

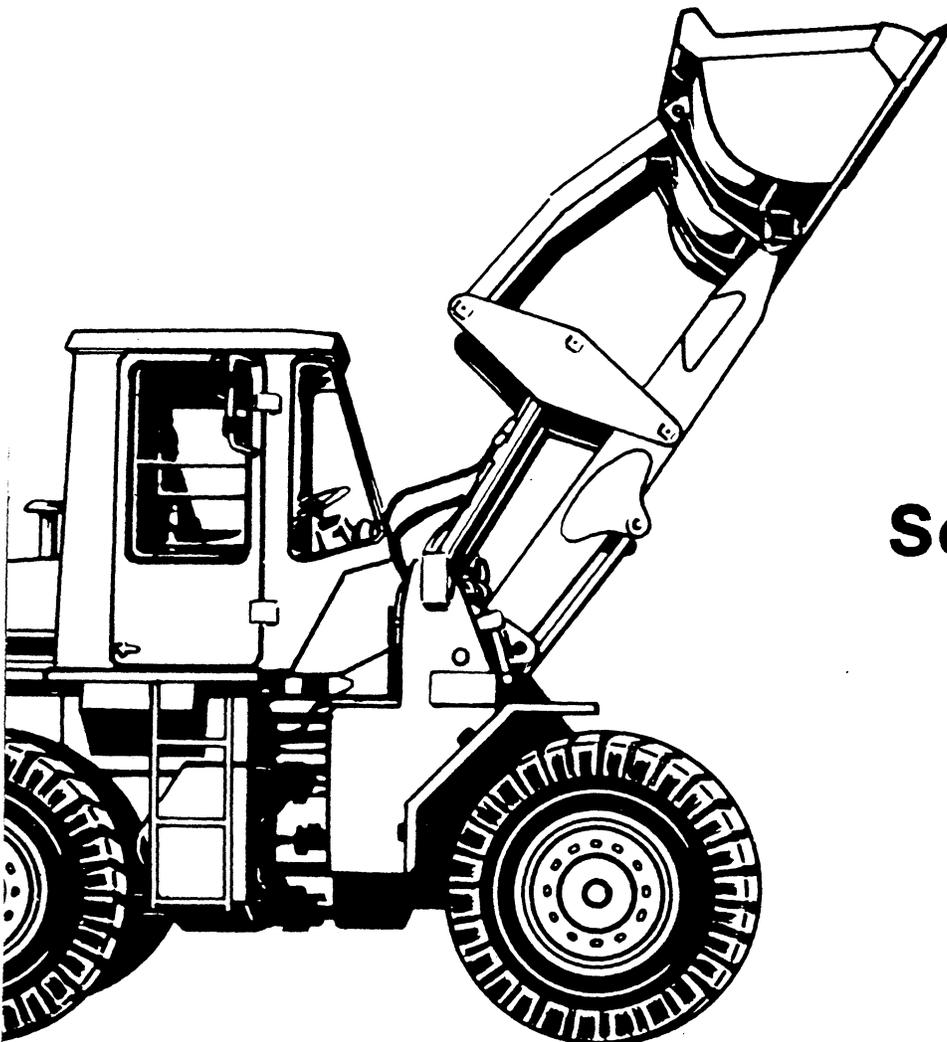
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# FR10 FR12 FR15

WHEEL LOADERS

## Brakes and air system

## Service manual



Form 73148730 English  
6-85

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# FR10,FR12,FR15

wheel loaders

## service manual

brakes and air system

S/N 78Y00101-UP

S/N 46C00101-UP

S/N 58M00101-UP

S/N 79M00101-UP

S/N 59U00101-UP

S/N 80U00101-UP

Form 73148730 English

## WARNING

**STUDY THE OPERATION AND MAINTENANCE INSTRUCTION MANUAL THROUGH BEFORE STARTING, OPERATING, MAINTAINING, FUELING OR SERVICING THIS MACHINE.**

-  The Operation and Maintenance Instruction Manual provides the instructions and procedures for starting, operating, maintaining, fueling, shutdown and servicing that are necessary for properly conducting the procedures for overhaul of the related components outlined in this Service Manual.
-  This symbol is your safety alert sign. It means **ATTENTION! BECOME ALERT! YOUR SAFETY IS INVOLVED!**
-  Read and heed all safety instructions carrying the signal words **WARNING** and **DANGER**.
-  Machine mounted safety signs have been color coded yellow with black borders and lettering for **WARNING** and red with white borders and lettering for **DANGER** points.



# 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, overhangs, timber, demolitions, fire, high walls, dropoff, backfills, 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 dropoffs 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 handholds 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 shutdown 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.

To prevent entrapment in cabs or mounted enclosures, observe and know the mechanics of alternate exit routes.

On machines equipped with suction radiator fans, be sure to periodically check all engine exhaust parts for leaks as exhaust gases are dangerous to the operator. Keep a vent open to outside air at all times when operating within a closed cab.

**STARTING FLUID IS FLAMMABLE.** Follow the recommendations as outlined in the Operation and Maintenance Instruction Manual and as marked on the containers. Store containers in cool, well-ventilated place secure from unauthorized personnel. **DO NOT PUNCTURE OR BURN CONTAINERS.** Follow the recommendations of the manufacturer for storage and disposal.

Wire rope develops steel slivers. Use authorized protective equipment such as heavy gloves, safety glasses when handling.

# SAFETY RULES

## OPERATION

Before starting machine, check, adjust and lock the operator's seat for maximum comfort and control of the machine.

**DO NOT START OR OPERATE AN UNSAFE MACHINE.** Before working the machine, be sure that any unsafe condition has been satisfactorily remedied. Check brakes, steering and attachment controls before moving. Advise the proper maintenance authority of any malfunctioning part or system. Be sure all protective guards or panels are in place, and all safety devices provided are in place and in good operating condition.

Check instruments at start-up and frequently during operation.

Do not run the engine of this machine in closed areas without proper ventilation to remove deadly exhaust gases.

Be sure exposed personnel in the area of operation are clear of the machine before moving the machine or its attachments. **WALK COMPLETELY AROUND** machine before mounting. Sound horn. Obey flagman, safety signals and signs.

Know the principles of cross steering of crawler tractors. Read section in Operation and Maintenance Instruction Manual on cross steering.

Keep engine exhaust system and exhaust manifolds clear of combustible material. Equip machine with screens and guards when working under conditions of flying combustible material.

If engine has a tendency to stall for any reason under load or idle, report this for adjustment to a proper maintenance authority immediately. Do not continue to operate machine until condition has been corrected.

Never use bucket as a man-lift.

Use recommended bucket for machine and material loadability and heaping characteristics of material, terrain, and other pertinent job conditions.

Avoid abrupt starts and stops when transporting a loaded bucket.

Inspect your seat belt webbing and hardware at least twice a year for signs of fraying, wear or other weakness that could lead to failure.

Use only designated towing or pulling attachment points. Use care in making attachment. Be sure pins and locks as provided are secure before pulling. Stay clear of drawbars, cables or chains under load.

When pulling or towing through a cable or chain, do not start suddenly at full throttle. Take up slack carefully. Guard against kinking chains or cables. Inspect carefully for flaws before using. Do not pull through a kinked chain or cable due to the high stresses and possibility of failure of the kinked area. Always wear heavy gloves when handling chain or cable.

Be sure cables are anchored and the anchor point is strong enough to handle the expected load. Keep exposed personnel clear of anchor point and cable or chain. **DO NOT PULL OR TOW UNLESS OPERATORS COMPARTMENTS OF MACHINES INVOLVED ARE PROPERLY GUARDED AGAINST POTENTIAL CABLE OR CHAIN BACKLASH.**

During operation always carry ripper in full raised position when not in use and lower to ground when parked.

When counterweights have been provided, do not work machine if they have been removed unless their equivalent weight has been replaced. See the Operation and Maintenance Instruction Manual.

When operating a machine know what clearances will be encountered, overhead doors, wires, pipes, aisles, roadways; also the weight limitations of ground, floor, and ramps.

Know bridge and culvert load limits and do not exceed them. Know machine's height, width, and weight. Use a signal person when clearance is close.

Be sure that the exact location of gas lines, utility lines, sewers, overhead and buried power lines, and other obstructions or hazards are known. Such locations should be precisely marked by the proper authorities to reduce the risk of accidents. Obtain shut-down or relocation of any such facilities before starting work, if necessary.

Be certain to comply with all local, state, and federal regulations regarding working in the vicinity of power lines.

When roading find out what conditions are likely to be met - clearances, congestion, type of surface, etc. Be aware of fog, smoke or dust elements that obscure visibility.

When backing, always look to where the machine is to be moved. Be alert to the position of exposed personnel. **DO NOT OPERATE** if exposed personnel enter the immediate work area.

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 as 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 breakover 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 dropoffs, in congested areas or on ice or slippery surfaces.

# SAFETY RULES

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 dropoffs.

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 hillside proceed slowly. Never turn sharply uphill or downhill.

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

In steep downhill operation, do not allow engine to overspeed. Select proper gear before starting downgrade.

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 an 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 overhead 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 brushpiles, logs or rocks. **DO NOT DRIVE THE MACHINE ONTO BRUSHPILES, LOGS, LARGE ROCKS** or other surface irregularities that break traction with the ground especially when on slopes or near dropoffs.

Avoid operating equipment too close to an overhang or highwall either above or below the machine. Be on the lookout for caving edges, falling objects and slides. Beware of concealment by brush and undergrowth 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 for approaching traffic.

Move the machine away from pits, trenches, overhangs and overhead 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.

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 multipurpose 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 Manuals. 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.**

# SAFETY RULES

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, hands, and fingers 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, fingers, feet 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.

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 cardboard 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 Manuals 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 makeshift 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 handholds 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.

# SAFETY RULES

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 (30psi) 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

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



## **FOREWORD**

Always furnish serial number if making an inquiry to dealer or factory about this machine.

Many equipment owners employ the Dealer's Service Department for all work other than routine lubrication and minor service. This practice is encouraged, as our Dealers are well informed and equipped to render efficient service by factory trained mechanics.

This manual may not be reprinted or reproduced, either in whole or in part, without written permission of Fiatallis.

Illustrations show standard and optional items.

## **IMPORTANT**

The information in this manual was current at the time of publication. It is our policy to constantly improve our product and to make available additional optional items. These changes may affect procedures outlined in this manual. If variances are observed, verify the information through your Dealer.

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GENERAL DESCRIPTION  
TOPIC 1

1.1 DESCRIPTION

1.1.1

The FR10 & FR12 dual air-over-hydraulic brake system utilizes two power clusters to convert the energy of the compressed air into hydraulic pressure to actuate the pistons of the disc brake assemblies. The air system also supplies air pressure for the clutch cut-off.

1.1.2

The FR15 dual air-over-hydraulic brake system utilizes one power cluster for the rear axle brakes and a pressure converter for the front axle brakes. They are used to convert the energy of compressed air into hydraulic pressure to actuate the pistons of the disc brake assemblies. The air system also supplies air pressure for the clutch cut-off.

1.1.3

The air compressor supplies air under pressure to a "wet" storage reservoir. Compressed air flows from the wet reservoir to "dry" dual air storage reservoirs and on through dual lines to the air application valve. When either brake pedal is depressed, compressed air flows to the front and rear brake boosters (power clusters and pressure converter), and applies the service brakes on all four wheels.

Air pressure available for braking is indicated by an air pressure gauge on the instrument panel. The gauge is augmented by a red low pressure warning light and an electrically operated buzzer. A sending unit, connected to the same tee as the pressure gauge, activates the signaling devices whenever the electrical switch on the instrument panel is turned on and air pressure in the system is below approximately 4.48 - 5.17 bar (65 - 75 psi).

1.1.4

Clutch cut-off valve on the transmission is actuated to halt transmission operation when left treadle air application valve is depressed with the transmission in any gear. Right treadle valve does not actuate clutch cut-off valve.

1.1.5

Air brake system pressure for the FR10 and FR12 is controlled by a governor operating in conjunction with the compressor unloading mechanism. The FR15 system is controlled by an unloader valve between the compressor and the "wet" tank.

1.1.6

All components of Figs. 1, 2, and 3 are described in this manual. Refer to the Table of Contents for locating detailed service information.

GENERAL DESCRIPTION

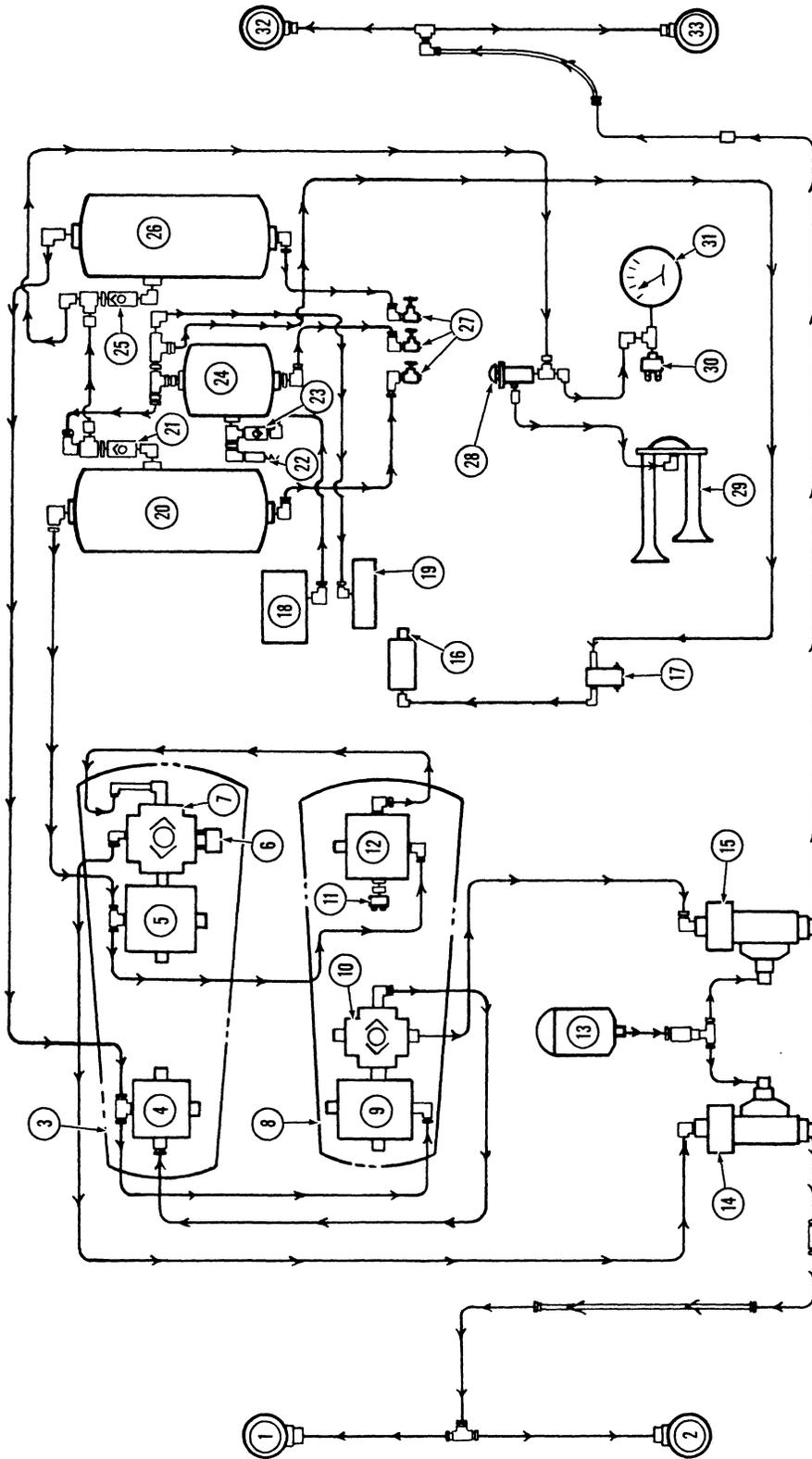


FIG. 1 BRAKES AND AIR SCHEMATIC (FR10)

T-84929

## GENERAL DESCRIPTION

### LEGEND FOR FIG.1(FR10)

- |                                     |  |
|-------------------------------------|--|
| 1. Brake caliper, right front       | 17. Solenoid switch, clutch cut-off    |
| 2. Brake caliper, left front        | 18. Air compressor                     |
| 3. Right treadle valve              | 19. Governor                           |
| 4. Right upper section              | 20. Air reservoir, dry                 |
| 5. Right lower section              | 21. Check valve, one-way (manual fill) |
| 6. Pressure switch, stop light      | 22. Relief valve                       |
| 7. Check valve, two-way             | 23. Check valve, one-way (manual fill) |
| 8. Left treadle valve               | 24. Air reservoir, wet                 |
| 9. Left upper section               | 25. Check valve, one-way (manual fill) |
| 10. Check valve, two-way            | 26. Air reservoir, dry                 |
| 11. Pressure switch, clutch cut-off | 27. Drain cocks                        |
| 12. Left lower section              | 28. Horn button                        |
| 13. Brake fluid reservoir           | 29. Air horn                           |
| 14. Power cluster, front brakes     | 30. Pressure switch, low air           |
| 15. Power cluster, rear brakes      | 31. air pressure gauge                 |
| 16. Clutch cut-off cylinder         | 32. Brake caliper, right rear          |
|                                     | 33. Brake caliper, left rear           |

GENERAL DESCRIPTION

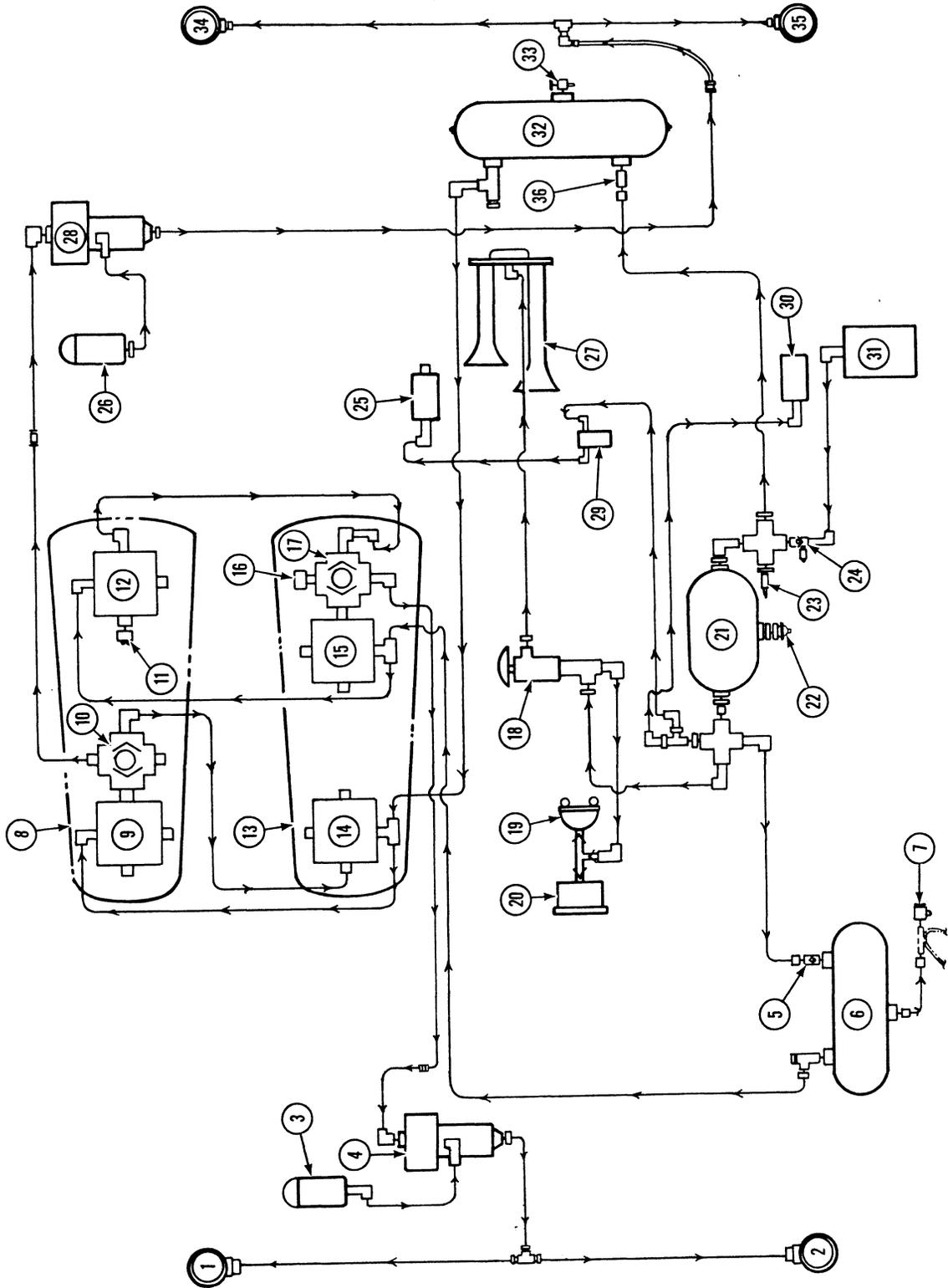


FIG. 2 BRAKES AND AIR SCHEMATIC (FR12)

T-84930

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

## GENERAL DESCRIPTION

### LEGEND FOR FIG.1 (FR10)

1. Brake caliper, right front
2. Brake caliper, left front
3. Brake fluid reservoir
4. Power cluster, front brakes
5. Check valve, one-way (manual fill)
6. Air reservoir, dry
7. Drain cock
8. Left treadle valve
9. Left upper section
10. Check valve, two-way
11. Pressure switch, clutch cut-off
12. Left lower section
13. Right treadle valve
14. Right upper section
15. Right lower section
16. Pressure switch, stop light
17. Check valve, two-way
18. Horn button
19. Pressure switch, low air
20. Air pressure gauge
21. Air reservoir, wet
22. Drain cock
23. Relief valve
24. Check valve, one-way (manual fill)
25. Clutch cut-off cylinder
26. Brake fluid reservoir
27. Air horn
28. Power cluster, rear brakes
29. Solenoid switch, clutch cut-off
30. Governor
31. Air compressor
32. Air Reservoir
33. Drain cock
34. Brake caliper, left rear
35. Brake caliper, right rear
36. Check valve, one way (manual fill)

GENERAL DESCRIPTION

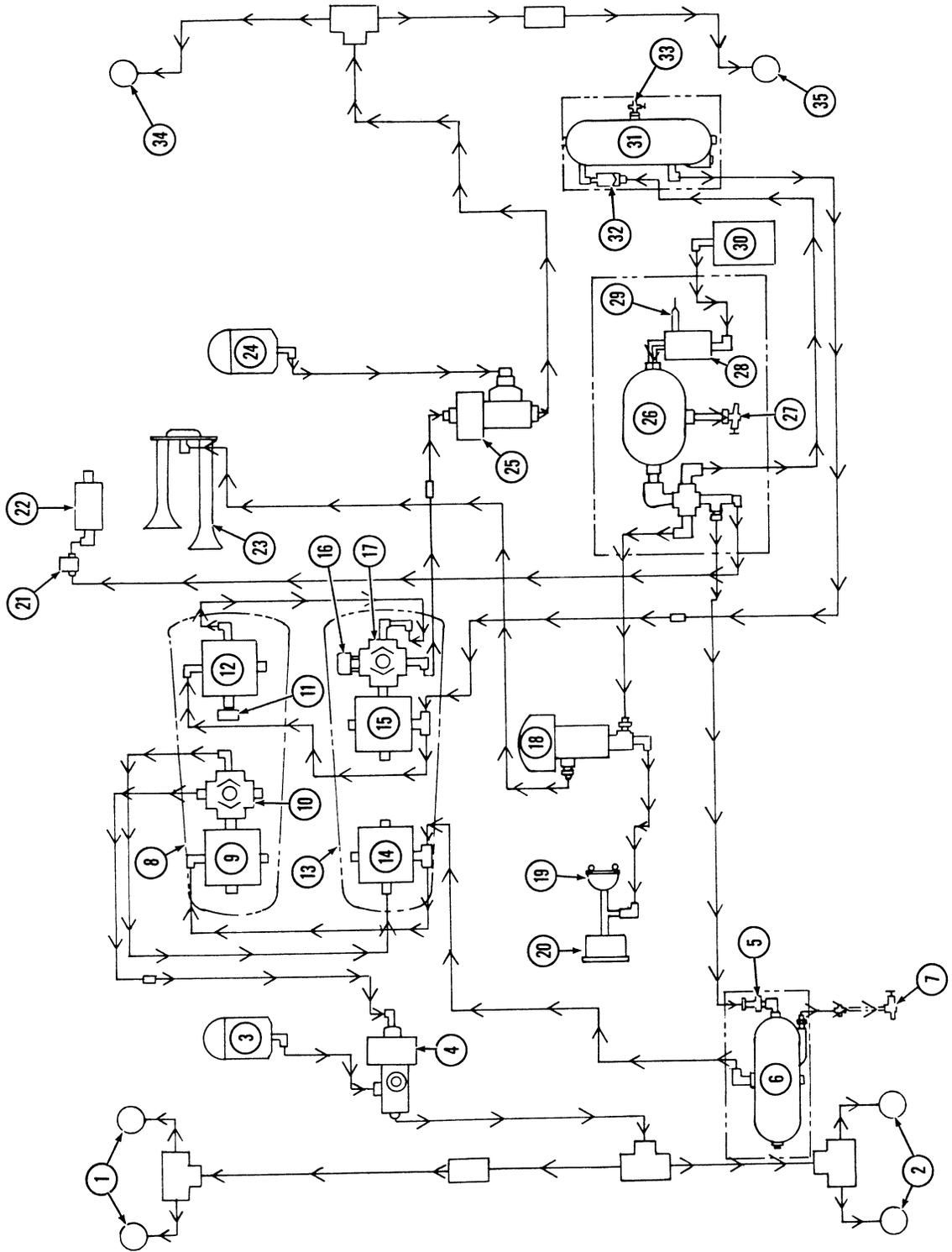


FIG. 3 BRAKES AND AIR SCHEMATIC (FR15)

T-84931

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

## GENERAL DESCRIPTION

### LEGEND FOR FIG.1 (FR10)

- |                                       |  |
|---------------------------------------|--|
| 1. Brake caliper, right front         | 18. Horn button                        |
| 2. Brake caliper, left front          | 19. Pressure switch, low air           |
| 3. Brake fluid reservoir              | 20. Air pressure gauge                 |
| 4. Pressure converter front brakes    | 21. Solenoid switch, clutch cut-off    |
| 5. Check valve, one-way (manual fill) | 22. Clutch cut-off cylinder            |
| 6. Air reservoir, dry                 | 23. Air horn                           |
| 7. Drain cock                         | 24. Brake fluid reservoir              |
| 8. Left treadle valve                 | 25. Power cluster, rear brakes         |
| 9. Left upper section                 | 26. Air reservoir, wet                 |
| 10. Check valve, two-way              | 27. Drain cock                         |
| 11. Pressure switch, clutch cut-off   | 28. Unloader valve                     |
| 12. Left lower section                | 29. Relief valve                       |
| 13. Right treadle valve               | 30. Air compressor                     |
| 14. Right upper section               | 31. Air reservoir                      |
| 15. Right lower section               | 32. Check valve, one-way (manual fill) |
| 16. Pressure switch, stop light       | 33. Drain cock                         |
| 17. Check valve, two-way              | 34. Brake caliper, left rear           |
|                                       | 35. Brake caliper, right rear          |

TROUBLESHOOTING  
TOPIC 2

TROUBLE	POSSIBLE CAUSE
Insufficient braking force	<ol style="list-style-type: none"><li>1. Brake pads excessively worn.</li><li>2. Low air pressure in brake system caused by leaks, a faulty compressor, governor or unloader valve.</li><li>3. Hydraulic line fluid loss.</li><li>4. Fluid level low in reservoir.</li><li>5. Defective air application valve.</li><li>6. Defective pressure converter or power cluster.</li><li>7. Brake head piston packing leaking.</li><li>8. Air trapped in brake lines.</li></ol>
Brakes apply too slowly	<ol style="list-style-type: none"><li>1. Air brake system pressure low caused by leaks, a faulty compressor, governor, unloader valve or air application valve.</li><li>2. Excessive air leakage when brakes are applied.</li><li>3. Restricted tube or hose line.</li><li>4. Defective brake head assembly.</li><li>5. Defective pressure converter or power cluster.</li></ol>
Brakes release too slowly	<ol style="list-style-type: none"><li>1. Defective air application valve.</li><li>2. Restricted tube or hose valve.</li><li>3. Excessive leakage in air system.</li><li>4. Defective brake head assembly.</li><li>5. Defective pressure converter or power cluster.</li></ol>
Brakes do not apply	<ol style="list-style-type: none"><li>1. No air pressure in brake system caused by air leaks or a faulty compressor.</li><li>2. Restricted or broken tubing or hose line.</li><li>3. Defective air application valve.</li><li>4. Insufficient fluid level in reservoirs.</li><li>5. Defective pressure converters or power cluster.</li></ol>
Brakes heat up excessively and fail to release	<ol style="list-style-type: none"><li>1. Defective air application valve.</li><li>2. Restriction in tubing or hose line.</li><li>3. Brake pedal binding (treadle).</li><li>4. Grease or brake fluid on brake pads or disc.</li><li>5. Restricted or collapsed hydraulic line.</li><li>6. Low fluid level in reservoirs.</li><li>7. Air trapped in brake hydraulic lines.</li><li>8. Frozen or sticking brake head pistons.</li><li>9. Operator riding the brake pedal.</li></ol>
Grabbing or uneven brake action	<ol style="list-style-type: none"><li>1. Grease or brake fluid on pads or disc.</li><li>2. Brake pedal not releasing.</li><li>3. Scored brake disc.</li><li>4. Bend or distorted brake disc.</li><li>5. Pistons sticking in brake head.</li><li>6. Defective air application valve.</li><li>7. Brake head mounted improperly or loose.</li><li>8. Incorrect tire pressures.</li></ol>

## TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE
Grabbing or uneven brake action (Continued)	<ol style="list-style-type: none"><li>9. High friction pad on one side of disc and low friction pad on opposite side (not in pairs).</li><li>10. Soft or swollen seals in pressure converter, power cluster and brake heads (or wrong brake fluid).</li><li>11. Rough or corroded brake head piston bores.</li></ol>
Excessive brake pedal travel	<ol style="list-style-type: none"><li>1. Air trapped in brake hydraulic lines.</li><li>2. Low fluid level in reservoirs.</li><li>3. Defective pressure converter or power cluster.</li><li>4. Brake disc worn out.</li><li>5. Leakage in the brake hydraulic lines.</li><li>6. Leaking brake head piston packing.</li></ol>
Excessive force required to apply brake pedal	<ol style="list-style-type: none"><li>1. Brake pedal assembly binding.</li><li>2. Pressure converter or power cluster defective.</li><li>3. Lines, hoses or fittings dented, kinked, collapsed or blocked.</li><li>4. Grease or brake fluid on pads or disc.</li><li>5. Brake pads excessively worn.</li><li>6. Incorrect pads installed.</li><li>7. Frozen or sticking brake head pistons.</li></ol>
Brake roughness, chatter or pedal pulsation	<ol style="list-style-type: none"><li>1. Brake head mounted improperly or loose.</li><li>2. Scored brake disc.</li><li>3. Bent or distorted brake disc.</li><li>4. Grease or brake fluid on pads disc.</li></ol>
Parking brake lever will not operate	<ol style="list-style-type: none"><li>1. Linkage and lever needs adjustment.</li><li>2. Linkage joints binding.</li><li>3. Linkage joints frozen.</li><li>4. Brake lever assembly frozen.</li><li>5. Brake lever assembly rusted.</li></ol>
Overload relief valve blows off	<ol style="list-style-type: none"><li>1. Air pressure in system above normal.</li></ol>
Excessive oil or water in system	<ol style="list-style-type: none"><li>1. Air tank must be drained more often.</li><li>2. Compressor passing oil excessively.</li></ol>
Air application valve leaks when pedal is in released position	<ol style="list-style-type: none"><li>1. Inlet/exhaust valve is not sealing.</li></ol>
Air application valve leaks while pedal is in applied position	<ol style="list-style-type: none"><li>1. Indicates the valve is not sealing its exhaust.</li></ol>

## TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE
Air pressure will not rise to normal	<ol style="list-style-type: none"><li>1. Defective air pressure gauge.</li><li>2. Excessive leakage.</li><li>3. Air tank drain cock(s) open</li><li>4. Governor needs adjusting.</li><li>5. Defective compressor.</li><li>6. Slipping compressor drive belt (FR10,FR12)</li></ol>
Air pressure rises to normal too slowly	<ol style="list-style-type: none"><li>1. Excessive leakage</li><li>2. No clearance at compressor unloading valves.</li><li>3. Compressor discharge valves leaking.</li><li>4. Defective unloader valve.</li><li>5. Worn compressor.</li><li>6. Excessive carbon in compressor cylinder head or discharge line.</li><li>7. Worn inlet/outlet valves in compressor (FR15).</li></ol>
Air pressure rises above normal	<ol style="list-style-type: none"><li>1. Defective air pressure gauge (registering incorrectly).</li><li>2. Compressor governor or unloader valve needs adjustment.</li><li>3. Defective compressor governor or unloader valve.</li><li>4. Restriction in line between governor and compressor unloading mechanism.</li><li>5. Too much clearance at compressor unloader valve.</li><li>6. Compressor unloading cavities and passages in cylinder head blocked with carbon.</li><li>7. Defective unloader relief valve.</li></ol>
Air pressure drops quickly with engine stopped and brakes released	<ol style="list-style-type: none"><li>1. Leaking air application valve.</li><li>2. Leaking tubing or hose lines.</li><li>3. Compressor discharge valve leaking.</li><li>4. Compressor governor or unloader valve leaking.</li><li>5. Excessive leaking elsewhere in system.</li></ol>
Air pressure drops quickly with engine stopped and brakes fully applied	<ol style="list-style-type: none"><li>1. Leaking pressure converter or power cluster.</li><li>2. Leaking air application valve.</li><li>3. Leaking hoses or lines.</li><li>4. Air tank drain cock left open.</li></ol>
Compressor knocks continuously intermittently	<ol style="list-style-type: none"><li>1. Loose drive pulley (FR10,FR12).</li><li>2. Worn bearings.</li><li>3. Excessive carbon deposits in compressor cylinder head.</li><li>4. Worn compressor.</li><li>5. Insufficient lubrication.</li></ol>

AIR COMPRESSOR (FR10 & FR12)  
TOPIC 3

3.1 GENERAL

3.1.1

The function of the air compressor is to build up and maintain the air pressure required to operate the various air powered devices.

3.1.2

The single stage, reciprocating air compressor has two cylinders and is belt driven, Fig.4. This compressor has a capacity of 205.3 L (7.25 cu.ft) per minute.

3.1.3

Lubrication for the compressor is provided by an external oil line extending from the engine to the rear cover of the compressor. Oil then enters the drilled passage in the compressor crankshaft. From this passage oil flows through drilled holes in the connecting rods providing pressure lubrication to piston pins and bearings. The bearings are splash lubricated by oil spilling down into the hollow mounting base of the compressor. Oil returns to the engine crankcase through the compressor crankcase to timing gear housing.

3.1.4

The compressor is water cooled by an external water line extending from the engine cylinder block to the compressor cylinder block and out the cylinder head to the engine cooling system. The air supply for the compressor is obtained from the engine air intake manifold. It is cleaned and filtered by the engine air cleaner.

3.2 OPERATION

3.2.1 GENERAL

3.2.1.1

The air compressor runs continuously whenever the engine is operating but actual compression of air is controlled by the air compressor governor. The governor, in conjunction with the air "unloading" mechanism in the cylinder block, controls the air supply by unloading the compressor when pressure in the air tank reaches maximum setting of the governor.

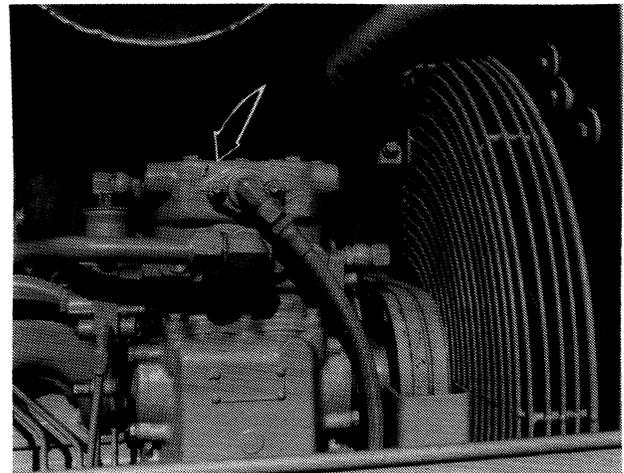


FIG.4 AIR COMPRESSOR T-84978

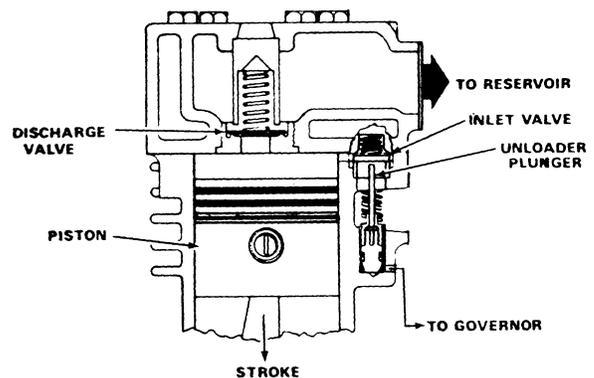


FIG.5 INTAKE FUNCTION T-78785

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

## AIR COMPRESSOR (FR10 & FR12)

### 3.2.2 INTAKE AND COMPRESSION

#### 3.2.2.1

Fig.5, during the downstroke of each piston, a partial vacuum is created above the piston, unseating the inlet valve. This allows intake air to be drawn into the cylinder.

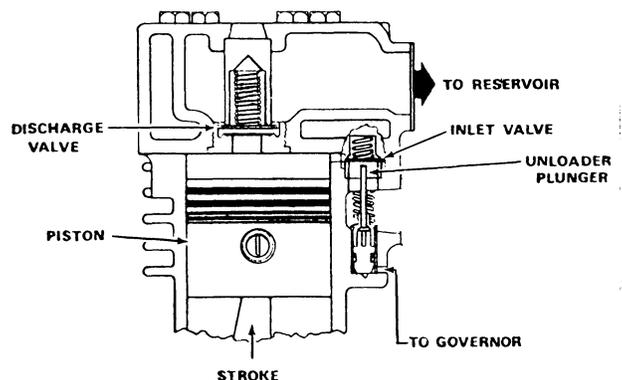


FIG.6 COMPRESSION FUNCTION T-78786

#### 3.2.2.2

Fig.6, as the piston starts its upward stroke, air pressure on the inlet valve, plus force of the inlet valve return spring, closes the inlet valve. Air above the piston is further compressed until the pressure lifts the discharge valve. Air is then released through the discharge line into the air tank.

#### 3.2.2.3

As each piston starts its down stroke, the discharge valve returns to its seat, preventing air delivered to the air tank from escaping back into the compressor cylinders. The cycle is repeated until pressure in the air tank reaches maximum.

### 3.2.3 NON-COMPRESSION (UNLOADED)

#### 3.2.3.1

Fig.7, when pressure in the air tank reaches maximum setting of the governor, compressed air passes through the governor into the compressor block. Entering the cavity below the unloading pistons, air pressure lifts the unloading pistons to simultaneously open the air inlet valves.

With the inlet valves held off their seats, inlet air is passed from one cylinder to the other. During the upstroke of one piston, inlet air is forced through its inlet cavity to the adjacent cylinder where the piston is on a downstroke.

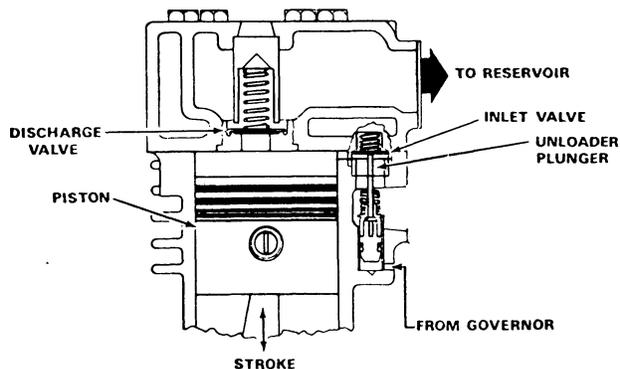


FIG.7 UNLOADING FUNCTION T-78787

#### 3.2.3.2

When pressure in air tank is reduced to minimum setting of the governor, the valve in the governor closes. The unloading piston return spring forces the unloading pistons down and releases the inlet valve springs. The inlet valves return to their seats and compression is resumed.

### 3.3 REMOVAL

=====

**⚠ WARNING**-Always set parking brake when leaving the machine for any reason.

=====

**⚠ WARNING**-Always secure fenders and hood side panels before servicing any component in the engine compartment.

=====

**⚠ WARNING**-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. Perform all service or maintenance carefully.

## AIR COMPRESSOR (FR10 & FR12)

### 3.3.1

Open the drain cocks, and drain the air from the reservoirs.

### 3.3.2

Drain engine cooling system.

### 3.3.3

Disconnect all air and water lines from the compressor. Remove the compressor drive belts.

### 3.3.4

Remove the compressor from the timing gear housing.

## 3.4 DISASSEMBLY

=====

**⚠ WARNING** Never use gasoline solvent or other flammable fluids to clean element. Use authorized commercial, non-flammable, non-toxic solvents.

### 3.4.1

Thoroughly clean the exterior of the compressor and then remove the drive pulley.

### 3.4.2

Mark the following items before disassembly to show component relationship when compressor is reassembled:

- a. Front and rear end covers in relation to crankcase.
- b. Cylinder head in relation to crankcase.

### 3.4.3

Remove cylinder head assembly and gasket, Fig.9 (1).

### 3.4.4

Remove discharge valve cap nuts, Fig. 8 (2) from top of cylinder head. Remove springs Fig. 9 (3) and valves (4) from counterbores. Remove discharge valve seats (8).

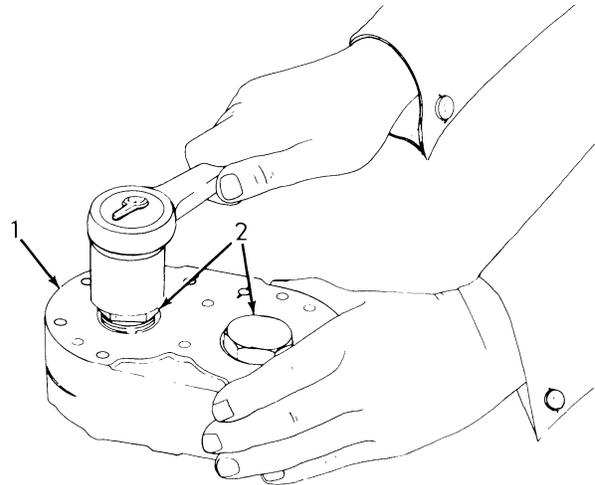


FIG.8 REMOVING DISCHARGE VALVE SEAT T-77191

1. Cylinder head      2. Discharge valves

### 3.4.5

Remove inlet valve springs (14) and inlet valves (26).

### 3.4.6

Remove the unloader valve spring (31) spring seat (30) saddle plate (32) unloader plunger (34) with piston (35) and guide (33).

### 3.4.7

Remove the crankcase cover plate (17) then remove bearing caps from connecting rods (47). Push each piston and connecting rod assembly out through the top of the cylinder block. Reassemble the bearing caps on their respective connecting rods as they are removed.

### 3.4.8

Remove the pistons (44) from the connecting rods.

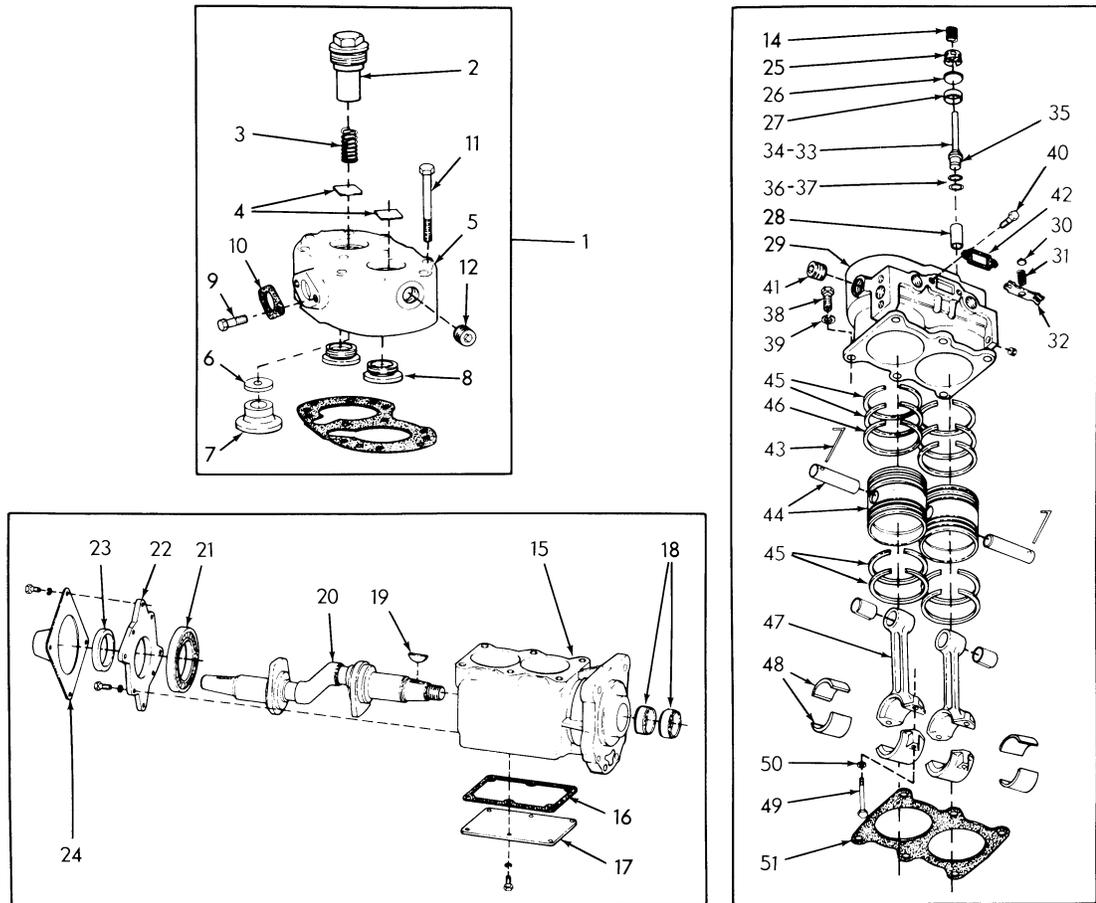
### 3.4.9

Remove the cylinder block (29) and gasket (51) from the crankcase.

### 3.4.10

Remove the crankshaft end cover (24) then remove seal retainer (22) with seal.

## AIR COMPRESSOR (FR10 & FR12)



**FIG. 9 AIR COMPRESSOR ASSEMBLY**

**T-81339**

- |   |   |   |
|---|---|---|
| <p>1. Cylinder head assy.<br/>                 2. Capnut, discharge valve<br/>                 3. Spring<br/>                 4. Valve (plate)<br/>                 5. Cylinder head<br/>                 6. Inlet valve spring seat<br/>                 7. Inlet valve spring insert<br/>                 (pressed into head)<br/>                 8. Seat, discharge valve<br/>                 9. Capscrew<br/>                 10. Gasket (outlet fitting)<br/>                 11. Capscrew<br/>                 12. Plug<br/>                 13. Gasket<br/>                 14. Spring, inlet valve<br/>                 15. Crankcase<br/>                 16. Not used<br/>                 17. Not used</p> | <p>18. Bushing<br/>                 19. Key<br/>                 20. Crankshaft<br/>                 21. Ball bearing<br/>                 22. Cover, seal retainer<br/>                 23. Seal<br/>                 24. Cover<br/>                 25. Inlet valve guide<br/>                 26. Inlet valve<br/>                 27. Inlet valve seat (pressed<br/>                 into cylinder block)<br/>                 28. Bushing<br/>                 29. Cylinder block<br/>                 30. Unloader spring seat<br/>                 31. Unloader spring<br/>                 32. Unloader saddle<br/>                 33. Unloader plunger guide<br/>                 34. Unloader plunger<br/>                 35. Unloader piston</p> | <p>36. Plunger back-up ring,<br/>                 unloader<br/>                 37. Plunger o-ring<br/>                 (grommet)<br/>                 38. Capscrew<br/>                 39. Lockwasher<br/>                 40. Capscrew<br/>                 41. Plug<br/>                 42. Gasket<br/>                 43. Lockwire<br/>                 44. Piston and pin<br/>                 45. Piston rings (over-<br/>                 sizes available)<br/>                 46. Piston ring, oil (over-<br/>                 sizes available)<br/>                 47. Connecting rods<br/>                 48. Bearings (oversizes<br/>                 available)<br/>                 49. Capscrew<br/>                 50. Lockwasher<br/>                 51. Gasket</p> |
|---|---|---|

**NOTE:** Pistons, connecting rods bearings and rings are available in 0.254 mm (0.010") and 0.508 mm (0.020") oversizes.

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

## AIR COMPRESSOR (FR10 & FR12)

### 3.4.11

Press crankshaft (with ball bearing) out of crankcase. Remove bearings (18) if damaged or worn.

### 3.5 AIR COMPRESSOR INSPECTION, REPAIRS AND TESTING

=====

**⚠ WARNING** -Never use gasoline solvent or other flammable fluids to clean element. Use authorized commercial, non-flammable, non-toxic solvents.

=====

**⚠ WARNING** -Wear safety glasses with side shields or goggles when using compressed air for cleaning to reduce danger of personal injury from flying particles. Limit the pressure to 2.07 bar (30 psi) according to local or national requirements.

#### 3.5.1

Clean all parts with solvent to remove dirt, oil and grease before inspection. Immerse the cylinder head and block in a cleaning solution to remove carbon from the valve cavities and rust and scale from the water cavities. Blow foreign material from the cavities with compressed air. Scrape carbon, dirt and particles of old gaskets from all surfaces.

#### 3.5.2

Thoroughly clean all oil passages in the crankshaft, connecting rods and end covers with a wire brush. Flush the passages with a cleaning solvent and compressed air.

#### 3.5.3

Inspect cylinder head and discharge valves.

#### 3.5.4

Inspect the cylinder head for cracks or warpage.

#### 3.5.5

Test the water passages in the cylinder head with compressed air.

#### 3.5.6

Replace the discharge valves if grooved 0.0508 mm (.002") or more at their position of contact with the valve seat.

#### 3.5.7

Replace the valve seats if excessively worn.

NOTE: The valve seats may be refaced with a lapping stone.

Discharge valve seat may be replaced by unscrewing the valve seat from cylinder head. When installing a new valve seat, tighten securely.

#### 3.5.8

After installing new discharge valves, discharge valve springs and discharge valve capnuts, the discharge travel should be between 1.42-1.78 mm (.056 - .070").

#### 3.5.9

To test for leakage, apply 6.90 bar (100 psi) of air pressure through the discharge port of the cylinder head. Apply soap suds to the discharge valve openings in the cylinder head. Leakage should not exceed a small 25.4 mm (1") soap bubble in five seconds. If excessive leakage is found, continue to apply air pressure and tap discharge valves off their seats using a hardwood dowel and a light hammer. Do this several times to improve the seal between the valves and their seats. Leakage tests should also be made by applying soap suds around the discharge valve capnuts.

#### 3.5.10

Inspection of cylinder block and components.

#### 3.5.11

Inspect the cylinder bores for excessive wear and scoring.

## AIR COMPRESSOR (FR10 & FR12)

### 3.5.12

Check the cylinder bores for roundness, taper and wear. Each bore should be round within 0.05 mm (.002"). Taper should not exceed 0.08 mm (.003"), Fig. 10.

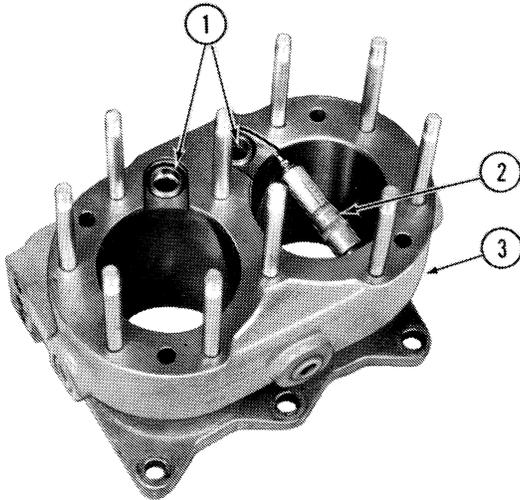


FIG. 10 CHECKING CYLINDER BORE FOR ROUNDNESS T-28934

1. Inlet valve seats
2. Inside micrometer
3. Cylinder block

NOTE: Cylinder bores should be rebored or honed while the cylinder block is attached to the crankcase.

### 3.5.13

Inspect the unloader pistons and seal rings for wear, Fig. 9 (36,37). Replace scored unloader pistons (always replace seal and back-up rings). While reinstalling the unloader piston, use care to avoid cutting or damaging O-ring. After the unit is assembled, test the unloader pistons by applying 6.90 bar (100 psi) air pressure through the governor line port. With the unloader pistons coated with soap suds, leakage should not exceed a small soap bubble in five sections.

### 3.5.14

Replace the inlet valves if they are grooved 0.08 mm (.003") or more at their position of contact with the valve seats.

### 3.5.15

If the inlet valve seats are not worn excessively, they may be refaced. Otherwise replace them. The dimension from the top of the cylinder block to the inlet valve seat should not exceed 3.68 mm (.145"). After installing new seats, the dimension should be between 2.57 mm (.101") and 2.87 mm (.113"). To remove the seat, install a thread tap in the seat bore and use a tool similar to the one in Fig. 11.

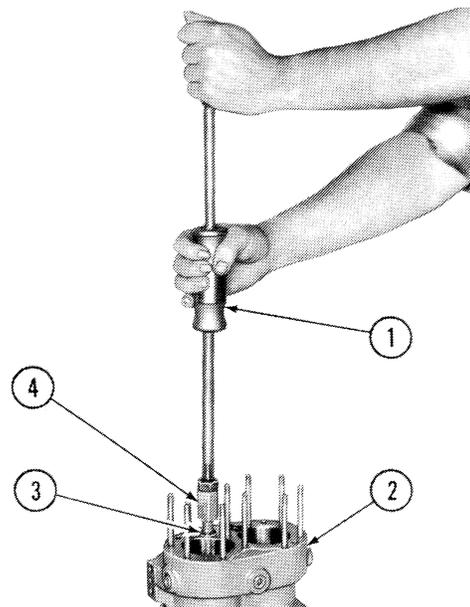


FIG.11 REMOVING INLET VALVE SEAT FROM CYLINDER BLOCK T-28932

1. Slide hammer puller
2. Cylinder block
3. Inlet valve seat
4. Puller adapter

Press in a new valve seat by using an old inlet valve positioned on top of the new one, using a press similar to the one shown in Fig. 12.

## AIR COMPRESSOR (FR10 & FR12)

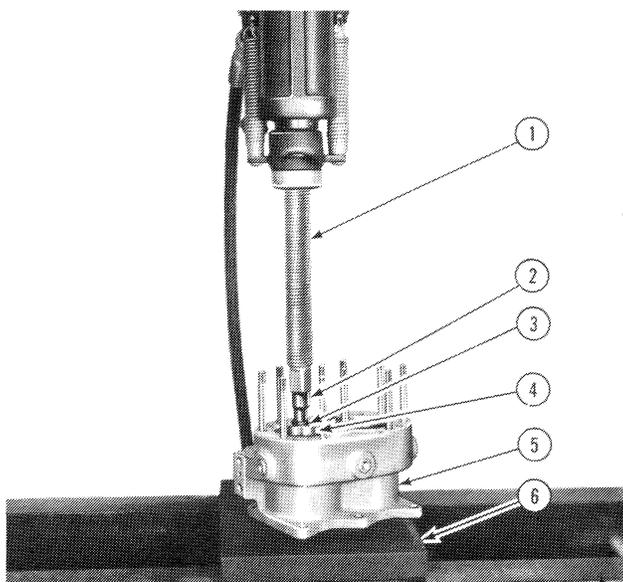


FIG.12 PRESSING INLET VALVE SEAT INTO CYLINDER T-28933

- |                      |                     |
|----------------------|---------------------|
| 1. Press             | 4. Inlet valve seat |
| 2. Driver            | 5. Cylinder block   |
| 3. Inlet valve (old) | 6. Steel block      |

### 3.5.16

Inspect pistons and connecting rods.

Replace pistons that are scored, cracked or excessively worn. Check to ensure the drilled holes in the piston walls are open and clean.

Measure the outer diameter of pistons in relation to the cylinder bore diameter. Specified clearance between the piston (without rings) and the cylinder bore is .05 - 0.10 mm (.002 - .004").

Check fit of piston in the connecting rod bushing. Clearance should not exceed 0.04 mm (0.0015 in).

### 3.5.17

Inspect the connecting rod bearings for proper fit on the crankshaft journals. If worn, cracked or chipped, the inserts should be replaced.

The connecting rod caps are not interchangeable. Position the caps so the two locking slots are adjacent to the same capscrew.

Clearance between the connecting rod journal and the connecting rod bearing must be between 0.01 mm (.0003") and 0.05 mm (.0021") after replacing the inserts.

### 3.5.18

Inspect crankshaft. Crankshaft journals that are more than 0.03 mm (.001") out-of-round or bruised must be reground. When regrinding, the fillets at the ends of the journals must be maintained. Connecting rod bearing inserts that are 0.25 mm (.010"), 0.51 mm (.020") and 0.76 mm (.030") undersize are available for reground crankshafts. Inspect the crankshaft ball bearing for roughness.

### 3.5.19

Inspect the main bearing bores in the crankcase. Bushings must be a finger press fit. If bushings are loose in the bores, bushings and/or the crankcase must be replaced.

**IMPORTANT:** The difference between the O.D. of crankshaft journals and I.D. of main bearings (bushings) must not exceed 0.165 mm (.0065").

## 3.6 ASSEMBLY OF AIR COMPRESSOR

### 3.6.1 (FIG.9)

Install new bushings (18) in crankcase; note that inner bushing should be flush with inside face of bore—outer bushing slightly under outer face of case. Lubricate bushings with clean oil.

### 3.6.2

Insert the crankshaft into case, and install ball bearing (21).

### 3.6.3

Install a new seal (23) in retainer (22). Install retainer and cover (24); note that faces of retainer should be coated with a thin coat of sealing compound before installation.

## AIR COMPRESSOR (FR10 & FR12)

### 3.6.4

Before installing rings on the pistons, measure the gap between the ring ends as follows: insert the rings, one at a time, into the cylinder bore in which they will be used. Using a piston, push the ring into the ring travel area. Measure the gap between the ends of the ring with a feeler gauge. The specified ring gap is 0.13- 0.38 mm (.005- .015").

### 3.6.5

Measure ring-to-groove clearance from the top of the ring to the top of the groove in the piston, Fig.13. Specified clearances are: Oil Ring, 0.025 - 0.076 mm (0.001 - 0.003"); piston rings, 0.05 - 0.10 mm (.002 - .004").

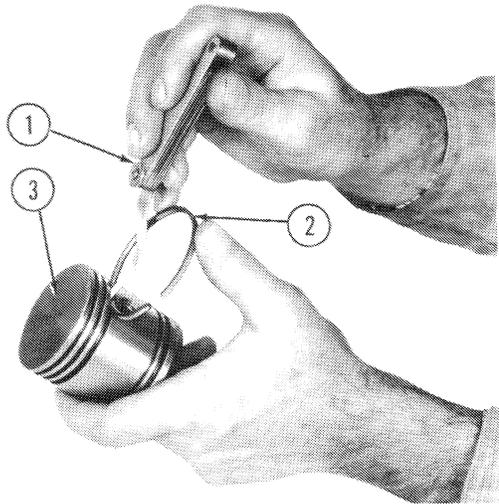


FIG. 13 CHECKING PISTON RING TO T-28936 GROOVE CLEARANCE

1. Feeler gauge                      3. Piston  
2. Piston ring

### 3.6.6

After the rings are properly fitted, install them on the pistons with the bevel (or punch mark) toward the top.

NOTE: Avoid spreading the rings more than the minimum necessary. Stagger the ring gaps evenly around the piston.

### 3.6.7

Replace the piston pin bushings if they are worn. Press the old bushing from the connecting rod and press in a new one. When installing new bushings, line up the oil hole in the bushing with the rifle drilled oil hole in the connecting rod. After being pressed in place, the bushings should be reamed to provide 0.025 mm (.001") clearance on the piston pin. Replace all piston pin lock wires.

### 3.6.8

Insert the upper end of the connecting rod into the piston. Install the piston pin so the lockwire holes in the piston pin are aligned with the lockwire holes in the piston. Install the long end of the lockwire in the piston and piston pin so that the short end may be locked near the bottom of the piston skirt.

### 3.6.9

Place a new cylinder block gasket, Fig.9 (51) on the crankcase, and install block on crankcase; secure block, lightly with two capscrews.

### 3.6.10

Select one of the piston and connecting rod assemblies. Remove the connecting rod caps, and install bearing inserts into rods and caps. Check to ensure the ring gaps are evenly staggered and the piston is well oiled. Using a piston ring compressor, insert the piston into the cylinder bore. Align the lower end of the connecting rod with the crankshaft. Tap the piston into the bore using care to avoid having the lower end of the connecting rod damage the bearing surface of the crankshaft.

### 3.6.11

Install the bearing caps; tighten retaining capscrews to 11.3 - 13.0 Nm (100 - 115 lbs.in).

3.6.12

A new unloader piston kit should be used when rebuilding. The unloader pistons, Fig. 9 (35) in the kit are pre-lubricated with a special lubricant and need no more lubrication. Install the unloader pistons in their bores being careful not to cut the O-rings or distort the backup rings. Position the unloader plungers in their guides and slip them in and over the tops of the pistons. Install the unloader spring seat in the crankcase inlet cavity; a small hole is drilled in the crankcase for this purpose. Position the saddle between the unloader piston guides, so its forks are centered on the guides. Install the unloader spring, making sure it seats over the spring seats, both in the crankcase and on the saddle. Position and install the inlet valve guides (25) then drop the inlet valves (26) in their guides. There should be a loose sliding fit between the guides and valves.

3.6.13

Install the balance of crankcase capscrews and tighten them evenly and securely.

3.6.14

Install the discharge valve seats, Fig. 9 (8) in the cylinder head.

Install the inlet valve springs (14) in the cylinder head by applying a turning motion to the spring after it is in the head. The turning motion should dig the spring wire into the spring seat in the bottom of the spring bore in the head. Should this procedure fail after repeated attempts, use a very small quantity of grease to hold them in place, just enough to keep the springs from falling out. Place the cylinder head gasket on the cylinder block. Carefully align the cylinder head assembly on the block and install the capscrews, tightening them evenly to a torque of 34-41 Nm (25 - 30 lbs.ft).

3.6.15

Install the discharge valves (4) and valve springs (3) in the cylinder head. Install and tighten the discharge valve capnuts(2).

3.6.16

Install belt pulley on compressor.

3.6.17

Install air compressor on timing gear housing with capscrews. Connect air lines, coolant lines, governor line and drive belts.

3.7 TEST

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**⚠ WARNING**-Before moving machine or attachments be sure exposed people in the area are clear of the machine. Walk completely around machine before mounting. Sound horn.

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**⚠ WARNING**-Never attempt to operate machine or attachment except when seated in the operator's seat. Keep head, body, limbs, hands and feet inside the operator's compartment to reduce exposure to hazards outside operator's compartment.

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**⚠ WARNING** -Warn all people who may be servicing or working around machine before starting engine.

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**⚠ WARNING** -Do not run engine of this machine in closed areas without proper ventilation to remove deadly exhaust gases.

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**⚠ WARNING** -Keep people clear of attachments and tools while in raised position, to prevent possible injury.

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**⚠ WARNING** -Observe all start up and shut down procedures and WARNINGS listed in the Operation and Maintenance Instruction Manual.

3.7.1

Refill the engine cooling system. Close the air reservoirs drain cocks. Start the engine and check for leaks.