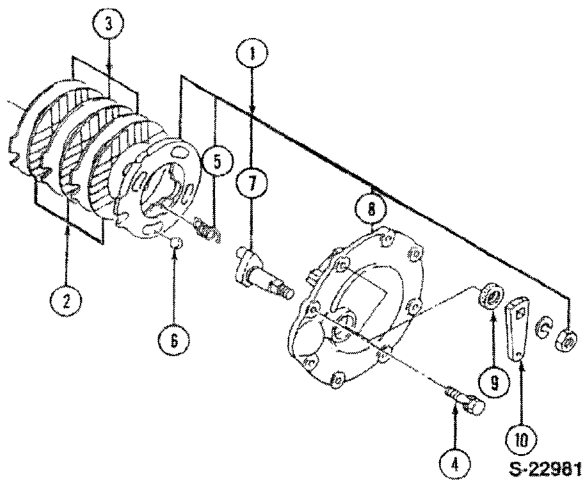


Figure 26
Brake Removal — Model 1720 Shown

1. Cover assembly
2. Discs
3. Stators
4. Bolt
5. Spring
6. Ball
7. Cam
8. Cover Plate
9. Seal
10. Lever

3. If the final pinion is to be removed, gently drive the pinion out of the housing, Figure 27.

NOTE: *Axle housing must be removed from the tractor prior to pinion shaft removal.*

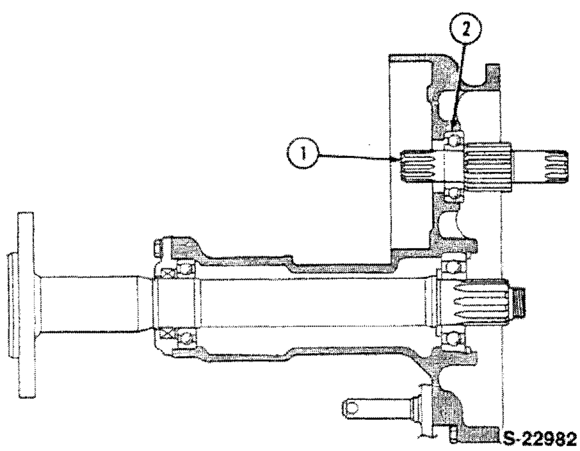


Figure 27
Final Pinion Shaft Removal
1. Final Drive Pinion 2. Bearing

COVER ASSEMBLY — DISASSEMBLY

1. Remove the spring (5), Figure 26.
2. Take out the brake cover plate (8) and steel balls (6).
3. Remove the nut and lever (10), Figure 26.
4. Pull out the brake actuating cam (7) and oil seal (9), Figure 26.

INSPECTION

1. Inspect the brake discs for excess wear or damage. See "Specifications," Chapter 2.
2. Inspect the stators for excess wear or damage. See "Specifications," Chapter 2.
3. Inspect the brake cover, steel balls, actuating cam and springs for wear and replace as required.

ASSEMBLY

COVER ASSEMBLY — ASSEMBLY

Assembly of the brake cover follows the disassembly procedure in reverse.

1. If removed, install the final pinion support bearings and pinion shaft.
2. Install the brake discs and stators.
3. Install the cover assembly.
4. Connect the brake control rod.

BRAKE ADJUSTMENT

1. Check the brake pedal free travel and if necessary adjust the brake rod to obtain 3/4 - 1-3/16 in. (19-30 mm) free travel at the pedal, Figure 28.

   NOTE: *Be sure to test drive the tractor to make sure the braking action on both wheels is equal. If necessary, adjust the outer brake rod to equalize the free-play travel.*

2. Tighten the clevis lock nuts securely.

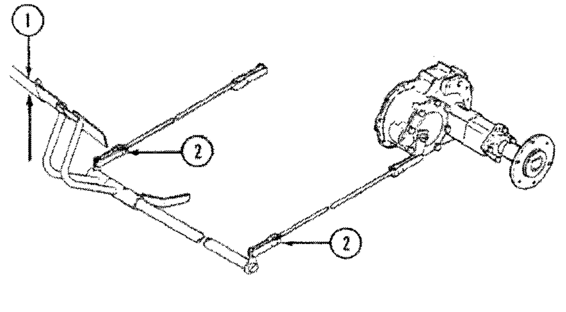


Figure 28
Brake Pedal Adjustment
1. Pedal Free-Play
2. Brake Rod Adjustment Clevis

DIFFERENTIAL LOCK

REMOVAL

To service the differential lock components, it will be necessary to remove the differential assembly, Figure 29 or 30. See "Differential Assembly — Removal," this Chapter.

To disassemble the differential linkage, remove the hydraulic lift cover assembly and the differential lock pedal. Drive the roll pin out of the differential lock shaft, Figure 31.

While supporting the differential fork and spring, slide the shaft out the side of the housing and remove the fork and spring.

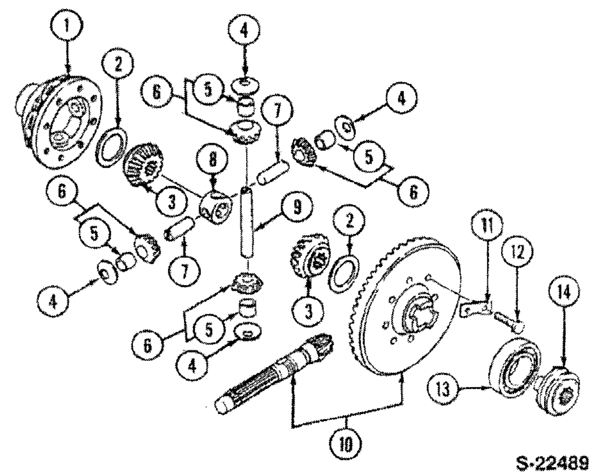


Figure 29
Differential Lock Removal — Model 1320/1520 Shown

1. Differential Housing
2. Thrust Washer
3. Differential Gear
4. Thrust Washer
5. Bushing
6. Gear Assembly
7. Pinion shaft
8. Joint
9. Pinion Shaft
10. Ring Gear Assembly
11. Lock Plate
12. Bolt
13. Ball Bearing
14. Differential Lock Clutch

ASSEMBLY

Position the fork and return spring in the center housing.

Install a new O-ring and oil seal on the shaft.

Insert the shaft through the housing, return spring and fork.

Install the roll pin.

Install the pedal.

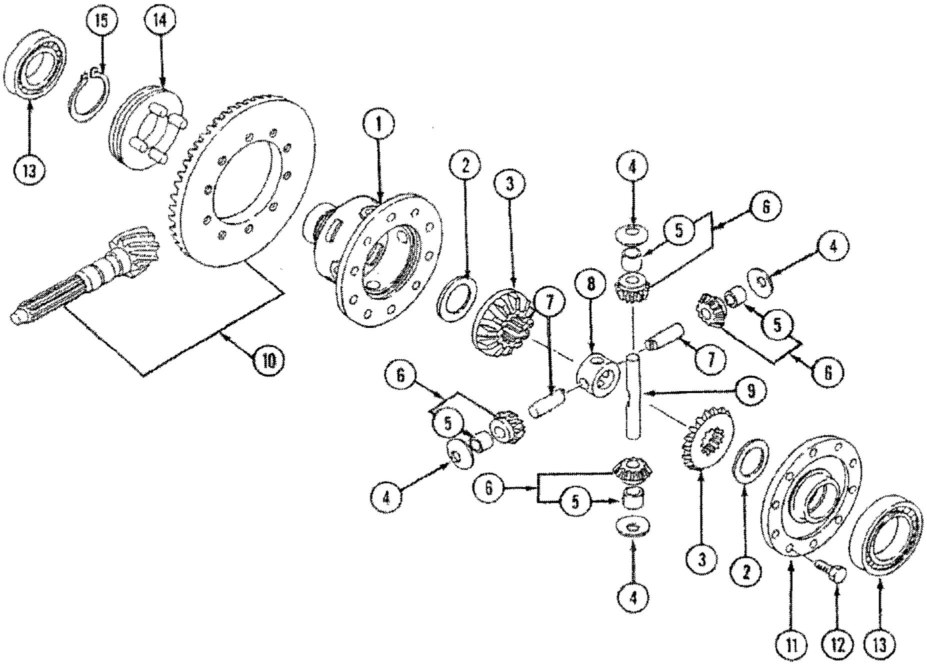


Figure 30
Differential Lock Removal — Model 1720

1. Differential Housing
2. Thrust Washer
3. Differential Gear (Side Gear)
4. Thrust Washer
5. Bushing
6. Gear Assembly
7. Pinion Shaft
8. Joint
9. Pinion Shaft
10. Ring Gear Assembly
11. Differential Housing End Plate
12. Bolt
13. Ball Bearing
14. Differential Lock Clutch
15. Snap Ring

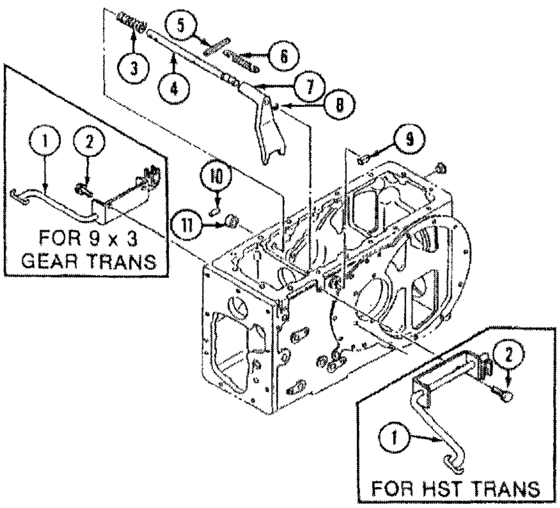


Figure 31
Differential Lock Linkage Disassembly — Model 1320/1520 Shown

1. Differential Lock Pedal
2. Bolt
3. Spring
4. Differential Lock Shaft
5. Roll Pin
6. Spring
7. Differential Lock Fork
8. O-Ring
9. Roll Pin
10. Roll Pin
11. Oil Seal

PART 7
DIFFERENTIAL —
REAR AXLE AND BRAKES

Chapter 2
SPECIFICATIONS

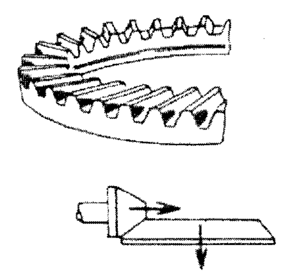
A. SPECIFICATIONS

DIFFERENTIAL ASSEMBLY

Clearance Between Differential Pinion and Pinion Shaft Allowable Limit		.004 in. (0.1 mm) .020 in. (0.5 mm)
Differential Gear Thrust Washer Thickness Allowable Limit		.047 in. (1.2 mm) .035 in. (0.9 mm)
Differential Gear and Differential Pinion Backlash Allowable Limit		.004-.012 in. (0.1-0.3 mm) .020 in. (0.5 mm)
Drive Pinion Preload	Model 1320/1520	15.4-19.8 lbs. (7-9 kg)
	Model 1720	28.6-37.5 lbs. (13-17 kg)
Drive Pinion and Ring Gear Backlash Allowable Limit		.004-.006 in. (0.1-0.15 mm) .012 in. (0.3 mm)

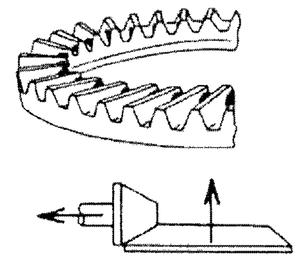
RING GEAR AND PINION GEAR PATTERN SPECIFICATION AND ADJUSTMENT

HEEL CONTACT:

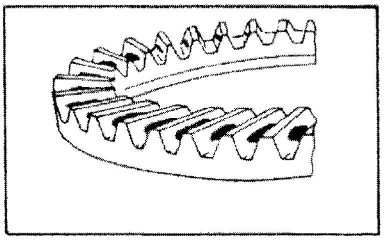


Select the shims so that the drive pinion is put nearer to the ring gear.

TOE CONTACT:

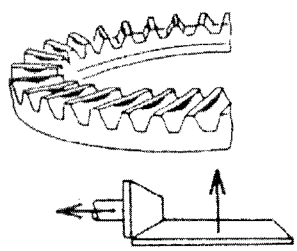


Select the shims so that the ring gear is put farther from the drive pinion.



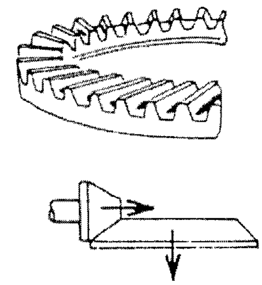
Correct pinion gear to ring gear tooth contact

FACE CONTACT:



Select the shims so that the ring gear is put near to the drive pinion.

FLANK CONTACT:



Select the shims so that the drive pinion is put farther from the ring gear.

BRAKES

Brake discs: Lining Groove Depth	Model 1320/1520	.004 in. (0.1 mm)
	Model 1720	.012 in. (0.3 mm)
Allowable Limit	Model 1320/1520	0.0 in. (0.0 mm)
	Model 1720	.002 in. (0.05 mm)
Stators Level Difference Allowable Limit		.004 in. (0.1 mm)
Clearance of Pedal Shaft and Bushing Allowable Limit		.002-.014 in. (0.05-0.35 mm) .039 in. (1.0 mm)
Brake Pedal Free Play		1.38-1.77 in. (35-45 mm)

BOLT TORQUES

Ring gear and differential cage housing bolts . . . . .36.2-47.0 lbs. ft
(49.0-63.7 Nm)

GENERAL TORQUE VALUES

Bolt Size	Grade No.	Coarse Thread			Fine Thread		
		Pitch (mm)	Pounds-Feet	Newton-Meters	Pitch (mm)	Pounds-Feet	Newton-Meters
M8	4T	1.25	9.4-12.3	12.7-16.7	1.0	11.2-14.8	15.2-20.1
	7T		16.6-21.0	22.6-28.4		19.5-25.3	26.5-34.3
	10T		21.0-26.8	28.4-36.3		22.4-29.7	30.4-40.2
M10	4T	1.5	18.8-24.6	25.5-33.3	1.25	21.0-26.8	28.4-36.3
	7T		32.5-41.2	44.1-55.9		36.2-46.3	49.0-62.8
	10T		39.8-51.4	53.9-69.6		42.7-54.2	57.9-73.5
M12	4T	1.75	27.5-34.7	37.3-47.1	1.25	31.8-40.5	43.1-54.9
	7T		48.5-61.5	65.7-83.4		55.0-69.4	74.5-94.1
	10T		68.0-85.4	92.2-116		73.1-93.3	99.0-127

PART 8
HYDRAULIC SYSTEM

Chapter 1
HYDRAULIC SYSTEM CIRCUITS

Chapter 2
HYDRAULIC PUMP AND FILTER

Chapter 3
REMOTE VALVE

Chapter 4
TROUBLE SHOOTING, PRESSURE TESTING, SPECIFICATIONS AND SPECIAL TOOLS

PART 8
HYDRAULIC SYSTEM

Chapter 1
HYDRAULIC SYSTEM CIRCUITS

A. DESCRIPTION AND OPERATION

The hydraulic position control is standard equipment on the Model 1320/1520/1720 tractors.

NOTE: *The hydraulic draft control is a dealer installed accessory on 1320 and 1520 tractors and a factory installed accessory on 1720 tractors.*

The hydraulic system consists essentially of an oil reservoir, hydraulic pump, lift cylinder and piston, control valve and lift links.

The rear axle center housing and transmission housing serve as a common oil reservoir and supplies oil to the hydraulic pump.

The hydraulic pump supplies oil to the system control valve. The control valve, when operated, effects raise, neutral or lowering action of the lift arms.

The hydraulic pump is mounted on the right hand side of the engine, Figure 1, and is driven by the engine oil pump gear located on the front of the engine block.

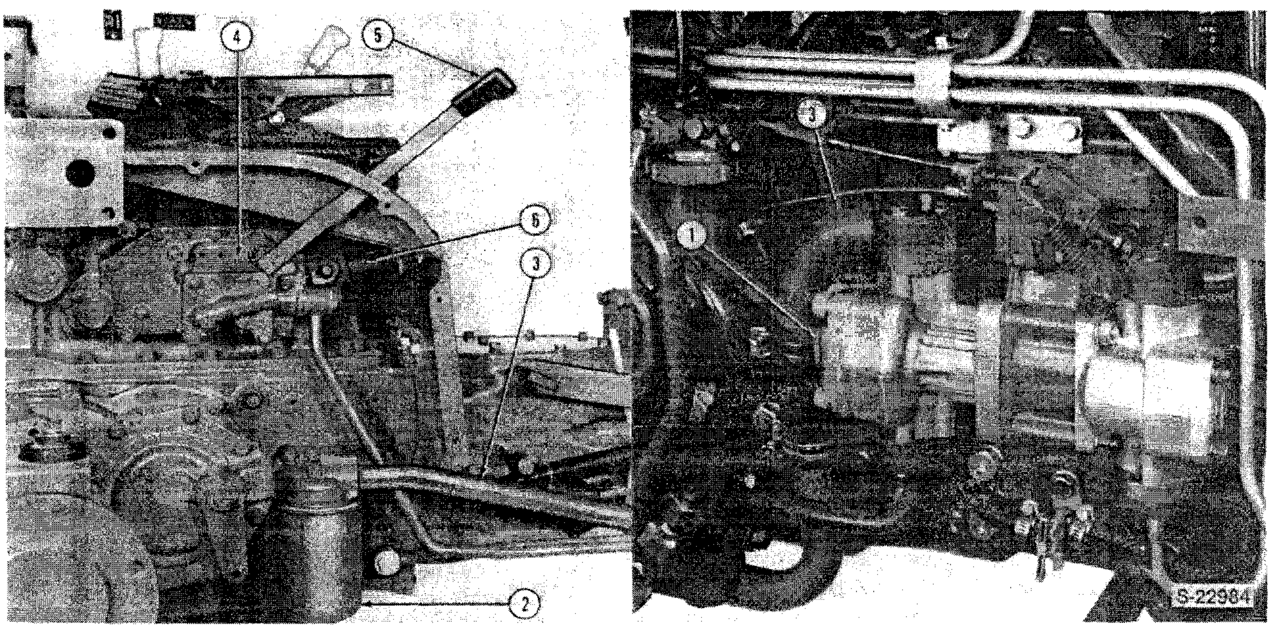


Figure 1
Hydraulic Pump and Filter — Model 1320/1520 Shown

1. Hydraulic Pump
2. Hydraulic Filter
3. Suction Tube
4. Control Valve (Not Visible)
5. Control Valve Lever
6. Flow Control Valve

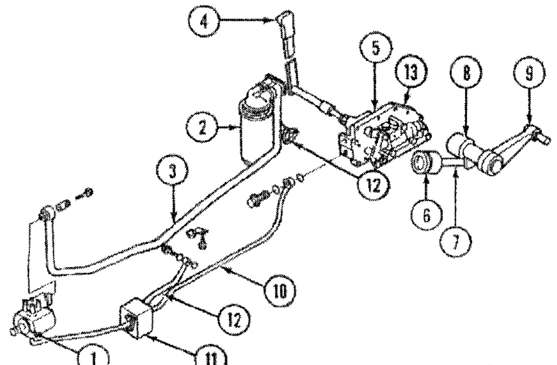


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Figure 2
Hydraulic System Components — Model 1720 Shown

1. Hydraulic Pump
2. Inlet Filter
3. Suction Tube
4. Control Valve Lever
5. Control Valve
6. Piston
7. Piston Rod
8. Ram Arm
9. Lift Arm
10. High Pressure Tube
11. System Relief — Diverter Valve Manifold
12. Return to Sump
13. Control Valve

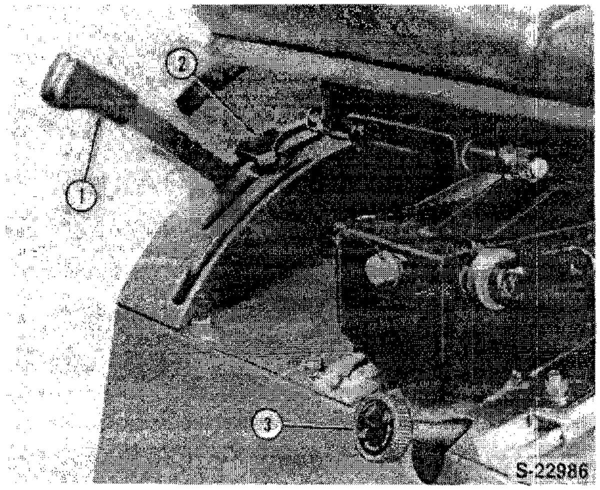

Figure 3
Hydraulic Controls

1. Control Valve Lever
2. Lever Stop
3. Flow Control Valve

The oil is pressurized by the hydraulic pump and flows through the combination system relief-diverter valve manifold (11), Figure 2, mounted on the right hand side of the tractor, and to the control valve (13) which is located inside the hydraulic lift cover assembly, Figure 2.

The hydraulic system is controlled by a single lever (1), Figure 3. An adjustable stop on the quadrant provides a reference for returning the control lever to a preset position.

A flow control valve (3), Figure 3, located on the front of the hydraulic lift cover provides control for the rate of drop of the mounted implement. Closing the control valve completely will lock the lift links in position.

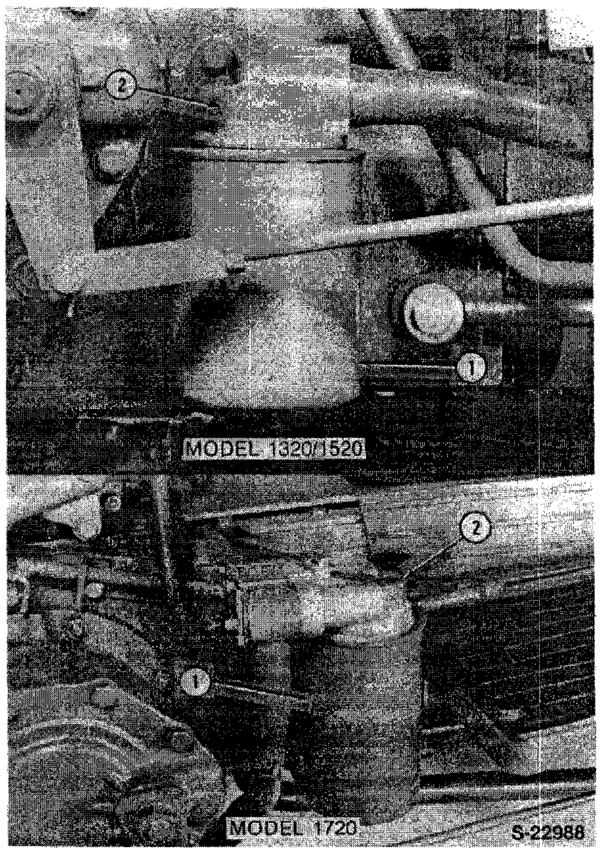

Figure 4
Inlet Filter

1. Inlet Filter Assembly
2. Flange

OIL FILTER

The suction filter is a canister type filter, Figure 4. The filter should be replaced after 300 hours of use.

COMBINATION SYSTEM RELIEF-DIVERTER VALVE MANIFOLD ASSEMBLY

The combination system relief-diverter valve manifold is located in the high pressure line on the right hand side of the tractor, Figure 5.

The valve assembly contains the system relief (8), Figure 6, which protects the hydraulic pump from overload conditions. The valve body also serves as a manifold, containing hose connection ports for use of auxiliary hydraulic equipment, such as loaders. The diverter valve spool (2) permits the operator to select operation of either the auxiliary hydraulic lift system circuits or the hydraulic lift system by rotating the diverter valve spool to the desired position.

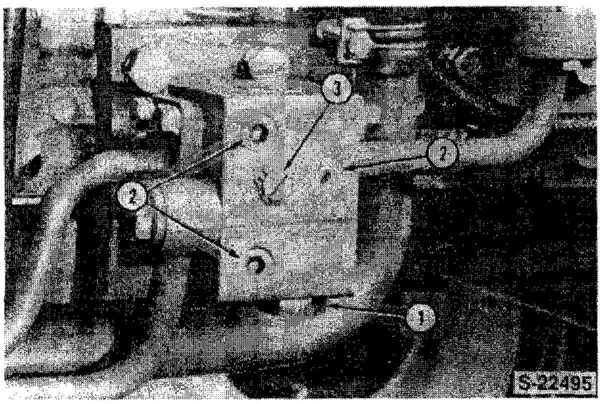

Figure 5
Combination System Relief and Diverter Valve Manifold

1. System Relief Valve
2. Manifold Ports
3. Diverter Valve Spool

CONTROL VALVE ASSEMBLY

The control valve assembly is located inside the hydraulic lift cover and contains the control valve spool (1), lowering valve (2), check valve (3) and shut-off valve (4), Figure 7.

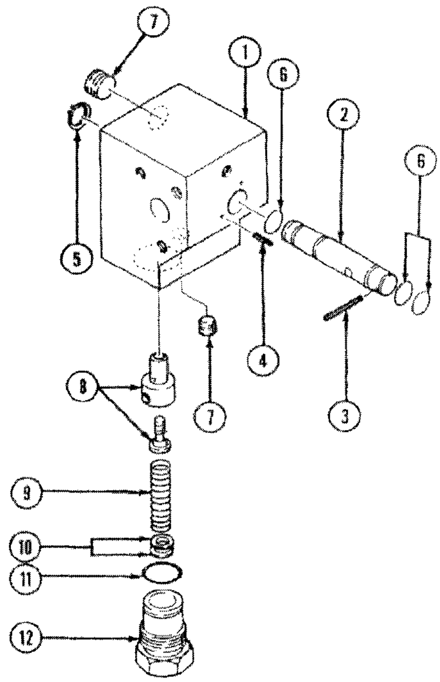

Figure 6
Combination System Relief and Diverter Valve Manifold Components

1. Valve Body
2. Diverter Valve Spool
3. Roll Pin
4. Roll Pin
5. Snap Ring
6. O-Rings
7. Plug
8. System Relief Valve
9. Spring
10. Shim
11. O-Ring
12. Cap Plug

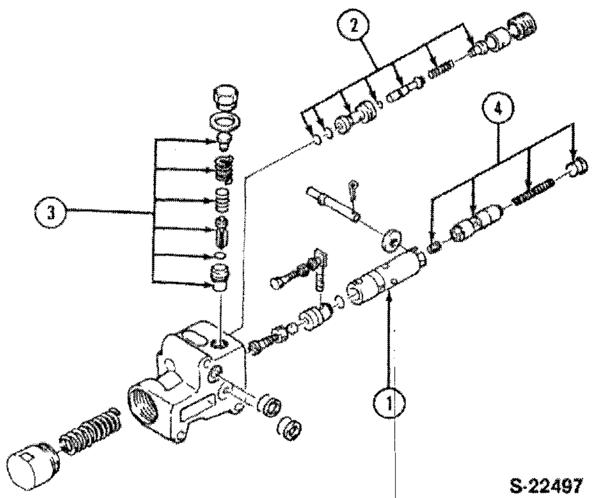

Figure 7
Draft Control Valve Assembly Components

1. Control Valve Spool
2. Lowering Valve
3. Check Valve
4. Shut-Off Valve

OIL FLOW — CONTROL SYSTEM
NEUTRAL POSITION
Reference — Figure 8

In the neutral position the control valve spool (1) is centered in the valve body. Oil from the hydraulic pump is directed through a small passage in the valve spool to the rear face of the control valve plunger (2). The oil pressure moves the plunger compressing the plunger spring (3) and aligns the passages (4) in the control valve and plunger. Oil flows from the pump through the passages (4) and returns to sump.

Oil trapped in the lift cylinder, under pressure caused by the weight of the implement on the lift arms, exerts pressure on the cylinder side of the check valve (5), keeping it in a closed position. The lowering valve spool (6), positioned by the spring (7), retains the oil in the lift cylinder and maintains the implement in a fixed position.

RAISING POSITION
Reference — Figure 9

When the draft control lever is moved to the "raise" position, the control valve spool (1) is moved inward (rearward). The oil passages in the control valve spool and plunger (2) are no longer aligned and oil flows around the control valve and lowering valve spool (3), through passage (4), to the check valve (5). The oil pressure against the check valve overcomes the check valve spring (6), and lift cylinder oil static pressure on the check valve, raising the check valve off its seat and allowing oil to flow to the lift cylinder to raise the implement.

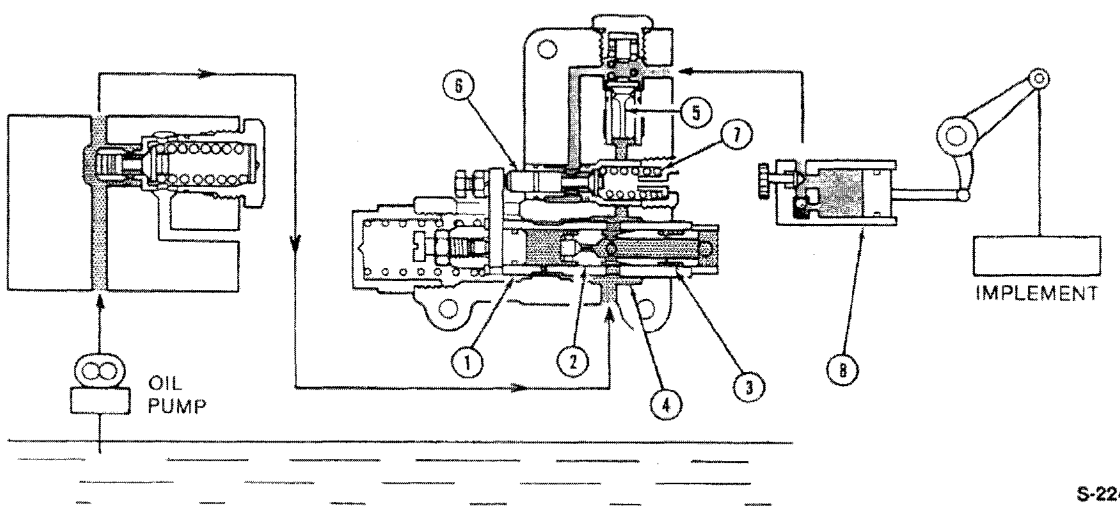

Figure 8
Oil Flow — Neutral Position
(Position Control Valve)

1. Control Valve Spool
2. Plunger
3. Plunger Spring
4. Oil Passage Ports
5. Check Valve
6. Lowering Valve Spool
7. Lowering Valve Spool Spring
8. Lift Cylinder

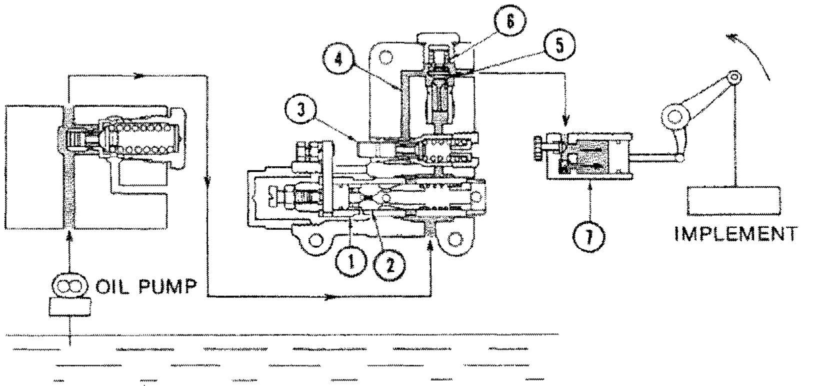

Figure 9
Oil Flow — Raising Position
(Position Control Valve)

1. Control Valve Spool
2. Plunger
3. Lowering Valve Spool
4. Check Valve Oil Passage
5. Check Valve
6. Check Valve Spring
7. Lift Cylinder

When the oil pressure in the system exceeds 2135 psi (150 bars), the relief valve opens and oil is returned to sump.

LOWERING POSITION
Reference — Figure 10

When the draft control lever is moved to lowering position, the control valve spool (1) is moved forward (outward). The pin (2), and adjusting bolt (3), attached to the control valve spool, also moves forward and contacts the lowering valve spool (4), pushing it off its seat (5).

Oil from the pump flows through the passages in the control valve spool and plunger and returns to sump as in the neutral position.

Oil in the lift cylinder (6) flows through passage past the check valve (7) to the lowering valve spool and seat and returns to sump permitting the implement to lower.

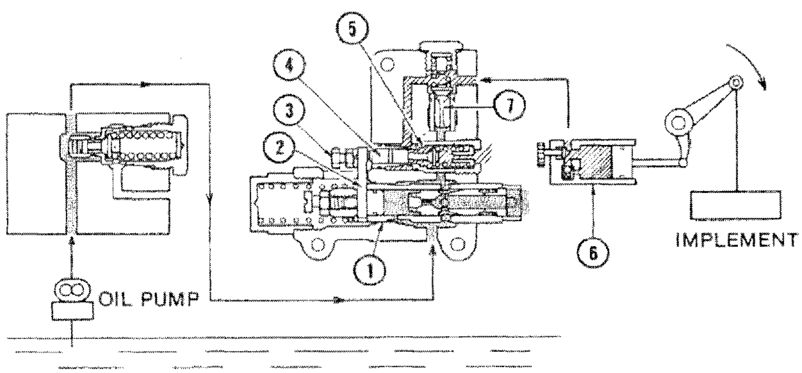

Figure 10
Oil Flow — Lowering Position
(Position Control Valve)

1. Control Valve Spool
2. Pin
3. Adjusting Bolt
4. Lowering Valve Spool
5. Lowering Valve Seat
6. Lift Cylinder
7. Check Valve

FLOW CONTROL VALVE
Reference — Figure 11

Oil flow from the pump enters the lift cylinder via the check ball and the flow control valve needle and seat, Figure 11. When the needle valve is closed or severely restricted, oil pressure opens the check valve and flows to the lift cylinder during the raising cycle. When the needle valve is closed, the one-way check valve prevents oil from returning from the lift cylinder and the lift arms remain at their set height.

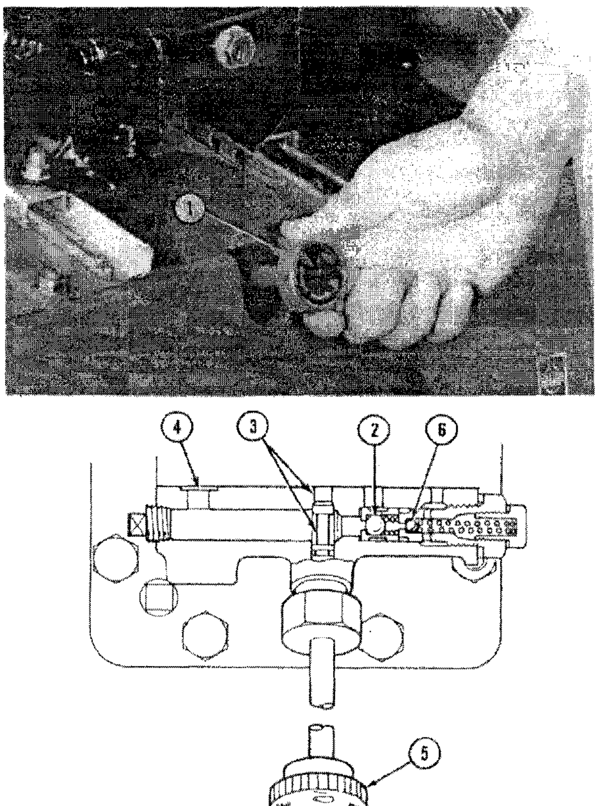

Figure 11
Flow Control Valve Assembly
(Needle Valve Shown in Closed Position)

1. Flow Control Valve Assembly
2. Check Ball
3. Needle and Seat
4. Inlet Passage
5. Needle Valve Control Knob
6. High Pressure Safety Valve

During the lowering cycle, the oil being exhausted from the lift cylinder must return to the reservoir via the needle valve and seat. To obtain the desired rate of drop, adjust the needle valve control knob to achieve the desired effect.

The high pressure safety valve located in the flow control valve body protects the lift cylinder against shock loads. When cylinder pressure exceeds 3625 ± 290 psi (250 ± 20 bars), the safety valve opens and allows the cylinder oil to escape to sump.

LINKAGE OPERATIONS — SINGLE LEVER — POSITION CONTROL MODELS
Reference — Figue 12

The single lever hydraulic system, Figure 12, consists of the single quadrant control lever (1), connected by internal linkage to the control valve spool and, when moved, determine a raise, lower, or neutral condition for the hydraulic system.

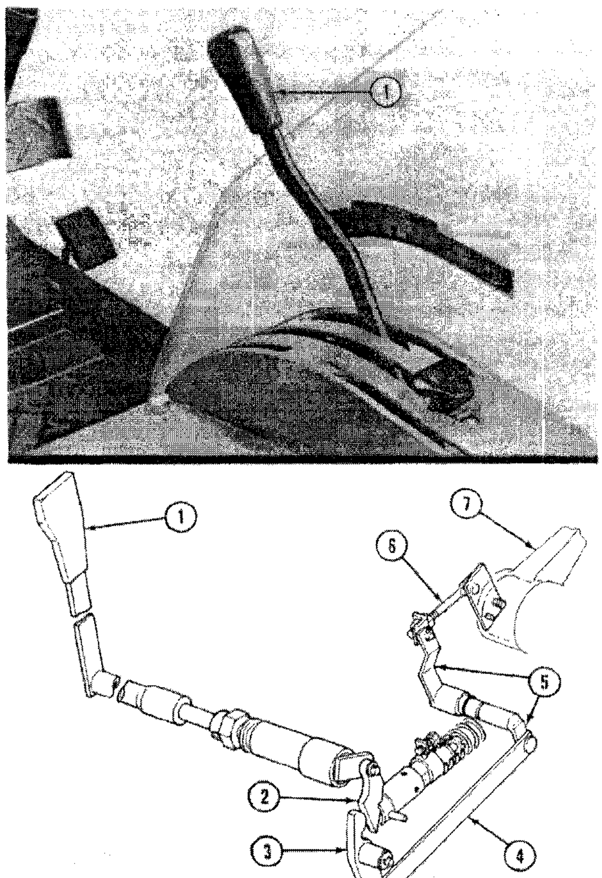

Figure 12
Position Control (Single Lever)
Linkage Operation — Model 1720 Shown

1. Position Control Lever
2. Position Control Lever Cam
3. Feedback Link Cam
4. Feedback Link (Internal)
5. Feedback Link Shaft
6. Feedback Rod
7. Lift Arm

The single lever control (position control) is used to maintain mounted implements at a constant height relative to the tractor. The lift arms (7) respond to the movement of the control lever (1). The rod (6), connected to the lift arm, actuates the feedback links (3), (4), and (5) to move the control valve spools to neutral position when the desired height is achieved.

POSITION CONTROL OPERATION — NEUTRAL POSITION TO RAISE

Reference — Figure 13

When the position control lever (1) is moved to the raise position, cam (2) is rotated between cam (3), and the control valve spool (8), forcing the control valve inward into a raise position. Pump oil then flows to the lift cylinder and the lift arms raise.

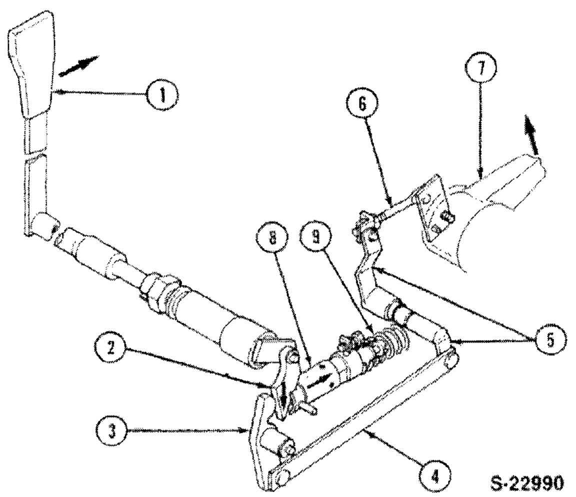

Figure 13
Position Control Operation — Neutral Position to Raise

1. Position Control Lever
2. Position Control Lever — Cam
3. Feedback Link — Cam
4. Feedback Link (Internal)
5. Feedback Link (Int./Ext.)
6. Feedback Adjustment Rod
7. Lift Arm
8. Control Valve Spool
9. Valve Return Spring

RAISE POSITION TO NEUTRAL POSITION

Reference — Figure 14

When the lift arms (7) raise, the feedback link (4) moves rearward allowing the spring loader control valve spool (8) to move forward (outward) to the neutral position. Pump oil flow is redirected to sump and the lift arms stop raising.

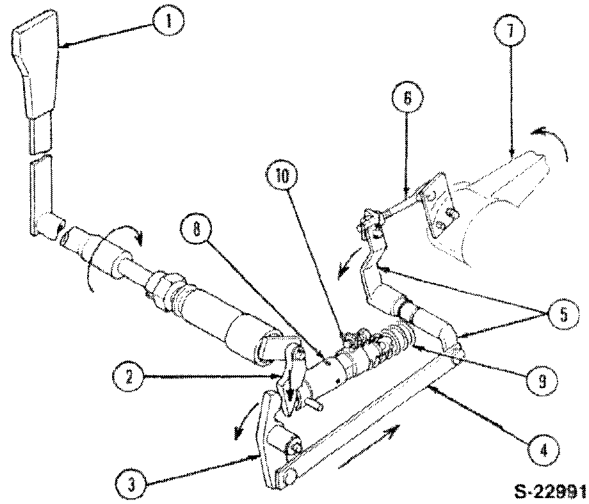

Figure 14
Position Control Operation — Raise Position to Neutral Position

1. Position Control Lever
2. Position Control Lever — Cam
3. Feedback Link — Cam
4. Feedback Link (Internal)
5. Feedback Link (Int./Ext.)
6. Feedback Adjustment Rod
7. Lift Arm
8. Control Valve Spool
9. Valve Return Spring
10. Lowering Pin and Bolt

NEUTRAL POSITION TO LOWERING POSITION

Reference — Figure 15

When the control lever (1) is moved to the lowering position, cam (2) is moved upward reducing the pressure on the control valve spool (8). The spring (9) then moves the control valve spool forward (outward) and pump oil flow is directed to sump. The lowering pin and bolt (10) moves toward the valve body contacting the lowering valve spool (not shown), pushing it off its seat allowing lift cylinder oil to exhaust to sump via the flow control valve. This lowers the lift arm.

LINKAGE OPERATION — TWO LEVER DRAFT CONTROL MODELS (OPTION)

Reference — Figure 16

The two lever hydraulic system has two quadrant levers connected by internal linkage to the control valve spool and when moved determine a raise, lower, or neutral condition for the hydraulic system. The front lever (11), position control, is used to maintain the mounted implement at a selected height relative to the tractor.

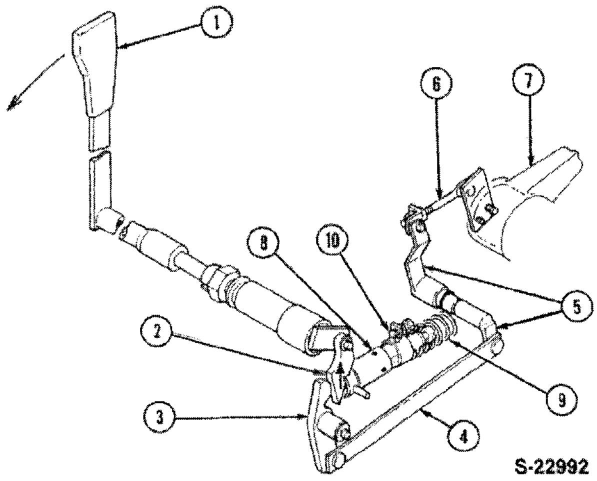

Figure 15
Position Control Operation — Neutral Position to Lowering

1. Position Control Lever
2. Position Control Lever — Cam
3. Feedback Link — Cam
4. Feedback Link (Internal)
5. Feedback Link (Int./Ext.)
6. Feedback Adjustment Rod
7. Lift Arm
8. Control Valve Spool
9. Valve Return Spring
10. Lowering Pin and Bolt

The rear lever (1), draft control, provides automatic implement depth control to maintan a constant draft on the tractor.

The system of automatic depth control (draft control) uses the top compression link to signal for raising or lowering the implement to maintain a constant draft.

When the control lever is moved to the full lowered position, the implement carried on the lift arms will float until a raise signal is received.

NOTE: *Position control operation (raise, netural and lowering condition) is same as single lever position control models.*

TOP LINK SENSING — RAISE
Reference — Figure 16

As soil conditions vary, an increase in implement draft will increase the force on the top link (8) and further compress the draft control main spring (7) to move the feedback linkage (3, 4, 5 and 6) in the direction of the arrows and push the control valve spool inward to a raise position. This action causes the implement to raise and as the implement is lifted, the force on the top link and main spring decreases and reduces the force on the feedback linkage and cam on the control valve spool. The control valve spring moves the control valve spool outward into the neutral position when the force on the top link and main spring is reduced to the original amount to maintain the original draft load on the tractor.

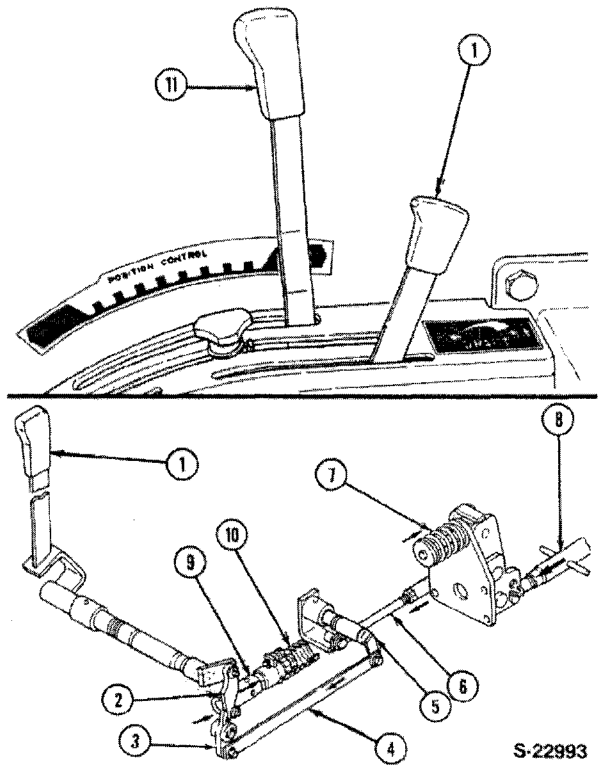

Figure 16
Draft Control Linkage Operation — Top Link Sensing to Raise

1. Draft Control Lever
2. Control Lever — Cam
3. Feedback Link — Cam
4. Feedback Link (Internal)
5. Feedback Arm
6. Adjustment Rod
7. Main Spring
8. Top Link
9. Control Valve Spool
10. Valve Spring
11. Position Control Lever

TOP LINK SENSING — LOWERING
Reference — Figure 17

As the soil conditions vary to decrease the draft load of the implement, the force on the top link (8) is reduced and causes the main spring (7) to extend. This action causes the feedback linkage (3, 4, 5 and 6), to move in the direction of the arrows reducing the force on the control valve spool (9). The control valve spring (10) then moves the spool forward into the lowering position. This action causes the implement to lower and as the implement lowers, the force on the top link and main spring increases the force of the linkage (3, 4, 5 and 6) against the control valve spool. The control valve spool then moves inward to the neutral position when the force on the top link and main spring is increased to the original amount to maintain the original draft load on the tractor.

The raising and lowering actions are repeated with changing forces on the top link as created by variations in soil conditions.

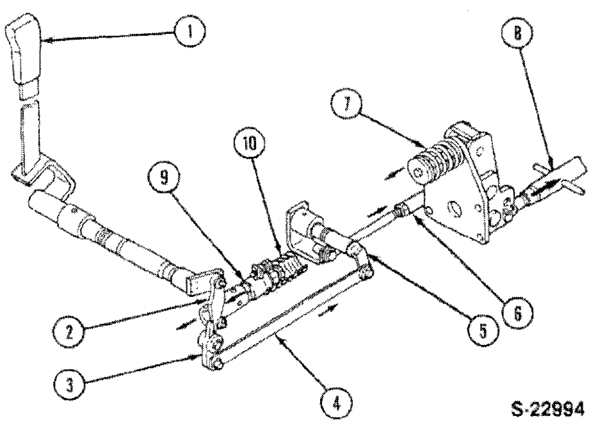

Figure 17
Draft Control Linkage Operation — Top Link Sensing-To Lower

1. Draft Control Lever
2. Control Lever — Cam
3. Feedback Link — Cam
4. Feedback Link (Internal)
5. Feedback Arm
6. Adjustment Rod
7. Main Spring
8. Top Link
9. Control Valve Spool
10. Valve Spring

TOP LINK SENSING — VARYING DRAFT CONTROL SETTINGS
Reference — Figure 18

As described above, varying forces on the top link (7) move the feedback linkage (3, 4 and 5), back and forth to apply appropriate pressure on the control valve spool and spring to maintain a constant draft load on the tractor.

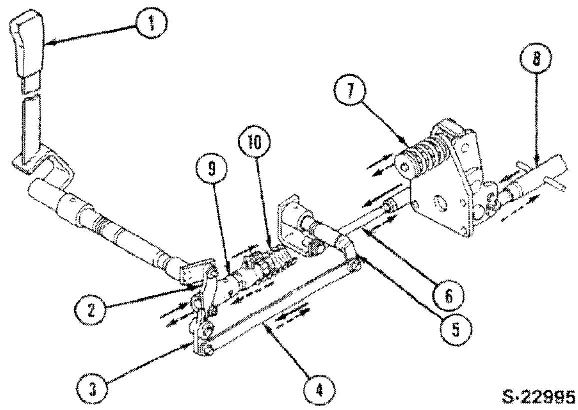

Figure 18
Top Link Sensing — Varying Draft Sensing

1. Draft Control Lever
2. Lever Cam
3. Feedback Cam
4. Feedback Link
5. Feedback Arm
6. Feedback Adjustment Rod
7. Main Spring
8. Top Link
9. Control Valve Spool
10. Valve Spring

The draft load is manually selected by the operator by positioning of the draft control lever. As the draft control lever is moved forward (down), the lever cam (2) is moved up causing greater top link force to move the feedback linkage and control valve spool into the raise position.

As the draft control lever is moved up on the quadrant, the lever cam (2) is moved downward and the control valve spool is moved closer to the raise position and lifting takes places with a small increase in top link pressure and movement of the feedback linkage.

Adjusting the draft control lever up or down on the quadrant repositions the lever cam (2) to provide the appropriate resistance to the top links to suit operating conditions.

LINKAGE OPERATION — COMBINING POSITION AND DRAFT CONTROL SETTINGS
Reference — Figures 19 and 20

The hydraulic sytem linkage consists of two sets of control lever cams (1 and 2) and feedback cams (3 and 4) to actuate the control valve spool.

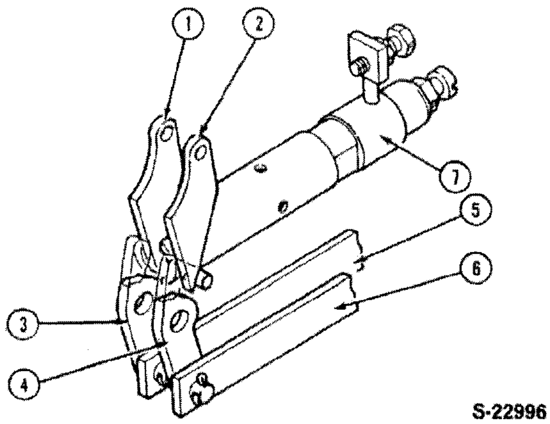

Figure 19
Position and Draft Control Linkage

1. Draft Control Lever — Cam
2. Position Control Lever — Cam
3. Draft Feedback Link — Cam
4. Position Feedback Link — Cam
5. Draft Feedback — Link
6. Position-Feedback Link
7. Control Valve Spool

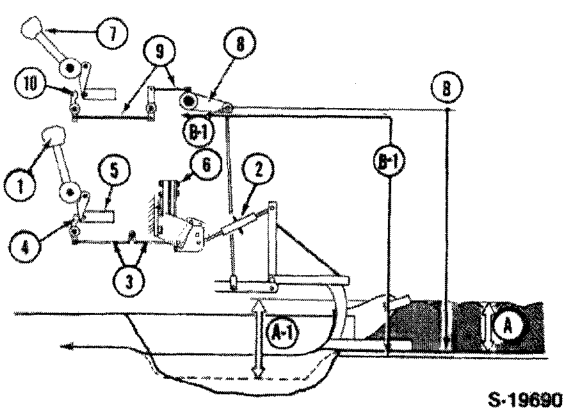

Figure 20
Combined Position and Draft Control Operation

1. Draft Control Lever
2. Top Link
3. Draft Control Feedback Links
4. Draft Control Feedback Cam
5. Control Valve Spool
6. Main Spring
7. Position Control Lever
8. Lift Arms
9. Position Control Feedback Links
10. Position Control Feedback Cam

Draft control (implement sensitivity to raising and lowering) is adjusted with the draft control lever (1), Figure

20. When the ground conditions remain constant, the implement depth will also remain constant with the depth selected by the draft control lever. If ground conditions become soft, the top link (2) pressure decreases causing the draft control feedback links (3), and cam (4), to move the control valve spool (5) to lower the implement from position A to position A1 to maintain the same draft load and top link pressure against the top link main spring (6).

The position control lever (7) is used to provide a minimum implement operating depth. With the position control lever set at a minimum depth setting, the lift arms (8) lower from position B to position B1. The implement will not lower below the B1 position because the oil in the lift cylinder is retained as the control valve spool (5) is shifted from lowering to neutral position thus limiting the distance the implement will drop in soft ground.

When the tractor passes the soft ground, top link pressure increases and the draft control rod and cam react to raise the implement to maintain the orignal draft setting.

B. OVERHAUL

LIFT CYLINDER ASSEMBLY REMOVAL

1. Before removing the lift cover assembly, discharge the oil from the lift cylinder by lowering the lift links to their lowest position.

2. Disconnect the wiring harness at the fenders.

3. Remove the roll bar.

DRAFT CONTROL MODELS — ONLY

- Remove the draft control feedback rod (1), Figure 21.

- Remove the top link bracket assembly (2) as a unit, Figure 21.

4. Remove the fenders and tool box.

5. Remove the lynch pins and disconnect the lift rods (3) from the lift arms (4), both sides.

6. Remove the pin (1), Figure 22, and remove the seat (2), from the suspension assembly.

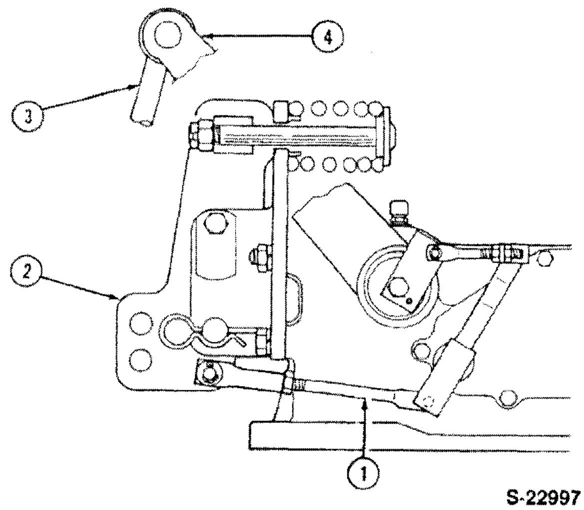

Figure 21
Lift Cover Removal
(Draft Control Model Shown)

1. Draft Control Feedback Link
2. Top Link Bracket and Main Spring
3. Lift Rods
4. Lift Arms

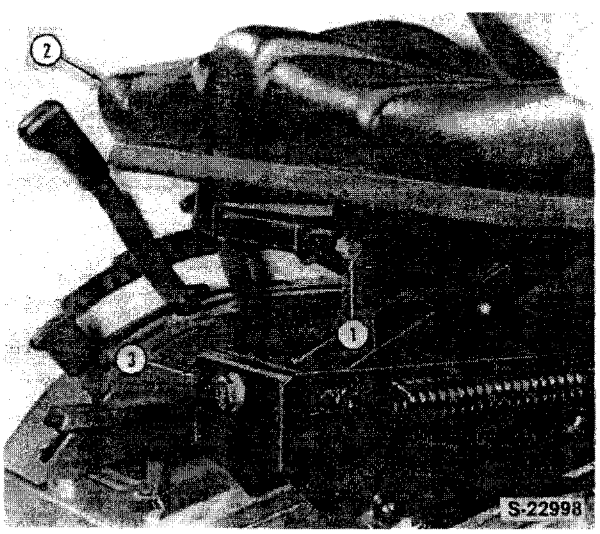

Figure 22
Seat Removal

1. Pin
2. Seat
3. Seat Suspension

7. Remove the seat suspension (3).

8. Disconnect the high pressure line (1) from the lift cover, Figure 23.

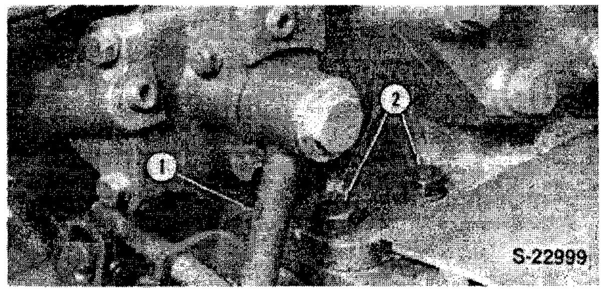

Figure 23
Lift Cover Removal

1. High Pressure Line
2. Lift Cover Retaining Bolt and Nut

9. Remove the shift control cover, left side, and hydraulic control lever guide, right side.

   NOTE: *Bolts of different length are used at various locations. Observe the bolt lengths as removed for ease of assembly.*

10. Remove the seat floor and remove the front hydraulic lift housing cover.

11. Disconnect the shifter links (1), Figure 24.

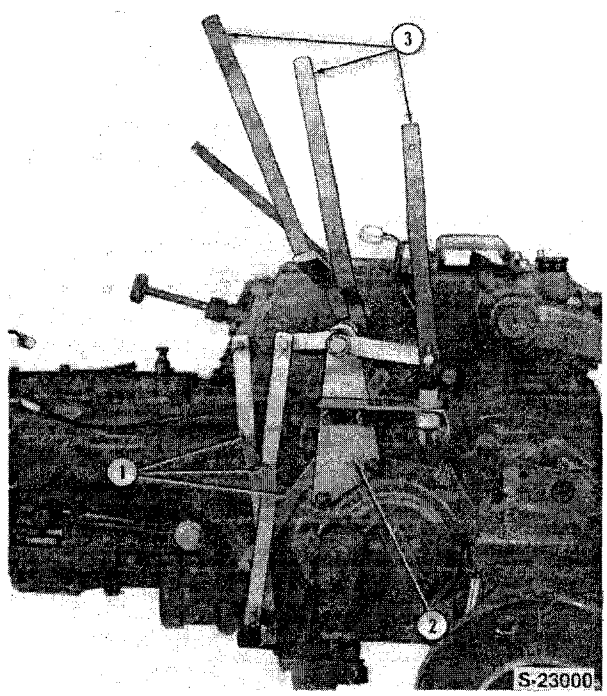

Figure 24
Shifter Linkage Removal —
Model 1320/1520 Shown

1. Links
2. Lever Support Bracket
3. Shifter Levers

12. Remove the shifter levers and support bracket as an assembly.

13. Remove the lift cover retaining bolts and nuts.

    NOTE: *Bolts of different length are used at various locations. Observe the bolt lengths as removed for ease of assembly.*

14. Using a suitable overhead hoist, remove the lift cover from the tractor, Figure 25.

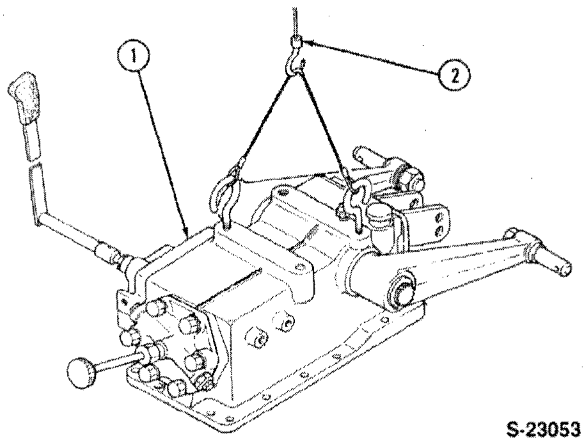

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Figure 25
Lift Cover Removal
1. Lift Cover Assembly 2. Hoist

DISASSEMBLY
Reference — Figure 26

1. Remove the pin (1) and remove the position control rod (2) from the lift arm (3).

2. Remove the control lever(s) grip(s).

3. Remove the valve cover bolts (5), Figure 26, and remove the cover and valve as an assembly, Figure 27.

4. Remove the flow control valve attaching bolts (7), and nut and remove the valve assembly from the lift cover, Figure 26.

5. Remove the cylinder liner (1) through the front of the cover assembly, Figure 28.

6. Using a wood dowel, push the piston out of the liner through the head end.

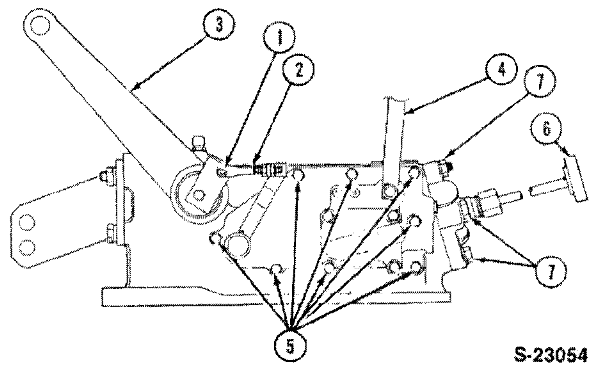

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Figure 26
Lift Cover Disassembly
1. Pin
2. Position Control Rod
3. Lift Arms
4. Control Lever
5. Valve Cover Bolts
6. Flow Control Valve
7. Flow Control Valve Retaining Bolts and Nut

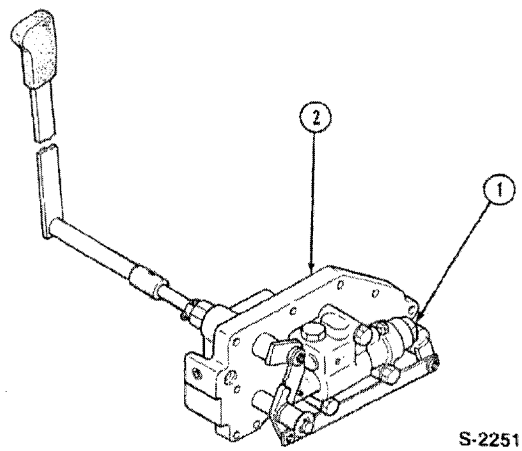

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Figure 27
Hydraulic Control Valve Removal
(Position Control Model Shown)
1. Control Valve 2. Cover

7. Remove the feedback link (5) from the cross shaft, Figure 29.

8. Remove the snap rings (1) holding the lift arms (2) on the shaft (3) from each side, Figure 29.

9. Scribe a reference mark (4) across the end of the cross shaft and lift arm for reference on assembly, Figure 29.

10. Using a suitable puller, remove the lift arms.

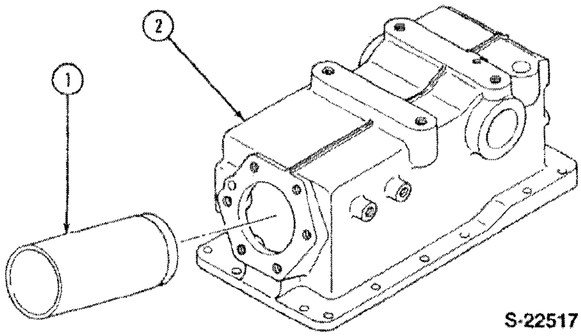

Figure 28
Hydraulic Lift Cylinder Removal
1. Cylinder Liner 2. Lift Cover

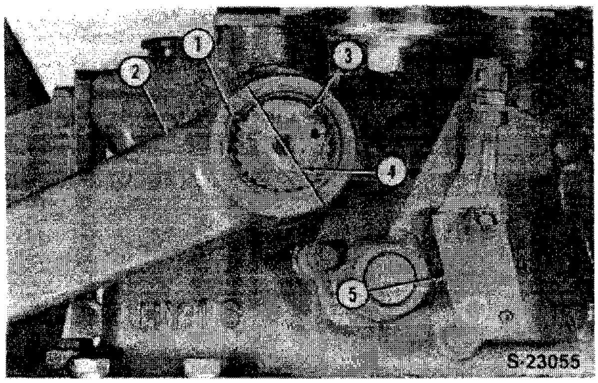

Figure 29
Lift Arm Removal
1. Snap Ring
2. Lift Arm
3. Cross Shaft
4. Reference Mark
5. Feedback Link

11. Scribe a mark (1) on the ram arm (2) and cross shaft (3) for assembly purposes, Figure 30.

12. Slide the ram arm back on the shaft while pulling the cross shaft out the left side of the housing, Figure 30.

INSPECTION AND REPAIR

1. Check the piston and cylinder liner for excess wear or damage. Replace if necessary.

2. Check the cross shaft bushings for excess wear or damage. Replace the bushings if necessary, using a suitable driver as shown, Figure 31.

   NOTE: *Be sure to install the bushings to the correct depth as shown, Figure 31.*

3. Replace all O-rings and seals using new parts.

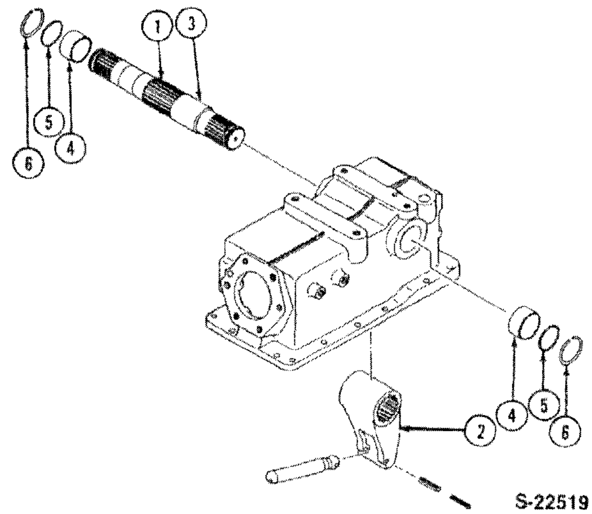

Figure 30
Lift Shaft and Ram Arm Removal
1. Reference Mark
2. Ram Arm
3. Cross Shaft
4. Bushing
5. O-Ring
6. Spring Washer

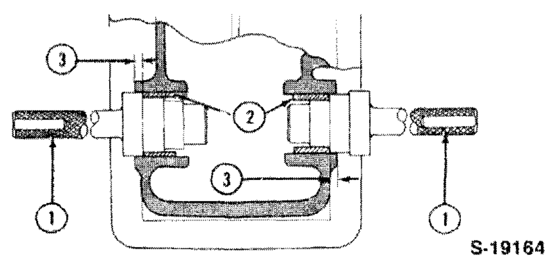

Figure 31
Cross Shaft Bushing Installation
1. Bushing Driver
2. Bushings
3. Clearance Dimension:
   .276 in (7 mm) 1720
   .236 in. (6 mm) 1320/1520

ASSEMBLY
Reference — Figure 32

1. Clean all parts in a suitable solvent and air dry.

2. Lubricate all parts including O-rings and seals with clean hydraulic oil during assembly.

3. Install the cross shaft (1) in the cover while correctly positioning the ram arm.

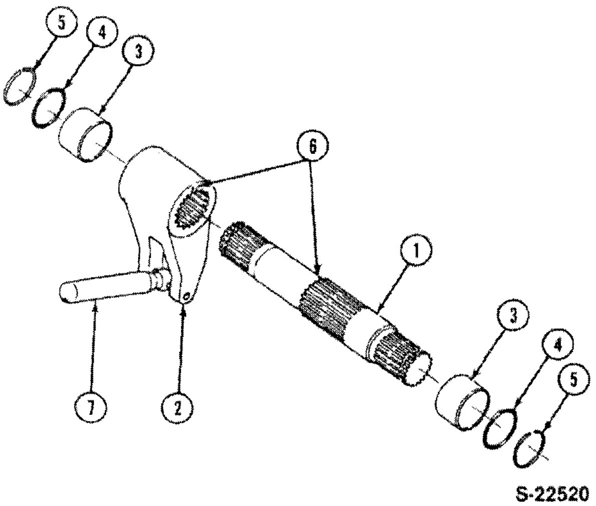

Figure 32
Lift Cross Shaft Assembly

1. Cross Shaft
2. Ram Arm
3. Bushing
4. O-Ring
5. Spring Washer
6. Reference Mark
7. Piston Rod

NOTE: *Be sure to align the reference marks (6) as shown, Figure 32.*

4. Install the cylinder liner in the lift cover housing, Figure 33. Be sure to position the piston rod inside the cylinder liner during installation.

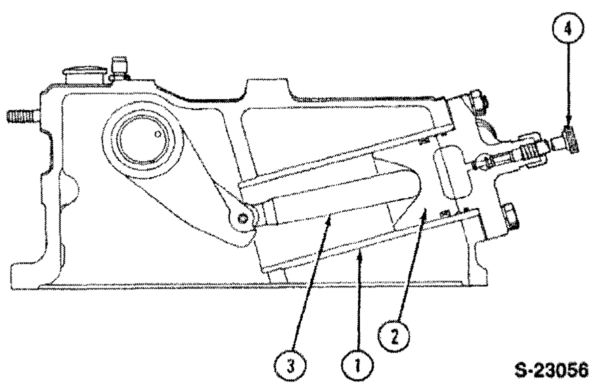

Figure 33
Cylinder Assembly

1. Cylinder "Liner"
2. Piston
3. Piston Rod
4. Flow Control Valve

5. Install the piston seal on the piston and position the cylinder through the head opening, Figure 34. Exercise care to not damage the seal during installation.

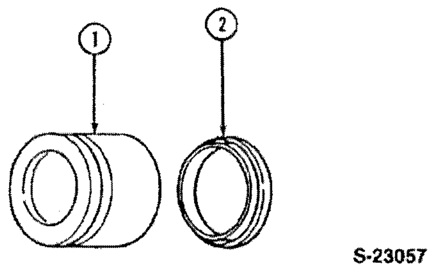

Figure 34
Hydraulic Piston Assembly

1. Piston
2. "U" Seal

6. Using a new O-ring and gasket, install the flow control valve assembly (4) and tighten the bolts to the specified torque, Figure 33. See "Specifications," Chapter 3.

7. Using a new O-ring, install the O-ring, spring washer, lift arm and snap ring on each side, Figure 35.

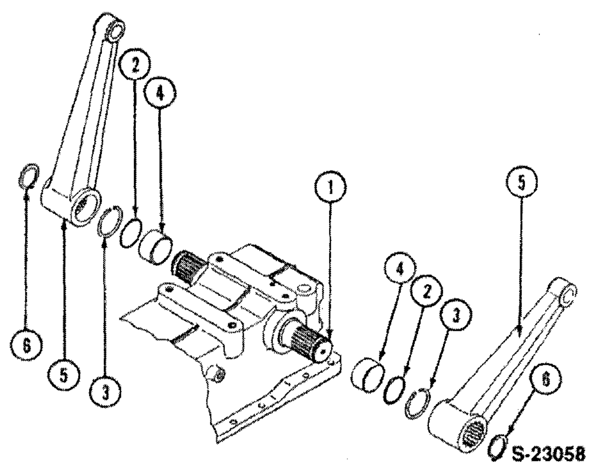

Figure 35
Lift Arm Assembly

1. Cross Shaft
2. O-Ring
3. Spring Washer
4. Bushings
5. Lift Arm (R. & L.)
6. Snap Ring

NOTE: *Be sure to align the reference marks scribed at time of disassembly. If no scribe marks are present, install the lift arms positioned as shown, Figure 36.*

8. Install the lift cover assembly on the tractor. Tighten the bolts to the specified torque. See "Specifications," Chapter 3.

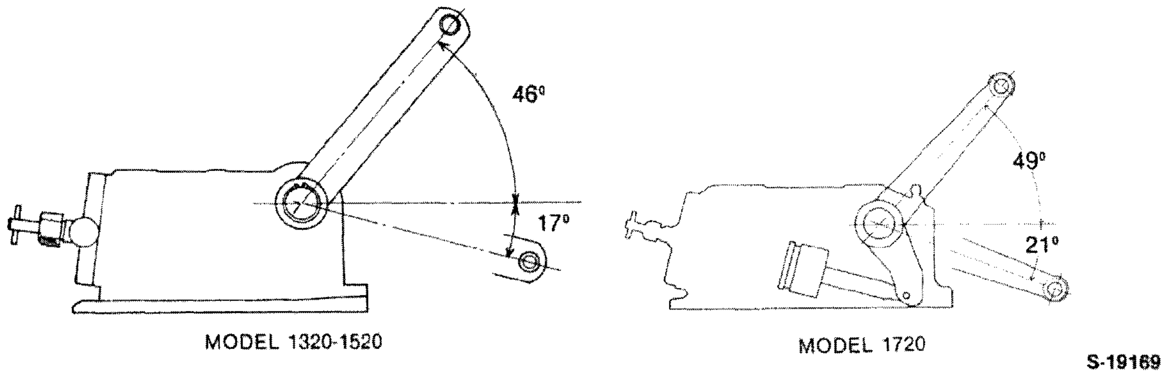

Figure 36
Lift Arm Assembly — Angle of Travel

9. On draft control models, if disassembled, assemble the top link bracket and main spring as shown, Figure 37.

10. Install the top link bracket assembly, control linkage and hydraulic line following the removal procedure in reverse.

    NOTE: *Observe and follow the linkage and main spring adjustment procedure described in section C, this Chapter.*

11. Be sure to reinstall seat belts on tractors equipped with ROPS. Do not install the seat belts if tractor is not equipped with ROPS.

FLOW CONTROL VALVE
Reference — Figures 38 and 39

REMOVAL

1. Remove the flow control valve — cylinder head assembly retaining bolts (1), and remove the valve from the lift cover, Figure 38.

DISASSEMBLY
Reference — Figure 39

1. Remove the safety valve (1) as an assembly.

2. Remove the check valve spring (10), ball (11), guide (12) and gasket (13).

3. Remove the guide nut (19) from the cylinder head and screw the valve stem (18) out of the body.

SAFETY RELIEF VALVE — DISASSEMBLY
Reference — Figure 39

1. Remove the bolt (2) and shims (3), Figure 39.

   NOTE: *Observe the quantity of shims (3) used between the spring and guide bolts.*

2. Remove the spring (5) and ball (6) from the valve body (7).

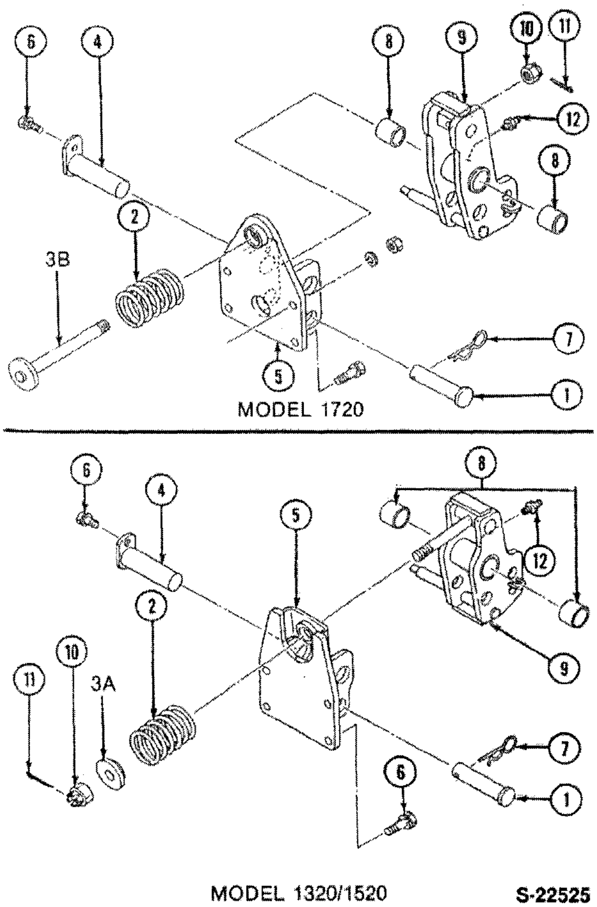

Figure 37
Top Link Bracket and Main Spring Components (Draft Control Model Only)

1. Pin
2. Main Spring
3A. Guide
3B. Pin
4. Pivot Pin
5. Bracket
6. Bolt
7. Pin
8. Bushing (2)
9. Arm
10. Nut
11. Cotter Pin
12. Grease Fitting

INSPECTION

1. Wash all valve components in a suitable solution and air dry.

2. Inspect the valve seats for excess wear or damage.

3. Inspect the flow control valve stem (seat) and check balls for excess wear or damage.

4. Inspect the springs for excess wear or chipping.

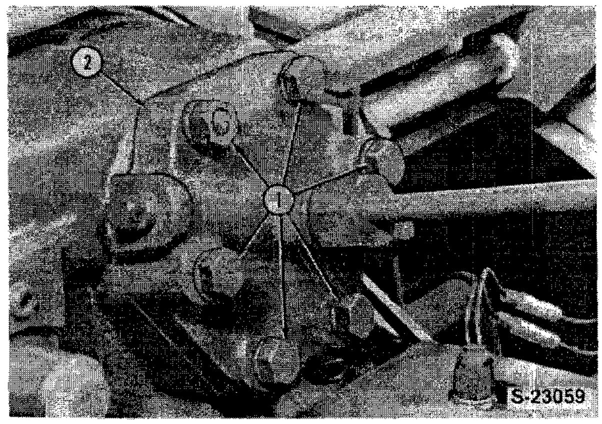

Figure 38
Flow Control Valve Removal

1. Retaining Bolts and Nut
2. Valve Assembly

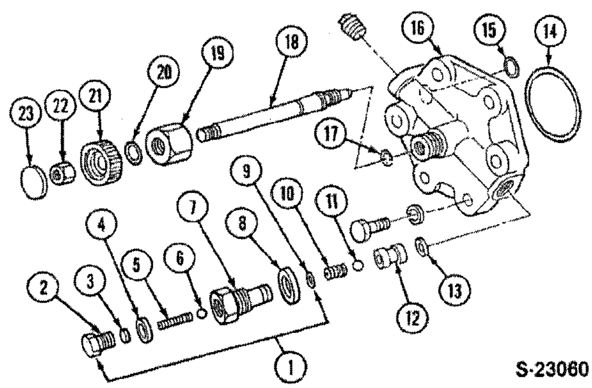

Figure 39
Flow Control Valve Components

1. Safety Valve Assembly
2. Bolt
3. Shim
4. Seal Washer
5. Spring
6. Ball (Relief Valve)
7. Valve Body
8. Seal
9. O-Ring
10. Spring
11. Ball (Check Valve)
12. Guide
13. Gasket
14. O-Ring
15. O-Ring
16. Cylinder Head
17. O-Ring
18. Valve Stem
19. Guide
20. O-Ring
21. Grip
22. Nut
23. Plate

ASSEMBLY

1. Lubricate all valve components with clean hydraulic oil during assembly.

2. Assemble the flow control valve as shown, Figure 39, using new O-rings and seals.

CONTROL VALVE ASSEMBLY

REMOVAL

See "Lift Cover Assembly — Disassembly"

SINGLE LEVER — POSITION AND TWO-LEVER DRAFT CONTROL MODELS

Reference — Figure 40

DISASSEMBLY

Two-Lever System Shown, Control Valve — Removal

1. Remove the valve to cover retaining bolts (1) and remove the valve (2) from the cover.

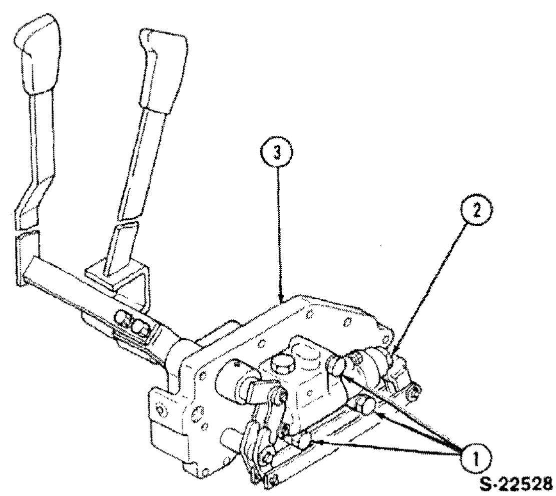

Figure 40
Two Lever Hydraulic Control Valve Removal

1. Control Valve Mounting Bolts
2. Control Valve Assembly
3. Cover

NOTE: *Single lever position control valve assembly is the same as two lever draft control valve assemby.*

2. Remove the control valve spool as follows. See Figure 41.
   - Remove the cap (1) and spring (2) from the valve body.
   - Loosen the locknut (4) and remove the screw (3) and plug (5) from the control valve spool (8).

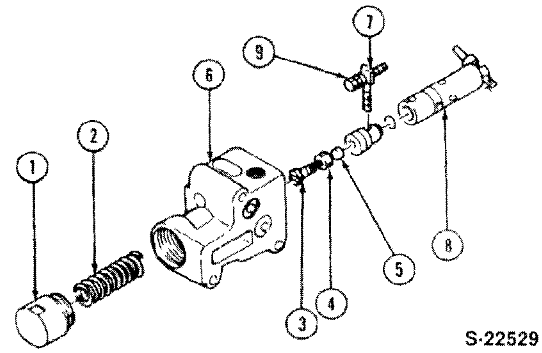

Figure 41
Two Lever Control Valve Disassembly

1. Cap
2. Spring
3. Screw
4. Locknut
5. Plug
6. Valve Body
7. Pin
8. Control Valve Spool
9. Adjustment Bolt

   - Remove the pin (7) and remove the spool from the body.

   NOTE: *Do not remove the adjusting bolt (9) from the pin, unless required, as this affects the valve adjustment setting.*

3. Disassemble the control valve spool as follows. See Figure 42.

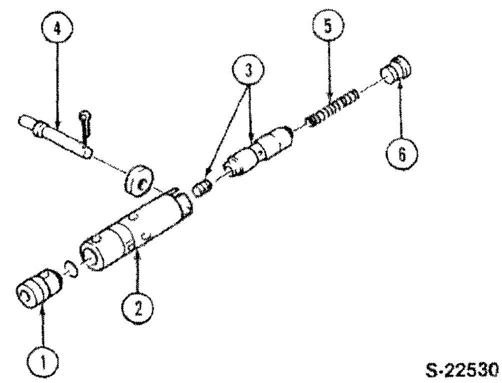

Figure 42
Two Lever Control Valve Spool Disassembly

1. Plug
2. Spool
3. Plunger
4. Pin
5. Spring
6. Spring Seat

   - Remove the plug and O-ring (1).
   - Push inward on the spring seat (6) and remove the pin (4) with a small punch.

- Remove the spring seat (6), spring (5), and plunger (3).

4. Remove the lowering valve spool plug (5), collar (4), spring seat (3), spring (2), and lowering valve spool (1) from the valve body, Figure 43.

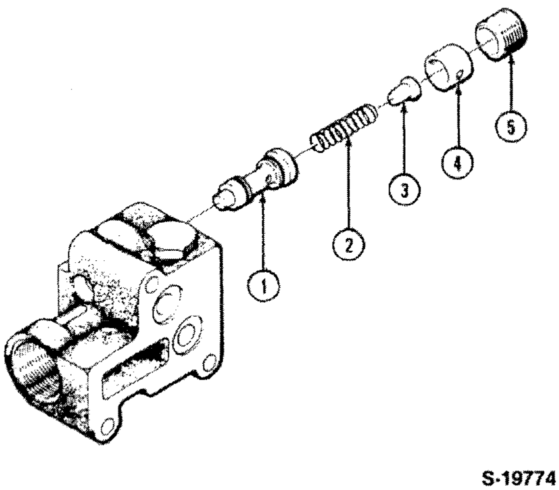

Figure 43
Two Lever Control Valve Disassembly

1. Lowering Valve
2. Spring
3. Spring Seat
4. Collar
5. Plug

5. Remove the check valve cap (1), spring seat (2), springs (3 and 4), check valve (5), and seat (6) from the top of the valve body, Figure 44.

INSPECTION

1. Clean all components in a suitable solvent and air dry.

2. Inspect the valve spools and bores for excess wear, scratches or other damage.

   NOTE: *The control valve assembly and body must be replaced as a matched set only.*

3. Inspect the check valve seat and bushing seat area for uneven wear or other damage. Replace the valve and bushings as a set if required.

4. Inspect all O-ring grooves for nicks or burrs.

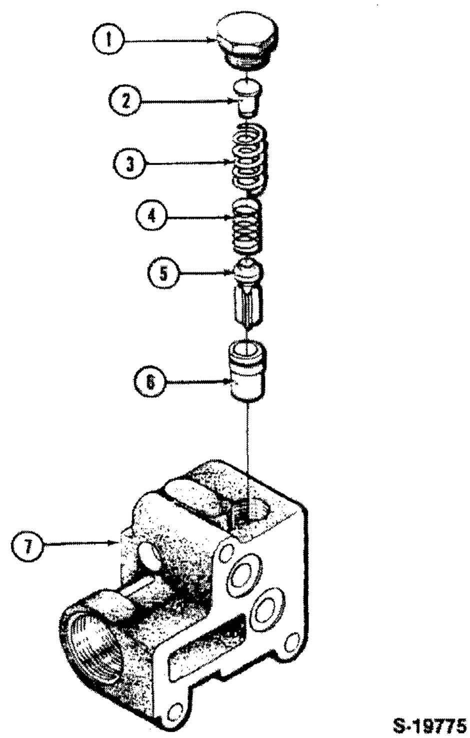

Figure 44
Two Lever Control Valve Disassembly

1. Cap
2. Spring Seat
3. Spring
4. Spring
5. Check Valve
6. Seat
7. Valve Body

ASSEMBLY

Reference — Figures 45 and 46

1. Clean all valve components in a suitable solvent and air dry.

2. Using clean hydraulic oil, lubricate all valve components including O-rings on assembly.

3. Replace all O-rings and gaskets using new parts.

4. Assemble and install the control valve spool assembly in reverse of the disassembly procedure, see Figure 42. Tighten the plug (1) to 72 lbs. ft. (98 Nm) torque.

5. Install the lowering valve spool components, Figure 43. Tighten the plug (5) to 18 lbs. ft. (24 Nm) torque.

6. Install the check valve components, Figure 44. Tighten the cap (1) to 43 lbs. ft. (58 Nm) torque.

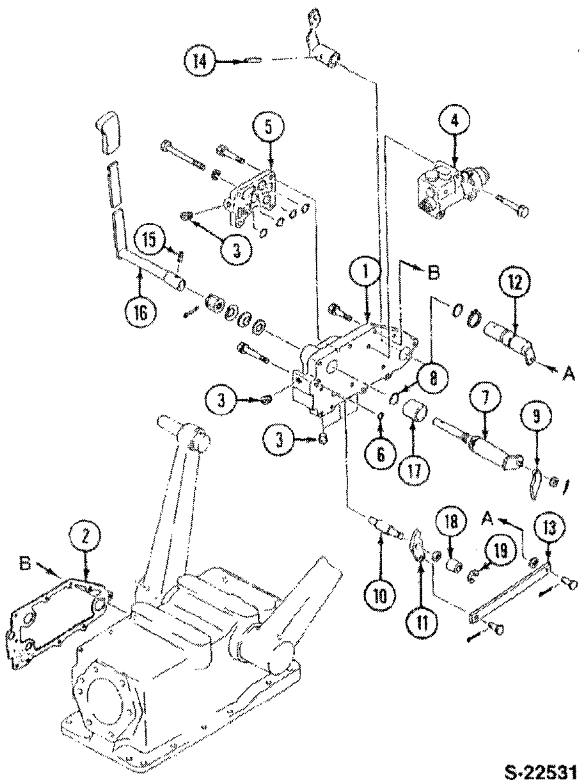

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Figure 45
Single Lever Position Control Valve Components

1. Cover
2. Gasket
3. Plug
4. Valve Assembly
5. Cover
6. O-Ring
7. Shaft — Position Control
8. O-Ring
9. Position Control Cam
10. Shaft
11. Position Control Cam
12. Shaft — Position Control
13. Position Control Link
14. Roll Pin
15. Roll Pin
16. Lever
17. Collar
18. Collar
19. Snap Ring

INSTALLATION

1. Using new O-rings, install the control valve to the cover.
2. Position the control valve and cover assembly with a new gasket on the lift cover assembly and install the attaching bolts. Tighten the attaching bolts to the specified torque. See "Specifications," Chapter 3.
3. Install the quadrant guide and handle grips.
4. Install the position control link and adjust as described in section C, this Chapter.

   On draft control models, install the draft control feedback rod and adjust as described in section C, this Chapter.

COMBINATION SYSTEM RELIEF AND DIVERTER VALVE ASSEMBLY

REMOVAL
Reference — Figure 47

1. Disconnect the relief valve to sump return line (2) at the valve body fitting.
2. Remove the pump pressure line (4) and pressure line to control valve (5) at the valve body fitting.
3. Remove the valve retaining bolts and remove the valve assembly.

DISASSEMBLY
Reference — Figure 48

1. Remove the relief valve plug (1).

   NOTE: *Make note of the quantity of shims (3) used between the spring (4) and plug. Retain shims for use during assembly.*

2. *Remove the spring (4) and relief valve and seat assembly (5).*
3. *Remove the roll pin (12) from the diverter valve spool (11) and withdraw the spool from the manifold body.*

INSPECTION

1. Inspect the relief valve seat and the guide (5) for excess wear or score marks.
2. Inspect the spring for wear or damage.
3. Inspect the diverter valve spool (11) and valve body (6), for excess wear or score marks.
4. Replace the manifold as an assembly if damaged.

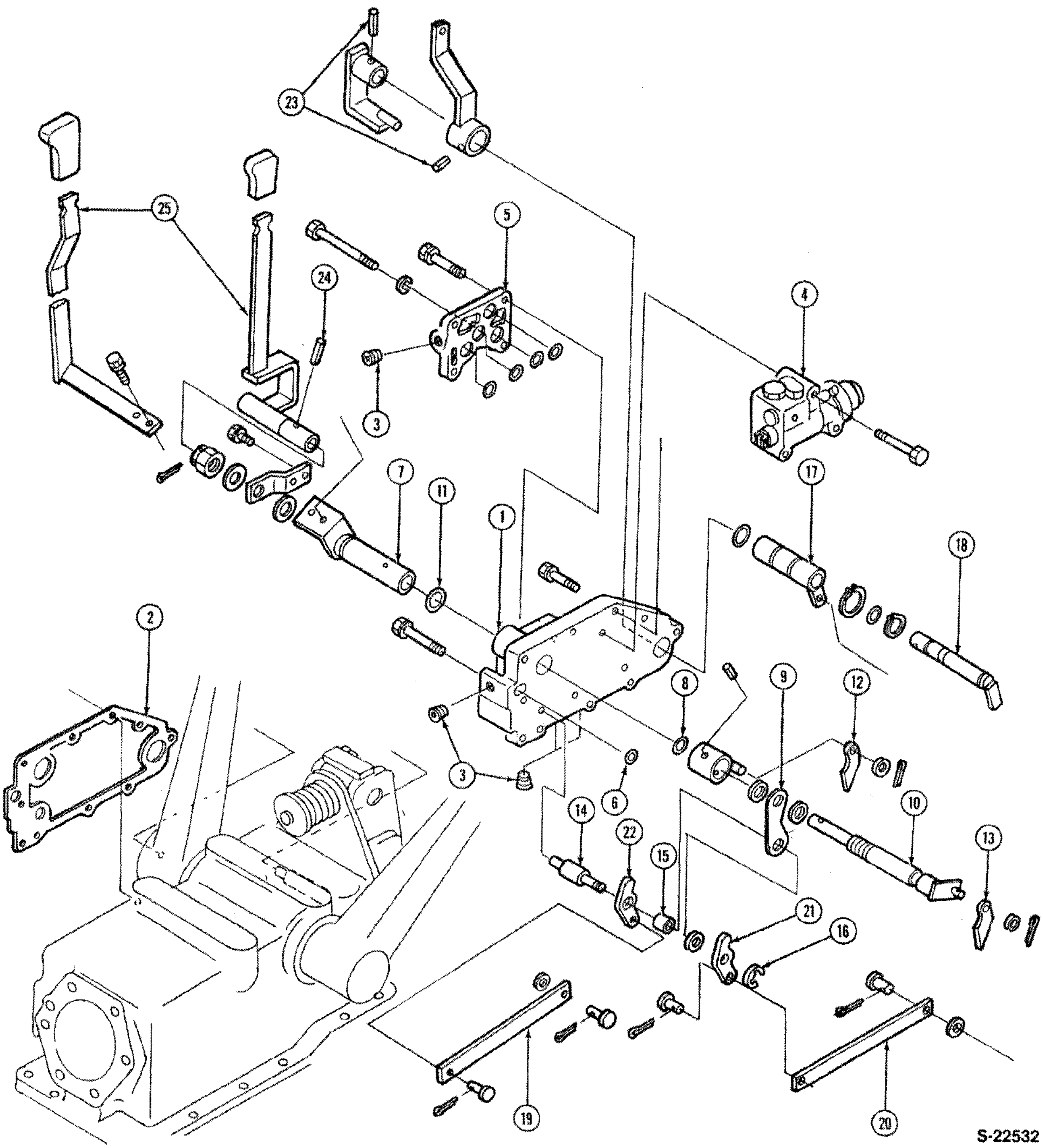


Figure 46
Two Lever Draft (Option) Control Valve Components

1. Cover
2. Gasket
3. Plug
4. Valve Assembly
5. Cover
6. O-Ring
7. Shaft — Position Control
8. O-Ring
9. Plate
10. Shaft — Draft Control
11. O-Ring
12. Position Control Cam
13. Draft Control Cam
14. Shaft
15. Collar
16. Snap Ring
17. Shaft — Position Control
18. Shaft — Draft Control
19. Position Control Link
20. Draft Control Link
21. Draft Control Cam
22. Position Control Cam
23. Roll Pins
24. Roll Pins
25. Levers

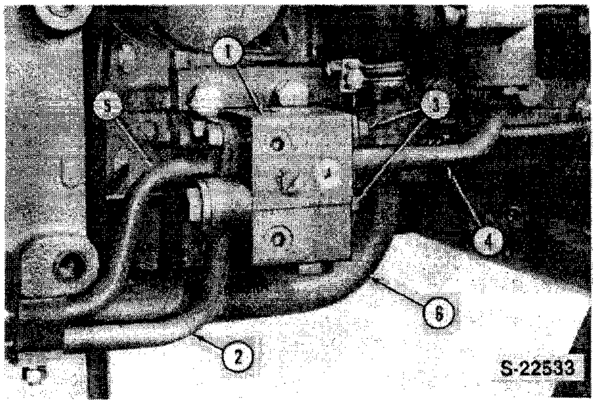


Figure 47
Combination System Relief and Diverter Valve Assembly

1. Valve Assembly
2. Return to Sump Line
3. Retaining Bolt
4. Pump Pressure Line
5. Pressure Line to Control Valve
6. Suction Line

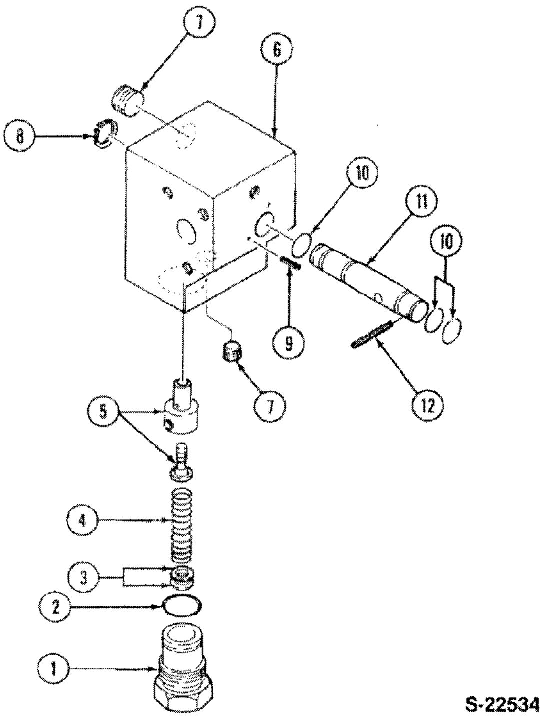


Figure 48
Combination System Relief Valve and Diverter Valve Manifold Components

1. Plug
2. O-Ring
3. Shim
4. Spring
5. Relief Valve Assembly
6. Body
7. Plugs (2)
8. Snap Ring
9. Roll Pins (2)
10. O-Rings (3)
11. Diverter Valve Spool
12. Roll Pin

ASSEMBLY

Reassembly of the valve follows the disassembly procedure in reverse.

Install new O-ring seals during assembly and reinstall the manifold assembly on the tractor.

C. ADJUSTMENTS

SINGLE LEVER POSITION CONTROL

LINKAGE ADJUSTMENTS

The length of the position control rod is critical and careful adjustment must be observed for proper operation. If the control rod is adjusted too short, the control valve spool will remain in the raised position when the lift arms have reached their maximum height and the system relief valve will blow. If the control rod is too long, the control valve spool will return to neutral before the lift arms reach their full height.

The position control rod should be adjusted any time the link is disconnected for service to the hydraulic system, or any time the relief valve operation is noted while the lift arms are at the full raise position.

ADJUSTMENT PROCEDURE
Reference — Figure 49

1. Loosen the locknut (3) on the position control rod (1) and remove the pin (4) from the link, Figure 49.

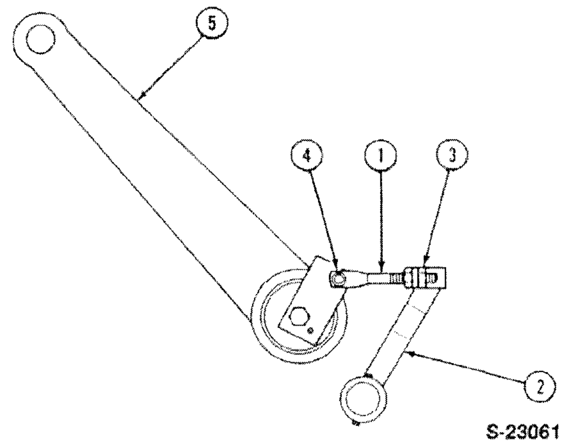


Figure 49
Linkage Adjustment

1. Position Control Rod
2. Position Control Arm
3. Locknut
4. Clevis Pin
5. Lift Arm

2. Set the control lever to the highest position.

3. Start the engine. The lift arms should raise and the relief valve should operate.

4. Move the control lever down until the relief valve ceases operation.

5. Adjust the length of the position control rod and clevis to align the pin holes in then lengthen the rod one additional turn and install the pin. Tighten the locknut.

6. Check the operation. The relief valve should not operate when the lift arms are in the fully raised position.

CONTROL LEVER ADJUSTMENT

Reference — Figure 50

The control lever should not move from vibration. If adjustment is required, remove the cotter pin (2) and adjust the nut (3) to require 4-7 lbs. (2-3 kg) of pull at the lever knob to move the lever.

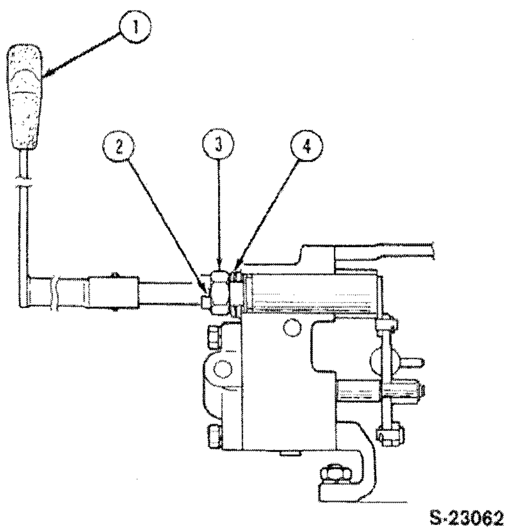


Figure 50
Control Lever Adjustment

1. Control Lever
2. Cotter Pin
3. Adjusting Nut
4. Spring Washers

TWO LEVER DRAFT CONTROL VALVE (OPTIONAL)

LINKAGE ADJUSTMENT

POSITION CONTROL ROD

The length of the position control rod is critical and careful adjustment must be observed for proper operation. If the control rod is adjusted too short, the control valve spool will remain in the raised position when the lift arms have reached their maximum height and the system relief valve will blow. If the control rod is too long, the control valve spool will return to neutral before the lift arms reach their full height.

The position control rod should be adjusted any time the link is disconnected for service to the hydraulic system, or any time the relief valve operation is noted while the lift arms are at the full raise position.

The adjustment procedure for position control is identical to the single lever hydraulic system.

DRAFT CONTROL ROD

ADJUSTMENT PROCEDURE

Reference — Figure 51

Adjust the draft control rod only after completing the position control adjustment.

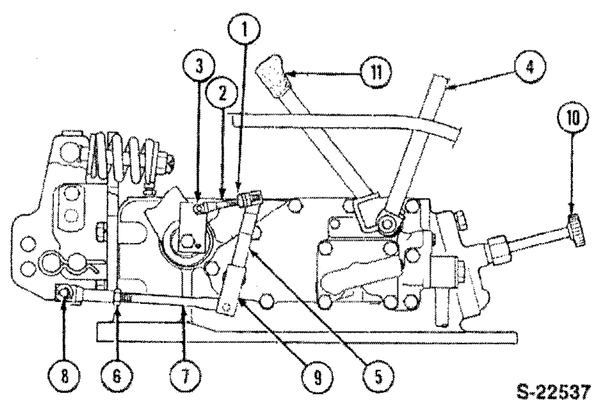


Figure 51
Draft Control Rod Adjustment

1. Locknut
2. Position Control Rod
3. Pin
4. Position Control Lever
5. Position Control Arm
6. Locknut
7. Draft Control Rod
8. Pin
9. Draft Control Arm
10. Flow Control Valve
11. Draft Control Lever

1. Set the draft control lever to the most sensitive "+" position.
2. Loosen the locknut (6) on the draft control rod (7).
3. Remove the cotter pin and disconnect the draft control rod from the draft control arm pin (8).
4. Open the flow control valve knob to the full open position.

   NOTE: *The position control lever must be in the raised position and the lift arms up.*
5. Start the engine and set at 1000-1500 rpm.
6. Move the draft feedback rod (7) rearward until the relief valve starts to operate. Then slowly move the rod forward until the relief valve stops operating. Adjust the length of the rod to match the rod hole with the draft arm pin (8) then shorten the rod one more turn and connect the rod to the draft arm.
7. Move the draft control lever (11), to the full down position. If the lift arms do not descend or descend too slowly, shorten the draft control rod one more turn.

TOP LINK MAIN SPRING ADJUSTMENT (OPTION)
Reference — Figure 52

Remove the cotter pin and adjust the main spring to the specified length.

1320/1520 .... 3.74 in. (95.9 mm)
1720 .... 3.03 in. (77 mm)

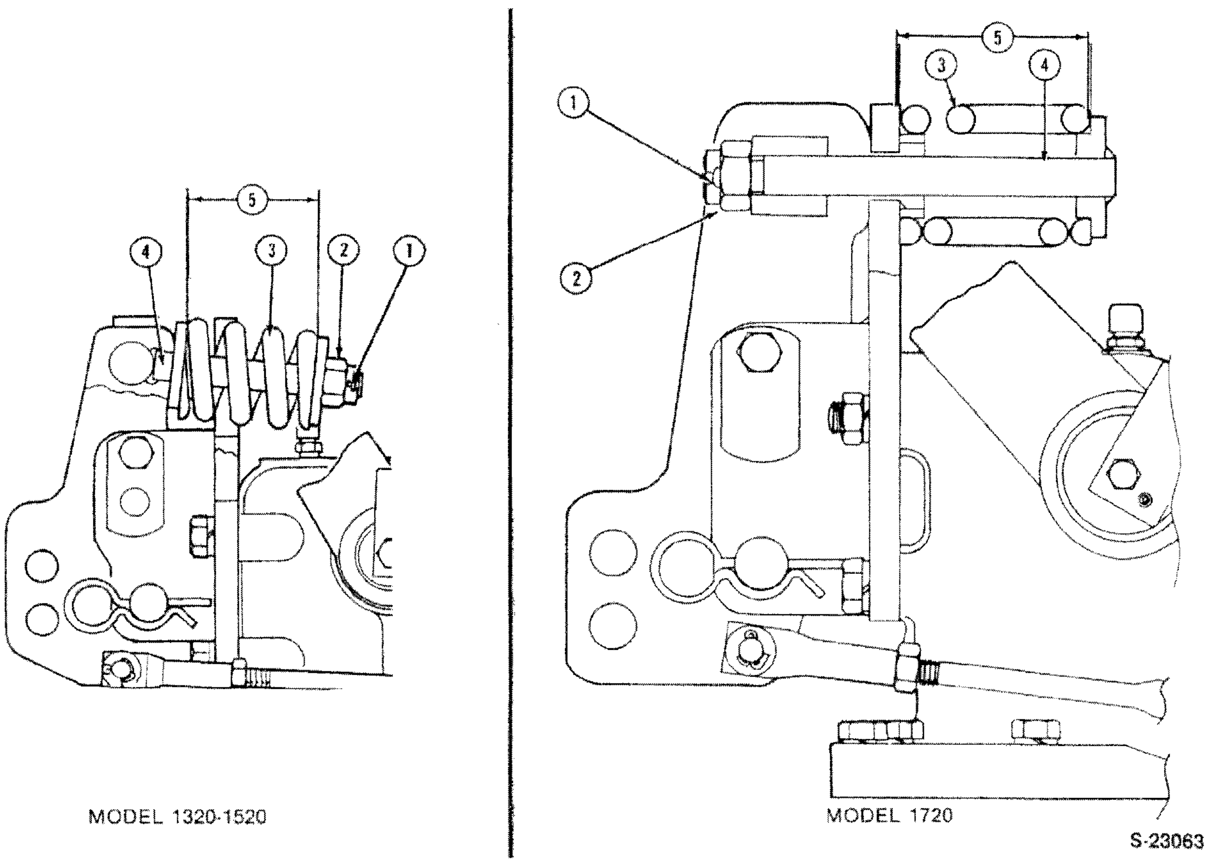


Figure 52
Top Link Main Spring Adjustment
(Draft Control Model)

1. Cotter Pin
2. Nut
3. Main Spring
4. Pin
5. Spring Length:
   3.74 in. (95.9 mm)
   Model 1320/1520
   3.03 in. (77 mm)
   Model 1720

CONTROL LEVER ADJUSTMENT (OPTION)
Reference — Figure 53

The control lever should not move from vibration. If adjustment is required, remove the cotter pin (1) and adjust the nut (2) to require 4-7 lbs. (2-3 kg) of pull at the lever knob to move the lever.

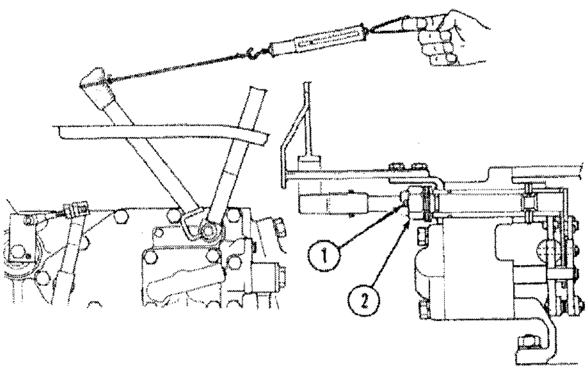


Figure 53
Quadrant Control Lever Adjustment
1. Cotter Pin
2. Adjusting Nut

CONTROL LEVER NEUTRAL ADJUSTMENT (DRAFT CONTROL MODELS ONLY)
Reference — Figure 54

With the engine running at 1000-1500 rpm, check the position control lever neutral adjustment as follows.

- Place the position control lever (1) in the neutral position.
- Measure the lever travel (2) required from the start of a continuous raise position to start lowering as shown, Figure 54.

  The travel distance should be .4 in. (10 mm).

- If the travel distance is excessive, remove the control valve assembly from the lift cover, Figure 54.

  Loosen the locknut (3), Figure 54, and turn the adjusting bolt (4) clockwise to decrease the distance between the adjusting bolt and the lowering valve spool.

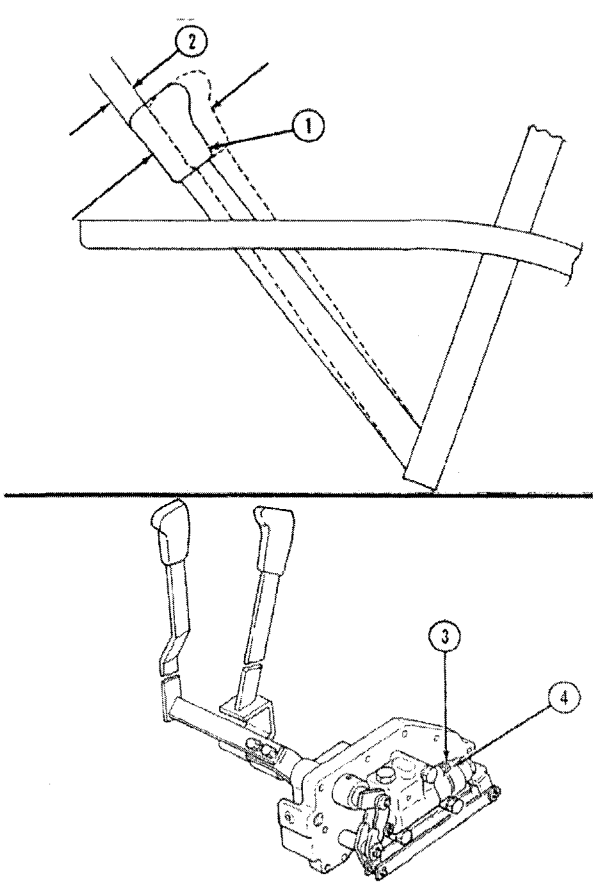


Figure 54
Control Valve Neutral Adjustment
1. Position Control Lever
2. Neutral Travel — .4 in. (10 mm)
3. Locknut
4. Adjusting Bolt

- If the travel distance is too small, turn the adjusting bolt counterclockwise to increase the distance between the adjusting bolt and lowering valve spool.
- After completing the adjustment, tighten the locknut.

NOTE: *Insufficient control lever neutral travel will cause the system to "hunt" in the neutral position.*

PART 8
HYDRAULIC SYSTEM

Chapter 2
HYDRAULIC PUMP AND FILTER

A. DESCRIPTION AND OPERATION

The hydraulic pump (1), Figure 55, is mounted on the right hand side of the engine and is driven by the engine oil pump gear mounted at the front of the engine block.

The Model 1320/1520 tractor has a 6.35 gpm (24.7 lpm) capacity pump. The Model 1720 tractor has a 7.82 gpm (29.6 lpm) pump.

A suction type filter (1), Figure 58, is located in the inlet line on the right hand side of the rear axle center housing. The filter is serviced by replacing the complete canister assembly.

Both hydraulic pumps are gear type pumps serviced with seal kits.

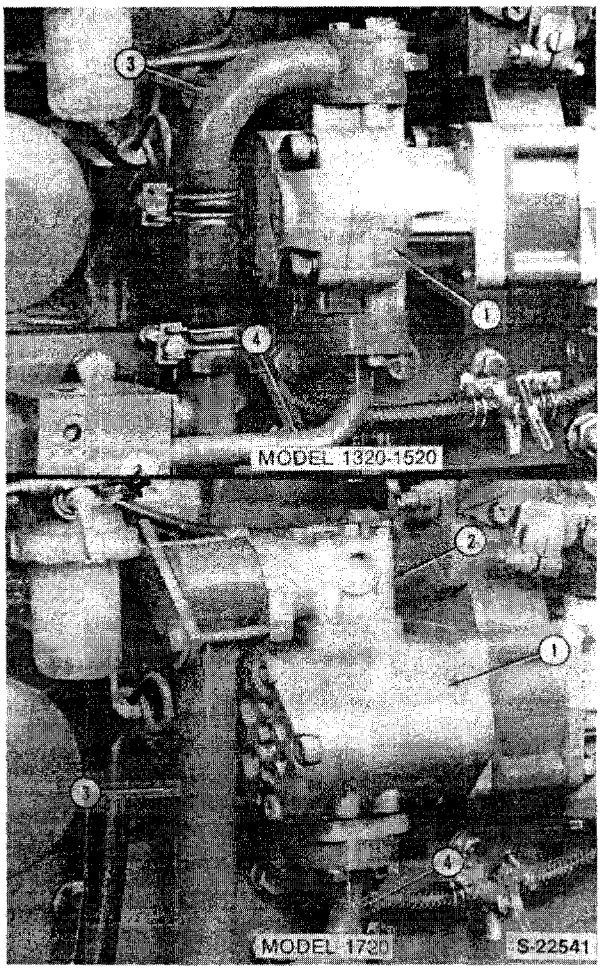


Figure 55
Hydraulic Pump

1. Pump Assembly
2. Suction Line Tube Flange
3. Suction Line
4. High Pressure Line

B. OVERHAUL

REMOVAL
Reference — Figure 55

1. Remove the suction line flange bolts and remove the suction line from the pump.

2. Remove the high pressure line attaching bolts and remove the high pressure line from the pump.

3. Remove the mounting bolts and nuts and remove the pump from the front mounting case, Figure 55.

HYDRAULIC PUMP (1320-1520)
Reference — Figure 56

The only parts serviced on the hydraulic pumps are the shaft seal and internal O-ring seals. If trouble shooting indicates a faulty pump, replace the pump with a new assembly.

DISASSEMBLY

1. Place the pump in a soft jawed vise with the drive shaft facing downward.
2. Scribe a line on the cover and the pump body for ease in assembly.
3. Remove the four bolts securing the cover and remove the cover.
4. Push outward on the drive shaft and remove the outer wear plate.
5. Remove the drive and driven gears from the housing.
6. Using a brass hook, or dental pick, remove the inner wear plate.

NOTE: *The inner and outer wear plates are not the same. Be sure during assembly that the wear plates are assembled correctly.*

7. Remove the pump body from the vise. Remove the snap ring and shaft seal from the pump body.

INSPECTION AND REPAIR

1. Wash all parts in clean solvent and air dry.
2. Discard all O-rings and seals.
3. Inspect the parts for damage or wear, and if necessary, replace the pump.

ASSEMBLY

Assembly follows disassembly procedures in reverse, however the following must be observed.

- Lubricate all parts during assembly with the correct grade of hydraulic oil.
- The inner and outer gear wear plates are not the same. The rectangular slots in the wear plates should be installed to the pump pressure side, and the wear plate with two openings is installed on the cover side of the gears.
- Make sure the cover bolts are torqued, see specifications.

HYDRAULIC PUMP (1720)
Reference — Figure 57

The only parts serviced on the hydraulic pump are the shaft seal, internal O-ring and internal seals and back-up rings. If trouble shooting indicates a faulty pump, replace the pump with a new assembly.

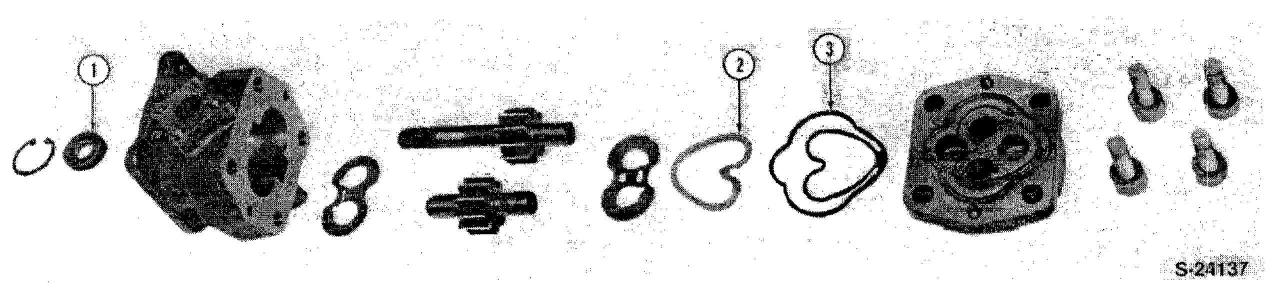


Figure 56
Hydraulic Pump Components — 1320-1520 Tractors
1. Shaft Seal 2. Back-Up Ring 3. Seal

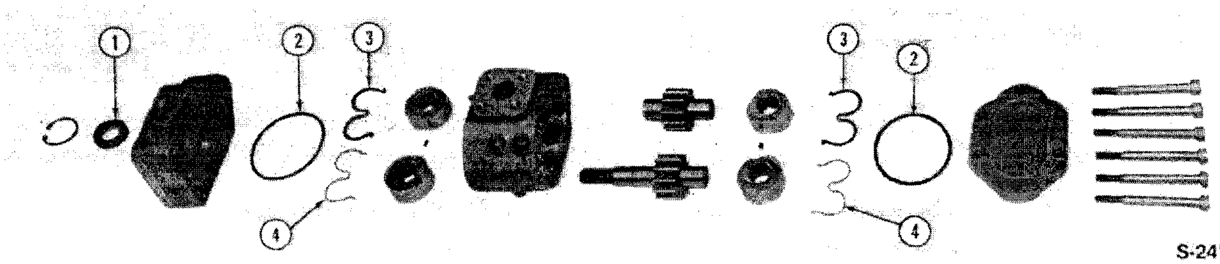


Figure 57
Hydraulic Pump Components — 1720 Tractor
1. Shaft Seal 2. O-Rings 3. Seal 4. Back-Up Ring

DISASSEMBLY

1. Place the pump in a soft jawed vise with the drive shaft facing downward.

2. Remove the six bolts securing the pump as an assembly, and remove the cover.

NOTE: *Lay the parts out as removed for ease in assembly.*

3. Hold down firm on the outer bearings, and remove the pump body.

4. Remove the seal and back-up ring from the bearings.

5. Firmly grasp the two outer bearing assemblies and remove them from the shaft of the gears.

IMPORTANT: *A key is used between the two bearings to lock them in place. Be sure not to lose the key during removal.*

6. Hold the inner bearings down firmly and remove the drive and driven gears.

7. Remove the inner bearings and key.

8. Remove the pump flange from the vise, and remove the snap ring and shaft seal.

INSPECTION AND REPAIR

1. Wash all parts in a clean solvent, and air dry.

2. Discard all seals, O-rings and back-up rings.

3. Inspect all parts for damage or wear. If the gear set, pump cover, body, bearings or flange require replacement, a new pump must be installed.

ASSEMBLY

Lubricate all parts during assembly with the correct grade of hydraulic oil, see specifications.

1. Install a new shaft seal into the flange and install the snap ring.

2. Install the inner bearings with the key in place as an assembly into the pump body doweled pin side.

3. Install the gear set into the inner bearings making sure that the drive gear shaft will align with the hole in the flange base.

4. Install the outer bearings with key, on the gear shafts in the center body.

5. Place the body assembly with the gears, inner and outer bearings, on a flat surface with the drive gear shaft up.

6. Install a new seal, with the flat side outward, into the bearing groove.

7. Install the small back-up ring into the step on the inside of the seal.

8. Install a new O-ring into the groove of the flange base, and place it over the gear drive shaft and on the body of the pump. Make sure the dowel pins in the body and holes in the flange base line up.

9. Carefully turn the flange base and body over with the drive shaft facing down and clamp the flange base into a soft jawed vise.

10. Install the bearing outer seal and back-up ring in the same manner as the inner bearing seals.

11. Install a new O-ring into the groove in the cover and secure it to the body and flange base with the six removed bolts.

12. Tighten the bolts to their correct torque, see specifications.

FILTER — DISASSEMBLY

1. Remove the filter canister from the flange, Figure 59.

2. Replace the filter assembly after every 300 hours of use.

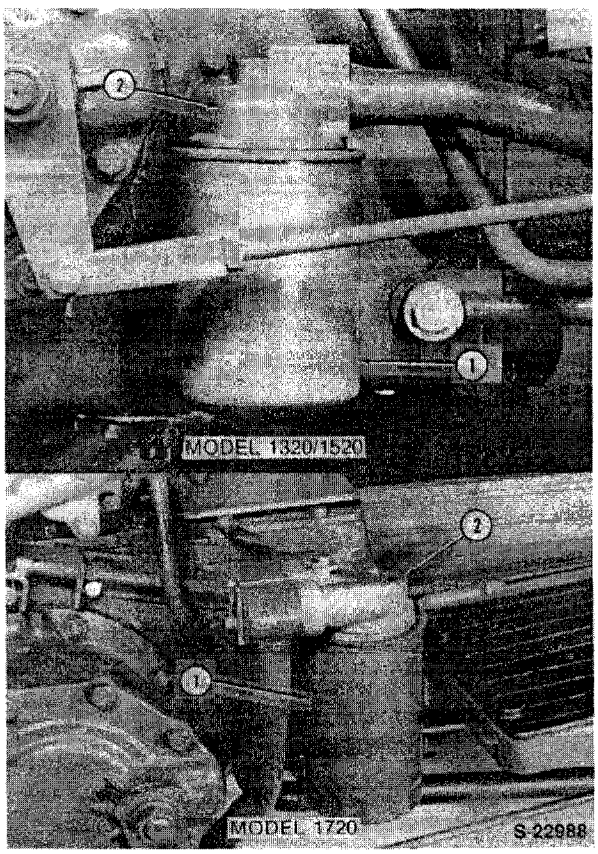


Figure 58
Inlet Filter
1. Inlet Filter Assembly 2. Flange

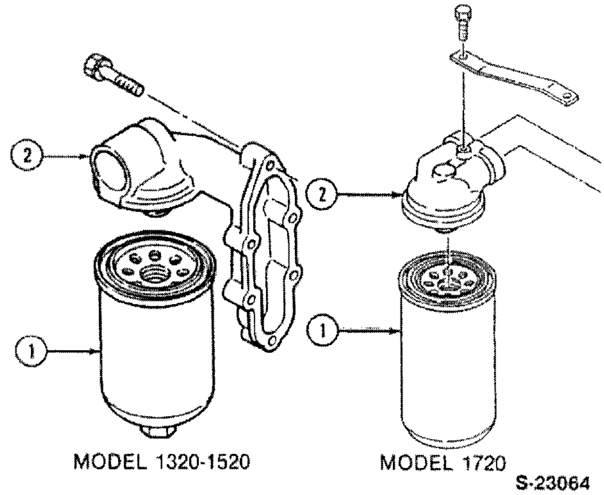


Figure 59
Hydraulic Filter Assembly Removal
1. Canister 2. Flange

HYDRAULIC PUMP — INSTALLATION

Installation of the hydraulic pump follows the removal procedure in reverse.

Observe the following:

Tighten all bolts to the specified torque. See "Specifications," Chapter 3.

Use new O-ring seals and lubricate with clean hydraulic oil on assembly.

PART 8
HYDRAULIC SYSTEM

Chapter 3
REMOTE VALVE

A. DESCRIPTION AND OPERATION

Single spool and double spool remote control valves are available as dealer installed accessories on the 1320/1520/1720 tractors.

The single spool remote control valve is mounted on the outside of the main control valve cover plate on the right hand side of the hydraulic lift cover, Figure 60.

The two spool valve is mounted on the right hand side of the hood, Figure 61.

Both control valves utilize the double acting control spool as shown in Figures 62 and 63.

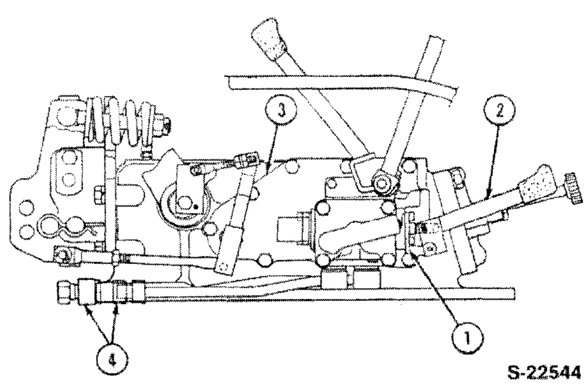


Figure 60
Single Spool Remote Control Valve

1. Single Spool Control Valve
2. Control Lever
3. Hydraulic Lift Cover
4. High Pressure Tube

The valves are equipped with self-centering springs so that the spools automatically return to neutral when the control handle is released following a raise or lowering operation.

The two spool control valve also contains a spring loaded detent mechanism to provide a float position for loader operation. In float position oil is free to flow between the piston and rod sides of the loader lift cylinder allowing the lift arms to float over uneven terrain.

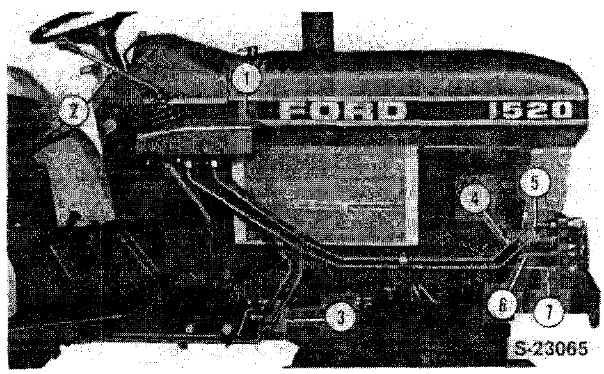


Figure 61
Two Spool Remote Control Valve

1. Two Spool Control Valve
2. Control Lever
3. System Relief Diverter Manifold
4. High Pressure Tube — Bucket Control — Scooping (Curling)
5. High Pressure Tube — Bucket Control — Dumping
6. High Pressure Tube — Lift Control — Raising
7. High Pressure Tube — Lift Control — Lowering

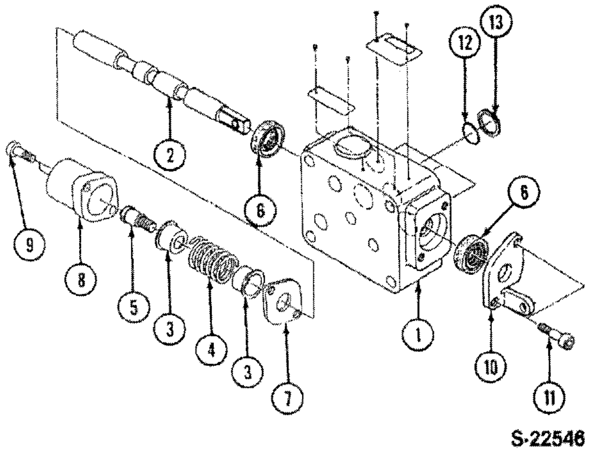


Figure 62
Single Spool Remote Valve Components

1. Valve Body
2. Spool
3. Spring Seat
4. Spring
5. Bolt
6. Oil Seal
7. Plate
8. Cap
9. Bolt
10. Bracket
11. Bolt
12. O-Ring
13. Back-Up Ring

The two spool control valve contains check valves, Figure 63, located in the valve spool passages. The check valves function to hold the loader lift and bucket cylinders in a fixed position while the valve is being initially operated to prevent dropping the load. In operation, the check valve, Figure 63, is retained on its seat by spring force plus the back side pressure of oil contained in the loader cylinder. During initial spool movement, pump pressure oil fills the passage to the check valve while returning the remaining pump oil flow to sump through the open center passage. With continued spool movement the open center passage closes and pump pressure increases on the force of the check valve overcoming the backside pressure and causes the check valve to open. Pump oil flow then flows to the cylinder. This action prevents any backflow out of the cylinder and provides a smooth lifting action of the loader. See Figures 67 through 70.

OIL FLOW — NEUTRAL POSITION SINGLE SPOOL REMOTE CONTROL SYSTEM

Reference — Figure 64

With the control valve in neutral position, oil flows from the pump past the system relief valve (7), through the main control valve (6) and into the remote control valve. In neutral position, the remote valve spool directs the pump oil flow back through the 3-point hydraulic system to sump.

Oil contained in the remote cylinder is blocked by the control valve spool and the implement is held in a fixed position.

OIL FLOW — REMOTE CYLINDER EXTENDING SINGLE SPOOL REMOTE CONTROL SYSTEM

Reference — Figure 65

When the remote control valve lever is pushed forward, the valve spool is moved outward to extend the cylinder.

Oil flows from the pump past the system relief valve (7) through the main control valve (6), to the remote control valve. The control valve spool (3) now directs the oil flow to the piston side of the remote cylinder and extends the cylinder. Oil in the rod side of the cylinder returns to sump via the return passage (10).

Oil flow to the 3-point hydraulic system (4) is blocked by the spool during this operation.

If the oil pressure exceeds 2133 psi (147 bar) the main relief valve opens and the oil returns to sump.

OIL FLOW — REMOTE CYLINDER RETRACTING SINGLE SPOOL REMOTE CONTROL SYSTEM

Reference — Figure 66

When the remote control valve lever is pulled upward the control valve spool is moved inward to retract the remote cylinder. Oil then flows from the pump past the system relief valve (7) through the main control valve (6) to the remote control valve. The control valve spool (3) now directs the oil flow to the rod side of the remote cylinder and retracts the cylinder. Oil in the piston side of the cylinder returns to sump via passage (11) and internal passages in the remote and main control valve and permits the cylinder to retract.

Whenever the remote cylinder oil pressure exceeds 2133 psi (147 bar) the main relief valve opens and the oil returns to sump.

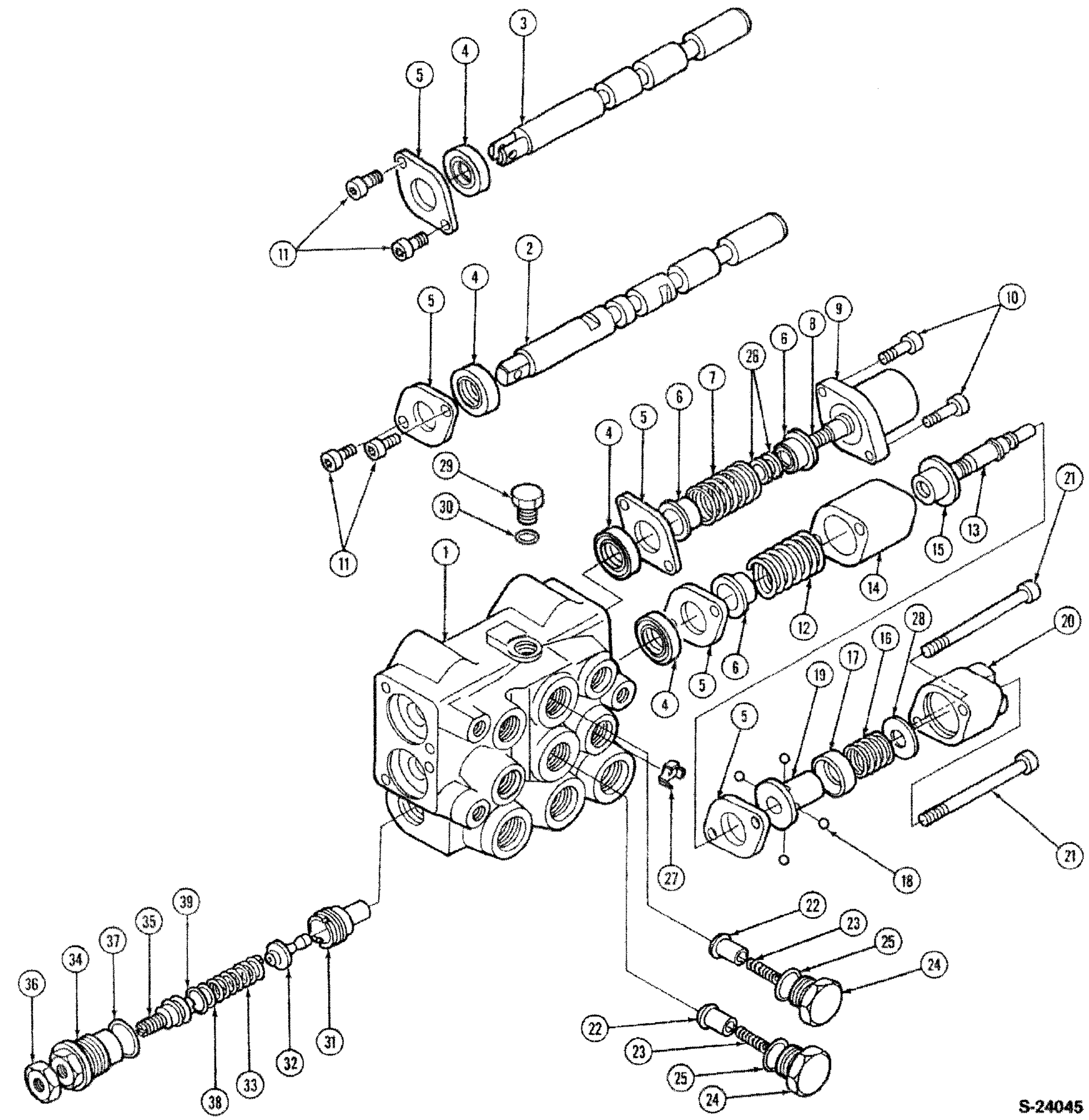


Figure 63
Two Spool Remote Valve Components

1. Housing
2. Spool — Lift Control
3. Spool — Bucket Control
4. Seal — Oil
5. Plate
6. Seat — Spring
7. Spring
8. Bolt
9. Cap
10. Bolt
11. Bolt
12. Spring
13. Bolt
14. Spacer
15. Seat — Spring
16. Spring
17. Bushing
18. Ball
19. Guide
20. Cap Nut
21. Bolt
22. Valve
23. Spring
24. Plug
25. O-Ring
26. Shim
27. Orifice — d =2.75 mm
28. Shim
29. Plug
30. O-Ring
31. Body
32. Valve
33. Spring
34. Plug
35. Screw
36. Nut
37. O-Ring
38. O-Ring
39. Back-Up Ring

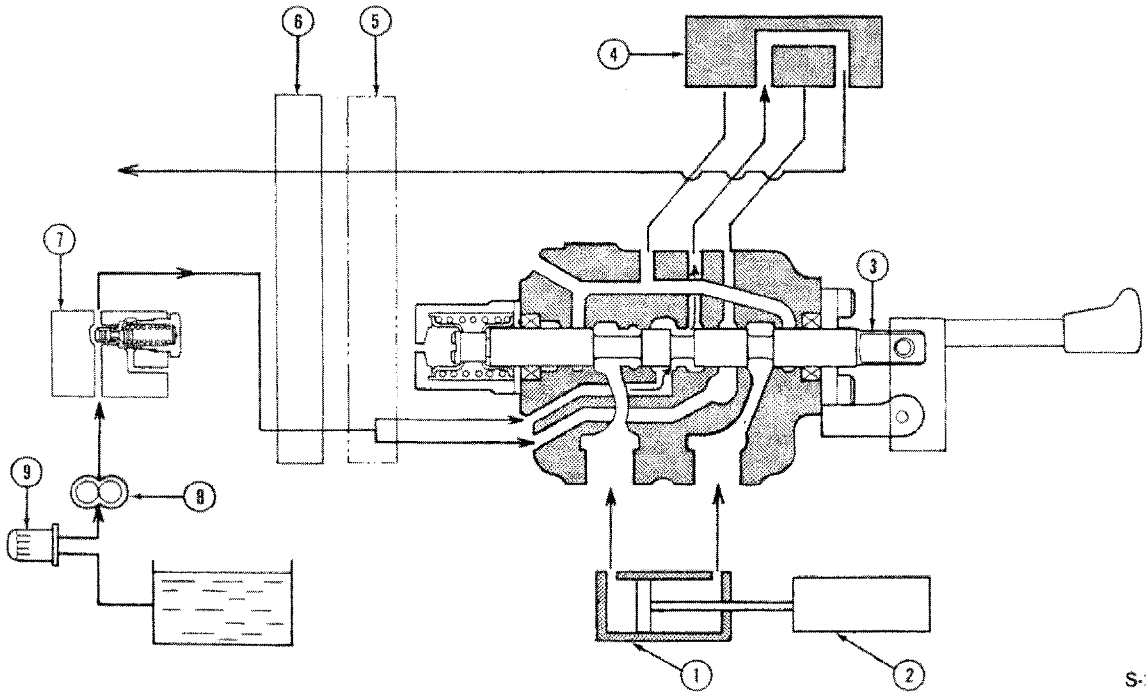


Figure 64
Oil Flow — Neutral Position (Schematic)
Single Spool Valve

1. Remote Cylinder
2. Implement
3. Remote Valve Spool
4. Valve Cover
5. Lift Valve Cover
6. Main Control Valve
7. System Relief Valve
8. Oil Pump
9. Suction Filter

OIL FLOW — BUCKET CONTROL — NEUTRAL AND LIFT CONTROL — NEUTRAL

TWO SPOOL REMOTE CONTROL SYTEM

Reference — Figure 67

In neutral position, the two control valve spools are centered in the valve body.

Oil from the hydraulic pump is directed to the center of the two control valve spool.

In this position, the spool lands block the passage to the loader cylinders. Oil contained in the loader bucket and lift cylinders is trapped by the spools and the cylinder remains in a fixed position.

Pump pressure oil flows through the diverter valve manifold and enters the valve body at passage "P" to the open center passage of both spools. Because all cylinder passages are blocked, the oil flows through the main hydraulic system control valve. If the oil is not used by the 3-point system, it is redirected back to sump.

OIL FLOW — BUCKET CONTROL — DUMPING AND LIFT CONTROL — NEUTRAL

Reference — Figure 68

When the control lever (5) is moved to the dumping position, the bucket control valve spool is moved inward, Figure 68.

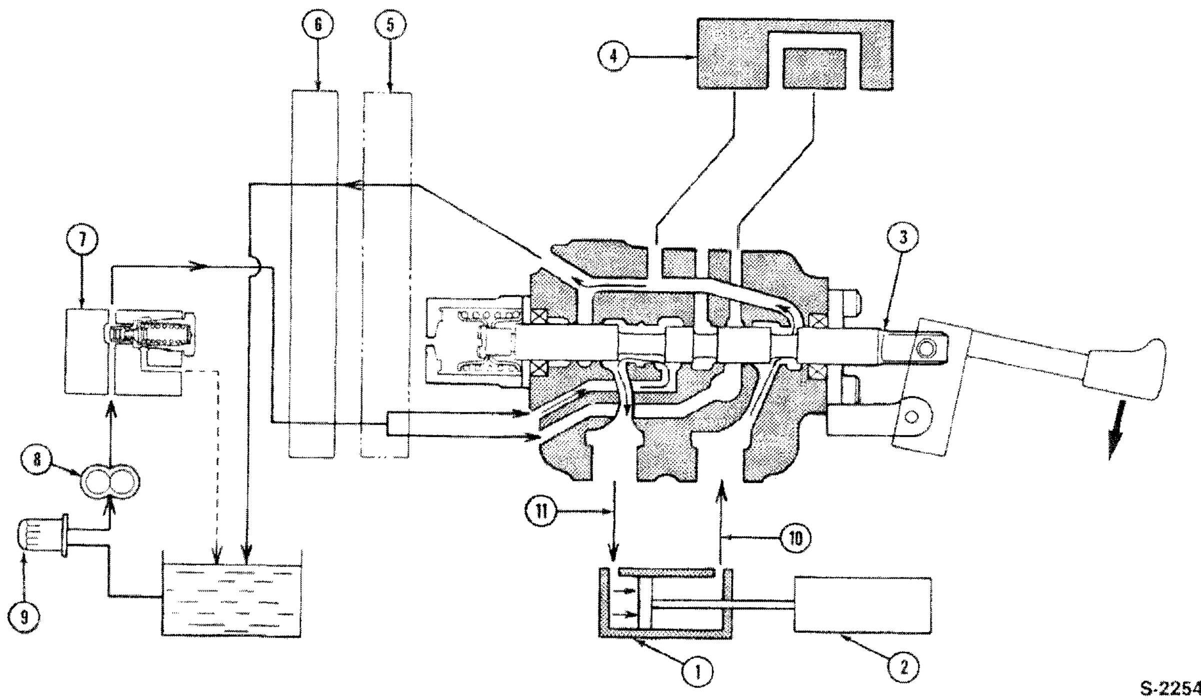


Figure 65
Oil Flow — Remote Cylinder Extending
(Single Spool Valve)

1. Remote Cylinder
2. Implement
3. Remote Valve Spool
4. Valve Cover
5. Lift Valve Cover
6. Main Control Valve
7. System Relief Valve
8. Oil Pump
9. Suction Filter
10. Return to Sump Line
11. High Pressure Line

Oil flow from the hydraulic pump is directed to the piston side of the bucket cylinder.

The oil contained in the rod side of the bucket cylinder flows out of the cylinder through a by-pass passage and orifice plate (27), Figure 63, to the piston side of the bucket cylinder.

Pump pressure oil flows to sump.

OIL FLOW — BUCKET CONTROL — NEUTRAL AND LIFT CONTROL — RAISING

Reference — Figure 69

When the control lever (5) is moved to the raising position the lift control valve spool is moved outward, Figure 69.

Oil flow from the hydraulic pump is directed to the piston side of the lift cylinder.

The oil contained in the rod side of the lift cylinder flows out of the cylinder past the port "C" to the reservoir allowing the implement to raise.

As the bucket control valve spool (4) is in neutral, the oil trapped in the bucket cylinder is blocked by the spool and the bucket cylinder is held in a fixed position.

OIL FLOW — BUCKET CONTROL — NEUTRAL AND LIFT CONTROL — DETENT (FLOATING)

Reference — Figure 70

When the lift control lever is moved to the detent position (float), the control valve spool is moved inward beyond the normal lowering position as shown, Figure 70. In this position, passages A and B are connected and oil is free to move between the lift cylinder rod and piston ends. The loader lift arms then move up and down as the loader passes over uneven terrain.

Pump pressure oil is directed to sump.

B. OVERHAUL

REMOVAL
SINGLE SPOOL REMOTE VALVE

1. Clean the area around the remote control valve and disconnect the remote tubes from the valve.
2. Remove the roll pin and control lever from the valve spool and body.
3. Remove the valve mounting bolts and carefully remove the valve from the side of the cover.

DISASSEMBLY
SINGLE SPOOL REMOTE VALVE
Reference — Figure 71

1. Remove the bracket.
2. Remove the end cap and gently withdraw the spool, complete with the coil spring.
3. Remove the oil seal from the spool bore on each end of the valve body.

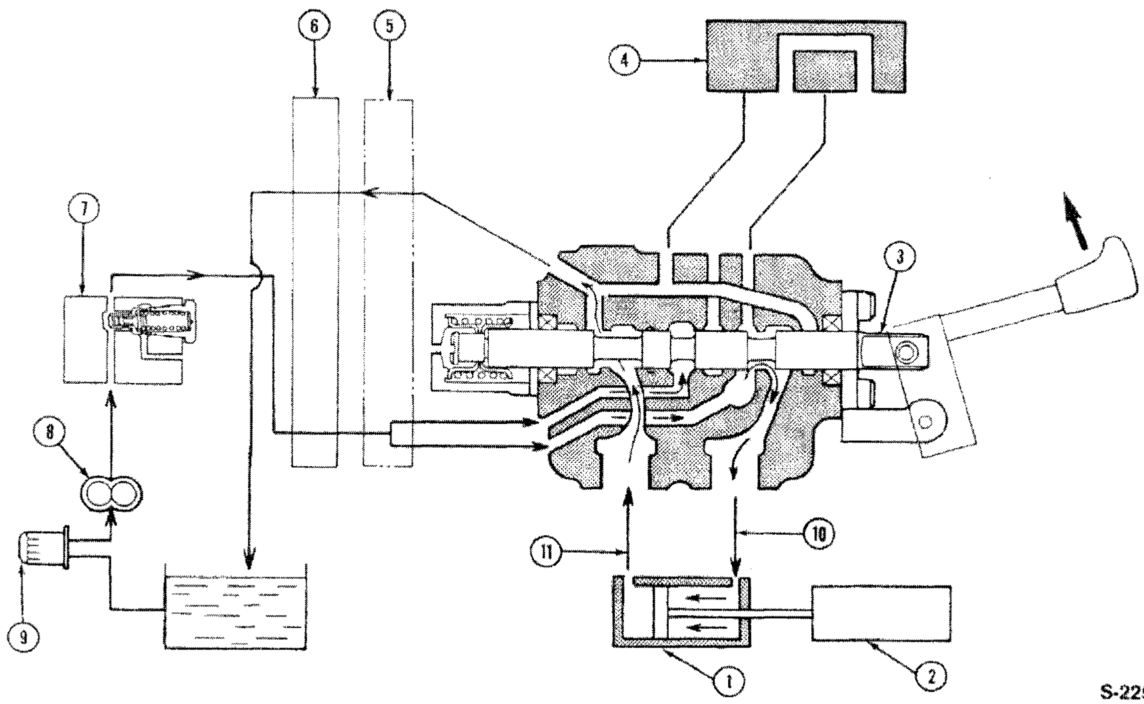
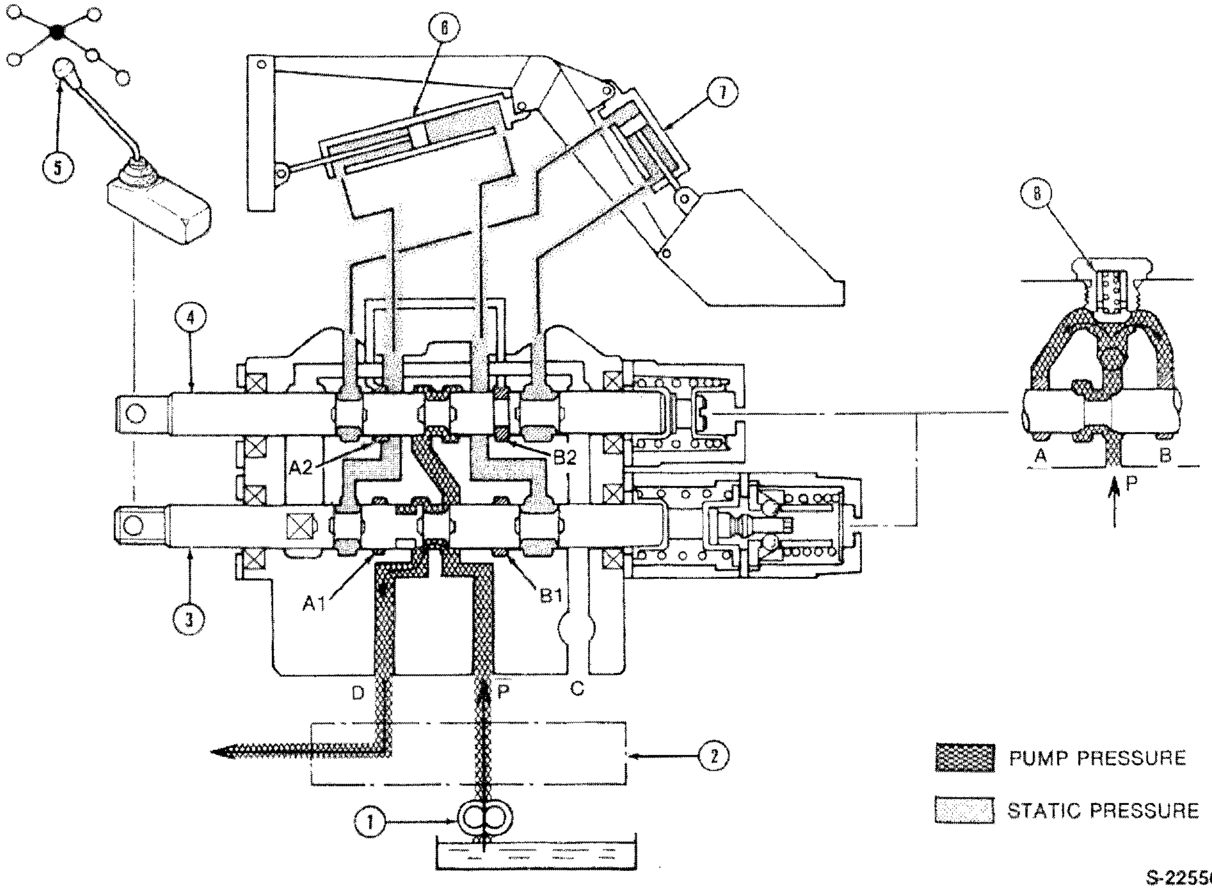


Figure 66
Oil Flow — Remote Control Cylinder Retracting

1. Remote Cylinder
2. Implement
3. Remote Valve Spool
4. Valve Cover
5. Lift Valve Cover
6. Main Control Valve
7. System Relief Valve
8. Oil Pump
9. Suction Filter
10. High Pressure Line
11. Return to Sump Line



S-22550

Figure 67
Oil Flow Bucket and Lift Cylinder — Neutral Position — Two Spool Valve

1. Oil Pump
2. System Relief — Diverter Manifold
3. Lift Control Valve Spool
4. Bucket Control Valve Spool
5. Control Lever
6. Lift Cylinder
7. Bucket Cylinder
8. Load Check Valve

A^1 Lift Cylinder Rod Port
B^1 Lift Cylinder Piston Port
A^2 Bucket Cylinder Piston Port
B^2 Bucket Cylinder Rod Port
P Pump Pressure Port
C Return-to-Sump Port
D Pump Pressure to Three-Point Hydraulic System

4. If required, remove the bolt (5) and separate the centering spring and seats from the spool.

INSPECTION

1. Inspect the spool and spool bore for pitting, scratches or excess wear. If inspection reveals defects, a new control valve assembly must be installed.
2. Check that the spool moves freely in the spool bore. If defective, replace the control valve assembly.

ASSEMBLY

Reassembly generally follows the dissasembly procedure in reverse.

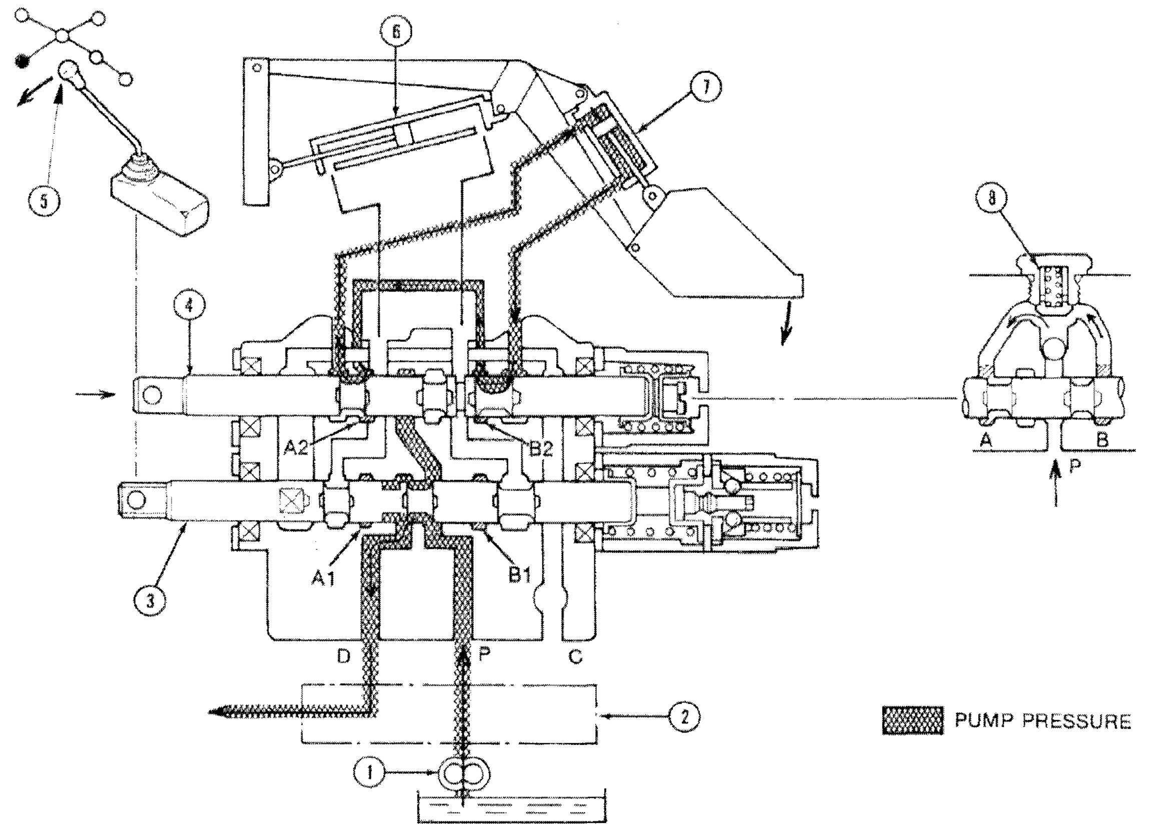


Figure 68
Oil Flow Bucket Cylinder Dump — Two Spool Valve

1. Oil Pump
2. System Relief — Diverter Manifold
3. Lift Control Valve Spool
4. Bucket Control Valve Spool
5. Control Lever
6. Lift Cylinder
7. Bucket Cylinder
8. Load Check Valve

A^1 Lift Cylinder Rod Port
B^1 Lift Cylinder Piston Port
A^2 Bucket Cylinder Piston Port
B^2 Bucket Cylinder Rod Port
P Pump Pressure Port
C Return-to-Sump Port
D Pump Pressure to Three-Poin Hydraulic System

During assembly observe the following:

1. Be sure all components are free of dirt and foreign matter and lubricate all components with clean hydraulic oil on assembly.
2. Install all new O-rings and seals on assembly.

INSTALLATION

Installation generally follows the removal procedure in reverse.

During installation observe the following:

1. Be sure the mounting surfaces are free of dirt and foreign material.
2. Install new O-rings on assembly.
3. Tighten the mounting bolts gradually to the specified torque.

REMOVAL
TWO SPOOL REMOTE VALVE

1. Clean the area around the remote control valve and disconnect the remote tube from the valve.
2. Remove the cover.

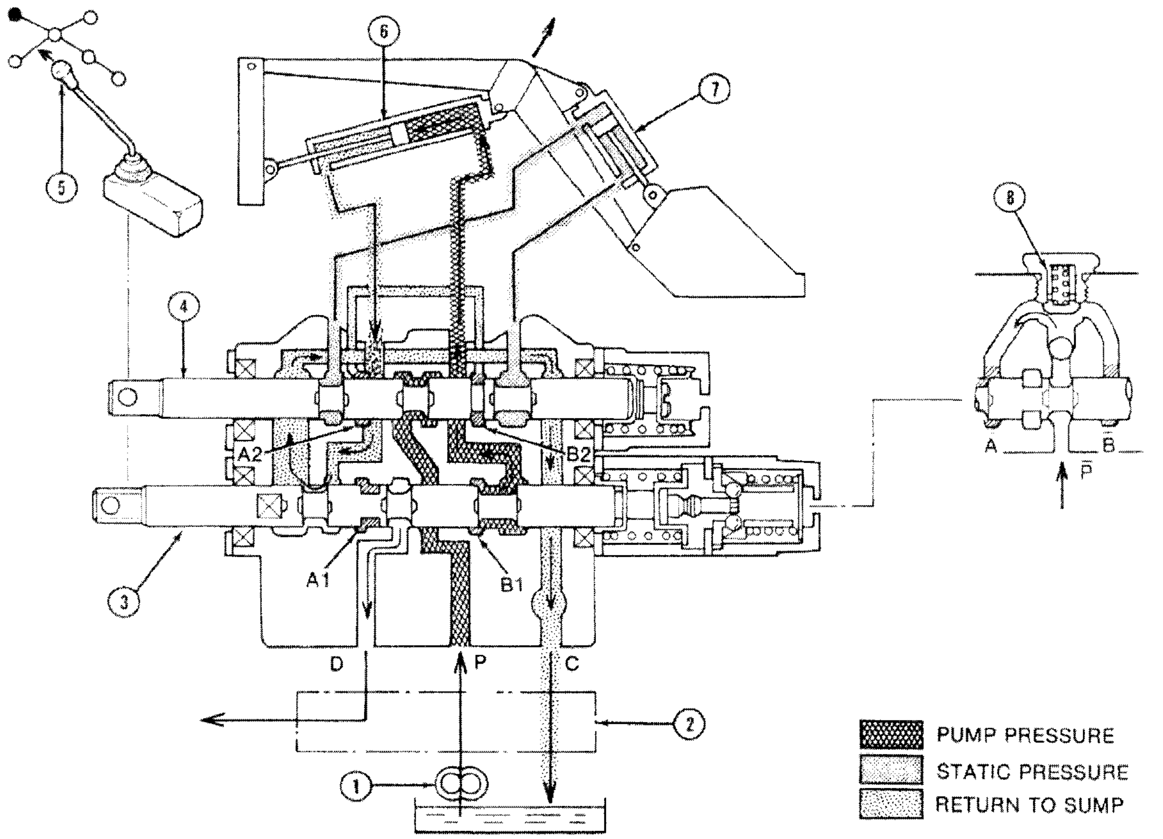


Figure 69
Oil Flow Lift Cylinder Raised — Two Spool Valve

1. Oil Pump
2. System Relief — Diverter Manifold
3. Lift Control Valve Spool
4. Bucket Control Valve Spool
5. Control Lever
6. Lift Cylinder
7. Bucket Cylinder
8. Load Check Valve

A^1 Lift Cylinder Rod Port
B^1 Lift Cylinder Piston Port
A^2 Bucket Cylinder Piston Port
B^2 Bucket Cylinder Rod Port
P Pump Pressure Port
C Return-to-Sump Port
D Pump Pressure to Three-Point Hydraulic System

3. Remove the roll pin and control lever from the valve spool.

4. Remove the valve mounting bolt and carefully remove the valve from the bracket.

DISASSEMBLY
TWO SPOOL REMOTE VALVE
Reference — Figure 72

1. Unscrew the bolts (11) and remove the plate (5).

2. Remove the end cap and gently withdraw the spool, complete with the coil spring assembly.

3. Remove the plugs (24) and remove the check valve spring and plunger.

4. Unscrew the plug (35) and remove the relief valve assembly.

5. Remove the oil seals (4) from each end of the spool bores.

6. If required, remove the spool end bolt and separate the centering springs, seats and detent components.

NOTE: *Use care to not lose the detent balls out of the end cap.*

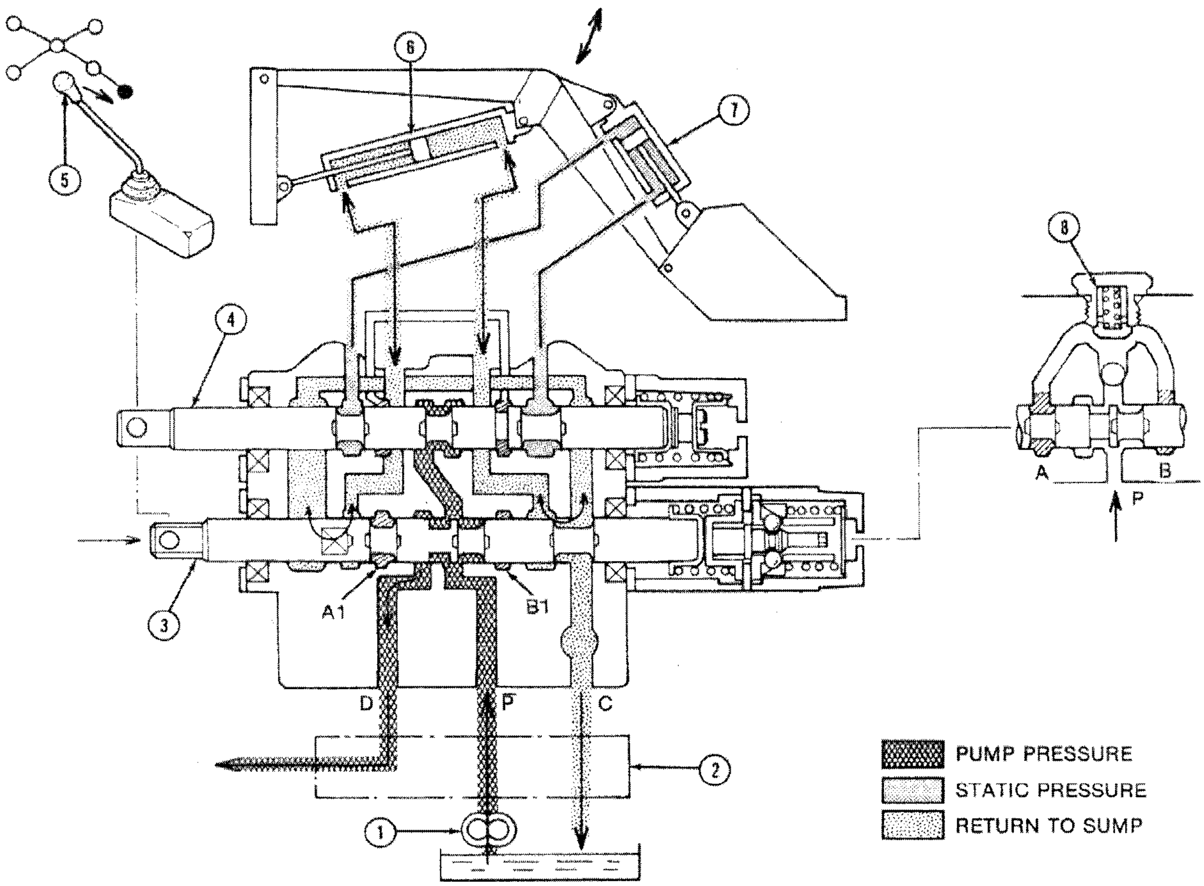


Figure 70
Oil Flow Lift Cylinder Float Position — Two Spool Valve

1. Oil Pump
2. System Relief — Diverter Manifold
3. Lift Control Valve Spool
4. Bucket Control Valve Spool
5. Control Lever
6. Lift Cylinder
7. Bucket Cylinder
8. Load Check Valve

A¹ Lift Cylinder Rod Port
B¹ Lift Cylinder Piston Port
A² Bucket Cylinder Piston Port
B² Bucket Cylinder Rod Port
P Pump Pressure Port
C Return-to-Sump Port
D Pump Pressure to Three-Point Hydraulic System

INSPECTION

1. Inspect the spool and spool bore for pitting, scratches or excess wear. If inspection reveals defects, a new control valve assemby must be installed.
2. Check that the spool moves freely in the spool bore. If defective, replace the control valve assembly.

ASSEMBLY

Reassembly generally follows the disassembly procedure in reverse.

During assembly observe the following:

1. Be sure all components are free of dirt and foreign matter and lubricate all components with clean hydraulic oil on assembly.
2. Install all new O-rings and seals on assembly.

INSTALLATION

Installation of the valve on the tractor generally follows the removal procedure in reverse.

During installation observe the following:

1. Be sure the mounting surfaces are free of dirt and foreign material.
2. Install new O-rings on assembly.
3. Tighten the mounting bolts gradually to the specified torque.

PART 8
HYDRAULIC SYSTEM

Chapter 4
TROUBLE SHOOTING, PRESSURE TESTING, SPECIFICATIONS AND SPECIAL TOOLS

A. TROUBLE SHOOTING

CONDITION	POSSIBLE CAUSE	REMEDY
Implement fails to lift when lever is in raised position	1. Linkage out of adjustment	1. Adjust linkage
	2. Relief valve setting too low	2. Perform system relief valve pressure test
	3. Faulty safety valve	3. Repair or replace safety valve
	4. Faulty hydraulic pump	4. Replace pump assembly
	5. O-Ring failure control valve body to cover	5. Replace O-rings
	6. Excessive oil leakage past lift cylinder piston seal	6. Replace pistons, piston seals or cylinder liner
	7. Restricted suction filter	
	8. Control valve plunger stuck in open position (two lever control system)	7. Clean and repair as required
	9. Lowering valve spool out of adjustment	8. Adjust lowering spool adjusting bolt
Lift arms cycle up and down when control lever is in neutral position	1. Faulty check valve and seat	1. Replace as required
	2. Faulty lowering valve spool (two lever control system)	2. Replace as required
	3. Leaking O-rings	3. Inspect and repair as required
	4. Faulty lowering valve spool	4. Replace as required
Implement rises too slow	1. Suction filter restricted	1. Replace filter
	2. Hydraulic pump capacity too low	2. Perform flow test and replace pump if required
	3. Faulty relief valve	3. Repair or replace as required
	4. Excessive leakage past lift cylinder piston	4. Inspect cylinder and piston assembly. Repair or replace as required
	5. Faulty safety valve	5. Repair or replace as required
	6. Faulty lowering valve spool operation	6. Replace lowering valve spool
	7. Faulty control valve and plunger operation	7. Repair or replace as required

A. TROUBLE SHOOTING

CONDITION	POSSIBLE CAUSE	REMEDY
Implement will not lower when control lever is in lowering position	1. Flow control valve in closed position 2. Lowering valve spool adjusting bolt out of adjustment	1. Open valve 2. Adjust lowering valve adjusting bolt
Implement does not raise to full height	1. Position control rod out of adjustment	1. Adjust position control rod
Relief valve operates when implement is raised to full raise position	1. Position control valve rod out of adjustment	1. Adjust position control rod
Hydraulic oil overheats	1. Faulty hydraulic pump 2. Restricted filter 3. Excessive oil leakage-internal	1. Replace pump 2. Replace filter 3. See Remedy for conditions 1, 2, 3 and 6
Control levers move to lowering position automatically while tractor is operating	1. Control lever tension set too low	1. Adjust control lever tension nut

B. PRESSURE TESTING

MAIN SYSTEM RELIEF VALVE
Reference — Figure 73

1. Remove the manifold plug (1/2"NPT) and install a 0-3000 psi (0-207 bars) pressure gauge as shown, Figure 71.

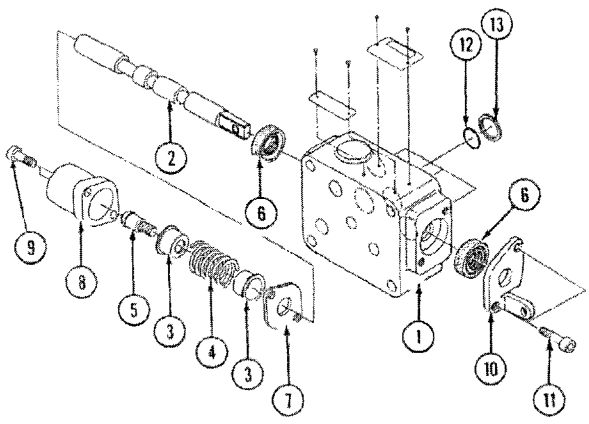


Figure 71
Single Spool Remote Valve Components

1. Valve Body
2. Spool
3. Spring Seat
4. Spring
5. Bolt
6. Oil Seal
7. Plate
8. Cap
9. Bolt
10. Bracket
11. Bolt
12. O-Ring
13. Back-Up Ring

2. Start the engine and operate the hydraulic system to warm the hydraulic oil to normal operating temperature.

3. Set the throttle rpm at full throttle.

4. If required, adjust the pressure setting by adding or deleting shims. One shim, .004 in. (0.1 mm) thickness will change the pressure setting approximately 51 psi (3.5 bars).

Relief valve pressure = 2133 psi (147 bars).

TWO SPOOL REMOTE CONTROL VALVE
Reference — Figure 74

1. Install a 0-5000 psi (0-207 bars) pressure gauge to the high pressure tube (6).

2. Start the engine and operate the hydraulic system to warm hydraulic oil to normal operating temperature.

3. Set the throttle rpm at full throttle.

4. Move the control lever to lift control — raising position.

5. Observe the pressure gauge reading.

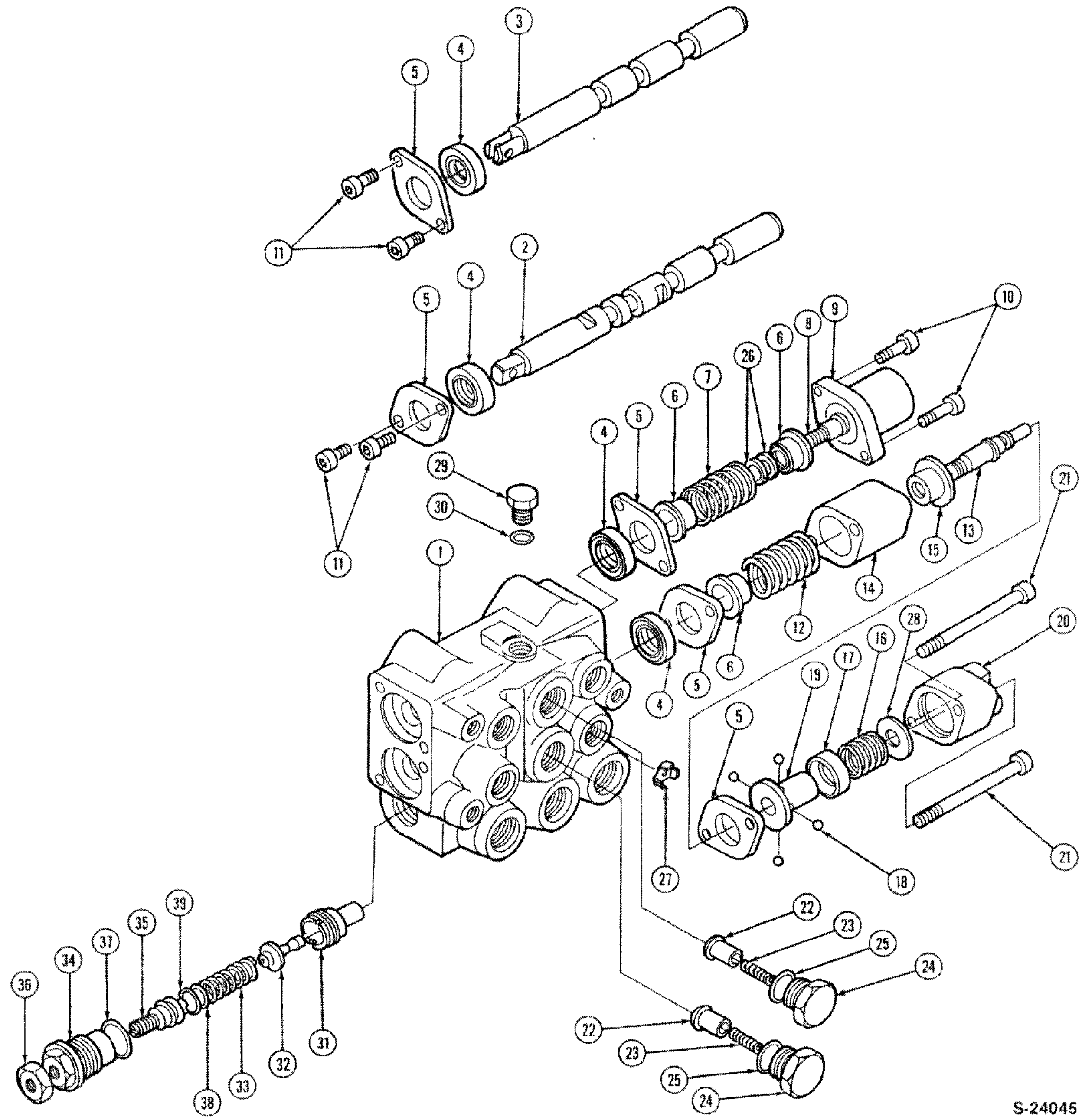


Figure 72
Two Spool Remote Valve Components

1. Housing
2. Spool — Lift Control
3. Spool — Bucket Control
4. Seal — Oil
5. Plate
6. Seat — Spring
7. Spring
8. Bolt
9. Cap
10. Bolt
11. Bolt
12. Spring
13. Bolt
14. Spacer
15. Seat — Spring
16. Spring
17. Bushing
18. Ball
19. Guide
20. Cap Nut
21. Bolt
22. Valve
23. Spring
24. Plug
25. O-Ring
26. Shim
27. Orifice — d =2.75 mm
28. Shim
29. Plug
30. O-Ring
31. Body
32. Valve
33. Spring
34. Plug
35. Screw
36. Nut
37. O-Ring
38. O-Ring
39. Back-Up Ring

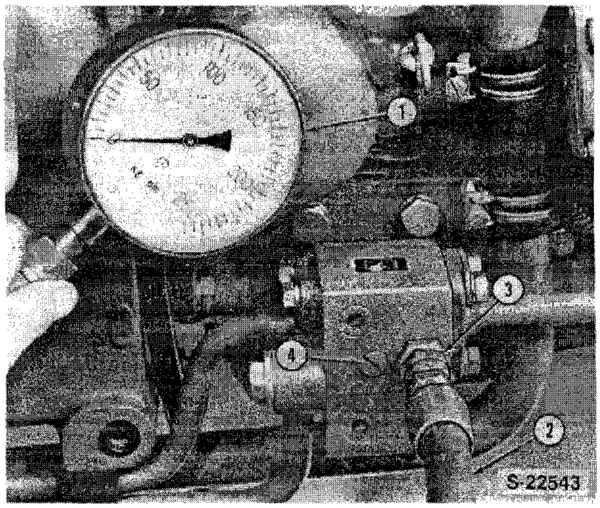


Figure 73
Hydraulic Pressure Test — Main System Relief Valve

1. Test Gauge — 0-3000 psi
2. Hose
3. Adapter
4. Diverter Valve Spool

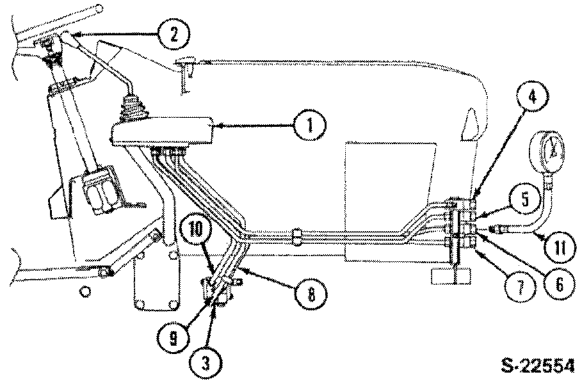


Figure 74
Pressure Test Procedure — Two Spool Remote Control Valve

1. Two Spool Control Valve
2. Control Lever
3. System Relief Diverter Manifold
4. High Pressure Tube — Bucket Control
5. High Pressure Tube — Bucket Control — Dumping
6. High Pressure Tube — Lift Control — Raising
7. High Pressure Tube — Lift Control — Lowering
8. Outlet Tube
9. Return to Sump Line
10. Line to Three Point Control System
11. Pressure Gauge

C. SPECIFICATIONS

Hydraulic Pump

Type		Gear
Pump Capacity	1320/1520	6.35 gpm (24.9 lpm)
	1720	7.82 gpm (29.6 lpm)
Hydraulic Oil		Ford 134
Pump Speed (rpm)		2115 rpm
Engine Speed (rpm)		2500 rpm
System Relief Valve Setting		2130 ± 70 psi (147 ± 5 bars)
Lift Cylinder Diameter	1320/1520	2.76 in. (70 mm)
	1720	2.95 (75 mm)
Maximum Lift Capacity	1320/1520	2865 lbs. (1280 kg)
	1720	3333 lbs. (1500 kg)
Safety Valve Setting		3625 ± 290 psi (250 ± 20 bars)
Remote Control Valve Relief Valve Setting	1320/1520	1607 + 71 − 0
	1720	1806 + 71 − 0

BOLT TORQUE SPECIFICATIONS

Bolt Size	Grade No.	Coarse Thread			Fine Thread		
		Pitch (mm)	Pounds Feet	Newton-Meters	Pitch (mm)	Pounds Feet	Newton-Meters
M8	4T	1.25	9.4-12.3	12.7-16.7	1.0	11.2-14.8	15.2-20.1
	7T		16.6-21.0	22.6-28.4		19.5-25.3	26.5-34.3
	10T		21.0-26.8	28.4-36.3		22.4-29.7	30.4-40.2
M10	4T	1.5	18.8-24.6	25.5-33.3	1.25	21.0-26.8	28.4-36.3
	7T		32.5-41.2	44.1-55.9		36.2-46.3	49.0-62.8
	10T		39.8-51.4	53.9-69.6		42.7-54.2	57.9-73.5
M12	4T	1.75	27.5-34.7	37.3-47.1	1.25	31.8-40.5	43.1-54.9
	7T		48.5-61.5	65.7-83.4		55.0-69.4	74.5-94.1
	10T		68.0-85.4	92.2-116		73.1-93.3	99.0-127

Flow Control — Cylinder Head .... 48.5-61.5 lbs. ft. (65.7-83.4 Nm)
Hydraulic Pump Bolts .... 16-20 lbs. ft. (22-28 Nm)

D. SPECIAL TOOLS

Tool	No.
Hose	7099
Gauge	2028
Hose	2106
Adapter	1119

PART 9
STEERING SYSTEMS

Chapter 1
POWER STEERING SYSTEM

Chapter 2
TROUBLE SHOOTING, TESTING AND SPECIFICATIONS

PART 9
STEERING SYSTEMS

Chapter 1
POWER STEERING SYSTEM

Section **Page**

A. DESCRIPTION AND OPERATION

The power steering system used on the Model 1320, 1520 and 1720 tractors is a fully hydraulic power steering system.

The system consists of a power steering control valve, pump, reservoir, cylinder assembly and tubing, Figure 1.

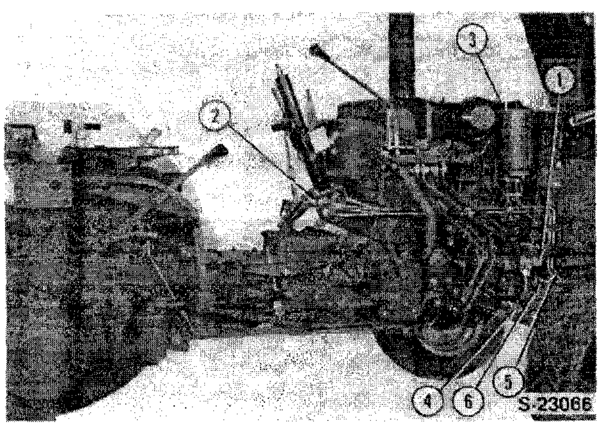


Figure 1
Power Steering System — Model 1320, 2WD Shown

1. Power Steering Pump
2. Power Steering Control Valve
3. Oil Reservoir
4. Power Steering Cylinder
5. Cylinder Line — Left Turn
6. Cylinder Line — Right Turn

POWER STEERING CONTROL VALVE
Reference — Figure 2

1. SPOOL AND SLEEVE
   1 Spool and sleeve constitute a rotary valve for selectively changing the oil passage as well as the direction of pressurized oil flow. There are three forms of oil passage, the first for NEUTRAL state, the second for RIGHT TURNING, and the third for LEFT TURNING.

   2 The spool is rotatably fitted into the sleeve, which is similary fitted into the bore of the valve body. Spool and sleeve are mechanically interconnected.

   A-The leaf springs extend through spool and sleeve, and urge the spool to take the indicated position relative to the sleeve. This position corresponds to NEUTRAL state, and persists as long as the steering handwheel is at its center position (for straight-ahead driving).

   B-The diametrally extending pin is loosely fitted to the drive shaft at the center and to the sleeve, there being some clearance between the pin and the radial holes in spool. When the drive shaft, spool and sleeve are in the indicated positions, the sleeve and shaft are capable of turning as much as 10° in either direction (CW or CCW) relative to spool. By this angular displacement, the oil passage for RIGHT TURNING or LEFT TURNING is introduced.

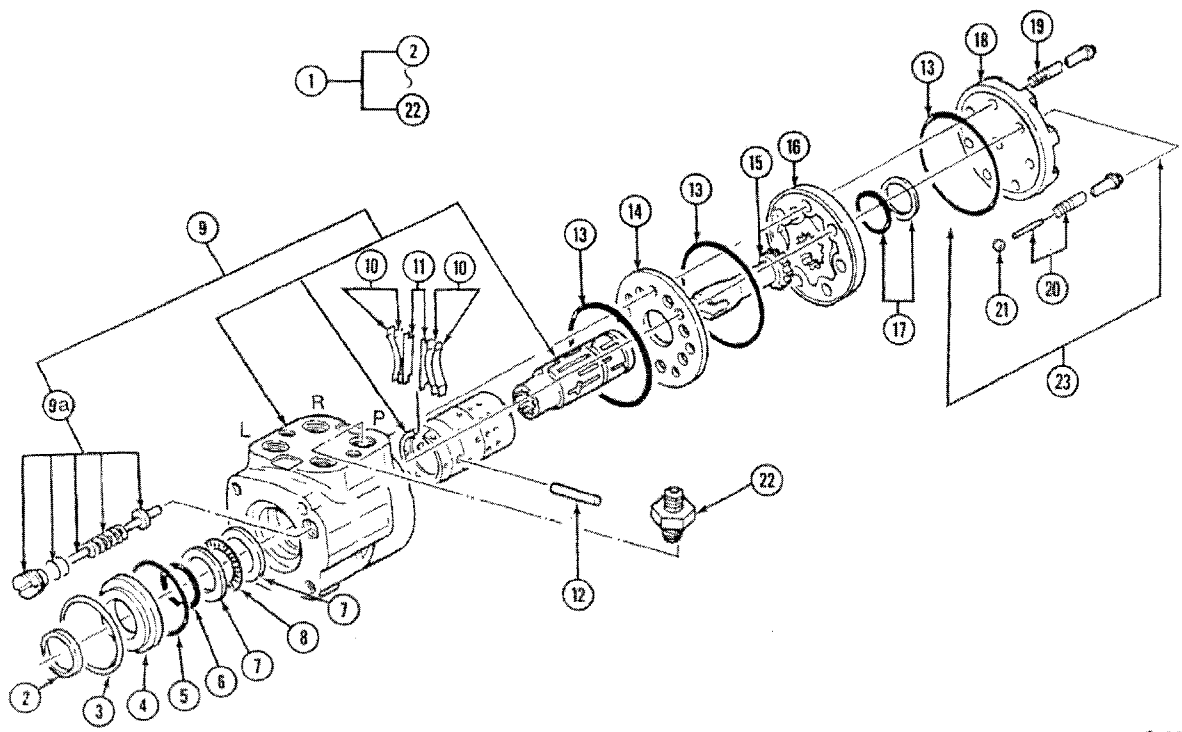


Figure 2
Power Steering Control Valve

1. Steering Case Assembly
2. Dust Seal
3. Retaining Ring
4. Seal Gland Bushing
5. O-Ring
6. Oil Seal
7. Race Bearing
8. Thrust Needle Bearing
9. Control Valve Assembly
9-a. Relief Valve
10. Centering Spring
11. Flat Spring
12. Pin
13. O-Ring
14. Spacer Plate
15. Drive (Shaft)
16. Gerotor
17. Star Seal Assembly
18. End Cap
19. Screw
20. Retainer Screw Assembly
21. Ball
22. Connector — Check Valve
23. Check Valve

2. DRIVE SHAFT
This shaft, slightly tilted off the spool axis, is splined into the pump gear of the GEROTOR pump assembly by its bottom end and is connected to the pin, mentioned above, by its top end.

In the event of loss of pressurized oil, turning the steering wheel turns this shaft (through spool and pin) to rotate the pump gear, so that the GEROTOR can operate as a manually driven pump to produce hydraulic pressure.

3. GEROTOR PUMP (conjugate-curv internal pump)
The GEROTOR pump (a proprietary name given by Gerotor May Corp.) operates as described above, and serves as a back-up device for this power steering system.

4. CHECK VALVE
Built in the valve body, this valve normally stays closed to prevent the pressurized oil from flowing from its "IN" side to "OUT" side but, if this oil is not available, it unseats to permit oil to be drawn from the oil tank to "IN" side.

5. RELIEF VALVE
   Built in the valve body, this valve prevents the oil pump and circuit from excessive oil pressure when the steering has been turned to the full extent of travel and against the stop, or at any time the front wheels are prevented from turning.

POWER STEERING PUMP

The power steering pump, Figure 3, is mounted on the front of the engine and is driven by the engine oil pump gear.

If trouble shooting indicates a faulty pump do not attempt to repair it. Due to the precision fit of the pump components, replace the pump with a new assembly.

POWER STEERING CYLINDER
Reference — Figure 4

The power steering cylinder is mounted transversely under the tractor with the cylinder end pinned to a fixed member and the rod end attached to either the tie rod or to the spindle arm.

POWER STEERING OPERATION

OIL FLOW — NEUTRAL POSITION
Reference — Figure 5

Pressurized oil from the power steering pump enters the valve body at port "P," Figure 5. The oil flows through the check valve (7), past the relief valve (3) and through radial holes in the sleeve to the center of the valve spool (2).

NOTE: *There are 24 radial holes in the sleeve (1) that index with 12 grooves provided in the spool.*

In neutral position the oil flows through the hollow spool and returns to the reservoir via port "T".

Passage to ports "L" and "R", leading to the cylinder, are blocked by the spool and sleeve. Oil contained in the tubes and cylinder is trapped and the cylinder remains in a fixed position. In this position the front wheels hold at a straight ahead position. The system is fully hydraulic and as such there is no road feel or front wheel reaction transmitted to the steering wheel.

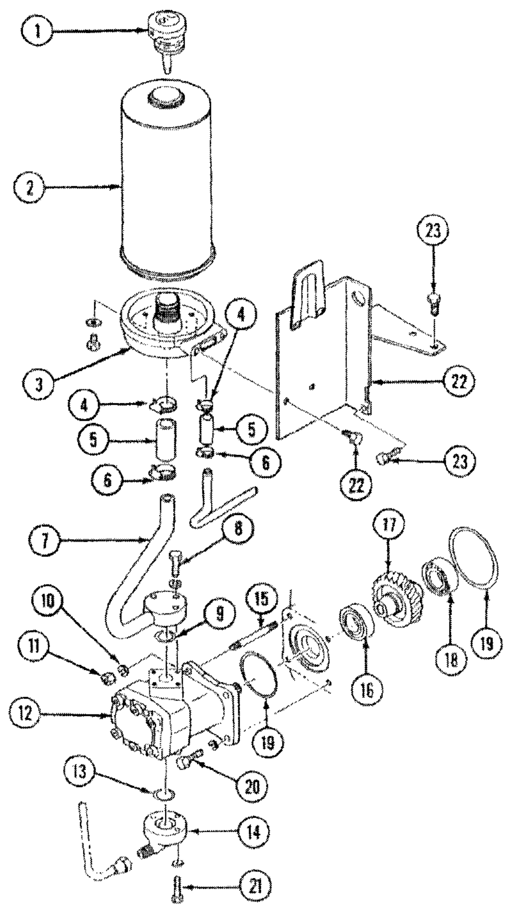


Figure 3
Power Steering Pump and Reservoir Assembly

1. Plug (Dip Stick-Oil Level)
2. Oil Tank-PS
3. Flange
4. Band
5. Rubber
6. Band
7. Pipe-Suction
8. Bolt
9. O-Ring
10. Spring Washer
11. Nut
12. Power Steering Pump
13. O-Ring
14. Flange
15. Stud Bolt
16. Bearing
17. Drive Gear
18. Bearing
19. O-Ring
20. Bolt
21. Bolt
22. Set Plate
23. Bolt

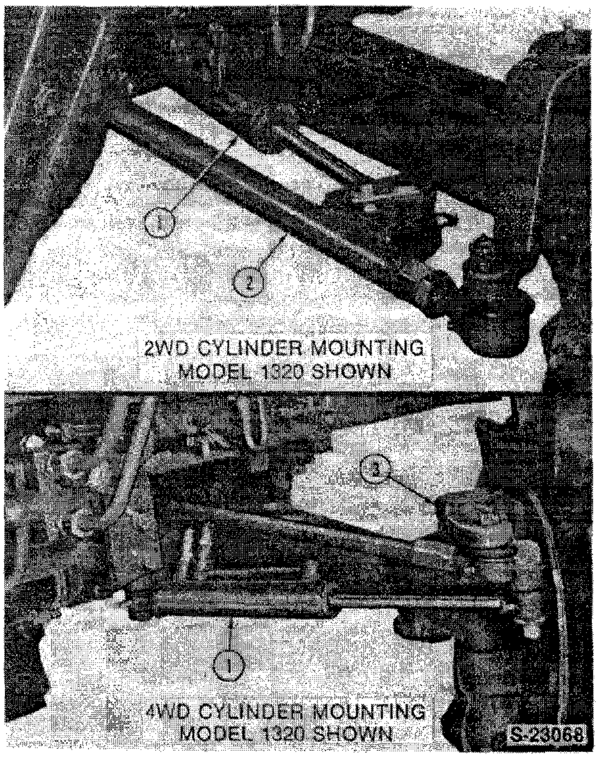


Figure 4
Power Steering Cylinder Mounting Location

1. Cylinder Assembly
2. Tie Rod
3. Steering Arm

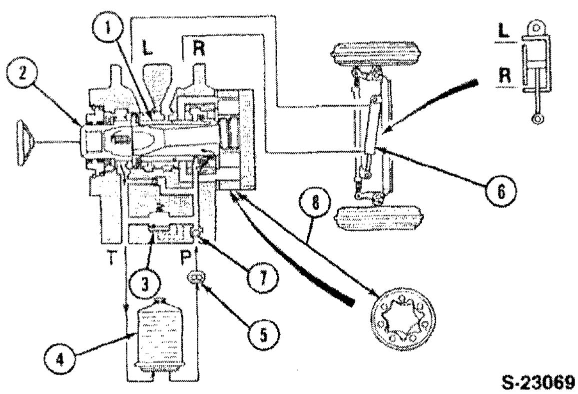


Figure 5
Oil Flow — Neutral Position

1. Sleeve
2. Spool
3. Relief Valve Assembly
4. Reservoir
5. P/S Pump
6. Cylinder
7. Check Valve Assembly
8. Gerotor Gear Pump

OIL FLOW — LEFT TURN
Reference — Figure 6

Turning the steering wheel to the left rotates the valve spool and indexes grooves in the spool with holes in the sleeve allowing oil flow to enter passages F, E and D in the control valve gear pump (see insert, Figure 6.) Since the gear pump is turning counterclockwise, the oil flows through passages C, B and A, to port "L" and to the power steering cylinder.

The oil enters the cylinder barrel end of the cylinder and causes the front wheels to turn left.

The oil contained in the cylinder rod side returns to the control valve through port "R" and is directed back to the reservoir through port "T."

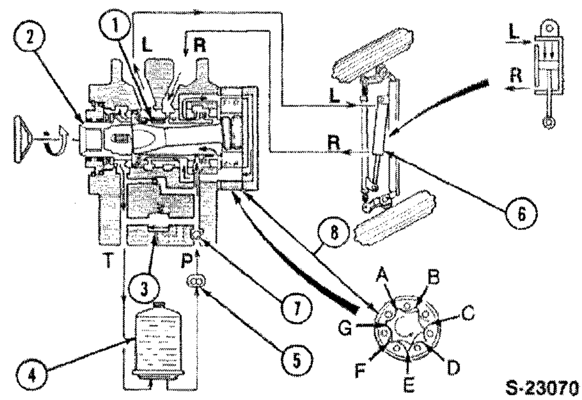


Figure 6
Oil Flow — Left Turn

1. Sleeve
2. Spool
3. Relief Valve Assembly
4. Reservoir
5. P/S Pump
6. Cylinder
7. Check Valve Assembly
8. Gerotor Gear Pump

OIL FLOW — RIGHT TURN
Reference — Figure 7

Turning the steering wheel to the right (clockwise) rotates the spool clockwise and indexes grooves in the spool with holes in the sleeve for a right turn.

Oil flow from the pump enters the gear pump passages A, B and C and flows out passages D, E and F to the valve port "R" to the cylinder. Oil in the piston side of the cylinder returns to the control valve through port "L" and is directed back to the reservoir through port "T."

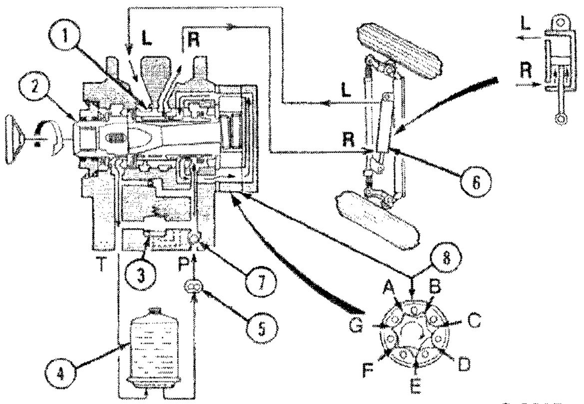


Figure 7
Oil Flow — Right Turn

1. Sleeve
2. Spool
3. Relief Valve Assembly
4. Reservoir
5. P/S Pump
6. Cylinder
7. Check Valve Assembly
8. Gerotor Gear Pump

MANUAL OPERATION
Reference — Figure 8

In the event of a power steering pump failure or engine shut-down, the steering system can be operated manually.

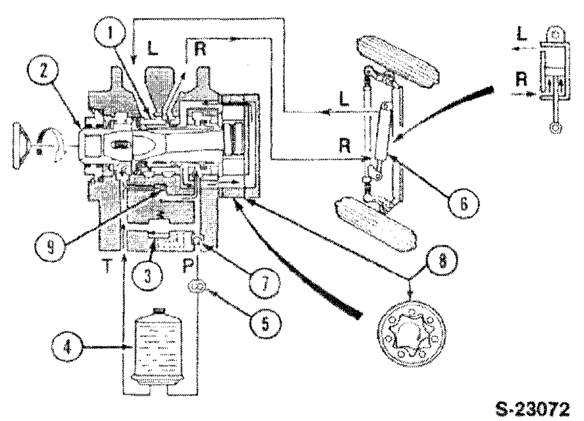


Figure 8
Power Steering — Manual Operation

1. Sleeve
2. Spool
3. Relief Valve Assembly
4. Reservoir
5. P/S Pump
6. Cylinder
7. Check Valve Assembly
8. Gerotor Gear Pump
9. Check Valve

Turning the steering wheel drives the gerotor gear pump in the control valve assembly to force oil to the power steering cylinder according to the direction that the steering wheel is being turned. Oil from the opposite side of the cylinder returns to the control valve. A check valve (9), located in a connecting passage between the "T" and "P" passages, unseats and allows the return oil and any reservoir oil that may be required to flow through the check valve and connecting passage to the "P" port passage, to supply the oil required for the pressure side of the system.

B. OVERHAUL

CONTROL VALVE REMOVAL

1. Remove the steering wheel, Figure 9.
2. Remove the snap ring (1) and oil seal (2), Figure 10.
3. Gently pull the steering shaft upward and remove from the top of the column.
4. Remove the steering column shroud center panel (2), Figure 9.
5. Remove the right hand side shroud panel (3), Figure 9.
6. Disconnect the power steering tubes (4), Figure 10, from the valve body and move them clear of the valve.

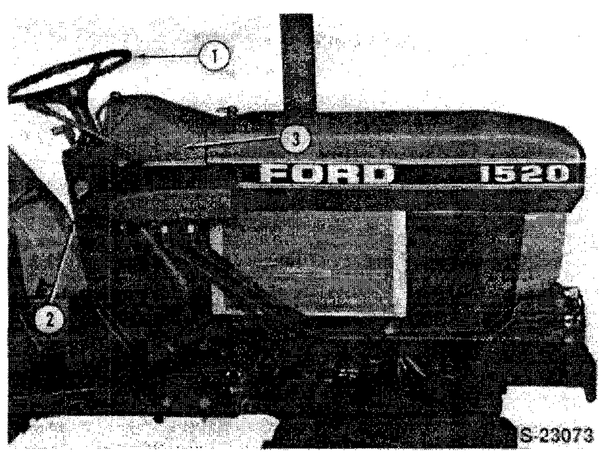


Figure 9
Power Steering Control Valve Removal

1. Steering Wheel
2. Shroud — Center Panel
3. Shroud Side Panel (R.H.)

7. Remove the four valve mounting bolts (5), Figure 10.

8. Lower the control valve and remove out the bottom from the left hand side of the tractor.

Figure 10
Power Steering Control Valve Removal

1. Snap Ring
2. Oil Seal
3. Steering Shaft
4. P/S Tubes
5. Mounting Bolts

DISASSEMBLY

1. Place the control valve upside down in a vise, remove the retaining bolts and check the valve retainer screw, Figure 11.

   NOTE: *Use soft metal jaws on the vise and apply only enough pressure to support the valve assembly. Do not overtighten or the valve body may become distorted and permanently damaged.*

2. Remove the end cap (21), seals (20) and O-ring (16), Figure 12.

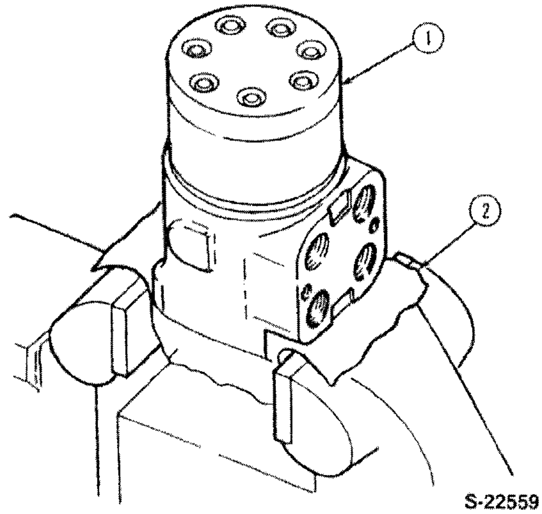


Figure 11
Control Valve Disassembly

1. Valve Assembly
2. Soft Jaw — Inserts

3. Remove the gerotor gear pump (19) and O-ring (16), Figure 12.

   NOTE: *The inner rotor separates easily from the outer pump body rotor. Use care in handling to not drop or other wise damage these components.*

4. Remove the second large O-ring (16).

5. Remove the drive shaft (18), spacer plate (17) and third large O-ring (16), Figure 12.

6. Remove the check ball (24), Figure 12.

7. Remove the retaining ring (2), Figure 12 and (1), Figure 13).

   NOTE: *Remove the valve from the vise and place on a clean lint-free shop towel. Use care in handling the valve parts so as not to mar or damage the precision finishes.*

8. Rotate the spool and sleeve to position the pin horizontally. Gently push on the bottom end of the spool and sleeve forcing the gland (3), Figure 12, and (1), Figure 14 out of the valve body.

9. Separate the seals (1) and (5) from the gland, Figure 12.

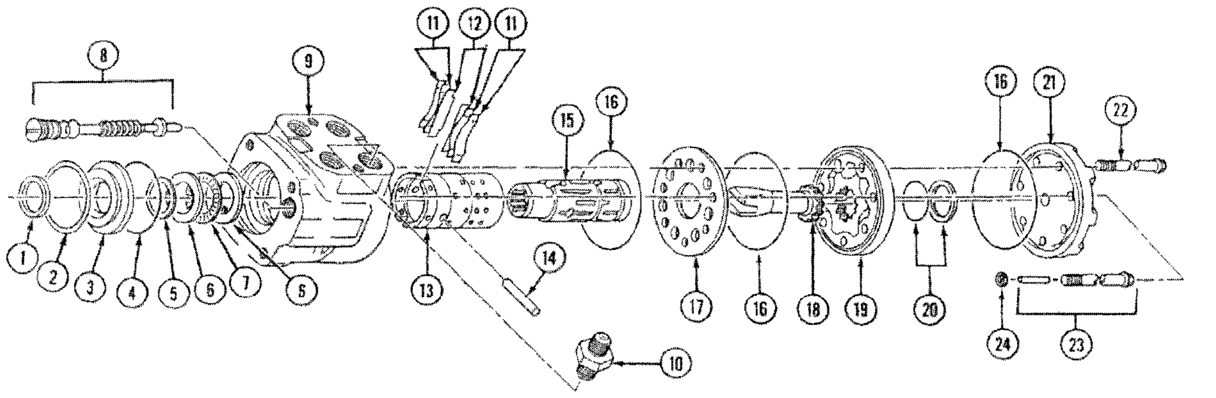


Figure 12
Power Steering Control Valve — Disassembly

1. Seal — Dust
2. Retaining Ring
3. Seal Gland
4. O-Ring
5. Oil Seal
6. Bearing Race
7. Bearing
8. Relief Valve Assembly
9. Body
10. Connector
11. Centering Springs (Curved)
12. Springs (Flat)
13. Sleeve
14. Pin
15. Spool
16. O-Rings
17. Spacer Plate
18. Shaft
19. Gerotor Pump
20. Seal Assembly
21. End Cap
22. Bolts
23. Check Ball and Retainer Bolt
24. Ball (Check)

10. Remove the thrust bearing (7) and two bearing races (6), Figure 12.

11. Remove the spool and sleeve as an assembly (13, 14 and 15,) Figure 12, and (1), Figure 15.

12. Remove the pin (2), Figure 15.

13. Push the spool upward out of the sleeve slightly and remove the centering springs (11 and 12), Figure 12, (3 and 4 Figure 16).

14. Remove the spool from the bottom side of the sleeve.

NOTE: *Rotate the spool while pushing it out of the sleeve to prevent binding.*

INSPECTION

1. Inspect the spool and sleeve for evidence of sticking, scuff marks and any other damage. If defective, replace the spool and sleeve as a matched set.

2. Upon assembly, replace all seals and O-rings with new.

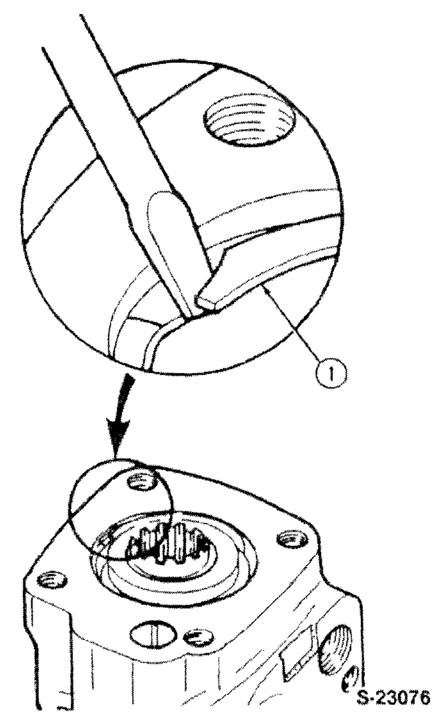


Figure 13
Retaining Ring Removal

1. Retaining Ring

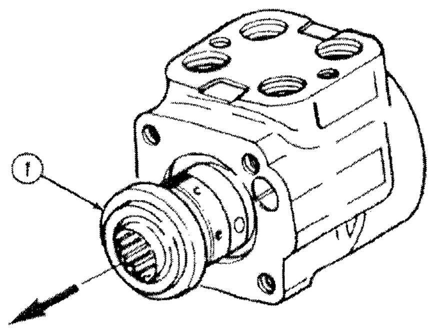


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Figure 14
Seal Gland Removal

1. Gland

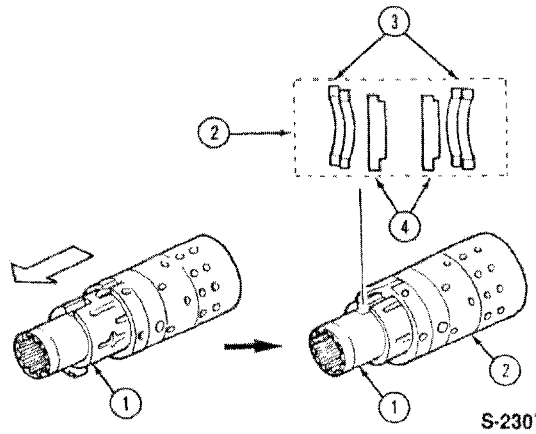

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Figure 16
Spool and Sleeve — Disassembly

1. Spool
2. Sleeve
3. Centering Springs (Curved)
4. Centering Springs (Flat)

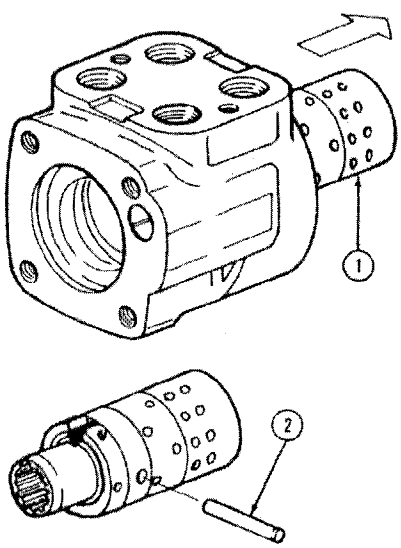

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Figure 15
Spool and Sleeve Removal

1. Spool and Sleeve Assembly
2. Pin

ASSEMBLY

1. Insert the spool into the sleeve while slowly rotating the spool.

   NOTE: *Bring the matching marks into register to align the centering spring slots. Check to be sure the spool rotates freely within the sleeve, Figure 17.*

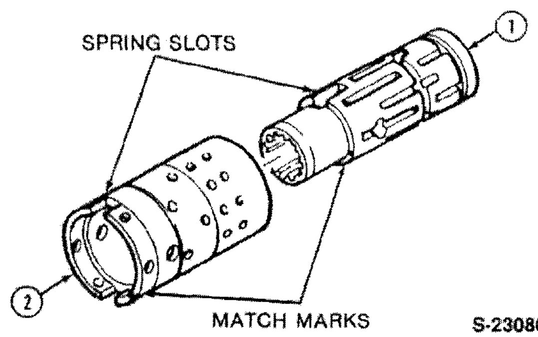

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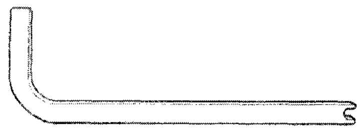
Figure 17
Spool and Sleeve Assembly

1. Spool
2. Sleeve

2. With the spring slots lined up insert the special tool (1), Figure 18, in the slots. See Special Tools, Chapter 2.
3. Position the combination of centering springs into the groove of the installer.



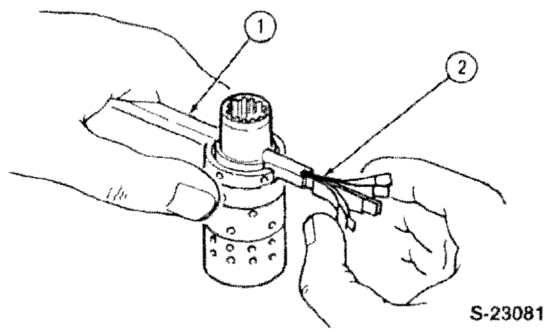


Figure 18
Centering Spring Assembly

1. Assembly Tool
2. Centering Springs

NOTE: *The springs are arranged with 2 flat springs in the center and 2 curved springs on each side with the convexed side facing the flat springs. Be sure the notched edges of the spring face downward.*

4. While griping the outer end of the spring combination and maintaining pressure against the tool, slide the tool out of the assembly leaving the springs positioned in the slots.

NOTE: *Positioning the spool in a slightly higher than normal position in the sleeve will faciliate this assembly operation.*

5. Position the spool and sleeve so that their ends are flush.

6. Install the pin (1), Figure 19, making its ends flush with the sleeve surface.

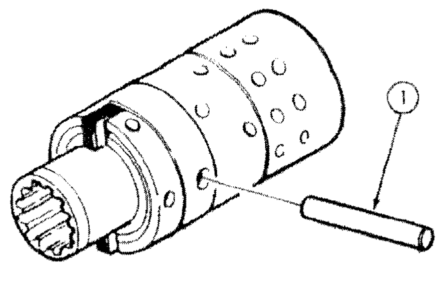


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Figure 19
Spool and Sleeve Assembly

1. Pin

7. Insert the spool and sleeve assembly into the valve body from the bottom. Position the assembly so that the end is flush with the valve body.

   Check the sleeve rotation to be sure it rotates freely in the housing bore.

8. Install the O-ring (1), Figure 20, into the valve body.

9. Position the thrust bearing assembly in the bore making sure it seats firmly on the sleeve and spool.

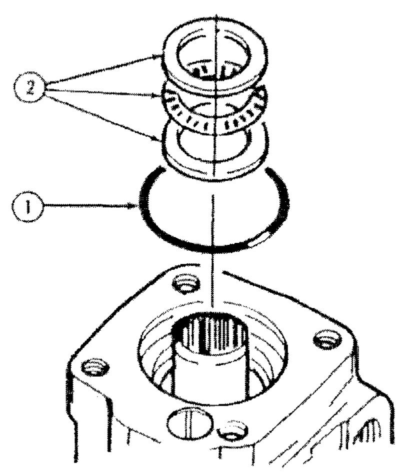

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Figure 20
Thrust Bearing Assembly

1. O-Ring
2. Thrust Bearing Assembly

10. Install the dust seal (2) to the gland bushing, Figure 21.

11. Install the oil seal (3) to the gland, Figure 21. Be sure the seal is not cocked in any way.

12. Position the gland assembly in the bore being sure its outer end face is parallel with the valve body end face.

13. Install the retaining ring in the valve body groove.

14. Position the valve body in a soft jawed vice to support the assembly. Do not over-grip the valve body as it will distort the valve body and cause permanent damage to the unit.

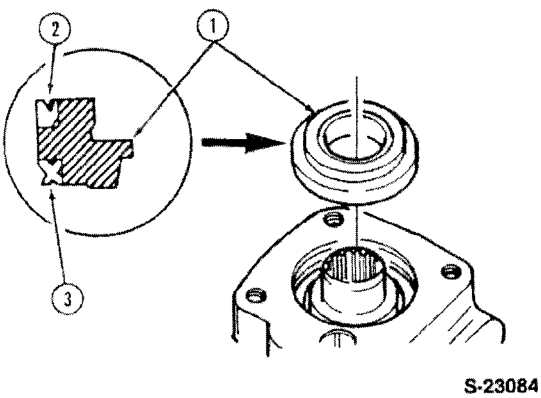


Figure 21
Seal and Gland Assembly 1320/1520

1. Gland
2. Dust Seal
3. Oil Seal

15. Position the check ball (1), Figure 22, into the retainer bolt bore.

16. Position the spool and sleeve assembly so that it is slightly below the bottom face of the valve body.

NOTE: *Be sure the mating surfaces of the components are clean and free of dirt and lint.*

17. Install the O-ring (1) and position the spacer plate on the valve body being sure to match the bolt holes and ports to that of the valve body, Figure 23.

18. Rotate the spool and sleeve to position the pin slots parallel with the valve body port face, Figure 24.

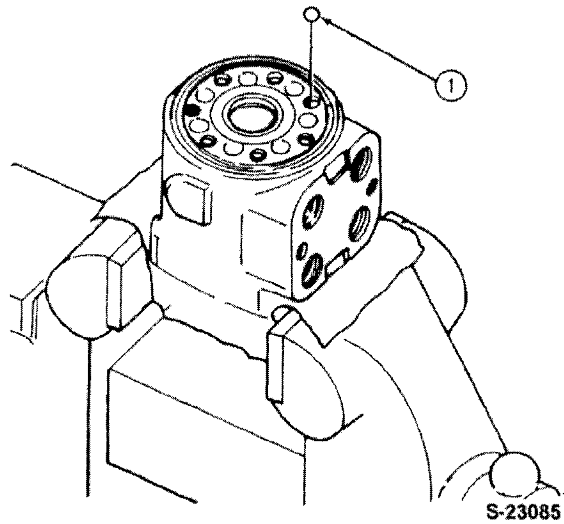


Figure 22
Check Ball Assembly

1. Ball

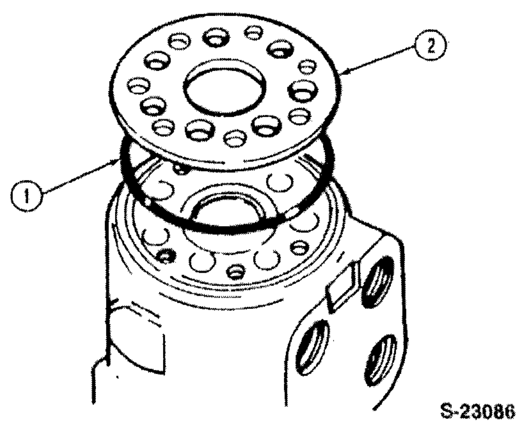


Figure 23
Spacer Plate Assembly 1320/1520

1. O-Ring
2. Spacer Plate

19. Scribe a reference mark on the splined end of the drive shaft parallel to the pin slot as shown, Figure 24.

20. Position the drive shaft in the valve body engaging the slot with the pin.

21. Install the O-ring (2) and seal (3) on the rotor (1), Figure 25.

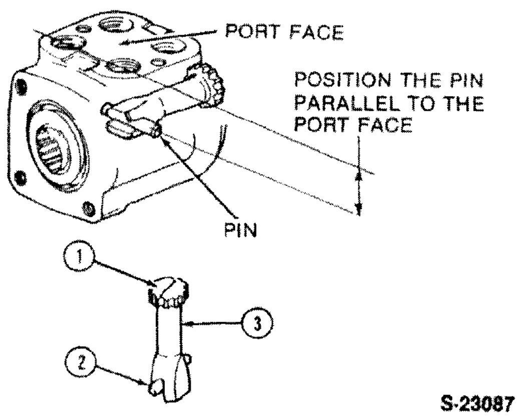


Figure 24
Valve and Gear Assembly and Timing Procedure

1. Reference Scribe Mark
2. Pin
3. Drive Shaft

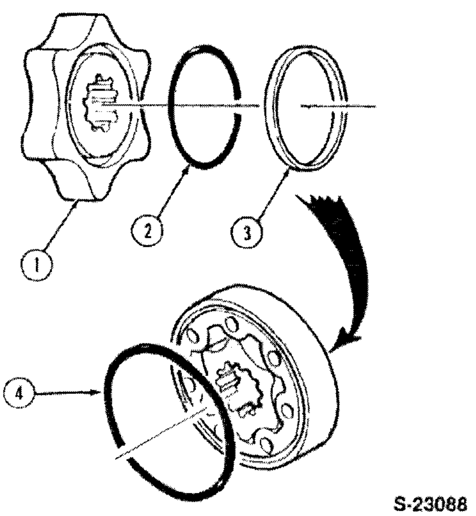


Figure 25
Gerotor Pump Assembly

1. Rotor
2. O-Ring
3. Seal
4. O-Ring

NOTE: *Apply a grease type lubricant to the face of the rotor to make the O-ring and seal adhere to the rotor surface.*

22. Position the rotor in the pump ring and install the O-ring (4) in the pump groove, Figure 25.

23. Position the gerotor pump assembly onto the valve body with the seal side up. Align the drive shaft reference line with a diametrical line running through the center of the pump gear valleys as shown, Figure 26.

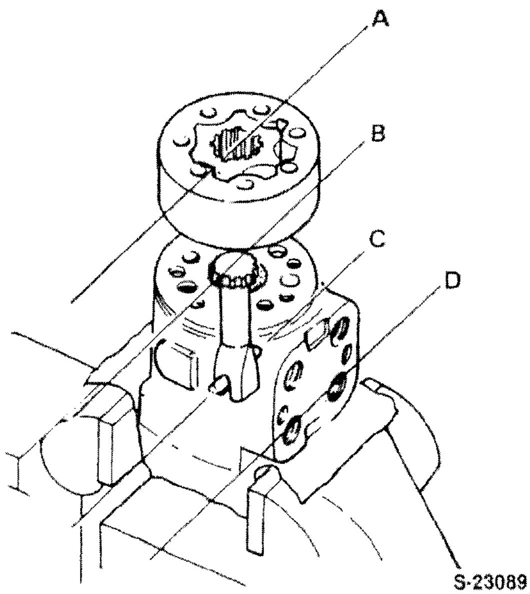


Figure 26
Gerotor Pump Assembly and Timing Procedure

A. Gear Lobe Reference
B. Drive Shaft Reference Mark
C. Drive Shaft Pin Location
D. Port Face Reference

NOTE: *It is important that the pump drive shaft, gear lobes and valve ports are in the correct relationship for proper valve timing as described above and referenced in the parallel lines A-B-C and D, Figure 26.*

24. Install the O-ring (1) onto the end cap (2) and position the assembly on the valve body. Align the bolts holes and install the retaining bolts.

NOTE: *Lubricate the bolt threads and tighten to specified torque in steps to maintain equal pressure on the valve body. Tighten the bolts in the sequence as shown, Figure 27.*

Tightening Torque . . . . 21 lbs. ft. (28 Nm)

Recheck the valve spool to be sure it rotates smoothly without binding.

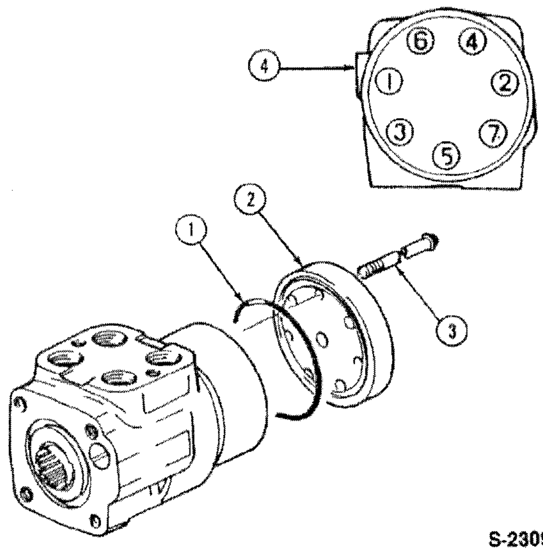


Figure 27
End Cap Assembly

1. O-Ring
2. End Cap
3. Retaining Bolts
4. Tightening Sequence

25. Install the connector fitting in the valve pressure port and tighten to the specified torque:

    Tightening Torque ....51 ± 7 lbs. ft. (69 ± 9 Nm)

26. Install the control valve assembly on the tractor and complete the assembly following the removal procedures in reverse.

STEERING CYLINDER

REMOVAL
Reference — Figure 28

1. Disconnect the hoses to the power steering cylinder and cap all openings.

2. Remove the cylinder from the tractor.

DISASSEMBLY
Reference — Figure 29

1. Using a suitable chisel, straighten the cylinder tube crimping from the gland head.

2. Using a spanner wrench, unscrew the gland head out of the tube. Pull the cylinder rod, gland head and piston assembly out of the tube.

3. Remove the piston nut from the rod and remove the piston assembly.

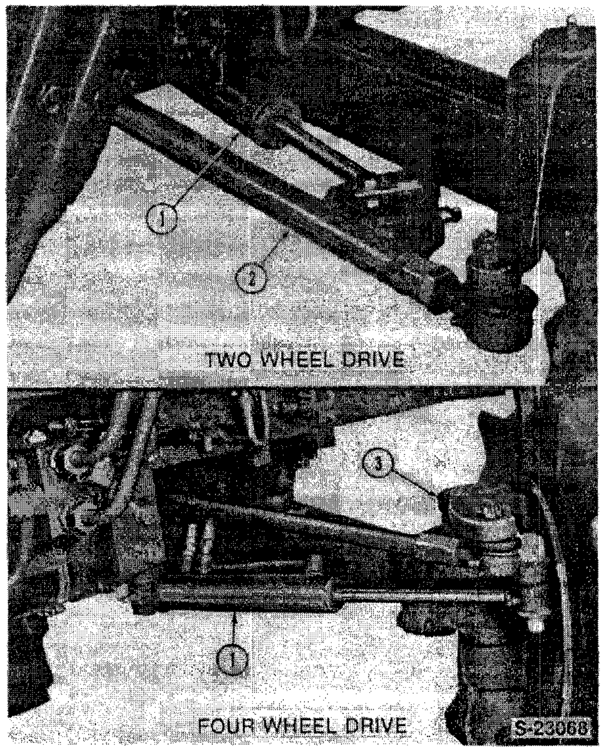


Figure 28
Power Steering Cylinder Removal

1. Cylinder Assembly
2. Tie Rod
3. Steering Arm

INSPECTION

1. Inspect the inside of the tube for any scuffing or scaring or unusual wear.

2. Inspect the piston for scuffing, score marks or other damage.

3. Using micrometers, measure the inside diameter of the cylinder tube and piston outside diameter and determine the working clearance.

   Replace the tube and/or piston if the working clearance exceeds the specified tolerance. See Specifications, Chapter 2.

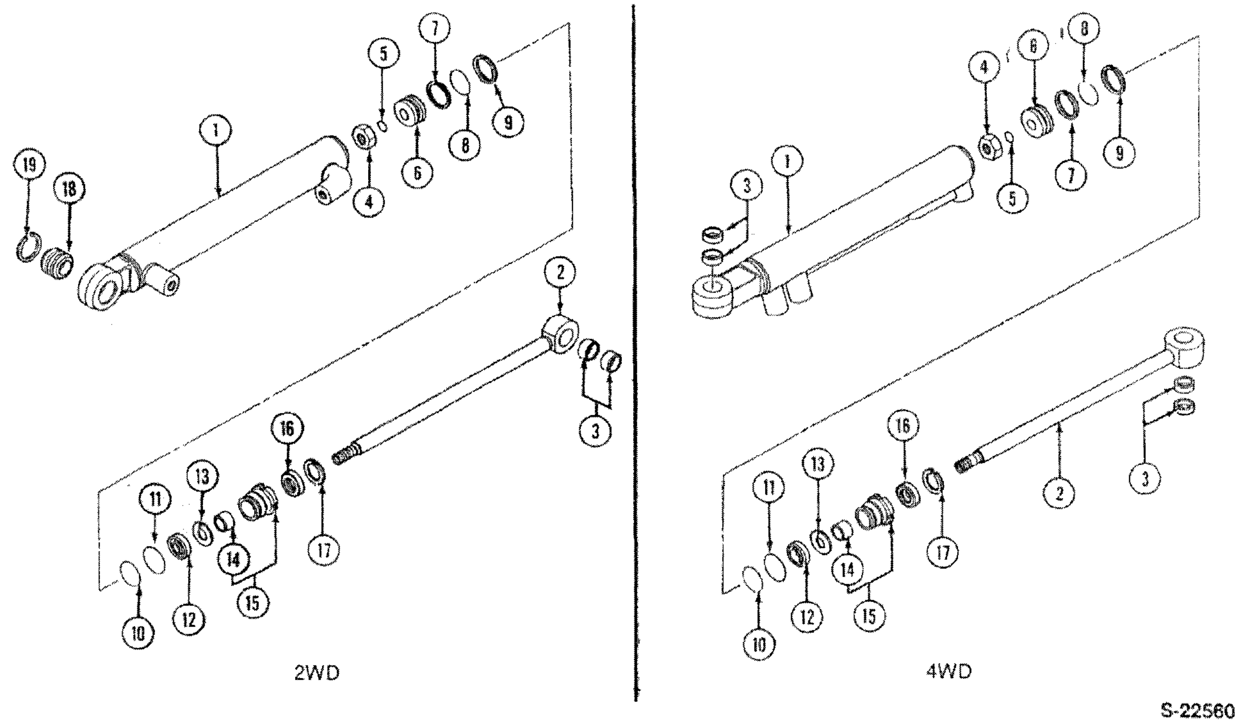


Figure 29
Power Steering Cylinder Disassembly

1. Cylinder Tube
2. Piston Rod
3. Bushing
4. Nut
5. O-Ring — Rod
6. Piston
7. Back-up ring
8. O-Ring — Piston
9. Back-up ring
10. O-Ring — Cylinder Head
11. O-Ring
12. U-Ring Seal
13. Back-up Ring
14. Bushing
15. Cylinder Head Assembly
16. Wiper-Ring
17. Snap Ring
18. Spherical Bearing
19. Snap — Ring

4. Inspect the cylinder rod for excess wear and scoring. Replace the rod if damaged.

5. Inspect the anchor pins and bearing for excess wear and excessive clearance. Replace bearings and or pins if the clearance is excessive. See Specifications, Chapter 2.

6. Check the rod to gland head bushing clearance. Replace the bushing if there is excessive clearance. See Specifications, Chapter 2.

7. On assembly, replace all O-rings and seals with new.

ASSEMBLY

Assembly of the power steering cylinder follows the disassembly in reverse.

On assembly observe the following:

- Tighten the piston retaining nut to the specified torque. Stake the nut and thread in two places to prevent it from loosening.

  Tightening Torque
  1320/1520 ....26 lbs. ft. (35 Nm)
  1720 ....34 lbs. ft. (46 Nm)

- Tighten the gland head to the specified torque. Crimp the end of the cylinder tube at the gland head notch to prevent the gland head from loosening.

  Tightening Torque
  1320/1520 ....94 lbs. ft. (127 Nm)
  1720 ....123 lbs. ft. (167 Nm)

INSTALLATION

Installation of the power steering cylinder generally follows the removal procedure in reverse.

On assembly of the hoses, use sealing tape on the hose fittings.

Start the tractor and operate the steering system and check for leaks before completing the sheet metal assembly.

POWER STEERING PUMP AND RESERVOIR TANK

PUMP REMOVAL

1. Remove the reservoir tank dipstick-filler cover (2), Figure 30, and using a suction pump, suck the oil out of the reservoir tank.

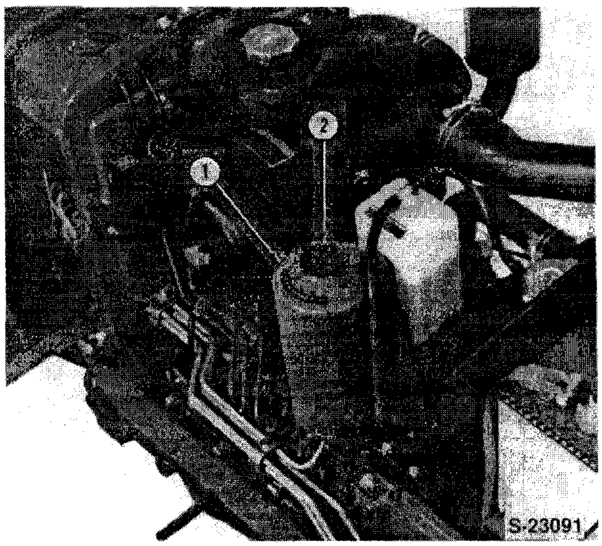


Figure 30
Power Steering Oil Removal
1. Reservoir Tank 2. Filler Cap

2. Remove the suction tube bolts (1), Figure 31.
3. Remove the pressure tube (2) from the bottom of the pump.
4. Remove the mounting bolts and nuts (3), Figure 31, and remove the pump from the front cover.

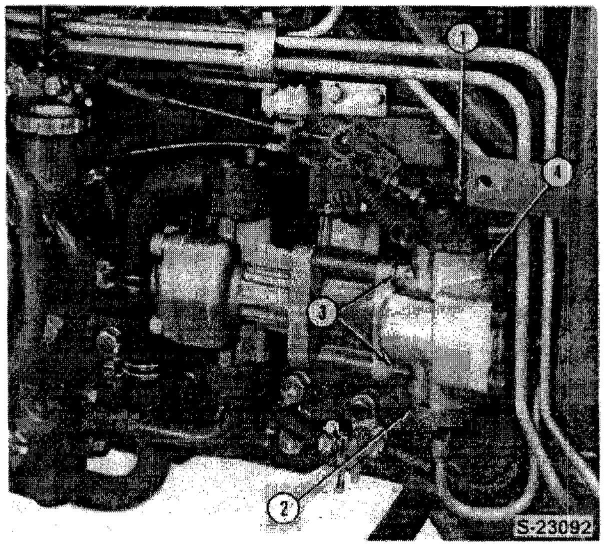


Figure 31
Power Steering Pump Removal
1. Suction Tube 3. Mounting Nuts
2. Pressure Tube 4. P/S Pump

POWER STEERING PUMP (1320-1520)
Reference — Figure 32

The only parts serviced on the power steering pumps are the shaft seal and internal O-ring seals. If trouble shooting indicates a faulty pump, replace the pump with a new assembly.

DISASSEMBLY

1. Place the pump in a soft jawed vise with the drive shaft facing downward.
2. Scribe a line on the cover and the pump body for ease in assembly.
3. Remove the six bolts securing the cover to the pump and remove the cover.
4. Remove the O-ring and the outer bearings
5. Remove the drive and driven gears from the housing.
6. Using a brass hook, or dental pick, remove the inner bearings and O-rings from the pump housing.
7. Remove the shaft seal from the pump housing.

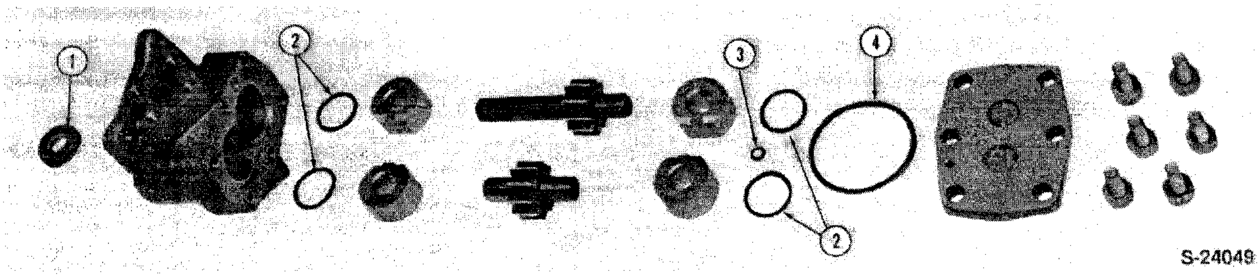


Figure 32
Power Steering Pump Components
1320-1520 Tractors

1. Shaft Seal
2. Bearing O-Rings
3. O-Ring
4. O-Ring

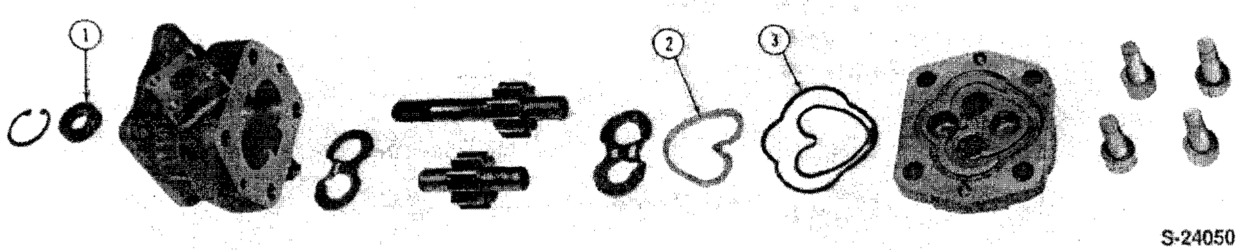


Figure 33
Power Steering Pump Components
1720 Tractor

1. Shaft Seal
2. Back-up Ring
3. Seal Ring

INSPECTION AND REPAIR

1. Wash all parts in a clean solvent and air dry.
2. Discard all O-rings and seal.
3. Inspect the parts for damage or wear, and if necessary, replace the pump.

ASSEMBLY

Assembly follows disassembly procedures in reverse however the following must be observed.

- Lubricate all parts during assembly with the correct grade of hydraulic oil.
- Make sure the cover bolts are torqued, see specifications.

POWER STEERING PUMP (1720)

The basic service procedure for the 1720 tractor power steering pump is the same as the 1320-1520 tractors.

The one difference is the inner and outer gear wear plates are not the same. The rectangular slots in the wear plates should be installed to the pump pressure side, and the wear plate with two openings is installed on the cover side of the gears.

INSTALLATION

Installation of the power steering pump generally follows the removal procedure in reverse.

After installation of the pump, fill the reservoir tank to the proper level with the specified power steering fluid.

Start the engine and cycle the steering system by turning the steering wheel to the extreme right and left several times with the engine idling. Make sure the relief valve operates. Stop the engine and refill the tank to the proper level. Check for possible leaking fittings or connections.

POWER STEERING TUBES
Reference — Figure 34

Power steering tubes should not be in contact with other parts on the tractor. Be sure mounting clamps are installed correctly and secured to prevent loosening.

Always use sealing tape on the tube fittings and tighten to the specified torque. See Specifications, Chapter 2.

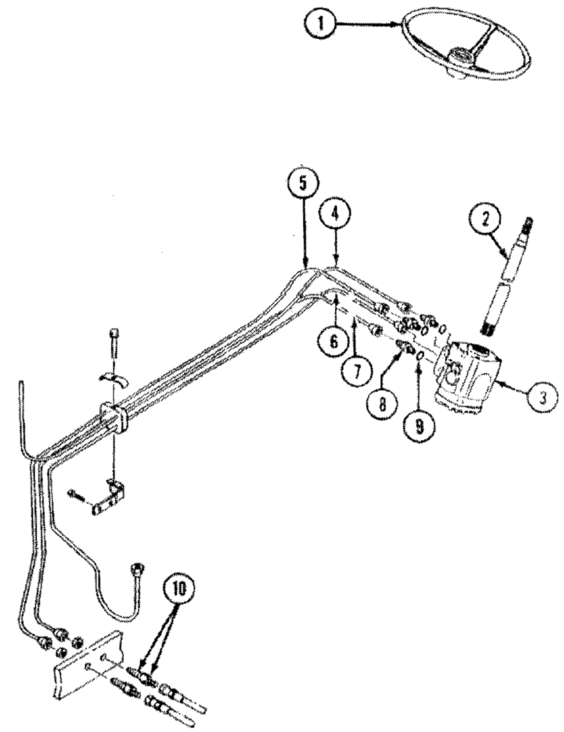


Figure 34
Power Steering Tubes — Model 1320/1520 Shown

1. Steering Wheel
2. Steering Shaft
3. Steering Control Valve
4. Pipe — T
5. Pipe — L
6. Pipe — P
7. Pipe — R
8. Adapter
9. O-Ring
10. Adapter

PART 9
STEERING SYSTEMS

Chapter 2
TROUBLE SHOOTING, TESTING AND SPECIFICATIONS

Section **Page**

A. TROUBLE SHOOTING

Most malfunctions in the steering system can usually be traced to dirt or foreign matter in the system. Dirt can cause such things as stickiness, erratic operation, or hard steering.

Before considering the procedures below, follow these suggested steps:

1. Check the pump for proper relief valve action. (See Testing).
2. Jack the front end of the tractor off the ground and cycle the steering from stop to stop to check for front axle binding.
3. Be sure the hydraulic hoses from the pump to motor, and from the motor to cylinder are hooked up correctly.

CONDITION	POSSIBLE CAUSE	REMEDY
Hard Steering	1. ORBITROL (control valve unit) (1)ORBITROL not aligned to steering column.	Reposition ORBITROL.(If loosening its mounting bolts lightens the handwheel, it means that ORBITROL was in misalignment.)
	(2)Spool-and-sleeve combination is seized because of foreign matter.	Replace.
	(3)Overtightening of the end cap bolts.	Re-tighten to the specified torque limit.
	2. Oil pump (1)The pump is struck and will not work.	Replace oil pump.
	(2)The pump is worn down.	Replace oil pump.
	(3)Pumping performance inadequate.	Test pump performance and, if necessary, remove the pump. Disassemble the pump and inspect the internal seals. Refer to the pump seal kit repair section.
	3. Relief valve (1)The valve is damaged because of internal deterioration.	Replace control valve assy.
	(2)Pressure setting is too low.	Replace control valve assy.

CONDITION	POSSIBLE CAUSE	REMEDY
Steering wheel will not return to neutral or will turn by itself.	1. ORBITROL (1)Spool and sleeve combination is stuck and will not rotate. (2)ORBITROL not aligned to steering column.	Replace control valve assy. Re-align.
Cylinder will not follow steering wheel rotation or will respond sluggishly.	1. ORBITROL (1)ORBITROL has been improperly rebuilt, resulting in valve mistiming. 2. Steering cylinder (1)Air is trapped in the cylinder. (2)Internal oil leakage because of damaged piston seal.	Repair. Bleed air out. Replace the seal.
Steering wheel will "kick back."	1. ORBITROL (1)ORBITROL has been improperly rebuilt, resulting in valve mistiming. 2. Piping (1)Pipes are improperly connected to the four ports of ORBITROL.	Repair. Correct the pipe connections.
Oil leakage 1. From the splined connection of column to spool. 2. From mated face joints (valve body, spacer plate, ORBITROL, end cap).	Leaky oil seal (1)Dirty hydraulic oil. Damaged "O" ring (1)A pinched or damaged "O" ring in a mated face joint can be the cause, which resulted from lack of attention in reassembling the ORBITROL.	Replace oil seal. Change the oil. Replace.

B. PRESSURE TESTING

PUMP, STEERING MOTOR, RELIEF VALVE

To check the operator of the pump and relief valve, use the following procedure:

1. With the tractor engine stopped, disconnect one of the hydraulic lines which run to the steering cylinder.

2. Connect the pressure gauge to the end of the line from the steering motor and cap the line leading to the steering cylinder Figure 35.

3. Install the male end cap into the open end of the tee.

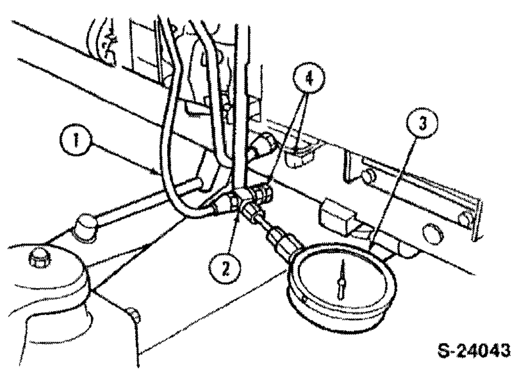


Figure 35
Pressure Testing Pump and Relief Valve
1. Steering Motor to Steering Cylinder Line
2. "Tee" Fitting #11451
3. 0-3000 psi Pressure Gauge
4. Caps

4. Start the tractor engine, and allow it to idle. Observe the gauge—it should read at or near 0 psi.

5. Turn the wheel so that the line which the gauge is connected to receives pump oil intended for the steering cylinder. For instance, if the gauge is connected to the left side of the cylinder (as viewed from the operator's seat), turn the wheel to the left. Observe the gauge reading.

Test Results

- If the pressure gauge reading rises before the wheel is turned, it indicates that steering motor valve timing is off, and the steering motor will have to be disassembled and inspected.
- If the pressure gauge reading rises to the relief valve setting (1420-1520 psi) when the wheel is turned, it indicated the pump and relief valve are working properly.
- If the pressure gauge reading is substantially below the relief valve setting, it may indicate a relief valve that is not working properly or a worn pump.

STEERING CYLINDER

If the reading from the pump and relief valve pressure test is within specifications, use the following procedure to modify the test setup and test the steering cylinder:

1. Remove the caps from the tee fitting and steering cylinder line.

2. Attach the tee fitting to the steering cylinder line Figure 36.

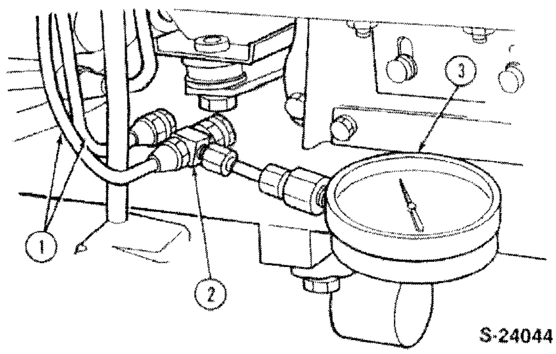


Figure 36
Pressure Testing Steering Cylinder

1. Steering Motor to Steering Cylinder Lines
2. "Tee" Fitting #11451
3. 0-3000 psi Pressure Gauge

3. Start the tractor and turn the wheel so that the line the gauge is teed into is carrying oil to the steering cylinder. Observe the gauge when the steering linkage reaches the limit of its travel.

4. Repeat the procedure for the other side of the steering cylinder.

Test Results

- If pressure rises to the relief valve setting at both stops, it indicates that the system is functioning as it should be.
- A low reading at both stops indicates a leak across the steering cylinder's piston.

C. SPECIFICATIONS

Oil Pump Capacity
Model 1320/1520 .... 1.5 Gal @ 2500 Engine rpm
Model 1720 .... 2.3 Gal @ 2500 Engine rpm

POWER STEERING TYPE .... Full Hydraulic

STEERING CYLINDER
STROKE — 2WD
1320/1520 .... 7.29 in. ± 1/16 (187 ± 1.25 mm)
1720
STROKE — 4WD
1320/1520 .... 7.21 in. ± 1/16 (185 ± 1.25 mm)
1720 .... 8.86 in. ± 1/16 (225 ± 1.25 mm)
INSIDE DIAMETER
1320/1520 .... 1.36 in. (35 mm)
1720 .... 1.57 in. (40 mm)

RELIEF VALVE PRESSURE
1320/1520/1720 .... (1400-1500 psi)

OIL SPECIFICATION .... Ford 134

STEERING CYLINDER
Piston-to-Tube Clearance .... 0.027 in. (0.7 mm) max.
Anchor Pin-to-Bushing Clearance
Piston Rod Eye .... 0.019 in. (0.5 mm) max.
Tube Eye .... 0.019 in. (0.5 mm) max.
Cylinder Rod-to-Gland
Bushing Clearance .... 0.012 in. (0.3 mm) max.

TORQUE SPECIFICATIONS

P/S Cylinder Gland Head
1320/1520 .... 94 lbs. ft. (127 Nm)
1720 .... 123 lbs. ft. (167 Nm)
P/S Cylinder Piston Nut
1320/1520 .... 26 lbs. ft. (35 Nm)
1720 .... 34 lbs. ft. (46 Nm)

ANCHOR PIN RETAINING BOLT .... 9-12 lbs. ft. (12-16 Nm)
POWER STEERING PUMP BOLTS .... 16-20 lbs. ft. (21-27 Nm)

TUBE FITTINGS — Reference — Figure 32

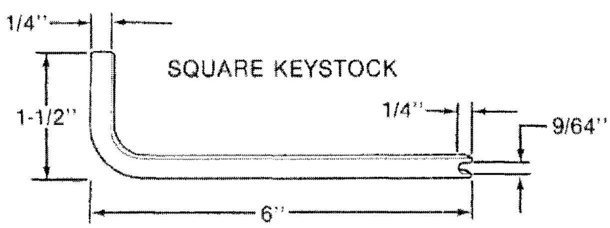
NO. 4 TUBE	22-29 lbs. ft. (30-39 Nm)
NO. 5 TUBE	22-29 lbs. ft. (30-39 Nm)
NO. 6 TUBE	22-29 lbs. ft. (30-39 Nm)
NO.7 TUBE	22-29 lbs. ft. (30-39 Nm)
NO. 8 ADAPTER	43-58 lbs. ft. (58-78 Nm)
NO. 8 ADAPTER	29-36 lbs. ft. (39-49 Nm)

D. SPECIAL TOOLS

Tool No.

Gauge 2028
Hose 2104
Tee Fitting 11451

Procure Locally Male Cap
Female Cap



Centering Springs — Installer

GENERAL

BOLT TORQUE SPECIFICATIONS

Bolt Size	Grade No.	Coarse Thread			Fine Thread		
		Pitch (mm)	Pounds-Feet	Newton-Meters	Pitch (mm)	Pounds-Feet	Newton-Meters
M6	4T	1.0	3.6-5.1	4.9-6.9	—	—	—
	7T		6.1-8.3	8.3-11.3			
	10T		8.7-11.6	11.8-15.7			
M8	4T	1.25	9.4-12.3	12.7-16.7	1.0	11.2-14.8	15.2-20.1
	7T		16.6-21.0	22.6-28.4		19.5-25.3	26.5-34.3
	10T		21.0-26.8	28.4-36.3		22.4-29.7	30.4-40.2
M10	4T	1.5	18.8-24.6	25.5-33.3	1.25	21.0-26.8	28.4-36.3
	7T		32.5-41.2	44.1-55.9		36.2-46.3	49.0-62.8
	10T		39.8-51.4	53.9-69.9		42.7-54.2	57.9-73.5
M12	4T	1.75	27.5-34.7	37.3-47.1	1.25	31.8-40.5	43.1-54.9
	7T		48.5-61.5	65.7-83.4		55.0-69.4	74.5-94.1
	10T		68.0-85.4	92.9-116		73.1-93.3	99.0-127
M14	4T	2.0	46.3-59.3	62.8-80.4	1.5	51.4-64.4	69.6-87.3
	7T		76.7-96.9	104-131		86.1-109	117-148
	11T		102-129	139-175		108-137	147-186
M16	4T	2.0	63.6-81.0	86.3-110	1.5	67.3-84.6	91.3-115
	7T		110-136	149-184		116-142	157-192
	11T		152-188	206-255		163-199	221-270
M18	4T	2.0	83.9-104	114-141	1.5	95.9-120	313-163
	7T		145-174	196-235		170-206	131-279
	11T		203-246	275-333		221-271	299-368
M20	4T	2.5	106-132	144-179	1.5	127-156	172-211
	7T		177-213	240-289		203-246	275-333
	11T		268-325	363-441		293-358	397-485

PART 10
FRONT AXLE AND RELATED PARTS

Chapter 1
FRONT AXLE AND RELATED PARTS — TWO WHEEL DRIVE

Chapter 2
FRONT AXLE AND RELATED PARTS — FOUR WHEEL DRIVE

Chapter 3
TROUBLE SHOOTING AND DESCRIPTION

PART 10
FRONT AXLE AND RELATED PARTS

Chapter 1
FRONT AXLE AND RELATED PARTS — TWO WHEEL DRIVE

A. DESCRIPTION AND OPERATION

A non-adjustable front axle is standard equipment on the model 1320 tractor, Figure 1.

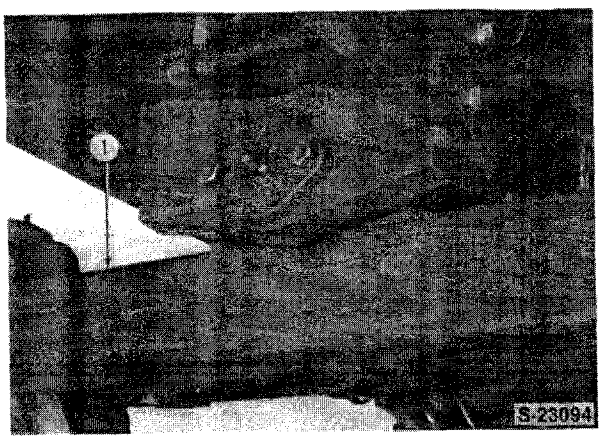


Figure 1
Non-Adjustable Front Axle — Model 1320
1. Axle Assembly

An adjustable front axle, Figure 2, is standard equipment on models 1520 and 1720 tractors.

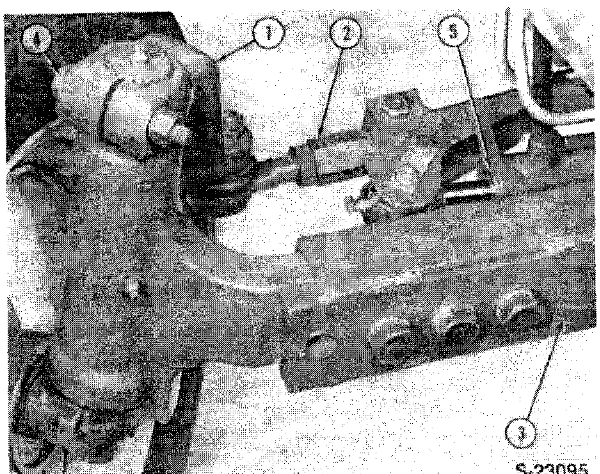


Figure 2
Adjustable Front Axle — Model 1720 Shown
1. Spindle Arm
2. Tie Rod
3. Front Axle - Center Section
4. Outer Axle
5. Power Steering Cylinder

The center section is mounted centrally to the engine support, Figure 3, by a pivot shaft. The axle rotates on the pivot shaft, thereby maintaining the tractor chassis in a level position and ensuring stable operation even on irregular ground.

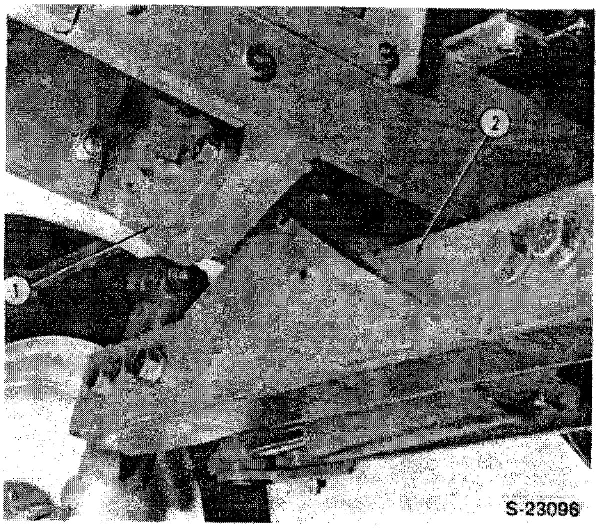


Figure 3
Front Axle Pivot – 2 WD
1. Support Assembly 2. Axle Assembly

Each outer axle section is attached to the center axle by means of bolts and nuts.

The holes in the front axle allow positioning the axle in three different positions on the model 1520 and four positions on the model 1720.

See Part 11 for different tread width settings.

The front wheels are reversible and provide additional increments of tread setting as shown in Part 11.

NOTE: *Turf tires cannot be reversed.*

The outer ends of the axle sections, Figure 4, accept the front wheel spindles (2). The spindles are located by bushings (3) in the outer axle sections and a thrust bearing (4) at the lower end of the axle section supports the vertical load.

The spindle acts as the king pin and keeps a constant inclination to the axle.

The top of the wheel spindles are splined to accept the spindle arms (2) which are retained by means of a clamp bolt (4), Figure 5.

The wheel hub, Figure 4, is supported on the wheel spindle by two opposed taper roller bearings. A nut on the spindle is used to retain the outer cone and roller assembly and provide a means of adjustment for the bearing pre-load.

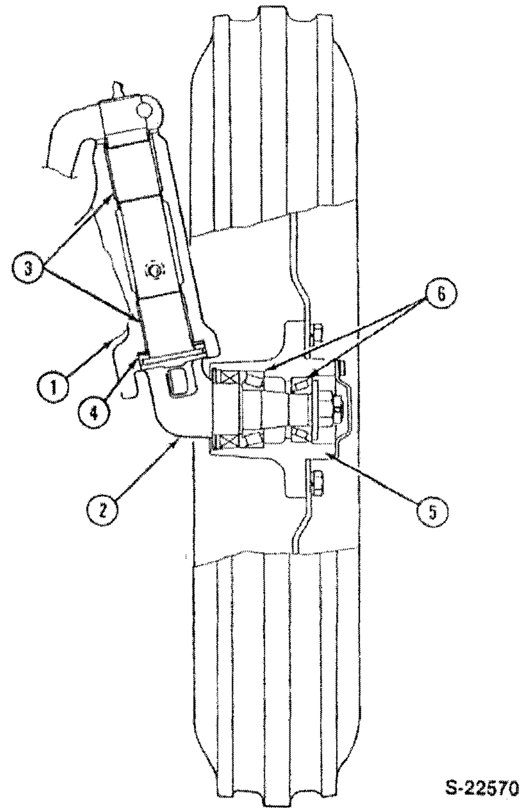


Figure 4
Front Axle and Wheel Assembly
1. Outer Axle Assembly
2. Spindle
3. Spindle Bushings (2)
4. Thrust Bearing
5. Hub
6. Taper Bearings

The right and left spindle arms are connected together with an adjustable tie rod. The tie rod adjustment is also utilized for making toe-in adjustments.

The power steering cylinder (1), is located between the front axle and tie rod, Figure 5.

B. OVERHAUL

REMOVAL

Remove the power steering cylinder from the front axle and tie rod. See "Steering System" Part 9, Chapter 1, Section B.

Remove the front axle from the tractor. See "Separating the Tractor," Part 12.

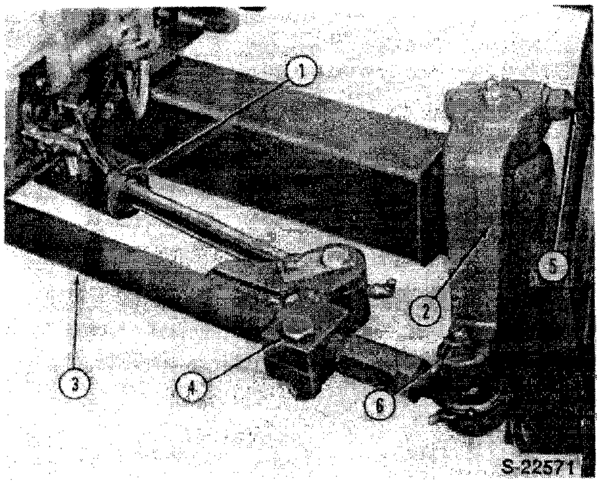


Figure 5
Steering Linkage Removal — Model 1320/1520 Shown

1. Power Steering Cylinder
2. Spindle Arm
3. Tie Rod
4. Clamp Bolt — Tie Rod
5. Clamp Bolt — Spindle Arm
6. Tie Rod Castellated Nut

NOTE: *Check the axle end play prior to removal from the support. See "Inspection," this section.*

1. Remove the front wheels from the axle hubs.
2. Remove the castellated nut and remove the tie rod ball joint pin from the spindle arms, Figure 5.
3. Remove the outer axle mounting bolts and remove the outer axle and spindle assembly.

FRONT WHEEL HUB — REMOVAL AND DISASSEMBLY

1. Remove the wheel cap retaining bolts and remove the cap (1), Figure 6.
2. Remove the axle shaft cotter pin, castellated nut (3) and washer (4), Figure 6.
3. Withdraw the hub (6) and bearing assembly from the axle.
4. Remove the outer hub bearing (5) from the hub assembly.
5. On models 1320/1520, remove the snap ring (10) and the washer, seal and tapered bearing, Figure 6.

   On the model 1720, remove the seal, spacer and taper bearing, Figure 6.

SPINDLE — REMOVAL AND DISASSEMBLY

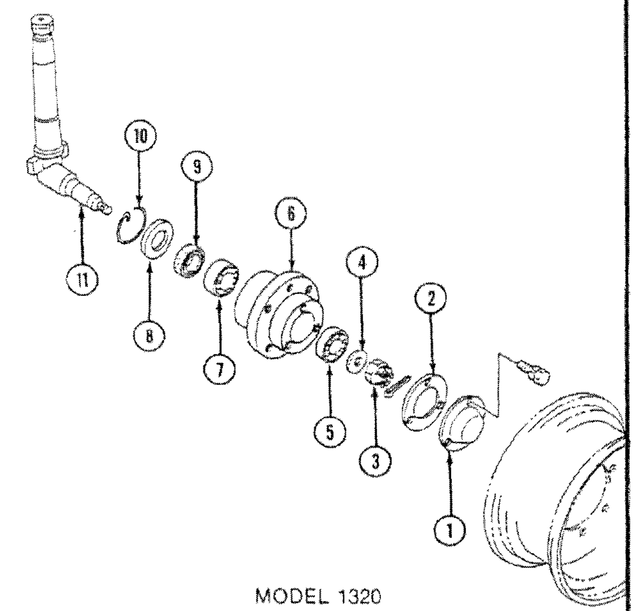
1. Remove the spindle arm clamp bolts, Figure 5.
2. Withdraw the spindle arms from the spindle.
3. Remove the spindle from the axle.
4. Remove the thrust bearing, thrust washers and O-Ring seal from the spindle.

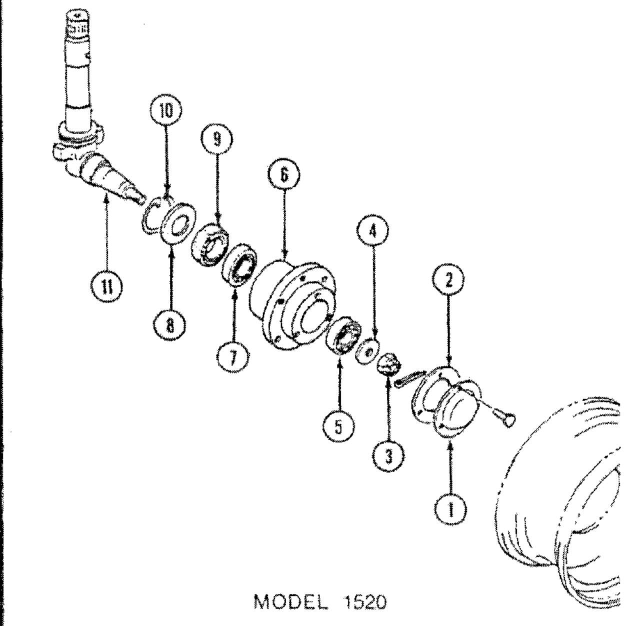
INSPECTION AND REPAIR

1. Clean all parts in a suitable solvent and air dry .
2. Check the end play of the front axle pivot shaft, Figure 7.

   If the axle pivot end play is excessive, add shims in the front bearing holder as required. See "Specifications," Chapter 3, for end play specifications.
3. Measure the pivot pin bearing journal diameter and the bushing inside diameter and determine the working clearance. Replace the bushings if the clearance is excessive. See "Specifications," Chapter 3.
4. Check the front wheel hub bearings, Figure 8, for wear or damage. Replace bearings exhibiting uneven rotation when rotated by hand.

   Replace the bearing race if the bearing is replaced.
5. Replace the oil seal during assembly.
6. Check the spindle bushings for excess wear or damage. Replace bushings using a suitable driver if required, as shown in Figure 9.
7. Inspect the spindle thrust bearings for excess wear or damage. Replace as required, Figure 10.
8. Replace oil seals and O-Ring seals during assembly.
9. Inspect the spindle shank and axle bearing journals for excess wear or damage. Replace if required.





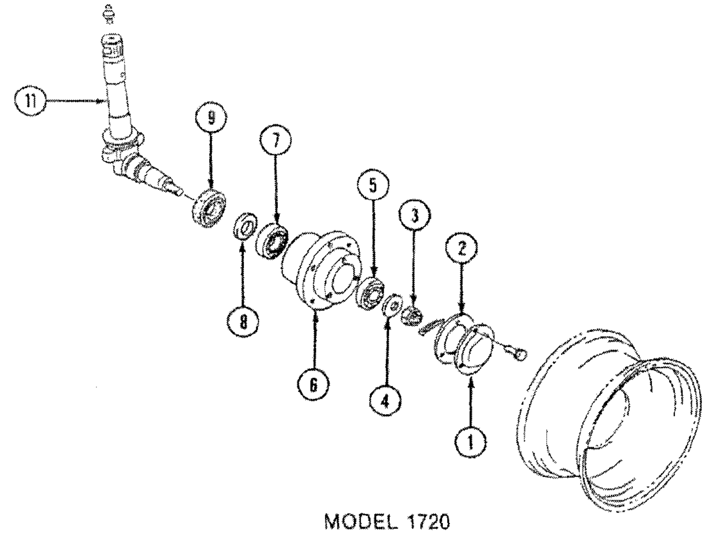


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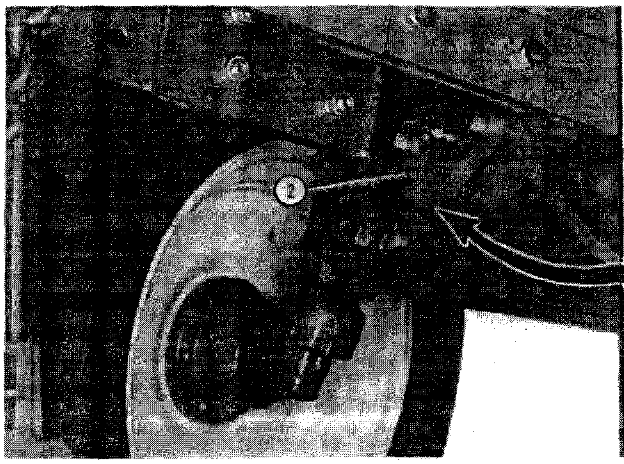
Figure 6
Front Wheel Hub Removal

1. Hub Cap
2. Gasket
3. Castel Nut
4. Washer
5. Taper Bearing
6. Hub
7. Taper Bearing
8. Spacer
9. Seal
10. Snap Ring
11. Spindle



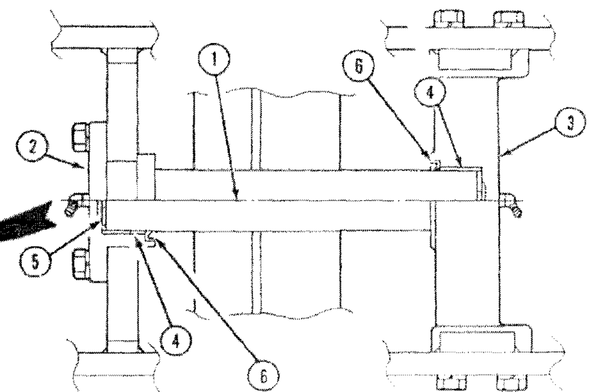


Figure 7
Front Axle Pivot (Model 1720 Shown)

1. Pivot Pin
2. Casing — Front
3. Casing — Rear
4. Bushing
5. Shims
6. Oil Seal

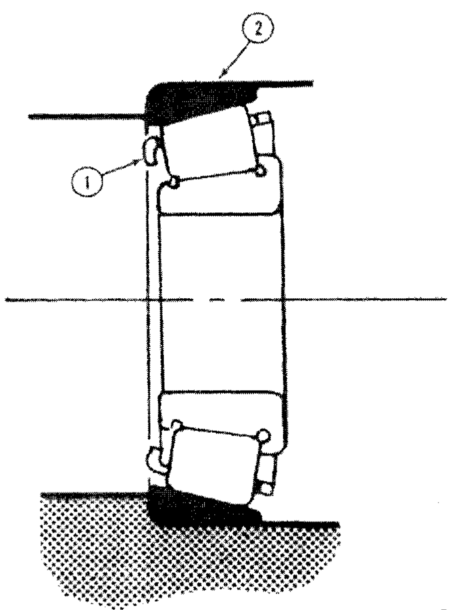


Figure 8
Wheel Hub Taper Bearing Wear Check

1. Taper Bearing
2. Race

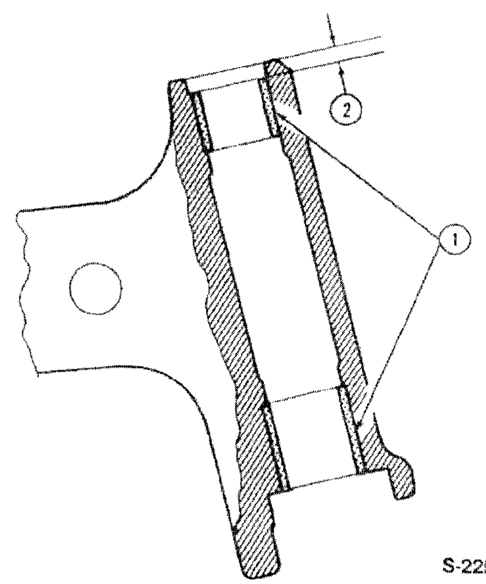


Figure 9
Outer Axle Spindle Bushings

1. Bushings
2. Recess depth — .197 in. (5 mm) 1320/1520 .275 in. (7 mm) 1720

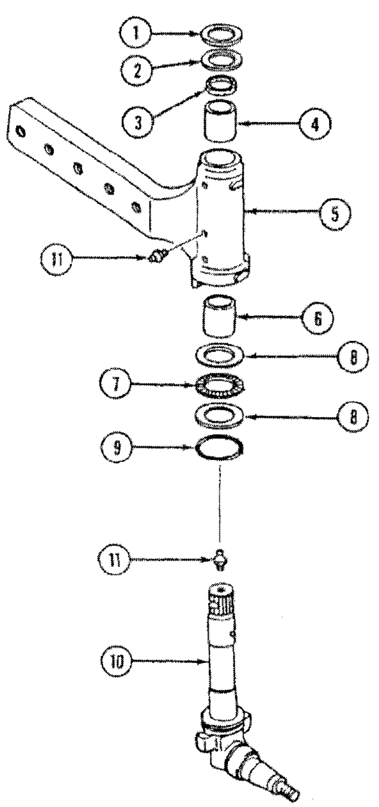


Figure 10
Front Axle Spindle Components — 2 WD

1. Shim	7. Needle Bearing
2. Spacer	8. Thrust Washer
3. Oil Seal	9. O-Ring
4. Bushing	10. Spindle
5. Outer Axle	11. Grease Fitting
6. Bushing	

ASSEMBLY

1. Lubricate all components during assembly.

2. Assemble the spindle assembly as shown, Figure 12.

NOTE: *Apply grease to the spindle and bushing areas on assembly.*

3. Using a suitable installer tool, install the oil seal being sure to position the seal with the lips facing upward.

4. Lubricate the mating surfaces and install the spindle arms.

5. Install the spindle clamp bolt and tighten to the specified torque.

6. Pack the wheel hub bearings with grease and assemble the front wheel hub onto the axle, Figure 6.

7. Tighten the axle nut slowly while rotating the hub until the hub begins to drag and then back off the nut to the next castellation. Install the cotter pin.

8. Install the cap along with a new gasket.

9. Position the front axle to the support assembly and install the front and rear pivot bearing holders, or cover as required, see Figure 7.

10. Using a suitable installer tool, install the oil seals being sure to position the seal lips facing outward from the casing, Figure 7.

11. Assemble the outer axle assemblies to the center section.

12. Install the front wheels and tighten the wheel nuts to the specified torque.

13. Position the tie rods ends to the spindle arms. Secure with the castle nut and cotter pin.

NOTE: *Use care in installing the power steering cylinder and hoses. Be sure the hoses do not touch or rub against frame parts during operation.*

PART 10
FRONT AXLE RELATED PARTS

Chapter 2
FRONT AXLE AND RELATED PARTS — FOUR WHEEL DRIVE

A. DESCRIPTION AND OPERATION

The four wheel drive is optional equipment and is available on all model tractors, Figure 10.

The four wheel drive system uses the same supporting system as the two wheel drive models.

The four wheel drive front axle is not adjustable and the front wheels are not to be reversed.

The four wheel drive tread setting for agricultural tires is:

1320	46.1 in. (117 cm)
1520	42.6 in. (108 cm)
1720	46.0 in. (117 cm)

The front wheel tie rod assembly is adjustable for toe-in adjustments.

The power steering cylinder (4) is located between the front axle and steering arm, Figure 11.

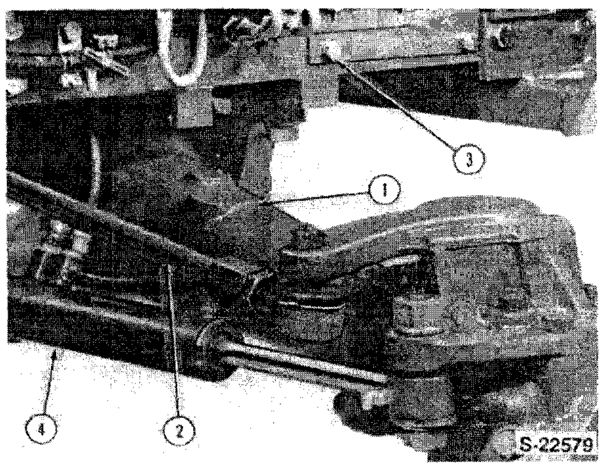


Figure 11
Front Axle Assembly — FWD (1320/1520 Shown)

1. Axle Assembly
2. Tie Rod
3. Support
4. Power Steering Cylinder

Power to the front wheels flows from the front axle differential side gear and axle shaft to the reduction gear box assembly, Figure 12. A pinion gear on the axle shaft drives an idler pinion and idler shaft in the drop box. A final drive pinion on the idler shaft drives the bevel gear, which is splined to the wheel hub and shaft assembly, Figure 12.

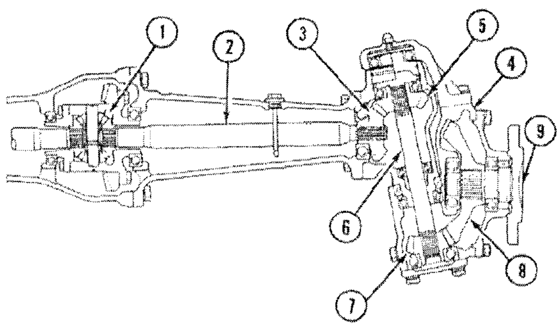


Figure 12
Front Axle Cut-A-Way — FWD

1. Differential Gear
2. Axle Shaft
3. Pinion Gear
4. Reduction Drop Box
5. Pinion Gear
6. Pinion Shaft
7. Pinion Gear
8. Bevel Gear
9. Wheel Hub and Axle

The front wheel drive is controlled by a lever as shown, Figure 13.

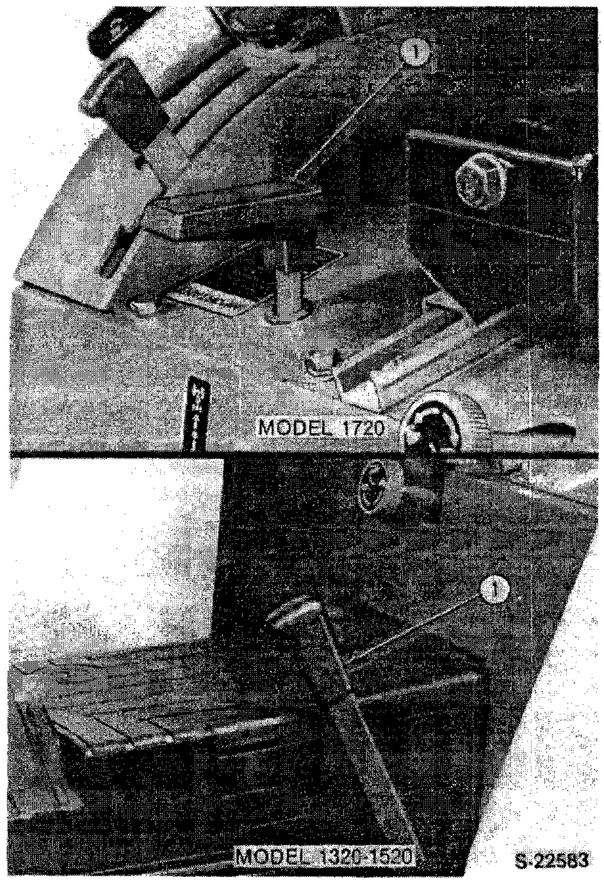


Figure 13
Front Wheel Drive Control Lever

1. Lever

B. OVERHAUL

REMOVAL

Remove the front axle as an assembly from the tractor. "Separating the Tractor", Part 11.

NOTE: *Prior to removal of the axle from the support, check the axle pivot end play. See "Inspection", this section.*

DISASSEMBLY

GEAR REDUCTION — DROPBOX

1. Remove the front wheel hub bolts and remove the front wheels.
2. Remove the tie rod from the steering arm, Figure 11. Tap the steering arm to loosen the ball joint pin if necessary.
3. Remove the power steering cylinder from the steering arm and front axle, Figure 11. See "Steering System" Part 9, Chapter 1, Section B.
4. Drain the oil from the dropbox case and collect in a clean container, Figure 14.
5. Remove the case cover bolts and remove the wheel hub shaft, cover the bevel gear as an assembly, Figure 15.
6. Remove the four king-pin cover and arm retaining bolts and remove the cover and arm assemblies, Figure 16.

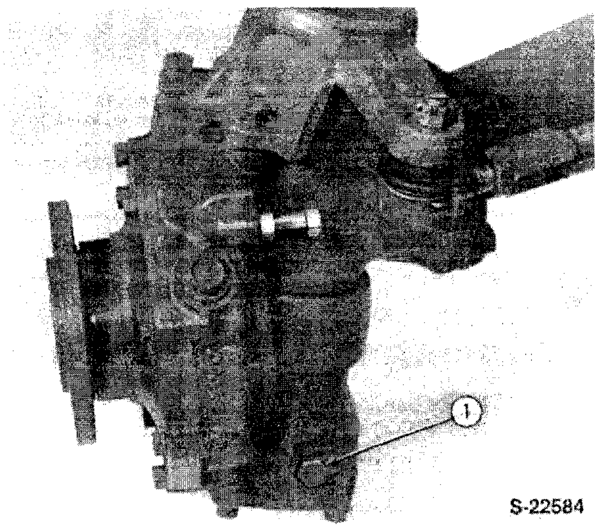


Figure 14
Front Axle — FWD (1320/1520)

1. Drain Plug

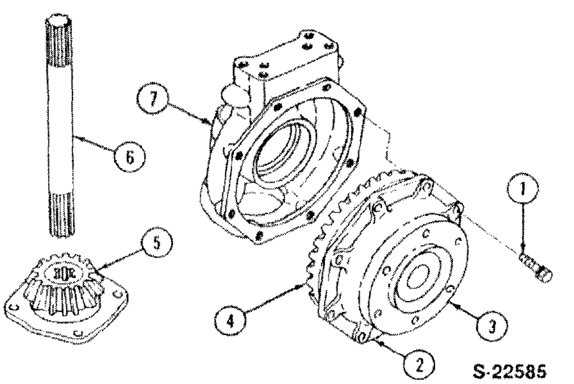


Figure 15
Gear Reduction Drop Box Disassembly — 1320/1520 Shown

1. Case Cover Bolts
2. Case Cover
3. Wheel Hub
4. Wheel Hub, Cover and Bevel Gear Assembly
5. Pinion, Bearing and Cover Assembly
6. Pinion Shaft
7. Bevel Gear Case

WARNING: *The bevel gear case assembly (7), Figure 15, is free to disengage and fall away from the idler gear case when the cover bolts are removed. Use care to avoid accidental disengagement of the components. Uncontrolled dropping of the components may cause personal injury.*

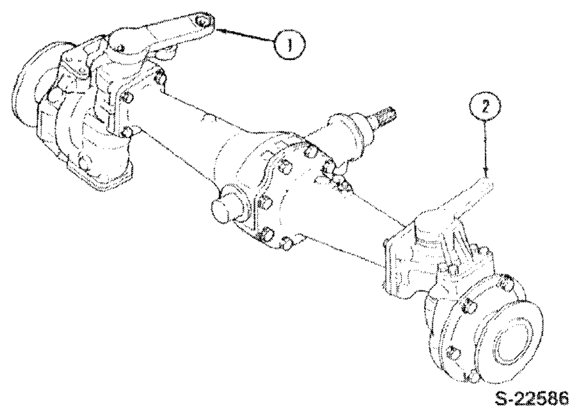


Figure 16
Front Wheel Drive Axle — 1320/1520 Shown

1. Steering Arm and Cover - Right
2. Steering Arm and Cover - Left

7. Remove the bevel gear case and the drive pinion and shaft as an assembly, Figure 15.

8. Remove the final pinion gear cover (5), and remove the drive pinion gear and bearing as an assembly, Figure 15.

9. Remove the pinion shaft (6), Figure 15.

10. Remove the seal (3), and taper bearing (2), from the gear case, Figure 17.

11. Remove the wheel hub shaft inner bearing (1) from the shaft and remove the bevel gear (2), Figure 18.

12. Remove the split ring (3), and gently drive the hub and shaft assembly out of the cover, Figure 18.

13. Remove the bearing (4) and oil seal (6) from the cover, Figure 18.

14. Remove the four idler gear case retaining bolts and remove the case and idler pinion from the axle housing, Figure 19.

15. Remove the axle drive pinion gear and O-Ring seal from the front axle housing.

16. Remove the bearing (6), king-pin (4), with the O-ring (5), snap ring (3) and idler pinion gear (8) from the top of the idler case, Figure 19.

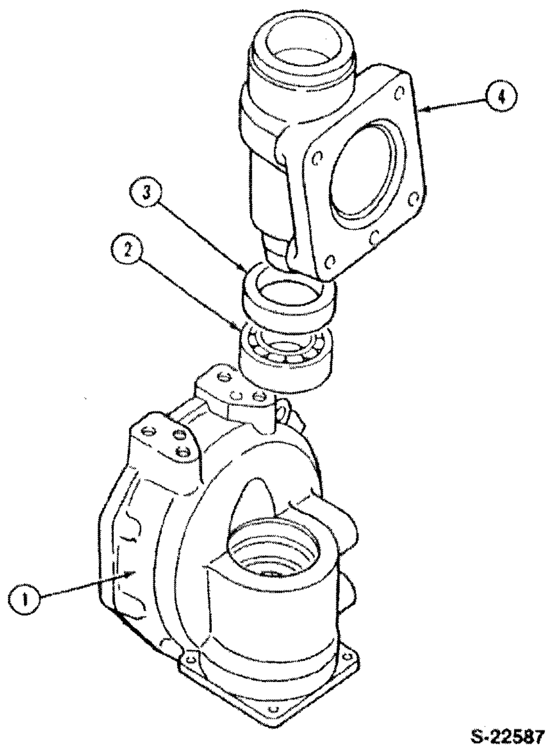


Figure 17
Gear Reduction Drop Box Disassembly

1. Bevel Gear Case
2. Taper Bearing
3. Seal
4. Idler Pinion Gear Case

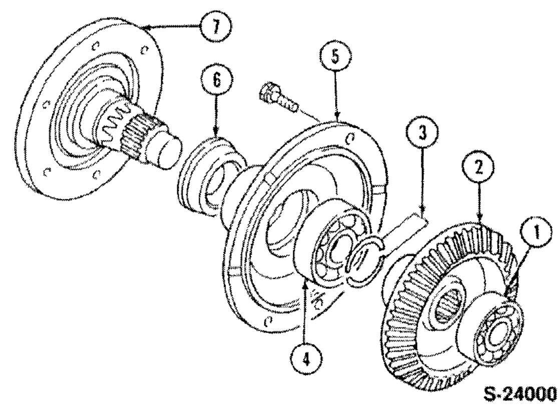


Figure 18
Front Wheel Hub and Bevel Gear Disassembly

1. Bearing
2. Bevel Gear
3. Split Ring
4. Bearing
5. Cover Assembly
6. Seal
7. Hub and Shaft Assembly

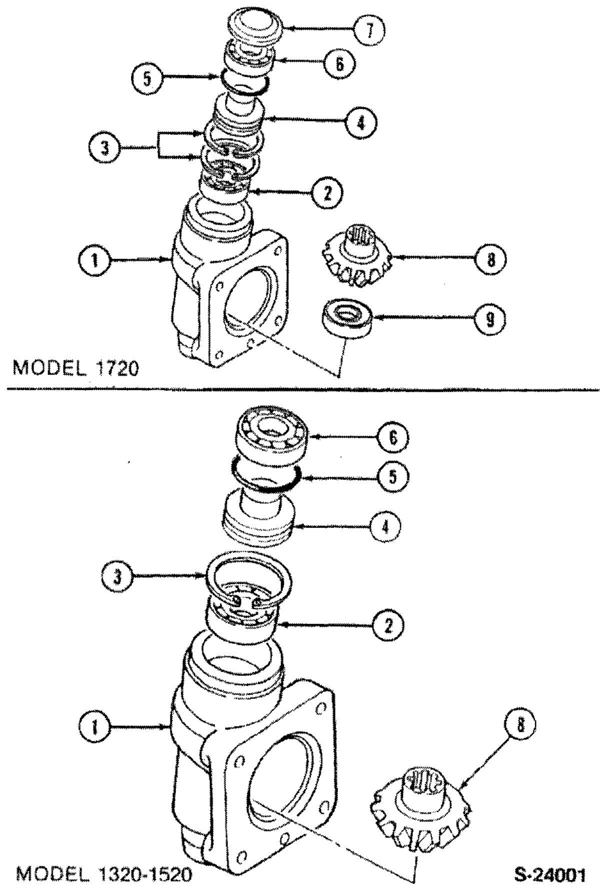


Figure 19
Idler Gear Case Disassembly

1. Case Assembly
2. Bearing
3. Snap Ring
4. King Pin
5. O-Ring
6. Bearing
7. Spacer (1720 only)
8. Pinion Gear
9. Bearing

DISASSEMBLY

FRONT AXLE AND DIFFERENTIAL ASSEMBLY

1. Remove axle pivot front and rear bearing holders (1 and 2), Figure 20.

2. Remove the left axle housing retaining bolts (3) and remove the axle housing and shaft as an assembly (4), Figure 20.

3. Remove the differential assembly (10), Figure 21, from the case.

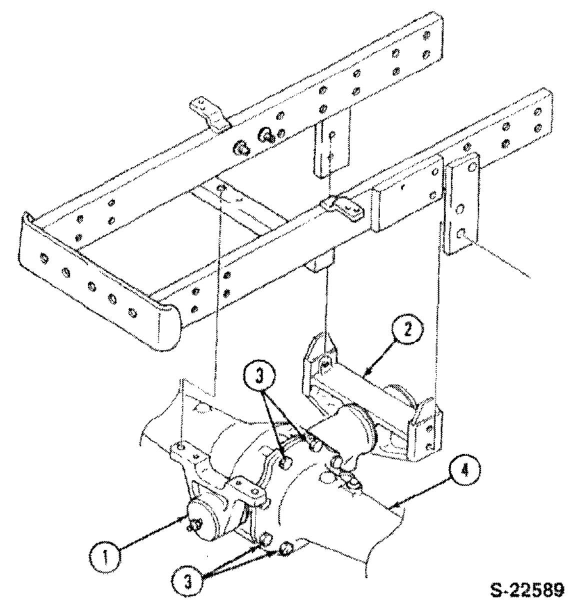


Figure 20
Front Axle Removal — FWD (1320/1520 Shown)

1. Front Pivot Bearing Holder
2. Rear Pivot Bearing Holder
3. Axle Housing Retaining Bolts
4. Axle Housing — Left

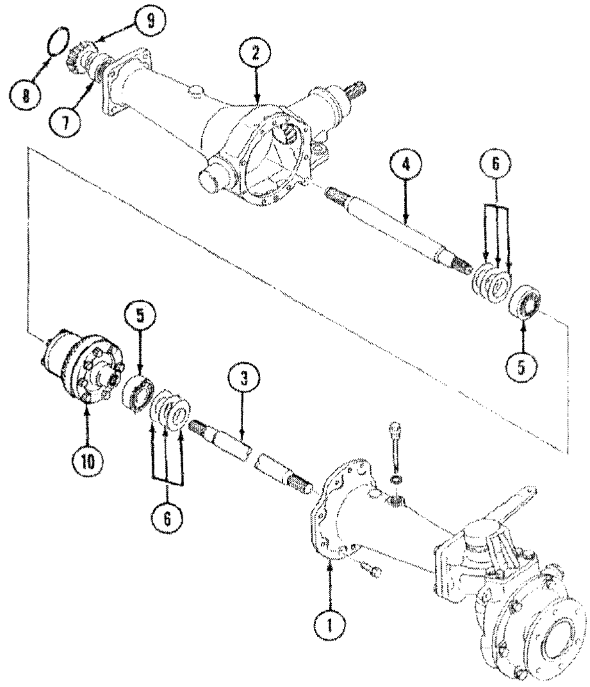


Figure 21
Front Axle Components — FWD

1. Axle Housing — Left
2. Axle Housing — Right
3. Axle Shaft — Left
4. Axle Shaft — Right
5. Differential Carrier Bearing
6. Shims
7. Axle Shaft Outer Bearing
8. O-Ring
9. Pinion Gear
10. Differential Assembly

4. Remove the axle outer pinion gear (9) from each end and gently drive the axle shaft (3 and 4) inward to remove from the housing.

   NOTE: *Observe the quantity and size shims between the axle shaft inner bearing and the axle housing, Figure 21.*

5. Check the differential side gear to pinion backlash. Replace the gears if backlash is excessive.

Backlash Wear Limit

1320/1520 .... 0.012 in. (0.3 mm)
1720 .... 0.012 in. (0.25 mm)

6. If not previously removed, remove the differential support bearings from the differential gear case.

Do not disassemble the differential case unless it requires repairing.

If required, disassemble the differential as follows.

- Remove the bolts from the differential case cover, Figure 22.
- Remove the differential side gear and thrust washer.
- Remove the pinion gear shaft retaining ring (9), Figure 22, and slide the pinion shaft out of the case.
- Remove the four pinion gears and thrust washers.
- Remove the differential side gear and thrust washer, Figure 22.

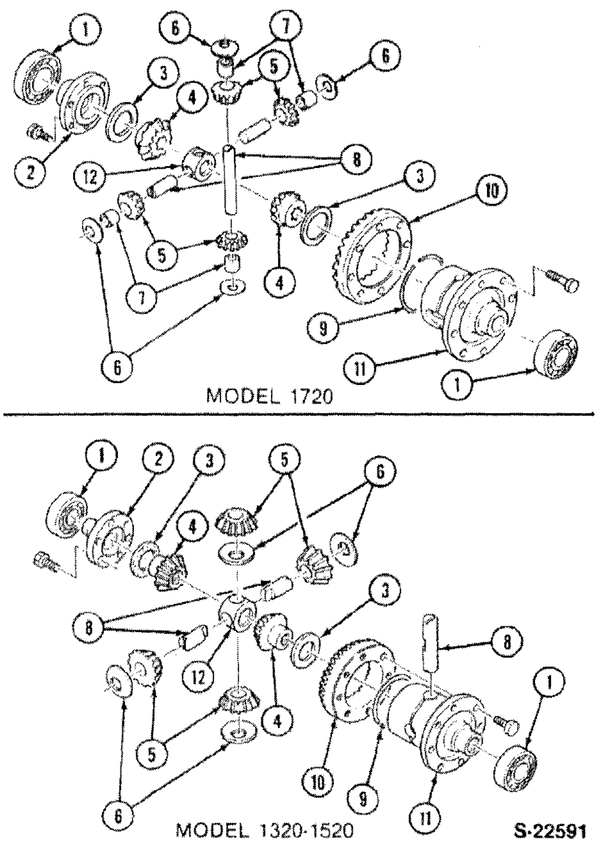


Figure 22
Differential Disassembly —

1. Differential Support Bearing
2. Differential Case Cover
3. Thrust Washer
4. Differential Side Gear (2)
5. Pinion Gear (4)
6. Pinion Thrust Washer (4)
7. Bushing (4) 1720 only
8. Pinion Shafts
9. Pinion Shaft Retaining Ring
10 Ring Gear
11. Differential Case
12. Joint

DISASSEMBLY

DRIVE PINION ASSEMBLY

1. Remove the drive pinion lock nut (1) model 1320/1520; (1, 2 and 3) model 1720, Figure 23.

   NOTE: *On model 1720, release the locking tabs before removing the locknut.*

2. Remove the oil seal (6), collar (4) and O-Ring (5), Figure 23.

3. Gently drive the pinion shaft inward and remove the pinion assembly with bearing, washer and shims, Figure 23.

   NOTE: *Observe the quantity and size shims used on the pinion shaft.*

4. Remove the bearing, shims and washer from the pinion.

5. Remove the bearings from the housing.

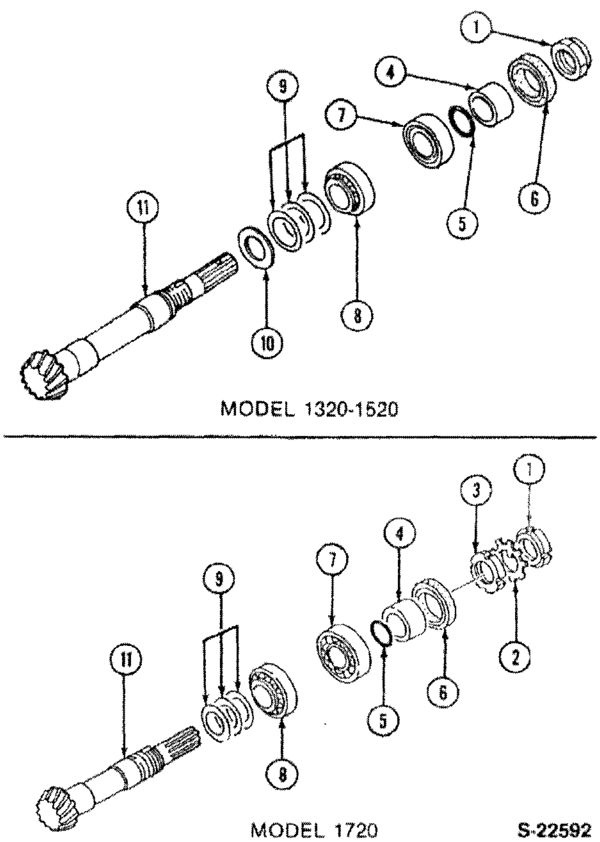


Figure 23
Drive Pinion Disassembly and Removal

1. Nut
2. Locking Tab
3. Nut
4. Collar
5. O-Ring
6. Oil Seal
7. Bearing
8. Bearing
9. Shims
10. Thrust Washer (1320/1520)
11. Pinion Assembly

INSPECTION AND REPAIR

FRONT AXLE ASSEMBLY

1. Wash all parts in a suitable solvent and air dry.

2. Check the clearance between the axle pivot bushings and differential case trunnions, Figure 24.

   Replace the bushing in the bearing holders if the clearance is excessive:

   Bearing Clearance

   Front and Rear . . . . .001 in. (.02 mm)
   Wear Limit . . . . .014 in. (.35 mm)

   NOTE: *When bushings are replaced, install new bushings using a suitable driver and recess the bushings to allow for the O-Rings and seals as shown, Figure 24.*

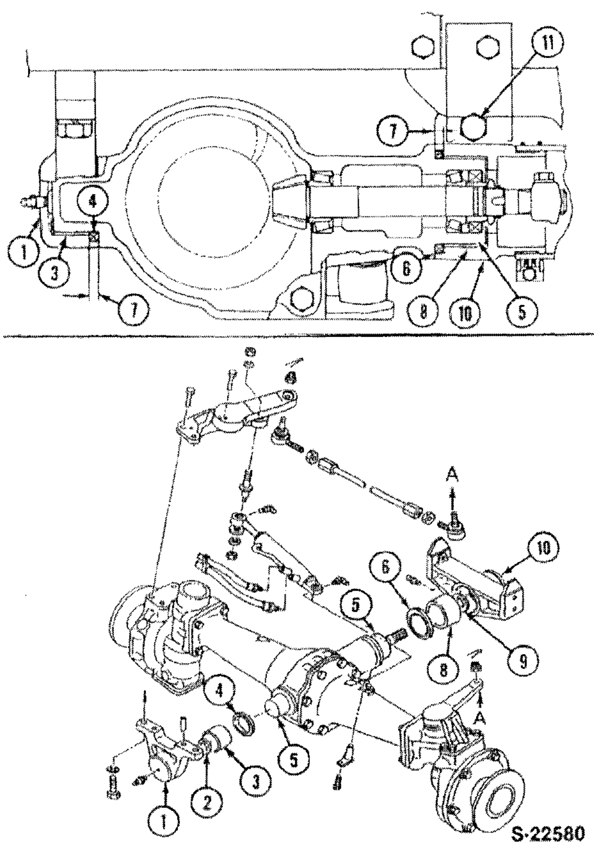


Figure 24
Front Axle Pivot Inspection Checks — Models 1320/1520 Shown

1. Front Bearing Holder
2. Thrust Washer
3. Bushing (Front)
4. Oil Seal (Front)
5. Pivot Trunnion
6. Oil Seal (Rear)
7. Bushing Recess Clearance
8. Bushing (Rear)
9. Thrust Washer
10. Rear Bearing Holder
11. Adjusting Bolt

3. Using a suitable driver, install new oil seals being sure to install with the seal lips facing toward the differential assembly.

4. If not checked previously, assemble the differential housing to the support and check the axle pivot end play. Use a dial indicator to measure the end play clearance. If end play clearance is excessive, loosen the mounting bolts (11), Figure 24, and slide the rear bearing holder foward to obtain the proper clearance. Tighten the retaining bolts to the specified torque.

INSPECTION AND REPAIR

DIFFERENTIAL ASSEMBLY

1. Wash all parts in a suitable solvent and air dry.

2. Using a hole gauge and micrometer, measure the pinion gear bore and the pinion shaft and determine the gear to shaft clearance.

   Replace the gear and/or shaft if the clearance exceeds .020 in. (.5 mm).

3. Measure the pinion gear thrust washer thickness. Replace the thrust washers if the thickness is less than 0.032 in. (0.08 mm).

4. Measure the differential side gear thrust washer thickness.

   Replace the thrust washers if the thickness is less than .035 in. (0.9 mm).

   NOTE: *If the thrust washers are replaced, recheck the side gear to pinion gear backlash during assembly. Refer to backlash check made during disassembly.*

5. Inspect all gear teeth for excessive wear or damage.

   Replace the gears if teeth wear is excessive.

INSPECTION AND REPAIR

GEAR REDUCTION — DROP BOX

1. Wash all parts in a suitable solvent and air dry.

2. Inspect the gears for excess wear or damage. Replace gears that show excessive wear. See "Assembly," for gear backlash checks.

3. Inspect the splines on the pinion gears, idler shaft and axle shaft for excess wear or damage.

4. Check the bearings for wear or roughness. Rotate the bearings by hand and replace bearings as required.

5. On assembly, check the bevel gear and pinion backlash. See "Gear Reduction — Drop Box Assembly."

ASSEMBLY

FRONT AXLE AND DIFFERENTIAL ASSEMBLY

Pinion Assembly and Installation

1. Assemble the thrust washers, shims and front pinion bearing on the shaft as shown, Figure 25.

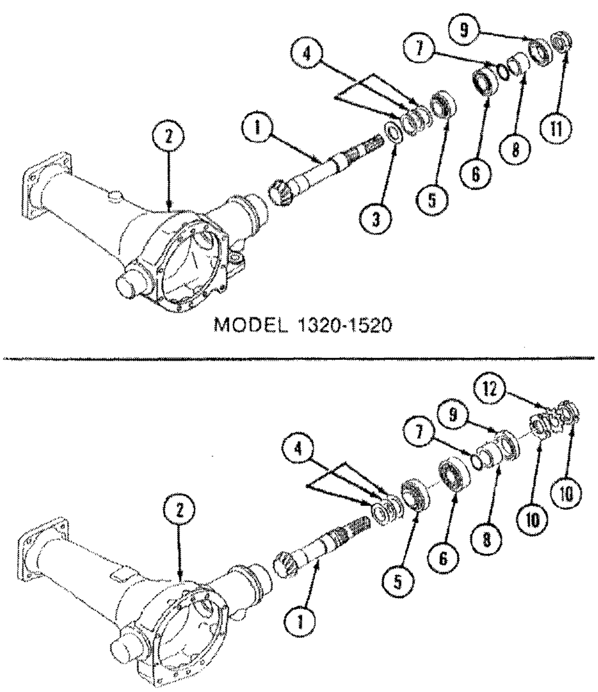


Figure 25
Drive Pinion Assembly

1. Drive Pinion
2. Housing
3. Thrust Washer (1320/1520)
4. Shims
5. Bearing
6. Bearing
7. O-Ring
8. Collar
9. Oil Seal
10. Locknuts (Model 1720)
11. Locknut (1320/1520)
12. Locking Washer (1720)

2. Install the pinion in the differential housing.

3. Install the second pinion bearing on the shaft and in the differential housing.

   Using a suitable driver install the oil seal (4), O-ring (7), and collar (8) on the shaft, Figure 25.

4. Install the pinion nut and tighten to obtain the correct bearing pre-load as follows:

   Wrap a strong cord around the pinion shaft, Figure 26. Using a pull scale, measure the pounds pull to rotate the pinion shaft.

   Tighten the nut to obtain the following pre-load adjustment.

   Model 1320-1520 . . . . .28.7-37.4 lbs. pull (13-17 Kg)

   Model 1720 . . . . . . .31.7-38.8 lbs (14.4-17.6 Kg) pull — new bearings

   Model 1720 . . . . .15.9-19.4 lbs. (7.2-8.8 Kg) pull — used bearings

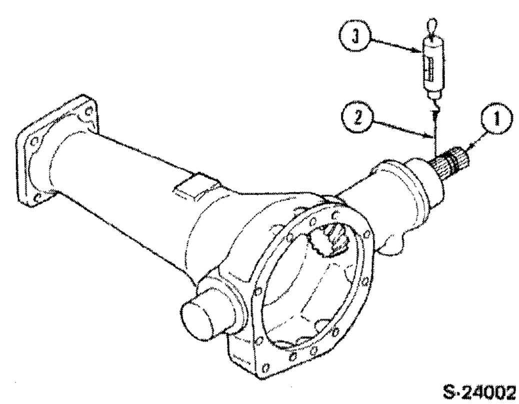


Figure 26
Pinion Pre-Load Adjustment

1. Pinion Shaft
2. Cord
3. Pull Scale

ASSEMBLY

DIFFERENTIAL GEAR ASSEMBLY

Assembly of the differential gear assembly generally follows the disassembly procedure in reverse.

Upon assembly of the ring gear to the case, tighten the ring gear bolts to the specified torque and bend the locking tabs to secure in place. On assembly use new bolts and locking straps, Figure 27.

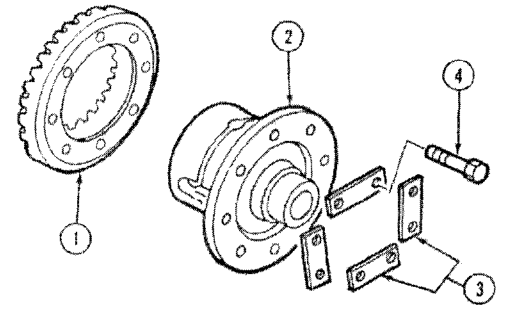


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Figure 27
Differential Ring Gear-Assembly

1. Ring Gear
2. Case Assembly
3. Locking Plates
4. Attaching Bolts

ASSEMBLY

AXLE AND DIFFERENTIAL ASSEMBLY

If any of the following components are not being replaced, assemble the front axle using the original components.

- Differential assembly
- Differential case carrier bearings
- Axle Housing
- Axle shaft

ASSEMBLY PROCEDURE
Reference — Figure 28

1. Install the shim pack (6) and bearing (5) in the differential axle housing.
2. Install the axle shaft in the housing from the outer end through the shim pack.
3. Install the axle shaft outer bearing (7).
4. Position the differential in the housing inserting the differential carrier cover end inside the bearing previously positioned in the axle housing.
5. Assemble the left axle shaft and housing in the same manner as described for the right side.
6. Install differential carrier left bearing on the differential case.
7. Apply liquid gasket to the left axle housing mating surface and install it on the differential housing.
8. Install the axle housing retaining bolts and tighten to the specified torque. See "Specification," Chapter 3.

   NOTE: *The differential carrier bearing pre-load and ring gear backlash must be checked and adjusted if any of the following components have been replaced:*

   - *Differential assembly components*

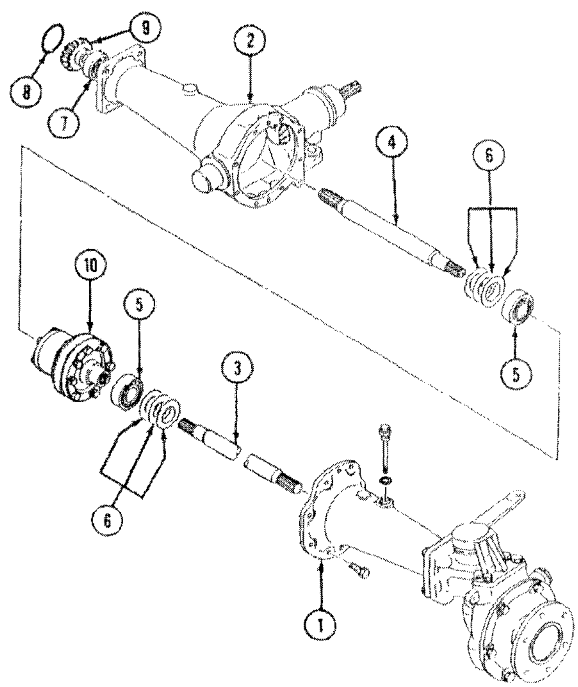

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Figure 28
Front Axle Assembly — FWD

1. Axle Housing — Left
2. Axle Housing — Right
3. Axle Shaft — Left
4. Axle Shaft — Right
5. Differential Carrier Bearing
6. Shims
7. Outer Bearing
8. O-Ring
9. Pinion Drive Gear
10. Differential Assembly

- *Differential case bearings*
- *Axle shaft inner bearings*
- *Axle housings*
- *Axle shaft*

DIFFERENTIAL CASE BEARING PRE-LOAD CHECK AND ADJUSTMENT

Reference — Figure 29

1. Position the differential carrier bearing and shim pack in place in the differential axle housing (6), Figure 29.
2. Place the differential assembly in the housing being sure the differential case is fully seated inside the bearing.

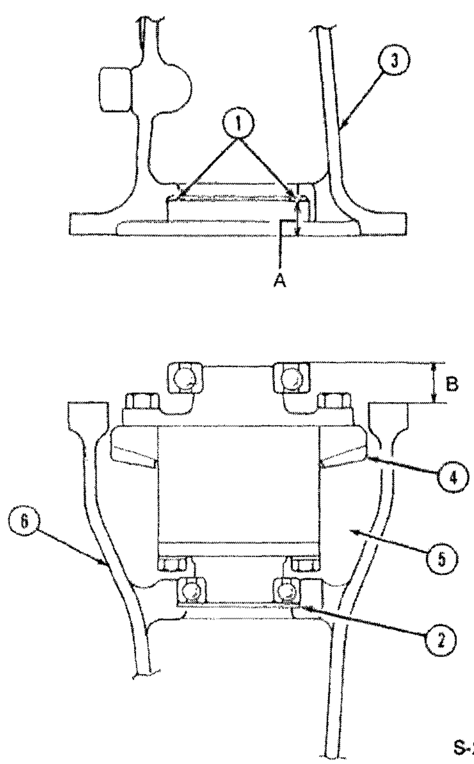

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Figure 29
Differential Carrier Bearing Pre-Load Check and Adjustment (1320/1520)

1. Shims	4. Ring Gear
2. Shims	5. Differential Case
3. Axle Housing — Left	6. Axle Housing — Right

3. Position the left differential case bearing on the differential case, being sure it is fully seated.
4. Measure the distance "A" and "B", Figure 29. Add or subtract shims from the shim pack so that the measurements "A" - "B" = .006 in (0.15 mm).

RING GEAR-TO-PINION BACKLASH CHECK AND ADJUSTMENT

Ring gear to pinion backlash must be checked and adjusted whenever new components are used or if the shim requirements are unknown.

NOTE: *This is a continuation of the differential carrier bearing pre-load adjustment.*

1. Assemble the differential axle housing complete with axle shaft, bearing and drive pinion following the disassembly procedure in reverse.
2. Position the assembled axle housing assembly in a vertical position, supported by the housing and not on the shaft.

   NOTE: *For personal safety, be sure the assembly is properly supported to prevent falling.*
3. Position the differential assembly in the housing being sure the differential case is fully seated in the bearing and axle housing counterbore.

   Be sure there is clearance between the ring gear and the pinion gear. There must not be any interference here.
4. Place a dial indicator on the axle housing as shown Figure 30. Rock the ring gear back and forth to obtain the ring gear free-play clearance reading on the dial indicator. If the reading is not within the range of 0.004-0.006 in. (.10-.15 mm), adjust the shims between the left and right axles to obtain the correct free-play clearance.
5. Apply Prussion Blue to the pinion gear teeth.
6. Rotate the pinion until the ring gear has rotated one complete revolution.
7. Inspect the gear tooth marking. See Figure 31 for correct tooth contact pattern. If the markings are incorrect adjust the pinion gear assembly as required to obtain the correct pattern as shown, Figure 31.

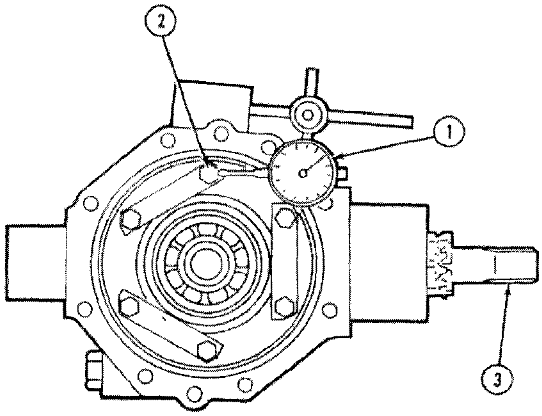

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Figure 30
Ring Gear Backlash Measurement
1. Dial Indicator 3. Pinion Shaft
2. Ring Gear Bolt Head

ASSEMBLY

REDUCTION GEAR BOX ASSEMBLY

1. Using a suitable driver, install a new oil seal (2) in the bevel gear case cover (3), Figure 32.
2. Position the wheel shaft outer bearing (4) in the cover.
3. Install the hub and shaft assembly in the cover.
4. Position the two piece locking ring in the shaft groove, Figure 32.
5. Install the bevel gear on the shaft. Be sure the bevel gear counterbore hub fits down fully over the locking ring.
6. Install the inner bearing on the shaft.
7. Install the idler case bearing (3) and seal (2) in the bevel gear case as shown, Figure 33.

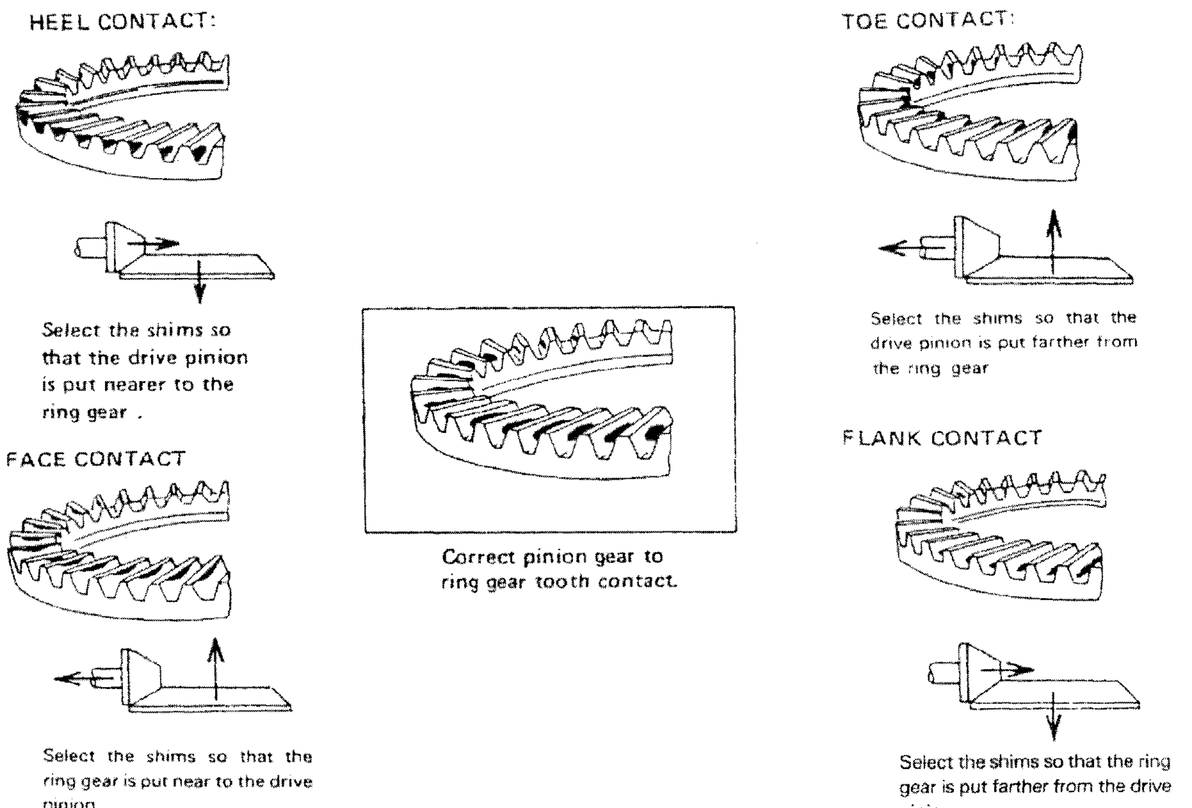

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Figure 31
Ring Gear To Pinion Adjustment

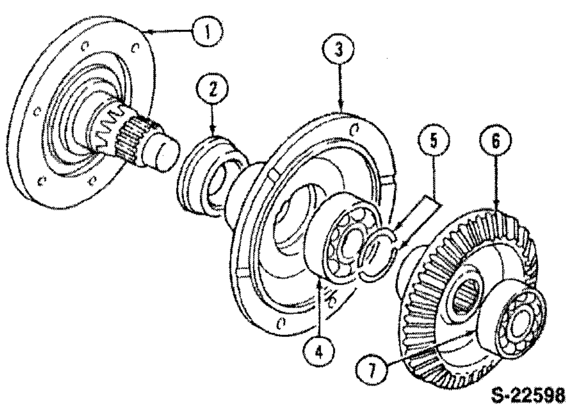


Figure 32
Wheel Axle and Bevel Gear Assembly

1. Hub and Axle Assembly
2. Seal
3. Cover
4. Bearing — Outer
5. Split Rings
6. Bevel Gear
7. Bearing — Inner

8. Install the final drive pinion gear, bearing and cover in the bottom of the bevel gear case, as shown, Figure 33.

9. Install the pinion shaft (1), from the top, Figure 33.

10. Insall the idler gear case bearing (3), snap ring (4), king-pin (7), O-Ring (6), and bearing (5), Figure 34.

11. Position the idler gear (2) inside the idler case.

12. Position the idler case onto the bevel gear case, Figure 35.

13. Install the steering arm and cover assembly onto the idler gear case.

14. Install the retaining bolts and tighten to the specified torque. See "Specifications," Chapter 3.

15. Install the pinion gear on the axle shaft. Apply liquid gasket to the mating surface of the axle housing and idler gear case.

16. Position the O-Ring in place on the axle housing and install the drop box assembly to the axle housing, Figure 35.

17. Install the retaining bolts and tighten to the specified torque.

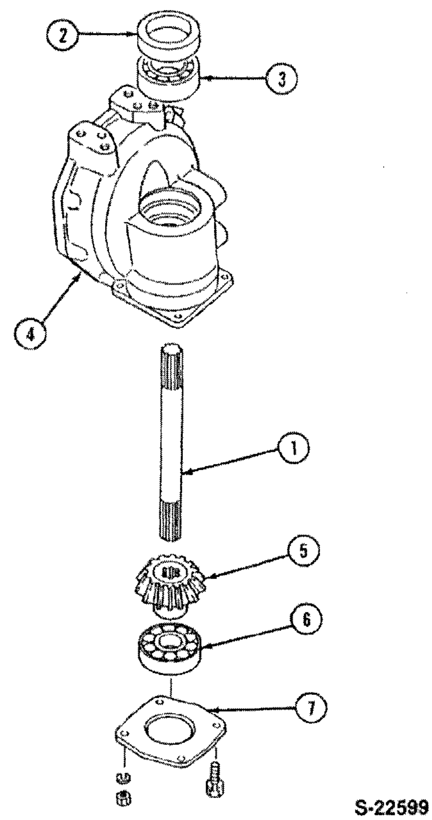


Figure 33
Reduction Gear Box Assembly

1. Pinion Shaft
2. Seal
3. Bearing
4. Bevel Gear Case
5. Pinion Gear
6. Bearing
7. Cover

18. Apply liquid gasket to the bevel gear cover mating surfaces and install the cover and hub assembly to the bevel gear case.

19. Install the retaining bolts and tighten to the specified torque.

BEVEL GEAR-TO-PINION BACKLASH CHECK
Reference — Figure 36

With the front wheels removed and the front end of the tractor supported, check the bevel gear to pinion gear backlash.

1. Remove the oil drain plug from the bevel gear case and drain the oil.

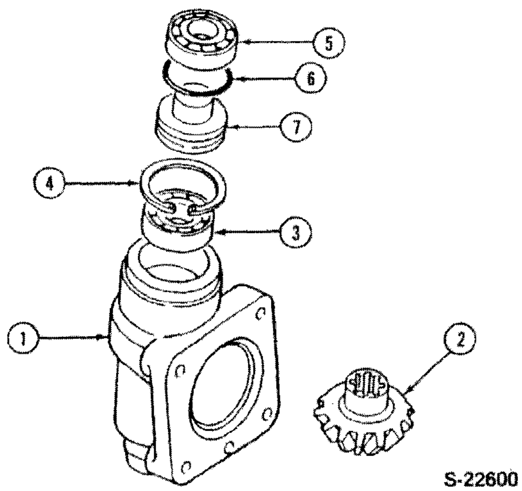


Figure 34
Reduction Gear Box Assembly

1. Idler Case
2. Idler Pinion Gear
3. Bearing
4. Snap Ring
5. Bearing
6. O-Ring
7. King Pin

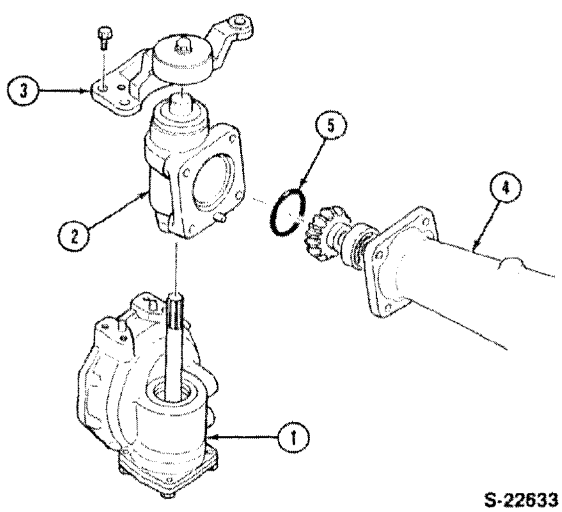


Figure 35
Reduction Gear Box

1. Bevel Gear Case Assembly
2. Idler Gear Case Assembly
3. Steering Arm and Cover Assembly
4. Axle Housing
5. O-Ring

2. Install a long bolt in the drain plug hole so that it contacts the pinion gear and keeps it from rotating.

3. Install a bolt in the wheel hub flange and attach a dial indicator as shown, Figure 36.

4. Rotate the hub back and forth and observe the dial indicator reading.

   Replace the bearings and/or gears if the backlash exceeds 0.020 in. (0.5 mm).

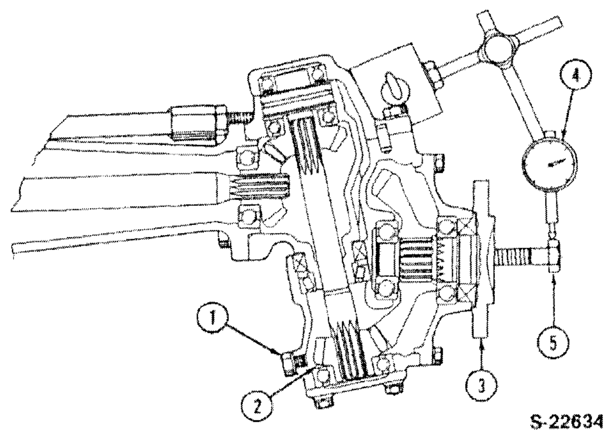


Figure 36
Bevel Gear to Pinion Backlash Check

1. Drain Plug
2. Pinion Gear
3. Wheel Hub
4. Dial Indicator
5. Hub Bolt

PART 10
FRONT AXLE AND RELATED PARTS

Chapter 3
TROUBLE SHOOTING AND SPECIFICATION

A. TROUBLE SHOOTING

CONDITION	POSSIBLE CAUSE
Front Wheel Shimmy	1. Worn spindle shaft and/or bushings (2 WD) 2. Worn pivot shaft and/or bushings 3. Loose wheel hub nut (2 WD) 4. Loose tie-rod 5. Loose or damaged thrust bearing (2 WD) 6. Loose spindle arm 7. Worn king pin and/or bearing (4 WD)
Hard Steering	1. Spindle bushings lack lubrication (2 WD) 2. Damaged spindle shaft and/or bushings (2WD) 3. Worn or damaged thrust bearing (2 WD) 4. Faulty power steering system
Loose Spindle	1. Worn Bushings 2. Worn spindle shaft 3. Worn or damaged thrust bearing

B. SPECIFICATIONS

TWO WHEEL DRIVE

King Pin Inclination (fixed) . . . . .08°
Toe-In . . . . 0-3/16 in. (0-.5 mm)
Caster (fixed) . . . . 0°
Camber (fixed) . . . . 3°
Pivot Shaft to Bushing Clearance . . . . .001-.006 in. (.02-.15 mm)
Wear Limit . . . . .012 in. (0.3 mm)
Front Axle End Play — Maximum . . . . .008 in. (.2 mm)
Shims Available . . . . .008 in (.2 mm)
.020 in. (.5 mm)

FOUR WHEEL DRIVE

Differential Pinion Gear To Pinion Shaft Clearance . . . . .004 in. (.1 mm)
Differential Pinion Gear Thrust Washer Thickness . . . . .047 in. (1.2 mm)
Differential Side Gear To Pinion Gear Backlash . . . . .004-.006 in (.1-.15 mm)
Drive Pinion Bearing Pre-Load
1320/1520 . . . . 28.7-37.4 lbs. pull
(13-17 Kg)
1720 . . . . 31.7-38.8 lbs. pull
(14.4-17.6 Kg)
Differential Housing Pivot-
Trunnion to Bushing Clearance —
Front . . . . .001-.007 in. (.02-.2 mm)
Maximum . . . . .014 in. (.35 mm)
Rear . . . . .001-.006 in. (.02-.16 mm)
Maximum . . . . .014 in. (.35 mm)
King Pin Inclination (fixed) . . . . 10°

Camber (fixed) . . . . 2°
Final Pinion Gear To Bevel Gear Backlash . . . . .008-.016 in. (.2-.4 mm)
Front Axle Pivot End Play . . . . .012 in. (0.3 mm)
Maximum . . . . .023 in. (0.6 mm)
Front Wheel Toe-In . . . . 0-3/16 in. (0-5 mm)

GENERAL

BOLT TORQUE SPECIFICATIONS

Bolt Size	Grade No.	Coarse Thread			Fine Thread		
		Pitch (mm)	Pounds-Feet	Newton-Meters	Pitch (mm)	Pounds-Feet	Newton-Meters
M6	4T	1.0	3.6-5.1	4.9-6.9	–	–	–
	7T		6.1-8.3	8.3-11.3			
	10T		8.7-11.6	11.8-15.7			
M8	4T	1.25	9.4-12.3	12.7-16.7	1.0	11.2-14.8	15.2-20.1
	7T		16.6-21.0	22.6-28.4		19.5-25.3	26.5-34.3
	10T		21.0-26.8	28.4-36.3		22.4-29.7	30.4-40.2
M10	4T	1.5	18.8-24.6	25.5-33.3	1.25	21.0-26.8	28.4-36.3
	7T		32.5-41.2	44.1-55.9		36.2-46.3	49.0-62.8
	10T		39.8-51.4	53.9-69.9		42.7-54.2	57.9-73.5
M12	4T	1.75	27.5-34.7	37.3-47.1	1.25	31.8-40.5	43.1-54.9
	7T		48.5-61.5	65.7-83.4		55.0-69.4	74.5-94.1
	10T		68.0-85.4	92.9-116		73.1-93.3	99.0-127
M14	4T	2.0	46.3-59.3	62.8-80.4	1.5	51.4-64.4	69.6-87.3
	7T		76.7-96.9	104-131		86.1-109	117-148
	11T		102-129	139-175		108-137	147-186
M16	4T	2.0	63.6-81.0	86.3-110	1.5	67.3-84.6	91.3-115
	7T		110-136	149-184		116-142	157-192
	11T		152-188	206-255		163-199	221-270
M18	4T	2.0	83.9-104	114-141	1.5	95.9-120	313-163
	7T		145-174	196-235		170-206	131-279
	11T		203-246	275-333		221-271	299-368
M20	4T	2.5	106-132	144-179	1.5	127-156	172-211
	7T		177-213	240-289		203-246	275-333
	11T		268-325	363-441		293-358	397-485

PART 11
WHEELS AND TIRES

Chapter 1
WHEELS AND TIRES

PART 11
WHEELS AND TIRES

Chapter 1
WHEELS AND TIRES

A. TREAD SETTING

TWO WHEEL DRIVE MODELS:

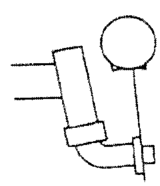
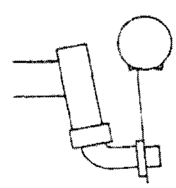
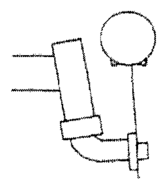
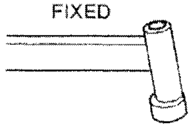
MODEL 1320 — AGRI TIRES

The front wheel tread setting on the model 1320, equipped with a fixed axle, is adjustable by reversing the front wheels only. See Figure 1.

The rear wheels are adjusted by repositioning the wheels from side to side. See Figure 2.

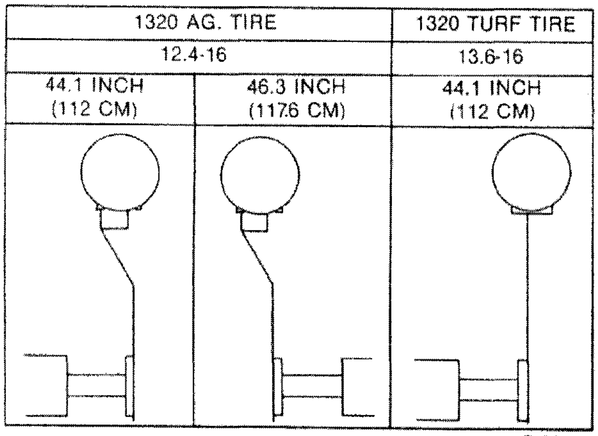
MODEL 1520/1720 — AGRI TIRES

The model 1520-1720 tractors are equipped with an adjustable front axle and is adjustable by repositioning the front axle and by reversing the front wheels. See Figure 3.

WHEEL POSITION / AXLE POSITION			
	AG. TIRE 6.50-10		TURF TIRE 23 x 8.50-12
FIXED 	40.7 (103.4)	41.7 (105.0)	42.6 (108.3)

S-22636

Figure 1
Model 1320
Front Wheel Tread Width Setting — Inch (cm)



S-22637

Figure 2
Rear Wheel Tread Width Setting — Inch (cm)

The rear wheel tread setting is adjustable by a combination of repositioning the wheel discs and rims and repositioning the wheels from side to side. See Figures 4 and 5.

TURF TIRES — ALL MODELS — 2WD

Tread setting on tractors equipped with turf tires is adjustable by switching the tires from side to side only.

TREAD SETTING WITH TURF TIRES

1320 Front ....42.7 in. (108.5 cm)
....................44.1 in. (112.0 cm)
1320 Rear ....44.1 in (112.0 cm)
.....................46.3 in. (117.5 cm)
1520 Front ....42.6 in. (108.5 cm)
......................52.8 in (134 cm)
1520 Rear ....42.6 in. (108.5 cm)
47.0 in. (119.5 cm)
1720 Front ....46.9 in. (119.0 cm)
....................56.9 in. (144.5 cm)
1720 Rear ....49.8 in. (126.5 cm)
.....................52.0 in. (132.0 cm)

FOUR WHEEL DRIVE MODELS

FRONT WHEELS — ALL MODELS

The front wheel drive front axle is non-adjustable and the front wheels must NOT be reversed.

FRONT WHEEL TREAD WIDTH — FWD

Model
1320 ....46.0 in. (117 cm)
1520 ....42.4 in. (108 cm)
1720 ....46.0 in. (117 cm)

REAR WHEEL

MODEL 1320/1520

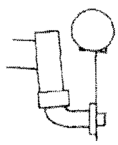
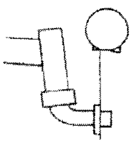
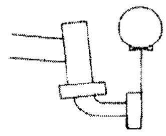
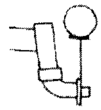
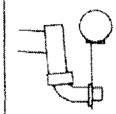
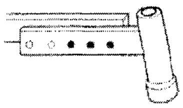
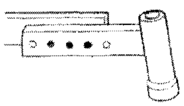
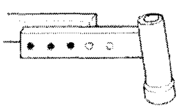
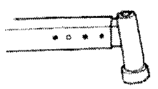
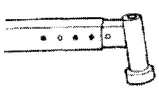
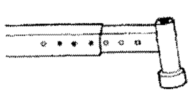
The rear wheel tread width is adjustable only by switching the wheels from side to side.

MODEL 1720

On the model 1720, rear wheel tread width is adjusted by a combination of repositioning the rear wheel rims and discs and by switching the wheels from side to side.

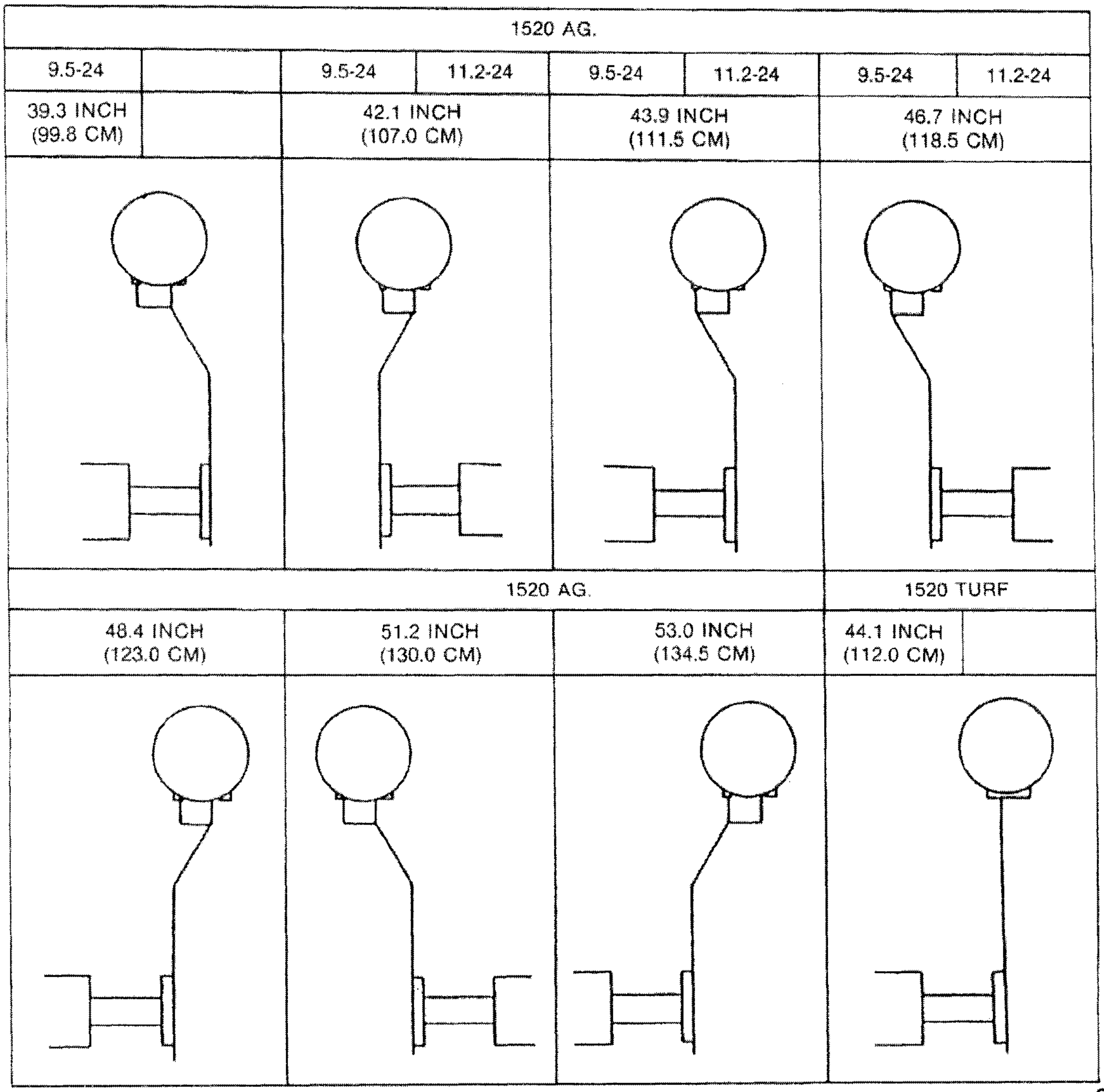
REAR WHEEL TREAD WIDTH — FWD

Model		AGRI TIRES	TURF TIRES
1320	....	44.1 in. (112 cm)	44.1 in. (112 cm)
	....	46.3 in. (117.6 cm)	
1520	....	41.1 in. (104.5 cm)	44.1 in. (112.0 cm)
1720	....	(43.3 in. (111.0 cm)	49.8 in. (126.5 cm)
	....	45.1 in. (114.5 cm)	52.0 in. (132.0 cm)
	....	47.8 in. (121.5 cm)	
	....	49.6 in. (126.0 cm)	
	....	52.4 in. (133.0 cm)	
	....	54.1 in. (137.5 cm)	
	....	57.1 in. (145.0 cm)	
	....	58.7 in. (149.0 cm)	

	MODEL 1520 AG.		MODEL 1520 TURF	MODEL 1720 AG.	
WHEEL POSITION / AXLE POSITION					
	39.1 (99.5)	41.3 (105.0)	42.7 (108.3)		
	43.5 (110.5)	45.6 (116.0)	47.0 (119.3)		
	47.8 (121.5)	50.0 (127.0)	51.3 (130.3)		
				43.5 (110.5)	47.4 (120.5)
				46.9 (119.0)	50.8 (129.0)
				50.2 (127.5)	54.1 (137.5)
				53.5 (136.0)	57.5 (146.0)

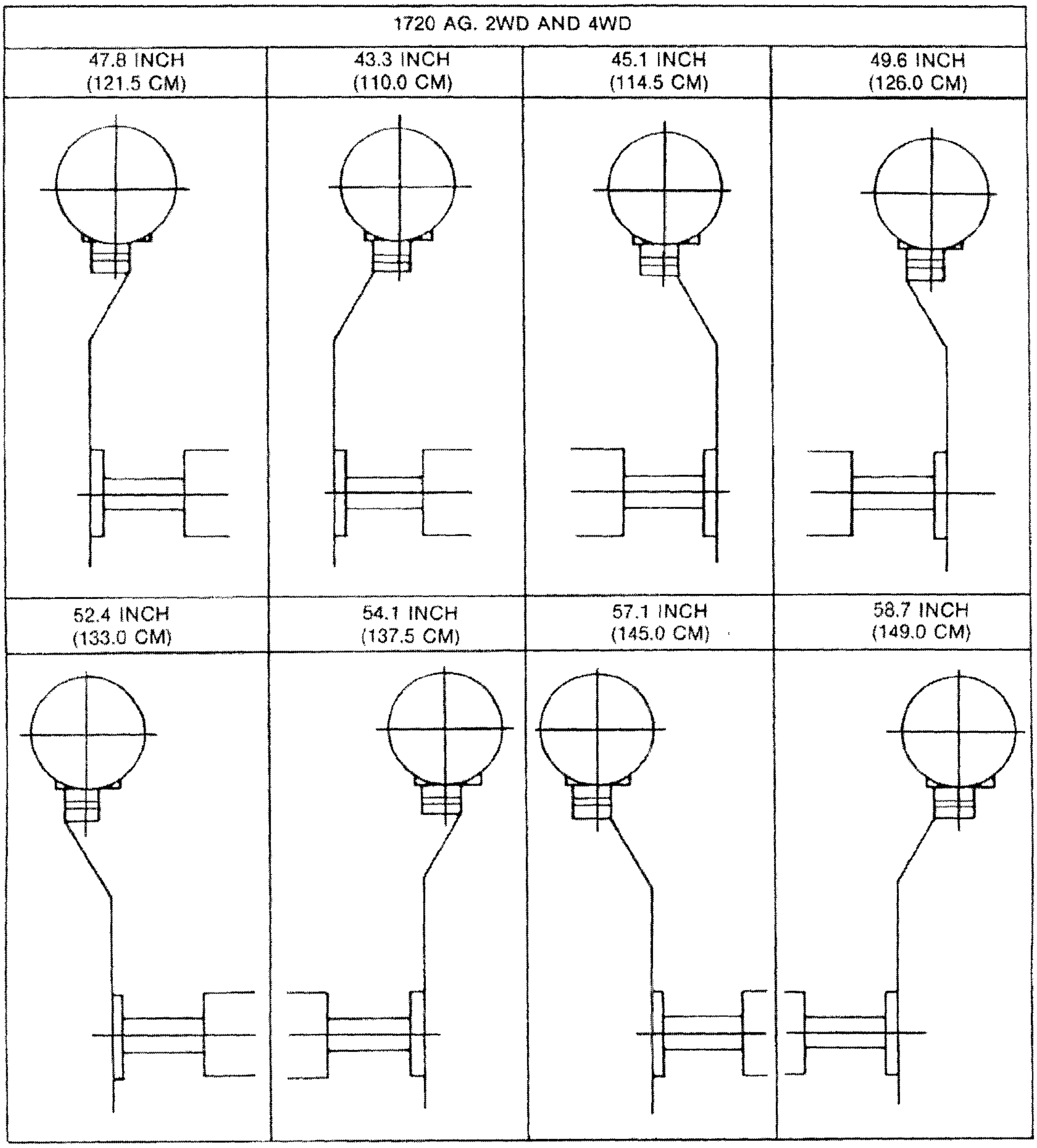
S-23097

Figure 3
Tread Width Setting — Inch (cm)



S-24005

Figure 4
Rear Wheel Tread Setting — Model 1520



S-24006

Figure 5
Rear Wheel Tread Setting — Model 1720

B. WEIGHT LIMITATIONS

To obtain sufficient traction for maximum performance, liquid ballast and/or cast iron weight should be added to the tractor. Use only enough weight to provide good stability and traction. Adding more weight than is necessary results only in unnecessary soil compaction and increased fuel consumption. See Figures 6, 7, 8, & 9.

LIQUID BALLAST

When adding weight by filling the tires with liquid ballast, a calcium choride solution is recommended because of its low freezing point and greater weight per gallon to fill the tires. See your Ford New Holland dealer.

Tires should never be filled beyond 75% capacity. Fill the tires to the valve stem with the valve stem positioned at the top of the wheel.

TIRE INFLATION

Tire inflation pressure affects the amount of load a tire may carry. Do not under inflate or over inflate tires. See Tire Inflation vs. Permissible Load Chart, Figures 10 and 11.

	1320	1520	1720	
Maximum Front End Weight	99 Lb. (45)	99 Lb. (45)	893 Lb. (405)	
Maximum Rear End Weight	264 Lb. (120)	264 Lb. (120)	1446 Lb. (656)	
Front Wheel Weights Number Seg. 33 Lb./Seg. (30 Kg) Tot. Wt. Two Wheel Drive Only	NA	2 per each wheel 132 Lb. (60)	2 per each wheel 132 Lb. (60)	
Rear Wheel Weights Number Seg. 66 Lb./Seg. (30 Kg) Total Weight	2 per wheel 264 Lb. (120)	2 per wheel 264 Lb. (120)	2 per wheel 264 Lb. (120)	
Front End Counter Weight Number Seg. Total Weight 33 Lb./Seg. (15 Kg.)	3 99 Lb. (45)	3 99 Lb. (45)	5 175 Lb. (79)	165 Lb. (75)
Rear Counter Weight Number Seg. 66 Lb./Seg. (30 Kg) Total Weight	4 264 Lb. (120)	4 264 Lb. (120)	7 245 Lb. (111)	4 264 Lb. (120)

S-24007

Figure 6

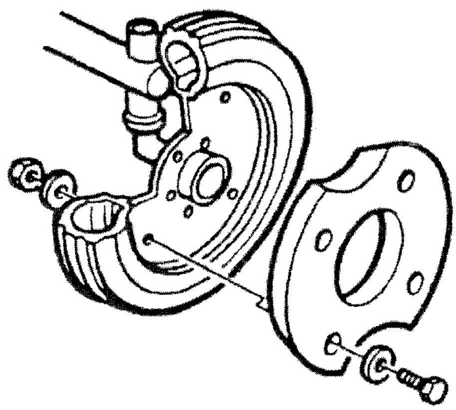


Figure 7
Front Wheel Weights

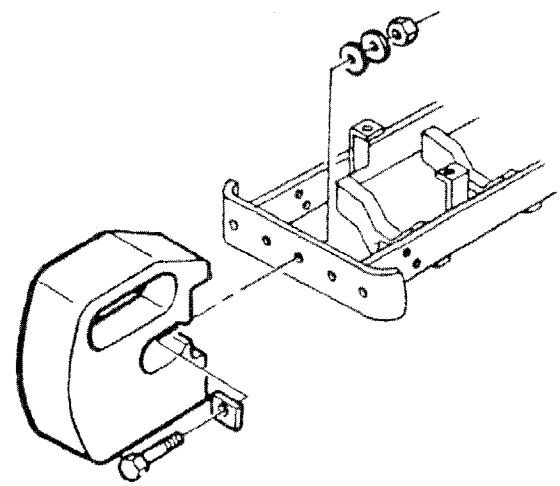


Figure 9
Front End Counterweights

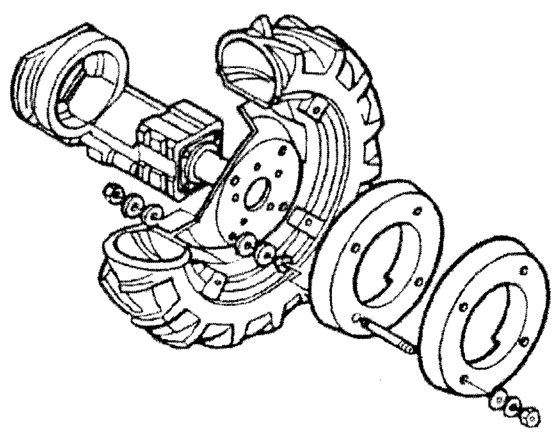


Figure 8
Rear Wheel Weights

MODEL 1320-1520

	INFLATION PRESSURES — psi (bar)								
FRONT TIRE SIZE	**8 (.55)**	**10 (.69)**	**12 (.83)**	**20 (1.4)**	**24 (1.7)**	**28 (1.9)**	**32 (2.2)**	**36 (2.5)**	**40 (2.8)**
	MAXIMUM PERMISSIBLE LOAD — Lbs. (Kg)								
5.00-15,4PR,F2	—	—	—	540 (250)	600 (272)	660 (299)	710 (322)	760 (345)	810 (367)
5.50-16,4PR,F2	—	—	—	—	660 (300)	740 (336)	810 (367)	870 (395)	940 (426)
6.50-10,4PR,F2	—	—	—	—	705 (320)	750 (340)	820 (372)	885 (401)	—
23 x 8.50-12,4PR,R3	620 (281)	705 (320)	785 (356)	1055 (479)	—	—	—	—	—
6-12,4PR,R1	280 (127)	310 (141)	350 (159)	485 (220)	540 (245)	595 (270)	— —	— —	— —
6-14,4PR,R1	—	—	—	—	570 (259)	650 (295)	730 (331)	—	—
7-14, 4PR,R1	410 (186)	470 (213)	520 (236)	570 (259)	610 (277)	710 (322)	—	—	—
25 x 8.50-14,4PR,R3	705 (320)	805 (365)	895 (406)	1205 (547)	—	—	—	—	—
	INFLATION PRESSURES — psi (bar)								
REAR TIRE SIZE	**12 (.83)**	**14 (.96)**	**16 (1.1)**	**18 (1.2)**	**20 (1.4)**				
	MAXIMUM PERMISSIBLE LOAD — lbs. (Kg)								
9.5-24,4PR,R1	1230 (558)	1310 (594)	1390 (630)	—	—				
11.2-24,4PR,R1	1470 (667)	1610 (730)	1740 (789)	1860 (844)	—				
12.4-16,4PR,R1	1350 (612)	1480 (671)	1590 (712)	—	—				
13.6-16,4PR,R3	1610 (730)	1760 (798)	—	—	—				

NOTE: *Do not exceed the maximum load list. Also do not under inflate or over inflate the tires.*

S-22639

Figure 10
Tire Inflation vs. Permissible Load (1320/1520)

MODEL 1720

	INFLATION PRESSURES — psi (bar)									
FRONT TIRE SIZE	8 (.55)	10 (.69)	12 (.83)	14 (.96)	16 (1.1)	20 (1.4)	28 (1.9)	32 (2.2)	36 (2.5)	40 (2.75)
	MAXIMUM PERMISSIBLE LOAD — lbs. (kg)									
5.00-15, 4PR, F2	—	—	—	—	—	540 (245)	660 (299)	710 (322)	760 (345)	810 (367)
5.50-16,4PR,F2	—	—	—	—	—	—	740 (336)	810 (367)	870 (395)	940 (426)
7-14,4PR,R1	410 (186)	470 (213)	520 (236)	570 (258)	610 (277)	710 (322)	—	—	—	—
7-16,4PR,R1	450 (204)	510 (231)	570 (259)	620 (281)	670 (304)	780 (354)	—	—	—	—
23x8.50-12,4PR,R3	620 (281)	705 (320)	785 (356)	855 (388)	925 (420)	1055 (479)	—	—	—	—
25x8.50-14,4PR,R3	705 (320)	805 (365)	895 (406)	980 (445)	1055 (479)	1205 (547)	—	—	—	—
	INFLATION PRESSURES — psi (bar)									
REAR TIRE SIZE	12 (.83)	14 (.96)	16 (1.1)	18 (1.2)	20 (1.4)	22 (1.5)	24 (1.7)	26 (1.8)		
	MAXIMUM PERMISSIBLE LOAD — lbs. (kg)									
11.2-24, 4PR, R1	1470 (667)	1610 (730)	1740 (789)	1860 (844)	—	—	—	—	—	—
12.4-24, 4PR, R1	1760 (789)	1920 (871)	2080 (943)	—	—	—	—	—	—	—
13.6-16 4PR, R3	1610 (730)	1760 (789)	—	—	—	—	—	—	—	—

NOTE: *Do not exceed the maximum load listed. Also, do not under-inflate or over-inflate the tires.*

S-24008

Figure 11
Tire Inflation vs. Permissible Load (1720)

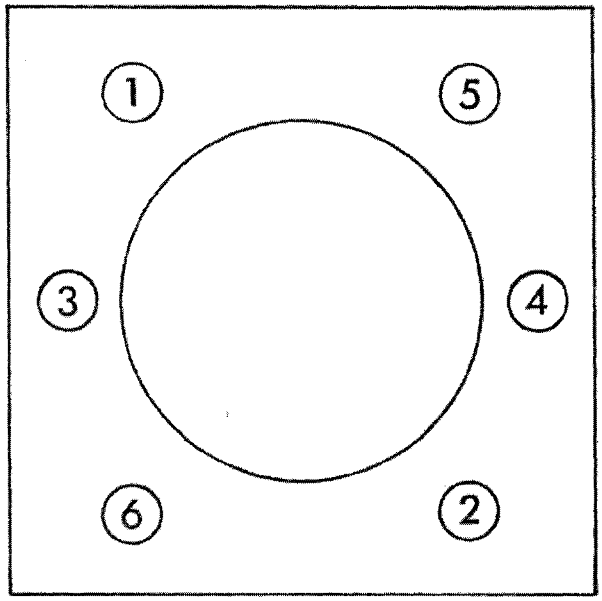
C. WHEEL NUT TORQUE SPECIFICATION

Front Wheel Bolts

2WD — 1320/1520 .... 43-54 lbs. ft. (58-73 Nm)
2WD — 1720 .... 48.5-61.5 lbs. ft. (65.7-83.4 Nm)
4WD — 1320/1520 .... 69-87 lbs. ft. (93-117 Nm)
4WD — 1720 .... 116-142 Lbs ft. (157-192 Nm)

Rear Wheels

Rim To Disc Bolt-Nuts — All Models .... 137-159 lbs. ft. (186-215 Nm)
Disc To Hub Bolts — 1320/1520 .... 137-159 Lbs ft. (186-215 Nm)
Disc To Hub Bolts — 1720 .... 116-142 lbs. ft. (152-192 Nm)



FRONT AND REAR WHEEL HUB BOLT TORQUE SEQUENCE

PART 12
SEPARATING THE TRACTOR

Chapter 1
SEPARATING THE TRACTOR

Chapter 2
SPECIFICATIONS

PART 12
SEPARATING THE TRACTOR

Chapter 1
SEPARATING THE TRACTOR

A. FRONT AXLE REMOVAL

TWO WHEEL DRIVE

1. Disconnect the power steering cylinder hoses and cap all openings, Figure 1.
2. Place a floor jack and safety jack stands under the transmission housing to support the weight of the front end of the tractor.
3. Remove the axle pivot front bearing casing (1), Figure 2.
4. Remove the axle pivot rear support retaining bolts (3), Figure 1.
5. Gently raise the tractor front end at the same time separating the axle pivot from the front support. Then gently roll the front axle assembly forward out from under the tractor.

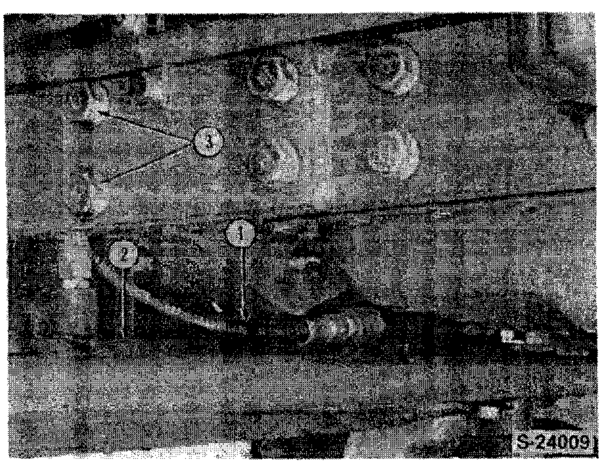


Figure 1
Front Axle Removal — Two Wheel Drive

1. Power Steering Cylinder Hoses
2. Power Steering Cylinder
3. Bolts Pivot Bearing — Rear

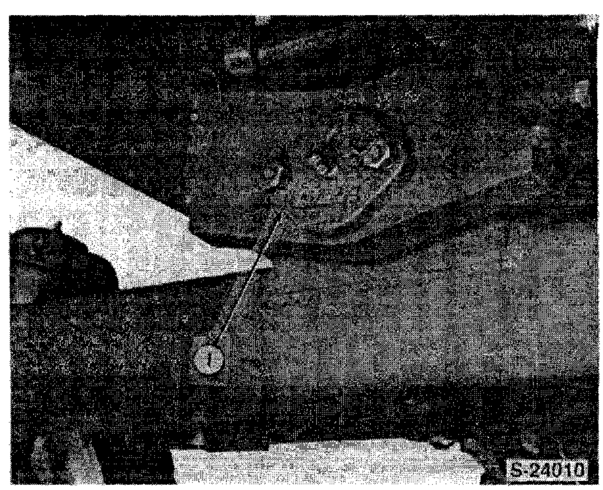


Figure 2
Front Axle Removal — Two Wheel Drive

1. Pivot Bearing Casing — Front

FOUR WHEEL DRIVE

1. Place a floor jack and safety stands under the transmission housing to support the front end of the tractor.

2. Remove the boot clamps (2), Figure 3, and slide the rubber boot rearward to obtain access to the front universal joint.

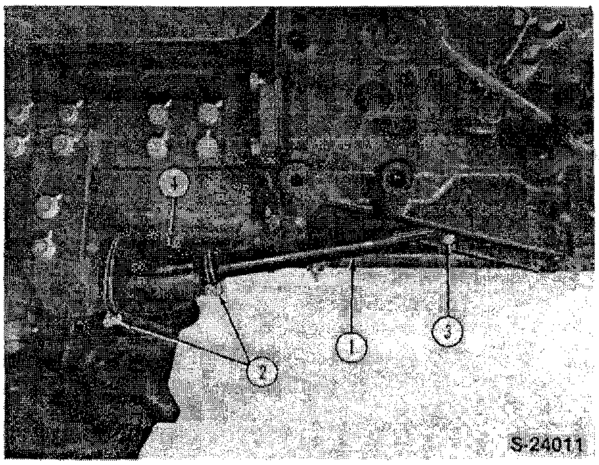


Figure 3
FWD Drive Shaft Removal

1. FWD Drive Shaft
2. Boot Clamps
3. Bolt — Universal Joint
4. Rubber Boot

3. Remove the universal joint retaining bolt from each end of the drive shaft, Figure 3. Disconnect the drive shaft from the transmission end.

4. Remove the drive shaft front universal from the axle drive pinion shaft.

5. Disconnect the power steering cylinder hoses (1) and cap all openings, Figure 4.

6. Remove the front and rear pivot support bolts, Figure 5.

7. Carefully roll the front axle forward out from under the tractor.

B. SEPARATING THE TRACTOR BETWEEN THE FRONT AXLE SUPPORT AND ENGINE

1. Drain the radiator and block coolant and collect in a clean container, Figure 6.

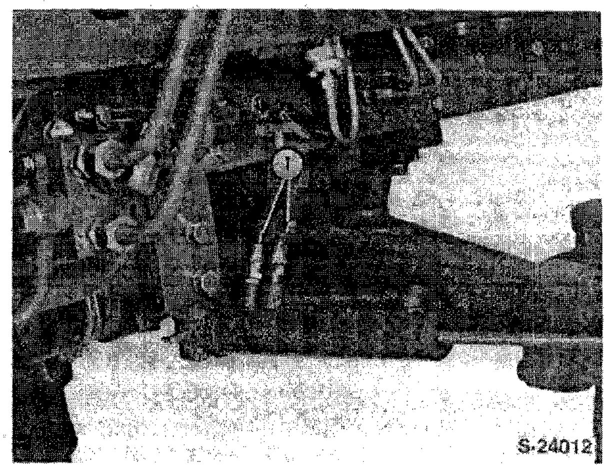


Figure 4
FWD Front Axle Removal

1. Hoses — Power Steering Cylinder

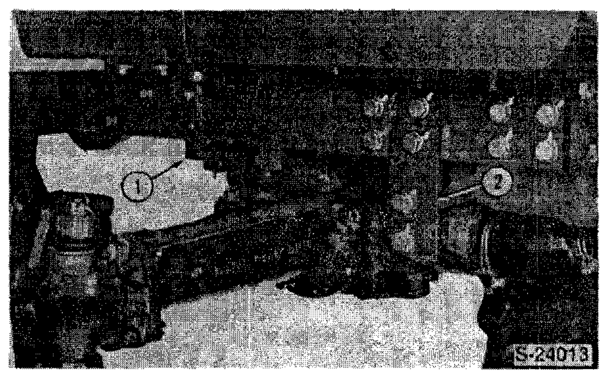


Figure 5
FWD Front Axle Removal

1. Pivot Bearing Support — Front
2. Pivot Bearing Support — Rear

2. Open the hood and remove the side screens and panels, Figure 7.

3. Disconnect the headlamp wiring connectors, Figure 8.

4. Disconnect the battery ground strap.

5. Remove the hood pivot pin cotter pins and remove the hood, Figure 8.

6. Loosen the upper and lower radiator hose clamps and remove the hoses from the radiator.

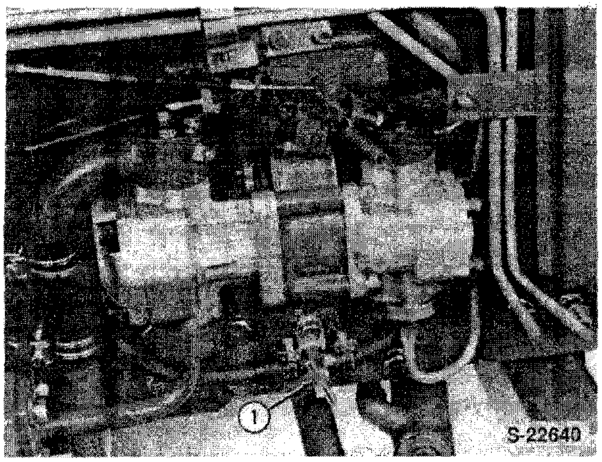


Figure 6
Radiator and Block Drain
1. Drain Cock

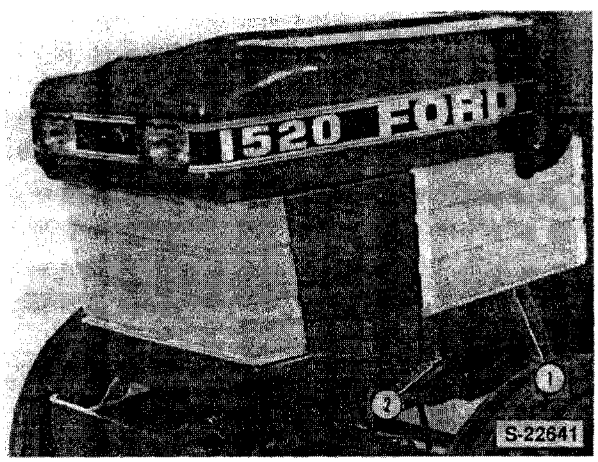


Figure 7
Engine Side Screens and Panel Removal
1. Side Screen
2. Lower Side Panel

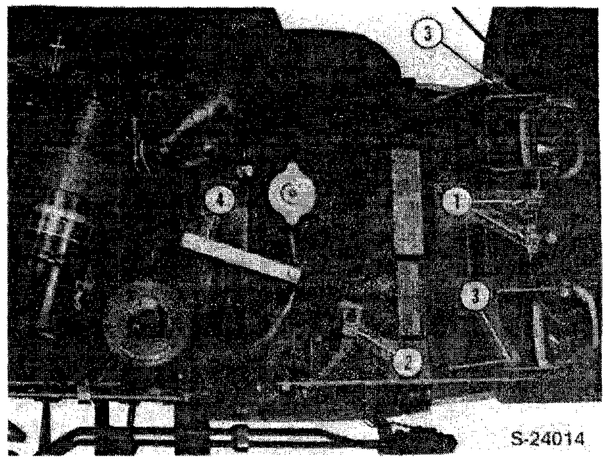


Figure 8
Hood Removal — Model 1320/1520 Shown
1. Headlamp Connectors
2. Battery Ground Strap
3. Pivot Pins — Hood
4. Radiator Support Strap — Model 1320/1520

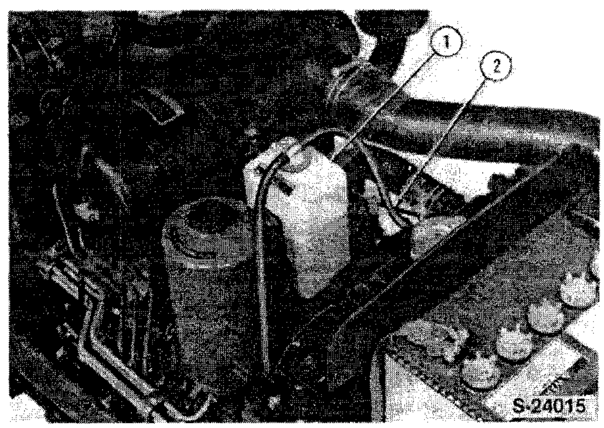


Figure 9
Coolant Reserve Tank — Model 1720
1. Reserve Tank
2. Hose — Radiator

7. On model 1320/1520 tractors, remove the radiator upper brace, Figure 8.

8. On model 1720 tractors, disconnect the coolant reserve tank hose (2) from the radiator, Figure 9.

9. Disconnect the power steering tubes (1) from the front axle support and cap all openings, Figure 10.

10. On FWD models, disconnect the FWD drive shaft. See Section "A" this chapter.

11. Using a floor jack and safety stands under the clutch housing, raise the tractor to support the weight of the front end.

12. Remove the bolts from each side of the support rails, Figure 11.

13. Carefully roll the front axle assembly away from the tractor.

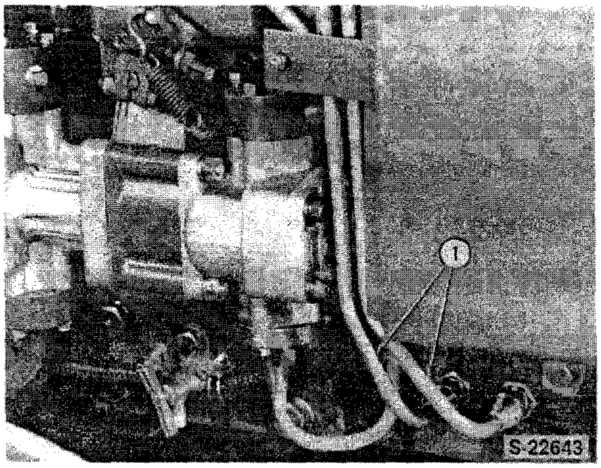


Figure 10
Power Steering Tubes Removal
1. Power Steering Tubes

INSTALLATION

Installation generally follows the removal procedure in reverse.

Tighten all bolts to the specified torque.

See "Specifications," Chapter 2.

C. SEPARATING THE TRACTOR BETWEEN THE ENGINE AND TRANSMISSION CLUTCH HOUSING

1. Open the hood and remove the side screens and panels, Figure 7.
2. Disconnect the battery negative cable, Figure 8.
3. Disconnect the headlamp wiring connectors, Figure 8.
4. Remove the hood pivot pin cotter pins and remove the hood.
5. Remove the steering wheel, Figure 12.
6. Remove the steering column shroud center panel.
7. Disconnect the wiring harness connectors from the instrument panel, key switch and rear harness assembly.
8. Remove the throttle control cable from the injection pump lever.
9. Remove the instrument panel.
10. Remove the instrument panel shroud as an assembly.

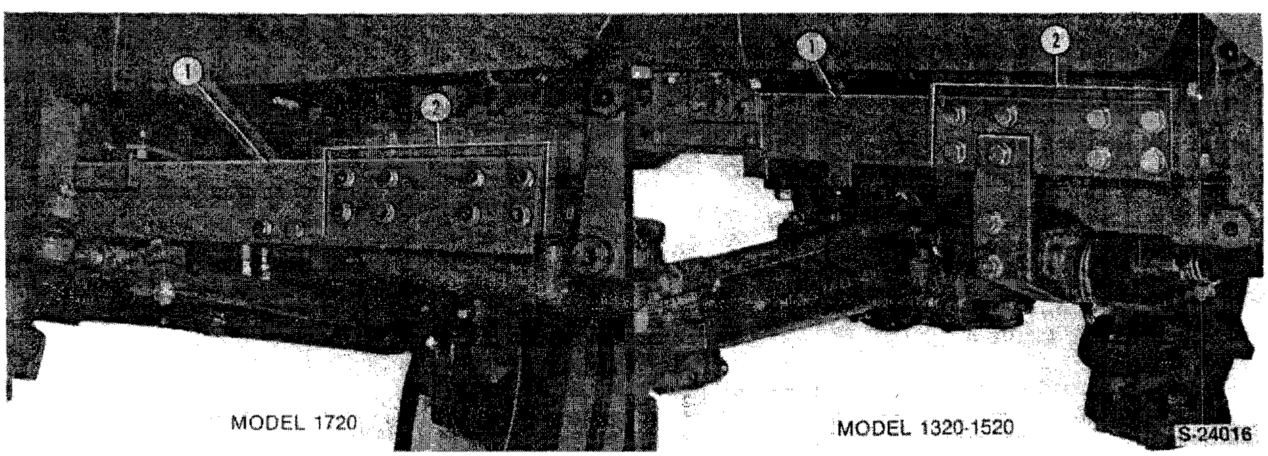


Figure 11
Separating the Tractor Between the Front Axle and Engine
1. Engine Support Rails 2. Mounting Bolts (8 Ea. Side)

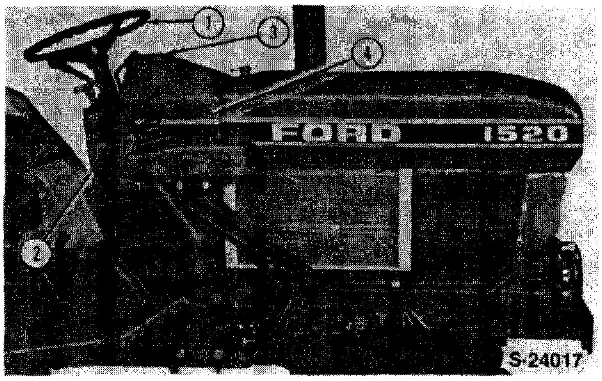


Figure 12
Separating the Tractor Between the Engine and Transmission

1. Steering Wheel
2. Center Panel
3. Instrument Panel
4. Shroud

11. Remove the fuel hose (1) from the fuel shut-off valve and filter and drain the fuel into a clean container, Figure 13.

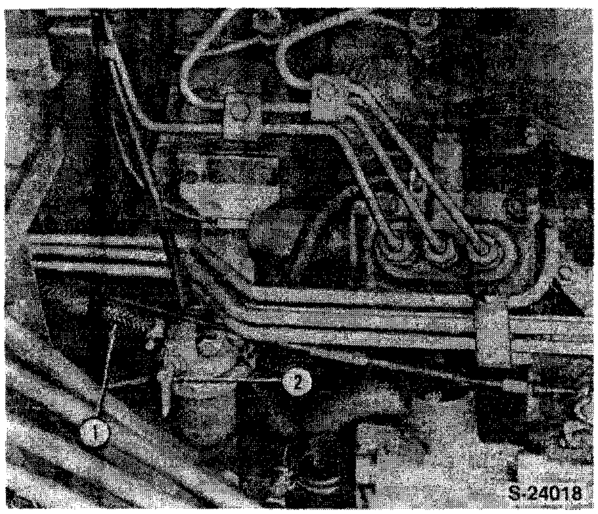


Figure 13
Fuel Tank Removal — Model 1320 Shown

1. Fuel Line
2. Shut-Off Valve

12. Disconnect the fuel gauge sender wires (2), Figure 14.

13. Disconnect the fuel return lines from the fuel tank (4), Figure 14.

14. Remove the fuel tank retaining band (1), Figue 15.

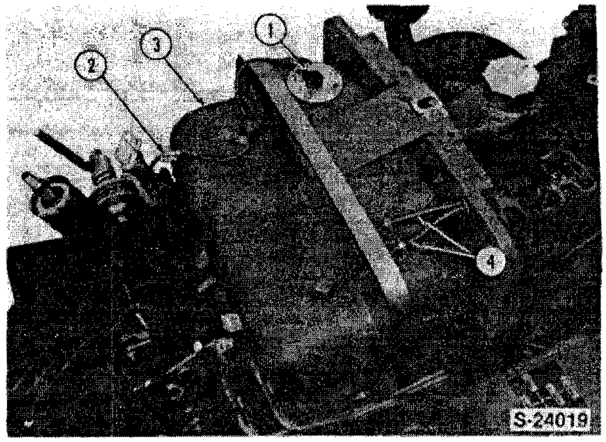


Figure 14
Fuel Tank Removal

1. Fuel Gauge Sender
2. Wire Connectors
3. Fuel Tank
4. Fuel Return Tubes

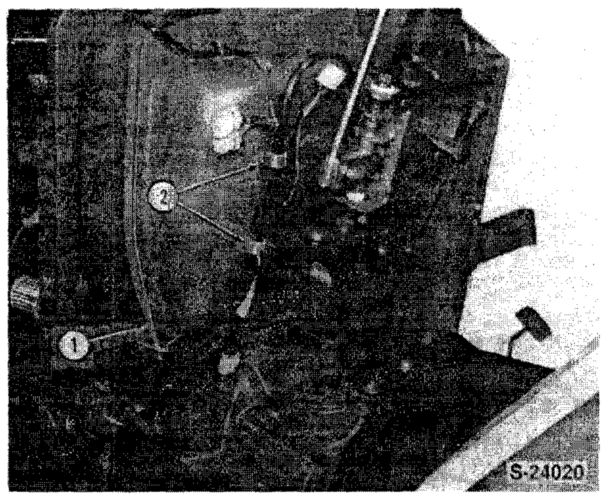


Figure 15
Fuel Tank Removal

1. Retaining Band
2. Wire Harness Straps

15. Release the wiring harness straps and remove the fuel tank from the tractor, Figure 15.

16. Remove the hydraulic suction tube (1) from the tractor, Figure 16.

17. Remove the hydraulic system pressure tube (2), Figure 16 from the tractor .

18. Remove the oil return line (3), Figure 16, from the tractor.

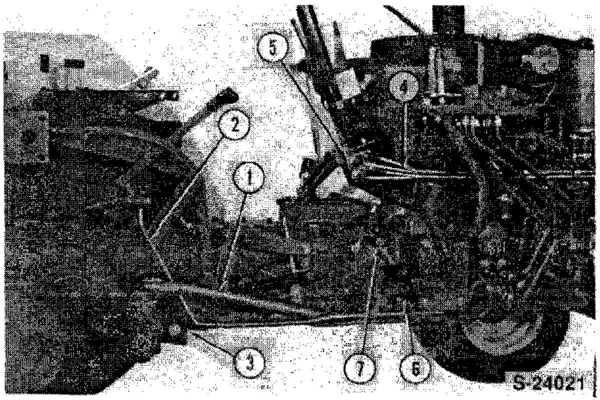


Figure 16
Hydraulic Tube Removal

1. Suction Tube
2. Pressure Tube
3. Hydraulic Oil Return Tube
4. Power Steering Tubes
5. Power Steering Control Valve
6. Hose Clamp
7. Tube — Inlet

19. Disconnect the four power steering oil tubes from the control valve, Figure 16.

20. Disconnect the starter motor wiring from the starter, Figure 17.

21. Remove the starter motor assembly.

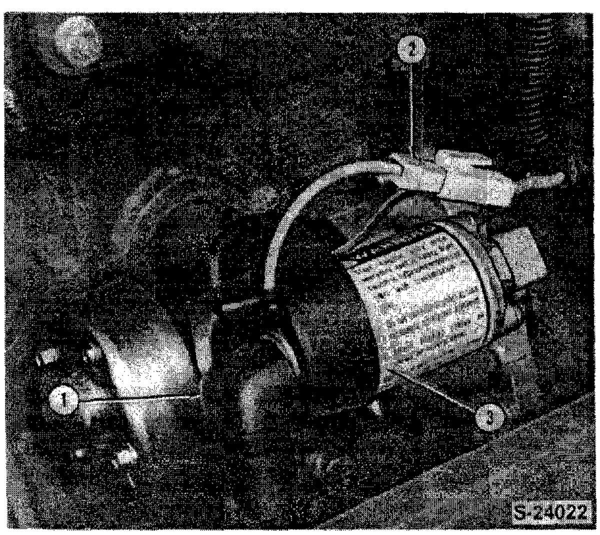


Figure 17
Starter Motor Removal

1. Starter Cable
2. Solenoid Wire
3. Starter Motor

22. If equipped with hydrostatic transmission, disconnect the transmission to cooler tube at the hose connector (2), Figure 18.

23. Remove the cooler return tube (3), Figure 18.

24. Remove the engine to transmission buckle-up bolts and carefully separate the engine from the transmission.

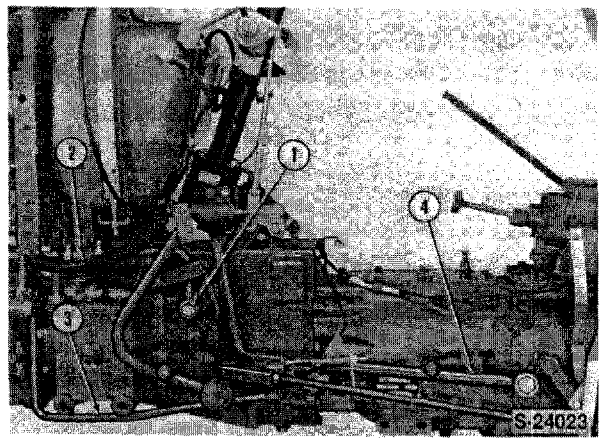


Figure 18
HST Transmission Cooler Tubes Removal

1. Tube To Cooler
2. Hose Connector
3. Tube Cooler Return
4. Oil Return Tube

D. TRANSMISSION REMOVAL AND INSTALLATION

9x3 GEAR TRANSMISSION — 1320/1520

REMOVAL

1. Separate the engine from the transmission clutch housing. See Section "C" this chapter.
2. Drain the transmission, rear axle and hydraulic system and collect the oil in a clean container. See Operator's Manual.
3. Remove the roll bar.
4. Remove the rear wheels.
5. Remove the seat and seat platform and track assembly, Figure 19.
6. Remove the rear fenders.
7. Remove the brake and clutch pedal return spring.

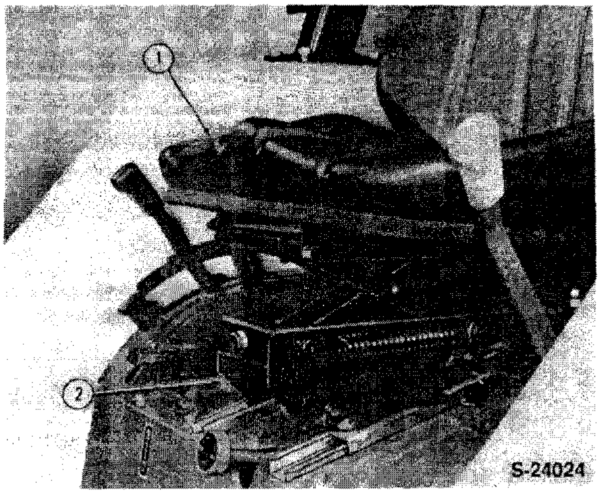


Figure 19
Seat and Track Removal
1. Seat Assembly 2. Track Assembly

8. Disconnect the foot throttle linkage from the pedal.

9. Remove the right and left step plates.

10. Remove the rubber mat covering the transmission case.

11. Disconnect the rear wiring harness from the transmission case.

12. If equipped with remote control, Figure 12, remove the control valve, mounting stand and tubing as an assembly, Figure 12.

13. Disconnect and remove the brake pedal control rods from each side.

14. Remove the clutch housing to transmission buckle-up bolts.

15. Using a heavy rubber mallet, loosen the clutch housing mating joint. While rotating the shift lever, slide the clutch housing forward separating the shift lever ball end from the shift rail notches, Figure 20.

NOTE: *The steering column and shift linkage need not be removed for this operation.*

16. Remove the transmission cover, Figure 21.

17. Remove the hydraulic lift cover.

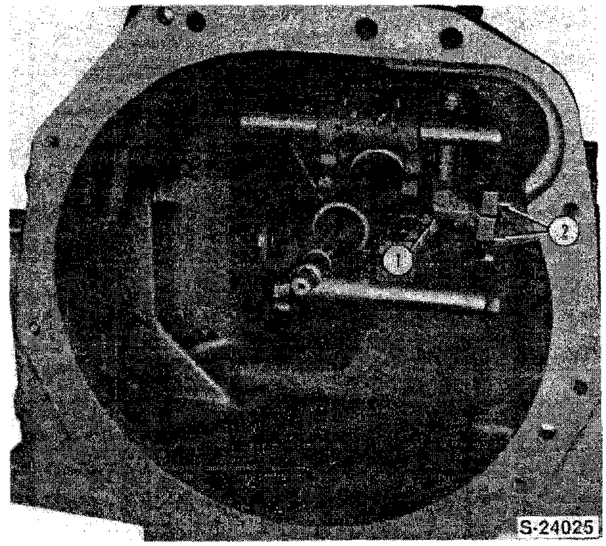


Figure 20
Clutch Housing Removal
1. Shift Lever — Ball End 2. Shift Rails

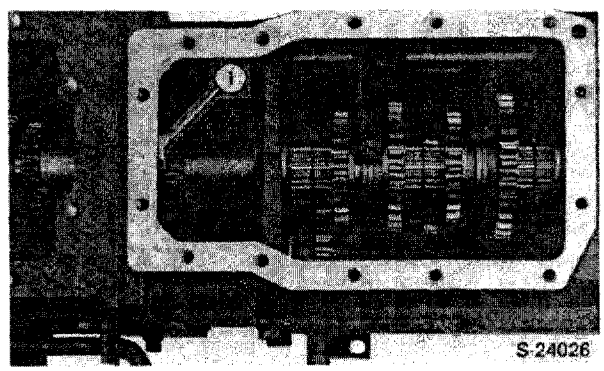


Figure 21
Internal Buckle-Up Bolts
1. Buckle-Up Bolt — Internal

18. Remove the internal buckle-up bolt (1), Figure 21.

19. Attach an overhead hoist to the transmission case.

20. Remove the external buckle-up bolts.

21. Using a heavy rubber mallet, loosen the transmission case mating joint and slide the transmission foward off of the dowel pins.

INSTALLATION

Installation generally follows the removal procedure in reverse order.

During installation coat the transmission, clutch housing and rear axle center housing mating surfaces with liquid gasket sealer. Use caution to prevent excess sealer from entering the inside of the housing and contaminating the hydraulic oil supply.

HYDROSTATIC TRANSMISSION

REMOVAL AND INSTALLATION — MODEL 1320/1520

HYDROSTATIC UNIT — REMOVAL

1. Separate the engine from the transmission clutch housing. See Section "C" this chapter.
2. Drain the transmission rear axle and hydraulic systems and collect the oil in a clean container. See Operator's Manual.
3. Remove the right and left step plates.
4. If equipped with remote control valve, Figure 12, remove the control valve, mounting stand and tubing as an assembly and cap all openings.
5. Disconnect and remove the brake control rods.
6. Loosen the hose clamp (6), Figure 17, and remove the tube (7) from the hydrostatic unit, Figure 16.
7. Disconnect the hydrostatic control rod (1), Figure 22, from the HST lever (2).
8. Disconnect the HST control rod (3), Figure 22, from the linkage lever.
9. Remove the eye bolts and remove the HST oil return tube (4), Figure 18.
10. Remove the two HST test port pipes (4), Figure 22.
11. If not previously removed, remove the oil cooler return tube (1) and clamp, Figure 23.
12. Remove the clutch housing buckle-up bolts.

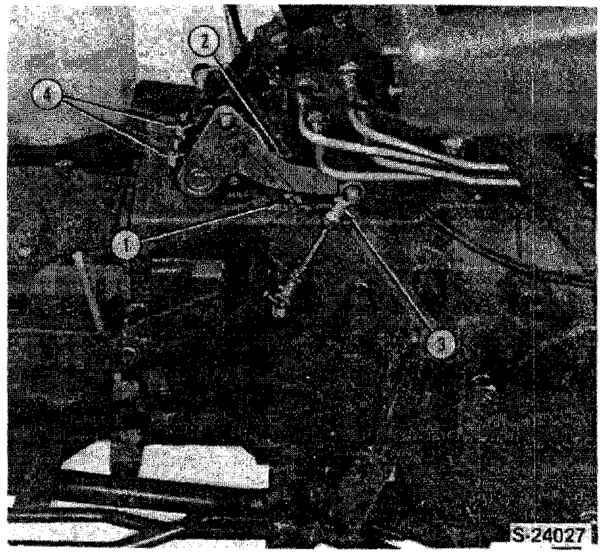


Figure 22
Hydrostatic Transmission Control

1. HST Control Rod
2. HST Control Lever
3. HST Control Rod
4. Test Port Pipes

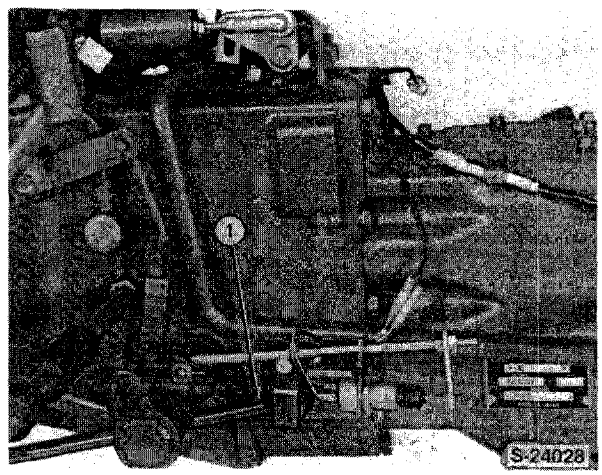


Figure 23
HST Oil Cooler Return Tube Removal

1. Tube and Clamp

13. Using a heavy rubber mallet, loosen the clutch housing and slide it forward off the dowel pins.
14. Remove the four HST mounting bolts and nuts, Figure 24, and remove the HST unit from the gearbox case.

HYDROSTATIC GEARBOX — REMOVAL

See "Separating the Tractor Between the Engine and Transmission Clutch Housing," this Chapter.

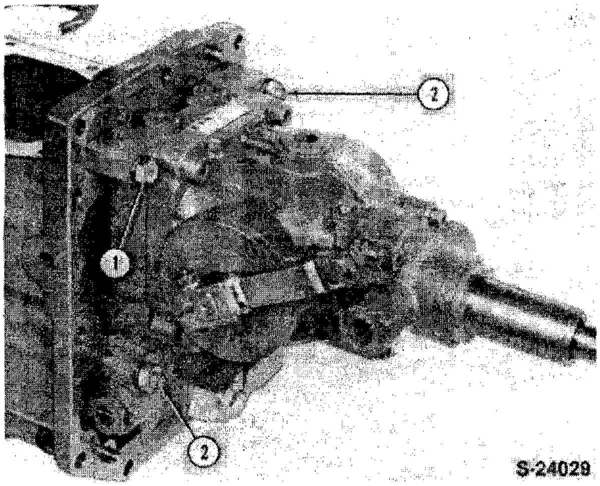


Figure 24
HST Transmission Unit Removal
1. Mounting Bolts (2)   2. Mounting Studs (2)

Perform steps 1 through 14 above.

1. Remove the roll bar assembly.
2. Remove the rear wheels.
3. Remove the seat and seat platform and track assembly, Figue 19.
4. Remove the rear fenders.
5. Remove the rubber matting from the transmission case.
6. Disconnect the rear wiring harness from the transmission case.
7. Remove the transmission cover and hydraulic lift cover, Figure 25.
8. Remove the internal buckle-up bolt (1), Figure 25.
9. Remove the snap ring (1) and drive gear (2), Figure 26.
10. Attach an overhead hoist to the gearbox case.
11. Remove the external buckle-up bolts.
12. Using a heavy rubber mallet, loosen the gear case and slide the gear case forward off the dowel pins.

NOTE: *The transmission range gears are located inside of the rear axle center housing.*

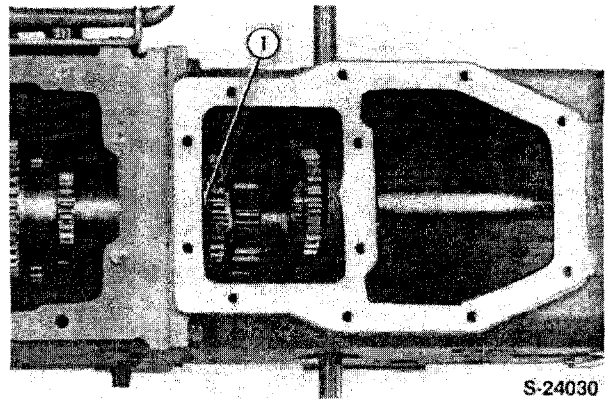


Figure 25
Hydraulic Lift and Transmission Cover Removal
1. Buckle-Up Bolt – Internal

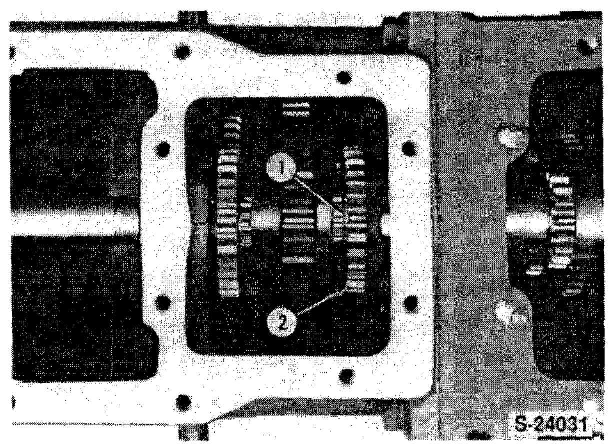


Figure 26
Main Shaft Drive Gear Removal
1. Snap Ring   2. Drive Gear

12x4 GEAR AND 12x12 SHUTTLE TRANSMISSION – REMOVAL AND INSTALLATION – MODEL 1720

1. Separate the engine from the transmission. See Section "C" this section.
2. Drain the transmission, rear axle and hydraulic systems and collect the oil in a clean container. See Operator's Manual.
3. Remove the brake and clutch pedal return springs.
4. Disconnect the foot throttle linkage from the pedal.
5. Remove the rubber mats and remove the step plates from each side, Figure 27.

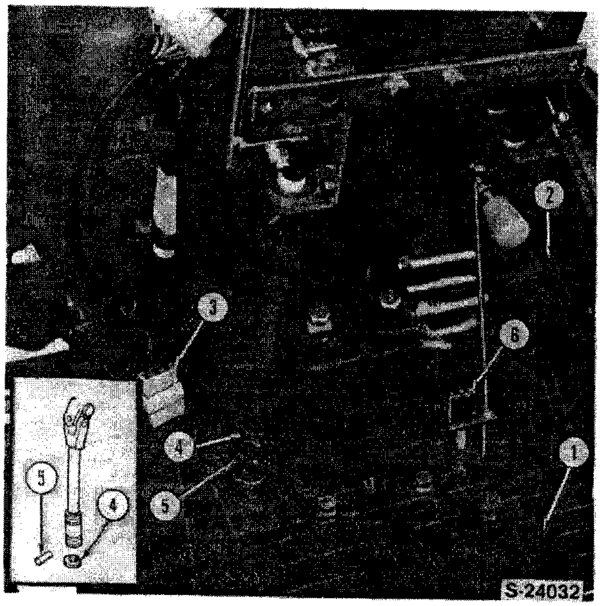


Figure 27
Transmission Removal — Model 1720

1. Rubber Mat — Transmission Case
2. Rubber Mat — Step Plates
3. Rear Wiring Harness
4. Snap Ring
5. Pin
6. Switch — Park Brake

6. Remove the rubber mat from the top of the transmission case, Figure 27.

7. Disconnect the rear wiring harness from the transmission case.

8. If equipped, remove the remote valve, stand and tubing if not previously removed, Figure 12.

9. Disconnect the brake pedal rods from the pedals.

10. Disconnect the clutch pedal rod from the bell crank, Figure 28.

11. Remove the brake cross shaft support bolts and remove the cross shaft and pedals as an assembly, Figure 28.

12. Remove the snap ring (4) and pin (5) from the shift arm linkage rod, Figure 27.

NOTE: *The shuttle shift transmission two shift lever assemblies attach to the main transmission, one set on each side of the steering column.*

13. Remove the steering column, shift linakge and throttle control linkage as an assembly, Figure 28.

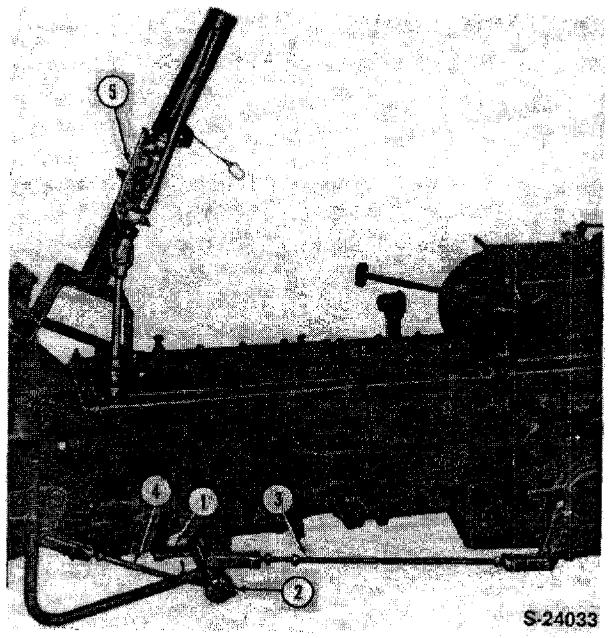


Figure 28
Brake Cross Shaft Removal

1. Support — Brake Cross Shaft
2. Brake Cross Shaft
3. Brake Rod — L.H.
4. Clutch Control Rod
5. Steering Column and Shift Linkage Assembly

14. Disconnect the parking brake switch (6) wire connector, Figure 27.

15. Remove the parking brake mounting bolt (3), Figure 29, and remove the parking brake linkage and switch as an assembly.

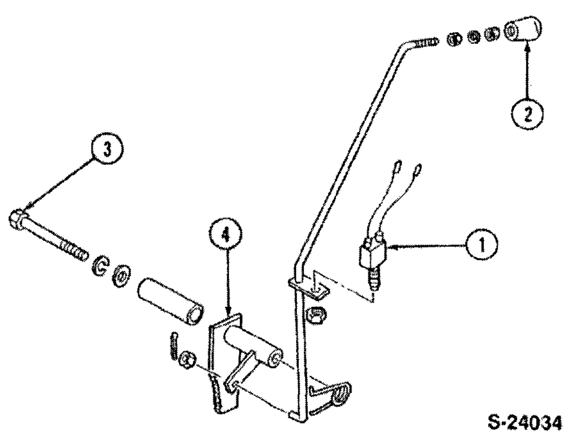


Figure 29
Parking Brake Lever

1. Switch
2. Control Lever
3. Mounting Bolt
4. Linkage

16. Remove the clutch housing to transmission buckle-up bolts and nuts.

17. Using a heavy rubber mallet, loosen the clutch housing mating joint. Slide the clutch housing forward off the dowel pins.

18. Remove the transmission cover (1) and rear cover (2), Figure 30.

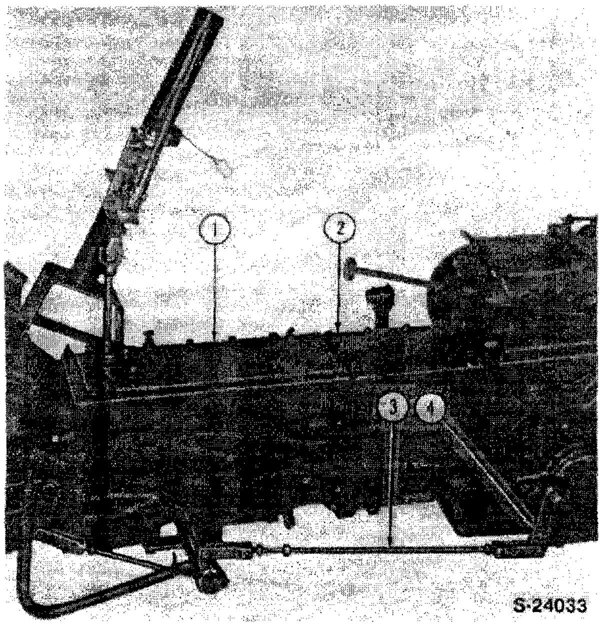


Figure 30
Transmission Cover Removal
1. Cover — Transmission
2. Cover — Rear
3. Brake Control Rod
4. Brake Actuator Arm

19. On the model 1720, disconnect the range gear shift links (1), Figure 31.

20. Remove the three internal buckle-up bolts (1), Figure 32.

21. Attach an overhead hoist to the transmission assembly.

22. Remove the external buckle-up bolts.

23. Using a heavy rubber mallet, loosen the mating joint and slide the transmission forward off the dowel pins.

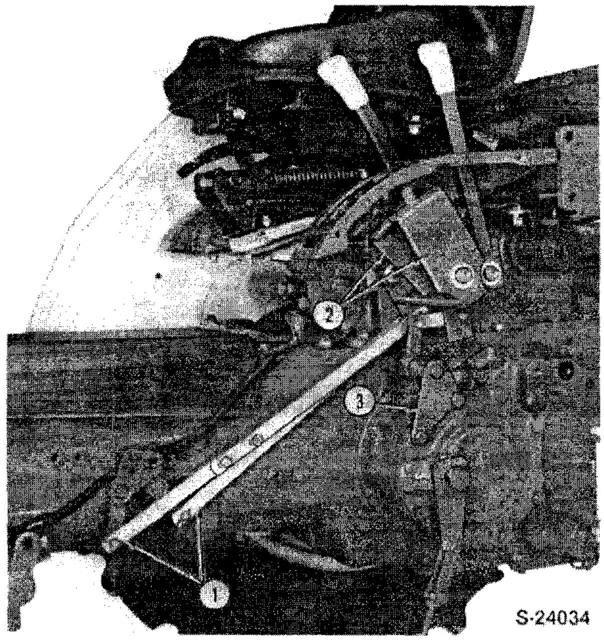


Figure 31
Transmission Range Gear Shift Links Removal — Model 1720 (12x4 Transmission Shown)
1. Shift Links
2. Lever Guides
3. Mounting Bracket

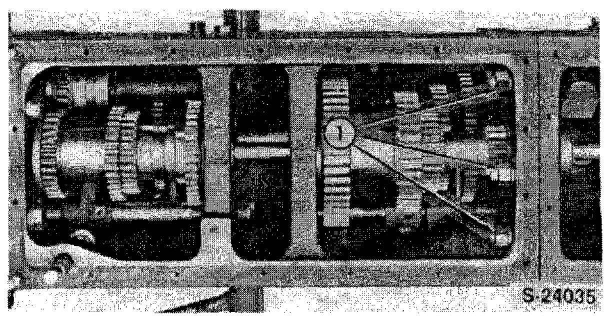


Figure 32
Internal Buckle-Up Bolts Removal (12x4 Transmission Shown)
1. Buckle-Up Bolts — Internal

INSTALLATION

Installation generally follows the removal procedure in reverse.

During installation, coat the housing mating surfaces with liquid gasket sealer. Use caution to prevent excess sealer from entering the inside of the housing and contaminating the hydraulic oil supply.

E. REAR AXLE AND CENTER HOUSING — REMOVAL AND INSTALLATION

1. Drain the oil from the transmission, rear axle and hydraulic systems and collect in a clean container.

2. Disconnect the flasher warning light wiring from the roll bar light fixtures.

3. Remove the roll bar assembly.

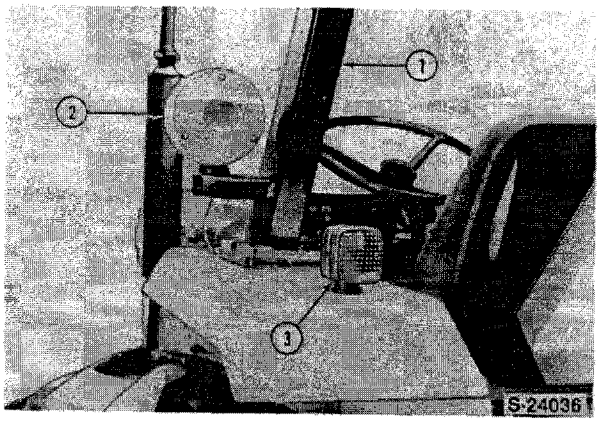


Figure 33
Roll Bar Removal
1. Roll Bar
2. Flasher Warning Light
3. Taillight

4. Remove the seat and track assembly, Figure 34.

5. Place wedge blocks between the engine side rails and front axle to prevent the engine from tipping.

6. Place blocking in front and rear of the front wheels.

7. Place a safety jack stand under the transmission.

8. Remove the rear wheels.

9. Remove the brake and clutch pedal return springs from the step plates.

10. Disconnect the foot throttle pedal linkage from the pedal.

11. Remove the step plates.

12. Disconnect the wiring to the taillight fixtures.

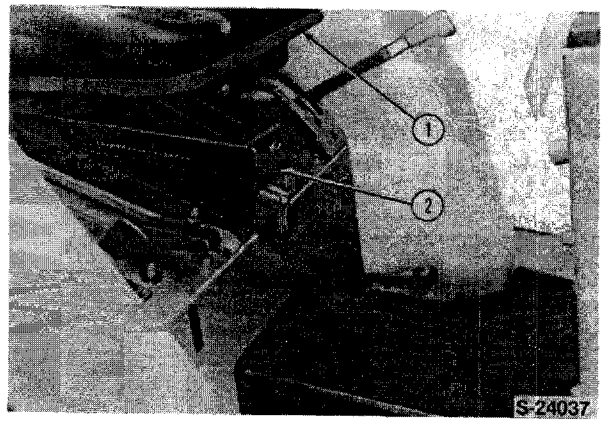


Figure 34
Seat and Track Removal
1. Seat
2. Track Assembly

13. Remove the hydraulic and transmission control lever grips, Figures 35 and 36.

14. If equipped with FWD, remove the FWD lever (1), Figure 37.

15. Remove both fenders.

16. Remove the platform and tool box as an assembly, Figure 36.

17. Remove the lever guide and mounting bracket from the hydraulic lift cover, Figures 31 and 36.

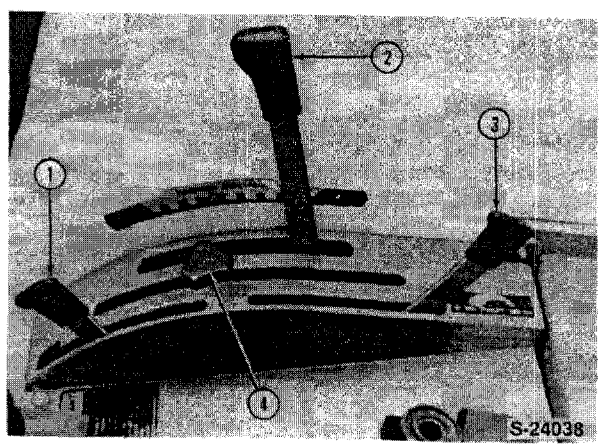


Figure 35
Hydraulic Control Levers — Model 1720 Shown
1. Remote Valve (Single) Control
2. Position Control
3. Draft Control
4. Adjustable Stop

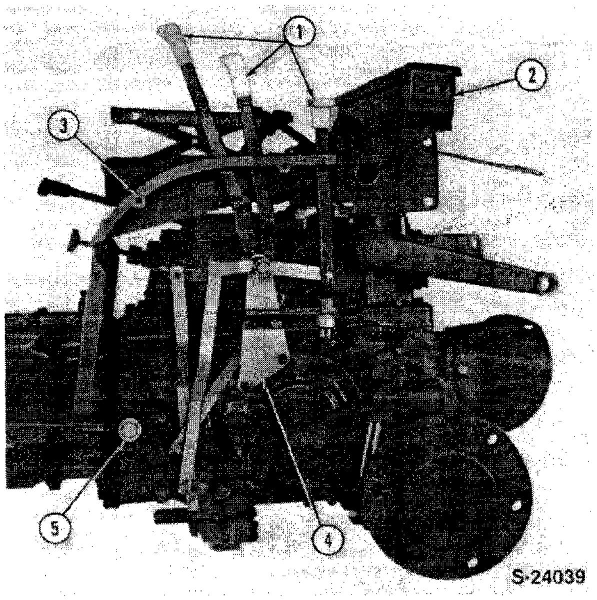


Figure 36
Transmission Control Lever Grips Removal (Model 1320/1520 Shown)

1. Control Levers (Transmission Range and PTO)
2. Tool Box
3. Platform Assembly
4. Mounting Bracket
5. Oil Return Tube (HST Transmission)

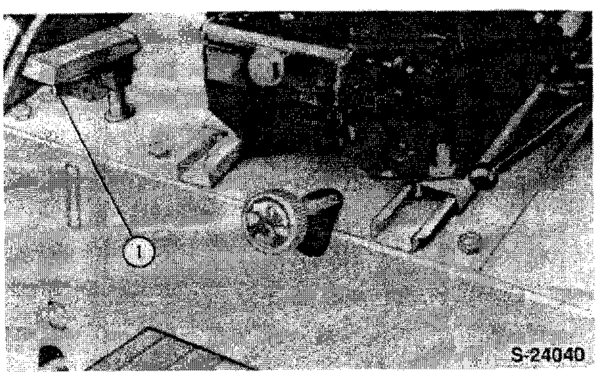


Figure 37
FWD Lever Grip Removal

1. FWD Lever

18. Remove the hydraulic filter and mounting flange as an assembly, Figure 38.

19. Remove the suction tube (4), Figure 38.

20. Remove the hydraulic system pressure tube (3) from the lift cover.

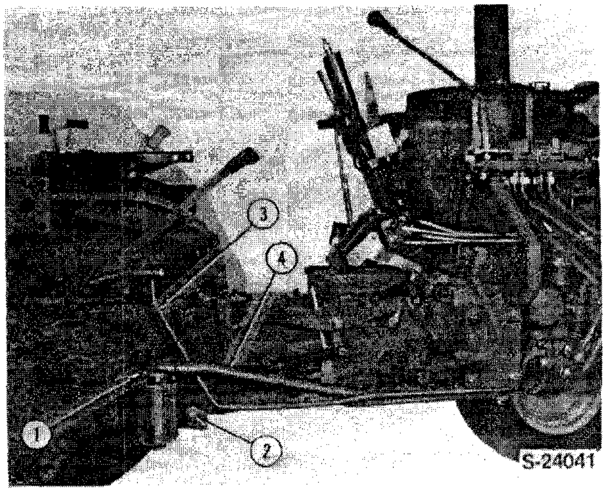


Figure 38
Rear Axle Center Housing Removal

1. Filter and Flange Assembly
2. Oil Return Tube
3. Oil Pressure Tube
4. Suction Tube

21. If equipped with hydrostatic transmission, remove the transmission oil return tube, Figure 36.

22. Remove the hydraulic system oil return tube (2), Figure 38.

23. Remove the hydraulic lift cover.

24. Remove the transmission cover, Figure 30.

25. Remove the internal buckle-up bolt (5), Figure 32.

26. Attach an overhead hoist to the rear axle and center housing assembly.

27. Remove the external buckle-up bolts and gently remove the rear axle assembly from the transmission.

INSTALLATION

Installation generally follows the removal procedure in reverse order.

During installation, coat the transmission and center housing mating surfaces with liquid gasket sealer. Use caution to prevent excess sealer from entering the inside of the housing and contaminating the hydraulic oil supply.

F. REAR AXLE CENTER HOUSING — REMOVAL AND INSTALLATION

(LEFT SIDE)

1. Drain the oil from the rear axle assembly and collect in a clean container. See Operator's Manual.
2. Place wood wedge blocking between the engine side rails and front axle to prevent the engine from tipping.
3. Place blocking in front and back of the front wheels.
4. Disconnect the flasher warning light wire connector at the light fixture, Figure 33.
5. Disconnect the taillight wiring connector at the taillight fixture.
6. Remove the roll bar assembly.
7. Place a safety jack stand under the rear axle center housing.
8. Remove the rear wheel.
9. Remove the lower links.
10. Disconnect the brake rod from the brake actuator arm, Figure 30.
11. Remove the rear fender.
12. Remove the transmission range gear and PTO shift linkage support bracket, Figures 31 and 36, from the brake housing.
13. Attach a suitable overhead hoist to the rear axle assembly.
14. Remove the rear axle retaining bolts.
15. Carefully remove the rear axle assembly from the tractor, Figure 39.

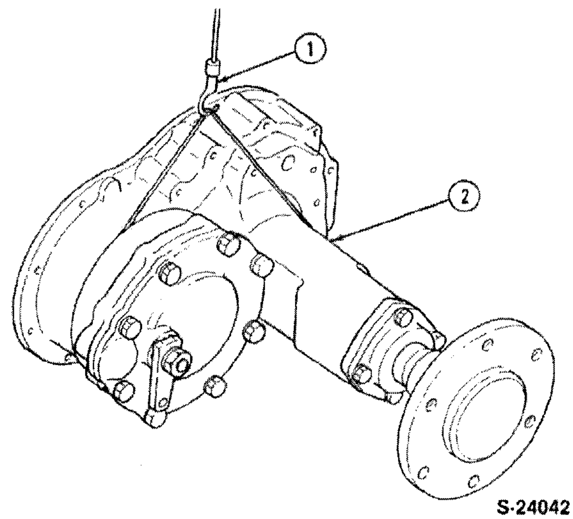


Figure 39
Rear Axle Assembly Removal
1. Hoist 2. Axle Assembly

WARNING: *The rear axle is difficult to balance. Exercise care during removal to avoid personal injury.*

Remove the right rear axle assembly in a similar manner.

INSTALLATION

Installation generally follows the removal procedure in reverse.

During installation, coat the rear axle center housing and axle housing mating surfaces with liquid gasket sealer. Use caution to prevent excess sealer from entering the inside of the housing and contaminating the hydraulic oil supply.

PART 12
SEPARATING THE TRACTOR

Chapter 2
SPECIFICATIONS

A. SPECIFICATIONS

Lubricant

Transmission, Rear Axle and Hydraulic System — Oil .... Ford 134

Front Axle .... Ford 134

Ford Sealant (Gasket Eliminator) .... Ford FP-119

METRIC BOLT TORQUE SPECIFICATIONS

Bolt Size	Grade No.	Coarse Thread			Fine Thread		
		Pitch (mm)	Pounds-Feet	Newton-Meters	Pitch (mm)	Pounds-Feet	Newton-Meters
M6	4T 4T 4.8	1.0	3.6-5.1	4.9-6.9	—	—	—
	7T 7T 8T 8.8		6.1-8.3	8.3-11.3			
	10T 10T 11T		8.7-11.6	11.8-15.7			
M8	4T	1.25	9.4-12.3	12.7-16.7	1.0	11.2-14.8	15.2-20.1
	7T		16.6-21.0	22.6-28.4		19.5-25.3	26.5-34.3
	10T		21.0-26.8	28.4-36.3		22.4-29.7	30.4-40.2
M10	4T	1.5	18.8-24.6	25.5-33.3	1.25	21.0-26.8	28.4-36.3
	7T		32.5-41.2	44.1-55.9		36.2-46.3	49.0-62.8
	10T		39.8-51.4	53.9-69.9		42.7-54.2	57.9-73.5
M12	4T	1.75	27.5-34.7	37.3-47.1	1.25	31.8-40.5	43.1-54.9
	7T		48.5-61.5	65.7-83.4		55.0-69.4	74.5-94.1
	10T		68.0-85.4	92.9-116		73.1-93.3	99.0-127
M14	4T	2.0	46.3-59.3	62.8-80.4	1.5	51.4-64.4	69.6-87.3
	7T		76.7-96.9	104-131		86.1-109	117-148
	11T		102-129	139-175		108-137	147-186
M16	4T	2.0	63.6-81.0	86.3-110	1.5	67.3-84.6	91.3-115
	7T		110-136	149-184		116-142	157-192
	11T		152-188	206-255		163-199	221-270
M18	4T	2.0	83.9-104	114-141	1.5	95.9-120	313-163
	7T		145-174	196-235		170-206	131-279
	11T		203-246	275-333		221-271	299-368
M20	4T	2.5	106-132	144-179	1.5	127-156	172-211
	7T		177-213	240-289		203-246	275-333
	11T		268-325	363-441		293-358	397-485