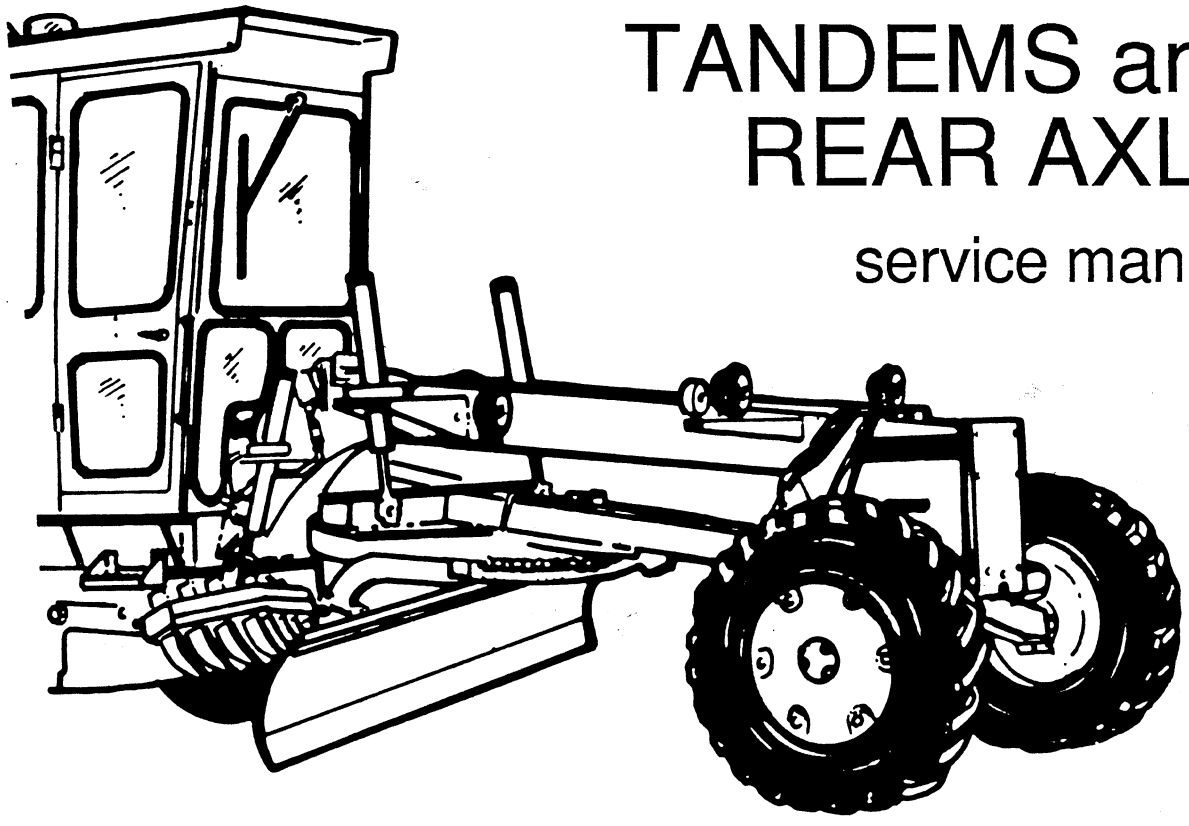
M100, 100-B
100-C, 150-C
200-C

motor graders



TANDEMS and REAR AXLE

service manual

FORM 70641623 English
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SAFETY RULES

Never use gasoline or solvent or other flammable fluid to clean parts. Use authorized commercial, non-flammable, non-toxic solvents.

Never place gasoline or diesel fuel in an open pan.

Shut off engine and be sure all pressure in system has been relieved before removing panels, housings, covers, and caps. See Operation and Maintenance Instruction Manual.

Do not remove hoses or check valves in the hydraulic system without first removing load and relieving pressure on the supporting cylinders. Turn radiator cap slowly to relieve pressure before removing. Add coolant only with engine stopped or idling if hot. See Operation and Maintenance Instruction Manual.

Fluid escaping under pressure from a very small hole can almost be invisible and can have sufficient force to penetrate the skin. Use a piece of card board or wood to search for suspected pressure leaks. *DO NOT USE HANDS.* If injured by escaping fluid, see a doctor at once. Serious infection or reaction can develop if proper medical treatment is not administered immediately.

Never use any gas other than dry nitrogen to charge accumulators. See Operation and Maintenance Instruction Manual.

When making pressure checks use the correct gauge for expected pressure. See the Operation and Maintenance Instruction Manual or Service Manual for guidance.

For field service, move machine to level ground if possible and block machine. If work is absolutely necessary on an incline, block machine and its attachments securely. Move the machine to level ground as soon as possible.

Brakes are inoperative when manually released for servicing. Provision must be made to maintain control of the machine by blocking or other means.

Block all wheels before bleeding or disconnecting any brake system lines and cylinders.

Never use make shift jacks when adjusting track tension. Follow the Undercarriage Service Manual.

Know your jacking equipment and its capacity. Be sure the jacking point used on the machine is appropriate for the load to be applied. Be sure the support of the jack at the machine and under the jack is appropriate and stable. Any equipment up on a jack is dangerous. Transfer load to appropriate blocking as a safety measure before proceeding with service or maintenance work according to local or national requirements.

Always block with external support any linkage or part on machine that requires work under the raised linkage, parts, or machine per local or national requirements. Never allow anyone to walk under or be near unblocked raised equipment. Avoid working or walking under raised blocked equipment unless you are assured of your safety.

When servicing or maintenance requires access to areas that cannot be reached from the ground, use a ladder or step platform that meets local or national requirements to reach the service point. If such ladders or platforms are not available, use the machine hand holds and steps as provided. Perform all service or maintenance carefully.

Shop or field service platforms and ladders used to maintain or service machinery should be constructed and maintained according to local or national requirements.

Lift and handle all heavy parts with a lifting device of proper capacity. Be sure parts are supported by proper slings and hooks. Use lifting eyes if provided. Watch out for people in the vicinity.

In lifting and handling heavy parts, slings must be of adequate strength for the purpose intended and must be in good condition.

Handle all parts with extreme care. Keep hands and fingers from between parts. Wear authorized protective equipment such as safety glasses, heavy gloves, safety shoes.

When using compressed air for cleaning parts use safety glasses with side shields or goggles. Limit the pressure to 207 kPa (30 psi) according to local or national requirements.

Wear welders protective equipment such as dark safety glasses, helmets, protective clothing, gloves and safety shoes when welding or burning. Wear dark safety glasses near welding. *DO NOT LOOK AT ARC WITHOUT PROPER EYE PROTECTION.*

Replace seat belts every two years on open canopy units and every three years on machines with cabs or at change of ownership.

Wear proper protective equipment such as safety goggles or safety glasses with side shields, hard hat, safety shoes, heavy gloves when metal or other particles are apt to fly or fall.

Use only grounded auxiliary power source for heaters, chargers, pumps and similar equipment to reduce the hazards of electrical shock.

Keep maintenance area *CLEAN* and *DRY.* Remove water or oil slicks immediately.

Remove sharp edges and burrs from reworked parts.

Be sure all mechanics tools are in good condition. *DO NOT* use tools with mushroomed heads. Always wear safety glasses with side shields.

Do not strike hardened steel parts with anything other than a soft iron or non-ferrous hammer.

Do not rush. Walk, do not run.

Know and use the hand signals used on particular jobs and know who has the responsibility for signaling.

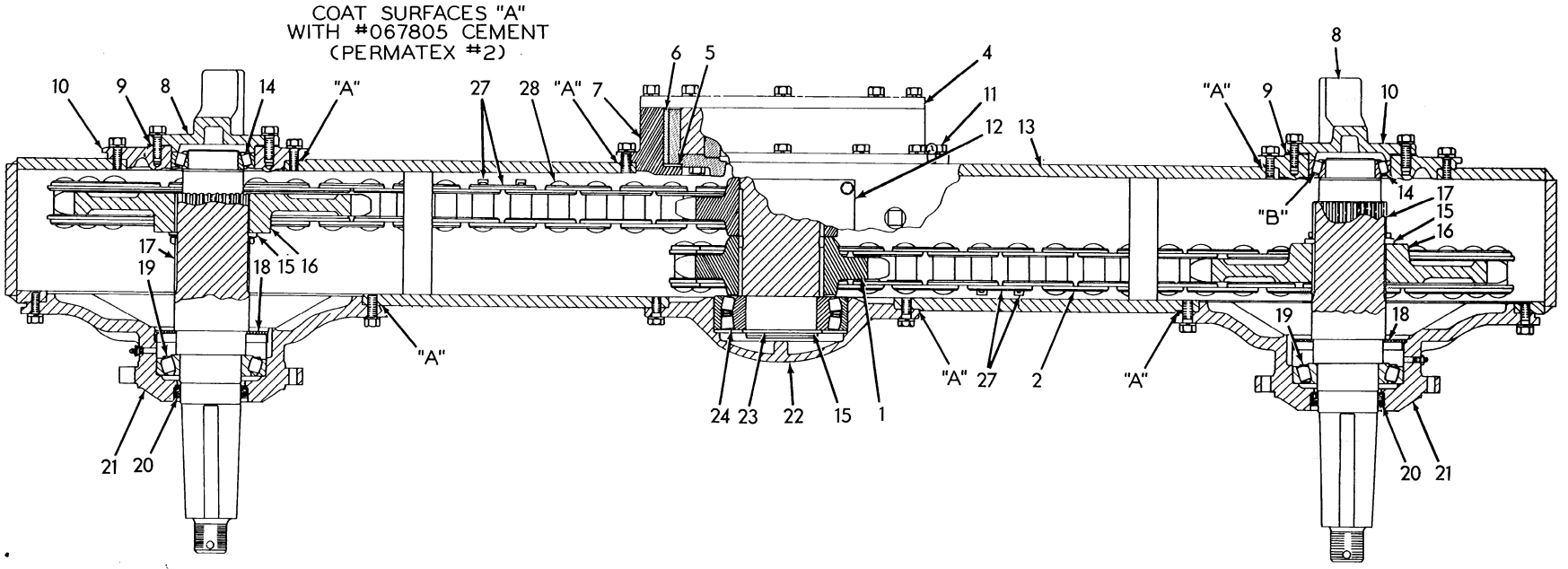

Fig. 4 Tandem (Eff. S/N 1704)
(T-73646)

1. Sprockets, drive
2. Chain, driving, outer
3. O-ring, sealing (shown only in Fig. 4)
4. Ring, tandem retaining
5. Washers, thrust
6. Bushing, hub
7. Hub
8. Tandem stop
9. Shims (.005" and .010")
10. Eccentrics, inner
11. Vent, air
12. Access cover and gasket
13. Case
14. Bearing cup and cone; inner
15. Lock plates
16. Sprockets, wheelshaft
17. Wheelshafts
18. Seal, inner oil
19. Bearing cup and cone, outer
20. Seal, outer oil
21. Eccentrics, outer
22. Carrier, bearing
23. Snap ring
24. Bearing, outboard
25. Cover, access (not shown in Fig. 4)
26. Gasket (not shown in Fig. 4)
27. Chain master link
28. Chain, driving, inner

Legend for Fig. 18

*1. Nut, axle
*2. Pin, cotter
*3. Washer
(*Eff. S/N 1704, one snap ring replaces these parts)
4. Sleeve, outer oil seal
5. Seal, outer oil
6. Bearing cone, outer
7. Bearing cup, outer
8. Cap, bearing retaining
8a. Washer, thrust
8b. Ring, tandem retaining
8c. O-ring
(Eff. S/N 1704 only)
9. Bearing cone, inner
10. Bearing cup, inner
11. Seal, inner oil
12. Cover, left bearing
13. Pinion, cross shaft
14. Bearing cone
15. Shims, bearing adjusting
16. Bearing cup
17. Housing, cross shaft
18. Carrier, pinion
19. Seal, pinion oil
20. Pinion, bevel
21. Pin, cotter
22. Nut, pinion
23. Shims, bearing adjusting
24. Gear, pinion drive
25. Bearing cone, front
26. Bearing cup, front
27. Shims, pinion adjusting
28. Bearing cone, rear
29. Bearing cup, rear
30. Pipe plug
31. Bevel gear, cross shaft
32. Key
33. Bearing cup
34. Bearing cone
35. Washer
36. Cover, right bearing
37. Washer, spacing
38. Gaskets, shimming (.015" and .020")
39. Same as item 9
40. Same as item 10
41. Vent, housing
42. Plugs, oil drain (end compartments)
43. Plug, oil level and filler (end compartments)
44. Housing, axle
45. Plug, drain (center compartment)
46. Plug, oil level and filler (center compartment)
47. Drive gear, rear axle
48. Sleeve, inner oil seal
49. Shims, bearing adjusting
50. Shaft, rear axle

Rear axle housing assembly contains axle shafts, inner, and outer bearings, outer bearing retaining caps, and axle driving gear. Axle driving gear is supported by axle shafts and axle shaft bearings. Axle housing has three separate, sealed, oil compartments. The two end compartments are for right and left axle bearings; center compartment is for axle driving gear, cross shaft pinion, bevel gear, bevel pinion, cross shaft bearings, and bevel pinion rear bearing.

Procedure for removal of rear axle assembly components from grader for disassembly and repair may vary according to specific type of repair necessary and may also vary depending on facilities and equipment available.

It is possible to remove and repair certain components of rear axle assembly without a complete tear down. For example, cross shaft housing assembly may be removed by first removing transmission; also, rear axle shafts and bearings may be removed and replaced by first removing corresponding tandem assembly, or complete tandem and rear axle assembly may be removed as a unit.

B. REMOVAL OF CROSS SHAFT HOUSING ASSEMBLY

1. Remove transmission (refer to transmission service manual)

2. Drain center compartment of rear axle assembly.

3. Remove front covers from seat and tank assembly; remove seat and seat frame; remove battery hold downs; remove seat adjusting latch mechanism; remove batteries and battery boards; remove center battery supporting brace.

4. Remove capscrews attaching shifting lock mechanism bracket to engine clutch housing, and lift bracket and mechanism up and to the rear.

5. Lower suitable hoist down through open space where seat and seat frame, batteries, etc. were removed. Refer to Fig. 19, and attach a suitable length of chain to each side of cross shaft housing under bearing cover capscrews.

6. Attach hoist to lift chain and raise cross shaft housing just enough to take weight of housing off of mounting studs.

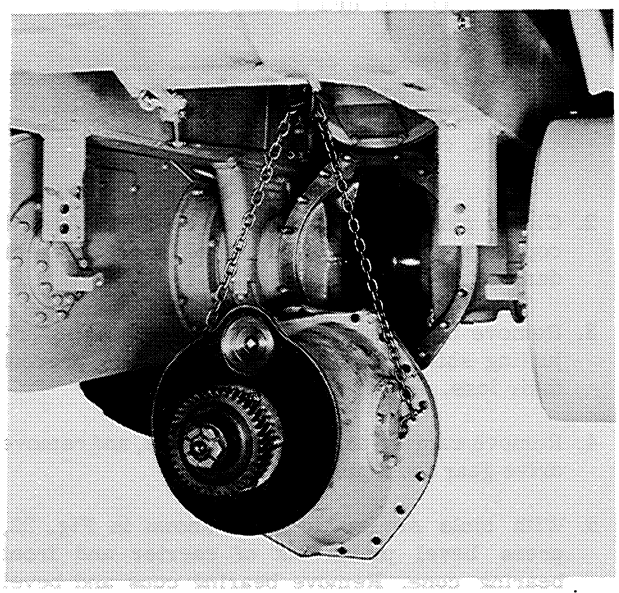

Fig. 19 Removing Cross Shaft Housing Assembly (T-39437)

stone. Try mating components on shaft splines to be sure they slide freely on splines.

Check bearing journals to be certain they are smooth and within specified tolerances.

C. OIL SEALS

1. When any work has been done which involves removal of a shaft from an oil seal, or removal of an oil seal from shaft, the sealing lip of seal must be carefully examined.

2. The sealing lip must not be scratched, folded over, torn, or charred from heat. The lip must be flexible; the spring, located inside (under) lip, must have proper tension to return lip to its proper position when lip is pressed in by hand.

3. When installing an oil seal on a shaft, or a shaft through a seal, be sure to protect sealing lip from damage which might be caused from keyway, splines, threads, or hole through shaft. A scratch or cut, or a fold in lip of seal, will render seal useless.

4. Before installing a seal in its bore, coat bore with liquid-type gasket cement, (unless specifically stated to the contrary).

5. Always lubricate lip of seal with clean oil at assembly.

D. GASKETS

When a gasket is removed, clean and inspect it for damage. If it is in good condition and is to be used again, immerse it in container of clean oil and keep it in container until it is needed. Do not use a gasket which is torn, hardened, or shrunken out of shape.

E. GEARS

1. Clean and inspect all gears for worn, pitted, chipped, or cracked teeth.

2. Check internal splines for galling, roughness, and wear, and be certain gears slide freely onto shaft splines.

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SUPPLEMENT NO. 6

SERVICE MANUAL FORM 70645121

10000, 11000, 11000 MKII, 685T ENGINES

(5-80)

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Reason: Update and revise service tools and procedures.

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SAFETY RULES

Never travel a machine on a job site, in a congested area, or around people without a signal person to guide the operator.

In darkness, check area of operation carefully before moving in with machine. Use all lights provided. Do not move into area of restricted visibility.

Maintain clear vision of all areas of travel or work. Keep cab windows clean and repaired. Carry blade low for maximum visibility while traveling. Obtain and use fan blast deflectors where tractors are used a pusher tractors in tandem.

Transport a loaded bucket with the bucket as far tipped back and in as low a position as possible for maximum visibility, stability, and safest transport of the machine. Carry it at a proper speed for the load and ground conditions.

Carry the bucket low when traveling with a load.

Maintain a safe distance from other machines. Provide sufficient clearance for ground and visibility conditions. Yield right-of-way to loaded machines.

Avoid going over obstacles such as rough terrain, rocks, logs, curbs, ditches ridges, and railroad tracks whenever possible. When obstructions must be crossed, do so with extreme care at an angle if possible. Reduce speed - down-shift. Ease up to the break over point - pass the balance point slowly on the obstruction and ease down on the other side.

Cross gullies or ditches at an angle with reduced speed after insuring ground conditions will permit a safe traverse.

Be alert to soft ground conditions close to newly constructed walls. The fill material and weight of machine may cause the wall to collapse under the machine.

Operate at speeds slow enough to insure complete control at all times. Travel slowly over rough ground, on slopes or near drop offs, in congested areas or on ice or slippery surfaces.

Be alert to avoid changes in traction conditions that could cause loss of control. *DO NOT* drive on ice or frozen ground conditions when working the machine on steep slopes or near drop offs.

Keep the machine well back from the edge of an excavation.

Be especially careful when traveling up or down slopes. Position the bucket in such a way as to provide a possible anchorage on the ground in case of a slide.

When proceeding across a hill side proceed slowly. Never turn sharply up hill or down hill.

Avoid side hill travel whenever possible. Drive up and down the slope. Should the machine start slipping sideways on a grade, turn it immediately downhill.

In steep down hill operation, do not allow engine to over speed. Select proper gear before starting down grade.

There is no substitute for good judgement when working on slopes.

The grade of slope you should attempt will be limited by such factors as condition of the ground, load being handled, the type of machine, speed of machine and visibility.

NEVER COAST the machine down grades and slopes with the transmission in neutral on power shift machines, or clutch disengaged on manually shifted machines.

To reduce the danger of uncontrolled machine, choose a gear speed before proceeding down grade that will hold machine to proper speeds for conditions.

Operating in virgin rough terrain that includes previously mentioned hazards is called pioneering. Be sure you know how this is done. Danger from falling branches and upturning roots is acute in these areas.

When pushing over trees, the machine must be equipped with proper over head guarding. Never allow a machine to climb up on the root structure particularly while the tree is being felled. Use extreme care when pushing over any tree with dead branches.

Avoid brush piles, logs or rocks. *DO NOT DRIVE THE MACHINE ONTO BRUSH PILES, LOGS, LARGE ROCKS* or other surface irregularities that break traction with the ground especially when on slopes or near drop offs.

Avoid operating equipment too close to an over hang or high wall either above or below the machine. Be on the look out for caving edges, falling objects and slides. Beware of concealment by brush and under growth of these dangers.

Park in a non-operating and non-traffic area or as instructed. Park on firm level ground if possible. Where not possible, position machine at a right angle to the slope, making sure there is no danger of uncontrolled sliding movement. Set the parking brake.

Never park on an incline without carefully blocking the machine to prevent movement.

If parking in traffic lanes cannot be avoided, provide appropriate flags, barriers, flares and warning signals as required. Also provide advance warning signals in the traffic lane of approaching traffic.

Move the machine away from pits, trenches, overhangs and over head power lines before shutting down for the day.

When stopping operation of the machine for any reason, always return the transmission or hydrostatic drive control to neutral and engage the control lock to secure the machine for a safe start up. Set parking brake, if so equipped.

Never lower attachments or tools from any position other than seated in operator's seat. Sound the horn. Make sure the area near the attachment is clear. Lower the attachment slowly. *DO NOT USE* float position to lower hydraulic equipment.

SECTION 2 - COOLING SYSTEM

Study SAFETY RULES, pages I thru III, thoroughly for the protection of personal and machine safety.

G. FAN BELT TIGHTENER REMOVAL, DISASSEMBLY, AND INSPECTION

1. FAN BELT TIGHTENER REMOVAL, DISASSEMBLY, AND INSPECTION (TRACK-TYPE TRACTORS) Fig. 9

   a. Loosen tension on fan belts.

   b. Remove nut (15) and lockwasher (14) from slide clamping bolt (10) and remove fan belt tightener from fan mounting bracket.

   c. Remove pulley cover (3) and gasket (4).

   d. Remove front snap ring (6).

   e. Place tightener assembly in a press, pulley side up, and press fan belt tightener slide (16) from pulley (5).

   f. Remove oil seal (9) and rear snap ring (8) and drive or press ball bearing (7) from pulley (5).

   g. Wash all parts thoroughly in clean solvent or fuel and inspect parts for wear or damage. Rotate ball bearing by hand and check for looseness, roughness, and binding. Replace if necessary. The bearing must fit snugly in pulley and on slide shaft. Inspect the fan belt slide tightener and make certain it is in good condition and that the grease passage is clean. Make certain that grooves in pulley are smooth and that pulley is not chipped or cracked. Replace fan drive belts if they are worn or frayed.

2. FAN BELT TIGHTENER REMOVAL, DISASSEMBLY, AND INSPECTION (MOTOR GRADERS) Fig. 10

   a. Remove the fan hub.

   b. Remove locking clamp capscrew (17), lockwasher (16), and locking clamp (15).

   c. Pull fan belt tightener assembly from fan mounting bracket (12).

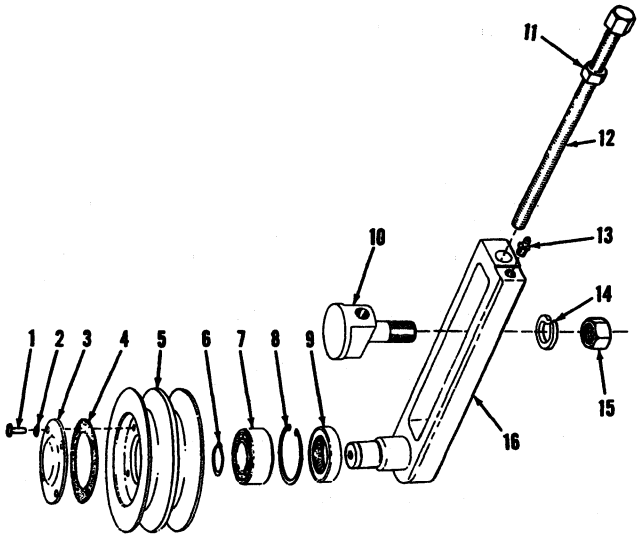

Fig. 9—Fan Belt Tightener Details
(Track-Type Tractors)
(T-70421)

1. Capscrew
2. Lockwasher
3. Pulley Cover
4. Gasket
5. Pulley
6. Front Snap Ring
7. Ball Bearing
8. Rear Snap Ring
9. Oil Seal
10. Slide Clamp Bolt
11. Jam Nut
12. Fan Belt Adjustment Screw
13. Lubricating Fitting
14. Lockwasher
15. Nut
16. Fan Belt Tightener Slide

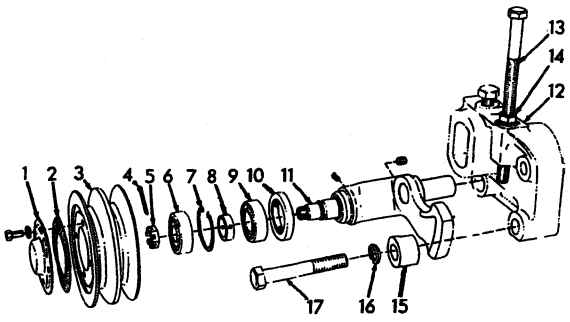

Fig. 10 — Fan Belt Tightener Details
(Motor Graders)
(T-14062)

1. Pulley Cover
2. Gasket
3. Pulley
4. Cotter Pin
5. Slotted Nut
6. Front Ball Bearing
7. Snap Ring
8. Bearing Spacer
9. Rear Ball Bearing
10. Oil Seal
11. Lever Assembly
12. Fan Mounting Bracket
13. Fan Belt Adjustment Screw
14. Jam Nut
15. Locking Clamp
16. Lockwasher
17. Locking Clamp Capscrew

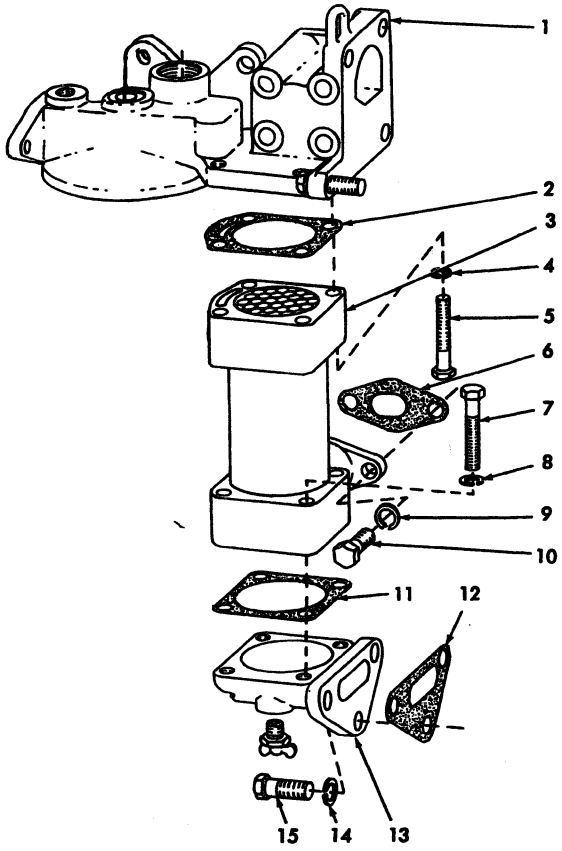

Fig. 13—Engine Oil Cooler Details (Track-Type Tractors) (T-41946)

1. Oil Filter Head Assembly
2. Gasket
3. Engine Oil Cooler
4. Lockwasher
5. Capscrew
6. Gasket
7. Capscrew
8. Lockwasher
9. Lockwasher
10. Capscrew
11. Gasket
12. Gasket
13. Adapter
14. Lockwasher
15. Capscrew

attaching oil cooler (4) to water inlet connection (6).

d. Remove capscrews (17) (18) and lockwasher (16) (19) and remove engine oil cooler (4) and water outlet connection (1) from the engine as an assembly. Remove gaskets (2) and (5).

e. Remove capscrews (14) and lockwashers (15) and remove outlet connection (1) and gasket (3) from oil cooler (4).

3. ENGINE OIL COOLER REMOVAL (TRACTOR LOADERS)

Refer to "TORQUE CONVERTER OIL COOLER REMOVAL (TRACTOR LOADERS)" in this Topic.

4. TRANSMISSION, TORQUE CONVERTER, AND/OR ENGINE CLUTCH OIL COOLER REMOVAL (TRACK-TYPE TRACTORS) Fig. 15

The front and rear covers (10) (1) are the same on all engines used in track-type tractors, however, the type of oil cooler used depends upon the engine application. The various oil coolers used are illustrated in Fig. 15 and the following removal procedure applies to all.

a. Drain cooling system.

b. Disconnect hose (15).

c. Disconnect all external hoses from the transmission, torque converter and/or engine clutch oil cooler.

d. Remove capscrews and lockwashers attaching front cover (10) to oil cooler(s).

e. Remove nuts, capscrew and lockwashers attaching front cover (10) to cylinder block and remove front cover spacing washer (14), and gaskets (13) and (11) or (7).

f. Remove capscrews and lockwashers attaching oil cooler(s) to rear cover (1) and remove oil cooler(s).

5. TORQUE CONVERTER OIL COOLER REMOVAL (TRACTOR LOADERS) Fig. 16

a. Drain cooling system.

b. Disconnect all external hoses from the oil cooler(s).

c. Remove capscrews and lockwashers attaching water outlet connection (1) to oil cooler(s) and cylinder block and remove water outlet connection and gasket (2).

d. Remove capscrews and lockwashers attaching oil cooler(s) to water inlet connection (4) and remove oil cooler(s).

6. TRANSMISSION, TORQUE CONVERTER, AND ENGINE OIL COOLER (12G CRAWLER LOADER AND 745 WHEEL LOADER) Fig. 16A

a. Drain cooling system.

b. Disconnect all external hoses and tubes from oil coolers.

SECTION 3 - ELECTRICAL SYSTEM

TOPIC 1 - GENERAL

The electrical system, which includes the starter, generator (or alternator), generator regulator (or alternator regulator), batteries, and ammeter, is a 24 volt system throughout. Current is supplied by wet cell storage batteries. Three circuits work together to supply the needed electrical energy.

A. CHARGING CIRCUIT

The basic units of the charging circuit are the batteries, generator, and generator regulator. The batteries are the storage plant for electrical energy and must be kept fully charged while using a minimum amount of water. Refer to the "Operator's Manual", furnished with the unit, for battery testing information.

Electrical energy, drained from the batteries, is replaced by the generator. Too much generator output will usually burn out the generator or damage the batteries so they will not hold a charge. To prevent this, a generator regulator is connected into the circuit.

B. CRANKING CIRCUIT

The basic units of the cranking circuit are the batteries, starter, solenoid switch, and a remote control switch. The remote control switch completes the circuit between the batteries and solenoid switch. As current flows through the solenoid, the drive pinion of the starter is shifted into mesh with the flywheel ring gear, the main contacts in the solenoid close, connecting the batteries directly to the starter which turns the engine. When the engine starts and the remote control switch (starter button or ignition key) is released, the solenoid contacts open and the drive pinion is automatically disengaged. To prevent overheating and damage, never operate the starter for more than 30 seconds at a time.

C. ACCESSORY CIRCUIT

The accessory circuit is composed entirely of current-consuming devices such as lights, horn, heaters, etc. In this circuit, good connections at junction points, fuses, switches, and circuit breakers, are important to prevent voltage losses which will reduce the efficiency of operation.

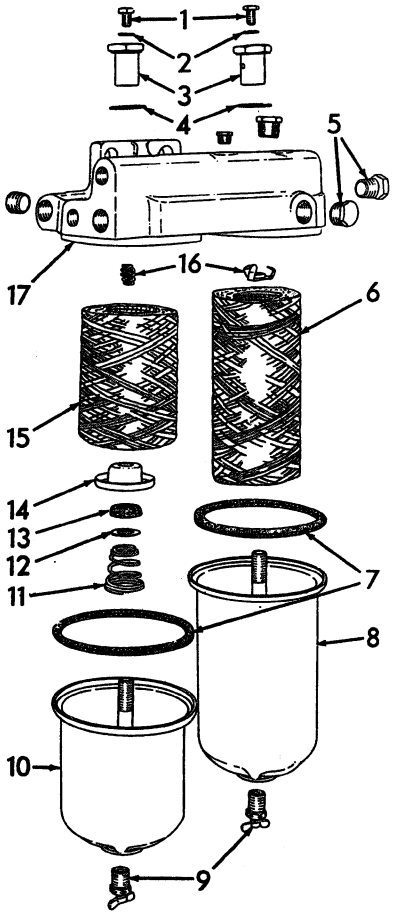

Fig. 5 — Fuel Filter Details (T-22578)

1. Vent Screws
2. Copper Washers
3. Shell Retaining Nuts
4. Gaskets
5. Hex-Head Pipe Plugs
6. First Stage Fuel Filter Element
7. Filter Shell Gaskets
8. First Stage Fuel Filter Shell
9. Drain Cocks
10. Second Stage Fuel Filter Shell
11. Element Spring
12. Metal Washer
13. Element Seating Plate Gasket
14. Element Seating Plate
15. Second Stage Fuel Filter Element
16. Element Centering Guides
17. Filter Head

NOTE

Close the fuel tank shut-off valve.

b. Loosen retaining nut (3), in the filter head, until it is free from shell centerbolt and remove shell from filter head.

c. Remove and discard filter element (15). Remove centering guide (16), element seating plate (14), seating plate gasket (13), and metal washer (12) from the shell centerbolt. Discard seating plate gasket (13), metal washer (12), and shell gasket (7).

d. Thoroughly wash and dry interior of filter shell. Close and tighten drain cock (9).

e. Place element spring (11), large end downward, in position on shell centerbolt and install a new metal washer (12) over the shell centerbolt and down onto element spring.

f. Install a new seating plate gasket (13) in position in element seating plate (14) then install element seating plate in position on shell centerbolt.

NOTE

When installing element seating plate and gasket on shell centerbolt, install seating plate so that the gasket contacts the metal washer.

g. Install centering guide (16) in position near the top of shell centerbolt and install a new filter element (15) in position in the filter shell. Install a new shell gasket (7) in position in lip of filter shell.

h. Fill filter shell with CLEAN fuel. Hold filter shell in position under filter head, and install retaining nut (3) and gasket (4). Tighten the nut securely.

NOTE

After replacing filter elements, vent fuel system (refer to "VENTING OF FUEL SYSTEM" in this Section).

B. FUEL FILTER HEAD (Fig. 5)

The fuel filter head (17) is a manifold to collect and distribute fuel and also serves as a holder for the filter elements and filter shells.

To remove fuel filter head from the engine, when dismantling of filters or element replacement is not required, use the following procedure:

1. Clean the area around filter head and shells. Loosen vent screws (1) in the top of the filter head, and drain cocks (9) in the bottom of the shells, allowing the filter shells to drain completely.

NOTE

Close fuel tank shut-off valve.

2. Disconnect all hoses necessary to permit re-

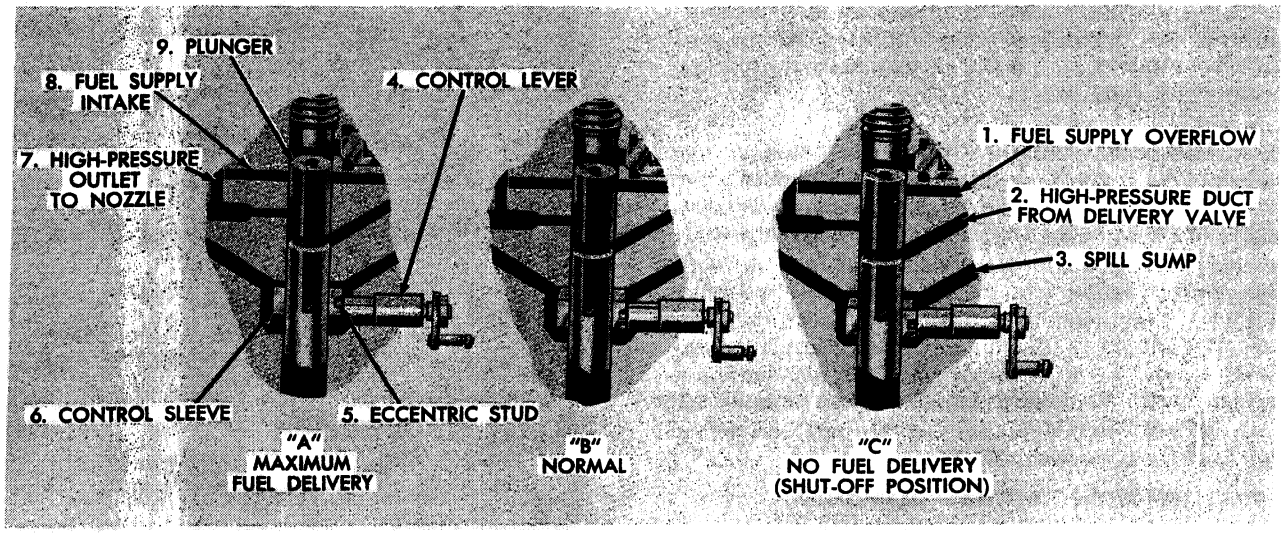

Fig. 22 — Fuel Injection Pump Control Sleeve Positions (T-29549)

the intake ports), for as the spill annulus on the plunger breaks over the top edge of the control sleeve, pumping pressure is relieved down through the center hole of the plunger and out into the sump surrounding the control sleeve, and delivery terminates despite the continued upward movement of the plunger.

If the control sleeve position is raised, the spill annulus on the plunger remains covered by the sleeve until relatively late in the plunger stroke, hence the effective fuel delivery stroke of the plunger is longer and more fuel is delivered "A". If the control sleeve position is lowered, the spill annulus on the plunger is uncovered by the sleeve relatively sooner in the plunger stroke, hence the effective fuel delivery stroke of the plunger is shorter and less fuel is delivered, "B". The position of the control sleeve is controlled by governor movement transmitted by an internal control rod connecting the fulcrum lever of the governor to the sleeve control lever (4) of the fuel injection pump.

When the control sleeve is lowered to its extreme point, "C". The spill annulus on the plunger is uncovered by the top edge of the sleeve before the upper end of the plunger can cover the intake ports. Under this condition, no pressure can build up even after the ports are closed, hence no fuel can be delivered by the plunger. This is the fuel shut-off position.

C. FUEL INJECTION PUMP SERVICE

In most cases, malfunctioning of the fuel injection equipment is the direct result of dirty fuel. Dirt in the fuel causes rapid wear on the precision parts, particularly the plunger, hydraulic head, control sleeve, delivery valves and seats, and the fuel injection nozzle valves and valve bodies. Therefore, extreme care should be used in the storage and handling of fuel to prevent the entrance of dirt, water, and abrasive particles. Any water or sediment should be drained from the fuel filters daily.

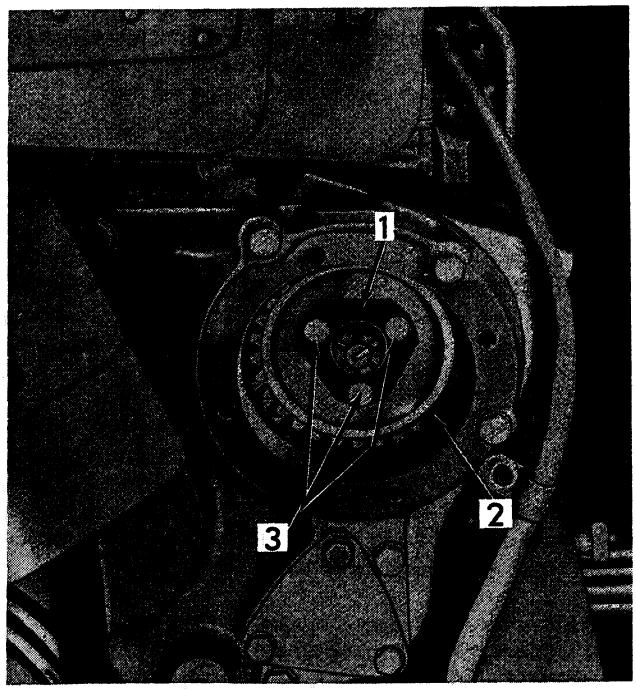

Fig. 23 — Fuel Injection Pump Drive Gear Installed (Engines Without Fan Drive Pulley) (T-15281)

1. Serrated Plate
2. Fuel Injection Pump Drive Gear
3. Gear Attaching Capscrews

Study SAFETY RULES, pages I thru III, thoroughly for the protection of personal and machine safety.

5. Daily, drain the water from the fuel tank.

6. Periodically check injection pump timing.

7. Keep all fuel line connections, filter, injection pump and injection nozzle assemblies tightened. securely to the engine.

8. Before removing any part of the fuel injection system from the engine be sure to wash the part with cleaning solvent, also the surrounding area to prevent the entrance of abrasives into the system. COVER ALL OPENINGS IMMEDIATELY.

TOPIC 2 - CHECKING FUEL SYSTEM

"Missing" or uneven running of the engine, excessive vibration, stalling when idling, and loss of power are indications of insufficient fuel supply to the engine. Before performing any of the following checks, make certain there is an ample supply of the proper fuel in the tank and the fuel tank shutoff valve is open.

A. CHECK FOR CLOGGED FUEL FILTERS AND CLOGGED OR COLLAPSED FUEL LINES

1. Install a vacuum gauge in fuel supply line as close to fuel pump inlet as possible. Make sure that connection is made with pipe compound or a similar sealant to prevent air entering at this point.

2. Install a fuel shut-off valve(if one is not available on the tractor) close to the fuel tank in the fuel supply line.

3. Operate the Engine under a loaded condition as near full load as possible, with the fuel shut-off valve in the open position.

4. If the vacuum reading on the gauge exceeds 8" of mercury, some restriction is indicated,such as dirty fuel filters,or fuel supply line plugged or crimped. The fuel filters should be replaced, and all low pressure fuel lines blown out with filtered compressed air. If a reading in excess of 8 inches of mercury is still present, all low pressure fuel lines should be checked for clogging, crimping, etc., and cleaned or replaced.

B. CHECK FOR AIR LEAKS AND FUEL TRANSFER PUMP SUCTION MALFUNCTION

While operating the engine at no load, low idle speed, close the supply line valve. The vacuum gauge should indicate approximately 18 inches of mercury, just before the engine stalls out. This vacuum should remain for several minutes after the engine has stalled.

1. If slight vacuum only is registered(below 15" of mercury) and remains after the engine is stopped, a defective transfer pump is indicated.

2. If slight vacuum is registered and disappears rapidly after the engine stops, a suction-side air leak in the low pressure fuel supply system is indicated.

C. CHECK FOR INADEQUATE FUEL TRANSFER PUMP PRESSURE

If checks listed above in A and B have been performed without indication of a problem, and the engine is still erratic, check the operation of the fuel transfer pump and end plate pressure regulating valve. Operate the engine until normal operating temperature is reached, then shut off the engine. Remove plug marked OUT in bottom of end plate,opposite the fuel inlet,and install a pressure gauge. With the key switch in the OFF position, and the throttle in the idle position, crank the engine with the starter. A minimum of 10 psi should register on the gauge. If it does not, check for malfunction in the end plate and transfer pump parts.

D. CHECK FOR MALFUNCTION OF HIGH PRESSURE FUEL LINES AND/OR FUEL INJECTION NOZZLES

1. To check the high pressure lines between the pump and fuel injection nozzles, start the engine and loosen the line nuts (one at a time) at the nozzles. If no fuel is observed at the loosened line nut, the line may be clogged, crimped or cracked. In any case, the line must be replaced.

   Check the fuel strainer in the end-plate of the injection pump. Remove any foreign matter if the screen is clogged.

2. To check fuel injection nozzles, operate the engine at low idle speed, and "cut-out" each fuel nozzle in turn by loosening the line nut attaching the high pressure line to its corresponding fuel nozzle.

   A decrease in engine speed with the line nut loosened, indicates that the fuel nozzle for that cylinder is functioning properly.

   If the engine speed does not decrease, the fuel nozzle is inoperative and should be repaired or replaced.

E. CHECK FOR INOPERATIVE FUEL INJECTION PUMP

Do not replace the fuel injection pump before making a compression test. The compression test eliminates the possibility of burned or stuck valves, worn or scored pistons and sleeves, worn or stuck rings, etc., to be causing improper engine operation.

If all possible causes for insufficient fuel supply have been eliminated and the engine still runs uneven,,and normal engine performance is not obtained, the fuel injection pump may be at fault and should be checked, repaired or replaced.

IMPORTANT

Do not replace the fuel pump until making certain that all other possible causes for improper engine operations have been eliminated.

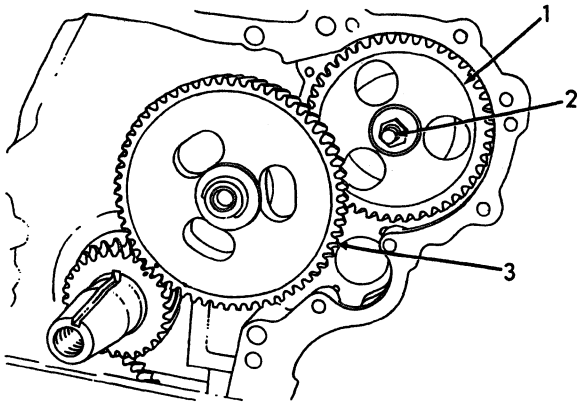

Fig. 11—Location of Fuel Pump Drive Gear (T-72703)

1. Fuel Pump Drive Gear
2. Thrust Button
3. Camshaft Gear

aged, place them in position in cover (5). If they are damaged, use new ones.

h. Place cover (5) in position on pump drive shaft. Install fuel injection pump on shaft and secure to cover with serrated washers (9) and nuts.

i. Position engine flywheel so that timing pointer, Fig. 5, indicates proper number of degrees B.T.D.C. for injection pump installation (refer to "INSTALLATION AND TIMING OF FUEL INJECTION PUMP" in this Topic).

j. Place spring and thrust button, Fig. 8, in position in end of pump shaft. Rotate the pump drive gear until the timing marks on the fuel injection pump are aligned, Fig. 4. Hold the gear in this position and carefully install the assembly on the timing gear housing so that pump drive gear meshes with the dual gear on the camshaft gear.

k. With cover, Fig. 7 (5), in position on timing gear housing, make certain pump timing marks are still aligned. Slight misalignment must be corrected by loosening the pump mounting stud nuts and rotating the pump, however, if misalignment is too great, remove the pump drive gear and reinstall it so that it meshes with the camshaft gear one tooth removed from the former position. Repeat until proper pump timing mark alignment is attained.

l. Install lockwashers and capscrews to secure pump mounting cover to timing gear housing. Tighten capscrews securely.

m. Install the timing window cover and gasket in position on the fuel injection pump.

n. Install and connect the fuel injection lines to their corresponding openings in the fuel injection pump and fuel injection nozzles.

o. Complete the installation by reversing the removal procedure.

p. Open the fuel supply shutoff valve and vent the fuel system.

G. GOVERNOR

1. GOVERNOR ADJUSTMENTS

Before changing the low idle or high idle speed settings, move the throttle control rod to its low and high speed positions and make certain that the throttle control rod moves the speed control lever of the pump through its full length of travel.

Refer to the OPERATING INSTRUCTIONS AND FIELD MAINTENANCE manual, furnished with the unit, for specified high and low idle engine speeds. Check the idle speed and the full-load speed. If it is necessary to adjust either, proceed as follows:

a. Operate engine until normal operating temperature is reached.

b. Disconnect the throttle-control from the speed control lever of the fuel injection pump so the lever can be moved by hand.

c. With the engine running, loosen the jam nut on the low-idle adjusting screw. Hold the speed-

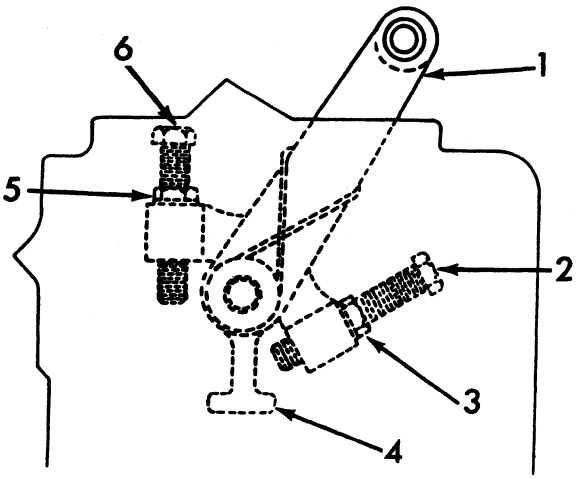

Fig. 12—Engine Speed Adjustment (T-50894)

1. Speed Control Lever (Spring Loaded)
2. Low Speed Adjustment Screw
3. Jam Nut
4. Lever Stop
5. Jam Nut
6. High Speed Adjustment Screw

The fuel injection pump governor assembly is lubricated by the engine lubricating system. No lubrication service on the injection pump and governor assembly is required.

Fiat-Allis dealers are equipped with fuel injection pump calibrating and test stands and the special tools required to test, adjust, and repair the fuel injection pump and governor assembly. Therefore, if at any time the fuel injection pump and governor assembly requires repairs or adjustment, the assembly should be removed and taken to your nearest Fiat-Allis dealer. It is important that the dealer be furnished with the injection pump serial number and the model and serial number of the unit so that the pump may be properly calibrated and the correct replacement pump or pump parts may be furnished.

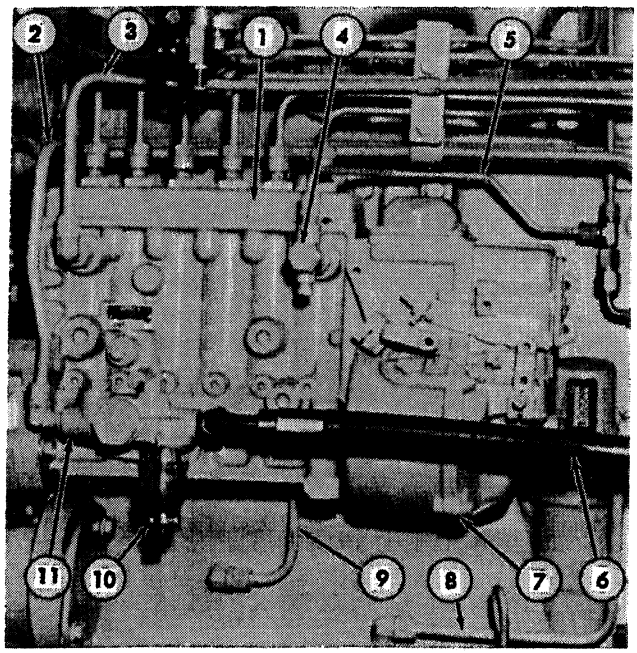

Fig. 4 Fuel Injection Pump and Governor—Bosch (Germany) (T-76387)

1. Fuel Injection Pump
2. Fuel Transfer Pump-to-Fuel Filter Line
3. Fuel Filter-to-Fuel Injection Pump Line
4. Pressure Relief Valve
5. Fuel Return Line
6. Fuel Supply Line
7. Governor
8. Lube Oil Return Line
9. Lube Oil Supply Line
10. Fuel Filter and Sediment Bowl
11. Fuel Transfer (Supply) Pump

C. FUEL INJECTION PUMP REMOVAL

1. Remove pipe plug, Fig. 5 (1). Rotate engine until timing marks on drive gear hub, Fig. 8 (3), and timing pointer are aligned (these marks are visible through the pipe plug hole). Aligning these marks will position the #1 piston on its compression stroke and facilitate pump installation.
2. If engine is so equipped, remove hydraulic pump located below fuel injection pump.
3. If engine is equipped with an hour meter located in the block at the rear of the injection pump, loosen the mounting screws and rotate it so the window is halfway between the injection pump and the rear tappet cover.
4. Shut off fuel supply and disconnect all low and high pressure fuel lines and lube oil supply and return lines. Remove capscrew securing line supporting bracket to cylinder block.
5. Disconnect throttle and stop control linkage from fuel injection pump.
6. Remove capscrew securing rear pump mounting bracket to cylinder block.
7. Remove capscrews securing pump mounting cover, Fig. 5 (4), to timing gear housing (5). Pull pump back and swing it away from the cylinder block just as the pump drive gear clears the timing gear housing. If removal of the pump at this point cannot be accomplished due to interference at the front valve lifter cover, remove cover to gain additional clearance.
8. If engine has a fan drive pully installed in front of injection pump extend timing mark from hub on to gear before loosening gear attaching capscrews. Remove gear from hub and pump from mounting cover.

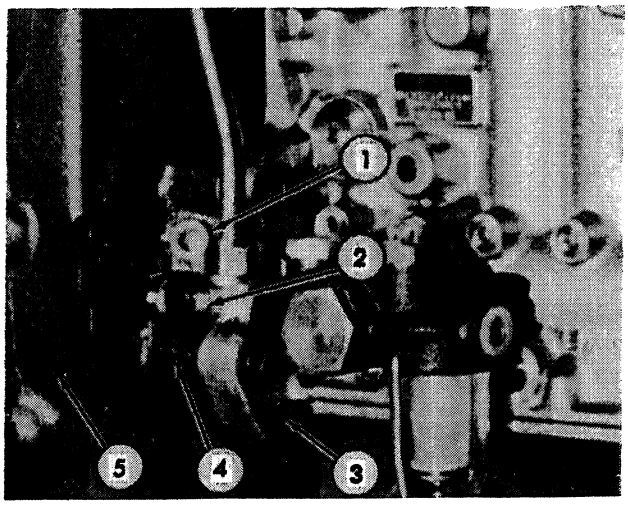

Fig. 5 Fuel Injection Pump Timing Window (T-76871)

1. Pipe Plug (Pump Timing Window)
2. Pipe Plug
3. Fuel Injection Pump
4. Pump Mounting Cover
5. Timing Gear Housing

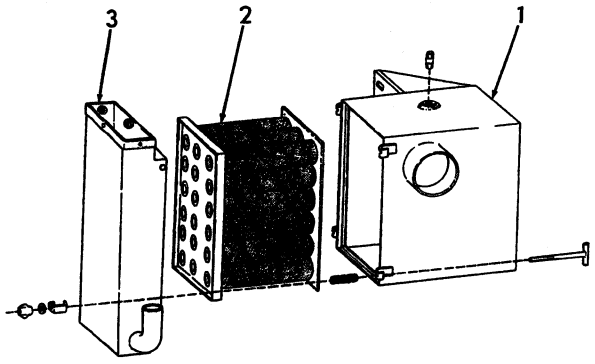

Fig. 4 — Air Cleaner (Type IV)
(T-72062)

1. Housing Assembly
2. Cartridge
3. Dyna-Panel Pre-Cleaner

particles of dirt which are then removed through a suction line and aspirator connected to the engine exhaust system. The pre-cleaned air is then drawn through the filter elements, removing the remaining dust. The cleaned air then passes through air tight hoses and/or tubes into the turbocharger and then into the intake manifold which directs the air into the cylinders.

B. AIR CLEANER SERVICE

Periodic inspection of air cleaner body for dents, cracks, etc. should be made frequently. Also check for damaged hoses, loose hose clamps, damaged gaskets or any kind of leak that allows air to enter engine cylinders without first passing through the air cleaner. If any of above conditions are found they MUST be corrected immediately.

A dirty air filter can greatly reduce the horsepower output of an engine. If unit is equipped with an air cleaner indicator, this will help to tell the condition of the air cleaner filter.

The detailed and correct procedure for replacing the air cleaner filter element can be found in the "Operating Instructions and Field Maintenance Manual" furnished with the unit.

C. PRESSURE TESTING AIR INTAKE SYSTEM FOR LEAKAGE

Whenever any work that involves partial or complete dismantling of the air intake system (such as removal of engine, turbocharger air cleaner, etc.) the air intake system should be pressure tested for leakage immediately after repair or replacement is completed. Also, if when the air filter cartridge is removed and any dust is found to be present in the inside of the filter housing, the system must be pressure tested immediately and the cause located and corrected.

1. The following equipment is required to pressure test the air intake system (refer to Fig. 5).
   a. Air tight rubberized or plastic material (3) to cover intake face of air cleaner or, on earlier model units, air cleaner intake pipe.
   b. Tire pump (1) or low pressure air supply (preferably equipped with a regulating valve).
   c. Pressure gauge (2) (that will read accurately at 5 psi).
   d. 1/4" pipe nipple (4).
   e. 1/4" pipe tee (5).
   f. Valve stem with 1/4" pipe plug (6) (not required if low pressure air supply with regulating valve is used).
   g. Adequate hose clamps if required.
2. Pressure test air intake system as follows:
   a. Position engine so that valves will not allow air to exhaust to atmosphere. On engines covered in this manual, this position is approximately 25° ATDC.

NOTE

Usually when the engine is cranked with the starter, the engine will stop at approximately 25° ATDC when the starter button is released.

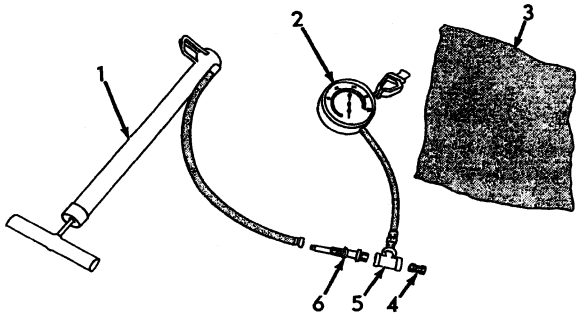

Fig. 5 — Equipment Required to Pressure Test Air Intake System
(T-71532)

1. Tire Pump
2. Pressure Gauge
3. Air Tight Rubberized or Plastic Material
4. 1/4" Pipe Nipple
5. 1/4" Pipe Tee
6. Valve Stem with 1/4" Pipe Plug

Study SAFETY RULES, pages I thru III, thoroughly for the protection of personal and machine safety.

Legend for Fig. 1

1. Head Assembly
2. Exhaust Valve Seat Insert
3. Intake Valve Seat Insert
4. Valve Guides
5. Fuel Injection Nozzle-Holder Sleeve
6. Exhaust Valve
7. Intake Valve
8. Cylinder Head Gasket (one pc. gasket eff. eng. s/n 11-25689)
9. Stud (1/2" x 7" and 1/2" x 8-5/8")
10. Stud (5/8" x 6-1/2")
11. Stud (1/2" x 6-1/8")
12. Stud (1/2" x 7-3/8")
13. Exhaust Valve Spring
14. Exhaust Valve Spring Retainer
15. Valve Spring Retainer Lock
16. Intake Valve Spring Retainer or Rotator
17. Intake Valve Outer Spring
18. Intake Valve Inner Spring
19. Intake Valve Indexing Locator
20. Nut (5/8" NF) - Nylock nuts for end studs only
21. Washer (For 5/8" stud)
22. Washer (For 1/2" stud)
23. Nut (1/2" NF)
24. Engine Lifting Eye
25. End Plate
26. Rocker Cover Gasket
27. Rocker Cover
28. Breather Tube
29. Hose Clamps
30. Hose
31. Breather Tube
32. Cylinder Sleeve Gasket (Used prior to eng. s/n 11-25689)

and cylinder block, and into the valve lifters which are held in valve lifter brackets. The valve lifters contact the lobes on the camshaft. The upper ends of the push rods are concave to receive the ends of the valve lash adjusting screws threaded into one end of the rocker arms. The other end of the rocker arm actuates the valve by the action of the push rod. When the push rod is forced upward by the camshaft lobe, the rocker arm is raised on one end and forces the other end down, opening the valve. The tension of the valve spring closes the valve when the push rod moves downward.

A horizontal and vertical oil passage through the center of the cylinder block extends from the main oil gallery to a cavity in the left side of the cylinder block. From this cavity there are two openings which align with an oil passage in each cylinder head, conveying the oil to a passage in the Nos. 3 and 4 rocker arm shaft brackets and to the hollow center of the rocker arm shafts which have oil holes at each rocker arm location.

NOTE

Engines prior to S/N 90846 have an oil restrictor located in the vertical oil passages in the cylinder block that restrict the flow of oil to the rocker arm shafts. Engines S/N 90846 and up do not have these restrictors and the Nos. 3 and 4 rocker arm shaft brackets have a restricted drilled oil passage leading to the rocker arm shafts.

The oil is forced out through the oil hole at each rocker arm location and into the drilled passage of each rocker arm providing lubrication for the rocker arm bushing. The oil spills down over the push rods and valve springs and drains back to the oil pan.

B. SERVICE OF VALVE MECHANISM

Service on some of the parts contained in the cylinder heads can be accomplished with the heads installed on the engine. For other service the heads must first be removed from the engine.

1. Operations which DO NOT require that the cylinder heads be removed are:
   a. Replacement of fuel injection nozzles.
   b. Adjustment of valves.
   c. Replacement of rocker arms or rocker arm shafts.
   d. Replacement of valve push rods.
   e. Replacement of valve lifters.
   f. Replacement of valve lifter brackets.
   g. Replacement of valve springs.
   h. Replacement of intake valve indexing locators.
2. Operations which DO require that the cylinder heads be removed are:
   a. Grinding, reseating, or replacement of valves.
   b. Replacement of valve guides.
   c. Replacement of valve seat inserts.
   d. Replacement of fuel injection nozzle sleeves.

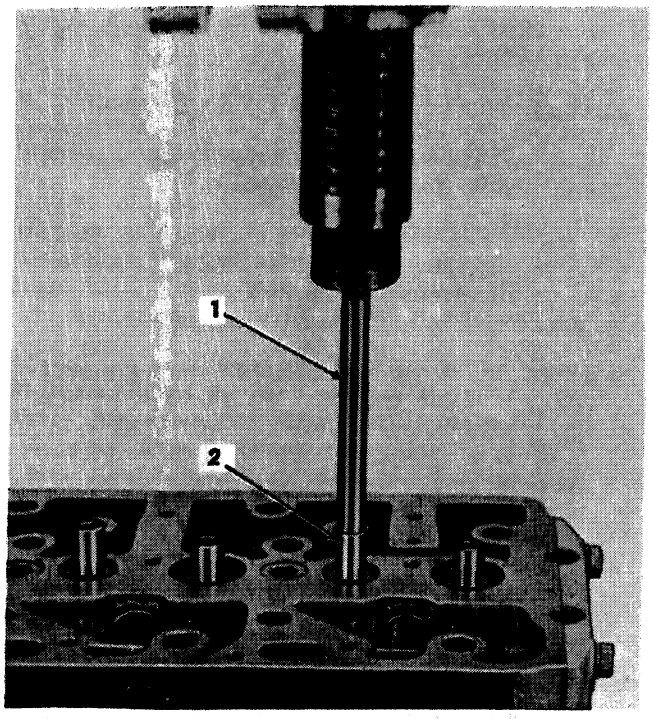

Fig. 15 — Removing Valve Guides
(T-27615)

1. Valve Guide Removing Tool
2. Valve Guide

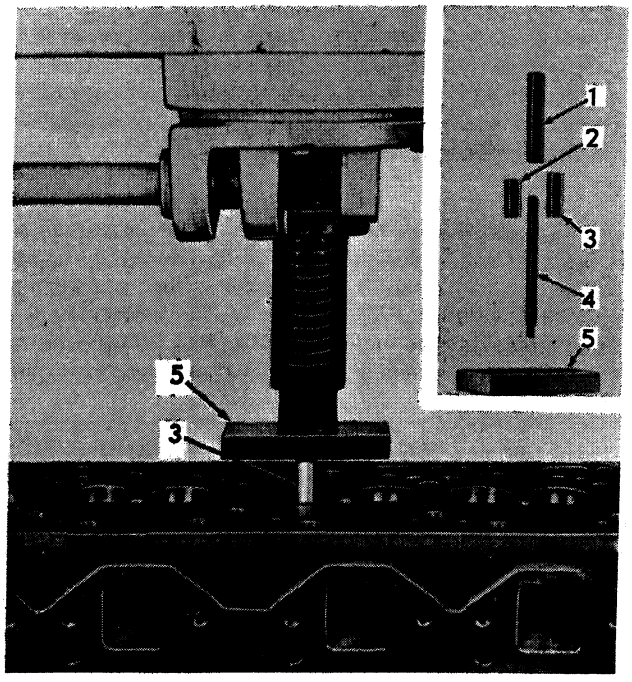

Fig. 16 — Installing Valve Guides
(T-29557 & T-29559)

1. Valve Guide
2. Valve Guide Adapter (Intake)
3. Valve Guide Adapter (Exhaust)
4. Guide Pilot
5. Plate

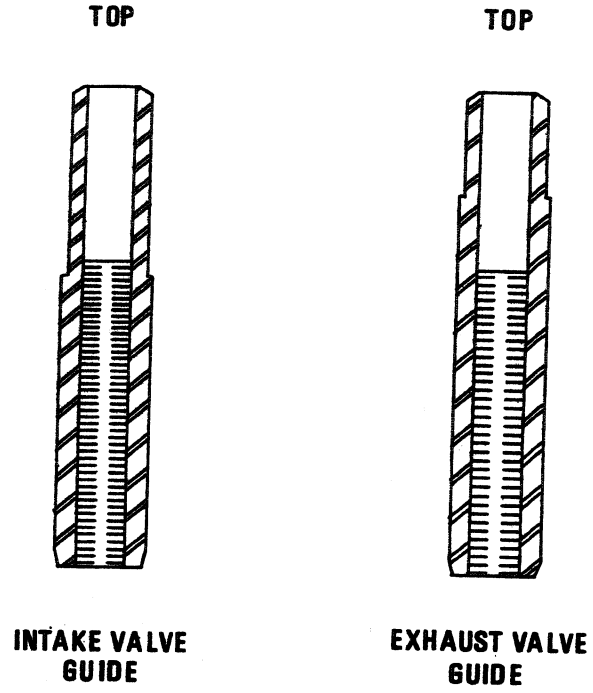

Fig. 17 — Valve Guides
(T-76812)

CAUTION

To eliminate possibility of scuffing the guide or the bore in the head, coat outside surface of guide with a 50/50 mixture of white lead and lubricating oil before pressing guide into position.

7. New valve guides are pressed into position from bottom of head with a guide installing tool, Fig. 16. The adapters (2) (3) establish proper protrusion of guides above the cylinder head. To use the tool, place cylinder head in a press with head gasket surface up. Assemble guide installing tool by screwing pilot (4) into plate (5). Insert the proper adapter, exhaust (3) or intake (2) on the pilot (4). Insert valve guide (1) on pilot with bottom end against the adapter.

Insert installing tool, with guide, into guide bore in the head and press downward until plate rests on head gasket surface of head.

The valve guides are prefinished and do not require reaming after they are pressed into the cylinder head.

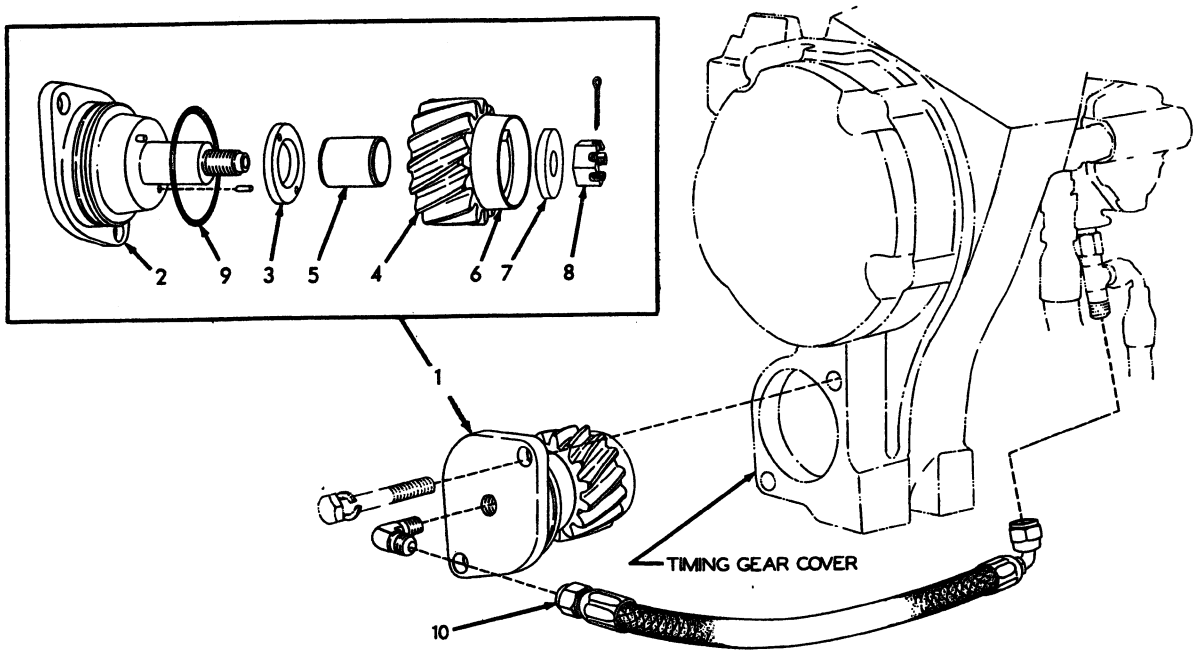

Fig. 12 — Type I Hydraulic Pump Drive
(T-24154)

1. Hydraulic Pump Drive
2. Shaft Assembly
3. Thrust Washer
4. Gear
5. Bushing
6. Sleeve
7. Gear Retaining Washer
8. Nut
9. O-Ring
10. Lubricating Oil Hose

4. Remove capscrews and lockwashers and pull drive gear assembly (1) from timing gear cover.

5. Remove cotter pin and nut (8) from shaft.

6. Remove washer (7) gear (4) and washer (3). Remove O-ring (9).

7. Inspect bushing in gear, the specified I.D. is .812" - .813" and the O.D. of the shaft, at the gear location, is .8095" - .8105". If bushing is worn, replace and burnish to the specified .812" - .813" I.D. If shaft is worn, replace.

G. TYPE I HYDRAULIC PUMP DRIVE ASSEMBLY AND INSTALLATION (Fig. 12)

1. Assemble drive gear by reversing the disassembly procedure. Install thrust washer (3) on dowel pins with oil grooves in washer facing the gear (4). Install retaining washer (7) with chamfered side facing the gear. After nut (8) is tightened, check end play between thrust washer (3) and gear (4). The specified end play is .002" - .007". If end play exceeds .010", replace thrust washer (3). The specified thickness of a new thrust washer is .186" - .188".

NOTE

When cotter pin is installed, spread ends tightly against nut (8) to prevent interference with tangs of pump drive coupling.

2. Using a new O-ring (9) install drive gear assembly on timing gear cover. Connect lubricating oil hose(s). Install hydraulic pump.

H. TYPE II HYDRAULIC PUMP DRIVE REMOVAL, DISASSEMBLY, AND INSPECTION (Fig. 13)

1. Remove hydraulic pump and adapter (8) from rear of timing gear housing.

2. Remove coupling (11) and coupling (12).

3. Remove bearing retainer (1).

4. Drive or press gear (16) and bearings (6) and (15) from timing gear housing.

5. Drive or press bearings (6) and (15) from gear (16).

A horizontal oil passage, extending from the main oil gallery to a fitting in the left side of the cylinder block, conveys oil to the fuel injection pump (20) through an external oil line. Excess oil from the fuel injection pump is dumped into the timing gear housing and returns to the oil pan.

If the engine is equipped with a turbocharger (3) and/or a fan drive gear oil is conveyed to and returned from these units through external oil lines.

On motor graders equipped with an oil-type engine clutch, oil to the clutch is supplied from a drilled passage at the rear main bearing and returns to the oil pan through an oil return line.

TOPIC 2 - OIL PAN

A. GENERAL

The oil pan is the reservoir for the engine lubricating oil. On some engine applications the oil pan is provided with a clean-out cover for ease of inspecting and cleaning the oil pump suction screen. The oil drain plug is located in the clean-out cover or bottom of pan.

B. OIL PAN REMOVAL, INSPECTION, AND INSTALLATION

1. In all units using engines covered in this manual, except tractor loaders, the oil pan may be removed with the engine mounted in the unit. To remove oil pan on tractor loaders the engine must be removed from the unit (refer to "ENGINE REMOVAL AND INSTALLATION" Section).
2. Remove engine crankcase guard if so equipped.
3. Remove oil drain plug and drain lubricating oil.
4. On motor graders, disconnect the oil return line elbow from the oil pan.
5. Remove capscrews and lockwashers or Nylok capscrews securing rear of oil pan to flywheel housing. Remove capscrews and lockwashers securing oil pan to cylinder block.
6. Jar oil pan loose from cylinder block and remove oil pan.
7. Remove clean-out cover, if so equipped, and thoroughly wash all parts in cleaning solvent.
8. Inspect clean-out cover, drain plug, and oil pan for cracks or other damage. Replace if necessary.
9. Using gasket cement, cement a new oil pan gasket set to bolting flange of oil pan.
10. Using care to prevent damage to seal ring in flywheel housing, place oil pan in position on cylinder block and insert a capscrew and lockwasher near each corner, but do not tighten capscrews to extent that oil pan cannot be shifted.
11. Install capscrews and lockwasher or Nylok capscrews which secure rear flange of oil pan to flywheel housing and tighten securely. Install remaining capscrews and lockwashers securing oil pan to cylinder block. Tighten 5/16" NC capscrews to a torque of 11 - 13 lbs. ft. Tighten 3/8" NC (grade 2) capscrews to 18 - 21 lbs. ft. and, if 3/8" NC (grade 5) capscrews are used on the rear flange, tighten to 28 - 33 lbs. ft.
12. If equipped with a clean out cover, use a new gasket, install cover and secure with capscrews and lockwashers.
13. Install drain plug and tighten securely.
14. Fill engine crankcase to the proper level with specified lubricant.

TOPIC 3 - OIL PRESSURE PUMP

A. OIL PRESSURE PUMP REMOVAL, DISASSEMBLY AND INSPECTION

1. OIL PRESSURE PUMP REMOVAL (Figs. 2, 3)

a. Drain engine lubricating oil and remove oil pan.

b. Remove oil pressure pump discharge pipe (2).

c. Remove oil pressure pump suction pipe (4).

d. Remove lockwire, capscrews, and lockwashers securing lubricating oil pump assembly (1) to cylinder block and remove oil pump assembly.

TOPIC 4 - OIL SCAVENGING PUMP

A. GENERAL

The oil scavenging pump is used only on track-type tractors, it serves as a transfer pump, transferring oil from front oil sump of oil pan to main oil sump in rear of oil pan, keeping oil pressure pump suction screen submerged at all times. The scavenging oil pump is driven by a spiral gear in mesh with the

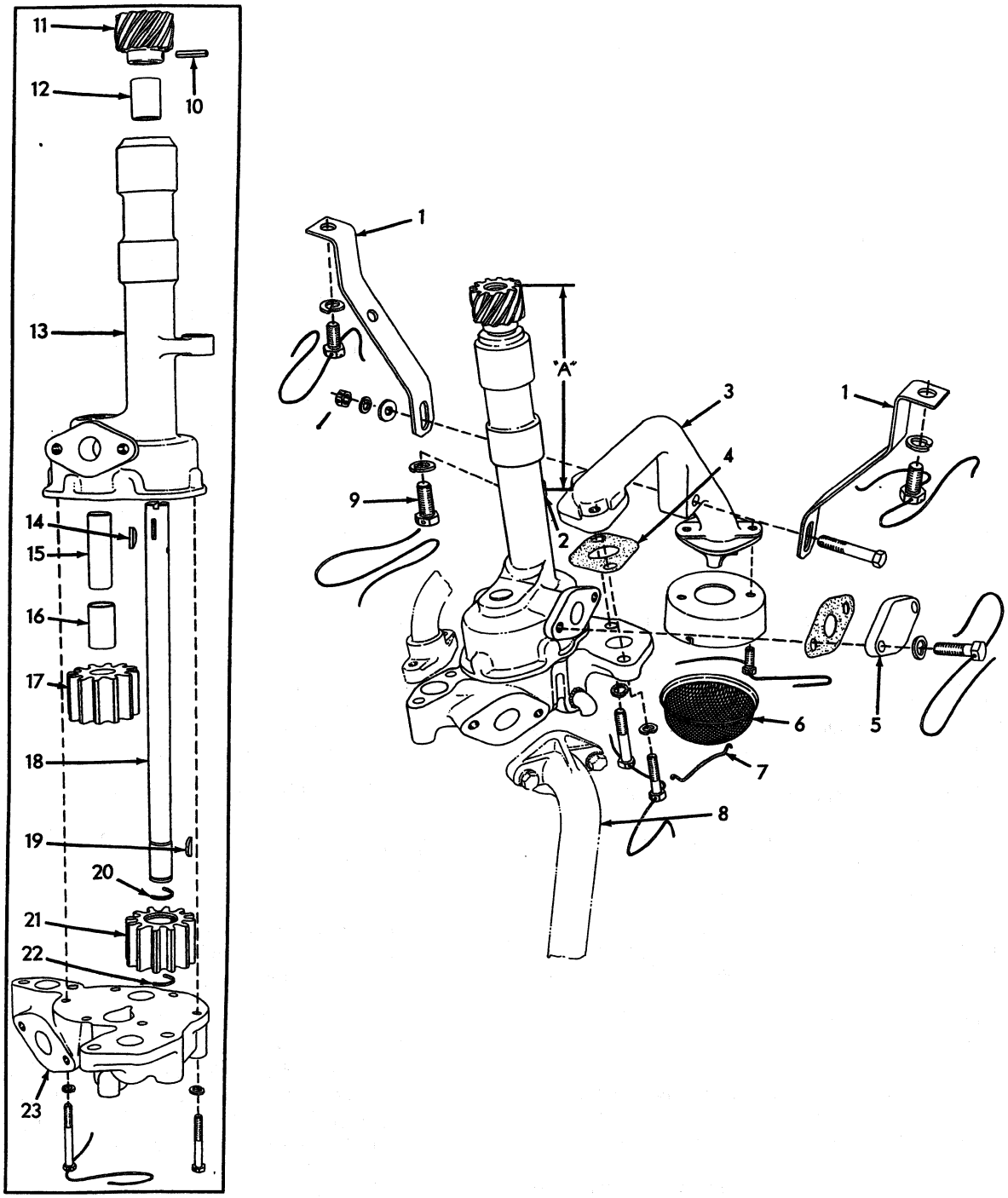

Fig. 8 — Scavenging Oil Pump Details
(T-13980)

Study SAFETY RULES, pages I thru III, thoroughly for the protection of personal and machine safety.

TOPIC 2 - CAMSHAFT BEARINGS

A. GENERAL

The specified clearance between camshaft bearings and journals is .0019" — .0055". If clearance is .0075" or more, new camshaft bearings must be installed. The specified diameter of camshaft bearing journals is 2.2465" — 2.2475" and inside diameter of new camshaft bearings when installed is 2.2494" — 2.2520". With camshaft removed, measure diameter of camshaft journals and inside diameter of camshaft bearings, with micrometers, to determine clearance.

NOTE

As a field expedient and when the proper micrometers are not available, the camshaft journal-to-bearing clearance may be measured with a feeler gauge as shown in Fig. 4. This is not an accurate or recommended method.

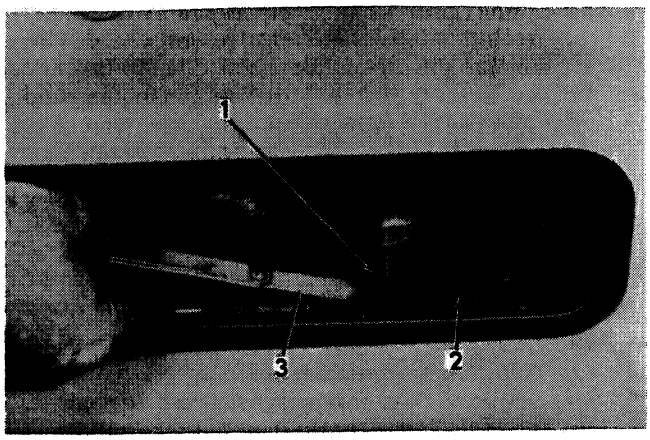

Fig. 4 — Checking Camshaft Bearing Clearance (T-20215)

1. Camshaft Bearing
2. Camshaft
3. Feeler Gauge

B. CAMSHAFT BEARING REMOVAL AND INSTALLATION

1. Remove the engine.
2. Remove camshaft (refer to "CAMSHAFT REMOVAL AND INSTALLATION" in this Section).
3. Remove timing gear housing (refer to "FRONT END AND GEAR TRAIN" Section).
4. Remove flywheel and flywheel housing (refer to "FLYWHEEL AND RING GEAR; FLYWHEEL HOUSING AND CRANKSHAFT REAR OIL SEAL" Section).
5. Using a slide hammer puller and a 1/4" x 20 NC adapter, pull camshaft hole plug and O-ring from rear end of cylinder block.
6. It is possible to remove and install camshaft bearings without removing the oil pan, however, to prevent dirt from falling into crankcase and to facilitate bearing removal and installation, it is advisable to drain engine oil and remove oil pan.
7. Using a camshaft bearing removing and installing set similar to the one shown in Fig. 5, proceed as shown in Fig. 6 to remove the old and install new camshaft bearings.

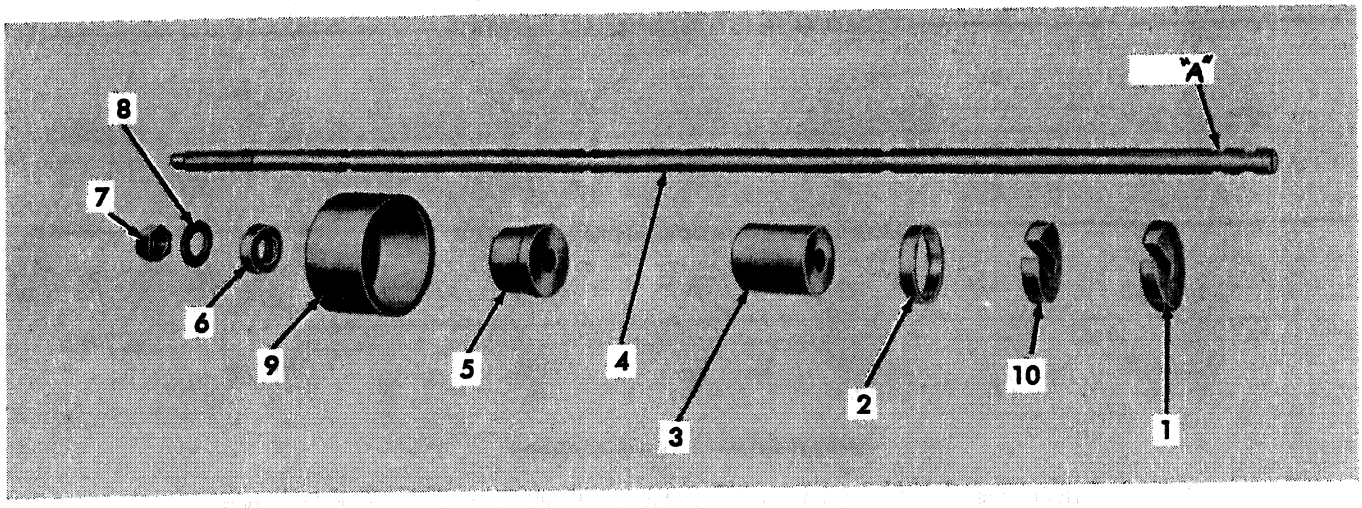

Fig. 5 — Camshaft Bearing Removing and Installing Tool Set (T-20252)

1. Stop Plate
2. Spacer
3. Installing Pilot
4. Puller Shaft
5. Puller Shaft Pilot
6. Thrust Bearing
7. Hex Nut
8. Flat Washer
9. Collar
10. "C" Washer

"A" Notch to be used for all 10000 and 11000 engines

Study SAFETY RULES, pages I thru III, thoroughly for the protection of personal and machine safety.

SECTION 14 - CRANKSHAFT AND CRANKSHAFT GEAR, MAIN BEARINGS, AND MAIN BEARING CAPS

TOPIC 1 - CRANKSHAFT AND CRANKSHAFT GEAR

A. GENERAL

The seven bearing, counterbalanced crankshaft is a steel drop forging, carefully heat-treated to assure utmost strength and durability. The crankshaft is balanced dynamically. End thrust of the crankshaft is taken up by thrust flanges, Fig. 1 (4) (9), at the center main bearing. The specified end play of the crankshaft is .006" - .014" and must not exceed .022". Thrust flanges are available in standard size and .005", .010" and .015" oversize.

The crankshaft gear is keyed and pressed onto the front end of the crankshaft with a .0005" - .0025" interference fit.

B. CRANKSHAFT REMOVAL AND INSPECTION

1. Remove the engine (refer to "ENGINE REMOVAL AND INSTALLATION" Section). Drain engine lubricating oil.

2. Remove flywheel and flywheel housing (refer to "FLYWHEEL AND RING GEAR, FLYWHEEL HOUSING AND CRANKSHAFT REAR OIL SEAL" Section).

3. Remove the timing gear housing cover (refer to ("FRONT END AND GEAR TRAIN" Section).

4. Remove oil pan, oil pump(s), and associated tubing (refer to "LUBRIFICATING SYSTEM" Section).

5. Remove connecting rod bearing caps and connecting rod bearing shells (refer to "PISTONS, PISTON RINGS, CONNECTING RODS, AND CONNECTING ROD BEARINGS" Section).

6. Remove main bearing caps and lower main bearing shells.

7. Remove the crankshaft.

8. Remove upper main bearing shells from the cylinder block.

9. Clean crankshaft thoroughly and inspect the journals for scoring, chipping, cracking, or signs of over-heating. If crankshaft has been overheated (usually indicated by discolored or blue bearing journal surfaces), or is scored or excessively worn, reconditioning or replacement will be required. Examine bearing journals for cracks if over-heating has occurred.

10. Measure the crankshaft main bearing and connecting rod journals at several places on their diameter to check for roundness. The specified diamenter of main bearing journals is 3.498" - 3.499"; connecting rod journals 2.7715" - 2.7725".

    If out-of-round or taper of journals exceeds .002", crankshaft must be reground to a standard undersize or replaced.

11. Remove the hex-socket pipe plugs from crankshaft and blow out all oil passages in crankshaft

TOPIC 3 - MAIN BEARING CAPS

A. GENERAL

Replacement caps for front, intermediate, and rear bearings locations are machine finished except for the bore which is semi-finished. The replacement center cap is machine finished except for the bore and the thrust faces.

Main bearing caps are not interchangeable, and if replacement becomes necessary, new caps must be machined in place. To maintain correct alignment and size in the main bearing bore in the block, caps must be installed to the specified torque before machining. Replacement of main bearing caps is a machine shop job.

B. MAIN BEARING CAP REPLACEMENT

When it is necessary to do any machining to the main bearing bore in the block, it is important that the center line of the crankshaft is not altered from its original center line, especially at the timing gear end. Raising the bore .003"-.004" at the flywheel end of the engine can be tolerated if the bore is made straight and the front main bore is not repositioned. When installing a replacement cap, make certain the casting or part number on the cap is in the same relative position as the number on the old cap when installed.

If a main bearing burns out with enough heat to cause distortion at one or more of the main bearing bores or saddles, generally the block and bearing caps will pull in at their joint causing an oblong bore. If the flat areas, where the cap contacts the block around the main bearing attaching capscrews, have distorted so they are no longer flat and straight, the area will have to be hand filed and fitted to the replacement bearing cap so that when the new cap is installed it will not be distorted from being pulled down on an out-of-square surface. A thin coat of Prussian Blue can be used on the new cap to detect any out-of-squareness at this point.

SECTION 17 - ENGINE DISASSEMBLY AND ASSEMBLY

TOPIC 1 - GENERAL INFORMATION

This general information will be helpful when disassembling or assembling an engine. It should be read and kept in mind while the work is being performed.

A. CLEANING

After electrical equipment is removed, the exterior of the engine should be thoroughly cleaned, preferably steam cleaned.

In many repair shops and service departments, caustic compounds are used to clean grease, dirt, paint, gasket remnants, etc., off parts. These compounds are very effective and very useful when used properly, but can cause considerable damage to certain materials.

Materials such as aluminum, rubber, fiber, sintered bronze and bonding agents are particularly sensitive to all highly concentrated caustic cleaners. There are many of these cleaning compounds on the market, under various trade names, but the majority of them are based on the same active agent — sodium hydroxide. Steam jenny compounds also generally contain this agent.

Some current oil coolers and radiators are being manufactured with aluminum fins. A few cleaning solutions have been found to react with aluminum to the extent of dissolving the metal.

We recommend that Trichlorethylene solvent or equivalent be used for both internal and external cleaning of oil coolers and radiators used in Fiat-Allis units since there is no reaction between the aluminum and the solvent. Radiator service stations should be advised accordingly.

In all cleaning operations care should be taken in the selection of cleaning materials. When any doubt exists as to whether or not caustic compounds would damage the materials to be cleaned, the use of such compounds should be avoided.

B. BALL AND ROLLER BEARINGS

After removal, thoroughly clean the bearings in clean solvent and dry with compressed air free of moisture. Inspect bearings to see that they roll freely and are free from cracked, pitted, or worn balls, rollers, and races. Make certain that the shield(s) and the ball retainers are in good condition and are not dented or damaged.

Badly worn ball bearings can be detected by the presence of excessive end play between the outer and inner races. This condition can be detected by holding one race steady and moving the other race endwise, comparing the difference in movement of the races of the used bearing and a new bearing. Check the outer and inner races for indications of bearing creepage. This can be detected by marks on the bearing races or on the bearing area of the bore or shaft where the bearing has been used. Always lubricate a bearing at assembly with clean lubricant. Do not use a bearing which is in bad condition.

After the bearings have been removed, keep the bearings spotlessly clean, well lubricated, and wrap the bearings in clean oil proof paper to prevent the entrance of dirt and rusting. When installing new bearings, do not remove the bearings from package until ready for assembling. Do not wash the lubricant from a new bearing.

DESCRIPTION	SIZE OF NEW PARTS	
	INCHES	MILLIMETERS
9. Connecting Rods		
a. Type	Balanced Forging	Balanced Forging
b. Fasteners per rod-socket head cap-screw type	2	2
c. Connecting rod length (center-to-center)	10.498 - 10.502	266.65 - 266.75
d. Inside diameter of connecting rod bushing (finished bore)	1.6277 - 1.6282	41.34 - 41.36
e. Outside of diameter of connecting rod bushing	1.8155 - 1.8175	46.11 - 46.16
f. Bearing bore (without bearing, cap in place, and nuts tightened to specified torque)	3.025 - 3.0255	76.84 - 76.85
g. Connecting rod bearing-to-crankshaft journal clearance (with nuts tightened to specified torque)	.0020 - .0050	.05 - .13
h. Connecting rod width at lower end	1.744 - 1.746	44.30 - 44.35
i. Side clearance-to-crankshaft journal	.004 - .010	.10 - .25
j Piston pin diameter	1.6265 - 1.6267	41.31 - 41.32
k. Piston pin bushing length in connecting rod	1.552 - 1.572	39.42 - 39.93
l. Piston pin-to-connecting rod bushing clearance	.001 - .0017	.03 - .04
m. Bore in connecting rod for piston pin bushing	1.8120 - 1.8125	46.02 - 46.04
10. Exhaust Valves		
a. Valve lift (at valve) w/.018 in (0.46 mm) lash	.473	12.01
b. Valve lift (at cam)	.321	8.15
c. Seat angle	30°	30°
d. Valve seat contact width	Nominal .078 (5/64)	Nominal 1.98
e. Valve lash (cold)	.024	.61

DESCRIPTION	SIZE OF NEW PARTS	
	INCHES	MILLIMETERS
Bearing O.D.	2.0470 - 2.0472	51.993 - 51.998
Bore in retainer (for bearing)	2.047 - 2.048	51.99 - 52.02
2. Rear bearing		
Bearing bore (I.D. for shaft)	.9843 - .9845	25.001 - 25.006
Gear shaft diameter	.9842 - .9846	24.999 - 25.008
Fit - gear to bearing	.0003 loose - .0003 tight	0.008 loose-0.0008 tight
Bearing O.D.	2.0470 - 2.0472	51.993 - 51.998
Bore in timing gear housing (for bearing)	2.047 - 2.048	51.99 - 52.02
Fit - timing gear housing to bearing	.001 loose - .0002 tight	0.03 loose - 0.005 tight

32. FAN BELT TIGHTENER (TRACK-TYPE TRACTORS)

1. Bearing bore (I.D. for shaft)	.9839 - .9843	24.99 - 25.00
2. Shaft diameter	.9836 -.9840	24.98 - 24.99
Fit - shaft to bearing	.0001 - .0007 loose	0.003 - 0.017 loose
3. Bearing O. D.	2.0467 - 2.0472	51.99 - 52.00
4. Bore in Pulley (I.D. for bearing)	2.0466 - 2.0472	51.98 - 52.00
Fit - bearing to pulley	.0005 loose - .0006 tight	0.01 loose - 0.02 tight

33. FAN BELT TIGHTENER (MOTOR GRADERS)

1. Front bearing:		
Bearing bore (I.D. for shaft)	.7825 - .78740	19.996 - 19.999
Shaft diameter	.78670 - .78710	19.98 - 19.99
Bearing O.D.	2.0470 - 2.0472	51.993 - 51.998
Bore in pulley (I.D. for bearing)	2.0464 - 2.0472	51.978 - 51.998
Fit - bearing O.D. to pulley	.0002 - 0008 loose	0.005 - 0.020 loose
2. Rear bearing:		
Bearing bore (I.D. for shaft)	.98415 - .98430	24.997 - 25.001
Shaft diameter	.98360 - .98400	24.983 - 24.993
Bearing O.D.	2.0470 - 2.0472	51.993 - 51.998
Bore in pulley (I.D. for bearing)	2.0464 - 2.0472	51.978 - 51.998
Fit - bearing O.D. to pulley	.0002 loose - .0008 tight	0.005-0.020 loose
3. Pulley shaft diameter	1.1255 - 1.1275	28.59 - 28.64
Bore in fan idler arm for shaft	1.1245 - 1.1255	28.56 - 28.59
Fit - shaft to arm	.002 - .004 tight	0.05 - 0.10 tight
4. Mounting shaft diameter	.9854 - .9859	25.02 - 25.04
Bore in fan idler arm for shaft	.9839 - .9849	24.99 - 25.01
Fit - shaft to arm	.0005 - .002 tight	0.01 - 0.05 tight

TROUBLE	POSSIBLE CAUSES	REMEDY
	3. Thermostat inoperative.	3. Replace thermostat.
	4. Loose or broken fan drive belts.	4. Adjust or replace fan drive belts.
	5. Lime deposits in water passages of radiator, cylinder heads and/or cylinder block.	5. Thoroughly clean affected parts.
	6. Water passages in oil cooler restricted.	6. Remove and clean oil cooler core.
	7. Water pump inoperative.	7. Repair or replace water pump.
	8. Excessive load on tractor.	8. Reduce load.
	9. Engine speed set too high.	9. Adjust speed to within specified rpm limits.
Engine operating temperature too high due to loss of coolant	1. External leaks.	1. Repair affected parts.
	2. Ruptured oil cooler core (oil in coolant).	2. Replace oil cooler core.
	3. Engine or air compressor cylinder head gaskets leaking.	3. Replace gaskets and torque cylinder head nuts as specified.
	4. Engine or air compressor cylinder heads cracked.	4. Replace cylinder head.
	5. Engine or air compressor cylinder block cracked.	5. Replace cylinder block.
Engine operating temperature too low	1. Thermostat stuck in open position.	1. Replace thermostat.
	2. Operating in extremely cold weather.	2. Provide covers for radiator and engine side openings. Do not restrict air intake on models which have air cleaner located within engine compartment.

TOPIC 6 - LUBRICATING SYSTEM

TROUBLE	POSSIBLE CAUSES	REMEDY
No lubricating oil pressure	1. Insufficient oil in crankcase.	1. Fill crankcase to proper level.
	2. Oil pressure gauge inoperative.	2. Replace gauge.
	3. Lubricating oil pump screen clogged.	3. Remove and clean the screen.
	4. Lubricating oil pump inoperative.	4. Repair or replace oil pump.
	5. Oil lines loose or broken inside crankcase.	5. Repair or replace affected parts.
Low lubricating oil pressure with proper oil level in crankcase	1. Oil pressure gauge inaccurate.	1. Check gauge. Replace if necessary.
	2. Oil pressure relief valve or regulator valve stuck in open position.	2. Clean, repair, or replace affected parts.
	3. Oil lines in crankcase loose or broken.	3. Repair or replace affected items.

SAFETY RULES

GENERAL

Study the Operation and Maintenance Instruction Manual before starting, operating, maintaining, fueling, or servicing machine.

Read and heed all machine-mounted safety signs before starting, operating, maintaining, fueling or servicing machine.

Machine-mounted safety signs have been color coded yellow with black border and lettering for ***WARNING*** and red with white border and lettering for ***DANGER*** points.

Never attempt to operate the machine or its tools from any position other than seated in the operator's seat. Keep head, body, limbs, hands and feet inside operator's compartment at all times to reduce exposure to hazards outside the operator's compartment.

Do not allow unauthorized personnel to operate service or maintain this machine.

Always check work area for dangerous features. The following are examples of dangerous work areas: slopes, over hangs, timber, demolitions, fire, high walls, drop off, back fills, rough terrain, ditches, ridges, excavations, heavy traffic, crowded parking, crowded maintenance and closed areas. Use extreme care when in areas such as these.

An operator must know the machine's capabilities. When working on slopes or near drop offs be alert to avoid loose or soft conditions that could cause sudden tipping or loss of control.

Do not jump on or off machine. Keep two hands and one foot, or two feet and one hand, in contact with steps grab rails and handles at all times.

Do not use controls or hoses as hand holds when climbing on or off machine. Hoses and controls are movable and do not provide a solid support. Controls also may be inadvertently moved causing accidental machine or equipment movement.

Keep operator's compartment, stepping points, grab-rails and handles clear of foreign objects, oil, grease, mud or snow accumulation to minimize the danger of slipping or stumbling. Clean mud or grease from shoes before attempting to mount or operate the machine.

Be careful of slippery conditions on stepping points, hand rails, and on the ground. Wear safety boots or shoes that have a high slip resistant sole material.

For your personal protection. Do not attempt to climb on or off machine while machine is in motion.

Never leave the machine unattended with the engine running.

Always lock up machine when leaving it unattended. Return keys to authorized security. Heed all shut down procedures of the Operation and Maintenance Instruction Manual. Always set the parking brake when leaving the machine for any reason.

Do not wear rings, wrist watches, jewelry, loose or hanging apparel, such as ties, torn clothing, scarves, unbuttoned or unzipped jackets that can catch on moving parts. Wear proper safety equipment as authorized for the job. Examples: hard hats, safety shoes, heavy gloves, ear protectors, safety glasses or goggles, reflector vests, or respirators. Consult your employer for specific safety equipment requirements.

Do not carry loose objects in pockets that might fall unnoticed into open compartments. Do not use machine to carry loose objects by means other than attachments for carrying such objects.

DO NOT CARRY RIDERS unless the machine is equipped for carrying people to reduce personal exposure to being thrown off.

Do not operate machinery in a condition of extreme fatigue or illness. Be especially careful towards the end of the shift.

Roll Over Protective Structures are required on wheel loaders, dozer tractors, track type loaders, graders and scrapers by local or national requirements. *DO NOT* operate this machine without a Roll Over Protective Structure.

Do not operate a machine without a falling object protective structure (FOPS).

Do not operate this machine without a rear canopy screen when machine is equipped with rear mounted towing winch.

Seat belts are required to be provided with roll over protective structures or roll protection cabs by local or national regulations. Keep the safety belt fastened around you during operation.

Where noise exposure exceeds 90 dBA for 8 hours, wear authorized ear protective equipment per local or national requirements that apply.

Keep clutches and brakes on machine and attachments such as power control units, winches and master clutches adjusted according to Operation and Maintenance Instruction Manuals of the manufacturers at all times. *DO NOT* adjust machine with engine running except as specified.

Do not operate a machine with brakes out of adjustment. See the Operation and Maintenance Instruction Manual.

Move carefully when under, in or near machine or implements. Wear required protective equipment, such as hard hat, safety glasses, safety shoes, ear protectors.

To move a disabled machine, use a trailer or low boy truck if available. If towing is necessary, provide warning signals as required by local rules and regulations and follow Operation and Maintenance Instruction Manual recommendations. Load and unload on a level area that gives full support to the trailer wheels. Use ramps of adequate strength, low angle and proper height. Keep trailer bed clean of clay, oil and all materials that become slippery. Tie machine down securely to truck or trailer bed and block tracks (or wheels) as required by the carrier.

TOPIC 3 - ENGINE CLUTCH OILING SYSTEM

A. DESCRIPTION

Oil to engine clutch is supplied by engine lubricating system through a drilling in the crankshaft rear main bearing journal. Refer to Fig. 1. Oil flows through clutch shaft pilot bearing and is directed by oil slinger and centrifugal force to cool and lubricate clutch and components within engine flywheel housing and clutch housing. Oil drains back to engine oil pan through a large external line connected to engine flywheel housing.

B. SERVICE

No service required on engine clutch oiling system; service is accomplished when engine oil and filters are changed.

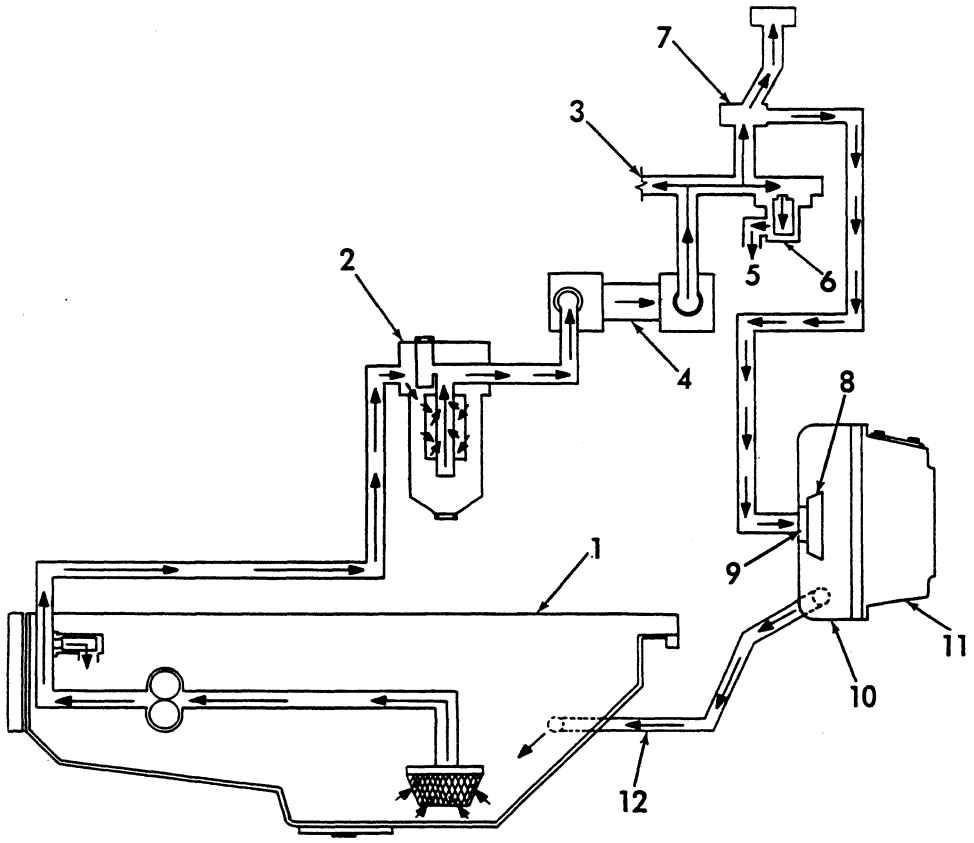

Fig. 1 Engine Clutch Lubrication System
(T-72350)

1. Pan, oil
2. Filter, oil
3. To main gallery
4. Cooler, oil
5. Return to oil pan
6. Valve, oil pressure regulating
7. Bearing, rear main
8. Slinger, oil
9. Bearing, clutch shaft pilot
10. Housing, flywheel
11. Housing, clutch
12. Return to oil pan

2. Push shifting lock plunger (10) toward transmission in locking position as far as it will go; adjust rod (15) until yoke pin (18) can be easily installed without compressing spring (16). Now, shorten this linkage by turning rod (15) three full turns so roll pin (17) is in vertical position before locking jam nut (14); then tighten jam nut securely.

3. Disengage engine clutch (pedal down) and check for free gear shifting. Repeat steps 1 and 2, if necessary.

TOPIC 7 - FITS AND TOLERANCES

A. ENGINE CLUTCH BRAKE

1. PRESSURE PLATE -
May be re-machined (maximum) . . . . . .060"

2. PRESSURE PLATE SPRINGS -
Minimum tension when compressed to height of 1.125" . . . . . 10.5 ± 1 lb.

3. HUB ASSEMBLY

Thickness of new hub assembly at lining area . . . . . .480" - .500"
Minimum allowable thickness (assembly) . . . . . .300"
Minimum allowable thickness (individual linings) . . . . . .050"

B. ENGINE CLUTCH

1. PRESSURE PLATE

Must be flat within . . . . . .005"
May be re-machined (maximum) . . . . . .060"

2. PRESSURE PLATE SPRINGS -
Minimum tension when compressed to height of 1.88" . . . . . 165 - 175 lbs.

3. FRICTION PLATES

Thickness of new plate . . . . . .245" - .255"
Minimum allowable thickness . . . . . .202"
Minimum allowable groove depth (either side) . . . . . .010"

4. STEEL PLATES

Thickness of new plate . . . . . .247" - .250"
Minimum allowable thickness . . . . . .227"
Must be flat within . . . . . .005"
May be re-machined (maximum) . . . . . .010"

5. CLUTCH SHAFT

Minimum allowable thickness (pilot bearing location) . . . . . 1.1788"
Minimum allowable thickness (front bearing location) . . . . . 2.1643"

TOPIC 8 - SERVICE TOOLS

No service tools other than standard hand tools and/or shop tools are required for servicing components covered in this manual.

SAFETY RULES

Never travel a machine on a job site, in a congested area, or around people without a signal person to guide the operator.

In darkness, check area of operation carefully before moving in with machine. Use all lights provided. Do not move into area of restricted visibility.

Maintain clear vision of all areas of travel or work. Keep cab windows clean and repaired. Carry blade low for maximum visibility while traveling. Obtain and use fan blast deflectors where tractors are used a pusher tractors in tandem.

Transport a loaded bucket with the bucket as far tipped back and in as low a position as possible for maximum visibility, stability, and safest transport of the machine. Carry it at a proper speed for the load and ground conditions.

Carry the bucket low when traveling with a load.

Maintain a safe distance from other machines. Provide sufficient clearance for ground and visibility conditions. Yield right-of-way to loaded machines.

Avoid going over obstacles such as rough terrain, rocks, logs, curbs, ditches ridges, and railroad tracks whenever possible. When obstructions must be crossed, do so with extreme care at an angle if possible. Reduce speed - down-shift. Ease up to the break over point - pass the balance point slowly on the obstruction and ease down on the other side.

Cross gullies or ditches at an angle with reduced speed after insuring ground conditions will permit a safe traverse.

Be alert to soft ground conditions close to newly constructed walls. The fill material and weight of machine may cause the wall to collapse under the machine.

Operate at speeds slow enough to insure complete control at all times. Travel slowly over rough ground, on slopes or near drop offs, in congested areas or on ice or slippery surfaces.

Be alert to avoid changes in traction conditions that could cause loss of control. *DO NOT* drive on ice or frozen ground conditions when working the machine on steep slopes or near drop offs.

Keep the machine well back from the edge of an excavation.

Be especially careful when traveling up or down slopes. Position the bucket in such a way as to provide a possible anchorage on the ground in case of a slide.

When proceeding across a hill side proceed slowly. Never turn sharply up hill or down hill.

Avoid side hill travel whenever possible. Drive up and down the slope. Should the machine start slipping sideways on a grade, turn it immediately downhill.

In steep down hill operation, do not allow engine to over speed. Select proper gear before starting down grade.

There is no substitute for good judgement when working on slopes.

The grade of slope you should attempt will be limited by such factors as condition of the ground, load being handled, the type of machine, speed of machine and visibility.

NEVER COAST the machine down grades and slopes with the transmission in neutral on power shift machines, or clutch disengaged on manually shifted machines.

To reduce the danger of uncontrolled machine, choose a gear speed before proceeding down grade that will hold machine to proper speeds for conditions.

Operating in virgin rough terrain that includes previously mentioned hazards is called pioneering. Be sure you know how this is done. Danger from falling branches and upturning roots is acute in these areas.

When pushing over trees, the machine must be equipped with proper over head guarding. Never allow a machine to climb up on the root structure particularly while the tree is being felled. Use extreme care when pushing over any tree with dead branches.

Avoid brush piles, logs or rocks. *DO NOT DRIVE THE MACHINE ONTO BRUSH PILES, LOGS, LARGE ROCKS* or other surface irregularities that break traction with the ground especially when on slopes or near drop offs.

Avoid operating equipment too close to an over hang or high wall either above or below the machine. Be on the look out for caving edges, falling objects and slides. Beware of concealment by brush and under growth of these dangers.

Park in a non-operating and non-traffic area or as instructed. Park on firm level ground if possible. Where not possible, position machine at a right angle to the slope, making sure there is no danger of uncontrolled sliding movement. Set the parking brake.

Never park on an incline without carefully blocking the machine to prevent movement.

If parking in traffic lanes cannot be avoided, provide appropriate flags, barriers, flares and warning signals as required. Also provide advance warning signals in the traffic lane of approaching traffic.

Move the machine away from pits, trenches, overhangs and over head power lines before shutting down for the day.

When stopping operation of the machine for any reason, always return the transmission or hydrostatic drive control to neutral and engage the control lock to secure the machine for a safe start up. Set parking brake, if so equipped.

Never lower attachments or tools from any position other than seated in operator's seat. Sound the horn. Make sure the area near the attachment is clear. Lower the attachment slowly. *DO NOT USE* float position to lower hydraulic equipment.

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TOPIC 3 - TROUBLESHOOTING AND PRESSURE CHECKING

This Topic includes PRESSURE CHECKING when and where applicable.

A. STEERING

Trouble shoot and perform remedies in order given for best results. Refer to pertinent Topics in this manual, or to other pertinent Modular Manuals for detailed information to perform remedies listed.

1. HARD TO STEER IN EITHER DIRECTION

CAUSES	REMEDIES
a. Extremely low air pressure in front tire(s).	a. Fill tires to specified air pressure.
b. Mechanical steering linkage excessively worn or loose; linkage bent, broken, or improperly adjusted.	b. Repair, replace, and/or adjust as necessary.
c. Malfunction of steering pump; or, power steering gear assembly. (Determine which component is faulty before proceeding.)	c. Determine which component is malfunctioning by installing pressure gauge (2000 psi capacity) in oil supply (pressure) line located on left side of power steering assembly. Start engine; turn wheels slightly to the right; place large solid block between main frame stop and steering arm; turn wheels hard to the right against block. Hold wheels in this position and note pressure on gauge; pressure should be approximately 1200 psi with engine running at high idle. Proper pressure on gauge indicates malfunction of power steering assembly; if pressure is low, remove pump relief valve cap and turn adjusting screw to obtain 1200 psi on gauge. If pressure can not be raised to specifications, proceed as follows: (1) Shut off engine and check tension on PTO drive belts; adjust if necessary. (2) Check oil level in hydraulic tank; fill to proper level with specified oil. (3) Check suction line from tank to pump for any loose or damaged parts permitting pump to suck air; tighten or replace parts as necessary. Make certain suction line is not plugged or obstructed. (4) Remove, clean, and re-install pump relief valve (adjusting screw, small spring, and large spring w/ball). (5) Start engine and re-check pressure with engine running at high idle and wheels turned hard to the right against block placed between steering arm and main frame stop. Turn pressure relief adjusting screw to obtain 1200 psi on gauge; if pressure can not be adjusted to specification, steering pump malfunction is indicated. Shut off engine.
d. Steering pump mal-function.	d. Remove steering pump; repair or replace pump and/or pump drive. Flush and clean entire system. Start engine and adjust pump relief valve to 1200 psi, using procedure in preceding paragraphs.

TOPIC 5 - ENGINE CLUTCH AND WHEEL BRAKES BOOSTERS

A. DESCRIPTION

Engine clutch and wheel brakes boosters utilize "flow-through" design; oil flows in and out of each booster at all times. Boosters are similar in design and operation. Output pressure of boosters is approximately double the input pressure.

Movement initiated at foot pedal is transmitted mechanically to push rod to actuate operating spool. As spool moves, oil by-pass port is closed off; pressure "builds-up" against spool side of piston and forces actuating (output) shaft to operate wheel brake master cylinder (or operate engine clutch linkage).

When pressure is released, booster piston spring returns piston and spool return spring returns spool to "neutral" (oil "flow-through") position.

If pressure exceeds preset relief valve pressure, relief valve will unseat and by-pass oil around booster piston.

Engine clutch and wheel brakes can be operated even if booster pressure is lost; however, more force will have to be applied manually.

B. REMOVAL, ENGINE CLUTCH BOOSTER

Remove engine clutch booster as follows:

1. Remove rear center floor plate to gain access to booster (it is possible to remove booster from bottom); refer to Fig. 9.
2. Disconnect hydraulic lines and plug ends to prevent oil loss.
3. Remove yoke pins (5) from front ends of booster actuating rod (11) and clutch operating rod (17).
4. Remove capscrews mounting booster to frame and remove booster; turn actuating rod (11) out of booster and re-connect to clutch bellcrank (7).

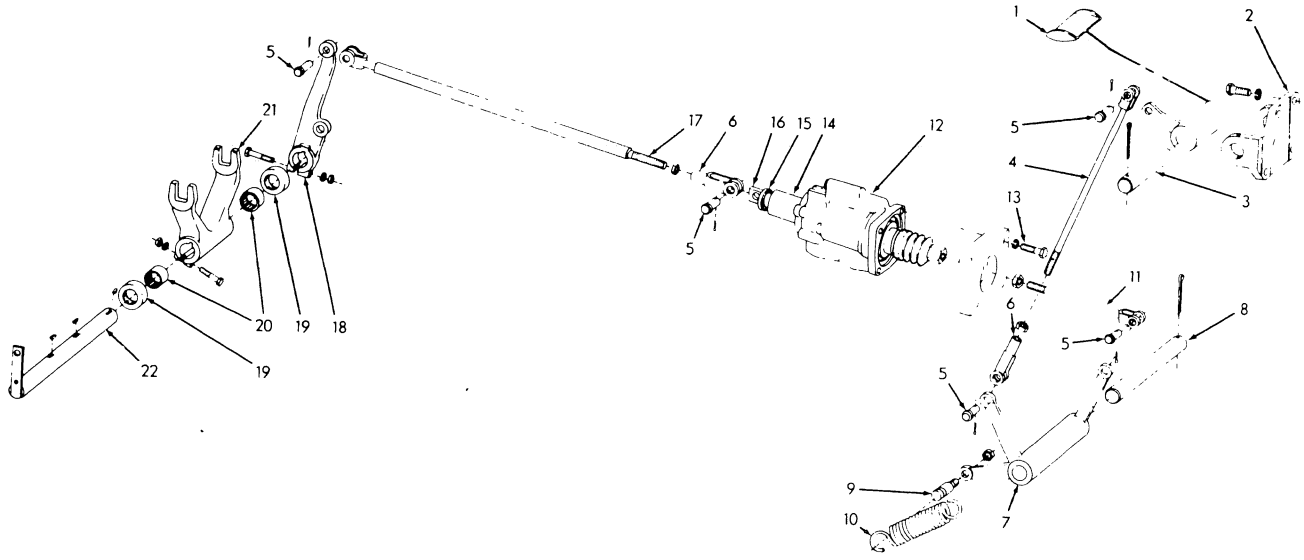


Fig. 9 Engine Clutch Booster
(T-71399)

1. Pedal
2. Bracket
3. Shaft
4. Rod, vertical operating
5. Pin
6. Yoke
7. Bellcrank
8. Shaft
9. Pin
10. Spring
11. Rod, booster actuating
12. Booster
13. Capscrew
14. Retainer
15. Seal
16. Shaft
17. Rod, horizontal operating
18. Lever
19. Seal
20. Bearing
21. Fork
22. Shaft

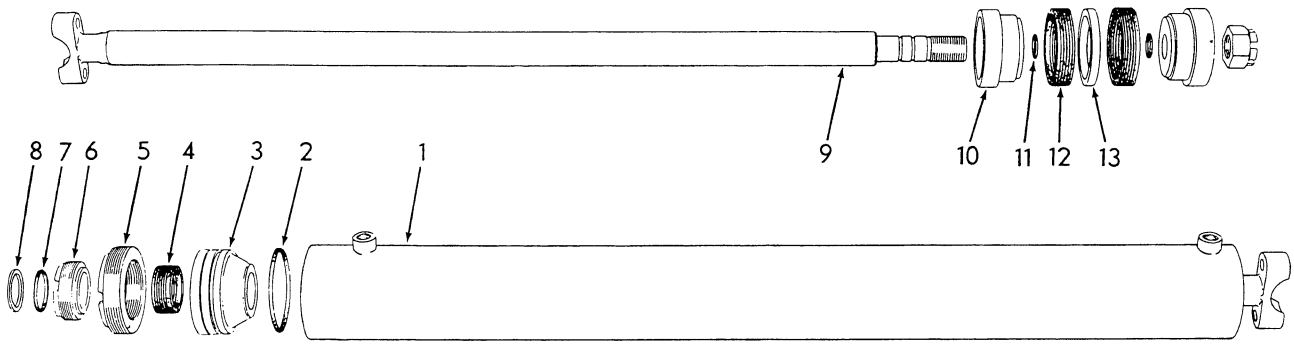


Fig. 19 Shiftable Moldboard Cylinder Components
(T-12020)

1. Tube
2. O-Ring, stuffing box
3. Box, stuffing
4. Packing, stuffing box
5. Nut, retaining stuffing box
6. Nut, packing adjustment
7. O-Ring, piston rod
8. Ring, piston rod wiping
9. Rod, piston
10. Piston
11. O-Ring, piston
12. Packing, piston
13. Washer

c. Assemble piston components (10, 11, 12 and 13) on piston rod.

d. Carefully insert piston rod assembly into cylinder bore; seat stuffing box and install stuffing box retaining nut.

5. INSTALLATION

a. Position cylinder for installation on moldboard. Refer to Fig. 18.

b. Install end caps (6) and attach hydraulic lines securely.

c. Start engine; operate cylinder to limits of travel to purge air from cylinder and hydraulic system. Check all connections for leaks; stop engine. Check oil level in reservoir and fill as required.

C. SHIFTABLE MOLDBOARD CONTROL VALVE

1. REMOVAL

Refer to Fig. 20. Clean surrounding area; disconnect hydraulic lines; plug lines and valve ports. Disconnect lower valve operating lever from valve spool. Remove attaching hardware and remove valve from grader.

2. DISASSEMBLY

a. Refer to Fig. 21. Remove screws attaching bonnet (1) to valve body (7). Remove screw (2), lockwasher (3) and plain washer (4) from spool (9). Disassemble spool centering spring (5) and collar (6) from valve body. Remove valve spool and seals (8) from valve body.

b. Remove pipe plug (11) and disassemble relief valve components (12, 13, 14 and 15) from valve body.

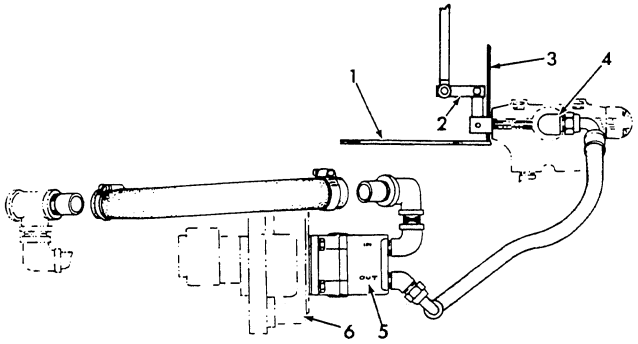


Fig. 20 Shiftable Moldboard Control Valve
(T-37254)

1. Plate, floor
2. Lever, operating
3. Plate, dash
4. Valve, control
5. Pump, shiftable moldboard
6. Housing, vertical drive

3. INSPECTION

Inspect control valve components for wear and any physical damage which may prevent or impair normal operation of valve. Replace component or complete valve as required. If clearance between spool and valve body is MORE than .001", REPLACE VALVE.

4. ASSEMBLY

a. Coat all components with clean oil. Refer to Fig. 21; assemble relief valve components (15, 14, 13, 12 and 11) into valve body. Plug (11) must extend from valve body a minimum of 3/16" to maximum of 1/4" when tight. Replace

NOTICE
THESE CHANGES ARE INCLUDED IN THIS COPY

NOTICE OF CHANGE

TO

SERVICE MANUAL 657712 (10-66)

REAR WHEELS AND BRAKES

M100 MOTOR GRADER

WRITE IN the following changes (changes are underlined):

Page 19	Paragraph C. 5.	Install cylinder in position on back plate; engage links with brake shoes. (see Fig. 6 or 10)
Page 19	Legend for Fig. 11	Delete item 12

REPLACE the following like pages:

7 (Revised)	15 (Revised)	23 (Revised)
8 (Revised)	16 (Revised)	24 (No change)
13 (Revised)	17 (Revised)	
14 (Revised)	18 (Revised)	

REASON: This mailing adds data for redesigned brake assembly which became effective grader S/N 2000-up.

INSERT THIS SHEET INTO THE FRONT OF MANUAL 657712 (10-66) TO INDICATE RECEIPT OF THIS MAILING.

Additional copies of this mailing are available. Please direct your order to the Technical Publications Department, Springfield Plant.

Printed in U.S.A.

MAILING NO. 1
Issued 1-70

INDEX

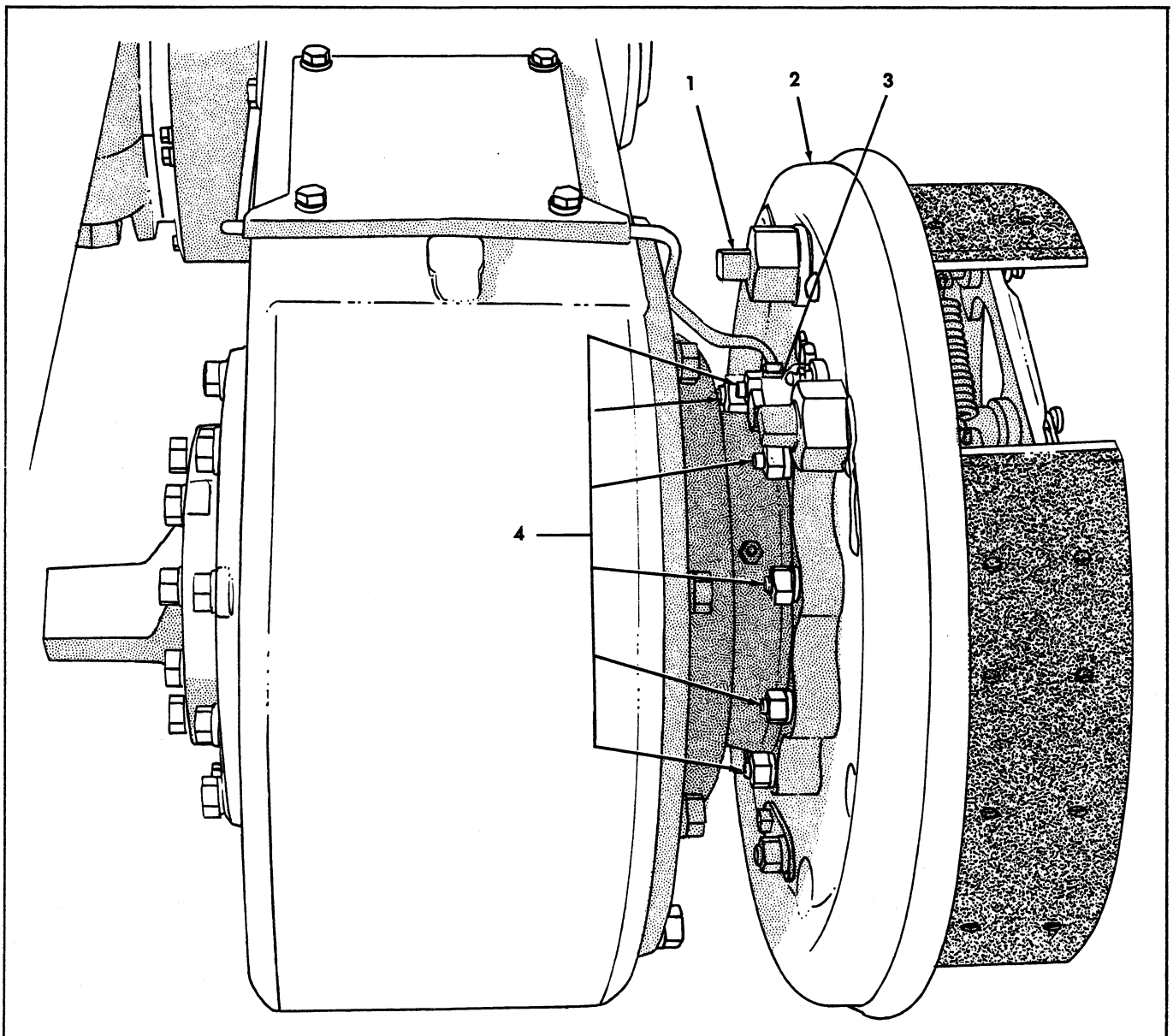
TOPIC 6 - BRAKES

Service personnel have a choice of either removing complete brake unit from tandem and then disassembling it, or disassembling unit piece by piece from tandem, which will accomplish removal when all parts are disassembled. Depending on nature and extent of job to be done, service personnel should decide which method will give the most staisfactory results.

The following procedure is for removal of complete brake unit, and then disassembly.

A. REMOVAL AND DISASSEMBLY

1. Remove wheel; refer to Fig. 4.
2. Refer to Fig. 5; remove high nuts (4) from back plate attaching studs (capscrews used prior to S/N 596).
3. Disconnect brake fluid line at fitting (3). Cover open end of line.
4. Grasp back plate with both hands and pull brake assembly from tandem. It may be necessary to tap back plate LIGHTLY with soft hammer to aid removal.
5. Remove wheel cylinder attaching capscrews from rear side of back plate; push cylinder links (yokes)



T-72872

FIG. 5 WHEEL BRAKE INSTALLED - EARLY MODEL SHOWN, LATE MODEL SIMILAR

1. Anchor pin
2. Back plate
3. Brake line fitting
4. Brake attaching nuts

TOPIC 9 - FITS AND TOLERANCES

A. BRAKE SHOES AND LINING

Drum to lining clearance (brakes released):

Prior to S/N 2000

at top of shoes	.004"
at bottom of shoes	.010"

Eff. S/N 2000-up no clearance adjustment necessary

Lining thickness . . . . . replace when worn to .031" of rivets.

B. BRAKE DRUM

Drum diameter at lining contact area (new drum)	17" + or -.005"
Approximate amount of material that may be removed by machining to recondition lining contact surface	.100"

IMPORTANT

When brake drums are remachined to recondition lining surface, it may become necessary to machine the brake linings, or use oversize linings in order to maintain proper contact of linings to drum. This is due to the brake drum having a larger diameter after machining than the linings. Linings may contact drum only in a small area near the center.

C. WHEEL CYLINDER

Cylinder bore I.D. (new)	1.5" -1.5030"
Spring tension (compressed to 2" length)	1 lb.

D. MASTER CYLINDER

Cylinder bore I.D. (new)	1.5" -1.5030"

E. TORQUE VALUES

Anchor pin nuts (prior to S/N 2000)	440 lbs. ft.
Anchor pin (eff. S/N 2000-up)	150-250 lbs. in.
Brake cylinder attaching capscrews (eff. S/N 2000-up)	180-200 lbs. in.
Wheel retaining nuts	300 lbs. ft.
Rim clamping nuts	150 lbs. ft.

TOPIC 10 - SERVICE TOOLS

No service tools other than standard hand tools and/or shop tools are required for servicing components covered in this manual.

SAFETY RULES

Always before leaving the operator's seat and after making certain all people are clear of the machine, slowly lower the attachments or tools flat to the ground in a positive ground support position. Move any multi purpose tool to positive closed position. Return the controls to hold. Place transmission control in neutral and move engine controls to off position. Engage all control locks, set parking brake, and open and lock the master (key, if so equipped) switch. Consult Operation and Maintenance Instruction Manual.

Always follow the shut down instructions as outlined in the Operation and Maintenance Instruction Manual.

MAINTENANCE

Do not perform any work on equipment that is not authorized. Follow the Maintenance or Service Manual procedures.

Machine should not be serviced with anyone in the operator's seat unless they are qualified to operate the machine and are assisting in the servicing.

Shut off engine and disengage the Power Take Off lever if so equipped before attempting adjustments or service.

Always turn the master switch (key switch if so equipped) to the *OFF* position before cleaning, repairing, or servicing and when parking machine to forestall unintended or unauthorized starting.

Disconnect batteries and *TAG* all controls according to local or national requirements to warn that work is in progress. Block the machine and all attachments that must be raised per local or national requirements.

Never lubricate, service or adjust a machine with the engine running, except as called for in the Operation and Maintenance Instruction Manual. Do not wear loose clothing or jewelry near moving parts.

Do not run engine when refueling and use care if engine is hot due to the increased possibility of a fire if fuel is spilled.

Do not smoke or permit any open flame or spark near when refueling, or handling highly flammable materials.

Always place the fuel nozzle against the side of the filler opening before starting and during fuel flow. To reduce the chance of a static electricity spark, keep contact until after fuel flow is shut off.

Do not adjust engine fuel pump when the machine is in motion.

Never attempt to check or adjust fan belts when engine is running.

When making equipment checks that require running of the engine, have an operator in the operator's seat at all times with the mechanic in sight. Place the transmission in neutral and set the brakes and lock. *KEEP HANDS AND CLOTHING AWAY FROM MOVING PARTS.*

Avoid running engine with open unprotected air inlets. If such running is unavoidable for service reasons, place protective screens over all inlet openings before servicing engine.

Do not place head, body, limbs, feet, fingers, or hands near rotating fan or belts. Be especially alert around a pusher fan.

Keep head, body, limbs, feet, fingers, or hands away from bucket, blade or ripper when in raised position.

If movement of an attachment by means of machine's hydraulic system or winches is required for service or maintenance, do not raise or lower attachments from any position other than when seated in the operator's seat. Before starting machine or moving attachments or tools, set brakes, sound horn and call for an all clear. Raise attachments slowly.

Never place head, body, limbs, feet, fingers, or hands into an exposed portion between uncontrolled or unguarded scissor points of machine without first providing secure blocking.

Never align holes with fingers or hands - Use the proper aligning tool.

Disconnect batteries before working on electrical system or repair work of any kind.

Check for fuel or battery electrolyte leaks before starting service or maintenance work. Eliminate leaks before proceeding.

BATTERY GAS IS HIGHLY FLAMMABLE. Leave battery box open to improve ventilation when charging batteries. Never check charge by placing metal objects across the posts. Keep sparks or open flame away from batteries. Do not smoke near battery to guard against the possibility of an accidental explosion.

Do not charge batteries in a closed area. Provide proper ventilation to guard against an accidental explosion from an accumulation of explosive gases given off in the charging process.

Be sure to connect the booster cables to the proper terminals (+ to +) and (- to -) at both ends. Avoid shorting clamps. Follow the Operation and Maintenance Instruction Manual procedure.

Due to the presence of flammable fluid, never check or fill fuel tanks, storage batteries or use starter fluid near lighted smoking materials or open flame or sparks.

Rust inhibitors are volatile and flammable. Prepare parts in well ventilated place. Keep open flame away - *DO NOT SMOKE.* Store containers in a cool well ventilated place secured against unauthorized personnel.

Do not use an open flame as a light source to look for leaks or for inspection anywhere on the machine.

DO NOT pile oily or greasy rags - they are a fire hazard. Store in a closed metal container.

CAUTION: Check for pieces of broken impeller in the air intake manifold, cylinder head, cylinders, and turbocharger-to-air cleaner piping. Failure to remove pieces of broken impeller is sure to result in damage to the turbocharger or engine.

8. Replace any parts found unserviceable. Refer to Topics 3, 4, and 5 for servicing instructions.

9. If the turbocharger meets the above inspection requirements, it can be reassembled and considered satisfactory.

CAUTION: Whenever a turbocharger is installed on an engine, a certain procedure MUST be followed to prevent early failure.

10. Refer to Topic 5, Paragraph B for installation instructions.

TOPIC 3. REMOVAL AND DISASSEMBLY

A. TURBOCHARGER REMOVAL

CAUTION: Ordinarily, the turbocharger is removed from the engine for one of three reasons: inspection, repair, or overhaul. While the turbocharger is off the engine, keep all intake and exhaust manifold openings covered. This will prevent foreign objects from accidently getting into the manifolds and damaging the turbocharger or engine when the engine is again put into operation.

1. Allow the turbocharger to cool if the engine has been run. Remove the exhaust pipe and engine hood, if applicable.
2. Remove the air cleaner hoses and duct assembly.
3. Remove the exhaust outlet elbow and turbocharger-to-elbow connecting parts.
4. Remove the hose connection between the compressor housing air outlet and intake manifold piping.
5. Remove the oil inlet tube.
6. Disconnect and remove the oil drain tube.
7. Remove the stud nuts and lockwashers which attach the turbocharger to the exhaust manifold and remove the turbocharger.

B. DISASSEMBLY OF TURBOCHARGER (Figure 6)

Clean the exterior with a non-caustic cleaning solvent that is not injurious to aluminum. As parts are removed, they should be placed in protective containers on a clean bench in the order of disassembly. Always handle the parts with care to prevent scratching or burring the precision machined surfaces.

CAUTION: Do not rest the center housing with the included stationary and rotating parts on the compressor impeller. Weight of the complete assembly will damage the impeller blades.

1. Fabricate the holding fixture as detailed on the inside back cover. The illustration is full sized and may be used as a template.
2. Mark the relative positions of the compressor and turbine housings to the center housing to facilitate reassembly.
3. Apply penetrating oil, or diesel fuel oil, to the capscrews that secure the turbine housing to the center housing.
4. Remove compressor housing
   a. T-04; Remove the clamp that secures the compressor housing to the backplate.
   b. T-04B; Remove the capscrews, lockplates, and clamps that secures the compressor housing to the backplate.
5. Remove the compressor housing. If necessary, tap the housing lightly with a soft hammer to loosen it. Remove the diffuser, from T-04.
6. Remove the capscrews, turbine housing clamps and lockplates, and turbine housing.
7. Record the shaft radial movement and shaft end play (refer to Topic 2, Paragraph B).
8. Insert the turbine wheel into the holding fixture. Use a slight twisting motion. Proper seating will prevent turning of the shaft while the compressor impeller locknut is being removed.
9. Use a sliding T handle and a 3/8", 12 point socket and remove the locknut. Hold the T handle at the ends to prevent bending of the shaft.
10. Twist and pull up to remove the compressor impeller.

FIATALLIS®

100-C, 100-B
M-100, M-70

motor graders

service manual

TRANSMISSION

Form 70693862 English

TOPIC 3 - LUBRICATING SYSTEM

A. DESCRIPTION

Oiling system of the pressure lubricated transmission consists basically of a gear type oil pump (driven from transmission top shaft), a full flow filter, an oil pressure gauge, and necessary tubing, etc.

Fig. 2: Oil flow is as follows: pump (8) draws oil through strainer (22), forces it through oil filter (11) and to top shaft front bearing retainer (6). Part of this oil is used to lubricate top shaft components; remainder of oil is directed through exterior tubing (7)(12) to intermediate shaft front bearing retainer (15) and reverse shaft (32). Restricted connectors (14) maintain backpressure to permit a portion of the oil to flow to bottom shaft bushings and rear bearing. Bottom shaft front bearing is lubricated by "spill over" oil from intermediate shaft front bearing. Note: oil flowing to bottom shaft is directed through cross shaft housing (28).

B. OIL PUMP

The fixed displacement pump supplies oil to transmission at approximately 3.5 gpm. Pump pressure is limited by a relief valve which bypasses oil back to inlet side of pump when pressure exceeds 80-100 psi. Normally, valve will open only if system has not

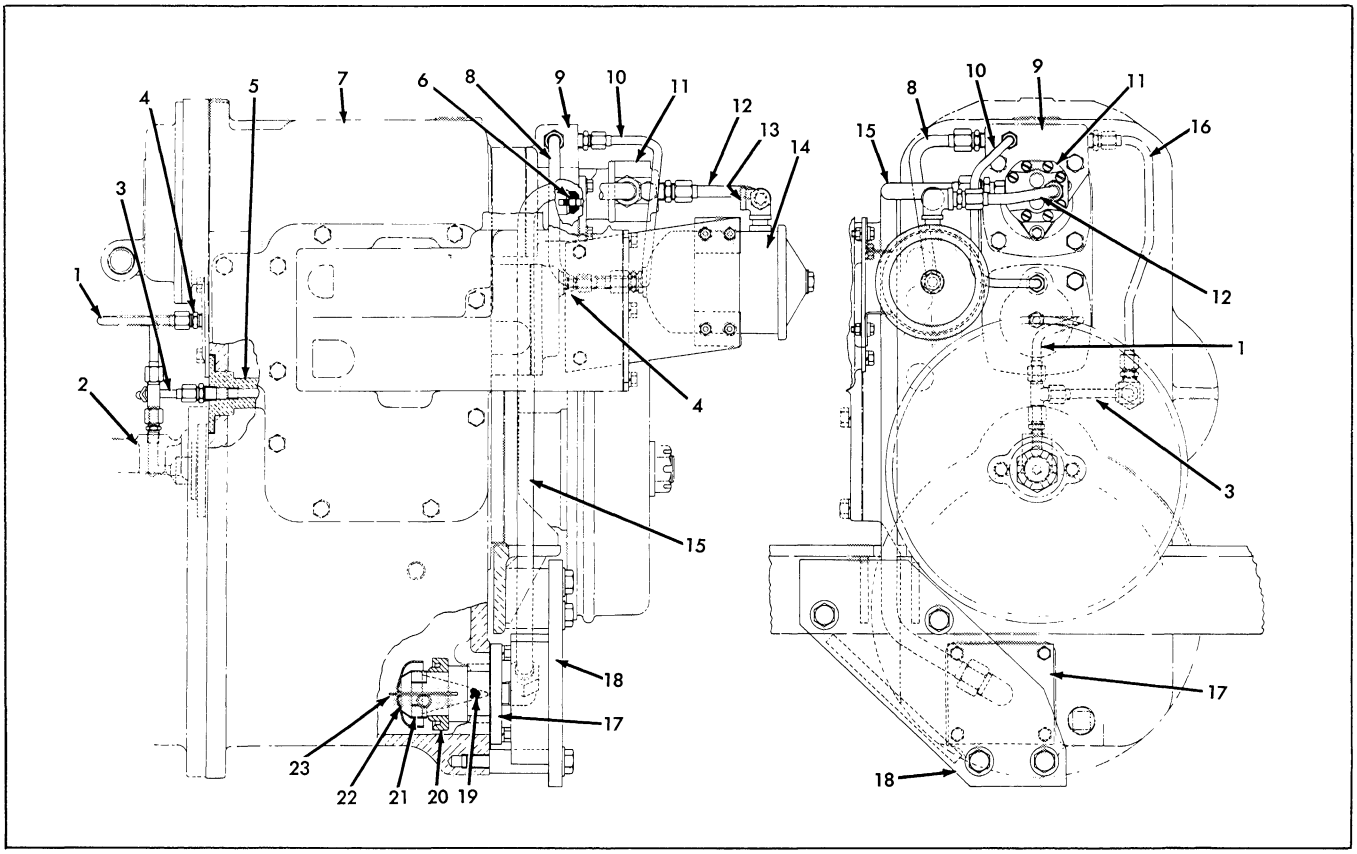


Fig. 1 Lubricating Components
(T-35091)

1. Tube, tee-to-intermediate shaft
2. Housing, cross shaft
3. Tube, to reverse shaft
4. Connector (restricted)
5. Shaft, reverse
6. Coupling, pump drive
7. Transmission
8. Tube, filter-to-top shaft
9. Retainer, top shaft front bearing
10. Tube, top shaft-to-intermediate shaft
11. Pump, oil
12. Tube, pump-to-filter
13. Fitting, to-oil pressure gauge
14. Filter, oil
15. Tube, pump suction line
16. Tube, top shaft-to-reverse shaft
17. Cover, oil strainer
18. Plate, suction line guard
19. Strainer, suction line
20. Magnet, suction line
21. Baffle support
22. Baffle
23. Wire bail

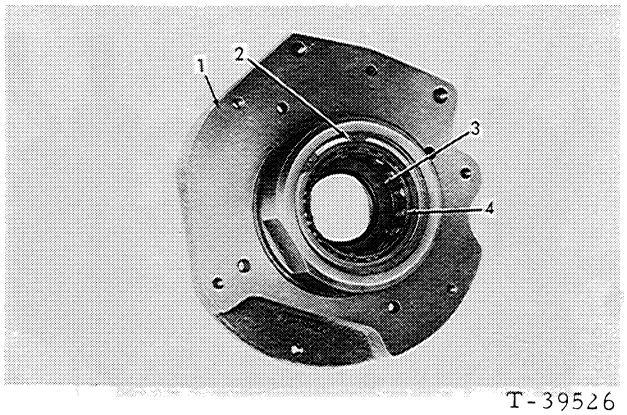


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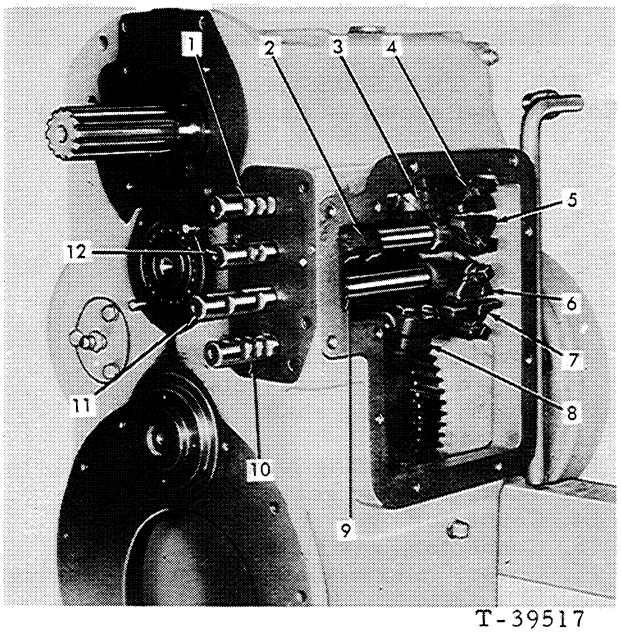
FIG. 12 TRANSMISSION CASE ADAPTER

1. Adapter
2. Snap ring
3. Seal, oil
4. Bearing, rear roller

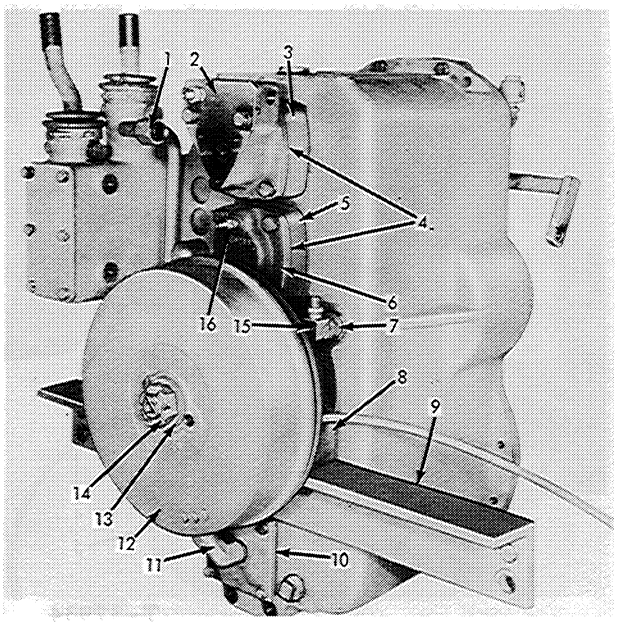


T-39517

FIG. 13 SHIFTING SHAFTS, FORKS AND GUIDES INSTALLED (Early model shown -- Late model similar)

1. Shaft, shifting (2nd, 3rd, 5th, 6th)
2. Fork, shifting (1st, 4th)
3. Fork, shifting (2nd, 3rd, 5th, 6th)
4. Guide, shifting (2nd, 3rd, 5th, 6th)
5. Guide, shifting (1st, 4th)
6. Guide, shifting, reverse
7. Guide, shifting, high-low range
8. Fork, shifting, high-low range
9. Fork, shifting, reverse
10. Shaft, shifting, high-low range
11. Shaft, shifting, reverse
12. Shaft, shifting (1st, 4th)

7. Remove the four shifting shaft interlocking detents from shifting shaft inner locking plate. Slide locking plate and gasket from shifting shafts.



T-40413

FIG. 14 TRANSMISSION -- LEFT FRONT VIEW

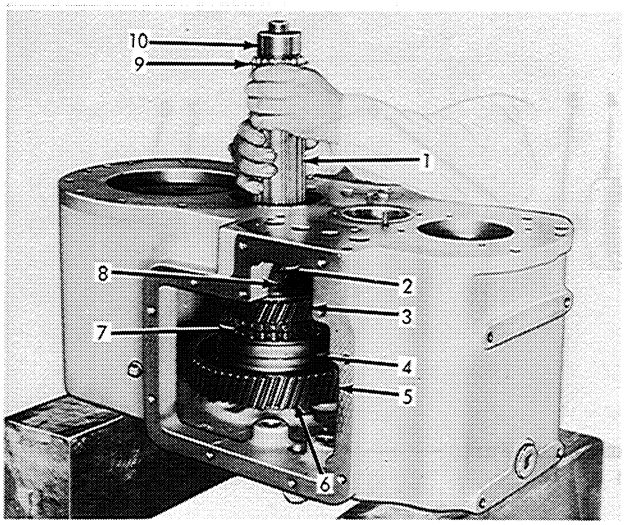
1. Tube, suction
2. Retainer, top shaft front bearing
3. Carrier, top shaft front bearing
4. Shims, retainer adjustment
5. Carrier, intermediate shaft front bearing
6. Retainer, intermediate shaft front bearing
7. Plug
8. Retainer, parking brake
9. Angle, supporting
10. Cover, strainer
11. Elbow
12. Drum, brake
13. Washer, drum retaining
14. Nut
15. Connector, reverse shaft oil tube
16. Connector, restricted

8. Remove gear shift housing assembly and gasket from transmission case.

9. Fig. 13: Cut and remove locking wires from shifter guide setscrews and shifting fork retaining capscrews.

10. Remove capscrew securing reverse shifting fork to shifting shaft. Loosen (do not remove) capscrews securing the three remaining shifting forks to shifting shafts. Loosen jam nuts on shifter guide setscrews, and loosen setscrews until shifter guides are loose on shafts.

11. Pull shifting shafts out, and remove forks as they become free of shafts.



T-39527

FIG. 26 POSITIONING BOTTOM SHAFT

1. Shaft, bottom
2. Gear, forward and reverse
3. Gear, high range
4. Collar, high-low
5. Gear, low range
6. Washer, retaining
7. Hub, gear, high-low
8. Spacer, gear
9. Snap ring
10. Race, inner

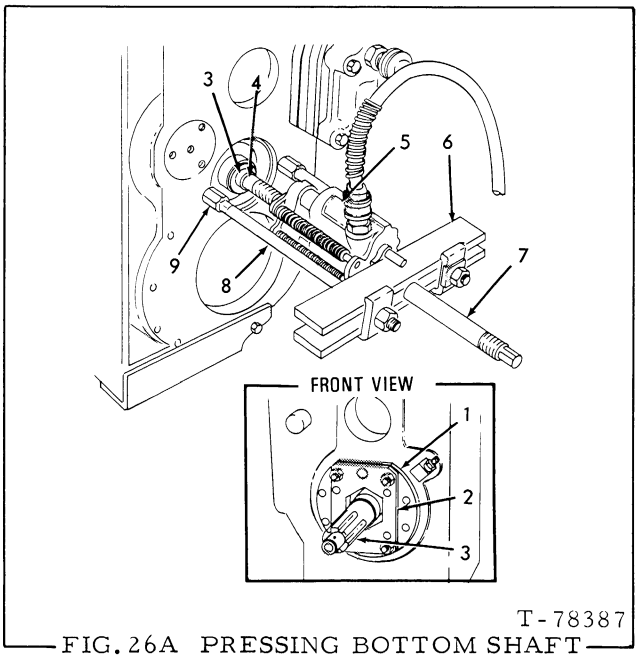


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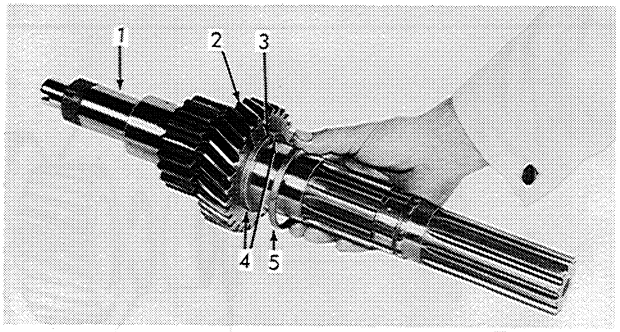
FIG. 26A PRESSING BOTTOM SHAFT INTO FRONT BEARING

1. Bearing carrier
*2. Tool
3. Bottom shaft
4. Shaft protector
5. Hydraulic ram
6. Push - puller
7. Forcing screw
8. Puller leg
9. Adapter

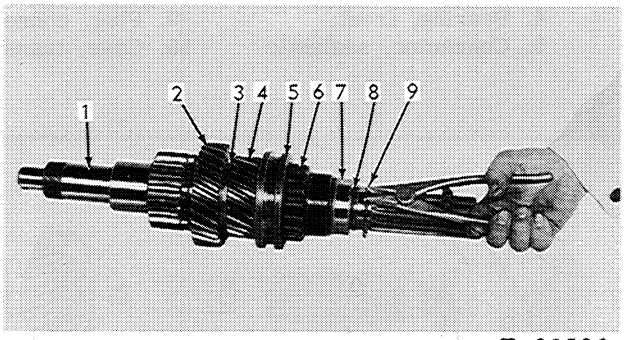
*See Service Tools



T-37929

FIG. 27 INSTALLING SPLIT THRUST WASHER AND RETAINING RING

1. Shaft, top
2. Gear, 2nd and 5th (29T)
3. Pin, thrust washer drive
4. Thrust washer, split
5. Ring, retaining



T-39530

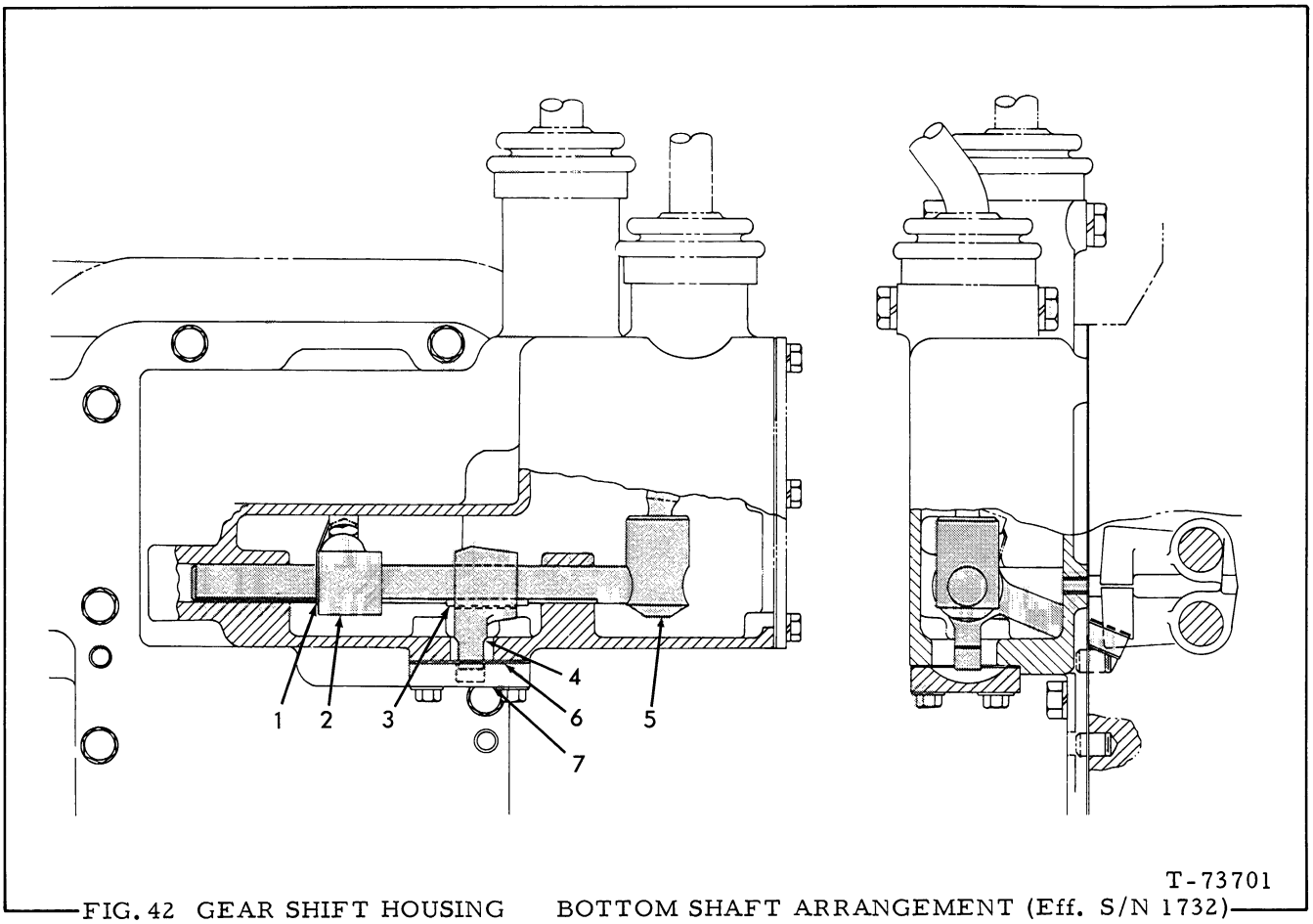
FIG. 28 INSTALLING SNAP RING

1. Shaft, top
2. Gear, 2nd and 5th (29T)
3. Ring, retaining
4. Gear, 1st and 4th (23T)
5. Collar, 1st and 4th shifting
6. Hub, driving
7. Race, rear bearing inner
8. Drilled oil passage
9. Snap ring

ents for each shaft on their respective shafts, and check for free fit between gears and splines, bushings and hubs, hubs and shafts, washers and shafts, shifting collars on speed range gears, etc. Remove components from shafts and keep them in order.

1. REVERSE GEAR AND SHAFT INSTALLATION

a. Fig. 24: Install snap rings in bore of reverse gear. Press rear bearing (double row ball bearing) in bore of helical gear. Press front bearing (single row bearing) in bore of straight tooth gear.



T-73701

FIG. 42 GEAR SHIFT HOUSING BOTTOM SHAFT ARRANGEMENT (Eff. S/N 1732)

1. Lockwire
2. Arm, selector
3. Key
4. Arm, locking
5. Shaft
6. Gasket
7. Block

8. Connect parking brake cable to operating lever bracket; install clips attaching cable to main frame. Turn operating lever adjusting knob (at top of lever) until a positive overcenter action on lever is obtained.

9. Install center battery supporting brace, battery boards and batteries, battery hold downs, seat adjusting latch mechanism, seat and seat frame, and seat and tank assembly front covers.

10. Be certain transmission oil drain plug is installed and tighten securely. Fill transmission with specified lubricant until oil level is even with oil level plug in right side of transmission.

11. Operate engine at 1/2 throttle with high-low range shift lever in LO. Transmission oil pressure must be within operating range on gauge. Check transmission oil lines for leaks; correct any leaks found.

12. Stop engine; install right floor plate. Install center floor plate with decelerator control rod and connect rod.

13. Install shifting levers.

ELECTRICAL SYSTEMS

service manual

FORM 73146366 English

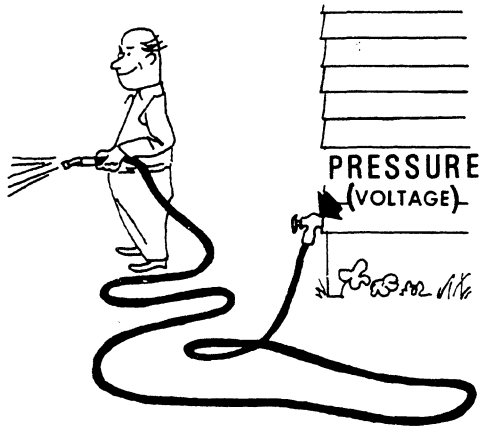
(Replaces 70695436, 73063024, 70696657)

TOPIC 2 TROUBLESHOOTING

2.1 TROUBLESHOOTING INSTRUMENTS

2.1.1
Introduction—Many different tools and instruments have been developed for checking the mechanical or electrical condition of the components of an electrical system. This specialized equipment enables quick and accurate checks in a minimum amount of time. Three basic instruments are used in the testing of electrical equipment. These instruments are the voltmeter, the ammeter, and the ohmmeter.

2.1.2
The Voltmeter—Voltage in an electrical circuit is frequently compared to water pressure in a piping system (Figure 1). The voltmeter is used to measure this electrical pressure to assist in the location of electrical malfunctions. For the applications associated with electrical systems described in this manual, greater accuracy is desired in the voltmeter than in any of the other electrical checking instruments because the most accurate settings have to be made to the voltages in these systems.

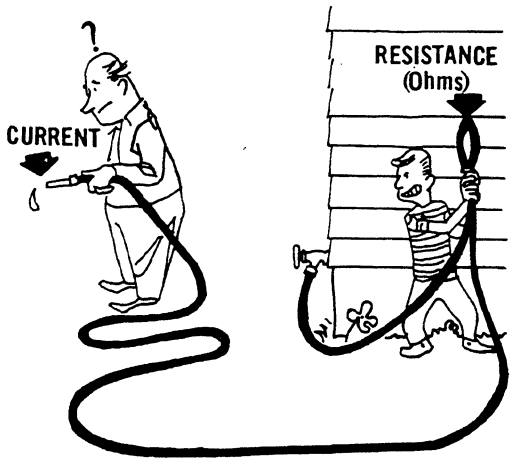


T-74522

FIG. 1 VOLTAGE IS SIMILAR TO PRESSURE IN A WATER HOSE

Voltmeters measure the difference in electrical pressure between the points where the voltmeter leads are attached. For example, a voltmeter connected across the terminal posts of a battery measures the difference in electrical pressure—the battery voltage—between the two terminals. A voltmeter connected across a resistor (in parallel, with one lead connected to each side of the resistor) measures the difference in voltage caused by the resistor. Typically, the voltage at a given point in a circuit is measured with respect to the voltage at some reference point, usually the return side of the circuit at the battery. It is often the case that one side of the battery is connected (grounded) to the conducting metal frame and chassis of the unit. In such cases, the chassis is used instead of many separate wires to the battery terminal. In general, the grounded battery terminal should be used as the reference point for the voltages in a circuit.

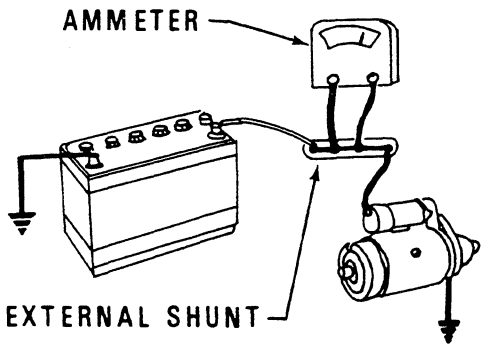
2.1.3
The Ammeter—The current past a point in an electrical circuit can be compared to the quantity of water that can flow through a particular pipe in a water system. The amount of current (measured in amperes) that will flow depends on the voltage (like pressure) available to push the current and on the amount of resistance encountered in the electrical circuit to impede it. (See Figure 2.)



T-74524

FIG. 2 AMPS AND OHMS ARE SIMILAR TO CURRENT AND RESISTANCE IN A WATER HOSE

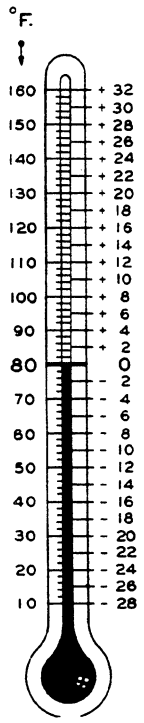
The ammeter is used to measure the flow of current. Since the current flows through the circuit, an ammeter must be connected in series with the circuit being measured. However, most ammeters cannot use all the current in the circuit in indicating a measurement, so a large, accurately measured fraction of the current is often diverted through an external path or shunt (shown in Figure 3) across the



T-74523

FIG. 3 EXTERNAL SHUNT

MEMO



EXAMPLE No. 1 —
Temperature *below* 80°F.
Hydrometer Reading 1.250
Acid Temperature 20°F.
***Subtract* .024 Sp. Gr.**
Corrected Sp. Gr. is 1.226

EXAMPLE No. 2 —
Temperature *above* 80°F.
Hydrometer Reading 1.235
Acid Temperature 100°F.
***Add* .008 Sp. Gr.**
Corrected Sp. Gr. is 1.243

(T-74527)

FIG. 22 CORRECTION FOR HYDROMETER

CAUTION

The battery electrolyte is a corrosive, acid solution. Avoid any contact of the electrolyte with skin, eyes, or clothing. If spills occur, they should be washed immediately with large amounts of water and, if possible, soap.

7.3 MAINTENANCE

7.3.1
Basic Servicing—A battery is a perishable item requiring periodic service. When a battery is properly maintained, the reward will be long and trouble-free operation. Regular maintenance should include the following steps:

1. Check the electrolyte level. Add clean water (distilled, if available) to maintain the prescribed level, but do not overfill the battery cells and cause a loss of electrolyte from spillage. Excessive use of water indicates overcharging or possible leakage.

2. Keep the top of the battery clean. When necessary, wash corrosion off the terminals with a baking soda solution, and rinse them with clear water. Use a steel brush or steel wool, if necessary, to be sure that the terminals are really clean. Coat the connections and the terminals with a very light layer of grease to retard additional corrosion.

3. Inspect the cables, clamps, and hold-down brackets. Clean them, and replace them as necessary.

7.3.2
Temperature Considerations—The electrolyte of a battery, in various states of charge, will start to freeze at the temperatures indicated below. The given temperatures indicate the approximate temperatures at which ice crystals first begin to form in the electrolyte. The electrolyte will not freeze solidly until a slightly lower temperature is reached, but solid freezing of the electrolyte may crack the battery container or damage the plates.

Specific Gravity (Corrected to 80°F (27°C)	Freezing Temperature
1.280	-90°F (-69°C)
1.250	-62°F (-55°C)
1.200	-16°F (-27°C)
1.150	+ 5°F (-15°C)
1.100	+19°F (- 7°C)

A battery charged three-fourths or more is in no danger of freezing, so batteries shoulc be kept at least three-fourths charged in winter weather.

7.3.3
Storage—If the equipment is not going to be used for more than one month, the battery should be removed and stored in a cool, dry place. During extended storage, it should be checked periodically and recharged as necessary. A battery left unused for a long period of time is subject to the crystallization of lead sulfate on the plates; this deterioration will adversely affect future performance.

7.3.4
Testing on the Unit—The electrolyte level should be checked and corrected, and the battery should be visually inspected. Signs of damage or serious abuse, like excessive corrosion, a cracked or bulging case, or cracked cell covers, will mean that the battery has to be replaced. A hydrometer test also can be performed.

The voltage of each cell of the battery may be checked with a voltmeter to be sure that each cell is properly charged. It is possible that a single cell of the battery has gone bad and has become incapable of holding a charge. This will be evident either through a low battery voltage, or a low individual cell voltage. Figure 18 illustrates the use of a special voltmeter to check the battery. Any voltmeter can be used, and the voltmeter should indicate between 1.7 and 1.8 volts per cell for battery temperatures between 70°F and 90°F (21°C and 33°C). If any cell indicates a low voltage and the situation cannot be remedied by charging (as described in Section 7.3.6), the battery will have to be replaced.

It is possible for a faulty battery to indicate sufficiently high cell voltages on a voltmeter, but still not perform satisfactorily on the unit. This is because the voltmeter

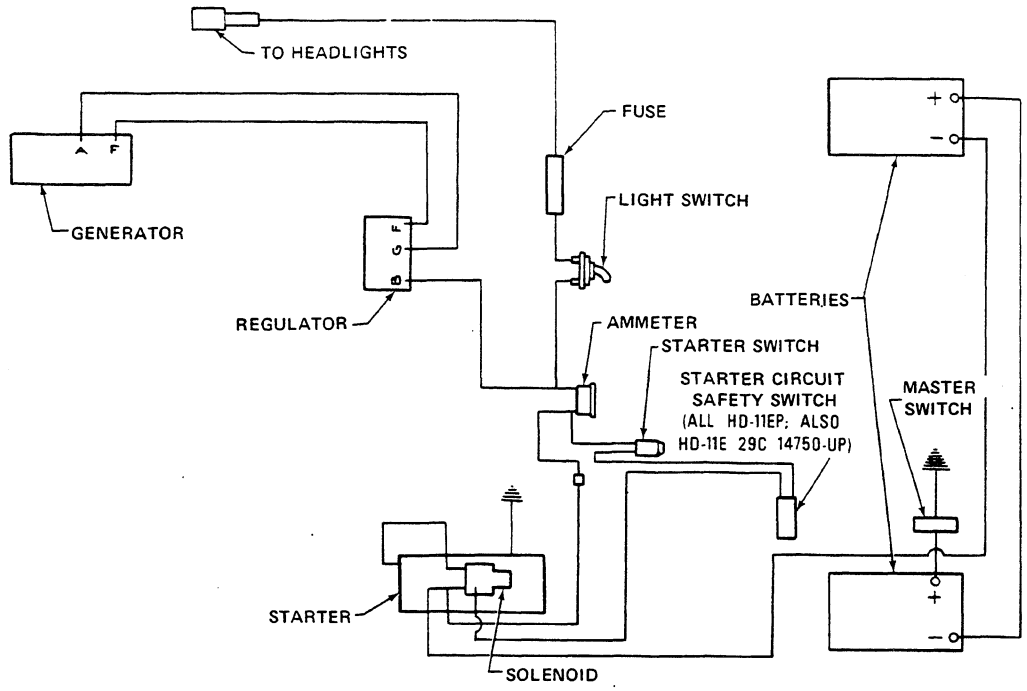


FIG. 27 HD-11 CRAWLER TRACTOR, HD11G CRAWLER LOADER (S/N 6427-up; 17L14651 through 17L16000; 29C14651 through 29C16000; 46Y14651 through 46Y16000)

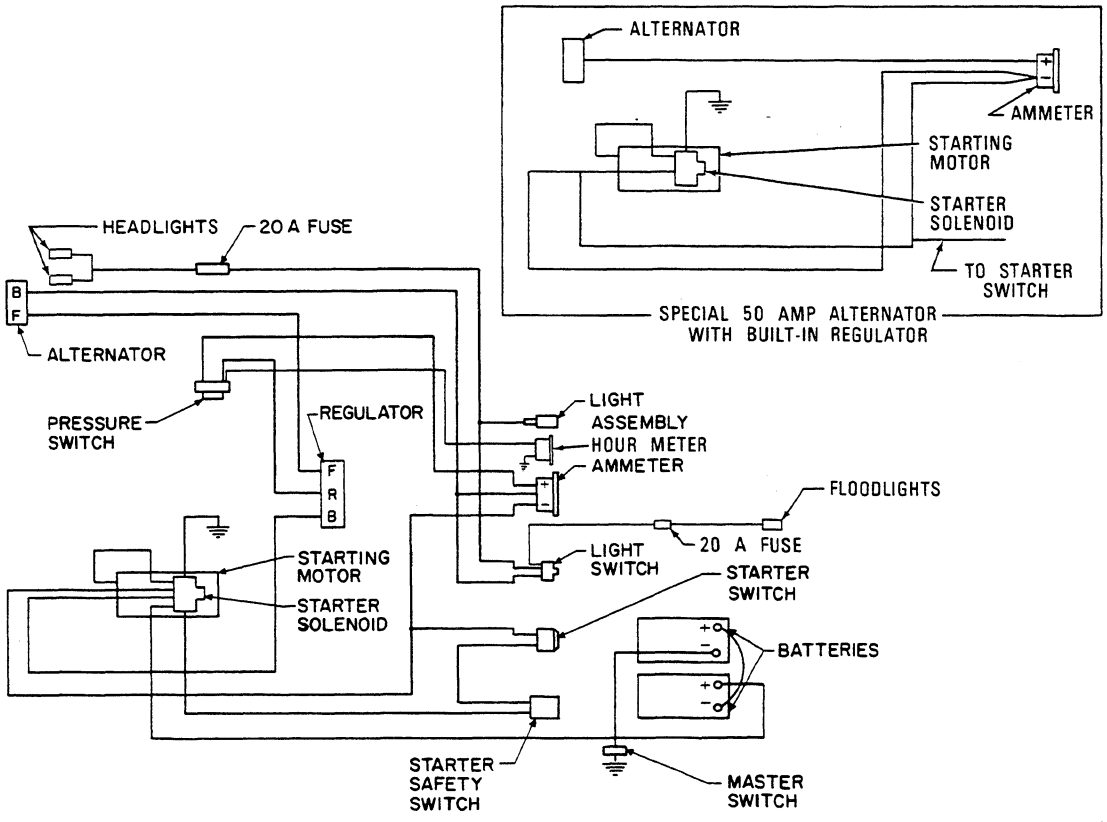
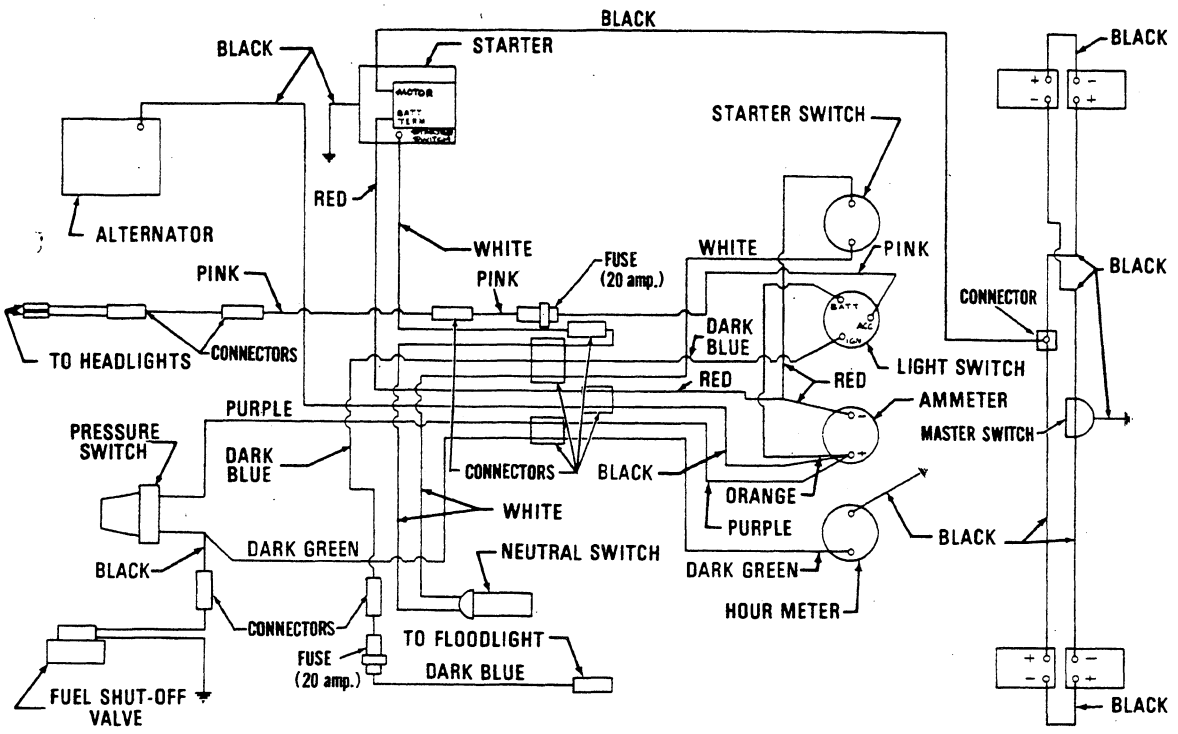
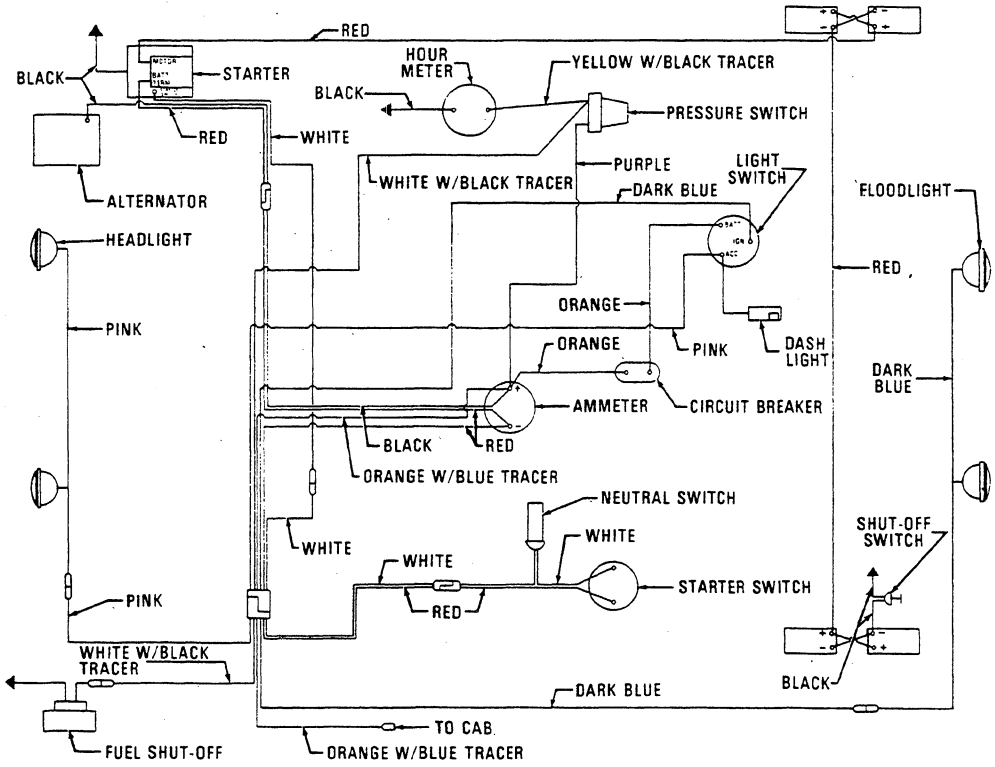


FIG. 28 11-B CRAWLER TRACTOR (S/N 16C16001-up; 25L16001-up)



HD-41

T-74508



41-B

T-78590

FIG. 39 WIRING SCHEMATIC

Study SAFETY RULES in the front of this manual thoroughly for the protection of machine and safety of personnel.

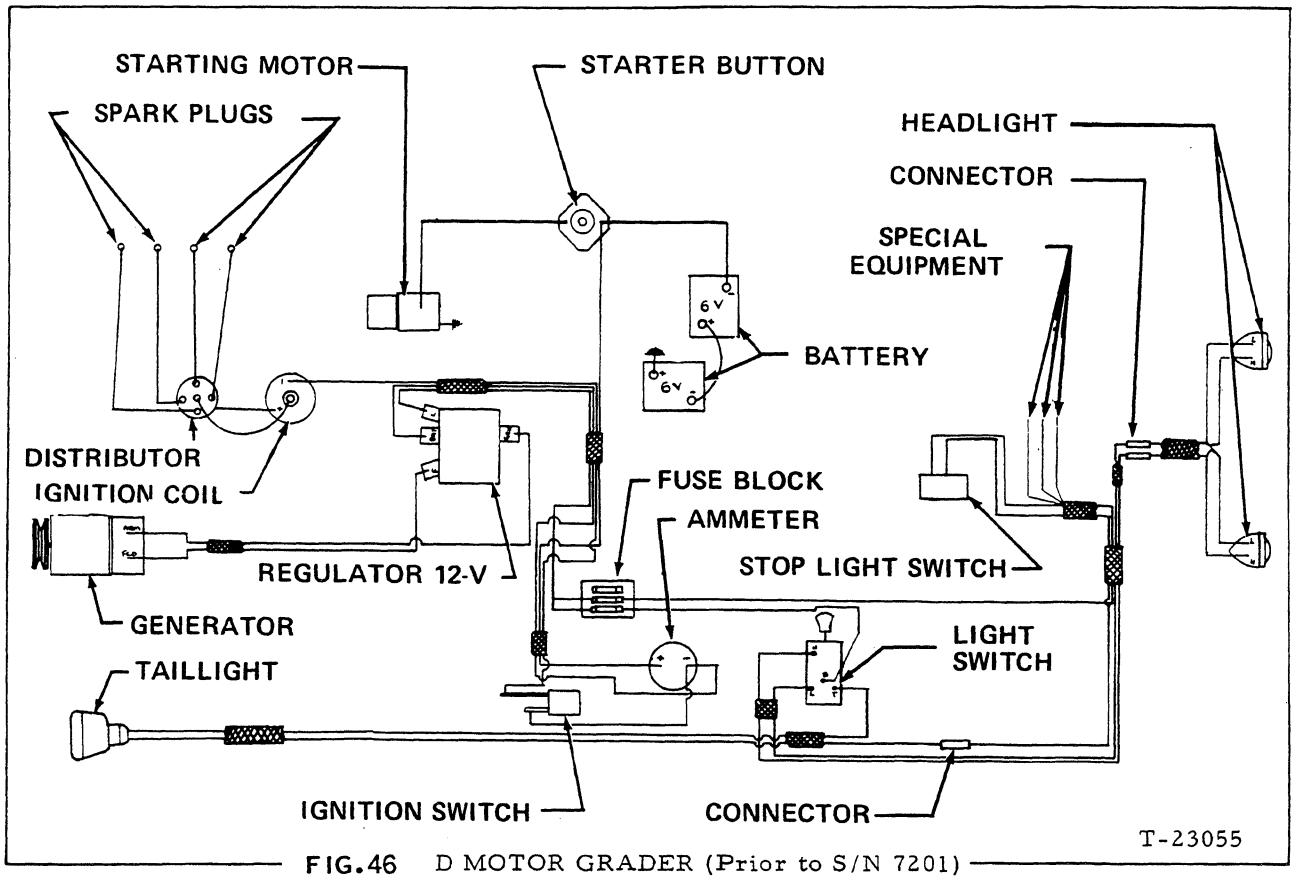


FIG. 46 D MOTOR GRADER (Prior to S/N 7201)

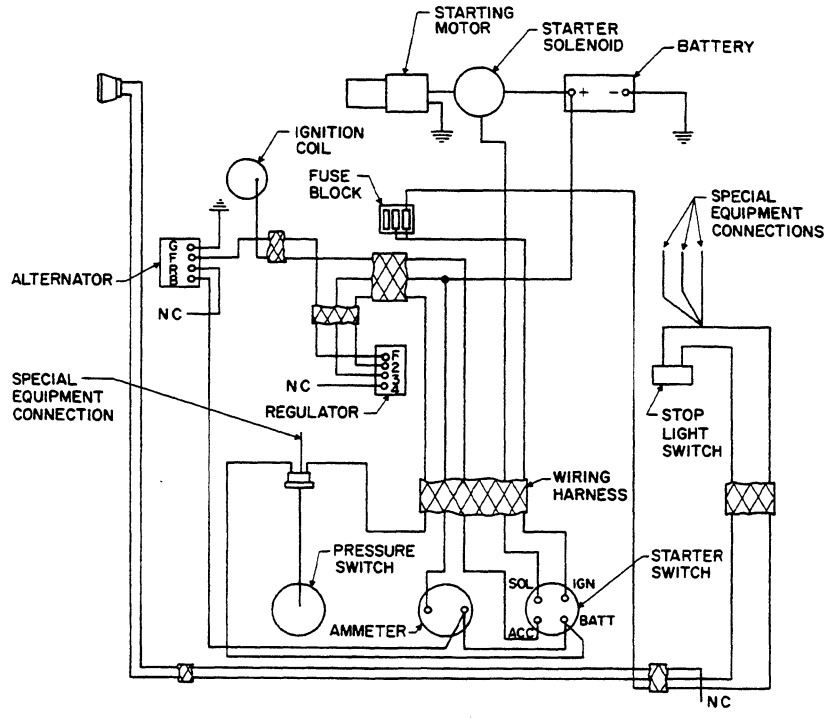


FIG. 47 D MOTOR GRADER (S/N 7201-up)

Electrical System Schematics

Legend for Fig. 59

1. Circuit Breaker
2. Circuit Breaker
3. Circuit Breaker
4. Circuit Breaker
5. Circuit Breaker
6. Circuit Breaker
7. Circuit Breaker
8. Circuit Breaker
9. Key switch
10. Hourmeter
11. Voltmeter
12. Engine start clearing switch(FG85,95 only)
13. Cold start switch
14. Cold start solenoid
15. Coldstart engine temperature switch
16. Engine oil pressure/hourmeter switch
17. Full fuel solenoid
18. Lamp diode(FG85,95 only)
19. Starter

Electrical System Schematics

Legend for Fig. 64

1. Circuit Breaker
2. Circuit Breaker
3. Circuit Breaker
4. Circuit Breaker
5. Circuit Breaker
6. Circuit Breaker
7. Circuit Breaker
8. Circuit Breaker
9. Key switch
10. Reverse alarm
11. Reverse alarm switch
12. Saddle lock pin solenoid
13. Moldboard pin switch
14. Beacon switch
15. Beacon

T-78864

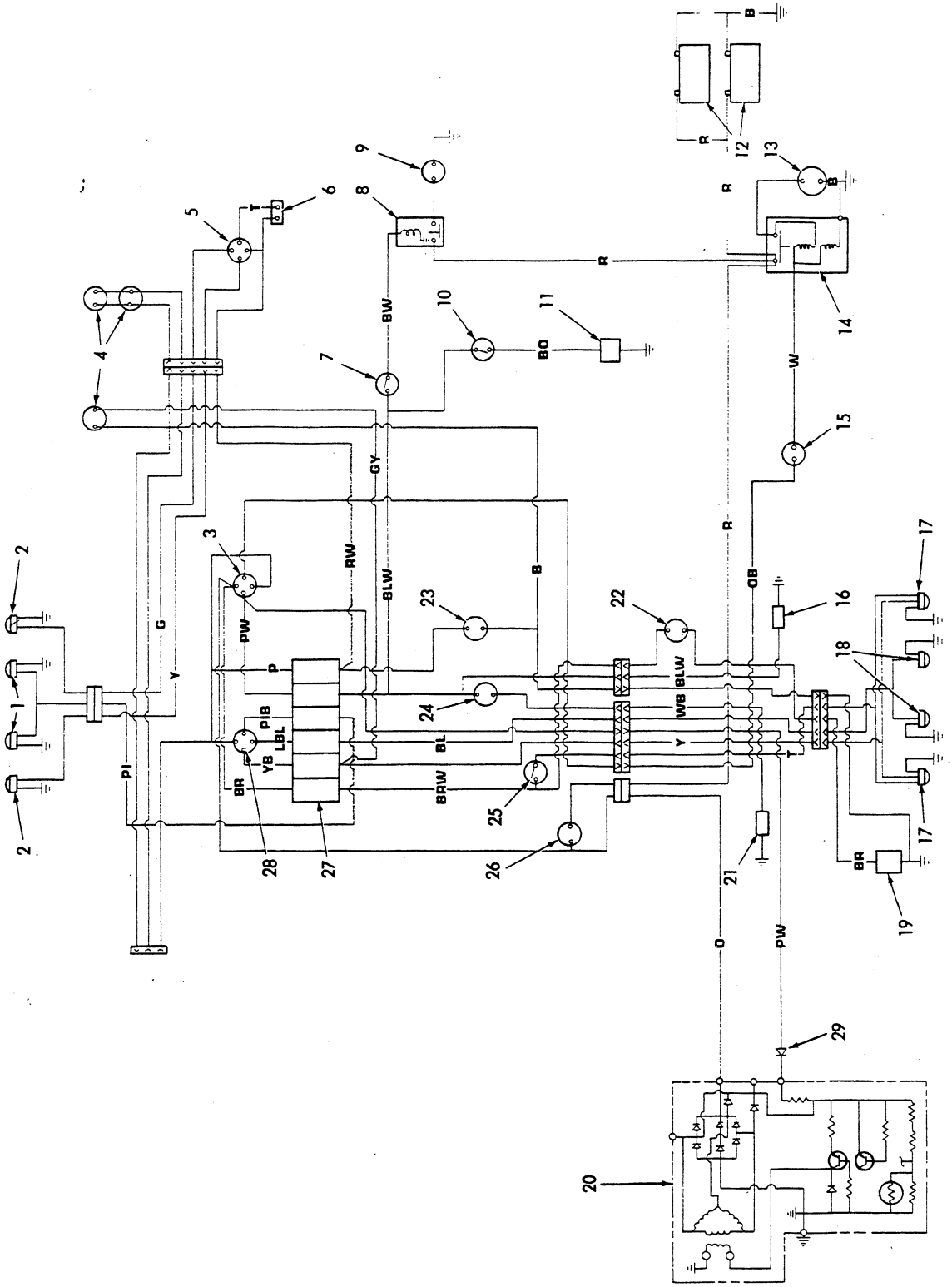
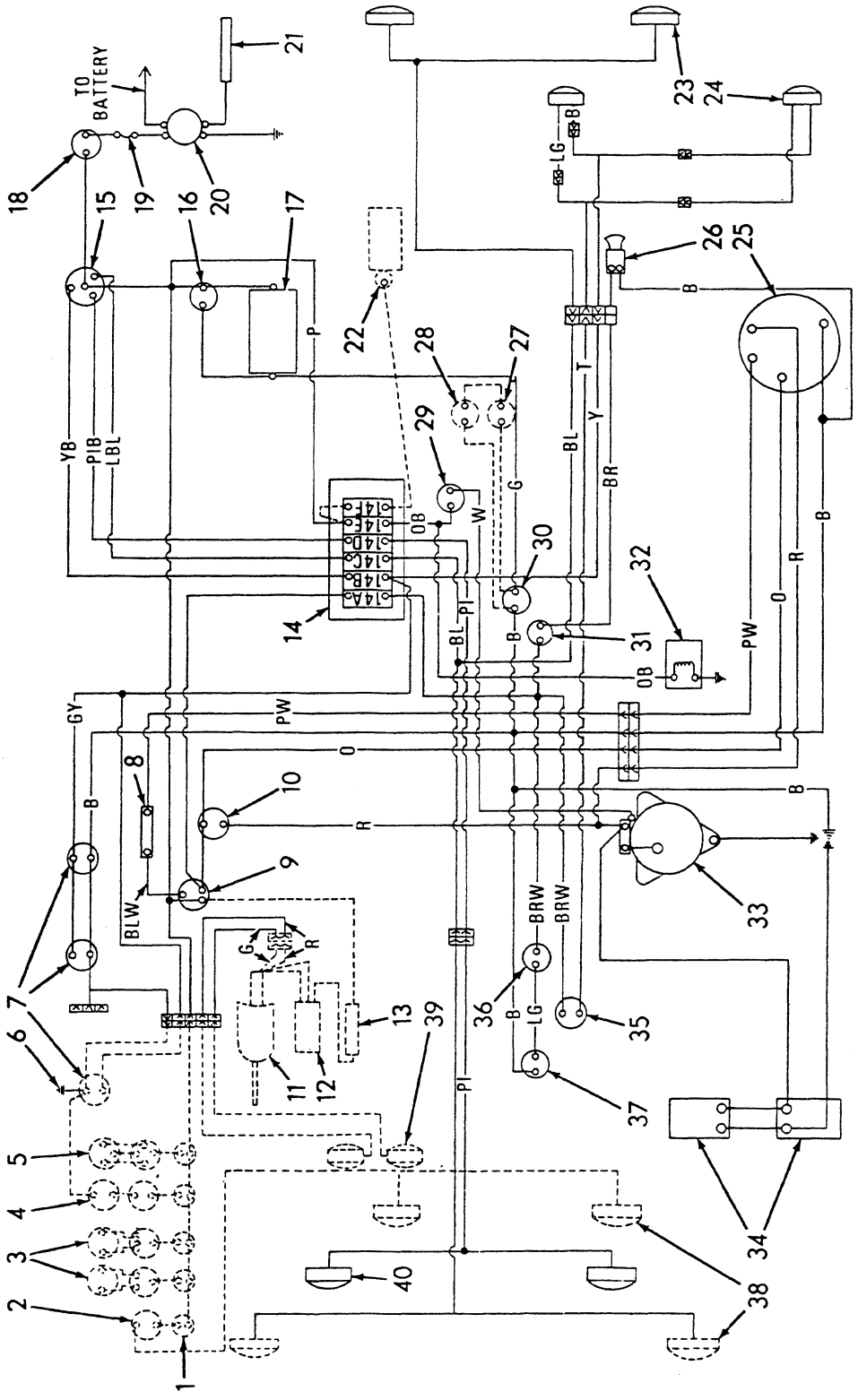


FIG. 73 345-B WHEEL LOADER



T-80419

FIG. 81 ELECTRICAL SYSTEM SCHEMATIC
(Eff. 545-B S/N 21C06870 and 605-B S/N 6863)
(Except 545-B S/N 33A07204-UP)

LEGEND FOR FIG. 49

1. Flood light switch
2. Cab defroster fans
3. Rear window wiper
4. Front window wiper
5. Cab ground
6. Instrument panel lights
7. Key switch
8. Ammeter
9. Circuit breaker junction box
9A. Stop lights - 8 amp
9B. Tail lights - 8 amp
9C. Flood lights - 15 amp
9D. Head lights - 8 amp
9E. Starter switch - 15 amp
9F. Cab heater - 8 amp
10. Low air pressure buzzer
11. Low air pressure warning light
12. Light switch
*13. Engine air heater switch
*14. Fuse
*15. Magnetic switch
*16. Air heater
17. Cab heater switch
18. Rear flood lights
19. Stop lights/tail lights
**20. Back-up alarm
21. Alternator (integral) 40, 45 or 50 amps
***22. Electric F.I.P. shut off
23. Low air pressure switch
24. Starter switch
**25. Back-up alarm pressure switch
26. Starting motor
27. Batteries
28. Stop light switch
**29. Hour meter pressure switch
**30. Hour meter
31. Optional flood lights
32. Optional turn signals
33. Fuse
34. Turn signal flasher
35. Turn signal switch
36. Head lights
37. Fuse and fuse holder
38. Resistor (part of integral alternator circuit)

See Note
*** Standard circuit after Feb. 1966 (S/N 11Y04904)
** Standard circuit after May 1966 (S/N 11Y05008)
* Standard circuit after Nov. 1977 (S/N 11Y05638)

NOTE: Not applicable to brush-type alternator

COLOR CODE FOR FIG. 49

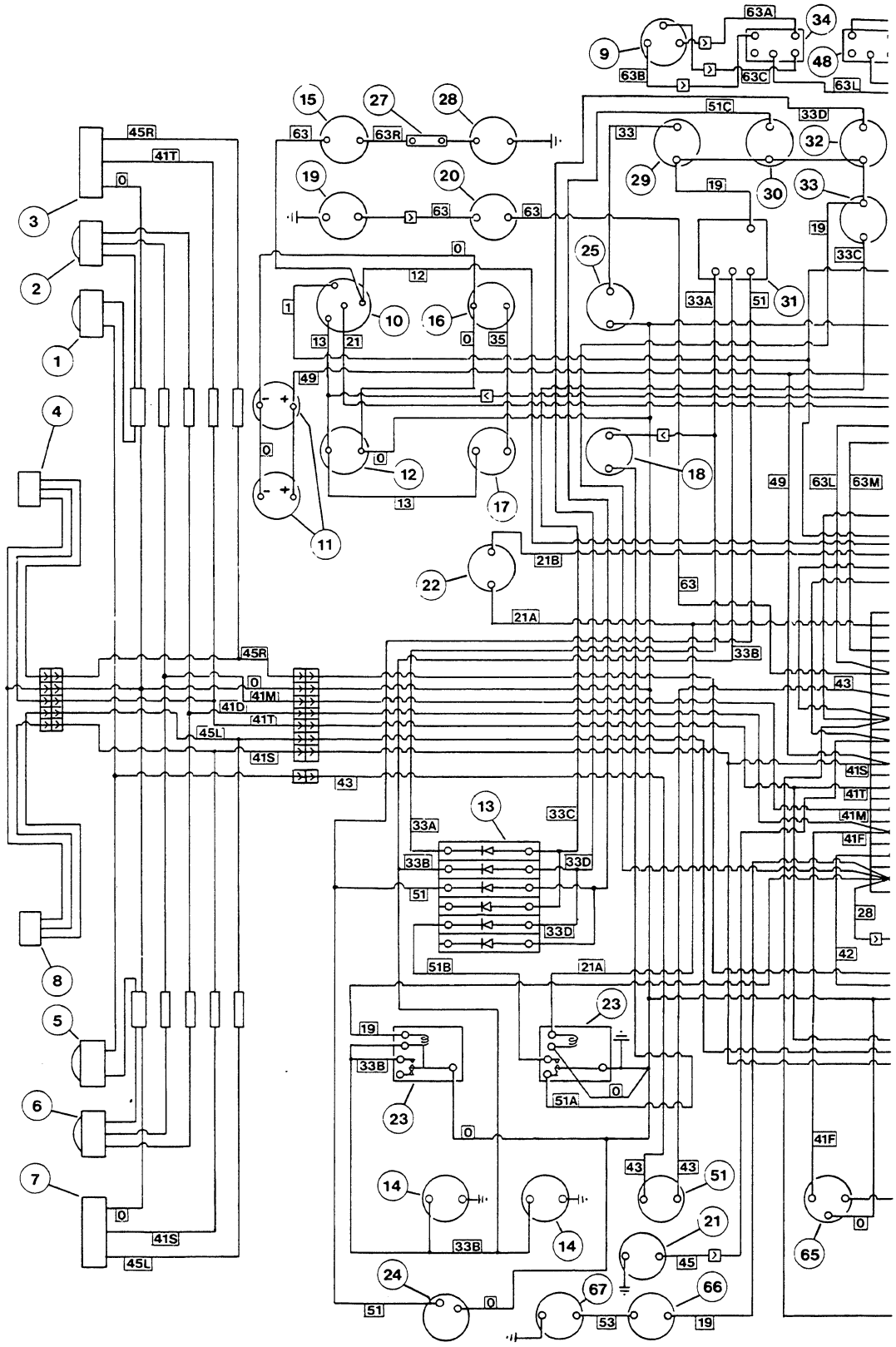
B - Black
LBl - Light Blue
Bl - Blue
Br - Brown
G - Green
LG - Light Green
Gy - Grey
O - Orange
P - Purple
Pi - Pink
R - Red
T - Tan
W - White
Y - Yellow
Br/W* - Brown with white tracer
O/B* - Orange with black tracer
Pi/B* - Pink with black tracer
Y/B* - Yellow with black tracer

LEGEND FOR FIG. 93

1. Panel Lights
2. Key Switch
3. Ammeter
4. Cab Junction Box
5. Brake Fluid Level Warning Light
6. Low Air Pressure Warning Light
7. Light Switch
8. Warning Buzzer
9. Headlight
10. Pressure Convertor Stroke Switch
11. Starter Switch
12. Pressure Switch
13. Pressure Switch
14. Back-Up Horn
15. Stop, Tail, Flasher Light
16. Alternator
17. Hourmeter
18. Starter Motor
19. Pressure Switch
20. Batteries
21. Floodlight
22. Resistor
23. Fuel Shut-Off Solenoid
24. Stoplight Switch
25. Flasher Switch
26. Flasher Unit
27. Flasher Warning Light
28. Hazard Warning Light
29. Side and Flasher Light
30. Main Beam Warning Light
31. Cab Connector
32. Diode
33. Warning Light, Floodlight

WIRING COLOUR CODE

B	—	Black
BL	—	Blue
BR	—	Brown
G	—	Green
LG	—	Light Green
GR	—	Grey
O	—	Orange
P	—	Purple
R	—	Red
T	—	Tan
DG	—	Dark Green
W	—	White
GW	—	Green/White
RB	—	Red/Black
RW	—	Red/White
YB	—	Yellow/Black
BRW	—	Brown/White
GR	—	Green/Red
BRY	—	Brown/Yellow
BRG	—	Brown/Green
BRR	—	Brown/Red
BLR	—	Blue/Red
BLW	—	Blue/White
GY	—	Green/Yellow
GB	—	Green/Black
GBR	—	Green/Brown
PB	—	Purple/Black



(LEGEND : see page 124)

FIG. 98-FR10 **ELECTRICAL**

(Loader serial no.

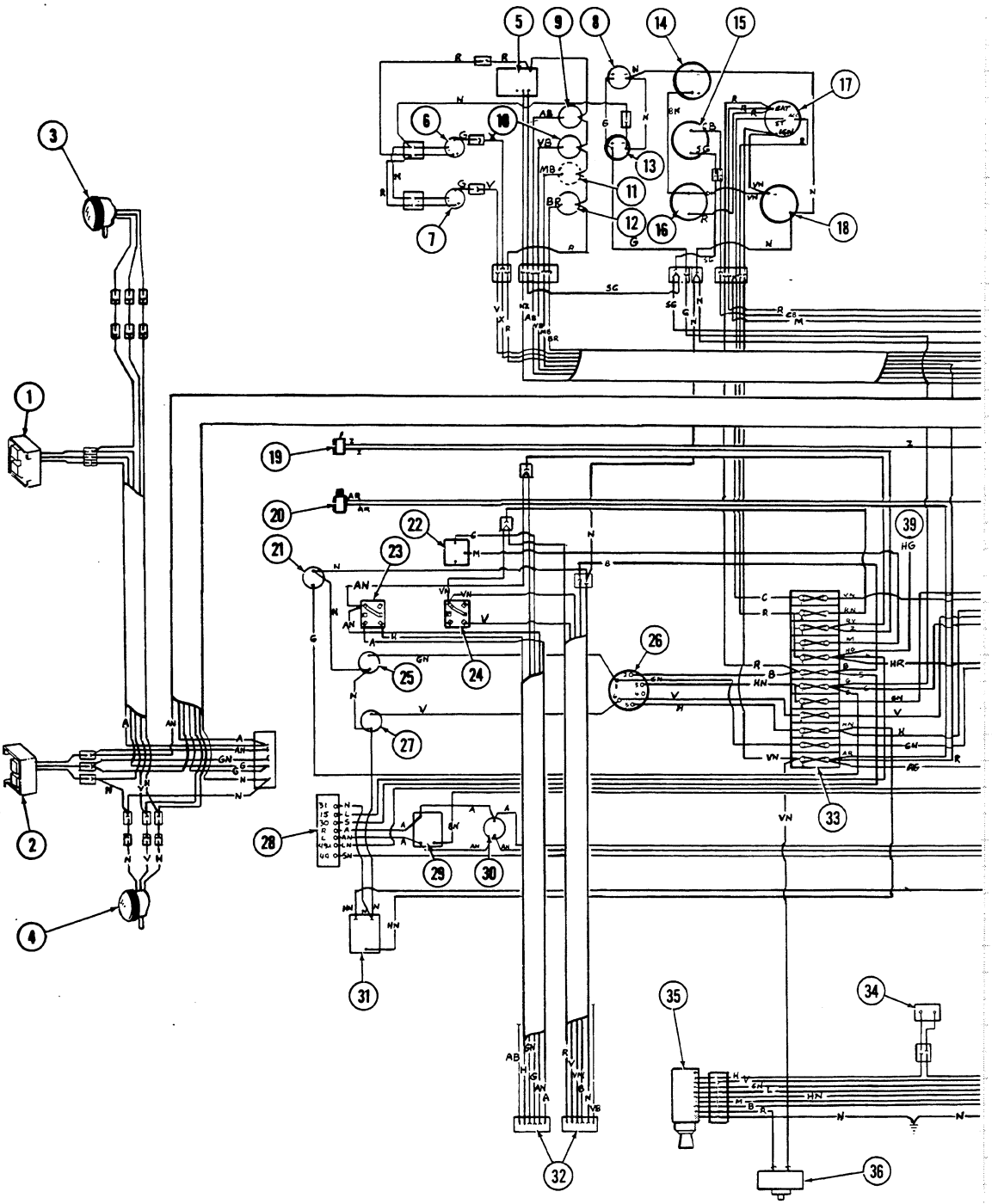
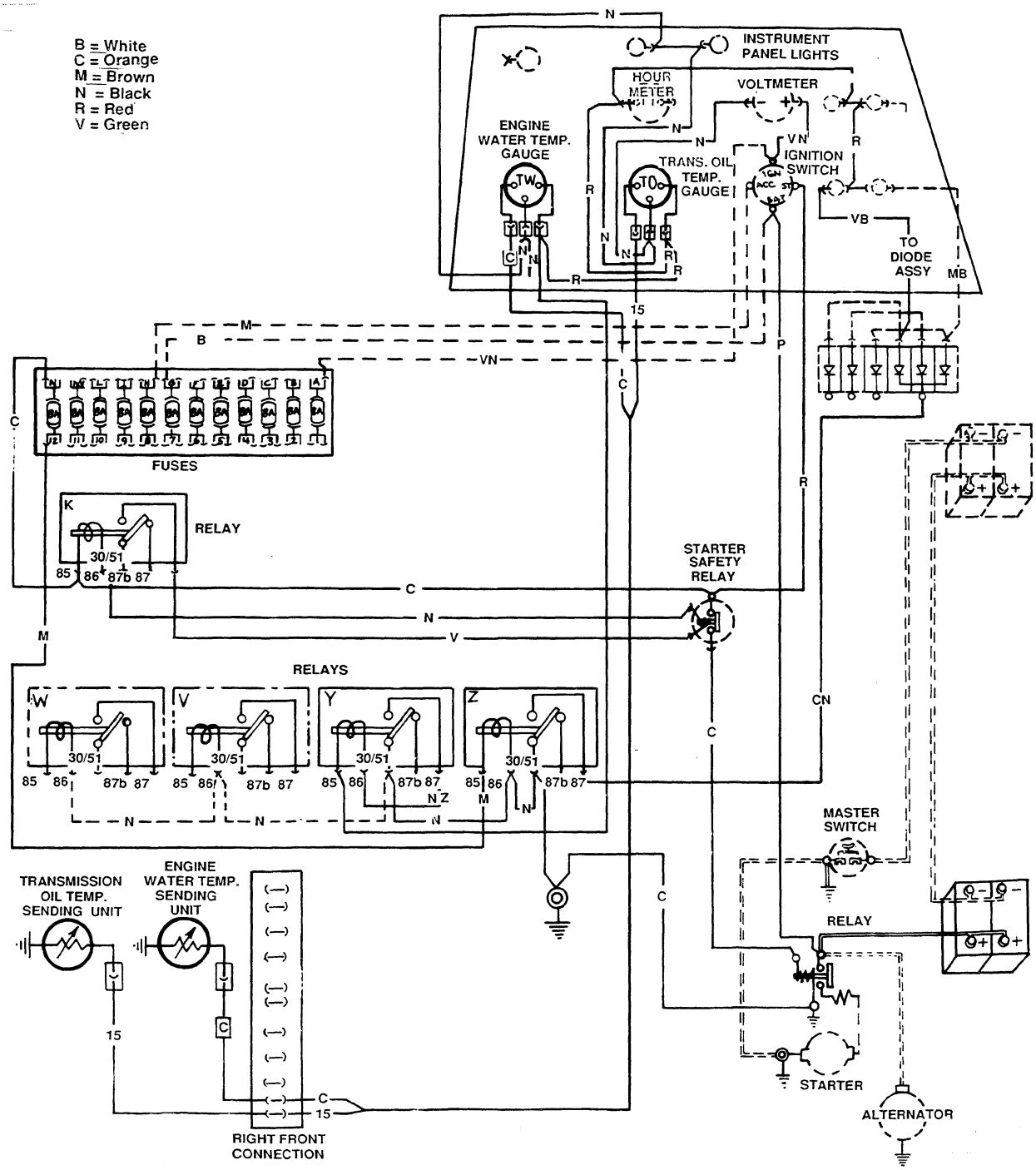


FIG. 101 FR10 (S/N 525395-UP);



T-85280

FIG. 107 FR15 (S/N 575403-UP) ENGINE WATER TEMP. and TRANS. OIL TEMP. GAUGES

NOTE:

1. Circuits are identified by a number, or by a number and letter, contained in a square box. Metal tags bearing the circuit identification number are attached to each wire at all connectors and / or connection points.

2. Components are designated by a number in a circle. The following list identifies each designated component by its name.

LEGEND FOR FIG. 113

1. Right front cab floodlight
2. Right front head light
3. Right front side and turn signal/hazard flasher light
4. * Right front side and turn signal/hazard flasher light
5. Left front cab floodlight
6. Left front head light
7. Left front side and turn signal/hazard flasher light
8. * Left front side and turn signal/hazard flasher light
9. Front windscreen wiper motor
10. Ignition switch
11. Panel lights
12. Voltmeter
13. Diode assembly
14. Overstroke sensor switch
15. Rear windscreen washer switch
16. Hour meter
17. Engine oil pressure switch
18. Air pressure switch
19. Front windscreen washer pump
20. Front windscreen washer switch
21. Dome light
22. Neutral safety switch
23. Relay
24. Flow switch
25. Parking brake switch
26. Circuit breaker assembly
27. 10 amp. fuse
28. Rear windscreen washer pump
29. Parking brake "on" light
30. Emergency steering activated light
31. Buzzer
32. Brake system fault light
33. Low air pressure light
34. Front windscreen wiper switch
35. Flasher unit
36. Turn signal switch
37. Hazard warning switch
38. Light switch
39. Ether starting aid switch
40. Starter solenoid
41. Battery disconnect switch
42. Starter motor
43. Ether start solenoid
44. Thermo guard
45. Panel light
46. Heater switch
47. Heater unit
48. Rear windscreen wiper switch
49. Rear windscreen wiper motor
50. Turn signal/hazard flasher indicator light
51. Cab floodlight switch
52. Brake light switch
53. Excess fuel solenoid
54. Alternator
55. Batteries (2)
56. Alarm switch
57. Back-up alarm
58. Right rear flood light
59. Right rear turn signal/hazard flasher/tail light
60. Registration number plate light
61. Left rear flood light
62. Left rear turn signal/hazard flasher/tail light
63. Main beam warning light
64. Flood warning light
65. Fog light switch

* Fitted to Bucket Tooth Guard (Special Equipment)

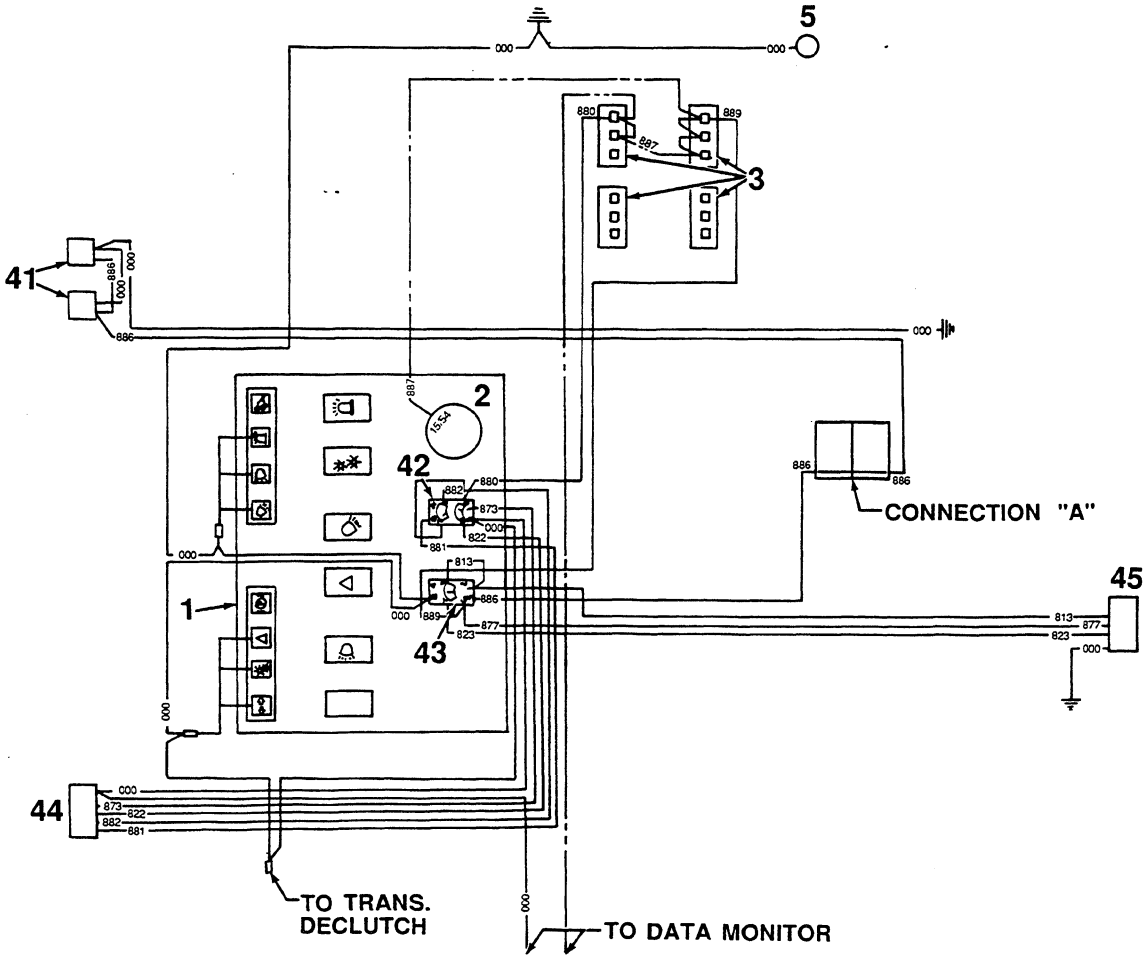


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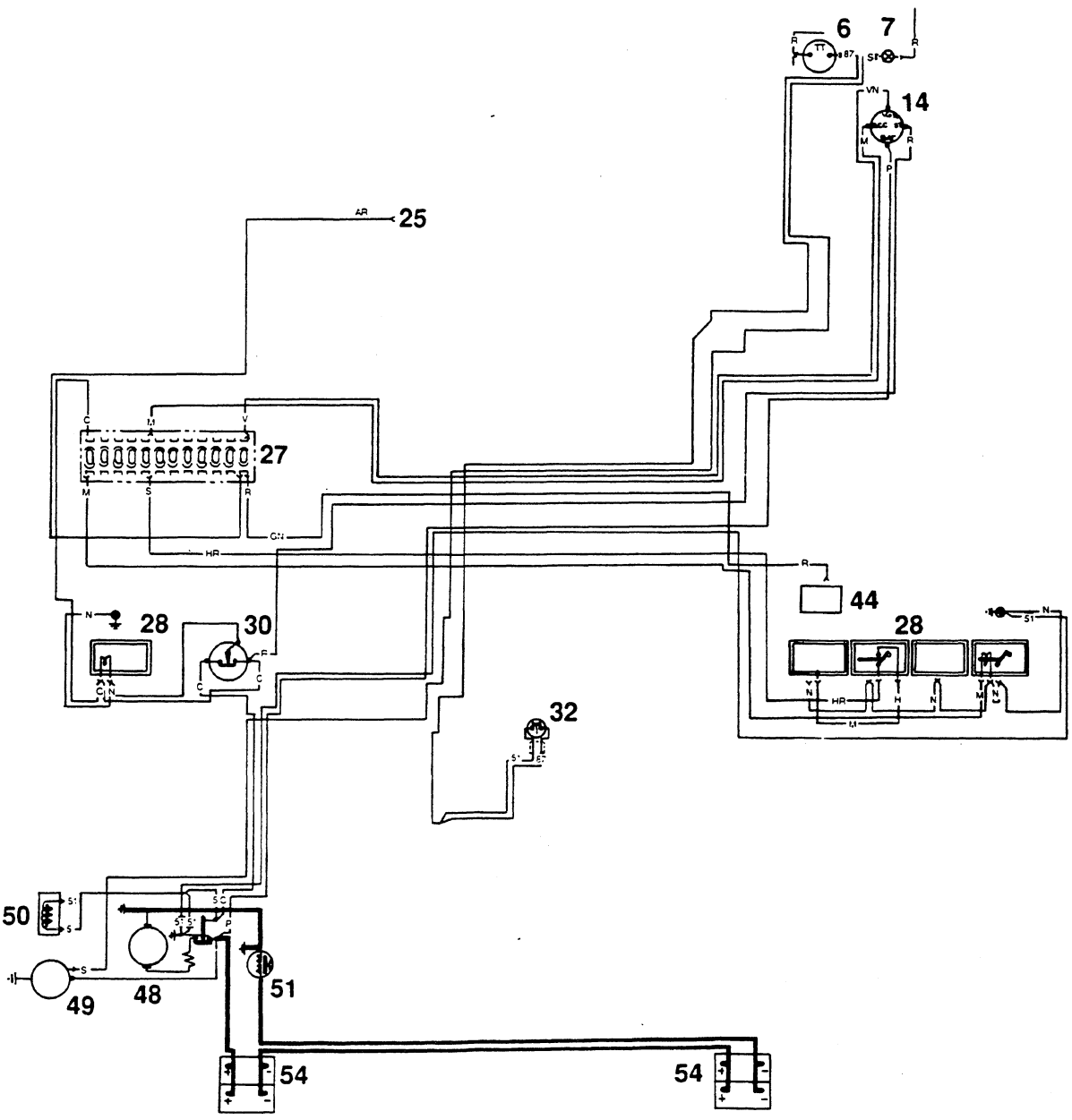
FIG. 120 FR10B WINDSHIELD WIPERS & WASHERS



T-85673

FIG. 128 FR11, 12B, 15B, 20B BATTERY FEED

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