TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS INFORMATION AND SUPPLEMENTAL MAINTENANCE AND REPAIR PARTS INSTRUCTIONS) FOR PAVING MACHINE BITUMINOUS MATERIEL CRAWLER MOUNTED DED MODEL BSF-400 (NSN 3895-01-063-7891) WITH DETROIT DIESEL ENGINE (SERIES 53) IOWA MANUFACTURING COMPANY

HEADQUARTERS, DEPARTMENT OF THE ARMY

JANUARY 1981

IMPORTANT NOTICE!

Federal, State and Local Safety Regulations must be complied with to prevent possible danger to person(s) or property, from accidents or harmful exposure. This equipment must be used in accordance with all operation and maintenance instructions.

(1) Read all warning, caution and instruction signs. Know what guards and protective devices are included and see that each item is in place. Additional guards and protective devices, that may be required due to proximity to related equipment, must be installed by the user (owner) before operating.
(2) NEVER LUBRICATE OR ADJUST EQUIPMENT WHEN IT IS IN MOTION!
(3) Always establish a positive lockout of the involved power source and block parts if necessary to prevent motion before performing maintenance, cleaning, adjusting or repair work. Secure the power source lockout to prevent start-up by other persons.
(4) Wear a protective mask whenever harmful air pollution exists.
(5) Use ear plugs wherever the noise level is above established acceptable limits.

SAFETY IS YOUR BUSINESS

Safety, based on technical skill and years of experience, has been carefully built into your Detroit Diesel engine. Time, money and effort have been invested in making your diesel engine a safe product. The dividend you realize from this investment is your personal safety.

It should be remembered, however, that power-driven equipment is only as safe as the man who is at the controls. You are urged, as the operator of this diesel engine, to keep your fingers and clothing away from the revolving "V" belts, gears, blower, fan, drive shafts, etc.

An accident can be prevented with your help.

SAFETY RECOMMENDATIONS

CEDARAPIDS Equipment is designed with the safety of all personnel in mind. Guards, covers and shields are added whenever necessary to prevent accidental injury to operators and others working on or near the equipment.

The following basic safety recommendations should be followed:

1. All guards and covers should be replaced after adjustment or maintenance of equipment.
2. Make sure handrails and walkways are on good repair and clear of tools, spare parts and obstructions.
3. Never adjust or lubricate equipment while it is operating.
4. Stand clear of hauling equipment that is dumping material into the hopper.
5. Always look around equipment before start-up to make sure no one is near moving parts, making inspection or adjustment.
6. Do not drop material or tools from walkways or ladders without being positive that no one is below.
7. Blocking under-and around plants must be suitable material and properly placed to support the structure. Periodically check blocking for signs of failure or shifting that could allow structure to fall.
8. Electricians should handle any kind of work on electrical equipment. Avoid touching any loose or misplaced electrical wires. Consider them all dangerous.
9. Mark all inflammable materials; such as, oils, greases, and gasoline. Store these materials in an incombustible building situated away from the operating plant. NO SMOKING while handling flammable material.
10. Proper clothing while on the job is important. Wear shoes with safety toes to protect your toes from falling objects. Do not wear loosely hanging clothes or neck ties on the job. This type of clothing will get caught in moving parts of the equipment and-generally hinders work. The use of hard hats and safety glasses or goggles are definite safety protective equipment and are required by many safety conscious contractors.
11. Think safety! If you have and maintain an attitude of safety on the job, then the chances of being injured are very greatly reduced. Point out hazards and instruct new employees on safety.

GUIDE TO GROUNDING SAFEGUARDS

ON ELECTRICALLY POWERED EQUIPMENT

1. Each electric drive motor must have its frame electrically bonded to its controlling starter. This is to be by a conductor of equal size to the conductors feeding power to the motor. The bonding shall be by the junction box mounting bolt at the motor end, and by a starter mounting bolt at the starter end. The bonding must be by tight connection of clean metal to clean metal.

2. All electric motor starters on a unit (separate piece of equipment) must have their cases (enclosures) bonded to each other, and to the metal structure of the unit.

3. All individually mounted push button units (not mounted on the starter covers) must have their cases (enclosures) bonded to the starter enclosure or encloses.

4. When electric drives are used on one or more portable units (separate pieces of equipment) in an installation, the metallic supporting structures of all units used in that installation must be bonded to each other by a bonding wire having a size rating of not less than #6AWG, and equal in size to the largest power supplying conductor. It is especially important that portable units using no electric drives be bonded to electrically driven units.

5. The starter or group of starters on each unit must have their cases (enclosures) bonded to the main power supply disconnect case (enclosure). This may be by a grounding conductor or conductors in the power supply cable(s).

6. The main power disconnect case (enclosure) must be bonded to the ground approved by the power supply company when electric energy is purchased, or to the generator common-ground when electric energy is being generated by one or more engine-generator sets.

7. Each generator of engine-generator installations must have its case (frame) bonded to the neutral connection of the generator power windings. This connection we refer to as the "common generator ground".

8. The common generator ground(s) must, wherever possible, be connected to a driven or plate earth ground in accordance with Article 250, Section H, of the 1962 National Electric Code.

9. In addition to the earth ground at the common generator grounds(s), there must also be at least one earth ground of the driven rod type or plate type to which the metallic supporting structures of the units are bonded. When operating a group of. highly portable units, such as in a quarry installation, the portable unit or units nearest the moist earth (quarry face) and nearest the metallic mounted equipment (track mounted shovel, etc.) shall have earth grounds.

10. When plugs and receptacles are used as a means of disconnecting power supplying or distributing lines, the plugs and receptacles shall have separate connections for the bonding wire(s). Wherever possible, these connections should be by separate pins rather than by the plug and receptacle cases.

11. Damaged electric power supply cables and damaged electric power distribution cables are hazardous. All exposed electric power supply conductors or exposed electric terminals must be guarded against accidental contact by operating personnel.

12. Manufacturers of equipment using electrical products cannot be responsible for owners and operators safety unless the above recommendations are followed...Play Safe ...Electrical Currents Can Kill.

INTRODUCTION

To The Owner and Operator:

In this manual we have tried to provide information which will give you a clear understanding of equipment construction, function, capabilities and requirements. The details are compiled from the knowledge and experience of highly qualified people at our factory and in our field organizations. By reading and using this information we believe you can better obtain the highest degree of performance efficiency, the maximum service life from normal wear-absorption parts, and the lowest possible maintenance expense. It is our strong recommendation that all persons directly involved with the equipment, be familiar with the contents of this manual.

Respectfully,
IOWA MANUFACTURING COMPANY

TO THE OPERATOR

This manual contains instructions on the operation and preventive maintenance of your Detroit Diesel engine. Sufficient descriptive material, together with numerous illustrations, is included to enable the operator to understand the basic construction of the engine and the principles by which it functions. This manual does not cover engine repair or overhaul.

Whenever possible, it will pay to rely on an authorized *Detroit Diesel Allison Service Outlet* for all your service needs from maintenance to major parts replacement. There are over 1500 authorized service outlets in the U.S. and Canada. They stock factory original parts and have the specialized equipment and personnel with technical knowledge to provide skilled and efficient workmanship.

The operator should familiarize himself thoroughly with the contents of the manual before running an engine, making adjustments, or carrying out maintenance procedures.

The information, specifications and illustrations in this publication are based on the information in effect at the time of approval for printing. Generally, this publication is reprinted annually. It is recommended that users contact an authorized *Detroit Diesel Allison Service Outlet* for information on the latest revision. The right is reserved to make changes at any time without obligation.

WARRANTY

The applicable engine warranty is contained in the form entitled POLICY ON OWNER SERVICE, available from authorized Detroit Diesel Allison Service Outlets.

TECHNICAL MANUAL
No. 5-3895-355-14&P

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, *26 January 1981*

Operator's,. Organizational, Direct Support and General Support
Maintenance Manual
(Including Repair Parts Information and Supplemental
'Maintenance and Repair Parts Instructions)
For
PAVING MACHINE BITUMINOUS MATERIEL CRAWLER MOUNTED DED
MODEL BSF-400
(NSN 3895-01-063-7891)
WITH
DETROIT DIESEL ENGINE (SERIES 53)
IOWA MANUFACTURING COMPANY

REPORTING OF ERRORS

You can help improve this manual. If you find any mistake or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Tank-Automotive Command, ATTN: DRSTA-MB, Warren, MI 48090. A reply will be furnished to you.

NOTE

This manual is published for the purpose of identifying an authorized commercial manual for the use of the personnel to whom the paving machine is issued.
Manufactured by: Detroit Diesel Allison, Division of General Motors Corp.
Iowa Manufacturing Company
Procured under Contract Nos: DSA 700-77-C-8481 and DAAE07-79-C5795

This technical manual is an authentication of the manufacturers' commercial literature and does not conform with the format and content specified in AR 310-3, Military Publications. This technical manual does, however, contain available information that is essential to the operation and maintenance of the equipment.

Part I. Operators Instructions for Series 53 Engine
II. Parts Listing for Detroit Diesel Engine
III. Equipment Operation and Maintenance Instructions
IV. Vane Pumps
V. Service Instructions for Cyclopac Series Air Cleaners
VI. Parts Listing for Paving Machine, Bituminous Material, Crawler Mounted, Model BSF-400
VII, Supplemental Operating, Maintenance and Repair Parts Instructions

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DESCRIPTION

PRINCIPLES OF OPERATION

The diesel engine is an internal combustion power unit, in which the heat of fuel is converted into work in the cylinder of the engine.

In the diesel engine, air alone is compressed in the cylinder; then, after the air has been compressed, a charge of fuel is sprayed into the cylinder and ignition is accomplished by the heat of compression.

The Two-Cycle Principle

In the two-cycle engine, intake and exhaust take place during part of the compression and power strokes respectively, as shown in Fig. 1. In contrast, a four-cycle engine requires four piston strokes to complete an operating cycle; thus, during one half of its operation, the four-cycle engine functions merely as an air pump.

A blower is provided to force air into the cylinders for expelling the exhaust gases and to supply the cylinders with fresh air for combustion. The cylinder wall contains a row of ports which are above the piston when it is at the bottom of its stroke. These ports admit the air from the blower into the cylinder as soon as the rim of the piston uncovers the ports as shown in Fig. 1 (scavenging).
The unidirectional flow of air toward the exhaust valves produces a scavenging effect, leaving the cylinders full of clean air when the piston again covers the inlet pons.

As the piston continues on the upward stroke, the exhaust valves close and the charge of fresh air is subjected to compression as shown in Fig. 1 (compression).

Shortly before the piston reaches its highest position, the required amount of fuel is sprayed into the combustion chamber by the unit fuel injector as shown in Fig. 1 (power). The intense heat generated during the high compression of the air ignites the fine fuel spray immediately. The combustion continues until the injected fuel has been burned.

The resulting pressure forces the piston downward on its power stroke. The exhaust valves are again opened when the piston is about halfway down, allowing the burned gases to escape into the exhaust manifold as shown in Fig. I (exhaust). Shortly thereafter, the downward moving piston uncovers the inlet ports and the cylinder is again swept with clean scavenging air. This entire combustion cycle is completed in each cylinder for each revolution of the crankshaft, or, in other words, in two strokes; hence, it is a "two-stroke cycle".

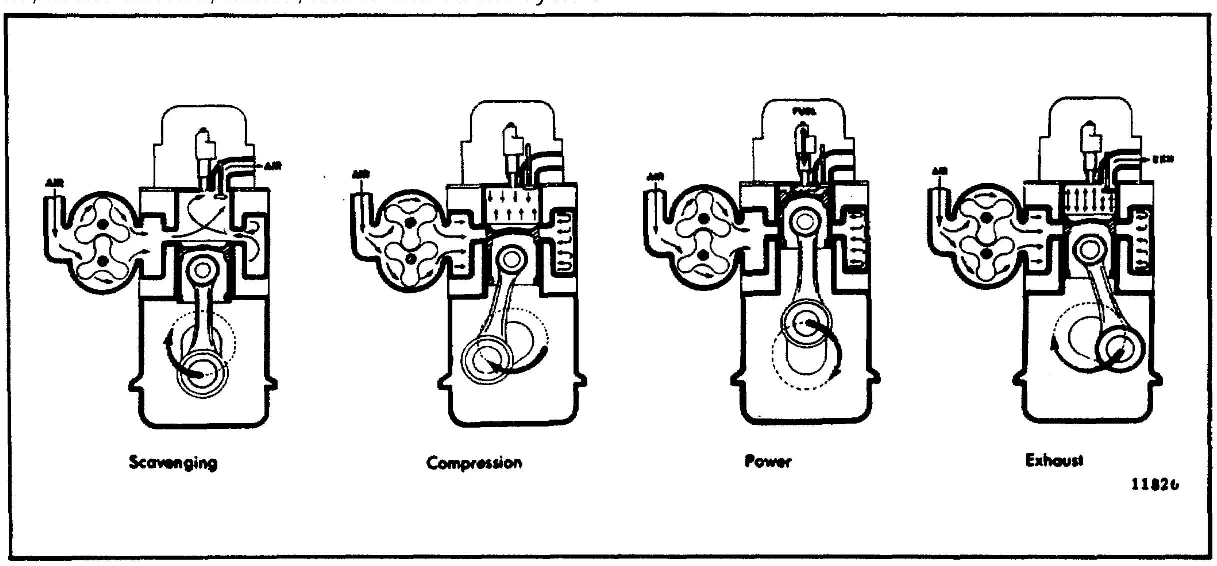


Fig. 1 - The Two-Stroke Cycle

GENERAL DESCRIPTION

The two-cycle diesel engines covered in this manual have the same bore and stroke and many of the major working parts such as injectors, pistons, connecting rods, cylinder liners and other parts are interchangeable.

The In-line engines, including the inclined marine models, include standard accessories such as the blower, water pump, governor and fuel pump, which, on some models, may be located on either side of the engine regardless of the direction the crankshaft rotates. Further flexibility in meeting installation requirements is achieved with the cylinder head which can be installed to accommodate the exhaust manifold on either side of the engine.

The V-type engine uses many In-line engine parts, including the 3-53 cylinder head. The blower is mounted on top of the engine between the two banks of cylinders and is driven by the gear train. The governor is mounted on the rear end of the 6V-53 blower.

The meaning of each digit in the model numbering system is shown in Figs. 2 and 3. The letter L or R indicates left or right-hand engine rotation as viewed from the front of the engine. The letter A,B,C or D designates the blower and exhaust manifold location on the In-line engines as viewed from the rear of the engine while the letter A or C designates the location of the oil cooler and starter on the 6V-53 engine.

Each engine is equipped with an oil cooler, replaceable element type lubricating oil filter, fuel oil strainer, fuel oil filter, an air cleaner or air silencer, a governor, a heat exchanger and raw water pump or a fan and radiator, and a starting motor.

Full pressure lubrication is supplied to all main bearings, connecting rod bearings, and camshaft bearings, and to other moving parts.

Oil is drawn by suction from the oil pan through the intake screen and pipe to the oil pump where it is pressurized and delivered to the oil filter and the oil cooler. From the oil cooler, the oil enters oil galleries in the cylinder block and cylinder head for distribution to the main bearings, connecting rod bearings, camshaft bearings, rocker arm mechanism and other functional parts.

The cooling system has a centrifugal water pump which circulates the engine coolant through the oil cooler and water jackets. The engine temperature is regulated by a thermostat(s).

Fuel is drawn from the supply tank through the fuel strainer and enters a gear type fuel pump at the inlet side. Upon leaving the pump under pressure, the fuel is forced through the fuel filter into the inlet manifold where it passes through fuel pipes into the inlet side of the fuel injectors. The fuel is filtered through elements in the injectors and then atomized through small spray tip orifices into the combustion chamber. Excess fuel is returned to the fuel tank through the fuel outlet galleries and connecting lines.

Air for scavenging and combustion is supplied by a blower which pumps air into the engine cylinders via the air box and cylinder liner ports. All air entering the blower first passes through an air cleaner or air silencer.

The engine may be started by either a hydraulic or an electric starting system.

The engine speed is regulated by a mechanical or hydraulic type engine governor, depending upon the engine application.

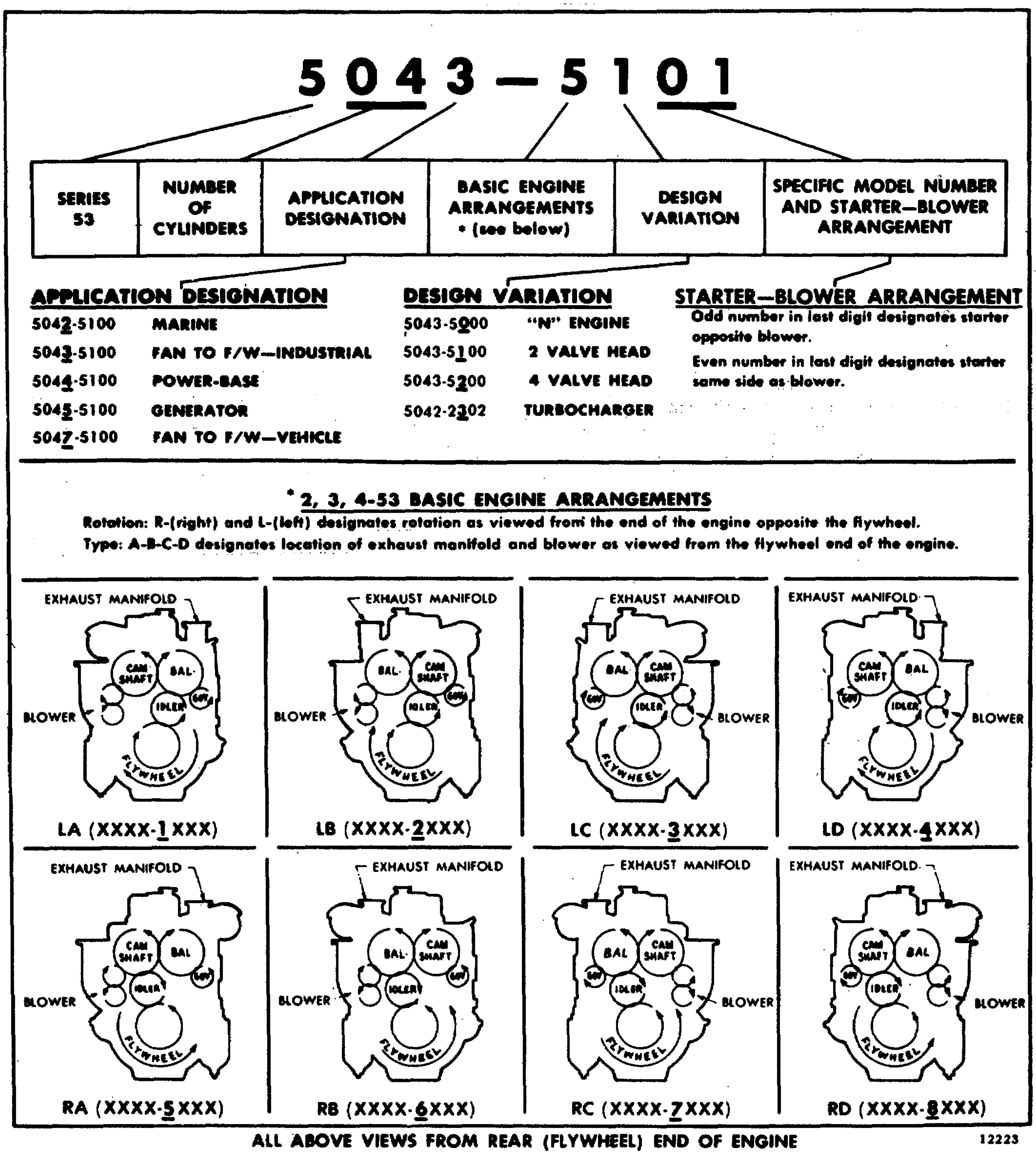
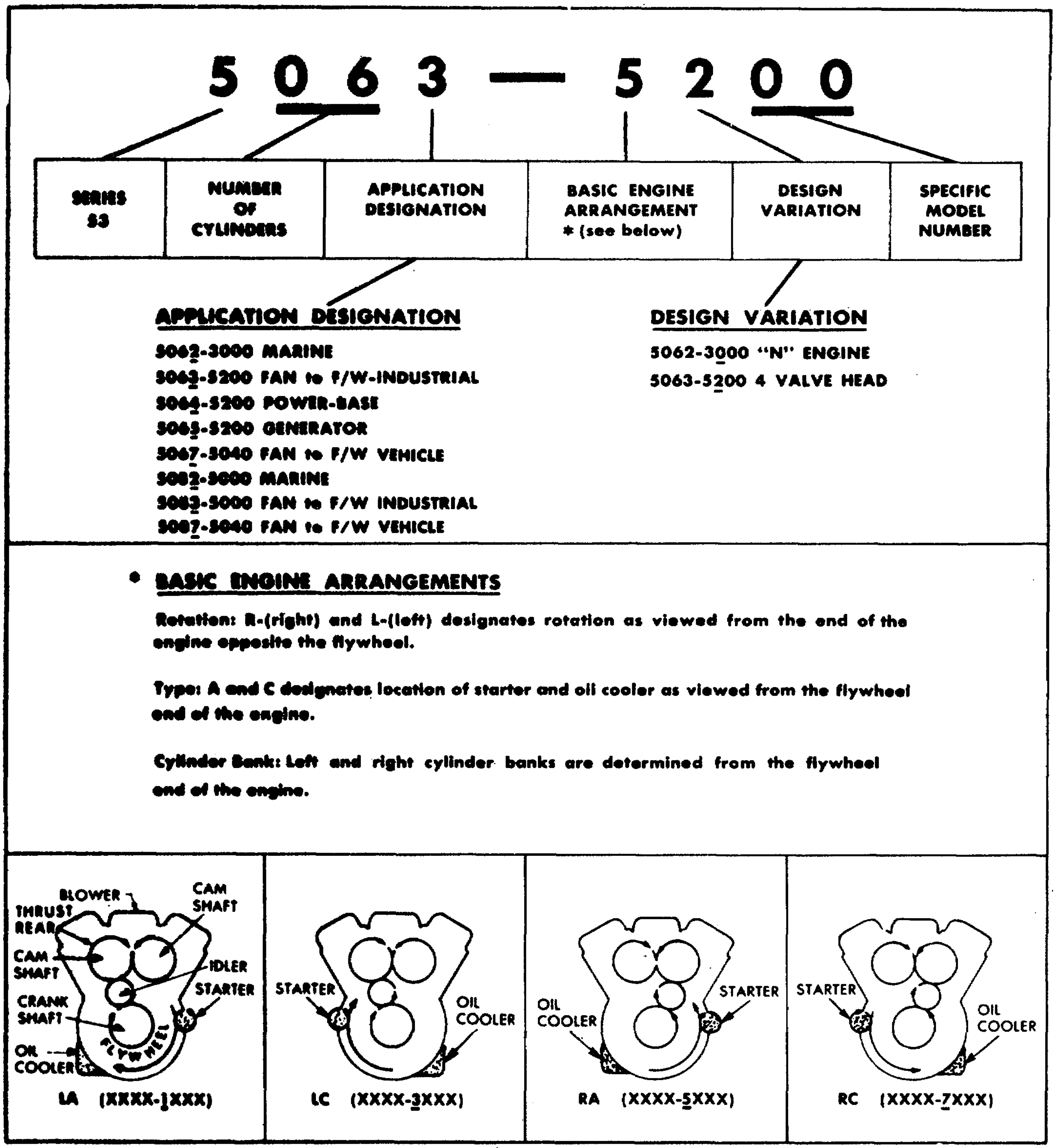


Fig. 2 - In-Line Engine Model Description, Rotation and Accessory Arrangement



ALL ABOVE VIEWS FROM REAR FLYWHEEL END OF ENGINE 11783

Fig. 3 · 6V Engine Model Description, Rotation and Accessory Arrangement

GENERAL SPECIFICATIONS

	3-53	4-53	6V-53
Type	2 Cycle	2 Cycle	2 Cycle
Number of cylinders	3	4	6
Bore (inches)	3.875	3.875	3.875
Bore (mm)	98	98	98
Stroke (inches)	4.5	4.5	4.5
Stroke (mm)	114	114	114
Compression Ratio (nominal)(standard engines)	17 to 1	17 to 1	17 to 1
Compression Ratio (nominal)("N" engines)	21 to 1	21 to 1	21 to 1
Total Displacement - cubic inches	159	212	318
Total Displacement - litres	2.61	3.48	5.22
Number of main bearings	4	5	4

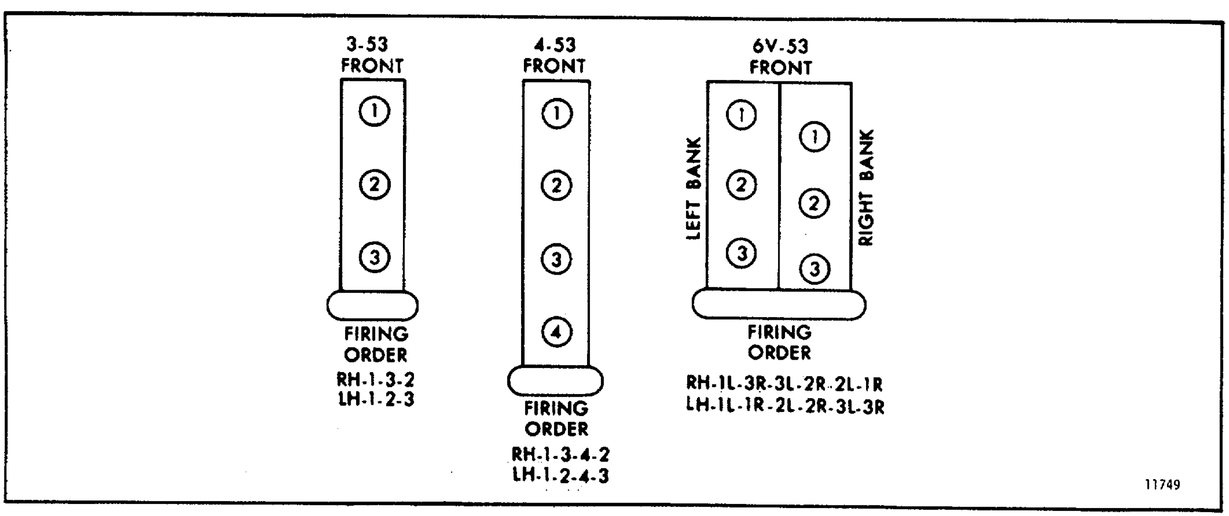


Fig. 4. Series 53 Cylinder Arrangement

ENGINE MODEL AND SERIAL NUMBER DESIGNATION

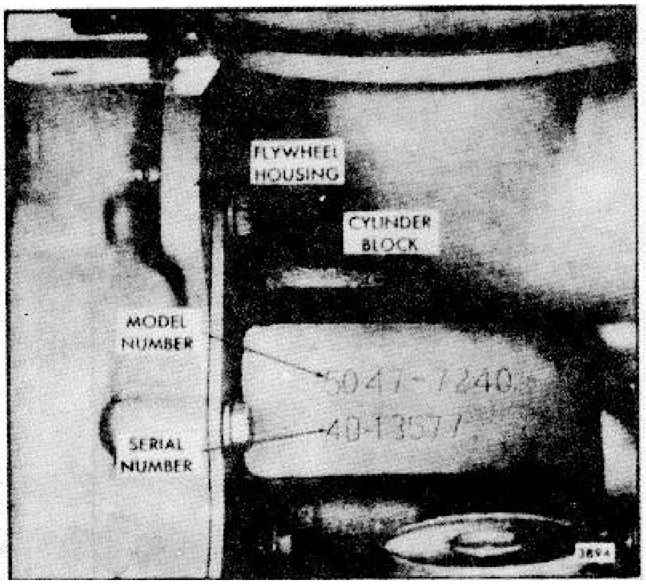


Fig. 5 - Typical Model and Serial Numbers as Stamped on Cylinder Block (In-Line Engine)

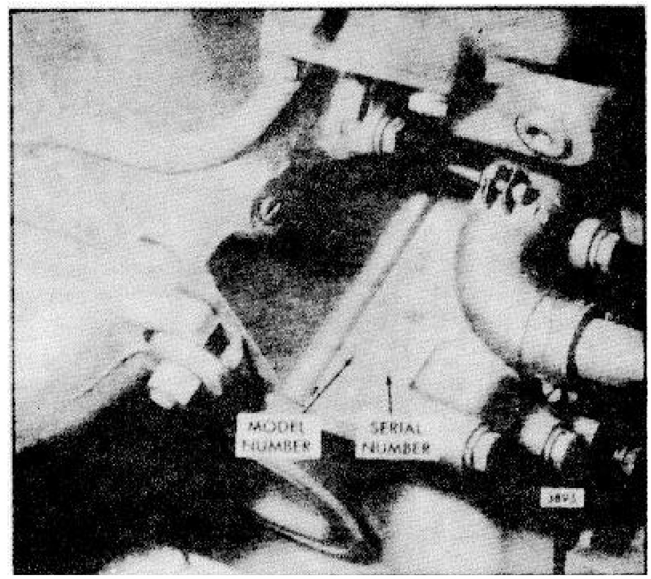


Fig 6 - Typical Model and Serial Numbers as Stamped on Cylinder Block (6V Engine)

On the In-line engines, the model number and serial number are stamped on the right-hand side of the cylinder block in the upper rear corner (Fig. 5). The model number and serial number on the V-type engine is located on the top right-hand front corner of the cylinder block, as viewed from the rear of the engine (Fig. 6).

An option plate, attached to the valve rocker cover, is also stamped with the engine serial number and model number and, in addition, lists any optional equipment used on the engine (Fig. 7).

With any order for parts, the engine model number and serial number must be given. In addition, if a type number is shown on the option plate covering the equipment required, this number should also be included on the parts order.

Power take-off assemblies, torque converters, hydraulic marine gears, etc. may also carry name plates pertaining to the particular assembly to which they are attached. The information on these name plates is useful when ordering parts for these assemblies.

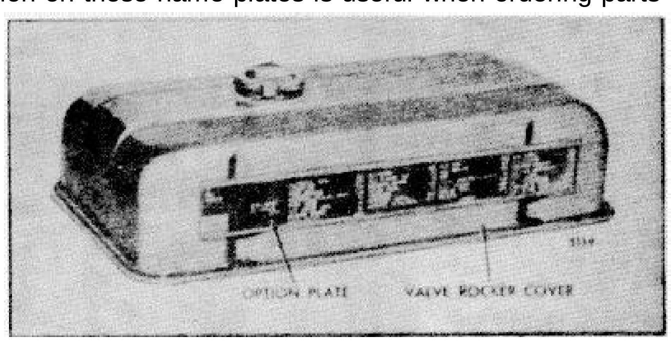
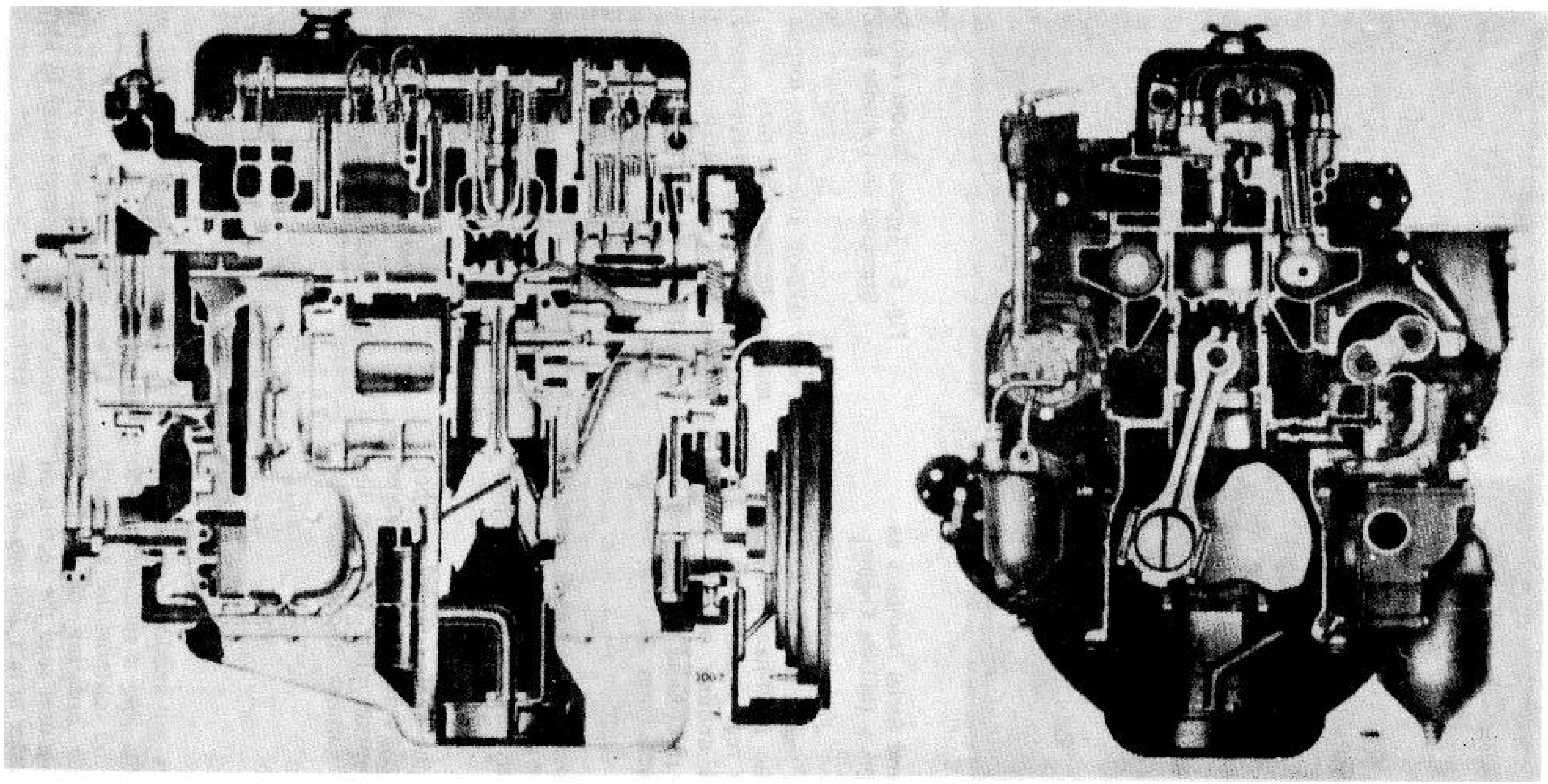


Fig. 7 - Option Plate

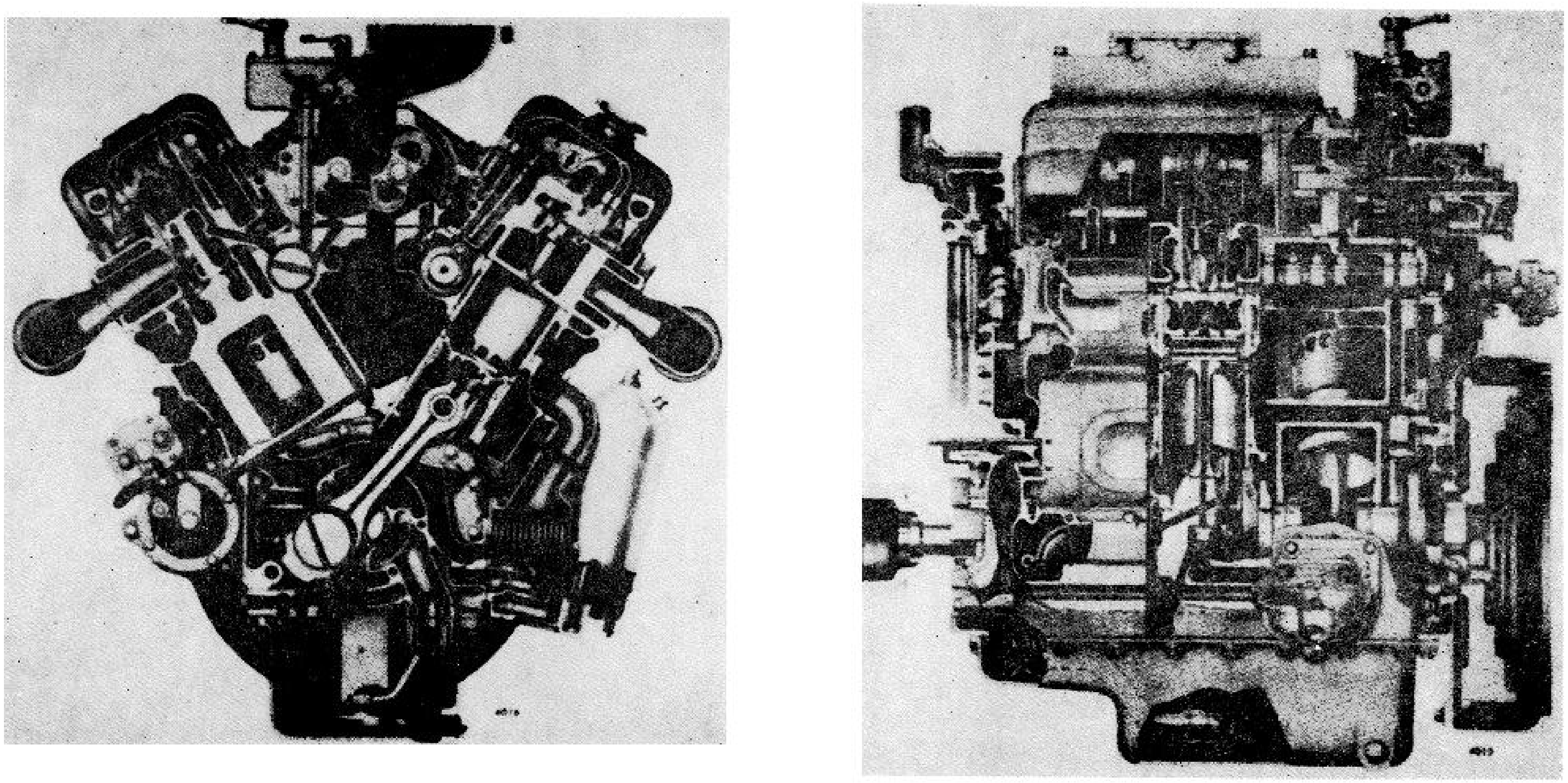
BUILT-IN PARTS BOOK

The *Built-In Parts Book* is an anodized aluminum plate (Option Plate) that fits into a retainer on the engine valve rocker cover and contains the necessary information required when ordering parts. It is recommended that the engine user read the section on t*he Built-In Parts Book* in order to take full advantage of the information provided on the engine option plate.

Numerous exploded view type illustrations are included to assist the user in identifying and ordering service parts.



Cross Section Views of a Typical In-Line Engine



Cross Section Views of a Typical 6V-53 Engine

ENGINE SYSTEMS

The Series 53 Detroit Diesel engines incorporate four basic systems which direct the flow of fuel, air, lubricating oil, and engine coolant.

A brief description of each of these systems and their components, and the necessary maintenance and adjustment procedures are given in this manual.

FUEL SYSTEM

The fuel system (Figs. I and 2) consists of the fuel injectors, fuel pipes, fuel manifolds (integral with the cylinder head), fuel pump, fuel strainer, fuel filter and the necessary connecting fuel lines.

On In-line engines, a restricted fitting is located in the cylinder head fuel return manifold outlet to maintain pressure within the fuel system. On V-type engines, this restricted fitting is located in the left-bank cylinder head.

Fuel is drawn from the supply tank through the fuel strainer and enters the fuel pump at the inlet side. Upon leaving the pump under pressure, the fuel is forced through the fuel filter and into the fuel inlet manifold where it passes through fuel pipes into the inlet side of each fuel injector. The fuel is filtered through elements in the injectors and atomized through small spray tip orifices into the combustion chamber. Surplus fuel, returning from the injectors, passes through the fuel return manifold and connecting fuel lines back to the fuel tank.

The continuous flow of fuel through the injectors helps to cool the injectors and remove air from the fuel system.

A check valve may be installed between the fuel strainer and the source of supply as optional equipment to prevent fuel drain back when the engine is not running.

Fuel Injector

The fuel injector combines in a single unit all of the parts necessary to provide complete and independent fuel injection at each cylinder. The injector creates the high pressure necessary for fuel injection, meters the proper amount of fuel, atomizes the fuel and times the injection into the combustion chamber.

Since the injector is one of the most important and carefully constructed parts of the engine, it is recommended that the engine operator replace the injector as an assembly if it is not operating properly. Authorized *Detroit Diesel Allison Service Outlets* are properly equipped to service injectors.

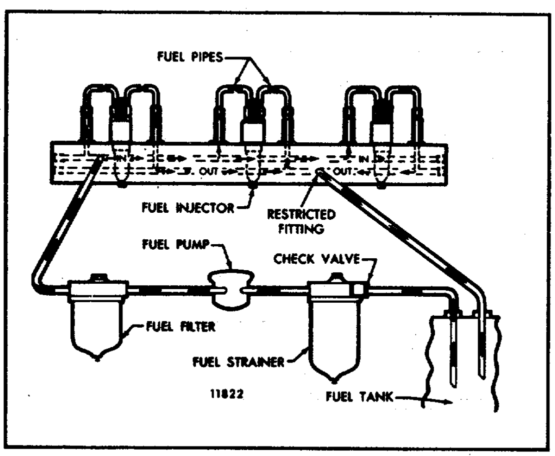


Fig. 1 - Schematic Diagram of Typical Fuel System - In-Line Engine

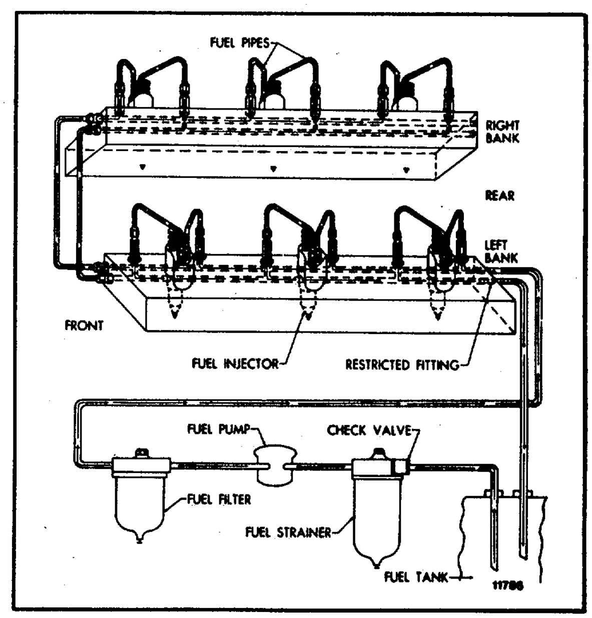


Fig. 2 - Schematic Diagram of Typical Fuel System - V-type Engine

Remove Injector

An injector may be removed in the following manner:

1. Clean and remove the valve rocker cover.

2. Disconnect the fuel pipes from both the injector and the fuel connectors.

3. Immediately after removing the fuel pipes, cover the injector inlet and outlet fittings with shipping caps to prevent dirt from entering.

4. Turn the crankshaft manually in the direction of engine rotation or crank the engine with the starting motor, if necessary, until the rocker arms for the particular cylinder are aligned in a horizontal plane.

 CAUTION: If a wrench is used on the crankshaft bolt at the front of the engine, do not turn the crankshaft in a left-hand direction of rotation as the bolt will be loosened. Remove the starting motor and use a pry bar against the teeth of the flywheel ring gear to turn the crankshaft.

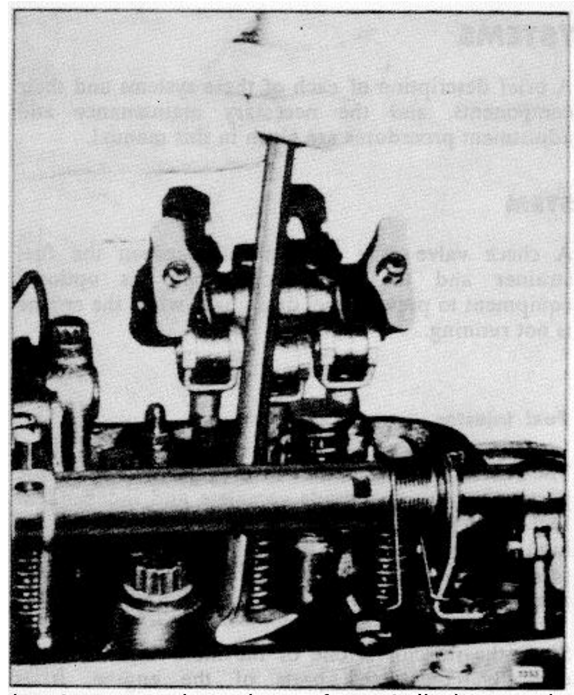


Fig. 3 - Removing Injector from Cylinder Head

5. Remove the two rocker shaft bracket bolts and swing the rocker arm assembly away from the injector and valves.

6. Remove the injector clamp bolt, washer and clamp.

7. Loosen the inner and outer adjusting screws on the injector rack control lever and slide the lever away from the injector.

8. Free the injector from its seat as shown in Fig. 3 and lift it from the cylinder head.

9. Cover the injector hole in the cylinder head to keep foreign particles out of the cylinder.

Install Injector

Before installing an injector, be sure the beveled seat of the injector tube is free from dirt particles and carbon deposits.

A new or reconditioned injector may be installed by reversing the sequence of operations given above for removal.

Be sure the injector is filled with fuel oil. If necessary, add clean fuel oil at the inlet filter until it runs out the outlet filter.

 CAUTION: On four valve cylinder heads, there is a possibility of damaging the exhaust valves if the exhaust valve bridge is not resting on the ends of the exhaust valves when tightening the rocker shaft bracket bolts. Therefore, note the position of the exhaust valve bridge before, during and after tightening the rocker shaft bracket bolts.

Do not tighten the injector clamp bolt to more than 20-25 lb-ft (27-34 Nm) torque, as this may cause the moving parts of the injector to bind. Tighten the rocker shaft bolts to *50-55* lb-ft (68-75 Nm) torque.

Align the fuel pipes and connect them to the injector and the fuel connectors. Use socket J 8932-01 and a torque wrench to tighten the fuel pipe nuts to 12-15 lb-ft (16-20 Nm) torque.

 CAUTION: Do not bend the fuel pipes and do not exceed the specified torque. Excessive tightening will twist or fracture the flared ends of the fuel pipes and result in leaks. Lubricating oil diluted by fuel oil can cause serious damage to the engine bearings.

Time the injector, position the injector rack control lever and adjust the exhaust valve clearance (cold setting) as outlined in the engine tune-up procedure. If all of the injectors have been replaced, perform a complete tune-up on the engine.

Fuel Pump

A positive displacement gear-type fuel pump is attached to the governor or blower on the In-line engines and to the flywheel housing on the V-type engines.

A spring-loaded relief valve, incorporated in the pump body, normally remains in the closed position, operating only when the pressure on the outlet side (to the fuel filter) becomes excessive due to a plugged filter or fuel line.

The fuel pump incorporates two oil seals. Two tapped holes are provided in the underside of the pump body, between the oil seals, to permit a drain tube to be attached. If fuel leakage exceeds one drop per minute, the seals must be replaced. An authorized *Detroit Diesel Allison Service Outlet* is properly equipped to replace the seals.

Fuel pumps are furnished in either left or right-hand rotation, according to the engine model, and are stamped RH or LH. These pumps are not interchangeable and cannot be rebuilt to operate in an opposite rotation.

Fuel Strainer and Fuel Filter

A replaceable-element type fuel strainer and fuel filter (Fig. 4) are used in the fuel system to remove impurities from the fuel. The strainer removes the larger particles and the filter removes the small foreign particles.

The fuel strainer and fuel filter are basically identical in construction, both consisting of a cover, shell and replaceable element. Since the fuel strainer is placed between the fuel supply tank and the fuel pump, it functions under suction; the fuel filter, which is installed between the fuel pump and the fuel inlet manifold in the cylinder head, operates under pressure.

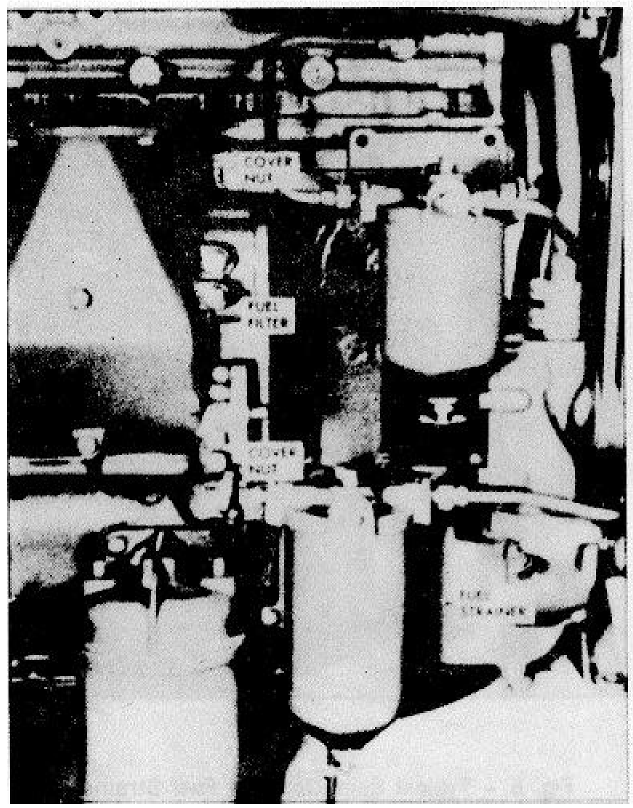


Fig. 4 - Typical Fuel Strainer and Filter Mounting

Replace the elements as follows:

1. With the engine shut down, place a suitable container under the fuel strainer or filter and open the drain cock. The fuel will drain more freely if the cover nut is loosened slightly.

2. Support the shell, unscrew the cover nut and remove the shell and element.

3. Remove and discard the element and gasket. Clean the shell with fuel oil and dry it with a cloth or compressed air.

4. Place a new element, which has been thoroughly soaked in clean fuel oil, over the stud and push it down on the seat. Close the drain cock and fill the shell approximately two-thirds full with clean fuel oil.

5. Affix a new shell gasket, place the shell and element into position under the cover and start the cover nut on the shell stud.

6. Tighten the cover nut only enough to prevent fuel leakage.

7. Remove the plug in the strainer or filter cover and fill the shell with fuel. Fuel system primer J 5956 may be used to prime the fuel system.

8. Start and operate the engine and check the fuel system for leaks.

Spin-On Type Fuel Filter

A spin-on fuel strainer and fuel filter (Fig. 5) is used on certain engines. The spin-on filter cartridge consists of a shell, element and gasket combined into a unitized replacement assembly. No separate springs or seats are required to support the filters.

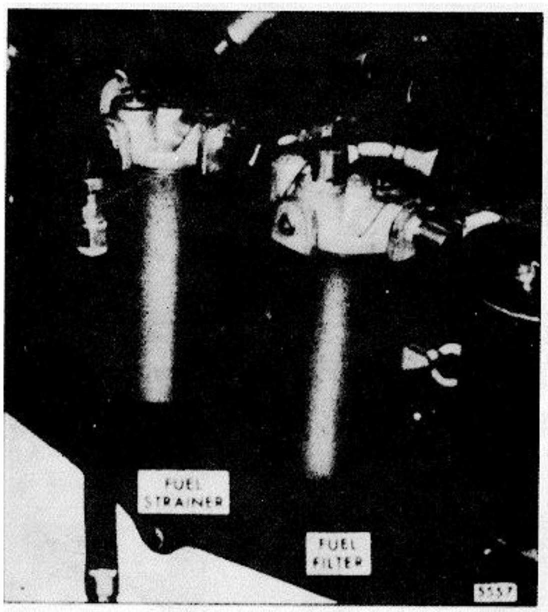


Fig. 5 - Typical Spin-On Type Fuel Strainer and Fuel Filter Mounting

The filter covers incorporate a threaded sleeve to accept the spin-on filter cartridges. The word "Primary" is cast on the fuel strainer cover and the word "Secondary" is cast on the fuel filter cover for identification. No drain cocks are provided on the spin-on filters. Where water is a problem, it is recommended that a water separator be installed. Otherwise, residue may be drained by removing and inverting the filter. Refill the filter with clean fuel oil before reinstalling it.

A 1" diameter twelve-point nut on the bottom of the filter is provided to facilitate removal and installation.

Replace the filter as follows:

1. Unscrew the filter (or strainer) and discard it.

2. Fill a new filter replacement cartridge about two-thirds full with clean fuel oil. Coat the seal gasket lightly with clean fuel oil.

3. Install the new filter assembly and tighten it to two-thirds of a turn beyond gasket contact.

4. Start the engine and check for leaks.

Fuel Tank

Refill the fuel tank at the end of each day's operation to prevent condensation from contaminating the fuel.

CAUTION: A galvanized steel tank should never be used for fuel storage because the fuel oil reacts chemically with the zinc coating to form powdery flakes which quickly clog the fuel strainer and filter and damage the fuel pump and the fuel injectors.

Engine Out of Fuel

The problem in restarting the engine after it has run out of fuel stems from the fact that after the fuel is exhausted from the fuel tank, fuel is then pumped from the primary fuel strainer and sometimes partially removed from the secondary fuel filter before the fuel supply becomes insufficient to sustain engine firing. Consequently, these components must be refilled with fuel and the fuel pipes rid of air in order for the system to provide adequate fuel for the injectors.
When an engine has run out of fuel, there is a definite procedure to follow for restarting the engine.

1. Fill the fuel tank with the recommended grade of fuel oil. If only partial filling of the tank is possible, add a minimum of ten gallons (38 litres) of fuel.

2. Remove the fuel strainer shell and element from the strainer cover and fill the shell with fuel oil. Install the shell and element.

3. Remove and fill the fuel filter shell and element with fuel oil as in Step 2.

4. Start the engine. Check the filter and strainer for leaks.

NOTE: In some instances, it may be necessary to remove a valve rocker cover and loosen a fuel pipe nut in order to bleed trapped air from the fuel system. Be sure the fuel pipe is retightened securely before replacing the rocker cover.

Primer J 5956 may be used to prime the entire fuel system. Remove the filler plug in the fuel filter cover and install the primer. Prime the system. Remove the primer and install the filler plug.

Air System

In the scavenging system used in two-cycle engines, illustrated in Figs. 6 and 7, a charge of air is forced into the cylinders by the blower and thoroughly sweeps out all of the burned gases through the exhaust valve ports. This air also helps to cool the internal engine parts, particularly the exhaust valves. At the beginning of the compression stroke, each cylinder is filled with fresh, clean air which provides for efficient combustion.

The air, entering the blower from the air silencer or air cleaner, is picked up by the blower rotor lobes and carried to the discharge side of the blower. The continuous discharge of fresh air from the blower enters the air chamber of the cylinder block and sweeps through the intake ports of the cylinder liners.

The angle of the ports in the cylinder liner creates a uniform swirling motion to the intake air as it enters the cylinder. This motion persists throughout the compression stroke and facilitates scavenging and combustion.

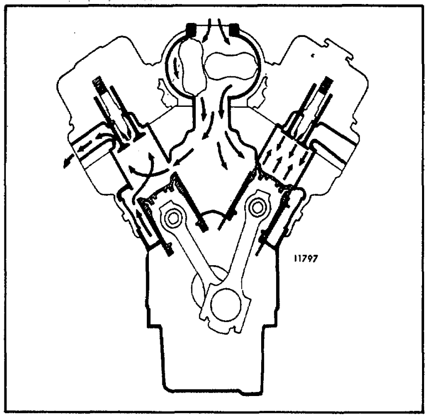


Fig. 7 - Air Intake System Through Blower and Engine (6V-53 Engine)

Air Cleaners

Several types of air cleaners are available for use with industrial engines. The light-duty oil bath air cleaner is used on most models. However, a heavy-duty oil bath type or a dry type air cleaner may be installed where the engine is operating in heavy dust concentrations.

The air cleaners are designed for fast, easy disassembly to facilitate efficient servicing. Maximum protection of the engine against dust and other forms of air contamination is possible if the air cleaner is serviced at regular intervals.

The *light-duty oil bath type air cleaner* (Fig. 8) consists of a metal wool cleaning element supported inside of a housing which contains an oil reservoir. A chamber beneath the oil reservoir serves as a silencer for the incoming air to the blower. Air is drawn into the cleaner by the blower and passes over the top of the oil bath, where a major portion of the dirt is trapped, then up through the metal wool, where the finer particles are removed, and then down the central duct to the blower.

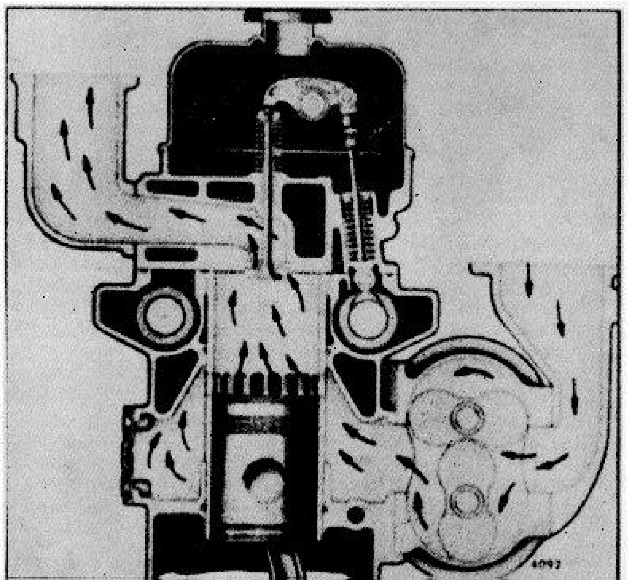


Fig. 6 - Air Intake System Through Blower and Engine (In-line Engine)

The *heavy-duty oil bath type air cleaner* (Fig. 9) consists of the body and fixed filter assembly which filters the air and condenses the oil from the air stream so that only dry air enters the engine. The condensed oil is returned to the cup where the dirt settles out of the oil and the oil is recirculated. A removable element assembly removes a major part of the dust from the air stream thereby decreasing the dust load to the fixed element. An inner cup, which can be removed from the outer (oil cup), acts as a baffle in directing the oil-laden air to the element and also controls the amount of oil in circulation and meters the oil to the element. The oil cup supports the inner cup and is a reservoir for oil and a settling chamber for dirt.

Service the *light-duty oil bath air cleaner* as follows:

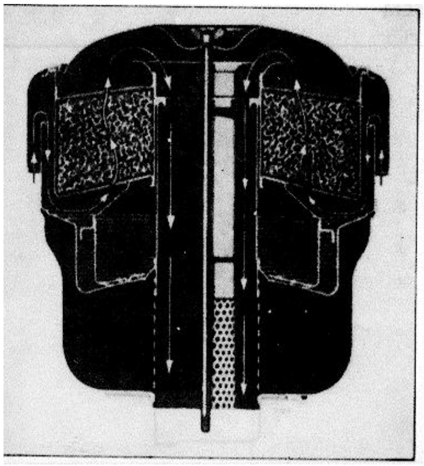


Fig. 8 - Light Duty Oil Bath Air Cleaner

1. Loosen the wing bolt and remove the air cleaner assembly from the air inlet housing. The cleaner may then be separated into two sections; the upper section or body assembly contains the filter element, the lower section consists of the oil cup, removable inner cup or baffle and the center tube.

2. Soak the body assembly and element in fuel oil to loosen the dirt; then flush the element with clean fuel oil and allow it to drain thoroughly.

3. Pour out the oil, separate the inner cup or baffle from the oil cup, remove the sludge and wipe the baffle and outer cup clean.

4. Push a lint-free cloth through the center tube to remove dirt or oil.

5. Clean and check all of the gaskets and sealing surfaces to ensure air tight seals.

6. Refill the oil cup to the oil level mark only, install the baffle, and reassemble the air cleaner.

7. Check the air inlet housing before installing the air cleaner assembly on the engine. The inlet will be dirty if air cleaner servicing has been neglected or if dust-laden air has been leaking past the air cleaner or air inlet housing seals.

8. Make sure that the air cleaner is seated properly on the inlet housing and the seal is installed correctly.

Tighten the wing bolt until the air cleaner is securely mounted.

Service the *heavy-duty oil bath air cleaner* as follows:

1. Loosen the wing nuts and detach the lower portion of the air cleaner assembly.

2. Remove the detachable screen by loosening the wing nuts and rotating the screen one-quarter turn.

One of the most important steps in properly cleaning the tray type oil bath air cleaner is a step that is most overlooked. Unless the filter tray is thoroughly cleaned, satisfactory performance of the engine cannot be realized. The presence of fibrous material found in the air is often underestimated and is the main cause of the malfunctioning-of heavy-duty air cleaners. This material comes from plants and trees during their budding season and later from airborne seed from the same sources. Figure 10 illustrates the severity of lugging in a tray that is 50% plugged. The solid black areas in the mesh are accumulations of this fibrous material. When a tray is plugged in this manner, washing in a solvent or similar washing solution will not clean it satisfactorily. It must be blown out with high pressure air or steam to remove the material that accumulates between the layers of screening. When a

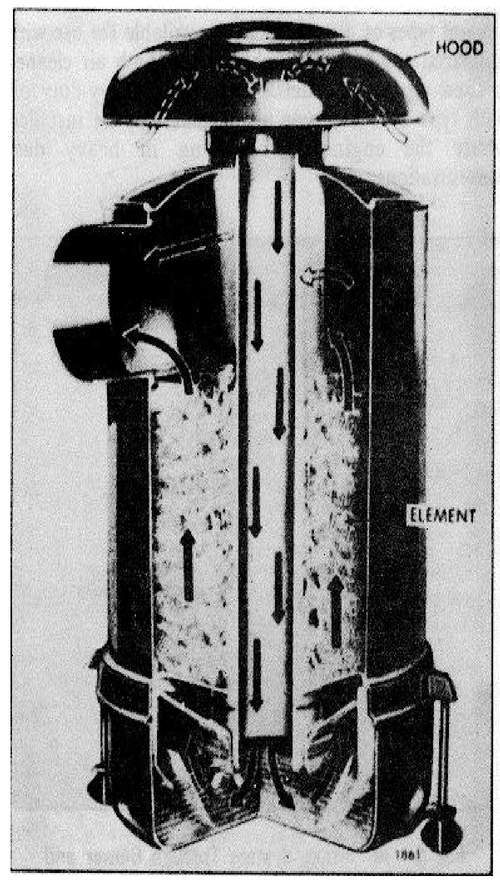
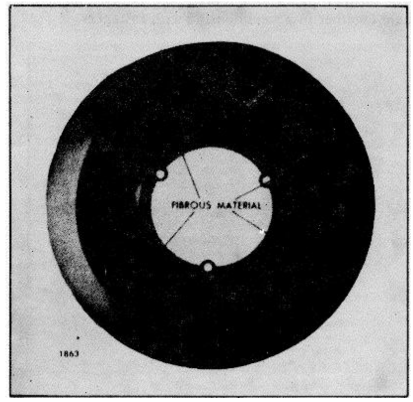


Fig. 9 - Heavy-Duty Oil Bath Air Cleaner

clean tray is held up to the light, an even pattern of light should be visible. It may be necessary, only as a last resort, to burn off the lint. Extreme care must be taken to prevent melting the galvanized coating in the tray screens. Some trays have equally spaced holes in the retaining baffle. Check to make sure that they are clean and open. Figure 11 illustrates a thoroughly cleaned tray. The dark spots in the mesh indicate the close overlapping of the mesh and emphasize the need for using compressed air or steam. It is suggested that users of heavy-duty air cleaners have a spare tray on hand to replace the tray that requires cleaning. Having an extra tray available makes for better service and the dirty tray can be cleaned thoroughly as recommended. Spare trays are well worth their investment.



Fig; 11 - Air Cleaner Tray (Clean)

3. Pour out the oil, separate the inner cup or baffle from the oil or outer cup, remove the sludge and wipe the baffle and outer cup clean.

4. Clean and inspect the gaskets and sealing surfaces to ensure an air tight seal.

5. Reinstall the baffle in the oil cup and refill to the proper oil level with the same grade of oil being used in the engine.

6. Remove the hood and clean by brushing, or by blowing out with compressed air. Push a lint-free cloth through the center tube to remove dirt or oil from the walls.

7. Inspect the lower portion of the air cleaner body and center tube each time the oil cup is serviced. If there are any indications of plugging, the body assembly should be removed from the engine and cleaned by soaking and then flushing with clean fuel oil. Allow the unit to drain thoroughly.

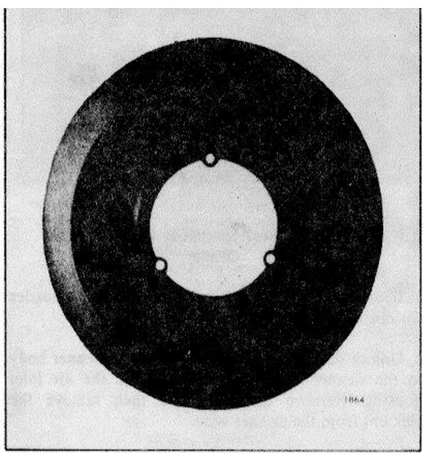


Fig. 10 - Air Cleaner Tray (Plugged)

8. Place the removable element in the body assembly. Install the body if it was removed from the engine for servicing.

9. Install the outer cup and baffle assembly. Be sure the cup is tightly secured to the body assembly.

All oil bath air cleaners should be serviced as operating conditions warrant. At no time should more than 1/2" of "sludge" be allowed to form in the oil cup or the area used for sludge deposit, nor should the oil cup be filled above the oil level mark.

The *United Specialties dry-type air cleaner* shown in Fig. 12 consists of a body, dust unloader and element clamped to a base.

Air is drawn through the cleaner intake pipe and is automatically set into a circular motion. This positive spinning of the dirty air "throws out" the heavier particles of dust and dirt where they are collected in the dust port and then expelled through the dust unloader. The circular action continues even during low air intake at engine idle speeds.

The *United Specialties dry-type air cleaner* should be serviced, as operating conditions warrant, as follows:

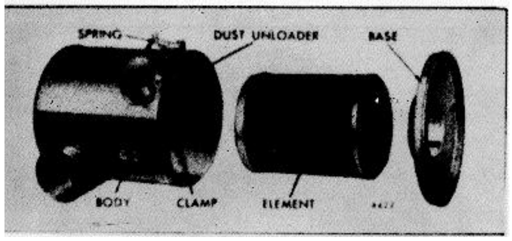


Fig. 12 - United Specialties Dry Type Air Cleaner

1. Loosen the clamp screw and check the dust unloader for obstruction or damage.

2. Unlock the spring clamps that hold the cleaner body to the cleaner base which is bolted to the air inlet housing. Remove the body and then remove the element from the cleaner base.

3. The paper pleated air cleaner element can be cleaned as follows:

a. For a temporary expedient in the field, tap the side or end of the element carefully against the palm of your hand.

CAUTION: Do not tap the element against a hard surface. This could damage the element.

b. Compressed air can be used when the major contaminant is dust. The compressed air (not to exceed 100 psi or 689 kPa) should be blown through the element in a direction opposite to the normal air flow. Insert the air nozzle inside of the element and gently tap and blow out the dust with air. When cleaning the dust from the outside of the element, hold the nozzle at least 6" from the element.

c. Wash the element if compressed air is not available, or when the contaminant is carbon, soot, oily vapor or dirt which cannot be removed with compressed air.

d. Agitate the element in warm water containing a non-sudsing detergent.

CAUTION: Do not use water hotter than your hand can stand, solvents, oil, fuel oil or gasoline.

Preceding the washing, it helps to direct air (not exceeding 100 psi or 689 kPa) through the element in a direction opposite the normal air flow to dislodge as much dust as possible. Reverse flush with a stream of water (not exceeding 40 psi or 276 kPa) until the water runs clean to rinse all loosened foreign material from the element. Shake out excess water from the element and allow it to dry thoroughly.

CAUTION: Do not attempt to remove excess water by using compressed air.

4. Inspect the cleaned element with a light bulb after each cleaning for damage or rupture. The slightest break in the element will admit sufficient airborne dirt to cause rapid failure of piston rings. If necessary, replace the element.

5. Inspect the gasket on the end of the element. If the gasket is damaged or missing, replace the element.

6. Install the element on the base with the gasket side of the element down against the base. Place the body over the element and base and tighten the spring clamps by hand.

7. Replace the element after 10 washings or I year of service, whichever comes first, or any time damage is noted.

8. Install the dust unloader and tighten the clamp. T*he Farr dry-type air cleaner,* (Fig. 13) is designed to provide highly efficient air filtration under all operating conditions and is not affected by engine speed. The cleaner assembly consists of a cleaner panel with a replaceable impregnated paper filter element.

The cleaner panel and replaceable filter element are held together in a steel housing with fasteners.

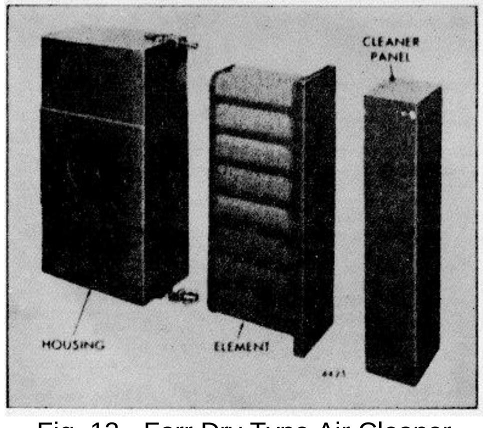


Fig. 13 - Farr Dry Type Air Cleaner

The deflector vanes impart a swirling motion to the air entering the air cleaner and centrifuge the dust particles against the walls of the tubes. The dust particles are then carried to the dust bin at the bottom of the cleaner by approximately 10% bleed-off air and are finally discharged into the atmosphere. The cleaner panel is fully effective at either high or low velocities.

The remainder of the air in the cleaner reverses direction and spirals back along the discharge tubes again centrifuging the air. The filtered air then reverses direction again and enters the replaceable filter element through the center portion of the discharge tubes. The air is filtered once more as it passes through the pleats of the impregnated paper element before leaving the outlet port of the cleaner housing.

The cleaner panel tends to be self-cleaning. However, it should be inspected and any accumulated foreign material removed during the periodic replacement of the impregnated paper filter element. Overloading of the paper element will not cause dirt particles to by-pass the filter and enter the engine, but will result in starving the engine for air.

The filter element should be replaced, as operating conditions warrant, as follows:

1. Loosen the wing nuts on the fasteners and swing the retaining bolts away from the cleaner panel.
2. Lift the cleaner panel away from the housing and inspect it. Clean out any accumulated foreign material.
3. Withdraw the paper filter element and discard it.
4. Install a new filter element.
5. Install the cleaner panel aid secure it in place with the fasteners.

Air Silencer

The air silencer, used on some marine engines, is bolted to the intake side of the blower housing. The silencer has a perforated steel partition welded in place parallel with the outside faces, enclosing flame-proof, felted cotton waste which serves as a silencer for air entering the blower.

While no servicing is required on the air silencer proper, it may be removed when necessary to replace the air inlet screen. This screen is used to filter out any large foreign particles which might seriously damage the blower assembly.

Air Box Drains

During normal engine operation, water vapor from the air charge, as well as a slight amount of fuel and lubricating oil fumes, condenses and settles on the bottom of the air box. This condensation is removed by the air box pressure through air box drain tubes mounted on the side of the cylinder block.

The air box drains must be open at all times. With the engine running, a periodic check is recommended for air flow from the air box drain tubes. Liquid accumulation on the bottom of the air box indicates a drain tube may be plugged. Such accumulations can be seen by removing the cylinder block air box cover(s) and should be wiped out with rags or blown out with compressed air. Then remove the drain tubes and connectors from the cylinder block and clean them thoroughly.

Some engines are equipped with an air box drain check valve. Refer to the *Lubrication and Preventive Maintenance* section of this manual for service instructions.

Crankcase Ventilation

Harmful vapors which may form within the engine are removed from the crankcase, gear train and valve compartment by a continuous, pressurized ventilation system.

A slight pressure is maintained within the engine crankcase by the seepage of a small amount of air from the airbox past the piston rings. This air sweeps up through the engine and is drawn off through a crankcase breather.

In-line engines are equipped with a breather assembly which is mounted on the rocker cover or the flywheel housing. The 6V engines incorporate a breather assembly mounted inside of the upper engine front cover.

The wire mesh pad (element) in the breather assemblies should be cleaned if excessive crankcase pressure is observed. If it is necessary to clean the element, remove the breather housing from the flywheel housing (In-line engines) and the upper engine front cover (6V engines). Wash the element in fuel oil and dry it with compressed air. Reinstall the element and the breather assembly.

LUBRICATING SYSTEM

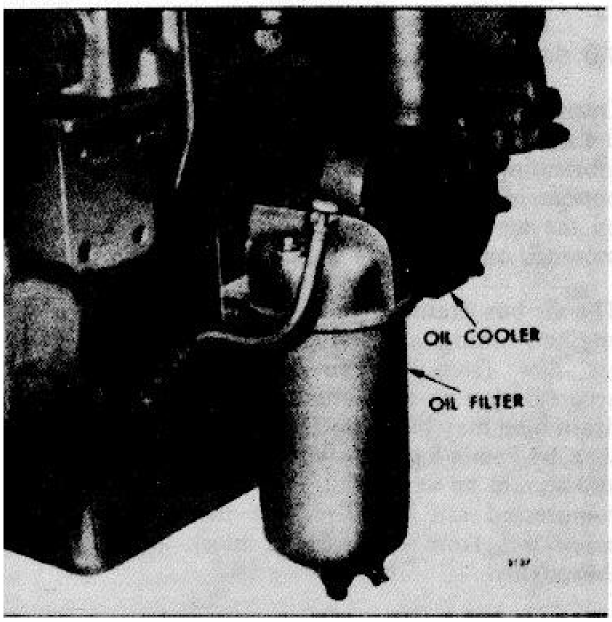


Fig. 14 - Typical In-Line Engine Oil Filter Mounting

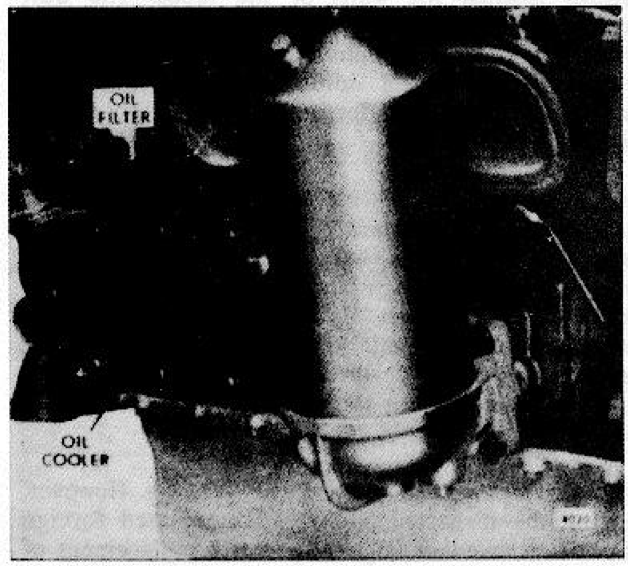


Fig. 15 - Typical V-Type Engine Oil Filter Mounting

The Series 53 engine lubricating system, illustrated in Figs. 16 and 17, includes an oil intake screen and tube assembly, an oil pump, a pressure regulator, a full-flow oil filter or by-pass filter with by-pass valve, and an oil cooler with a by-pass valve.

Lubricating oil from the pump passes from the lower front cover through short oil galleries in the cylinder block. From the block, the oil flows to the full-flow oil filter, then through the oil cooler (if used) and back into the front engine cover and cylinder block oil galleries for distribution to the various engine bearings. The drains from the cylinder head(s) and other engine parts lead back to the oil pan.

Oil pressure is regulated by a pressure relief valve mounted in the engine front cover. Oil cooler and oil filter by-pass valves prevent the stoppage of oil flow if these items become plugged.

Oil Filters

Each engine is equipped with a full-flow type lubricating oil filter (Figs. 14 and 15). If additional filtering is required, a by-pass type oil filter may also be installed.

All of the oil supplied to the engine passes through the full-flow filter that removes the larger foreign particles without restricting the normal flow of oil.

The by-pass filter assembly, when used, continually filters a portion of the lubricating oil that is being bled off the oil gallery when the engine is running. Eventually all of the oil passes through the filter, filtering out minute foreign particles that may be present.

The lubricating oil filter elements should be replaced, each time the engine oil is changed, as follows:

1. Remove the drain plug and drain the oil.
2. The filter shell, element and stud may be detached as an assembly, after removing the center stud from the base. Discard the gasket.
3. Clean the filter base.
4. Discard the used element, wipe out the filter shell and install a new element on the center stud.
5. Place a new gasket in the filter base, position the shell and element assembly on the gasket and tighten the center stud carefully to prevent damaging the gasket or center stud.
6. Install the drain plug and, after the engine is started, check for oil leaks.

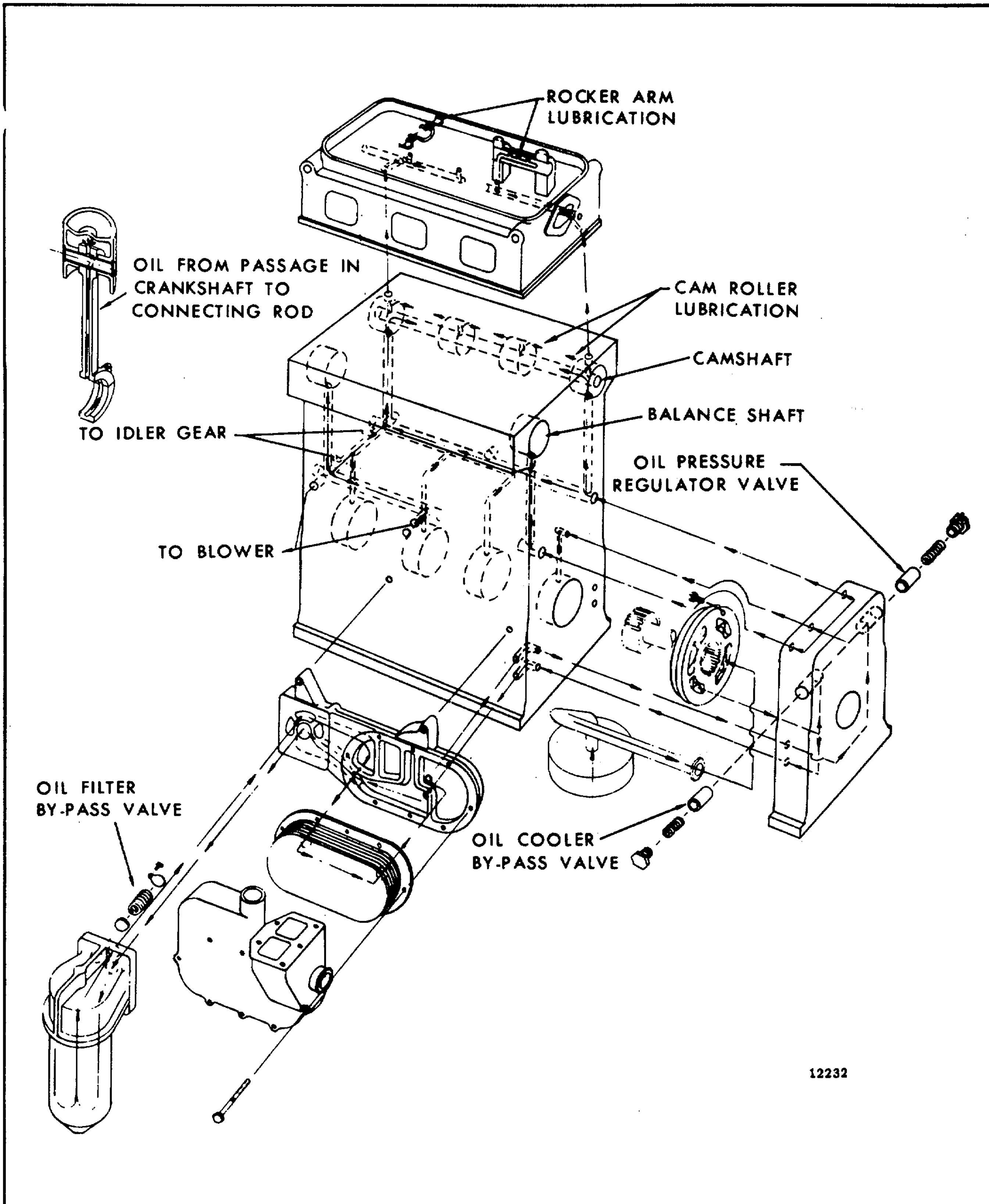


Fig. 16 - Schematic Diagram of Typical In-Line Engine Lubricating System

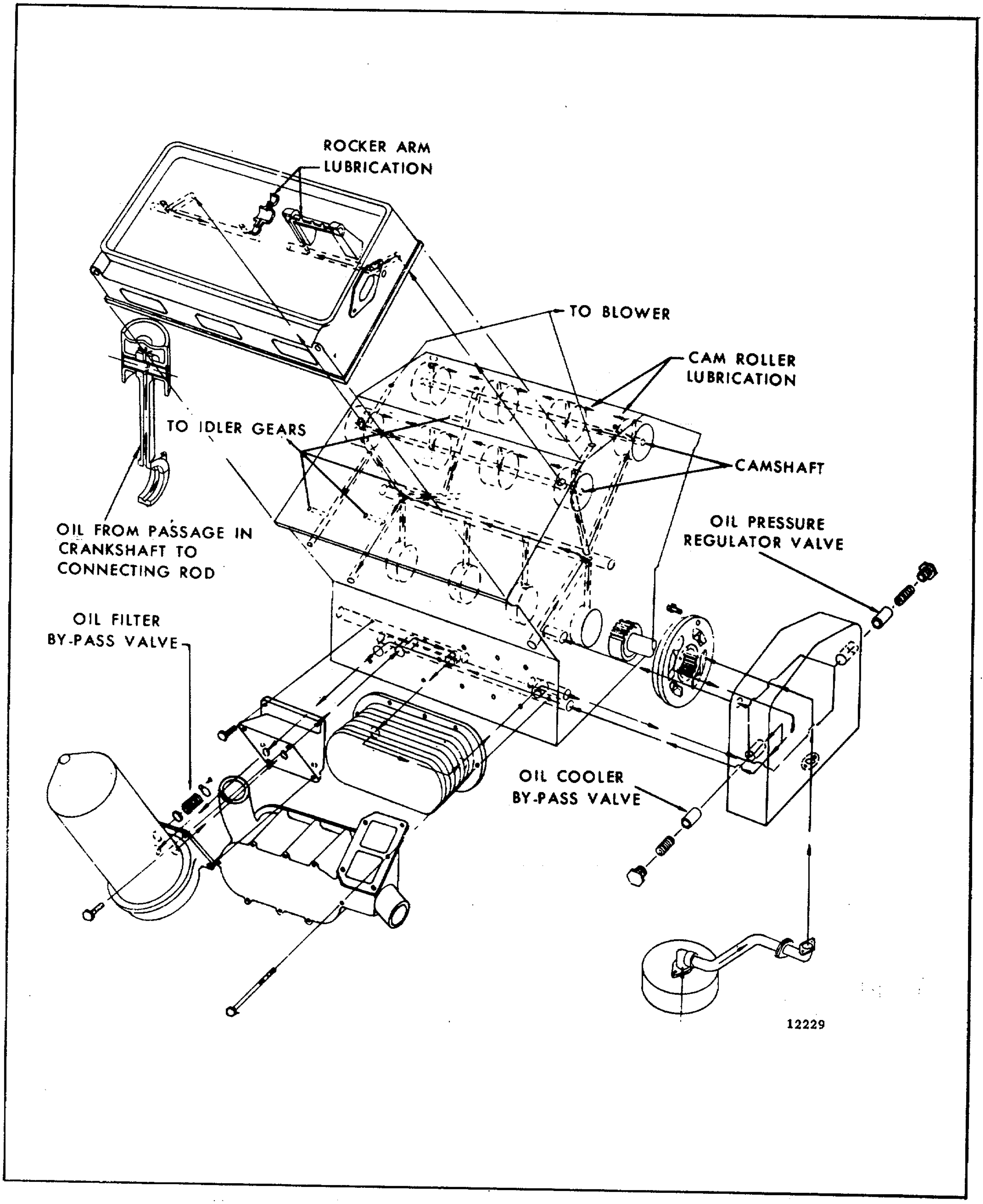


Fig. 17 - Schematic Diagram of Typical 6V Engine Lubricating System

COOLING SYSTEM

One of three different types of cooling systems is used on a Series 53 engine: radiator and fan, heat exchanger and raw water pump, or keel cooling. A centrifugal type water pump is used to circulate the engine coolant in each system. Each system incorporates thermostats to maintain a normal operating temperature of 160-185°F (71-85°C). Typical engine cooling system- are shown in Figs. 18 and 19.

Radiator Cooling System

The engine coolant is drawn from the bottom of the radiator core by the water pump and is forced through the oil cooler and into the cylinder block. The coolant circulates up through the cylinder block into the cylinder head, then to the water manifold and thermostat housing. From the thermostat housing, the coolant returns to the radiator where it passes down a series of tubes and is cooled by the air stream created by the fan.

When starting a cold engine or when the coolant is below operating temperature, the coolant is restricted at the thermostat housing(s) and a by-pass provides water- circulation within the engine during the warm-up period.

Heat Exchanger Cooling System

In the heat exchanger cooling system, the coolant is drawn by the circulating pump from the bottom of the expansion tank through the engine oil cooler, then through the engine the same as in the radiator and fan system. Upon leaving the thermostat housing, the coolant either passes through the heat exchanger core

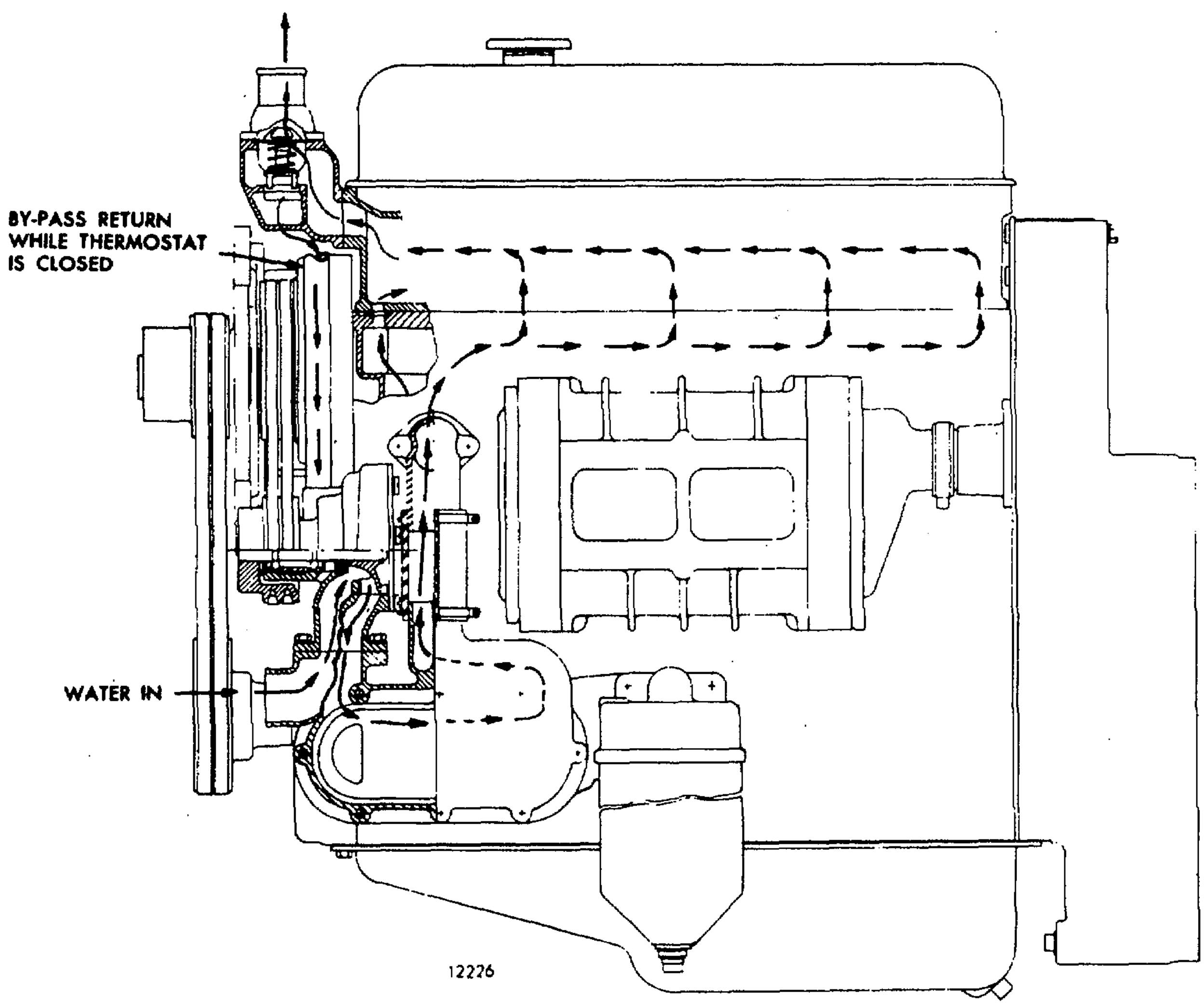


Fig. 18 • Typical Cooling System for In-Line Engines or by-passes the heat exchanger and flows directly to the water pump, depending on the coolant temperature.

While passing through the core of the heat exchanger, the coolant temperature is lowered by raw water, which is drawn by the raw water pump from an outside supply. The raw water enters the heat exchanger at one side and' is discharged at the opposite side.

To protect the heat exchanger element from electrolytic action, a zinc electrode is located in both the heat exchanger inlet elbow and the raw water pump inlet elbow and extends into the raw water passage.

The length of time a heat exchanger will function satisfactorily before cleaning will be governed by the kind of coolant used in the engine and the kind of raw water used. Soft water plus a rust inhibitor or a high boiling point type antifreeze should be used as the engine coolant.

When foreign deposits accumulate in the heat exchanger to the extent that cooling efficiency is impaired, such deposits can, in most instances, be removed by circulating a flushing compound through the fresh water circulating system without removing the heat exchanger. If this treatment does not restore the engine's normal cooling characteristics, contact an authorized *Detroit Diesel Allison Service Outlet.*

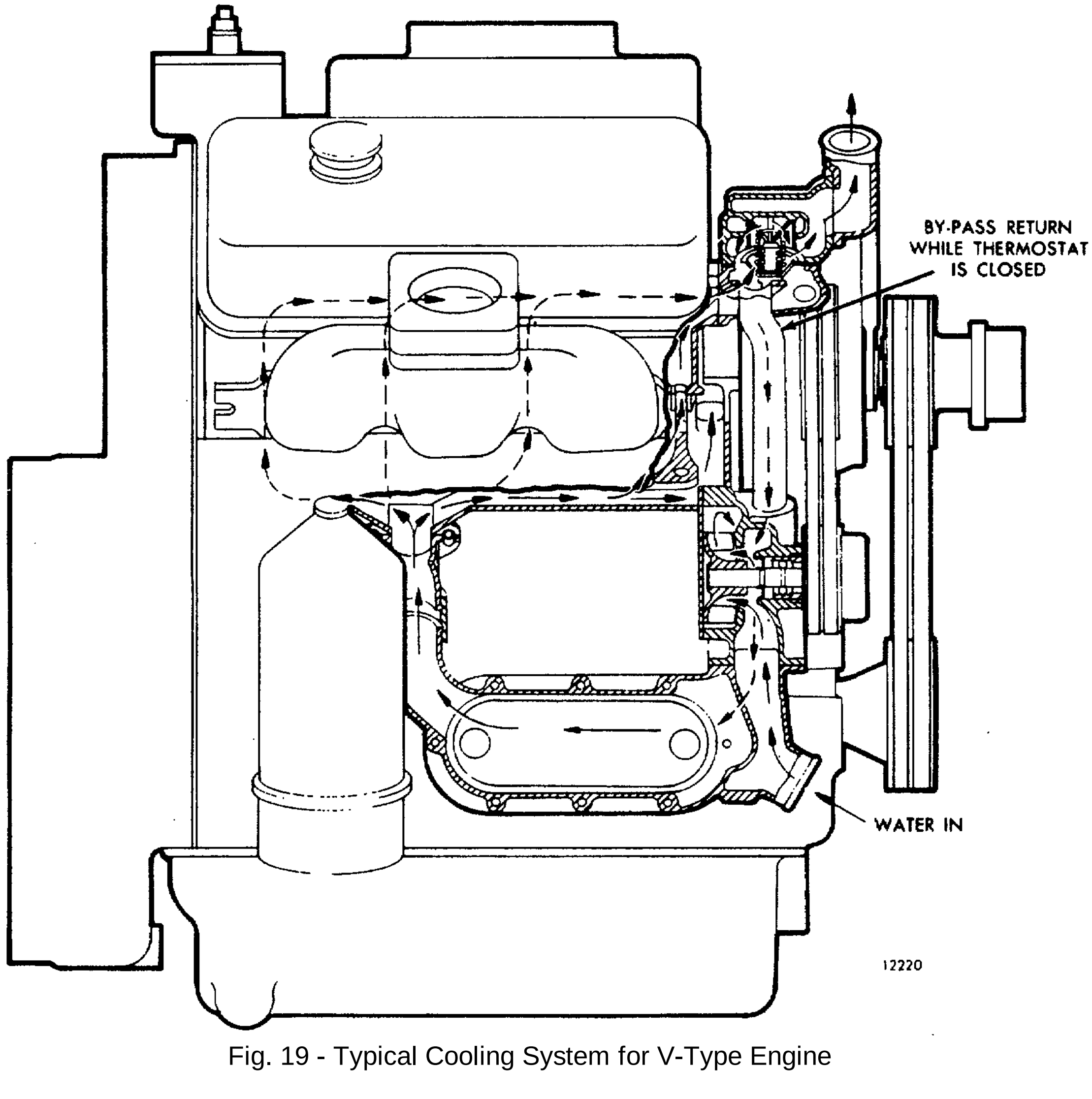


Fig. 19 - Typical Cooling System for V-Type Engine

Keel Cooling System

The keel cooling system is similar to the heat exchanger system, except that the coolant temperature is reduced in the keel cooler. In this system, the coolant is drawn by the circulating pump from the bottom of the expansion tank through the engine oil cooler. From the cooler the flow is the same as in the other systems. Upon leaving the thermostat housing, the coolant is by-passed directly to the bottom of the expansion tank until the engine operating temperature, controlled by the thermostat, is reached. As the engine temperature increases, the coolant is directed to the keel cooler, where the temperature of the coolant is reduced before flowing back to the expansion tank.

ENGINE COOLING SYSTEM MAINTENANCE

Engine Coolant

The function of the engine coolant is to absorb the heat, developed as a result of the combustion process in the cylinders, from the component parts such as exhaust valves, cylinder liners and pistons which are surrounded by water jackets. In addition, the heat absorbed by the oil is also removed by the engine coolant in the oil-to-water oil cooler.

For the recommended coolant, refer to *Engine Coolant.*

Cooling System Capacity

The capacity of the basic engine cooling system (cylinder block, head, thermostat housing and oil cooler housing) is shown in Table I.

To obtain the complete amount of coolant in the cooling system of an engine, the additional capacity of the radiator, hoses, etc. must be added to the capacity of the basic engine. The capacity of radiators and related equipment should be obtained from the equipment supplier.

Fill Cooling System

Before starting an engine, close all of the drain cocks and fill the cooling system completely. If the unit has a raw water pump, it should be primed, since operation without water may cause impeller failure.

COOLING SYSTEM CAPACITY CHART
(BASIC ENGINE)

ENGINE	CAPACITY	
	Quarts	Litres
3-53	8	8
4-53	9	9
6V-53	14	13

TABLE 1

Start the engine and, after normal operating temperature has been reached, allowing the coolant to expand to its maximum, check the coolant level. The coolant level should be within 2"of the top of the filler neck.

Should a daily loss of coolant be observed, and there are no apparent leaks, there is a possibility of gases leaking past the cylinder head water seal rings into the cooling system. The presence of air or gases in the cooling system may be detected by connecting a rubber tube from the overflow pipe to a water container. Bubbles in the water in the container during engine operation will indicate this leakage. Another method for observing air in the cooling system is by inserting a transparent tube in the water outlet line.

Drain Cooling System

The engine coolant is drained by opening the cylinder block and radiator (heat exchanger) drain cocks and removing the cooling system filler cap. Removal of the filler cap permits air to enter the cooling passages and the coolant to drain completely from the system. Drain cocks or plugs are located on each side of the 4-53 and 6V cylinder blocks. The 3-53 cylinder block has a drain cock or plug located on the side of the block opposite the oil cooler.

> **IMPORTANT:** Drain cocks or plugs on both sides of the engine must be opened to drain the engine completely.

In addition to the drains on the cylinder blocks, the In-line engines have a drain cock located on the bottom of the oil cooler housing. The V-type engines have two drain cocks that must be opened when draining the system. Radiators, etc., that do not have a drain cock, are drained through the oil cooler housing drain.

To insure that all of the coolant is drained completely from an engine, all cooling system drains should be opened. Should any entrapped water in the cylinder block or radiator freeze, it will expand and may cause damage. When freezing weather is expected, drain all engines not adequately protected by antifreeze. Leave all of the drain cocks open until refilling the cooling system.

The exhaust manifolds of marine engines are cooled by the same coolant used in the engine. Whenever the engine cooling system is drained, each exhaust manifold drain cock, located on the bottom near the exhaust outlet, must be opened. Raw water pumps are drained by loosening the cover attaching screws. It may be necessary to tap the raw water pump cover gently to loosen it. After the water has been removed, tighten the screws.

Flushing

The cooling system should be flushed each spring and fall. The flushing operation cleans the system of antifreeze solution in the spring and removes the summer rust inhibitor in the fall, preparing the cooling system for a new solution. The flushing operation should be performed as follows:

1. Drain the previous season's solution from the engine.
2. Refill the cooling system with soft clean water. If the engine is hot, fill slowly to prevent rapid cooling and distortion of the engine castings.
3. Start the engine and operate it for 15 minutes to circulate the water thoroughly.
4. Drain the cooling system completely.
5. Refill the system with the solution required for the coming season.

Cooling System Cleaners

If the engine overheats and the fan belt tension and water level are satisfactory, clean and flush the entire cooling system. Remove scale formation by using a quality de-scaling solvent. Immediately after using the solvent, neutralize the system with the neutralizer. It is important that the directions printed on the container of the de-scaling solvent be thoroughly read and followed.

After the solvent and neutralizer have been used, completely drain the engine and radiator and reverse-flush before filling the cooling system.

Reverse-Flushing

After the engine and radiator have been thoroughly cleaned, they should be reverse-flushed. The water pump should be removed and the radiator and engine reverse-flushed separately to prevent dirt and scale deposits clogging the radiator tubes or being forced through the pump. Reverse-flushing is accomplished by hot water, under air pressure, being forced through the cooling system in a direction opposite to the normal flow of coolant, loosening and forcing scale deposits out.

The radiator is reverse-flushed as follows:

1. Remove the radiator inlet and outlet hoses and replace the radiator cap.
2. Attach a hose at the top of the radiator to lead water away from the engine.
3. Attach a hose to the bottom of the radiator and insert a flushing gun in the hose.
4. Connect the water hose of the gun to the water outlet and the air hose to the compressed air outlet.
5. Turn on the water and, when the radiator is full, turn on the air in short blasts, allowing the radiator to fill between air blasts.

    CAUTION: Apply air gradually. Do not exert more than 30 psi (207 kPa) air pressure. Too great a pressure may rupture a radiator tube.

6. Continue flushing until only clean water is expelled from the radiator.

The cylinder block and cylinder head water passages re reverse-flushed as follows:

1. Remove the thermostat and the water pump.
2. Attach a hose to the water inlet of the cylinder block to drain the water away from the engine.
3. Attach a hose to the water outlet at the top of the cylinder block and insert the flushing gun in the hose.
4. Turn on the water and, when the water jackets are filled, turn on the air in short blasts, allowing the engine to fill with water between air blasts.
5. Continue flushing until the water from the engine runs clean.

If scale deposits in the radiator cannot be removed by chemical cleaners or reverse-flushing as outlined above, it may be necessary to remove the upper tank and rod out the individual radiator tubes with flat steel rods. Circulate water through the radiator core from the bottom to the top during this operation.

Miscellaneous Cooling System Checks

In addition to the above cleaning procedures, the other components of the cooling system should be checked periodically to keep the engine operating at peak efficiency. The thermostat and the radiator pressure cap should be checked and replaced, if found defective. The cooling system hoses should be inspected and any hose that feels abnormally hard or soft should be replaced immediately.

Also, check the hose clamps to make sure they are tight. All external leaks should be corrected as soon as detected. The fan belt must be adjusted to provide the proper tension, and the fan shroud must be tight against the radiator core to prevent re-circulation of air which may lower cooling efficiency.

Water Pump

A centrifugal-type water pump is mounted on top of the engine oil cooler housing, either on the right-hand or left-hand side of the engine, depending upon the engine model and rotation. It circulates the coolant through the cooling system. The pump is belt driven, by either the camshaft or balance shaft (In-line engines) or by one of the camshafts (V-type engines).

An impeller is pressed onto one end of the water pump shaft, and a water pump drive pulley is pressed onto the opposite end. The pump shaft is supported on a sealed double-row combination radial and thrust ball bearing. Coolant is prevented from creeping along the shaft toward the bearing by a seal. The shaft and bearing constitute an assembly and are serviced as such, since the shaft serves as the inner race of the ball
bearing.

The sealed water pump shaft ball bearing is filled with lubricant when assembled. No further lubrication is required. Contact an authorized *Detroit Diesel Allison Service Outlet* if more information is needed.

Raw Water Pump

The raw water pump (Figs. 20 and 21) is a positive displacement pump, used for circulating raw water through the heat exchanger to lower the temperature of the engine coolant. It is driven by a coupling from the end of the camshaft.

Seal failure is readily noticed by a flow of water visible at the openings in the raw water pump housing, located between the pump mounting flange and the inlet and outlet ports. These openings must remain open at all times.

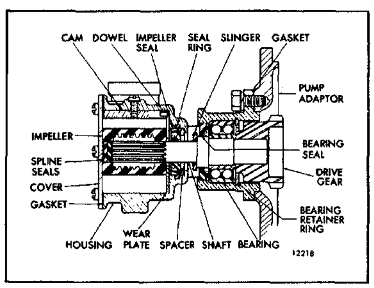


Fig. 20. - Raw Water Pump Used on In-Line Engine.

The impeller, cam and wear plate assembly, and water seal assembly may be serviced without removing the pump from the engine as outlined below.

1. Remove the cover and gasket.

2. Note the position of the impeller blades to aid in the reassembly. Then grasp a blade on each side of the impeller with pliers and pull the impeller off of the shaft.

3. The neoprene spline seal(s) can be removed from the impeller by pushing a screw driver through the impeller from the open end.

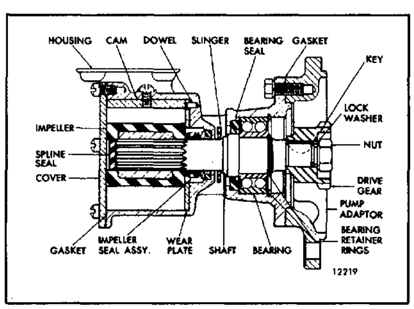


Fig. 21. - Raw Water Pump Used on V-Type Engine.

CAUTION: If the impeller is reuseable, exercise care to prevent damage to the splined surfaces.

4. Remove the cam retaining screw and withdraw the cam and wear plate assembly.

5. Remove the seal assembly from the pump used on a V-type engine by inserting two wires with hooked ends between the pump housing and seal with the hooks over the edge of the carbon seal. Remove the seal seat and gasket in the same way.

6. The seal may be removed from the pump used on the In-line engine by drilling two holes in the seal case and placing metal screws in the holes so that they may be grasped and pulled with pliers. Then remove the rubber seal ring.

7. Clean and inspect the impeller, cam and wear plate assembly and water seal. The impeller must have a good bond between the neoprene and the metal. If the impeller blades are damaged, worn or have taken a permanent set, replace the impeller. Reverse the wear plate if it is worn excessively and remove any burrs. Replace the seal, if necessary.

8. Install the seal assembly in the pump used on a V-type engine as follows:

   a. If the seal seat and gasket were removed, place the gasket and seal seat over the shaft and press them into position in the seal cavity.

   b. Place the seal ring securely in the ferrule, and with the carbon seal and washer correctly positioned against the ferrule, slide the ferrule over the shaft and against the seal seat. Use care to ensure that the seal ring is contained within the ferrule so that it grips the shaft.

   c. Install the flat washer and then the marcel washer. A new seal may be installed in the pump used on the In-Line engine by placing the rubber seal ring in its groove, starting the seal (with the lip facing the impeller cavity) over the shaft and tapping it into place against the seal spacer.

9. Install the cam and wear plate assembly.

NOTE: The wear plate is round and is doweled to the cam. The wear plate must be installed with the cam in the pump housing as an assembly.

10. Apply a non-hardening sealant to the cam retaining screw and the hole in the pump body to prevent any leakage. Then hold the cam with the tapped hole aligned and secure it with the screw.

11. Compress the impeller blades to clear the off-set cam and press the impeller on the splined shaft. The blades must be correctly positioned to follow the direction of rotation.

12. Install the neoprene splined seal(s) in the bore of the impeller.

13. Turn the impeller several revolutions in the normal direction of rotation to position the blades.

14. Affix a new gasket and install the pump cover.

The Jabsco raw water pump is equipped with a synthetic rubber impeller. Since synthetic rubber loses its elasticity at low temperatures, impellers made of natural rubber should be installed when it is necessary to pump raw water that has a temperature below 40° F (4° C).

The natural rubber impeller can be identified by a stripe of green paint between two of the impeller blades.

INSTRUMENT PANEL, INSTRUMENTS AND CONTROLS

The instruments (Fig. 1) generally required in the operation of a diesel engine consist of an oil pressure gage, a water temperature gage, an ammeter and a mechanical tachometer. Also, closely related and usually installed in the general vicinity of these instruments are certain controls consisting of an engine starter switch, an engine stop knob, an emergency stop knob and, on certain applications, the engine hand throttle.

Torqmatic converters are equipped with an oil pressure gage and, in some instances, an oil temperature gage. These instruments are mounted on a separate panel.

Oil Pressure Gage

The oil pressure gage registers the pressure of the lubricating oil in the engine. As soon as the engine is started, the oil pressure gage should start to register. If the oil pressure gage does not register at least the minimum pressure listed under *Running* in the *Engine Operating Instructions,* the engine should be stopped and the cause of low oil pressure determined and corrected before the engine is started again.

Water Temperature Gage

The engine coolant temperature is registered on the water temperature gage.

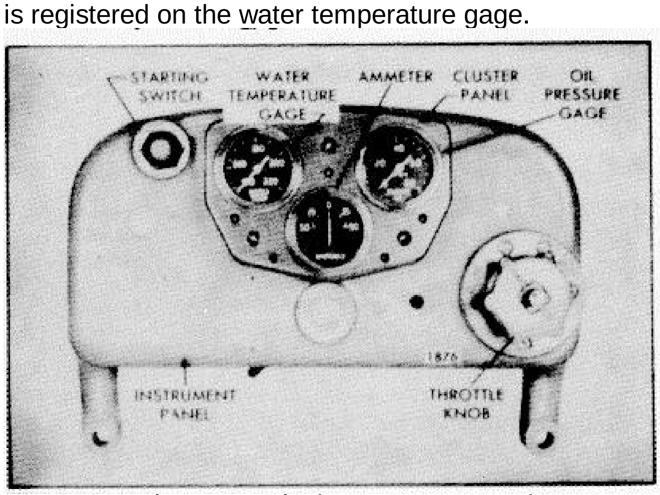


Fig. 1 - Typical Instrument Panel

Ammeter

An ammeter is incorporated into the electrical circuit to show the current flow to and from the battery. After starting the engine, the ammeter should register a high charge rate at rated engine speed. This is the rate of charge received by the battery to replenish the current used to start the engine. As the engine continues to operate, the ammeter should show a decline in charge rate to the battery. The ammeter will not show zero charge rate since the regulator voltage is set higher than the battery voltage. The small current registered prevents rapid brush wear in the battery-charging alternator. If lights or other electrical equipment are connected into the circuit, the ammeter will show discharge when these items are operating or the engine speed is reduced.

Tachometer

The tachometer is driven by the engine and registers the speed of the engine in revolutions per minute (rpm).

Engine Starting Motor Switch

The starting switch is mounted on the instrument panel with the contact button extending through the front face of the panel. The switch is used to energize the starting motor. As soon as the engine starts, release the switch.

Stop Knob

A stop knob is used on most applications to shut the engine down. When stopping an engine, the speed should be reduced to idle and the engine allowed to operate at idle for a few minutes to permit the coolant to reduce the temperature of the engine's moving parts. Then the stop knob should be pulled and held until the engine stops. Pulling on the stop knob manually places the injector racks in the "no-fuel" position. The stop knob should be returned to its original position after the engine stops.

Emergency Stop Knob

In an emergency or if after pulling the stop knob, the engine continues to operate, the emergency stop knob may be pulled to stop the engine. The emergency stop knob, when pulled, will trip the air shut-off valve located between the air inlet housing and the blower and shut off the air supply to the engine. Lack of air will prevent further combustion of the fuel and stop the engine.

The emergency stop knob must be pushed back in after the engine stops so the air shut-off valve can be opened for restarting after the malfunction has been corrected.

Throttle Control

The engine throttle is connected to the governor speed control shaft through linkage. Movement of the speed control shaft changes the speed setting of the governor and thus the engine speed.

ENGINE PROTECTIVE SYSTEMS

MANUAL SHUT DOWN SYSTEM

The manually operated emergency engine shutdown device, mounted in the air inlet housing, is used to stop the engine in the event an abnormal condition should arise. If the. engine continues to run after the engine throttle is placed in the *no fuel* position, or if combustible liquids or gases are accidentally introduced into the combustion chamber causing over-speeding of the engine, the shutdown device will prevent damage to the engine by cutting off the air supply and thus stopping the engine.

The shutdown device consists of an air shut-off valve mounted in the air inlet housing which is retained in the open position by a latch. A cable assembly is used to remotely trip the latch. Pulling the emergency shutdown knob all the way out will stop the engine. After the engine stops, the emergency shutdown knob must be pushed all the way in and the air shut-off valve manually reset before the engine can be started again.

AUTOMATIC MECHANICAL SHUTDOWN SYSTEM

The automatic mechanical shutdown system illustrated in Fig. 2 is designed to stop the engine if there is a loss of oil pressure, loss of engine coolant, overheating of the engine coolant, or overspeeding of the engine. Engine oil pressure is utilized to activate the components of the system.

A coolant temperature-sensing valve and an adapter and copper plug assembly are mounted on the exhaust manifold outlet. The power element of the temperature-sensing valve is placed against one end of the copper plug, and the other end of the plug extends into the exhaust manifold. Engine coolant is directed through the adapter and passes over the power element of the valve. Engine oil, under pressure, is directed through a restricted fitting to the temperature-sensing valve and to an oil pressure actuated bellows located on the air inlet housing.

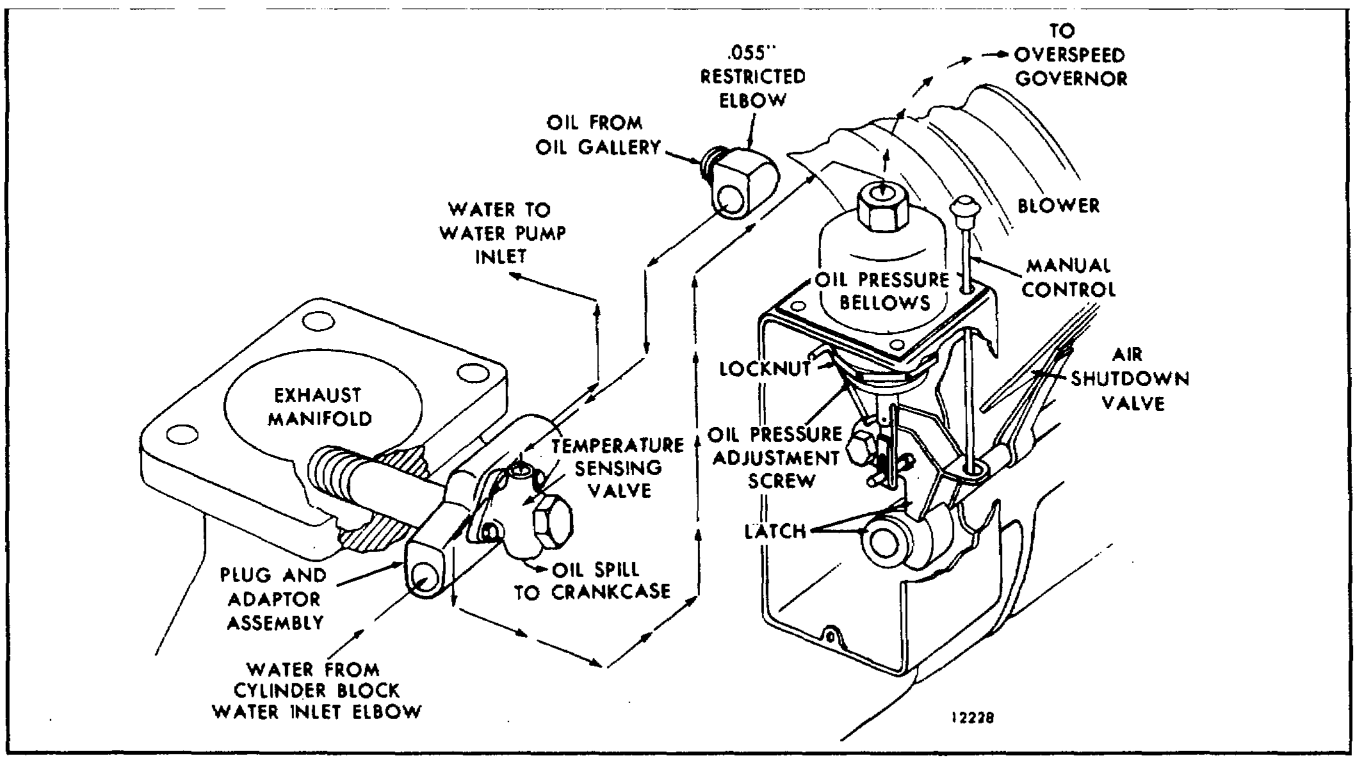


Fig. 2 - Mechanical Shutdown System Schematically Illustrated.

The pressure of the oil entering the bellows overcomes the tension of the bellows spring and permits the latch to retain the air shut-off valve in the open position. If the oil pressure drops below a predetermined value, the spring in the bellows will release the latch and permit the air shut-off valve to close and thus stop the engine.

The overspeed governor, used on certain applications, consists of a valve actuated by a se of spring-loaded weights. Engine oil is supplied to the valve through a connection in the oil line between the bellows and the temperature-sensing valve. An outlet in the governor valve is connected to the engine oil sump. Whenever the engine speed exceeds the overspeed governor setting, the valve (actuated by the governor weights) is moved from its seat and permits the oil to flow to the engine sump. This decreases the oil pressure to the bellows, thus actuating the shutdown mechanism and stopping the engine.

A restricted fitting, which will permit a drop in oil pressure great enough to actuate the shutdown mechanism, is required in the oil line between the cylinder block oil gallery and the shutdown sensing devices.

To be sure the protective system will function properly if an abnormal engine condition occurs, have the system checked periodically by your local *Detroit Diesel Allison Service Outlet.*

Also make sure the air shut-off valves close each time the engine is shut down.

Operation

To start an engine equipped with a mechanical shutdown system, first manually open the air shut-off valve and then press the engine starting switch. As soon as the engine starts, the starting switch may be released, but the air shut-off valve must be held in the open position until the engine oil pressure increases sufficiently to permit the bellows to retain the latch in the open position.

During operation, if the engine oil pressure drops below the setting of the pressure sensitive bellows, the spring within the bellows will release the latch and permit the air shut-off valve to close, thus stopping the engine.

If the engine coolant overheats, the temperature-sensing valve will open and permit the oil in the protective system to flow to the engine crankcase. The resulting decrease in oil pressure will actuate the shutdown mechanism and stop the engine. Also if the engine loses its coolant, the copper plug will be heated up by the hot exhaust gases passing over it and cause the temperature-sensing valve to open and actuate the shutdown mechanism.

Whenever the engine speed exceeds the overspeed governor (if used) setting, the oil in the line flows to the sump, resulting in a decrease in oil pressure. The oil pressure bellows then releases the latch and permits the air shut-off valve to close.

When an engine is stopped by the action of the shutdown system, the engine cannot be started again until the particular device which actuated the shutdown mechanism has returned to its normal position. *The abnormal condition which caused the engine to stop must be corrected before attempting to start it again.*

AUTOMATIC ELECTRICAL SHUTDOWN SYSTEM

The automatic electrical shutdown system shown in Fig. 3 protects the engine against a loss of coolant, overheating of the coolant, loss of oil pressure, or overspeeding. In the event one of the foregoing conditions arises, a switch will close the electrical circuit and energize the solenoid switch, causing the shutdown solenoid to release the air shutdown latch and stop the engine.

Operation

The electrical circuit is de-energized under normal operating conditions. When the engine is started, the oil pressure switch opens when the oil pressure reaches approximately 10 psi (69 kPa) and the fuel oil pressure switch closes at approximately 20 psi (138 kPa) fuel pressure. The water temperature switch remains open.

If the oil pressure drops below 10 psi (69 kPa), the oil pressure switch will close the circuit and energize the shutdown solenoid. This will activate the shutdown mechanism and stop the engine.

A loss of coolant or an increase in coolant temperature to approximately 203 °F (95 ° C) will close the contacts in the water temperature switch, thus closing the electrical circuit and activating the shutdown mechanism.

The water temperature switch consists of a temperature-sensing valve and a micro-switch. The valve

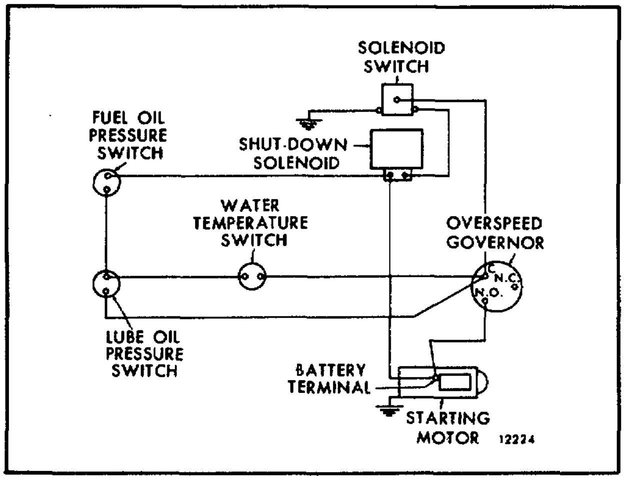


Fig. 3. - Automatic Electrical Shut-Down System Diagram.

contacts a copper plug (heat probe) which extends into the exhaust manifold outlet. Engine water is directed over the power element of the valve and should the water temperature exceed approximately 203° F (95° C), the valve will close the contacts in the micro- switch and energize the shutdown circuit. If a loss of water occurs, the heat of the exhaust gases will be transmitted through the copper plug to the temperature-sensing valve and cause the shutdown circuit to be activated.

If the engine speed exceeds the high speed setting of the overspeed governor, the governor switch will close and activate the shutdown mechanism.

When the engine is shut down, the decrease in speed will open the governor switch, and the decrease in oil and fuel pressures will close the oil pressure switch and open the fuel pressure switch, thus de-energizing the circuit.

The cause of the abnormal conditions must then be determined and corrected before the engine is started again. Also, the air shut-off valve must be manually reset in the open position before the engine can be started.

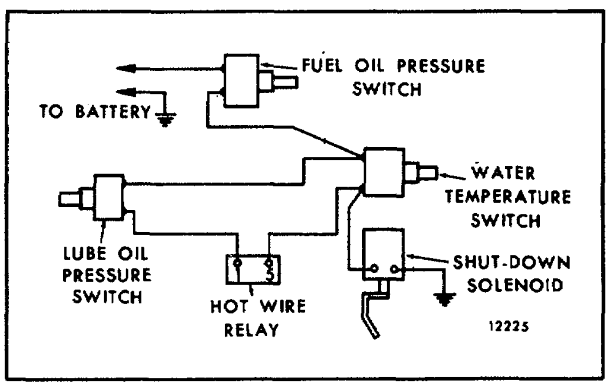


Fig. 4. - Automatic Electrical Shut-Down System Incorporating Hot Wire Relay.

Some engines are equipped with an electrically operated automatic shutdown system which incorporates a hot wire relay (Fig. 4). Since the fuel pressure builds up rapidly, the fuel oil pressure switch could close before the lubricating oil pressure switch opens and stop the engine. The hot wire relay, however, delays the closing of the fuel oil pressure switch for several seconds to enable the lubricating oil pressure to build up and open the oil pressure switch contacts.

When the lubricating oil pressure falls below 10 ± 2 psi (69 ± 14 kPa), the contacts in the oil pressure switch used in this system will close and current will flow through the hot wire relay to the solenoid. The few seconds required to heat the hot wire relay provides sufficient delay to avoid stopping the engine when low oil pressure is caused by a temporary condition such as an air bubble or a temporary overlap in the operation of the oil pressure switch and the fuel oil pressure switch when starting or stopping the engine.

The water temperature switch, which remains open during normal engine operation, is installed in the side of the thermostat housing. The switch contacts close when the water temperature reaches approximately 205 ° F (96 ° C) and activate the shutdown solenoid.

ALARM SYSTEM

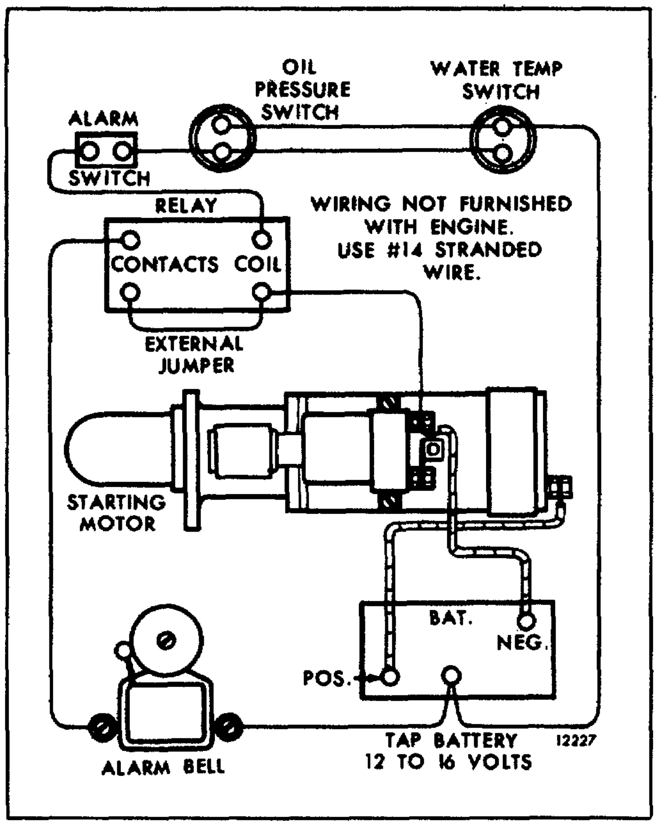


Fig. 5 - Alarm System Wiring Diagram.

The alarm system shown in Fig. 5 is similar to the automatic electrical shutdown system, but uses a warning bell in place of the air shut-off valve solenoid. The bell warns the engine operator if the engine coolant overheats or the oil pressure drops below the safe operating limit.

When the engine is started and the oil pressure is sufficient to open the oil pressure switch contacts (opening pressure is stamped on the switch cover), the alarm switch must be turned on manually to put the system in operation. The water temperature switch is normally open. Should the engine coolant exceed 205° ± 5° F (96° ± -15° C), the water temperature switch will close the electrical circuit and sound the alarm bell. Likewise, if the oil pressure drops below the setting of the oil pressure switch, the switch will close and cause the bell to ring. The bell will continue to ring until the engine operator turns the alarm switch off. The alarm switch must also be turned off before a routine stop since the decreasing oil pressure will close the oil pressure switch and cause the bell to ring.

If the alarm bell rings during engine operation, stop the engine immediately and determine the cause of the abnormal condition. *Make the necessary corrections before starting the engine again.*

STARTING SYSTEMS

ELECTRICAL STARTING SYSTEM

The electrical system on the engine generally consists of a battery-charging alternator, a starting motor, voltage regulator, storage battery, starter switch and the necessary wiring. Additional electrical equipment may be installed on the engine unit at the option of the owner.

Starting Motor

The starting motor has a Sprag overrunning clutch. Pressing the starting switch engages the starting motor pinion with the teeth of the flywheel ring gear and energizes the starting motor. The starting motor drives the pinion and rotates the crankshaft. When the engine begins to operate, the Sprag clutch permits the pinion to overrun on its shaft, until the starting switch is released, and prevents overspeeding the starting motor.

Starter Switch

To start the engine, a switch is used to energize the starting motor. Release the switch immediately after the engine starts.

Alternator

The battery-charging alternator provides the electrical current required to maintain the storage battery in a charged condition and to supply sufficient current to carry any other electrical load requirements up to the rated capacity of the alternator.

Regulator

A voltage regulator is introduced into the electrical system to regulate the voltage and current output of the battery-charging alternator and to maintain a fully charged storage battery.

Storage Battery

The lead-acid storage battery is an electrochemical device for converting chemical energy into electrical energy.

The battery has three major functions:

1. It provides a source of electrical power for starting the engine.
2. It acts as a stabilizer to the voltage in the electrical system.
3. It can, for a limited time, furnish current when the electrical demands of the unit exceed the output of the alternator.

The battery is a perishable item which requires periodic servicing. A properly cared for battery will give long and trouble-free service.

1. Check the level of the electrolyte regularly. Add water if necessary, but do not overfill. Overfilling can cause poor performance or early failure.
2. Keep the top of the battery clean. When necessary, wash with a baking soda solution and rinse with fresh water. Do not allow the soda solution to enter the cells.
3. Inspect the cables, clamps and hold-down bracket regularly. Clean and re-apply a light coating of grease when needed. Replace corroded, damaged parts.
4. Use the standard, quick in-the-unit battery test as the regular service test to check battery condition.
5. Check the electrical system if the battery becomes discharged repeatedly.

If the engine is to be stored for more than 30 days, remove the battery. The battery should be stored in a cool, dry place. Keep the battery fully charged and check the level of the electrolyte regularly. The *Lubrication and Preventive Maintenance* section of this manual covers the servicing of the starting motor and alternator.

Consult an authorized *Detroit Diesel Allison Service Outlet* for information regarding the electrical system.

HYDRAULIC STARTING SYSTEM (HYDROSTARTER)

The hydrostarter system schematically illustrated in Fig. 6 is a complete hydraulic system for starting internal combustion engines. The system is automatically recharged after each start, and can be manually recharged. The starting potential remains during long periods of inactivity, and continuous exposure to hot or cold climates has no detrimental effect upon the hydrostarter system. Also, the hydrostarter torque for a given pressure remains substantially the same regardless of the ambient temperature.

The hydrostarter system consists of a reservoir, an engine-driven charging pump, a hand pump, a piston type accumulator, a starting motor and connecting hoses and fittings.

Operation

Hydraulic fluid flows by gravity, or a slight vacuum, from the reservoir to either the engine-driven pump or the hand pump inlet. Fluid discharging from either pump outlet at high pressure flows into the accumulator and is stored at 3250 psi (22 383 kPa) under the pressure of compressed nitrogen gas. When the starter is engaged with the engine flywheel ring gear and the control valve is opened, fluid under pressure is forced out of the accumulator, by the expanding nitrogen gas, and flows into the starting motor which rapidly accelerates the engine to a high. cranking speed. The used fluid returns directly to the reservoir from the starter.

The engine-driven charging pump runs continuously during engine operation and automatically recharges the accumulator. When the required pressure is attained in the accumulator, a valve within the pump body opens and the fluid discharged by the pump is by-passed to the reservoir. The system can be shut down and the pressure in the accumulator will be maintained.

The precharge pressure of the accumulator is the pressure of the nitrogen gas with which the accumulator is initially charged. This pressure must be checked before the system pressure is raised for the initial engine start. To check the precharge pressure, open the relief valve, on the side of the hand pump, approximately 1/2 turn, allowing the pressure gage to return to zero. Close the relief valve and pump several strokes on the hand pump. The gage should show a rapid pressure rise from zero to the nitrogen precharge pressure, where it will remain without change for several additional strokes of the pump.

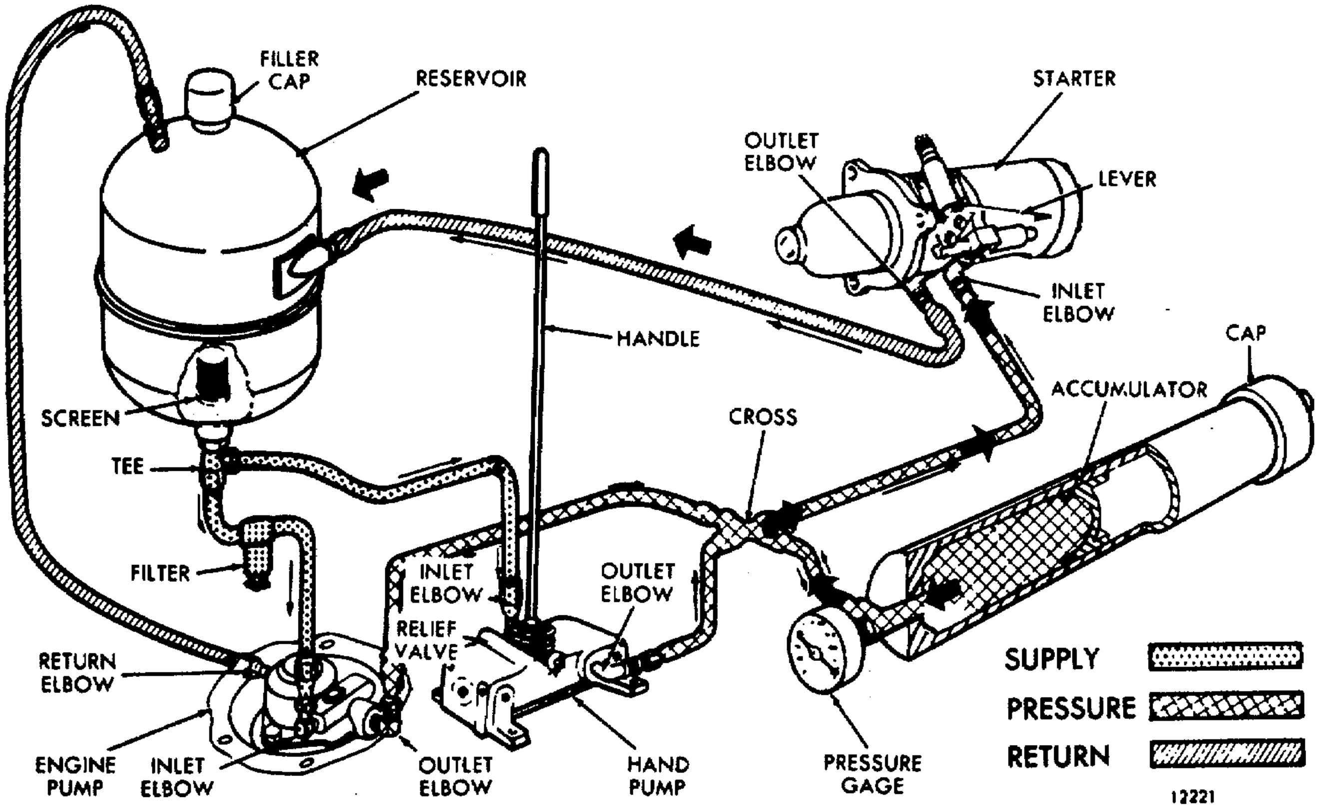


Fig. 6 - Schematic Diagram of Hydrostarter System Showing Oil Flow

Initial Engine Start

Use the hand pump to raise the accumulator pressure. An accumulator pressure of 1500 psi (10 335 kPa) when the ambient temperature is above 40°F (4°C) will provide adequate cranking to start the engine. Between 40°F (4°C) and 0°F (-18°C), 2500 psi (17 225 kPa) should be sufficient. Below 0° F (-18° C), the accumulator should be charged to the maximum recommended pressure. Although the hydrostarter cranks the engine faster than other starting systems, starting aids should be used in cold weather.

> **NOTE:** Use the priming pump to make sure the filters, lines, manifolds and injectors are full of fuel before attempting to start the engine.

For ambient temperatures below 40°F (4°C), use a fluid starting aid. Add the starting fluid just prior to moving the hydrostarter lever and during the cranking cycle as required. Do not wait to add the starting fluid after the engine is turning over, otherwise the accumulator charge may be used up before the engine can start. In this case, the accumulator charge must be replaced with the hand pump. With the engine controls set for start (throttle at least half-open), push the hydrostarter control lever to simultaneously engage the starter pinion with the flywheel ring gear and to open the control valve. Close the valve quickly when the engine starts, to conserve the accumulator pressure and prevent excessive overrunning of the starter drive clutch assembly. Three different basic types of flywheel ring gears are used; no chamfer, Bendix chamfer, or Dyer chamfer on the gear teeth. Some difficulty may be encountered in engaging the -starter pinion with the Dyer chamfered ring gears. When this happens, it .is necessary to disengage and re-engage until the starter pinion is cammed in the opposite direction enough to allow the teeth to mesh.

Remote Control System

The hydrostarter remote control system (Fig. 7) consists of a master cylinder, a pedal, a lever arm, two springs and a flexible hose. It is an independent hydraulic system using diesel fuel oil as a hydraulic fluid to actuate the hydrostarter control valve by means of the pedal operated master cylinder.

The master cylinder is connected to the control valve on the hydrostarter by a flexible hose. Pressing on the pedal forces the fluid through the hose to the control valve which engages the starter pinion with the engine flywheel ring gear. Release the pedal as soon as the engine starts.

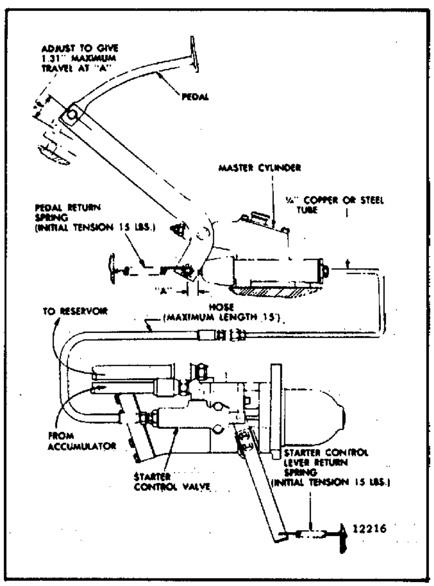


Fig. 7 - Hydrostarter Remote Control System

The hydrostarter motor is equipped with a control valve that incorporates a threaded valve housing plug with a 1/8" -27 tapped hole in the center for installation of the flexible hose. A 1/8"-27 pipe plug is installed when the remote control system is not used.

Springs are used to return the master cylinder pedal and the hydrostarter control lever to the off position.

Filling

Remove the filler cap from the reservoir and add a sufficient quantity of' hydraulic fluid (a mixture of 75% diesel fuel and 25% SAE 10 or 30 lubricating oil) to fill the system.

The required amount of hydraulic fluid will vary depending upon the size of the reservoir, length of hydraulic hoses and the size and number of accumulators. The reservoirs are available in 10, 12, 16 and 23 quart (9, 11, 15, 22 liters) capacities. In a 10 quart (9 liters) capacity reservoir, add approximately 8 quarts (8 liters) of hydraulic fluid, 10 quarts (9 liters) in a 12 quart (11 liters) reservoir, 14 quarts (13 liters) in a 16 quart (15 liters) reservoir or 21 quarts (20 liters) in a 23 quart (22 liters) reservoir.

NOTE: When the accumulator is charged to 3000 psi (20 670 kPa) and all hoses are filled, there should be enough hydraulic fluid remaining in the reservoir to completely cover the screen in the bottom of the reservoir.

Purging

A by-pass valve is located on the inlet side of the hand pump. Loosen the lock nut and rotate this valve approximately one turn counterclockwise with a screw driver. Operate the hand pump for 12 to 15 complete strokes. Do not pump too rapidly. Close the by-pass valve tightly and tighten the lock nut.

1. Move the starter control lever to engage the pinion with the flywheel and open the control valve. While holding the lever in this position, operate the hand pump until the starter has turned several revolutions. Close the control valve. Loosen the swivel hose fitting at the discharge side of the engine-driven pump about two turns. Operate the hand pump to force air out until oil begins to appear at the loose fitting. Tighten the swivel hose fitting and pressurize the system with the hand pump sufficiently to start the engine.

2. Perform the initial starting instructions under *Preparation for Starting Engine First Time.* Then, with the engine running at least 1500 rpm, purge the engine-driven pump of air. Break the hose connection at the discharge side of the engine driven-pump until a full stream of oil is discharged from the pump. Connect the hose to the pump and alternately loosen and tighten the swivel fitting on the discharge hose until the oil leaking out, when the fitting is loose, appears to be free of air bubbles. Tighten the fitting securely and observe the pressure gage. The pressure should rise rapidly to the accumulator precharge pressure (1250 psi or 10 413 kPa at 70°F or 21°C), then increase slowly, reaching 2900 to 3300 psi (19 981 to 22 737 kPa).

3. After the pressure has stabilized near 3000 psi (20 670 kPa), examine all of the high pressure hoses, connections and fittings for leaks.

4. The engine-driven pump must by-pass oil to the reservoir when the accumulator pressure reaches 2900 to 3300 psi (19 981 to 22-737 kPa). To determine whether the pump by-pass valve is operating properly, remove the reservoir filler cap, disconnect the pump by-pass hose at the reservoir, and hold the hose over the open reservoir filler spout. An occasional spurt of oil may be emitted from the hose prior to by-passing. When the by-pass valve opens, a full and continuous stream of oil will flow from the hose. Reconnect the hose to the reservoir and install the filler cap.

5. Fill the reservoir to the proper level.

The hydrostarter remote control system may be purged of air as follows:

1. Fill the master cylinder with fuel oil.

2. Loosen the hose fitting at the hydrostarter control valve.

3. Actuate the master cylinder pedal until all of the air is discharged from the system and a solid stream of fuel oil is being discharged with each stroke.

NOTE: Replenish the fluid in the master cylinder as required during the purging operation.

4. Tighten the hose fitting and check for leaks.

LUBRICATION AND PREVENTIVE MAINTENANCE

Inspect the system periodically for leaks. Primarily, examine the high pressure hoses, connections, fittings and the control valve on the starter. Make certain that the oil level in the reservoir is sufficient to completely cover the screen at the bottom of the tank. Make this check after the accumulator is charged and the engine driven pump is by-passing oil to the reservoir. Every 2000 hours, or as conditions warrant, drain the reservoir and remove the screen. Flush out the reservoir and clean the screen and filler cap. Then reinstall the screen. Remove the bowl and element from the filter in the engine-driven pump supply hose. Wash the bowl and element in clean fuel oil and reassemble the filter. Release the pressure and drain the remaining hydraulic fluid from the system by disconnecting the hoses from the hydrostarter components. Then reconnect all of the hydraulic hoses.

WARNING: The oil pressure in the system must be released prior to servicing the hydrostarter motor or other components to prevent possible injury to personnel or equipment.

NOTE: Make sure all hoses and fittings are clean before any connections are made.

Fill the hydrostarter system with new clean fluid.

Lubrication

Remove the hydrostarter from the engine every 2000 hours for lubrication, Before removing the hydrostarter, release the pressure in the system by means of the relief valve in the hand pump. Then remove the three bolts which retain the starting motor to the flywheel housing. Remove the starting motor without disconnecting the hydraulic oil hoses. This will prevent dirt and air from entering the hydraulic system.

Apply a good quality, lightweight grease on the drive clutch pinion to make sure the clutch will slide freely while compressing the spring. Also apply grease to, the fingers of the clutch fork and on the spool of the clutch yoke engaged by the fork. This lubrication period may be reduced or lengthened according to the severity of service.

Remove the pipe plug from the starting motor drive housing and saturate the shaft oil wick with engine oil. Then reinstall the plug.

After lubricating, install the starting motor on the flywheel housing and recharge the accumulator with the hand pump.

On engines equipped with a hydraulic remote control system, lubricate the shaft in the master cylinder through the pressure grease fitting every 2000 hours.

Cold Weather Operation

Occasionally, when an engine is operated in regions of very low temperatures, the starter drive clutch assembly may slip when the starter is engaged. If the clutch slips, proceed as follows:

1. Release the oil pressure in the system by opening the relief valve in the hand pump.

   WARNING: The oil pressure in the system must be released prior to servicing the hydrostarter motor or other components to prevent possible injury to personnel or equipment.

2. Disconnect the hydraulic hoses from the starting motor.
3. Remove the three retaining bolts and lock washers and withdraw the starting motor from the flywheel housing.
4. Disassemble the starting motor.
5. Wash the hydrostarter drive clutch' assembly in clean fuel oil to remove the old lubricant.
6. When the clutch is free, apply SAE 5W lubricating oil.
7. Reassemble the starting motor and reinstall it on the engine. Then attach a tag to the starter noting the lubricant used in the clutch.
8. Recharge the accumulator with the hand pump.

Marine Application

In addition to the normal hydrostarter lubrication and maintenance instructions, the following special precautions must be taken for marine installations or other cases where equipment is subject to salt spray and air, or other corrosive atmospheres:

1. Clean all exposed surfaces and apply a coat of zinc-chromate primer, followed by a coat of suitable paint.
2. Apply a liberal coating of Lubriplate, type 130-AA, or equivalent, to the following surfaces.
   a. The exposed end of the starter control valve and around the control shaft where it passes through the clutch housing.
   b. The exposed ends of the hand pump cam pin.
3. Operate all of the moving parts and check the protective paint and lubrication every week.

Consult an authorized *Detroit Diesel Allison Service Outlet* for any information relating to the hydrostarter system.

COLD WEATHER STARTING AIDS

In a diesel engine, the fuel injected into the combustion chamber is ignited by the heat, of the air compressed into the cylinder; However, when starting an engine in extremely cold weather, a large part of the energy of combustion is absorbed by the pistons and cylinder walls, and in overcoming the high friction created by the cold lubricating oil.

When the ambient temperature is low, it may be necessary to use an air heater or a starting fluid to assist ignition of the fuel.

> **NOTE:** Starting aids are NOT intended to correct for a low battery, heavy oil or other conditions which cause hard starting. They are to be used only when other conditions are normal, but the air temperature is too cold for the heat of compression to ignite the fuel-air mixture.

FLUID STARTING AID

The fluid starting aid (Fig. 8) is designed to inject a highly volatile fluid into the air intake system at low ambient temperatures to assist in igniting the fuel oil injected. The fluid is contained in suitable capsules to facilitate handling.

The starting aid consists of a cylindrical capsule container with a screw cap, inside of which a sliding piercing shaft operates. A tube leads from the capsule container to a hand operated pump and another tube leads to the atomizing nozzle threaded into a tapped hole in the air inlet housing.

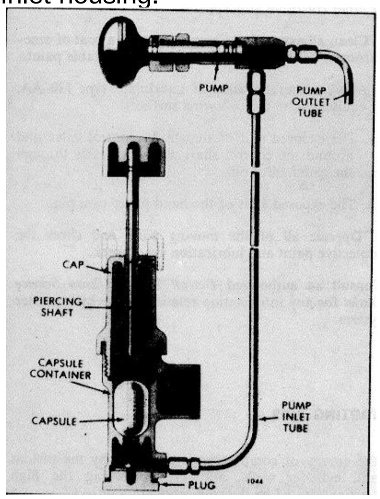


Fig. 8 - Typical Fluid Starting Aid

The capsule container should be mounted in a vertical position and away from any heat. Start the engine, using the fluid starting aid, as follows:

1. Remove the threaded cap and insert a fluid capsule in an upright position within the container.

   WARNING: The starting fluid is toxic and inflammable. Use caution when handling.

2. Pull the piercing shaft all the way out and install and tighten the cap on the container.
3. Push the piercing shaft all the way down. This will rupture the capsule and fill the container with the starting fluid.
4. Move the engine throttle to the maximum speed position.
5. Engage the starter and at the same time pull the pump plunger all the way out. Push the plunger in slowly, forcing the starting fluid through the atomizing nozzle into the air intake. Continue to push the pump in until the engine starts. If the plunger is not all the way in when the engine starts, push it in slowly until it locks in the IN position.
6. Unscrew the cap and remove the capsule. *Do not leave the empty capsule in the container.*
7. Replace the cap on the capsule container and make sure the piercing shaft is all the way down.

Service

The cold weather fluid starting aid will require very little service. Replace the piston seal packing if the pump leaks. If there is an excessive resistance to pumping, the nozzle may be plugged. Remove the nozzle and clean it.

PRESSURIZED CYLINDER STARTING AID

Start the engine during cold weather, using the "Quick Start" starting aid system (Fig. 9) as follows:

1. Press the engine starter button.
2. Pull out the "Quick Start" knob for one or two seconds, then release it.
3. Repeat the procedure if the engine does not start on the first attempt.

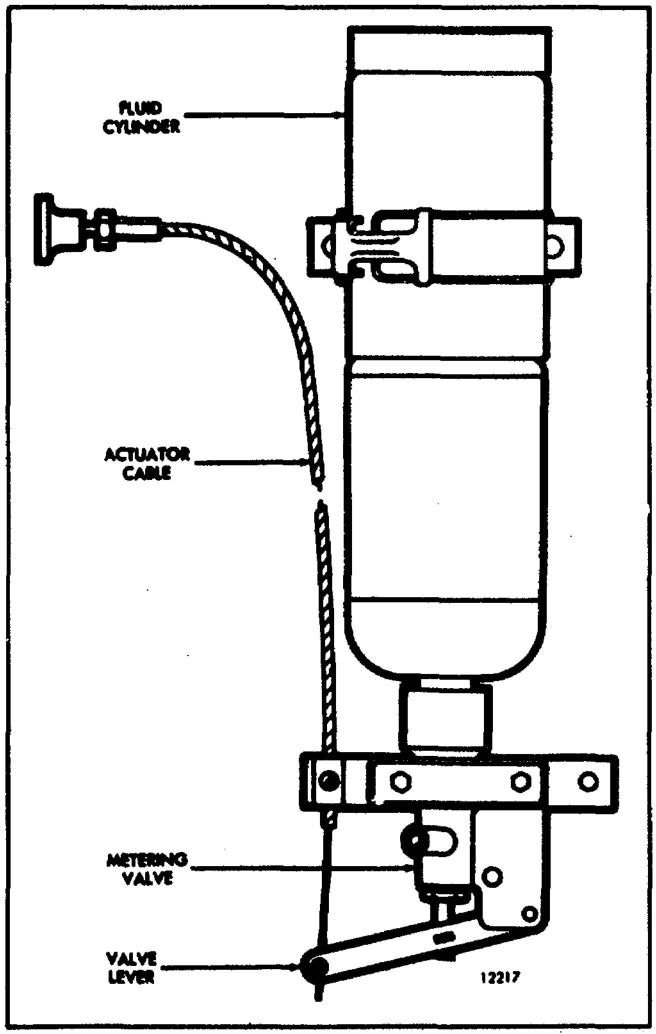


Fig. 9 - Quick-Start Assembly

CAUTION: Do not crank the engine more than 30 seconds at a time when using an electric starting motor. Always allow one minute intervals between cranking attempts to allow the starting motor to cool.

Service

Periodically perform the following service items to assure good performance:

1. Remove the fluid cylinder and lubricate the valve around the pusher pin under the gasket with a few drops of oil.
2. Lubricate the actuator cable.
3. Actuate the valve with the cable to distribute the oil on the cable and allow the oil to run down through the valve.
4. Remove any dirt from the orifice by removing the air inlet housing fitting, the orifice block and the screen. Then blow air through the orifice end only.
5. Assemble and tighten the air inlet housing fitting to the actuator valve and tube.
6. Check for leakage of fluid (fogging) on the outside of the engine air inlet housing by actuating the starting aid while the engine is stopped. If fogging occurs, disassemble and retighten the air inlet housing fitting to the housing.

WARNING: Do not actuate the starting aid more than once with the engine stopped. *Over- loading the engine air box with this high volatile fluid could result in a minor explosion.*

7. Check the fluid cylinder for hand tightness.

GOVERNORS

Horsepower requirements of an engine may vary continually due to the fluctuating loads; therefore, some means must be provided to control the amount of fuel required to hold the engine speed reasonably constant during such load fluctuations. To accomplish this control, one of three types of governors is used on the engines. Installations requiring maximum and minimum speed control, together with manually controlled intermediate speeds, ordinarily use a *limiting speed* mechanical governor. Applications requiring a near constant engine speed under varying load conditions, that may be changed by the operator, are equipped with a *variable speed* mechanical governor. The *hydraulic governor* is used where uniform engine speed is required under varying load conditions with a minimum speed droop.

Lubrication

The mechanical governors are lubricated by oil splash from the engine gear train. Oil entering the governor is directed by the revolving governor weights to the various moving parts requiring lubrication.

The hydraulic governor is lubricated by oil under pressure from the engine.

Service

Governor difficulties are usually indicated by speed variations of the engine. However, speed fluctuations are not necessarily caused by the governor and, therefore, when improper speed variations become evident, the unit should be checked for excessive load, misfiring or bind in the governor operating linkage. If none of these conditions are contributing to faulty governor operation, contact an authorized *Detroit Diesel Allison Service Outlet.*

TRANSMISSIONS

POWER TAKE-OFF ASSEMBLIES

The front and rear power take-off units are basically similar in design, varying in clutch size to meet the requirements of a particular application. The power take-off unit is attached to either an adapter (front power take-off) or the engine flywheel housing (rear power take-off).

Clutch Adjustment

These instructions refer to field adjustment for clutch facing wear. Frequency of adjustment depends upon the amount and nature of the load. To ensure a long clutch facing life and the best performance, the clutch should be adjusted before slippage occurs.

When the clutch is properly adjusted, a heavy pressure is required at the outer end of the hand lever to move the throwout linkage to the "over center" or locked position.

Adjust the clutch as follows:

1. Disengage the clutch with the hand lever.

2. Remove the inspection hole cover to expose the clutch adjusting ring. Rotate the clutch, if necessary, to bring the adjusting ring lock within reach.

3. Remove the clutch adjusting ring spring lock screw and lock from the inner clutch pressure plate and adjusting ring. Then, while holding the clutch drive shaft to prevent the clutch from turning, turn the clutch adjusting ring counterclockwise as shown in Fig. 10 and tighten the clutch until the desired pressure on the outer end of the hand lever, or at the

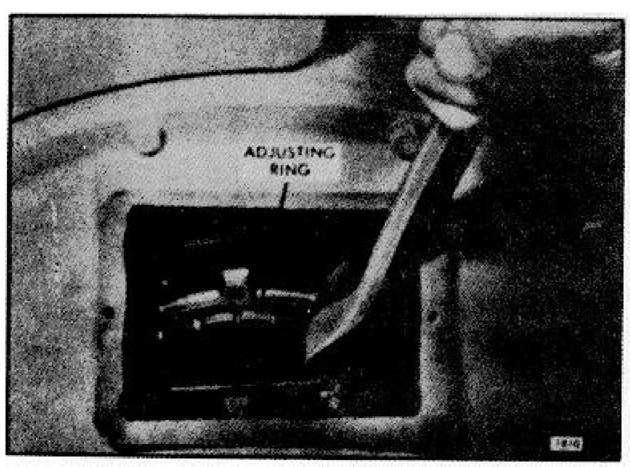


Fig. 10 · Adjusting Clutch

Clutch Diameter	Hand Lever Length	Pressure PSI	Pressure kPa	Torque lb-ft	Torque Nm
8"	15 1/2"	55	379	56-63	76-85
10"	15 1/2"	80	552	87-94	113-127
*11 1/2"	15 3/8"	100	689	129	175
11 1/2"	20"	105	724	112-120	152-163

*Twin Disc Clutch

TABLE 1

clutch release shaft (Fig. 11), is obtained as shown in Table 1.

When properly adjusted, the approximate pressure required at the outer end of the hand lever to engage the various diameter clutches is shown in the table. These specifications apply only with the hand lever which is furnished with the power take-off.

A suitable spring scale may be used to check the pounds pressure required to engage the clutch. However, a more accurate method of checking the clutch adjustment is with a torque wrench as shown in Fig. 11.

To fabricate an adapter, saw the serrated end off of a clutch hand lever and weld a 1-1/8" nut (across the hex) on it as shown in Fig. 11. Then saw a slot through the nut.

When checking the clutch adjustment with a torque wrench, engage the clutch slowly and note the amount of torque immediately before the clutch engages (goes over center). The specified torque is shown in Table 1.

CAUTION: The thrust load on the bronze clutch release bearing should be kept at an absolute minimum. Therefore, the hand lever should be positioned on the shaft as near the 12 o'clock or 6 o'clock position as possible. The 9 and 3 o'clock positions are to be avoided.

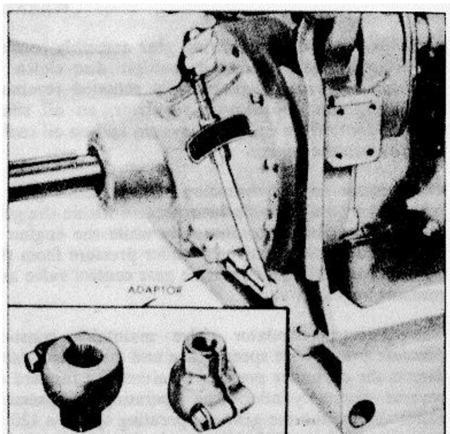


Fig. 11 - Checking Clutch Adjustment with a Torque Wrench and Adapter

Make a final clutch adjustment with the engine running as follows:

1. Start the engine and operate it at idling speed (approximately 500 rpm) with the clutch disengaged. The speed will be sufficient to move the segments out to the operating position.

2. Check the pressure required to engage the clutch. The engagement pressure should be the same as that following the adjustment. If the clutch engages at a lower pressure, the adjustment was probably made against the unworn portion of the facing.

3. Stop the engine and readjust the clutch, making sure all disc segments are properly positioned. Install the inspection hole cover.

TORQMATIC CONVERTERS

The Torqmatic converter is a self contained unit which transfers and multiplies the torque of the prime mover. This unit transmits the power through the action of oil instead of through gears and in addition to multiplying the torque also acts as a fluid coupling between the engine and the equipment to be powered. The converter will automatically adjust the output torque to load requirements.

There are various combinations of Torqmatic converters with features such as: an automotive or industrial flange on the shaft, a hydraulically operated lock-up clutch, a manual input disconnect clutch, and an accessory drive for either a governor or tachometer.

Check the oil level daily. If the converter is equipped with an input disconnect clutch, additional checks and service will be necessary daily or at intervals determined by the type of operation.
Adjust the disconnect clutches as outlined under power take-off clutch adjustment.

Contact an authorized *Detroit Diesel Allison Service Outlet* for service on Torqmatic converters.

The Warner hydraulic marine gear assembly consists of a hydraulically operated multiple disc clutch in combination with a hydraulically actuated reversing gear train, an oil pressure regulator, an oil sump independent of the engine oil system and an oil cooler mounted on the engine.

Oil pressure for the operation of the marine gear is provided by an oil pump incorporated within the gear housing and driven continuously while the engine is running. The oil is delivered under pressure from the pump to a combination marine gear control valve and pressure regulator valve.

The pressure regulator valve maintains constant pressure over a wide speed range and the control valve directs the oil under pressure to either the forward or reverse piston cylinder. The operating oil pressure range for the marine gear at operating speed is 120 to 140 psi (827 to 965 kPa) and the maximum oil temperature is 225°F (107°C). Minimum oil pressure is 100 psi (689 kPa) at idle speed (600 rpm).

Shifting from forward to reverse drive through neutral may be made at any speed; however, it is advisable to shift at low speeds, below 1000 engine rpm, to avoid damage to the engine, reverse gear or shaft. The marine reverse and reduction gear is lubricated by pressure and splash. The quantity of oil in the marine gear will vary with the inclination of the engine and must be properly maintained to the *full* mark on the dipstick to ensure satisfactory operation.

It is recommended that vessels utilizing a marine gear have-a suitable locking device or brake to prevent rotation of the propeller shaft when the vessel is not under direct propulsion. If the marine gear is not in operation and the forward motion of the vessel causes the propeller shaft to rotate, lubricating oil will not be circulated through the gear because the oil pump is not in operation. Overheating and damage to the marine gear may result unless rotation of the propeller shaft is prevented.

Consult an authorized *Detroit Diesel Allison Service Outlet* for major repairs or reconditioning of the marine gear.

ENGINE OPERATING INSTRUCTIONS

PREPARATION FOR STARTING ENGINE FIRST TIME

Before starting an engine for the first time, carefully read and follow these instructions. Attempting to run the engine before studying these instructions may result in serious damage to the engine.

> **NOTE:** When preparing to start a new or overhauled engine or an engine which has been in storage, perform all of the operations listed below. Before a routine start (at each shift), see *Daily Operations* in the *Lubrication and Preventive Maintenance Chart.*

Cooling System

Install all of the drain cocks or plugs in the cooling system (drain cocks are removed for shipping). Open the cooling system vents, if the engine is so equipped.

Remove the filler cap and fill the cooling system with clean, soft water or a protective solution consisting of high boiling point type antifreeze, if the engine will be exposed to freezing temperatures. Refer to *Engine Coolant.* Keep the liquid level about two inches below the filler neck to allow for fluid expansion.

Use a quality rust inhibitor if only water is used in the cooling system.

Close the vents, if used, after filling the cooling system.

On marine installations, prime the raw water cooling system and open any sea cocks in the raw water pump intake line. Prime the raw water pump by removing the pipe plug or electrode provided in the pump outlet elbow and pour water in the pump.

> **CAUTION:** Failure to prime the raw water pump may result in damage to the pump impeller.

Lubrication System

The lubricating oil film on the rotating parts and bearings of a new or overhauled engine, or one which has been in storage, may be insufficient for proper lubrication when the engine is started for the first time.

It is recommended that the engine lubricating system be charged with a pressure prelubricator, set to supply a minimum of 25 psi (172 kPa) oil pressure, to ensure an immediate flow of oil to all bearings at the initial engine start-up. The oil supply line should be attached to the engine so that oil under pressure is supplied to the main oil gallery.

With the oil pan dry, use the prelubricator to prime the engine with sufficient oil to reach all bearing surfaces. Use *heavy-duty* lubricating oil as specified under *Lubricating Oil Specifications.* Then remove the dipstick, wipe it with a clean cloth, insert and remove it again to check the oil level in the oil pan. Add sufficient oil, if necessary, to bring it to the full mark on the dipstick. Do not overfill.

If a pressure prelubricator is not available, fill the crankcase to the proper level with *heavy-duty* lubricating oil as specified. Then pre-lubricate the upper engine parts by removing the valve rocker covers and pouring lubricating oil, of the same grade and viscosity as used in the crankcase, over the rocker arms.

Turbocharger

Disconnect the turbocharger oil inlet line and pour approximately one pint of clean engine oil in the line, thus making sure the bearings are lubricated for the initial start. Reconnect the oil line.

Air Cleaner

If the engine is equipped with oil bath air cleaners, fill the air cleaner oil cups to the proper level with clean engine oil. *Do not overfill.*

Transmission

Fill the transmission case, marine gear or torque converter supply tank to the proper level with the lubricant specified under *Lubrication and Preventive Maintenance.*

Fuel System

Fill the fuel tank with the fuel specified under *Diesel Fuel Oil Specifications.*

If the unit is equipped with a fuel valve, it must be opened.

To ensure prompt starting, fill the fuel system between the pump and the fuel return manifold with fuel. If the engine has been out of service for a considerable length of time, prime the filter between the fuel pump and the injectors. The filter may be primed by removing the plug in the top of the filter cover and slowly filling the filter with fuel.

In addition to the above, on an engine equipped with a hydrostarter, use a priming pump to make sure the fuel lines and the injectors are full of fuel before attempting to start the engine.

> **NOTE:** The fuel system is filled with fuel before leaving the factory. If the fuel is still in the system when preparing to start the engine, priming should be unnecessary.

Lubrication Fittings

Fill all grease cups and lubricate at all fittings with an all purpose grease. Apply lubricating oil to the throttle linkage and other moving parts and fill the hinged cap oilers with a hand oiler.

Drive Belts

Adjust all drive belts as recommended under *Lubrication and Preventive Maintenance.*

Storage Battery

Check the battery. The top should be clean and dry, the terminals tight and protected with a coat of petroleum jelly and the electrolyte must be at the proper level.

> **NOTE:** When necessary, check the battery with a hydrometer; the reading should be 1.265 or higher. However, hydrometer readings should always be corrected for the temperature of the electrolyte.

Generator Set

Where applicable, fill the generator end bearing housing with the same lubricating oil as used in the engine.

A generator set should be connected and grounded in accordance with the applicable local electrical codes.

> **CAUTION:** The base of a generator set must be grounded.

Clutch

Disengage the clutch, if the unit is so equipped.

STARTING

Before starting the engine for the first time, perform the operations listed under *Preparation For Starting Engine First Time.*

Before a routine start, see *Daily Operations* in the *Lubrication and Preventive Maintenance Chart.*

If a manual or an automatic shutdown system is incorporated in the unit, the control must be set in the open position before starting the engine.

The blower will be seriously damaged if operated with the air shut-off valve in the closed position.

Starting at air temperatures below 40°F (4°C) requires the use of a cold weather starting aid. See *Cold Weather Starting.*

The instructions for the use of a cold weather fluid starting aid will vary dependent on the type being used. Reference should be made to these instructions before attempting a cold weather start.

> **WARNING:** Starting fluid used in capsules is highly inflammable, toxic and possesses anesthetic properties.

Initial Engine Start (Electric)

Start an engine equipped with' an electric starting motor as follows: Set the speed control lever at part throttle, then bring it back to the desired no-load speed. In addition, on mechanical governors, make sure the stop lever on the governor cover is in the *run* position. Then press the starting motor switch firmly. If the engine fails to start within 30 seconds, release the starting switch and allow the starting motor to cool a few minutes before trying again. If the engine fails to start after four attempts, an inspection should be made to determine the cause.

> **CAUTION:** To prevent serious damage to the starter, if the engine does not start, do not press the starting switch again while the starting motor is running.

Initial Engine Start (Hydrostarter)

Ambient Temperature	Pressure Gage Reading	
	psi	kPa
Above 40° F (4.4° C)	1500	10 342
40 - 0° F (4.4 to -18° C)	2500	17 237
Below 0° F (-18° C)	3300	22 753

Table 1

An engine equipped with a hydrostarter may be started as follows:

Raise the hydrostarter accumulator pressure with the hand pump until the gage reads as indicated in Table 1.

Set the engine controls for starting with the throttle at least half open.

> **NOTE:** During cold weather add starting fluid at the same time the hydrostarter motor lever is moved. Do not wait to add the fluid after the engine is turning over.

Push the hydrostarter control lever to simultaneously engage the starter pinion with the flywheel ring gear and to open the control valve . Close the valve as soon as the engine starts to conserve the accumulator pressure and to avoid excessive over-running of the starter drive clutch assembly.

RUNNING

Oil Pressure

Observe the oil pressure gage immediately after starting the engine. If there is no pressure indicated within 10 to 15 seconds, stop the engine and check the lubricating oil system. The minimum oil pressure should be at least 18 psi (124 kPa) at 1200 rpm. The oil pressure at normal operating speed should be 40-60 psi (276-414 kPa).

Warm- Up

Run the engine at part throttle and no-load for approximately five minutes, allowing it to warm-up before applying a load.

If the unit is operating in a closed room, start the room ventilating fan or open the windows, as weather conditions permit, so ample air is available for the engine.

Clutch

Do not engage the clutch at engine speeds over 1000 rpm.

Inspection

While the engine is running at operating temperature, check for coolant, fuel or lubricating oil leaks. Tighten the line connections where necessary to stop leaks.

Engine Temperature

Normal engine coolant temperature is 160-185° F (71- 85° C).

Crankcase

If the engine crankcase was refilled, stop the engine after normal operating temperature has been reached, allow the oil to drain back into the crankcase for approximately twenty minutes and check the oil level. Add oil, if necessary, to bring it to the proper level on the dipstick.

Use only the *heavy duty* lubricating oil specified under *Lubricating Oil Specifications.*

Cooling System

Remove the radiator or heat exchanger tank cap *slowly* after the engine has reached normal operating temperature and check the engine coolant level. The coolant level should be near the top of the opening. If necessary, add 'clean soft water or a high boiling point type antifreeze (refer to *Engine Coolant).*

Marine Gear

Check the marine gear oil pressure. The operating oil pressure range for the marine gear at operating speed is 120 to 160 psi (827 to 1103 kPa) and minimum oil pressure is 100 psi (689 kPa) at idle speed (600 rpm).

Turbocharger

Make a visual inspection of the turbocharger for leaks and excessive vibration. Stop the engine immediately if there is an unusual noise in the turbocharger.

Avoid Unnecessary Engine Idling

During long engine idling periods, the engine coolant temperature will fall below the normal operating range. The incomplete combustion of fuel in a cold engine will cause crankcase dilution, formation of lacquer or gummy deposits on the valves, pistons and rings and rapid accumulation of sludge in the engine.

> **NOTE:** When prolonged engine idling is necessary, maintain at least 800 rpm.

STOPPING

Normal Stopping

1. Release the load and decrease the engine speed. Put all shift levers in the *neutral* position.

2. Allow the engine to run at half speed or slower with no load for four or five minutes, then move the stop lever to *stop* to shut down the engine.

Emergency Stopping

If the engine does not stop after using the normal stopping procedure, pull the "Emergency Stop" knob all the way out. This control cuts off the air to the engine. Do not try to restart again until the cause for the malfunction has been found and corrected.

> **CAUTION:** The emergency shutdown system should never be used except in an emergency. Use of the emergency shutdown can cause oil to be sucked past the oil seals and into the blower housing.

The air shut-off valve, located on the blower air inlet housing, must be reset by hand and the "Emergency Stop" knob pushed in before the engine is ready to start again.

Fuel System

If the unit is equipped with a fuel valve, close it. Fill the fuel tank; a full tank minimizes condensation.

Exhaust System

Drain the condensation from the exhaust line or silencer.

Cooling System

Drain the cooling system if it is not protected with antifreeze and freezing temperatures are expected. Leave the drains open. Open the raw water drains of a heat exchanger cooling system.

Crankcase

If the engine crankcase was refilled, stop the engine after normal operating temperature has been reached, allow the oil to drain (approximately 20 minutes) back into the crankcase and check the oil level. Add oil, if necessary, to bring it to the proper level on the dipstick.

Use only the *heavy-duty* lubricating oil specified under *Lubricating Oil Specifications.*

Transmission

Check and, if necessary, replenish the oil supply in the transmission.

Clean Engine

Clean and check the engine thoroughly to make certain it will be ready for the next run.

Refer to *Lubrication and Preventive Maintenance* and perform all of the daily maintenance operations. Also perform the operations required for the number of hours or miles the engine has been in operation.

Make the necessary adjustments and minor repairs to correct difficulties which became apparent to the operator during the last run.

ALTERNATING CURRENT POWER GENERATOR SET OPERATING INSTRUCTIONS

These instructions cover the fundamental procedures for operating an alternating current power generator set (Fig. 1). The operator should read these instructions before attempting to operate the generator set.

Never operate a generator set for a short (15 minute) interval - the engine will not reach normal operating temperature in so short a period.

Avoid operating the set for extended periods at no- load.

Ideally, operate the set for one hour with at least 40% load (generator rating).

When a test must be made with a line load of less than 40% of the generator rating, add a supplementary load.

Connect the supplementary load to the load terminals of the control cabinet circuit breaker so that the generator can be "loaded" whenever the breaker is closed.

Make certain that the supplementary load is such that it can be controlled to permit a reduction in the load should a normal load increase occur while the set is operating. Locate the supplementary load outside the engine room, if desirable, to provide adequate cooling.

Loading the generator set to 40% of the generator rating and operating it for one-hour intervals will bring the engine and generator to normal operating temperatures and circulate the lubricants properly. Abnormal amounts of moisture, carbon and sludge are due primarily to low internal operating temperatures which are much less likely to occur when the set is tested properly.

PREPARATION FOR STARTING

Before attempting to start a new or an overhauled engine or an engine which has been in storage, perform all of the operations listed under *Preparation for Starting Engine First Time.* Before a routine start, s*ee Daily Operations* in the *Lubrication and Preventive Maintenance Chart.*

In addition to the *Engine Operating Instructions,* the

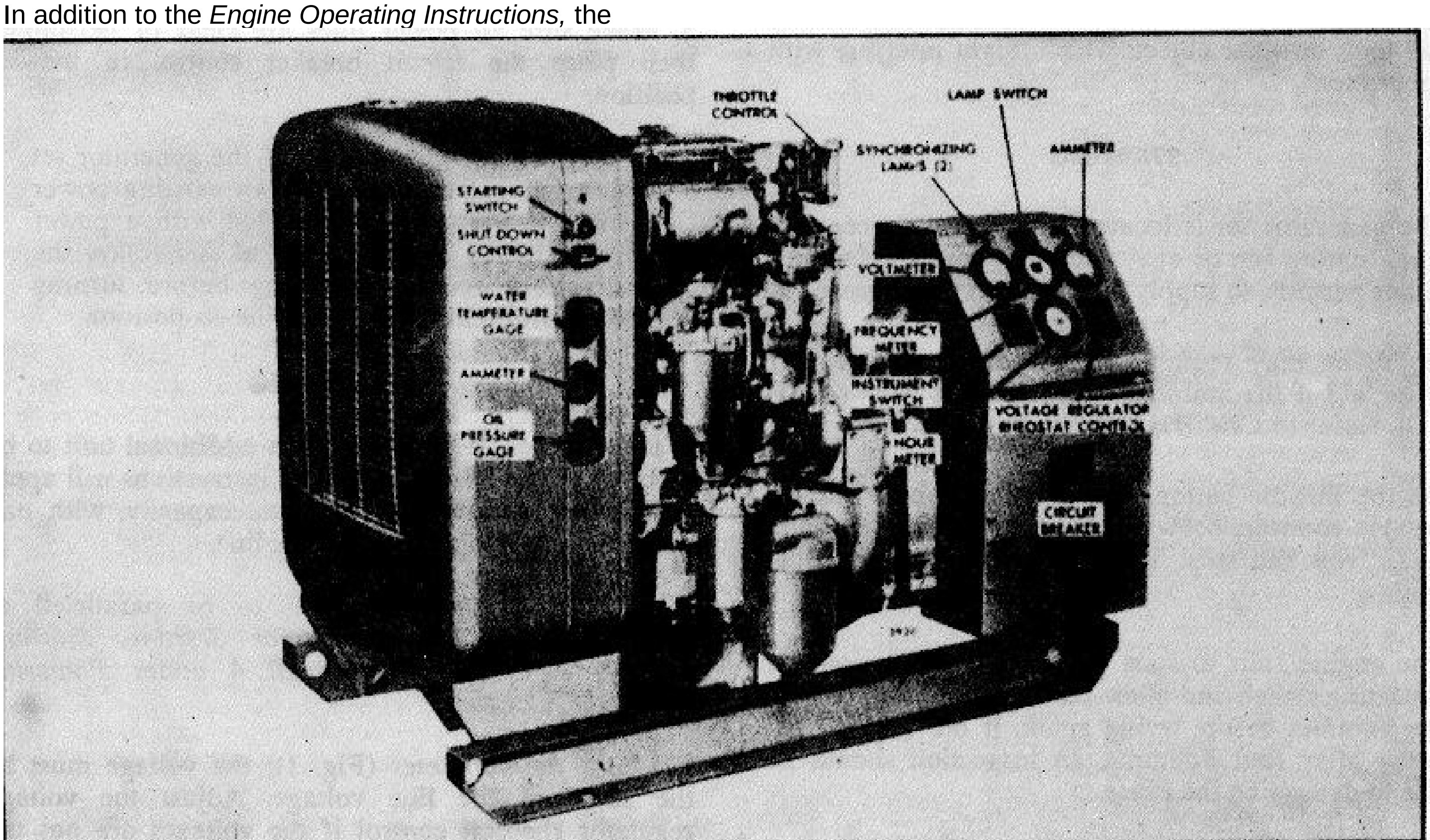


Fig. 1 - Location of Controls on Power Generator Set

following instructions also apply when operating an alternating current power generator set.

1. Before the first start, check the generator main bearing oil reservoir. If necessary, add sufficient lubricating oil, of the same grade as used in the engine crankcase, to bring it to the proper level on the sight gage.

2. Check the interior of the generator for dust or moisture. Blow out dust with low pressure air (25 psi or 172 kPa maximum). If there is moisture on the interior of the generator, it must be dried before the set is started. Refer to the appropriate Delco Products Maintenance bulletin.

3. The air shut-off valve located in the air inlet housing must be in the open or reset position.

4. Refer to Fig. 1 and place the circuit breaker in the **off** position.

5. If the generator set is equipped with synchronizing lamps, place the lamp switch in the **off** position.

6. Turn the voltage regulator rheostat knob counter- clockwise to its lower limit.

7. Make sure the power generator set has been cleared of all tools or other objects which might interfere with its operation.

STARTING

If the generator set is located in a closed space, start the ventilating fan or open the doors and windows, as weather permits, to supply ample air to the engine.

The engine may require the use of a cold weather starting aid if the ambient temperature is below 40° F (4° C). Refer to *Cold Weather Starting Aids.*

Press the throttle button and turn the throttle control (Fig. 1) counterclockwise to a position midway between **run** and **stop.** Then press the starting switch firmly.

If the engine fails to start within 30 seconds, release the starting switch and allow the starting motor to cool a few minutes before trying again. If the engine fails to start after four attempts, an inspection should be made to determine the cause.

> **CAUTION:** To prevent serious damage to the starter, if the engine does not start, do not press the starting switch again while the starting motor is rotating.

RUNNING

Observe the engine oil pressure gage immediately after starting the engine. If there is no oil pressure indicated within 10 to 15 seconds, stop the engine and check the engine lubricating system.

If the oil pressure is observed to be normal, increase the throttle setting to cause the engine to run at its synchronous speed.

PREPARING GENERATOR FOR LOAD

After the engine is warmed up (or the oil pressure has stabilized) prepare the generator set for load as follows:

1. Bring the engine up to the rated speed.

2. Turn the instrument switch to the desired position.

3. Turn the voltage regulator rheostat knob slowly in a clockwise direction to raise the voltage, while watching the voltmeter, until the desired voltage is attained.

4. If the generator set is equipped with a frequency meter, adjust the engine speed with the vernier throttle knob until the desired frequency is indicated on the meter.

5. Make sure all power lines are clear of personnel, then place the circuit breaker control in the **on** position.

> **NOTE:** Perform Step 5 only if the generator set is not being paralleled with an existing power source. If it is being paralleled with a power source already on the line, read and follow the instructions under *Paralleling* before turning the circuit breaker control to the on position.

PARALLELING

If the load conditions require an additional unit to be placed on the line, the following instructions will apply to power generator sets of equal capacity, with one generator set in operation on the line.

1. Prepare the generator set to be paralleled as outlined under *Preparation For Starting, Starting, Running* and Items 1through 4 under *Preparing Generator for Load.*

2. Check the voltmeter (Fig. 1); the voltage must be the same as the line voltage. Adjust the voltage regulator rheostat control if the voltages are not the same.

3. Place the synchronizing lamp switch, of the generator set to be paralleled, in the on position.

4. Turn the vernier throttle knob until both units are operating at approximately the same frequency as indicated by the slow change in the brilliancy of the synchronizing lamps.

5. When the synchronizing lamps glow and then go out at a very slow rate, time the dark interval. Then, in the middle of this interval, turn the circuit breaker control to the on position. This places the incoming generator set on the line, with no load. The proper share of the existing load must now be placed on this generator.

6. The division of the kilowatt load between the alternating current generators operating in parallel depends on the power supplied by the engines to the generators as controlled by the engine governors and is practically independent of the generator excitation. Divide the kilowatt load between the generators by turning the vernier throttle knob counterclockwise on the incoming generator and clockwise on the generator that has been carrying the load (to keep the frequency of the generators constant) until both ammeters read the same, indicating that each generator is carrying its proper percentage of the total K.W. load.

7. The division of the reactive KVA load depends on the generator excitation as controlled by the voltage .regulator. Divide the reactive load between the generators by turning the voltage regulator rheostat control on the incoming generator (generally clockwise to raise the voltage) until the ammeters read the same on both generator sets and the sum of the readings is minimum.

> **NOTE:** The generator sets are equipped with a resistor and current transformer connected in series with the voltage coil of the regulator (cross-current compensation) which equalizes most but not all of the reactive KVA load between the generators.

8. When the load is 80 per cent power factor lagging (motor and a few lights only), turn the vernier throttle knob on the incoming generator until the ammeter on that unit reads approximately 40 per cent of the total current load.

9. Rotate the voltage regulator rheostat control on the incoming generator clockwise to raise the voltage until the ammeters read the same on both units.

> **NOTE:** If a load was not added during paralleling, the total of the two ammeter readings should be the same as the reading before paralleling. Readjust the voltage regulator rheostat on the incoming generator, if necessary.

10. To reset the load voltage, turn the voltage regulator rheostat controls slowly on each unit. It is necessary to turn the controls the same amount and in the same direction to keep the reactive current equally divided. Power generator sets with different capacities can also be paralleled by dividing the load proportionately to their capacity.

STOPPING

The procedure for stopping a power generator set or taking it out of parallel is as follows:

1. Turn off all of the load on the generator when stopping a single engine unit.

2. Shift the load from the generator when taking it out of parallel operation by turning the vernier throttle knob until the ammeter reads approximately zero.

3. Place the circuit breaker control in the off position.

4. Turn the voltage regulator rheostat control in a counterclockwise direction to the limit of its travel.

5. Press the throttle button and turn the throttle control to stop to shut-down the engine.

> **NOTE:** When performing a tune-up on a generator set that will be operated in parallel with another unit, adjust the speed droop as specified in *Engine Tune-Up.*

LUBRICATION AND PREVENTIVE MAINTENANCE

To obtain the best performance and long life from a Detroit Diesel engine, the Operator must adhere to the following schedule and instructions on lubrication and preventive maintenance.

The daily instructions pertain to routine or daily starting of an engine and not to a new engine or one that has not been operated for a considerable period of time. For new or stored engines, carry out the instructions given under *Preparation for Starting Engine First Time* under *Operating Instructions.*

The time intervals given in the chart on the following page are actual operating hours or miles of an engine. If the' lubricating oil is drained immediately after an engine has been run for some time, most of the sediment will be in suspension and, therefore, will drain readily.

All authorized *Detroit Diesel Allison Service Outlets* are prepared to service engines with the viscosity and grade of lubricants recommended on the following pages.

LUBRICATION AND PREVENTIVE MAINTENANCE CHART — Item / Operation	Time Interval								
Hours		8	50	100	200	300	500	1,000	2,000
Miles	Daily	240	1,500	3,000	6,000	9,000	15,000	30,000	60,000
1. Engine Oil	X								
2. Oil Filter*									
3. Coolant and Filter	X						X	X	
4. Hoses							X		
5. Radiator								X	
6. Heat Exchanger Electrodes and Core							X	X	
7. Raw Water Pump	X								
8. Fuel Tank	X						X		
9. Fuel Strainer and Filter						X			
10. Air Cleaners		X					X		
11. Air Box Drains							X	X	
12. Ventilating System								X	
13. Blower Screen								X	
14. Starting Motor*									
15. Battery-Charging Alternator				X	X		X		X
16. Battery				X					
17. Tachometer Drive and Clutch Controls				X					
18. Throttle Controls					X				
19. Engine Tune-Up*									
20. Drive Belts		X			X				
21. Overspeed Governor							X		
22. Fan Hub Bearings*									
23. Shut-Down System						X			
24. Hydrostarter System*									
25. Air Compressor Air Strainer					X				
26. Turbocharger*									
27. Power Generator				X		X			
28. Power Take-Off		X	X				X		
29. Torqmatic Converter	X		X				X		
30. Marine Gear	X				X			X**	

*See items on following pages **Twin Disc Marine Gear

Item 1

Check the oil level daily before starting the engine. Add oil, if necessary, to bring it to the proper level on the dipstick. Select the proper grade of oil in accordance with the instructions in the *Lubricating Oil Specifications*. It is recommended that new engines be started with 100 hour oil change periods. The drain interval may then be gradually increased, or decreased, following the recommendations of an independent oil analysis laboratory or the oil supplier (based upon the oil sample analysis) until the most practical oil change period has been established.

Item 2

Install new engine oil filter elements and gaskets each time the engine oil is changed. Check for oil leaks after starting the engine. If the engine is equipped with a governor oil filter, change the element every 1,000 hours.

Item 3

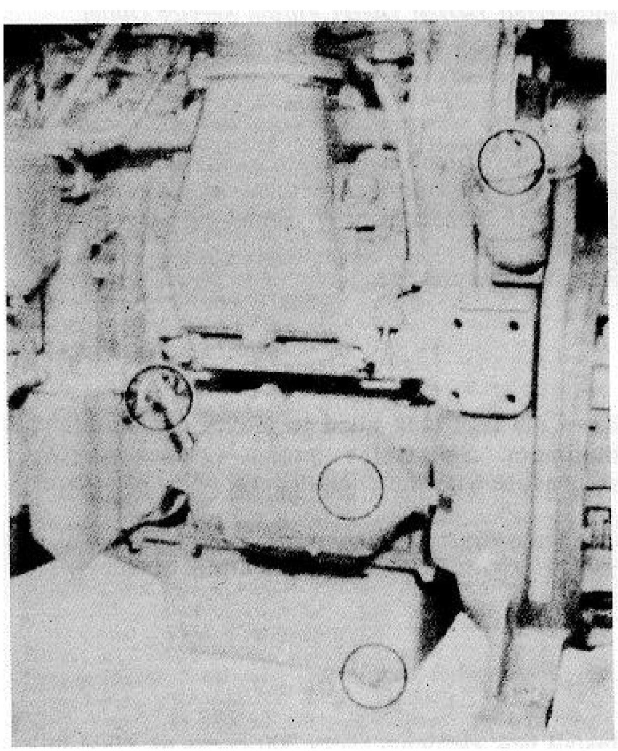
Check the coolant level daily and maintain it near the top of the heat exchanger tank or the radiator upper tank.

Clean the cooling system every 1,000 hours or 30,000 miles using a good radiator cleaning compound in accordance with the instructions on the container. After the cleaning operation, rinse the cooling system thoroughly with fresh water. Then fill the system with soft water, adding a good grade of rust inhibitor or a high boiling point type antifreeze (refer to *Engine Coolant*). With the use of a proper antifreeze or rust inhibitor, this interval may be lengthened until, normally, this cleaning is done only in the spring or fall. The length of this interval will, however, depend upon an inspection for rust or other deposits on the internal walls of the cooling system. When a thorough cleaning of the cooling system is required, it should be reverse-flushed.

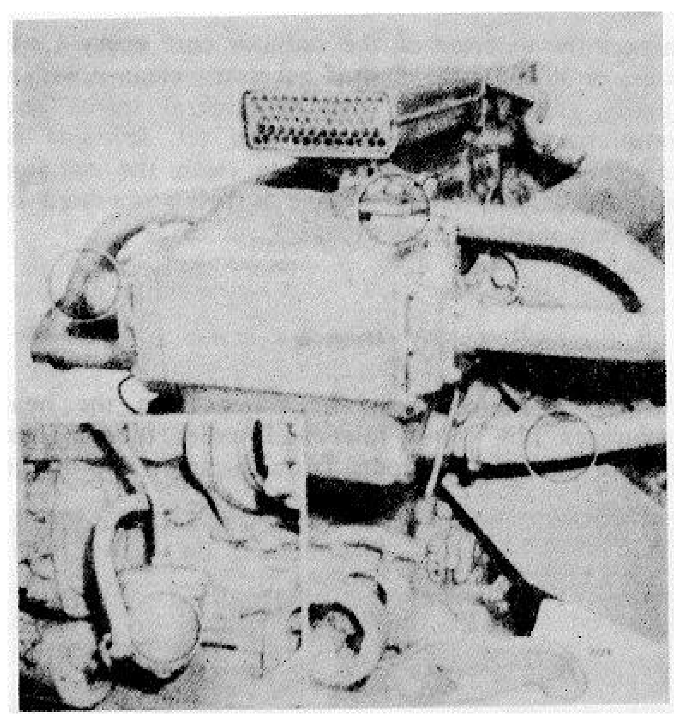
If the cooling system is protected by a coolant filter and conditioner, the filter element should be changed every 500 hours or 15,000 miles.

Item 4

Inspect all of the cooling system hoses at least once every 500 hours or 15,000 miles for signs of deterioration. Replace the hoses if necessary.



Items 1 and 2



Items 3 and 4

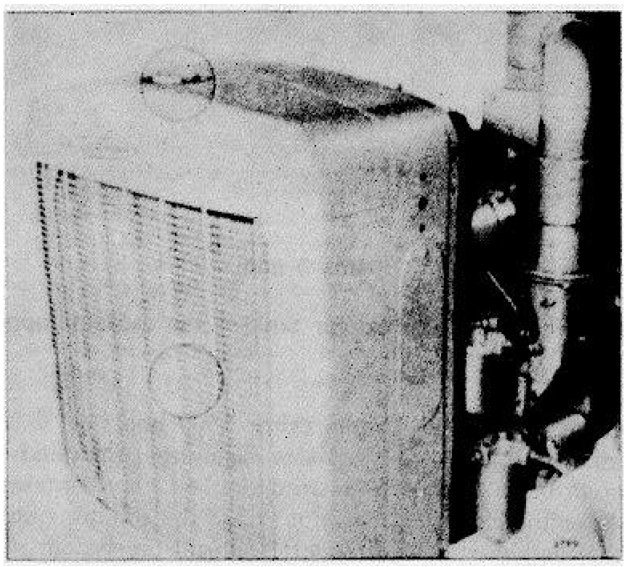
Item 5

Inspect the exterior of the radiator core every 1,000 hours or 30,000 miles and, if necessary, clean it with a quality grease solvent such as mineral spirits and compressed air. *Do not use fuel oil, kerosene or gasoline*. It may be necessary to clean the radiator more frequently if the engine is being operated in extremely dusty or dirty areas.

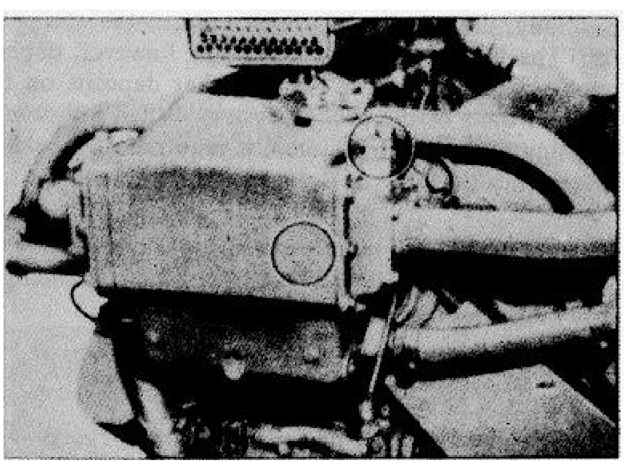
Item 6

Every 500 hours drain the water from the heat exchanger raw water inlet and outlet tubes. Then remove the zinc electrodes from the inlet side of the raw water pump and the heat exchanger. Clean the electrodes with a wire brush or, if worn excessively, replace with new electrodes. To determine the condition of a used electrode, strike it sharply against a hard surface; a weakened electrode will break.

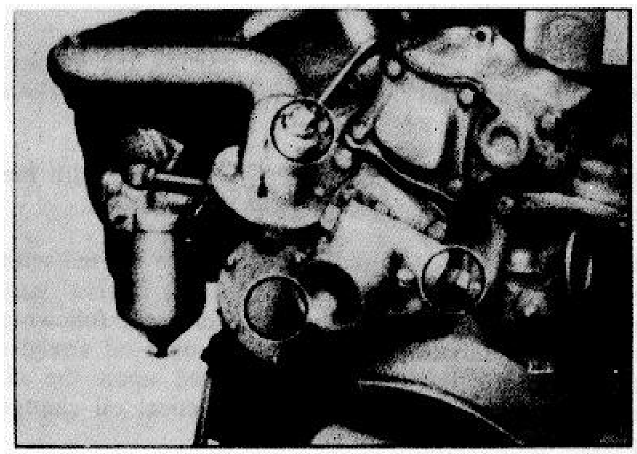
Drain the cooling system, disconnect the raw water pipes at the outlet side of the heat exchanger and remove the retaining cover every 1,000 hours and inspect the heat exchanger core. If a considerable amount of scale or deposits are present, contact an authorized *Detroit Diesel Allison Service Outlet.*



Item 5



Item 6



Item 7

Check the prime on the raw water pump; the engine should not be operated with a dry pump. Prime the pump, if necessary, by removing the pipe plug provided in the pump inlet elbow and adding water. Reinstall the plug.

Item 8

Keep the fuel tank filled to reduce condensation to a minimum. Select the proper grade of fuel in accordance with the *Diesel Fuel Oil Specifications*.

Open the drain at the bottom of the fuel tank every 500 hours or 15,000 miles to drain off any water or sediment.

Item 9

Install new elements every 300 hours or 9,000 miles or when plugging is indicated. A method of determining when elements are plugged to the extent that they should be changed is based on he fuel pressure at the cylinder head fuel inlet manifold and the inlet restriction at the fuel pump.

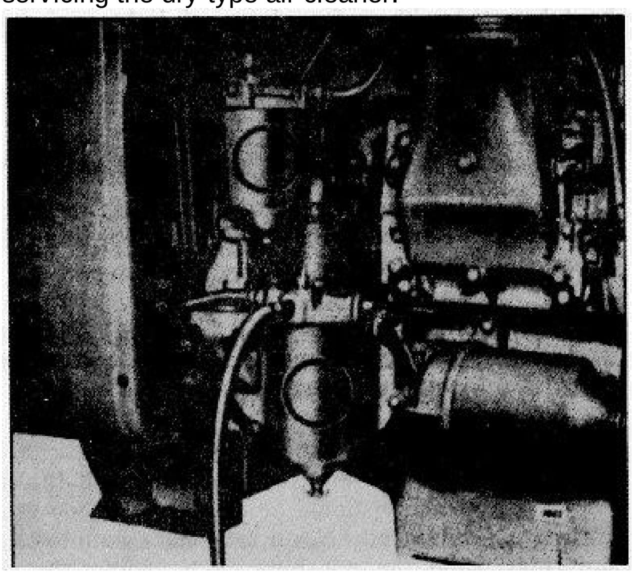
In a clean system, the maximum pump inlet restriction must not exceed 6 inches of mercury. At normal operating speeds (1800-2800 rpm), the fuel pressure is 45 to 70 psi (310 to 483 kPa). Change the fuel filter elements whenever the inlet restriction (suction) at the fuel pump reaches 12 inches of mercury at normal operating speeds and whenever the fuel pressure at the inlet manifold falls to 45 psi (310 kPa).

Item 10

Remove the dirty oil and sludge from the oil bath-type air cleaner cups and center tubes every 8 hours or less if operating conditions warrant. Wash the cups and elements in clean fuel oil and refill the cups to the level mark with the same grade of heavy duty oil as used in the engine. The frequency of servicing may be varied to suit local dust conditions.

It is recommended that the body and fixed element in the heavy-duty oil bath type air cleaner be serviced every 500 hours, 15,000 miles or as conditions warrant.

Clean or replace the element in the dry-type air cleaner when the restriction indicator instrument indicates high restriction or when a water manometer reading at the air inlet housing indicates the maximum allowable air inlet restriction (refer to the Air Inlet Restriction chart in the Trouble Shooting section). Refer to the instructions in the Air System section for servicing the dry-type air cleaner.



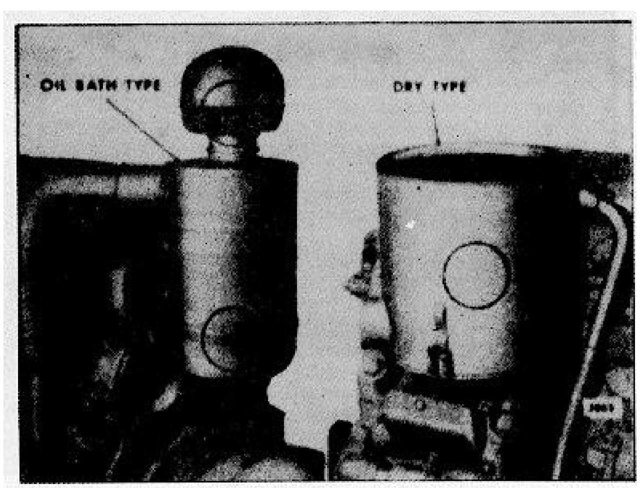
Item 9

Item 11

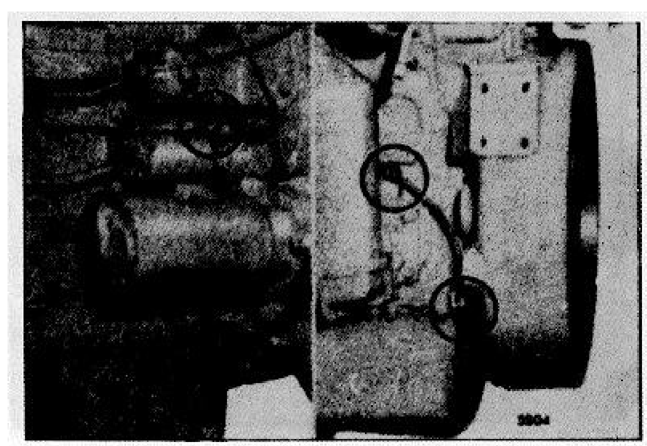
With the engine running, check for flow of air from the air box drain tubes every 1,000 hours or 30,000 miles. If the tubes are clogged, remove, clean and reinstall the tubes. The air box drain tubes should be cleaned periodically even though a clogged condition is not apparent. If the engine is equipped with an air box drain tank, drain the sediment periodically. If the engine is equipped with an air box drain check valve, replace the valve every 500 hours or 15,000 miles.

Item 12

Clean the externally mounted crankcase breather assemblies every 1,000 hours or 30,000 miles. This cleaning period may be reduced or lengthened according to severity of service. Clean the internally mounted breather pads at time of engine overhaul, or sooner if excessive crankcase pressure is observed.



Item 10



Item 11

Remove the crankcase breather from the engine and wash the steel mesh pad (element) in fuel oil and dry it with compressed air. Reinstall the breather assembly.

Clean the breather cap, mounted on the valve rocker cover, in clean fuel oil every time the engine oil is changed.

Item 13

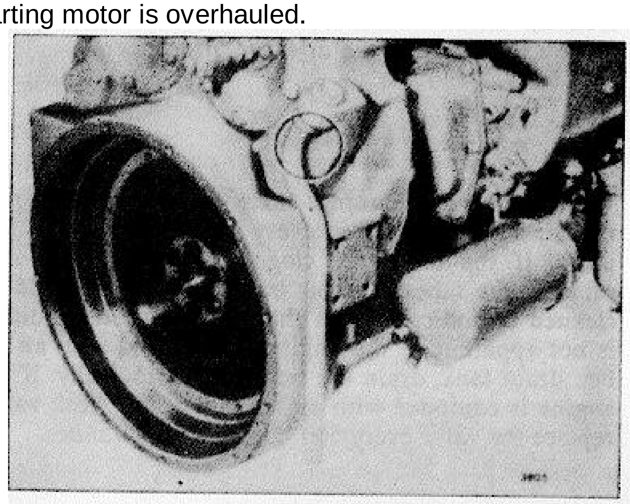
Inspect the blower screen and gasket assemblies every 1,000 hours or 30,000 miles and, if necessary, clean the screens in fuel oil and dry them with compressed air.

Reinstall the screen and gasket assemblies with the screen side of the assemblies toward the blower. Inspect for evidence of blower seal leakage.

Item 14

The electrical starting motor is lubricated at the time of original assembly. Oil can be added to the oil wicks, which project through each bushing and contact the armature shaft, by removing the pipe plugs on the outside of the motor. The wicks should be lubricated whenever the starting-motor is taken off the engine or disassembled.

The Sprag overrunning clutch drive mechanism should be lubricated with a few drops of light engine oil whenever the starting motor is overhauled.



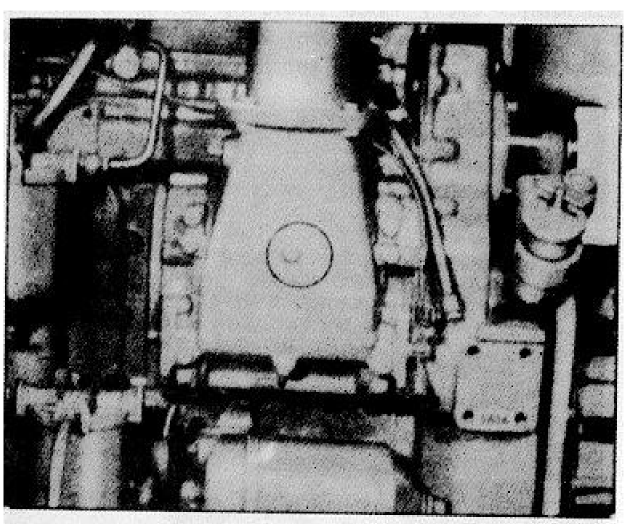
Item 12

Item 15

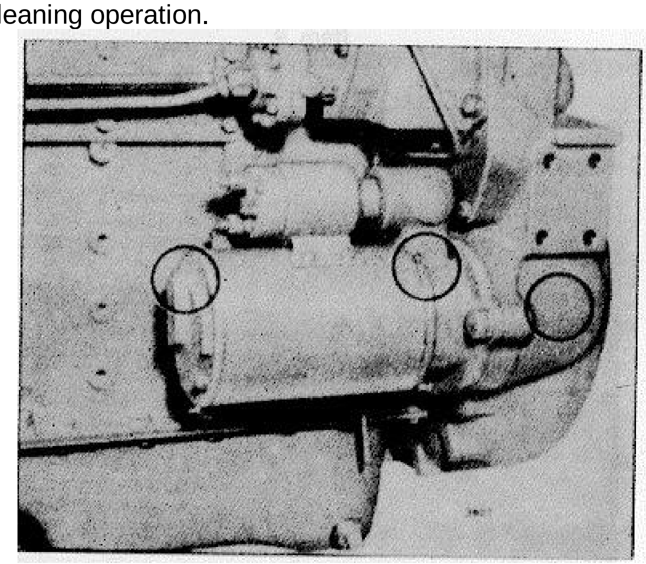
Lubricate the alternator bearings or bushings with 5 or 6 drops of engine oil at the hinge cap oiler every 200 hours or-6;000 miles.

Some alternators have a built-in supply of grease, while others use sealed bearings. In these latter two cases, additional lubrication is not necessary.

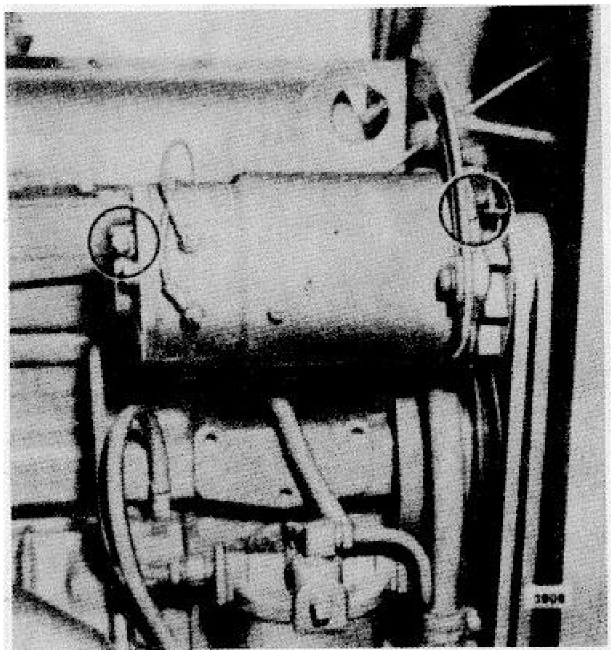
The slip rings and brushes of an alternator can be inspected through the end frame assembly. If the slip rings are dirty, they should be cleaned with 400 grain or finer polishing cloth. Never use emery cloth to clean slip rings. Hold the polishing cloth against the slip rings with the alternator in operation and blow away all dust after the cleaning operation.



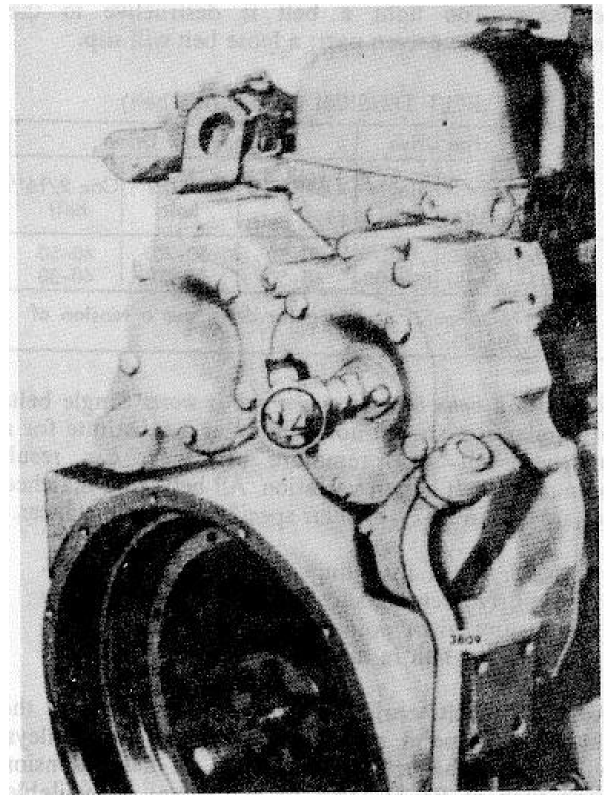
Item 13



Item 14



Item 15



Item 17

Item 15

If the slip rings are rough or out of round, replace them. Inspect the terminals for corrosion and loose connections and the wiring for frayed insulation.

Item 16

Check the specific gravity of the electrolyte in each cell of the battery every 100 hours or 3,000 miles. In warm weather, however, it should be checked more frequently due to a more rapid loss of water from the electrolyte. The electrolyte level should be maintained in accordance with the battery manufacturer's recommendations.

Item 17

Lubricate the tachometer drive every 100 hours or 3,000 miles with an all purpose grease at the grease fitting. At temperatures above +30°F (-1 C), use a No. 2 grade grease. Use a No. I grade grease below this temperature.

Item 18

Lubricate the throttle control mechanism every 200 hours or 6,000 miles with an all purpose grease. At temperatures above +30°F (-1°C), use a No. 2 grade grease. Use a No. 1 grade grease below this temperature. Lubricate all other control mechanisms, as required, with engine oil.

Item 19

There is no scheduled interval for performing an engine tune-up. As long as the engine performance is satisfactory, no tune-up should be needed. Minor adjustments in the valve and injector operating mechanisms, governor, etc. should only be required periodically to compensate for normal wear on parts.

Item 20

New drive belts will stretch after the first few hours of operation. Run the engine for 15 *seconds* to seat the belts and readjust the tension. Then check the belts and retighten the fan drive, pump drive and battery-charging alternator drive belts after 1/2 hour or 15 miles and again after 8 hours or 140 miles of operation. Thereafter, check the tension of the drive belts every 200 hours or 6,000 miles and adjust, if necessary.

Too tight a belt is destructive to the bearings of the driven part; a loose belt will slip.

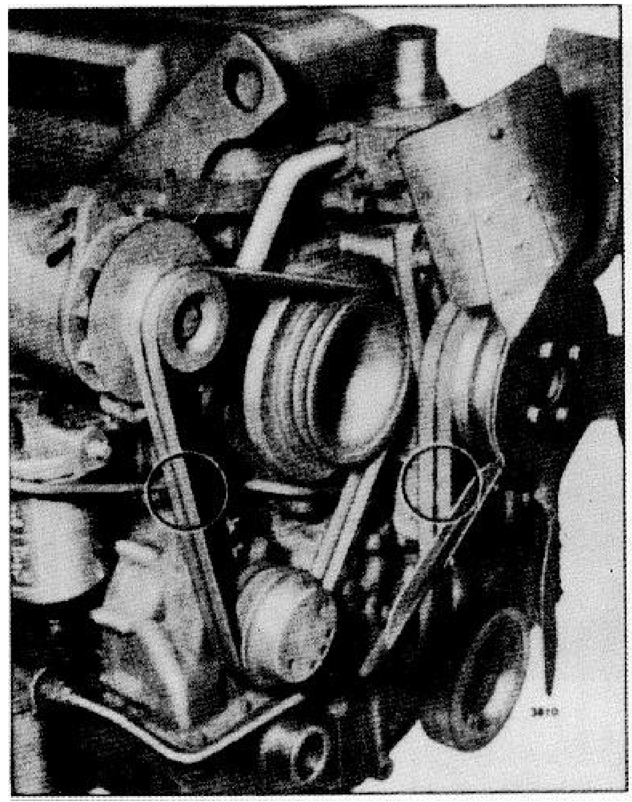
BELT TENSION CHART (lbs/belt)

Model	Fan Drive		Generator Drive		
	2 or 3 belts	Single belt	Two 3/8" or 1/2" belts	One 1/2" belt	One 9/16" belt
3,4-53	40-50	-	40-50	50-70	40-50
6V-53	60-80	80-100	40-50	50-70	40-50
All	For 3-point or triangular drive use a tension of 90-120.				

Replace all belts in a set when one is worn. Single belts of similar size should not be used as a substitute for a matched belt set; premature belt wear can result because of belt length variation. All belts in a matched set are within .032 " of their specified center distances.

> **NOTE**: When installing or adjusting an accessory drive belt, be sure the bolt at the accessory adjusting pivot point is properly tightened, as well as the bolt in the adjusting slot.

Adjust the belt tension so that a firm push with the thumb, at a point midway between the two pulleys, will depress the belt 1/2" to 3/4". If a belt tension gage such as BT-33-73FA or equivalent is available, adjust the belt tension as outlined in the chart.



Item 20

Item 21

Lubricate the overspeed governor, if it is equipped with a hinge-type cap oiler or oil cup, with 5 or 6 drops of engine oil every 500 hours. Avoid excessive lubrication and do not lubricate the governor while the engine is running.

Item 22

If the fan bearing hub assembly is provided with a grease fitting, use a hand grease gun and lubricate the bearings with one shot of Texaco Premium RB grease, or an equivalent Lithium base multi-purpose grease, every 20,000 miles (approximately 700 hours). Every 75,000 miles or 2500 hours, clean, inspect and repack the fan bearing hub assembly with the above recommended grease.

At a major engine overhaul, remove and discard the bearings in the fan hub assembly. Pack the hub assembly, using new bearings, with Texaco Premium RB grease or an equivalent Lithium base multi-purpose grease.

Check the shutdown system every 300 operating hours or each month to be sure it will function when needed.

Item 24

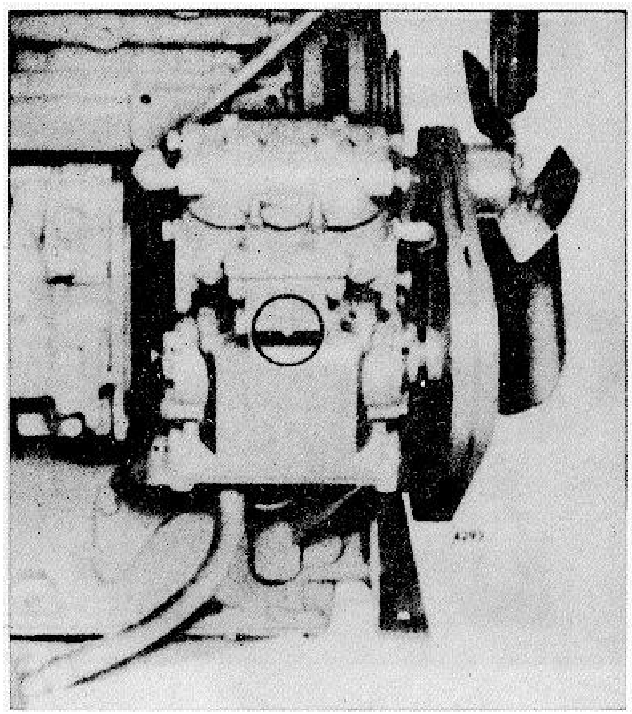
On engines equipped with a hydrostarter, refer to the *Hydraulic Starting System* in the section on *Engine Equipment* for preventive maintenance and lubrication.

Item 25

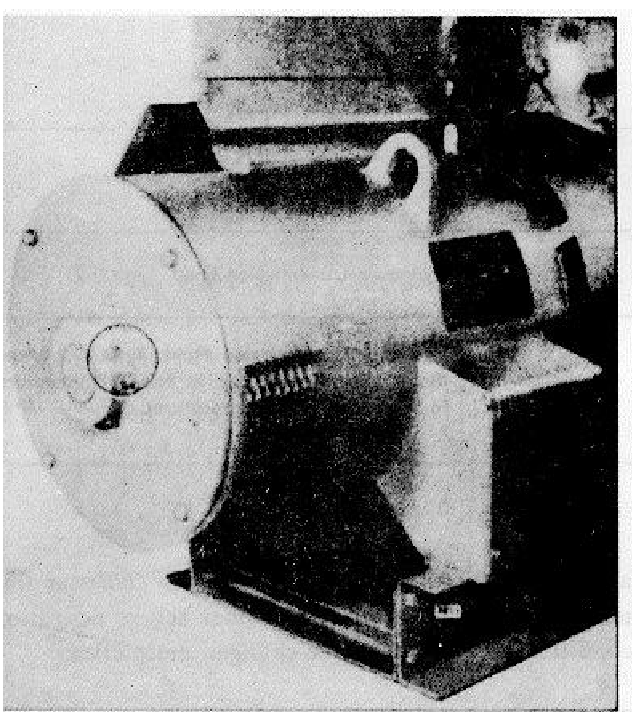
To clean either the hair or polyurethane type air compressor air strainer element, saturate and squeeze it in fuel oil, or any other cleaning agent that would not be detrimental to the element, until dirt free. Then dip it in lubricating oil and squeeze it dry before placing it back in the air strainer. For replacement of the air strainer element, contact the nearest Bendix Westinghouse dealer; replace with the polyurethane element, if available.

Item 26

There is no scheduled interval for performing an inspection on the turbocharger. As long as the turbocharger is operating satisfactorily and there is no appreciable loss of power, no vibration or unusual noise and no oil leaks, only a periodic inspection is necessary.



Item 25



Item 27

When service is required, contact an authorized *Detroit Diesel Allison Service Outlet.*

Item 27

The power generator requires lubrication at only one point - the ball bearing in the end frame. If the bearing is oil lubricated, check the oil level in the sight gage every 300 hours; change the oil every six months. Use the same grade of oil as specified for the engine. Maintain the oil level to the line in the sight gage. **Do not overfill.** After adding oil, recheck the oil level after running the generator for several minutes.

If the bearing is grease lubricated, a new generator has sufficient grease for three years of normal service. Thereafter, it should be lubricated at one year intervals. To lubricate the bearing, remove the filler and relief plugs on the side and the bottom of the bearing reservoir. Add grease until new grease appears at the relief plug opening. Run the generator a few minutes to vent the excess grease; then reinstall the plugs.

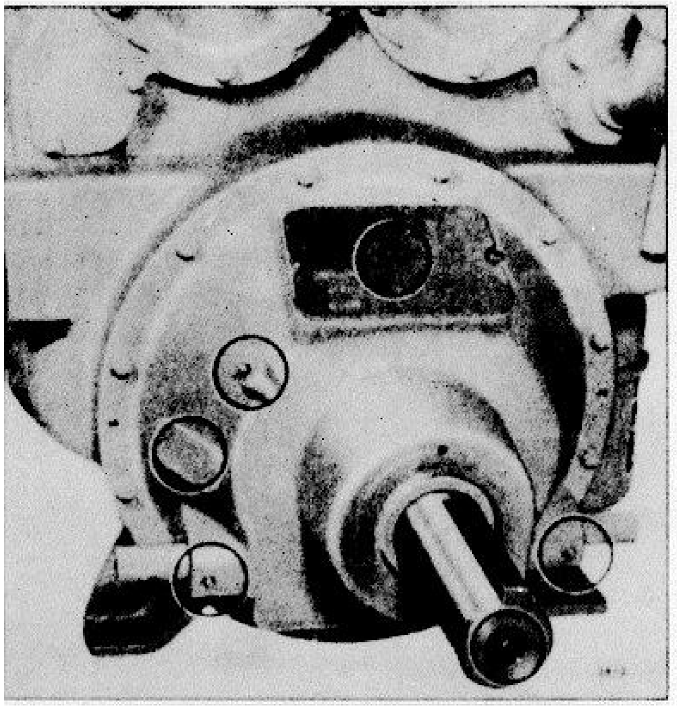
The following greases, or their equivalents, are recommended:

Keystone 44H........................... Keystone Lubrication Co.
BRB Lifetime............................ Socony Vacuum Oil Co.
NY and NJ F926 or F927.......... NY and NJ Lubricant Co.

After 100 hours on new brushes, or brushes in generators that have not been in use over a long period, remove the end frame covers and inspect the brushes, commutator and collector rings. If there is no appreciable wear on the brushes, the inspection interval may be extended until the most practicable
period has been established (not to exceed six months). To prevent damage to the commutator or the collector rings, do not permit the brushes to become shorter than 3/4 inch.

Keep the generator clean inside and out. Before removing the end frame covers, wipe off the loose dirt. The loose dirt and dust may be blown out with low pressure air (25 psi or 172 kPa maximum). Remove all greasy dirt with a cloth.

Lubricate all of the power take-off bearings with an all purpose grease such as Shell Alvania No. 2, or equivalent.



Lubricate sparingly to avoid getting grease on the clutch facing.

Open the cover on the side of the clutch housing (8" and 10" diameter clutch) and lubricate the clutch release sleeve collar through the grease fitting every 8 hours. On the 11-1/2" diameter clutch, lubricate the collar through the fitting on the side of the clutch housing every 8 hours.

Lubricate the clutch drive shaft pilot bearing through the fitting in the outer end of the drive shaft (8" and 10 " diameter clutch power take-offs) every 50 hours of operation. One or two strokes with a grease gun should be sufficient. The clutch drive shaft pilot bearing used with the 11-1/2" diameter clutch power take-off is prelubricated and does not require lubrication.

Lubricate the clutch drive shaft roller bearings through the grease fitting in the clutch housing every 50 hours under normal operating conditions (not continuous) and more often under severe operating conditions or continuous operation. Lubricate the clutch release shaft through the fittings at the rear of the housing every 500 hours of operation.

Lubricate the clutch levers and links sparingly with engine oil every 500 hours of operation. Remove the inspection hole cover on the clutch housing and lubricate the clutch release levers and pins with a hand oiler. To avoid getting oil on the clutch facing, do not over lubricate the clutch release levers and pins.

Check the clutch facing for wear every 500 hours. Adjust the clutch if necessary.

Item 29

Check the oil level in the Torqmatic converter and supply tank daily. The oil level must be checked while the converter is operating, the engine idling and the oil is up to operating temperature (approximately 200° F or 93 ° C). If the converter is equipped with an input disconnect clutch, the clutch must be engaged.

Check the oil level after running the unit a few minutes. The oil level should be maintained at the proper level on the dipstick. If required, add hydraulic transmission fluid type "C-2" (Table 1). *Do not overfill* the converter as too much oil will cause foaming and high oil temperature.

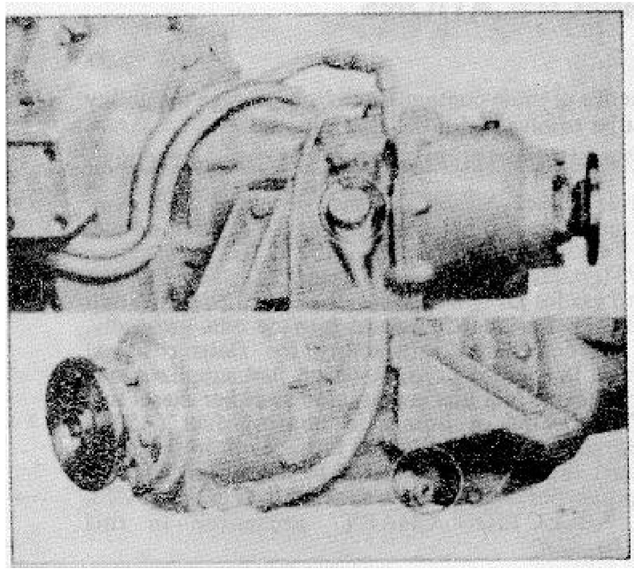
The oil should be changed every 500 hours of operation. Also, the oil should be changed whenever it shows traces of dirt or effects of high operating temperature as evidenced by discoloration or strong odor. If the oil shows metal contamination, contact an authorized *Detroit Diesel Allison Service Outlet* as this usually requires disassembly. Under severe operating conditions, the oil should be changed more often.

The converter oil breather, located on the oil level indicator (dipstick), should be cleaned each time the converter oil is changed. This can be accomplished by allowing the breather to soak in a solvent, then drying it with compressed air.

OIL RECOMMENDATIONS

Prevailing Ambient Temperature	Recommended Oil Specification
Above -10°F (-230C)	Hydraulic Transmission Fluid, Type C-2.
Below --10°F(--23°C)	Hydraulic Transmission Fluid, Type C-2. Aux-iliory preheat required to raise temperature in the sump to a temperature above -10°F. (-23°C)

TABLE 1



Item 30

The full-flow oil filter element should be removed, the shell cleaned and a new element and gasket installed each time the converter oil is changed. Lubricate the input clutch release bearing and ball bearing every 50 hours with an all purpose grease through the grease fittings provided on the clutch housing. This time interval may vary depending upon the operating conditions. Over-lubrication will cause grease to be .thrown on the clutch facing, causing the clutch to slip.

Item 30

WARNER MARINE GEAR:
Check the oil level daily. Start and run the engine at idle speed for a few minutes to fill the lubrication system. Stop the engine. Then immediately after stopping the engine, check the oil level in the marine gear. Bring the oil level up to the proper level on the dipstick. Use the same grade of lubricating oil that is used in the engine. **Do not overfill.**

Change the oil every 200 hours. After draining the oil from the unit, clean the removable oil screen thoroughly before refilling the marine gear with oil.

TWIN DISC MARINE GEAR:
Check the marine gear oil level daily. Check the oil level with the engine running at low idle speed and the gear in neutral. Keep the oil up to the proper level on the dipstick. Use oil of the same *heavy-duty* grade and viscosity that is used in the engine.

Change the oil every 200 hours. Remove and clean the oil inlet strainer screen after draining the oil and before refilling the marine gear. The strainer is located in the sump at the lower end of the pump suction line. When refilling after an oil drain, bring the oil up to the proper level on the dipstick (approximately 5 quarts or 4.74 litres).

DETROIT DIESEL FUEL OIL SPECIFICATIONS

GENERAL CONSIDERATIONS

The quality of fuel oil used for high-speed diesel engine operation is a very important factor in obtaining satisfactory engine performance, long engine life, and acceptable exhaust.

Fuel selected should be completely distilled material. That is, the -fuel should show at least 98 percent by volume recovery when subjected to ASTM D-86 distillation. Fuels marketed to meet Federal Specification VV-F-800 (grades DF-1 and DF-2) and ASTM Designation D-975 (grades 1-D and 2-D) meet the completely distilled criteria. Some of the general properties of VV-F-800 and ASTM D-975 fuels are shown below.

FEDERAL SPECIFICATION & ASTM DIESEL FUEL PROPERTIES

Specification or Classification Grade	VV-F-800 DF-1	ASTM D-975 1-D	VV-F-800 DF-2	ASTM D-975 2-D
Flash Point, min.	104° F 40° C	100° F 38° C	122° F 50° C	125° F 52° C
Carbon Residue (10% residuum), % max.	0.15	0.15	0.20	0.35
Water & Sediment, % by vol., max.	0.01	trace	0.01	0.05
Ash, % by wt., max.	0.005	0.01	0.005	0.01
Distillation Temperature, 90% by vol. recovery, min.	—	—	—	540°F (282°C)
max.	572°F (300°C)	550°F (288°C)	626°F (330°C)	640°F (338°C)
End Point, max.	626°F (330°C)	—	671°F (355°C)	—
Viscosity . 100°F (38°C)				
Kinematic, cs, min.	1.4	1.4	2.0	2.0
Saybolt, SUS, min.	—	—	—	32.6
Kinematic, cs, max.	3.0	2.5	4.3	4.3
Saybolt, SUS, max.	—	34.4	—	40.1
Sulfur, % by wt., max.	0.50	0.50	0.50	0.50
Cetane No.	45	40	45	40

Residual fuels and domestic furnace oils are not considered satisfactory for Detroit Diesel engines: however, some may be acceptable. (See "DETROIT DIESEL FUEL OIL SPECIFICATIONS.")

NOTE: Detroit Diesel Allison does not recommend the use of drained lubricating oil as a diesel fuel oil. Furthermore, Detroit Diesel will not be responsible for any engine detrimental effects which it determines resulted from this practice.

All diesel fuel oil contains a certain amount of sulfur. Too high a sulfur content results in excessive cylinder wear due to acid build-up in the lubricating oil. For most satisfactory engine life, fuels containing less than 0.5% sulfur should be used.

Fuel oil should be clean and free of contamination. Storage tanks should be inspected regularly for dirt, water or water-emulsion sludge, and cleaned if contaminated. Storage instability of the fuel can lead to the formation of varnish or sludge in the tank. The presence of these contaminants from storage instability must be resolved with the fuel supplier.

DETROIT DIESEL FUEL OIL SPECIFICATIONS

Detroit Diesel Allison designs, develops, and manufactures commercial diesel engines to operate on diesel fuels classified by the ASTM as Designation D-975 (grades I-D and 2-D). These grades are very similar to grades DF-I and DF-2 of Federal Specification VV-F-800. Residual fuels and furnace oils, generally, are not considered satisfactory for Detroit Diesel engines. In some regions, however, fuel suppliers may distribute one fuel that is marketed as either diesel fuel (ASTM D-975) or domestic heating fuel (ASTM D-396) sometimes identified as furnace oil. In this case, the fuel should be investigated to determine whether the properties conform with those shown in the "FUEL OIL SELECTION CHART" presented in this specification.

The "FUEL OIL SELECTION CHART" also will serve as a guide in the selection of the proper fuel for various applications. The fuels used must be clean, completely distilled, stable, and non-corrosive, DISTILLATION RANGE, CETANE NUMBER, and SULFUR CONTENT are three of the most important properties of diesel fuels that must be controlled to insure optimum combustion and minimum wear.

Engine speed, load, and ambient temperature influence the selection of fuels with respect to distillation range and cetane number. The sulfur content of the fuel must be as low as possible to avoid excessive deposit formation, premature wear, and to minimize the sulfur dioxide exhausted into the atmosphere.

To assure that the fuel you use meets the required properties, enlist the aid of a reputable fuel oil supplier.

The responsibility for clean fuel lies with the fuel supplier as well as the operator. During cold weather engine operation, the cloud point (the temperature at which wax crystals begin to form in diesel fuel) should be 10°F (6°C) below the lowest expected fuel temperature to prevent clogging of the fuel filters by wax crystals.

At temperatures below -20°F (-29°C), consult an authorized Detroit Diesel Allison service outlet, since particular attention must be given to the cooling system, lubricating system, fuel system, electrical system, and cold weather starting aids for efficient engine starting and operation.

FUEL OIL SELECTION CHART

Typical Application	General Fuel Classification	Final Boiling Point	Cetane No.	Sulfur Content
		(Max)	(Min)	(Max)
City Buses	No. 1-D	550°F (288°C)	45	0.30%
All Other Applications	Winter No. 2-D	675°F	45	0.50%
	Summer No. 2-D	675°F (357°C)	40	0.50%

NOTE: When prolonged idling periods or cold weather conditions below 32°F (0°C) are encountered. the use of lighter distillate fuels may be more practical. The same consideration must be made when operating at altitudes above 5,000 ft.

DETROIT DIESEL FUEL OIL SPECIFICATIONS

GENERAL CONSIDERATIONS

All diesel engines require heavy-duty lubricating oils. Basic requirements of such oils are*:*

Lubricating Quality *High Heat Resistance* *Control of Contaminants*

LUBRICATING QUALITY. The reduction of friction and wear by maintaining an oil film between moving parts is the primary requisite of a lubricant. Film thickness and its ability to prevent metal-to-metal contact of moving parts is related to oil viscosity. The optimums for Detroit Diesel engines are SAE 40 or 30 weight.

HIGH HEAT RESISTANCE. Temperature is the most important factor in determining the rate at which deterioration or oxidation of the lubricating oil will occur. The oil should have adequate thermal stability at elevated temperatures, thereby precluding formation of harmful carbonaceous and/or ash deposits.

CONTROL OF CONTAMINANTS. The piston and compression rings must ride on a film of oil to minimize wear and prevent cylinder seizure. At normal rates of consumption, oil reaches a temperature zone at the upper part of the piston where rapid oxidation and carbonization can 'occur. In addition, as oil circulates through the engine, it is continuously contaminated by soot, acids, and water originating from combustion. Until they are exhausted, detergent and dispersant additives aid in keeping sludge and varnish from depositing on engine parts. But such additives in excessive quantities can result in detrimental ash deposits. If abnormal amounts of insoluble deposits form, particularly on the piston in the compression ring area, early engine failure may result. Oil that is carried up the cylinder liner wall is normally consumed during engine operation. The oil and additives leave carbonaceous and/or ash deposits when subjected to the elevated temperatures of the combustion chamber. The amount of deposits is influenced by the oil composition, additive content, engine temperature. and oil consumption rate.

DETROIT DIESEL LUBRICATING OIL SPECIFICATIONS

OIL QUALITY

OIL QUALITY is the responsibility of the oil supplier. (The term *oil supplier* is applicable to refiners, blenders, and rebranders of petroleum products, and does not include distributors of such products.)

There are hundreds of commercial crankcase oils marketed today. Obviously, engine manufacturers or users cannot completely evaluate the numerous commercial oils. The selection of a suitable lubricant in consultation with a reliable oil supplier, observance of his oil drain recommendations (based on used oil sample analysis and experience) and proper filter maintenance, will provide the best assurance of satisfactory oil performance.

Detroit Diesel Allison lubricant recommendations are based on general experience with current lubricants of various types and give consideration to the commercial lubricants presently available.

RECOMMENDATION

Detroit Diesel engines have given optimum performance and experienced the longest service life with the following oil performance levels having the ash and zinc limits shown:

Former Military Identification	API Letter Code Service Classification	SAE Grade
MIL-L-2104B/1964MS *	CC/SC	40 or 30 •
Supplement 1**	CB	40 or 30 •

*Military Specification MIL-L-2104B is obsolete and new developed products can no longer be qualified to meet this performance level. However, many lubricants formulated to meet the performance criteria of MIL-L-2104B/1964MS are still being marketed. Detroit Diesel engines have given optimum performance and experienced the longest service life using MIL-L-2104B/1964MS lubricants. The majority of MIL-L-2104B/1964MS lubricants have a sulfated ash content between 0.55 and 0.85 percent by weight.

**Supplement I oils have a history of very satisfactory performance in Detroit Diesel engines. Supplement 1oils have a relatively low ash content. However, the Supplement I oil specification is obsolete and new products cannot be qualified to meet this performance level. Some older formulations are still distributed and used by Detroit Diesel engine customers.

• SAE 40 grade oil has performed satisfactorily and is recommended in Detroit Diesel engines. Obviously, the expected ambient temperatures and engine cranking capability must be considered by the engine owner/operator when selecting the proper grade of oil. Only when the ambient temperatures and engine cranking capabilities result in difficult starting should SAE 30 grade oil be used.

ASH LIMIT

The sulfated ash (ASTM D-874) limit of all the lubricants recommended or selected as alternates for use in Detroit Diesel engines shall not exceed 1.000 percent by weight, except lubricants that contain only barium detergent-dispersant salts where 1.500 percent by weight is allowed. Lubricants having a sulfated ash content between 0.55 and 0.85 percent by weight have a history of excellent performance in Detroit Diesel engines. Lubricants having a sulfated ash content greater than 0.85 percent by weight are prone to produce greater deposit levels in the ring belt and exhaust valve areas of the engine.

ZINC CONTENT

The zinc content, as zinc diorganodithiophosphate. Of all the lubricants recommended or selected as alternates for use in Detroit Diesel engines shall be a minimum of 0.07 percent by weight. However, where EMD or RR oils are used in marine service applications, the minimum zinc content is not required.

ALTERNATE LUBRICANT SELECTIONS

Current Military or Industry Accepted Identification	API Letter Code Service Identification	SAE Grade
MIL-L-2104C ***	CD/SC	40 or 30
MIL-L-46152 ***	CC/SE	40 or 30
Universal ***	Numerous	40 or 30

***Some lube suppliers have superseded the obsolete MIL-L-2104B oils with either MIL-L-2104C, MIL-L-46152, or' Universal lubricants. Generally, all of the above oil performance levels contain a higher sulfated ash content than the older MIL-L-2104B/1964MS lubricants. Ring belt and exhaust valve deposits are usually greater when higher ash lubricants are used. Excessive deposit formation in these areas may result in stuck rings and/or guttered valves.

MIL-L-2104C. MIL-L-46152, or Universal lubricants may be used if they meet the sulfated ash and zinc limits shown elsewhere in this specification and sufficient evidence of satisfactory performance in Detroit Diesel engines has been provided to the customer by the oil supplier.

LUBRICANTS NOT RECOMMENDED

The following lubricants are NOT recommended because of a history of poor performance in Detroit Diesel engines:

Former Military or Industry Accepted Identification	API Letter Code Service Classification	Comment on Performance
MIL-L-2104B/1968MS	CC/SD	Excessive ash deposits formed
MIL-L45199B (Series 3)	CD	Excessive ash deposits formed
All Multigrade Oils	Numerous	History of poor performance

MULTIGRADE OILS

Detroit Diesel does NOT recommend the use of multigrade oils. Recent investigations with some multigrade oils indicate they do NOT, generally, exhibit the antiscuffing and antiwear properties obtained from straight SAE 40 and 30 grade oils operating in the same service applications. Neither fuel or oil consumption rates were improved using multigrade lubricants. Detroit Diesel engines literally create their own environment after they have been started and warmed up. It is during the operational mode under load that the straight SAE 40 and 30 grade lubricants have provided more satisfactory service than multigrade oils. Detroit Diesel will continue to investigate the performance of multigrade oils.

SYNTHETIC OILS

The performance of single grade (e.g., SAE 4U or J0) synthetic oils is comparable to the performance of single grade mineral base oils. However, where low viscosity lubricants are required for cold starting, synthetic multigrade oils have shown significantly improved performance over mineral base multigrade oils. Multigrade synthetic oils are not as satisfactory as single grade mineral or synthetic SAE 40 or 30 oils where the latter can be used.

If a lubricant meets MIL-L-2104B or MIL-L-2104C oil performance requirements and the sulfated ash and zinc limits shown elsewhere in this specification, it qualifies for use in Detroit Diesel engines. The base stock may be either mineral or synthetic. It is the performance level (i.e., MIL-L-2104B) and properties (i.e., ash and zinc contents) that are significant. Refer to MIL-L46167 Arctic Lube Oil Section of this specification.

COLD WEATHER OPERATION

Cold weather starting will be facilitated when immersion type electrical coolant heaters can be used. Other practical considerations, such as the use of batteries, cables and connectors of adequate size, generators or alternators of ample capacity, proper setting of voltage regulators, ether starting aids, oil and coolant heater systems, and proper fuel selection will accomplish starting with the use of SAE 40 or SAE 30 oils.

For complete cold weather starting information, consult an authorized Detroit Diesel Allison service outlet. Ask for Engineering Bulletin No. 38 entitled, *Cold Weather Operation of Detroit Diesel Engines.*

MIL-L-46167 ARCTIC LUBE OILS FOR NORTH SLOPE & OTHER EXTREME SUB-ZERO OPERATIONS

The-MIL-L-46167 specification was published by the Military on 15 February, 1974. Federal Test Method 354 of Federal Test Standard 791 is an integral test requirement of MIL-L-46167. *Lubricants that have passed the oil performance requirement limits of Method 354 may be used where continuous sub-zero temperatures prevail and where engines are shut down for periods longer than eight (8/ hours.* The lubricants that have shown the best performance when subjected to Method 354 evaluation may be described as multigrades having a synthetic base stock and low volatility characteristics. These lubricants are not comparable to the performance of SAE 40 or 30 oils after the engine has started and is operating at normal engine temperature conditions. For this reason, MIL-L-46167 lubricants should be considered only as a last resort when engine cranking is a severe problem and auxiliary heating aids are not available.

EMD OR RR OILS

Lubricants specified by Electro-Motive Division of General Motors Corporation (EMD) are special lubricants. Generally, these may be described as SAE 40 fluids that possess low Viscosity Index (VI) properties and do not contain any or very low concentrations of zinc ingredients. They are identified by industry as EMD or railroad (RR) oils. They are an approved option for Series 149 engines in all marine appilications and for all other model Detroit Diesel engines used for auxiliary power in marine service applications.

OIL CHANGES

Oil change intervals are dependent upon the various operating conditions of the engines and the sulfur content of the diesel fuel used. Oil drain intervals in all service applications may be increased or decreased with experience using a specific lubricant, while also considering the recommendations of the oil supplier. Generally, the sulfur content of diesel fuels supplied throughout the U.S.A. and Canada are low (i.e., less than 0.5 per cent by weight-ASTM D-129 or D-1552 or D-2622). Fuels distributed in some overseas locations may contain higher concentrations of sulfur, the use of which will require reduced lube oil drain intervals.

Highway Trucks & Inter-City Buses (Series 53, 71, and 92 Naturally Aspirated and Turbo-charged Engines)

For highway trucks and buses, used for inter-city operation, the oil change interval is 100,000 miles. The drain interval may be extended beyond this point if supported by the results obtained from used lube oil analysis; it is recommended that you consult with your lube oil supplier in establishing any drain interval exceeding 100,000 miles.

City Transit Coaches and Pick-Up and Delivery Truck Service (Series 53, 71, and 92 Naturally Aspirated and Turbocharged Engines

For city transit coaches and pick-up and delivery truck service. the oil change interval is 12,500 miles. The oil drain interval may be extended beyond 12,500 miles if supported by used oil analyses.

Industrial and Marine (Series 53, 71, and 92 Naturally Aspirated and Turbo-charged Engines)

Series 53, 71, and 92 engines, in industrial and marine service, should be started with 150-hour oil change periods. The oil drain intervals may be extended if supported by used oil analyses.

Large Industrial and Marine (Series 149 Naturally Aspirated and Turbocharged Engines)

The recommended oil change period for naturally aspirated Series 149 engines is 500 hours, while the change period for turbocharged Series 149 engines is 300 hours. These drain intervals may be extended if supported by used oil analyses.

Used Lube Oil Analysis Warning Values

The presence of ethylene glycol in the oil is damaging to the engine. Its presence and need for an oil change and for corrective maintenance action may be confirmed by glycol detector kits which are commercially available. Fuel dilution of the oil may result from loose fuel connections or from prolonged engine idling. A fuel dilution exceeding 2.5 percent by volume indicates an immediate need for an oil change and corrective maintenance action. Fuel dilution may be confirmed by ASTM D-322 test procedure performed by oil suppliers or independent laboratories. In addition to the above considerations, if any of the following occur, the oil should be changed:

1. The viscosity at 1000 F. of a used oil sample is 40 percent greater than the viscosity of the unused oil measured at the same temperature (ASTM D-445 and D-2161).
2. The iron content is greater than 150 parts per million.
3. The pentane insolubles (total contamination) exceed 1.00 percent by weight (ASTM D-893).
4. The total base number (TBN) is less than 1.0 (ASTM D-664). Note: The sulfur content of the diesel fuel used will influence the alkalinity of the lube oil. With high sulfur fuels, the oil drain interval will have to be shortened to avoid excessive acidity in the lube oil.

LUBE OIL FILTER ELEMENT CHANGES

Full-Flow Filters

A full-flow oil filtration system is used in all Detroit Diesel engines. To insure against physical deterioration of the filter element, it should be replaced at a *maximum* of 25,000 miles for on-highway vehicles or at each oil change period, whichever occurs first. For all other applications, the filter should be replaced at a *maximum* of 500 hours or at each oil change period, whichever occurs first.

By-Pass Filters

Auxiliary by-pass lube oil filters are not required on Detroit Diesel engines.

NEW ENGINE OIL CLASSIFICATION SYSTEM

A relatively new engine oil classification system has been introduced to industry that describes the criteria required to meet each performance level. A simplified cross-reference of oil and current commercial and military specifications is shown below.

CROSS-REFERENCE OF LUBE OIL CLASSIFICATION SYSTEMS

API Code Letters	Comparable Military or Commercial Industry Spec.
CA	MIL-L-2104A
CB	Supplement I
CC	MIL-L-2104B (see Note below)
CD	MIL-L-45199B (Series 3)
t	MIL-L-46152 (supersedes MIL-L-2104B for Military only)
■	MIL-L-2104C (supersedes MIL-L-45199B for Military only)
SA	none
SB	none
SC	1964 MS oils - Auto passenger car
SD	1968 MS oils - Auto passenger car

NOTE: MIL-L-2t04B lubricants are currently marketed and readily available for commercial use. MIL-L-2104B lubricants are obsolete for Military service applications only.

t Oil performance meets or exceeds that of CC and SE oils.

■ Oil performance meets or exceeds that of CD and SC oils.

Consult the following publications for complete descriptions:

1. Society of Automotive Engineers (SAE) Technical Report J-183a.
2. Federal Test Method Standard 791a.

PUBLICATION AVAILABLE SHOWING COMMERCIAL "BRAND" NAME LUBRICANTS

A list of "brand" name lubricants distributed by the majority of worldwide oil suppliers can be purchased from the Engine Manufacturers Association (EMA). The publication is titled, *EMA Lubricating Oils Data Book for Heavy-Duty Automotive and Industrial Engines.* The publication shows the brand names, oil performance levels, viscosity grades, and sulfated ash contents of most "brands" marketed.

ENGINE MANUFACTURERS ASSOCIATION
111 EAST WACKER DRIVE
CHICAGO, ILLINOIS 60601

STATEMENT OF POLICY ON FUEL AND LUBRICANT ADDITIVES

In answer to requests concerning the use of fuel and lubricating oil additives, the following excerpt has been taken from a policy statement of General Motors Corporation:

"It has been and continues to be General Motors policy to build motor vehicles that will operate satisfactorily on the commercial fuels and lubricants of good quality regularly provided by the petroleum industry through retail outlets. "

Therefore, Detroit Diesel Allison does not recommend the use of any supplementary fuel or lubricant additives. These include all products marketed as fuel conditioners, smoke suppressants, masking agents, reodorants, tune-up compounds, top oils, break-in oils, graphitizers, and friction-reducing compounds.

NOTE: The manufacturer's warranty applicable to Detroit Diesel engines provides In part that the provisions of such warranty shall not apply to any engine unit which has been subject to misuse, negligence or accident. Accordingly, malfunctions attributable to neglect or failure to follow the manufacturer's fuel or lubricating recommendations may not be within the coverage of the warranty.

SERVICE AND INSPECTION INTERVALS

Generally, operating conditions will vary for each engine application, even with comparable mileage or hours and, therefore, maintenance schedules can vary. A good rule of thumb for piston, ring, and liner inspections, however, would be at 45,000 miles or 1500 hours for the first such inspection and at 30,000 miles or 1000 hour intervals thereafter.

ENGINE COOLANT

Engine coolant is considered as any solution which is circulated through the engine to provide the means for heat transfer from the different engine components. In general, water containing various materials in solution is used for this purpose. The function of the coolant is basic to the design and to the successful operation of the engine. Therefore, coolant must be carefully selected and properly maintained.

COOLANT REQUIREMENTS

A suitable coolant solution must meet the following basic requirements:

1. Provide for adequate heat transfer.
2. Provide a corrosion resistant environment within the cooling system.
3. Prevent formation of scale or sludge deposits in the cooling system.
4. Be compatible with the cooling system hose and seal materials.
5. Provide adequate freeze protection during cold weather operation.

The first four requirements are satisfied by combining a suitable water with reliable inhibitors. When operating conditions dictate the need for freeze protection, a solution of suitable water and a permanent antifreeze containing adequate inhibitors will provide a satisfactory coolant.

WATER

Any water, whether of drinking quality or not, will produce a corrosive environment in the cooling system. Also, scale deposits may form on the internal surfaces of the cooling system due to the mineral content of the water. Therefore, water selected as a coolant must be properly treated with inhibitors to control corrosion and scale deposition. To determine if a particular water is suitable for use as a coolant when properly inhibited, the following characteristics must be considered: the concentration of chlorides, sulfates, total hardness and dissolved solids. Chlorides and/or sulfates tend to accelerate corrosion, while hardness (percentage of magnesium and calcium present) causes deposits of scale. Total dissolved solids may cause scale deposits, sludge deposits, corrosion or a combination of these. Chlorides, sulfates, magnesium and calcium are among but not necessarily all the materials which make up dissolved solids. Water, within the limits specified in Tables 1 and 2 of Fig. 1, is satisfactory as an engine coolant when proper inhibitors are added.

CORROSION INHIBITORS

A corrosive inhibitor is a water soluble chemical compound which protects the metallic surfaces of the cooling system against corrosive attack. Some of the more commonly used corrosion inhibitors are chromates, borates, nitrates, nitrites and soluble oil.

TABLE 1

	PARTS PER MILLION	GRAINS PER GALLON
Chlorides (Maximum)	40	2.5
Sulfates (Maximum)	100	5.8
Total Dissolved Solids (Maximum)	340	20
Total Hardness (Maximum)	170	10

Refer to Table 2 for evaluation of water intended for use in a coolant solution.

TABLE 2

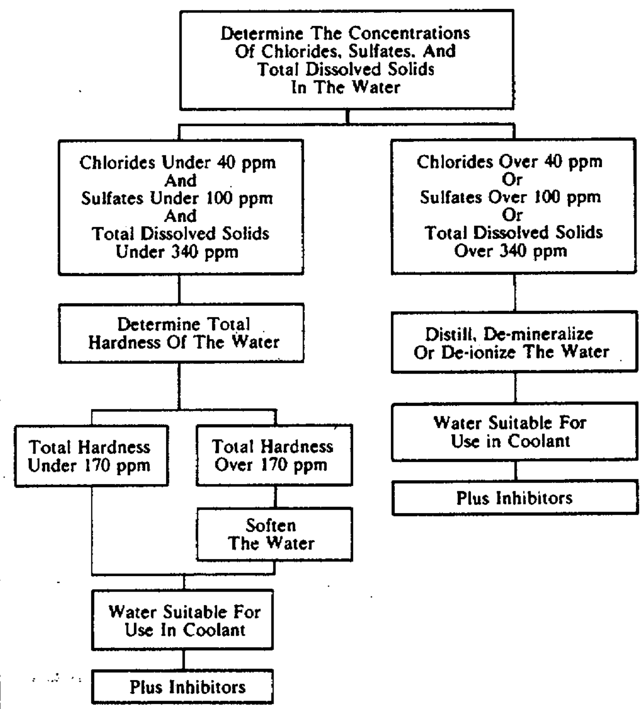


Fig 1. Water Characteristics

Depletion of all types of inhibitors occurs through normal operation. Therefore, strength levels must be maintained by the addition of inhibitors at prescribed intervals. Always follow the supplier's recommendations on inhibitor usage and handling.

Chromates

Sodium chromate and potassium dichromate are two of the best and most commonly used *water* system corrosion inhibitors. However, the restrictive use of these materials, due to ecology considerations, has de-emphasized their use in favor of non-chromates. Care should be exercised in handling these materials due to their toxic nature.

Chromate inhibitors should *not* be used in permanent type antifreeze solutions. Chromium hydroxide, commonly called "green slime", can result from the use of chromate inhibitors with permanent type antifreeze. This material deposits on the cooling system passages, reducing the heat transfer rate (Fig. 2) and results in engine overheating. Engines which have operated with a chromate-inhibited water must be chemically cleaned before the addition of permanent antifreeze. A commercial heavy-duty de-scaler should be used in accordance with the manufacturer's recommendation for this purpose.

Soluble Oil

Soluble oil has been used as a corrosion inhibitor for many years. It has, however, required very close attention relative to the concentration level due to adverse effects on heat transfer if the concentration exceeds 1% by volume. For example: 1 1/4% of soluble oil in the cooling system increases fire deck temperature 6% and a 2 1/2% concentration raises fire deck temperature up to 15%. Soluble oil is *not* recommended as a corrosion inhibitor.

Non-chromates

Non-chromate inhibitors (borates, nitrates, nitrites, etc.) provide corrosion protection in the cooling system with the basic advantage that they can be used with either water or a water and permanent antifreeze solution.

INHIBITOR SYSTEMS

An inhibitor system (Fig. 3) is a combination of chemical compounds which provide corrosion protection, pH control and water softening ability. Corrosion protection is discussed under the heading *Corrosion Inhibitors.* The pH control is used to maintain an acid-free solution. The water softening ability deters formation of mineral deposits. Inhibitor systems are available in various forms such as coolant filter elements, liquid and dry bulk inhibitor additives, and as an integral part of permanent antifreeze.

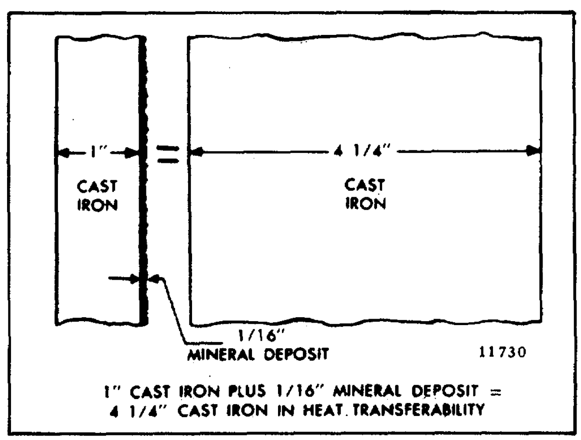


Fig. 2 - Heat Transfer Capacity

Coolant Filter Elements

Replaceable elements are available with various chemical inhibitor systems. Compatibility of the element with other ingredients of the coolant solution cannot always be taken for granted.

Problems have developed from the use of the magnesium lower support plate used by some manufacturers in their coolant filters. The magnesium plate will be attacked by solutions which will not be detrimental to other metals in the cooling system. The dissolved magnesium will be deposited in the hottest zones of the engine where heat transfer is most critical. The use of an aluminum or zinc support plate in preference to magnesium is recommended to eliminate the potential of this type of deposit. High chloride coolants will have a detrimental effect on the water softening capabilities of systems using ion-exchange resins. Accumulations of calcium and magnesium ions removed from the coolant and held captive by the zeolite resin can be released into the coolant by a regenerative process caused by high chloride content solutions.

Inhibitor or Inhibitor System	Corrosion Inhibitor Type	Inhibitor Compatibility: Complete Inhibitor System	Water	Ethylene Glycol Base Antifreeze	*Methoxy Propanol Base Antifreeze
Sodium chromate	Chromate	No	Yes	No	No
Potassium dichromate	Chromate	No	Yes	No	No
Perry filter elements:					
5020 (type OS)	Chromate	Yes	Yes	No	No
S-453 (Spin-on)	Chromate	Yes	Yes	No	No
5030 (type OS)	@Non-chromate	Yes	Yes	Yes	No
S-331 (Spin-on)	@Non-chromate	Yes	Yes	Yes	No
5070 (type OS)	# Non-chromate	Yes	Yes	Yes	No
S-473 (Spin-on)	# Non-chromate	Yes	Yes	Yes	No
Lenroc filter element	Non-chromate	Yes	Yes	Yes	No
Fleetguard filter elements:					
DCA (canister)	Non-chromate	Yes	Yes	Yes	No
DCA (Spin-on) (Eth. Gly.)	Non-chromate	Yes	Yes	Yes	No
DCA (Spin-on) (Meth. Prop.)	Non-chromate	Yes	No	No	Yes
AC filter elements:					
DCA (canister)	Non-chromate	Yes	Yes	Yes	No
DCA (Spin-on)	Non-chromate	Yes	Yes	Yes	No
Luber-Finer filter elements:					
LW-4739 (canister)	Non-chromate	Yes	Yes	Yes	No
LFW-4744 (spin-on)	Non-chromate	Yes	Yes	Yes	No
Nalcool 2000 (liquid)	Non-chromate	Yes	Yes	Yes	No
Perry LP-20 (liquid)	Non-chromate	Yes	Yes	Yes	No
Sy-Cool (liquid)	Non-chromate	Yes	Yes	Yes	No
Lubercool (liquid)	Non-chromate	Yes	Yes	Yes	No
Dowtherm cooling system condition	Non-chromate	Yes	Yes	Yes	Yes

*Dowtherm 209, or equivalent. @Perry "Year Around" formula. # Perry "Universal" formula.

Fig. 3 - Coolant Inhibitor Chart

Bulk Inhibitor Additives

Commercially packaged inhibitor systems are available which can be added directly to the engine coolant or to bulk storage tanks containing coolant solution. Both chromate and non-chromate systems are available and care should be taken regarding inhibitor compatibility with other coolant constituents.

Non-chromate inhibitor systems are recommended for use in Detroit Diesel engines. These systems can be used with either water or permanent antifreeze solutions and provide corrosion protection, pH control and water softening. Some non-chromate inhibitor systems offer the additional advantage of a simple on-site test to determine protection level and, since they are added directly to the coolant, require no additional hardware or plumbing.

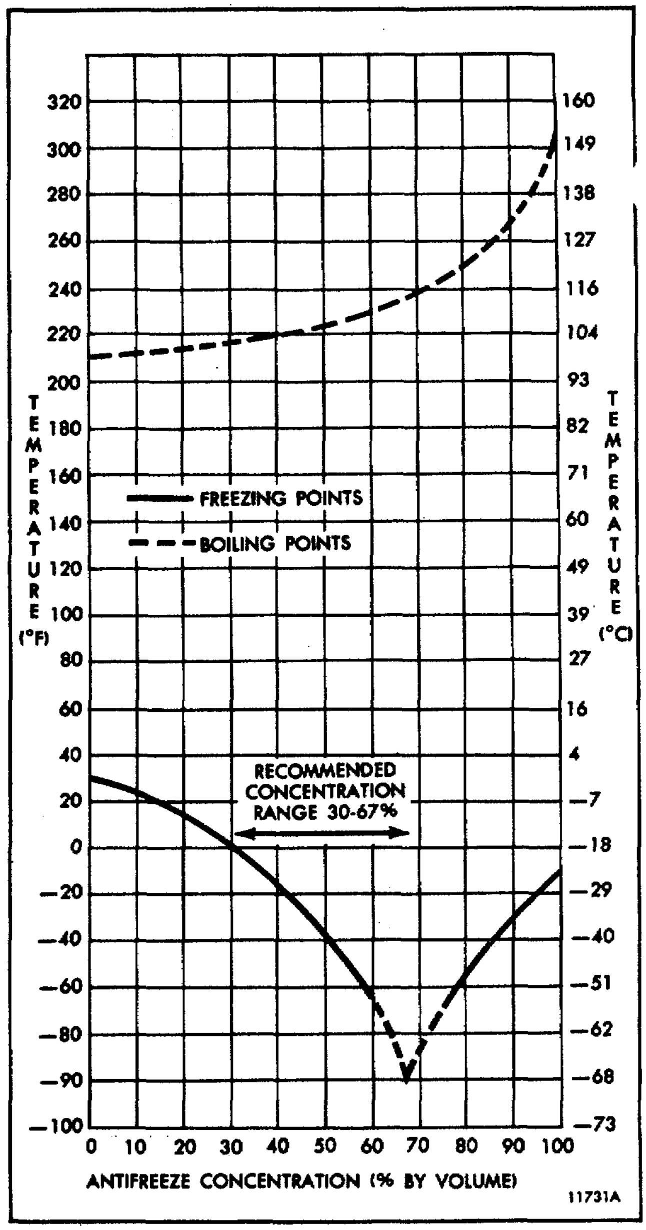
All inhibitors become depleted through normal operation and additional inhibitor must be added to the coolant at prescribed intervals to maintain original strength levels.

Always follow the supplier's recommendations on inhibitor usage and handling.

NOTE: Methoxy Propanol base permanent antifreeze (such as Dowtherm 209, or equivalent) must be re-inhibited only with compatible corrosion inhibitor systems.

ANTIFREEZE

When freeze protection is required, a permanent antifreeze must be used. An inhibitor system is included in this type of antifreeze and no additional inhibitors are required on initial fill if a minimum antifreeze concentration of 30% by volume is used. Solutions of less than 30%, concentration do not provide sufficient corrosion protection. Concentrations over 67% adversely affect freeze protection and heat transfer rates (Fig. 4).



Methoxy Propanol base antifreeze is not recommended for use in Detroit Diesel engines due to the presence of fluoroelastomer (Viton '0') seals in the cooling system. Before installing ethylene glycol base anti-freeze in an engine previously operated with Methoxy Propanol, the entire cooling system should be drained, flushed with clean water and examined for rust, scale, contaminants, etc. If deposits are present, the cooling system must be chemically cleaned with a commercial grade heavy-duty de-scaler.

Ethylene glycol base antifreeze is recommended for use in Detroit Diesel engines. Methyl alcohol antifreeze is *not* recommended because of its effect on the non-metallic components of the cooling system and because of its low boiling point.

The inhibitors in permanent antifreeze should be replenished at approximately 500 hour or 20,000 mile intervals with a non-chromate inhibitor system. Commercially available inhibitor systems may be used to re-inhibit antifreeze solutions.

Sealer Additives

Several brands of permanent antifreeze are available with sealer additives. The specific type of sealer varies with the manufacturer. Antifreeze with sealer additives is *not recommended* for use in Detroit Diesel engines due to possible plugging throughout various areas of the cooling system.

GENERAL RECOMMENDATIONS

All Detroit Diesel engines incorporate pressurized cooling systems which normally operate at temperatures higher than non-pressurized systems. It is essential that these systems be kept clean and leak-free, that filler caps and pressure relief mechanisms be correctly installed at all times and that coolant levels be properly maintained.

WARNING: Use extreme care when removing a radiator pressure control cap from an engine. The sudden release of pressure from a heated cooling system can result in a loss of coolant and possible personal injury (scalding) from the hot liquid.

1. Always use a properly inhibited coolant.

2. Do not use soluble oil.
3. Maintain the prescribed inhibitor strength.
4. Always follow the manufacturer's recommendations on inhibitor usage and handling.
5. If freeze protection is required, always use a permanent antifreeze.
6. Re-inhibit antifreeze with a recommended non-chromate inhibitor system.
7. Do not use a chromate inhibitor with permanent antifreeze.
8. Do not use Methoxy Propanol base antifreeze in Detroit Diesel engines.
9. DO NOT mix ethylene glycol base antifreeze with Methoxy Propanol base antifreeze in the cooling system.
10. Do not use an antifreeze containing sealer additives.
11. Do not use methyl alcohol base antifreeze.
12. Use extreme care when removing the radiator pressure control cap.

ENGINE TUNE-UP PROCEDURES

There is no scheduled interval for performing an engine tune-up. As long as the engine performance is satisfactory, no tune-up should be needed. Minor adjustments in the valve and injector operating mechanisms, governor, etc. should only be required periodically to compensate for normal wear on parts.

Three types of governors are used. Since each governor has different characteristics, the tune-up procedure varies accordingly. The three types are:

1. Limiting speed mechanical.

2. Variable speed mechanical.

3. Hydraulic.

The mechanical engine governors are identified by a name plate attached to the governor housing. The letters D.W.-L.S. stamped on the name plate denote a double-weight limiting speed governor. A single-weight variable speed governor name plate is stamped S.W.-V.S.

Normally, when performing a tune-up on an engine in service, it is only necessary to check the various adjustments for a possible change in the settings. However, if the cylinder head, governor or injectors have been replaced or overhauled, then certain preliminary adjustments are required before the engine is started.

The preliminary adjustments consist of the first four items in the tune-up sequence. The procedures are the same except that the valve clearance is greater for a cold engine.

To tune-up an engine completely, all of the adjustments are made by following the applicable tune-up sequence given below after the engine has reached the normal operating temperature. Since the adjustments are normally made while the engine is stopped, it may be necessary to run the engine between adjustments to maintain normal operating temperature.

Tune-Up Sequence for Mechanical Governor

> **CAUTION:** Before starting an engine after an engine speed control adjustment or after removal of the engine governor cover, the serviceman must determine that the injector racks move to the no-fuel position when the governor stop lever is placed in the stop position. Engine overspeed will result if the injector racks cannot be positioned at no fuel with the governor stop lever.

1. Adjust the exhaust valve clearance.
2. Time the fuel injectors.
3. Adjust the governor gap.
4. Position the injector rack control levers.
5. Adjust the maximum no-load speed.
6. Adjust the idle speed.
7. Adjust the buffer screw.
8. Adjust the throttle booster spring (variable speed governor only).
9. Adjust the supplementary governing device (if used).

Tune-Up Sequence for Hydraulic Governor

1. Adjust the exhaust valve clearance.
2. Time the fuel injectors.
3. Adjust the fuel rod.
4. Position the injector rack control levers.
5. Adjust the load limit screw.
6. Adjust the speed droop.
7. Adjust the maximum no-load speed.

> **NOTE:** Use new valve rocker cover gasket(s)after each tune-up.

EXHAUST VALVE CLEARANCE ADJUSTMENT

The correct exhaust valve clearance at normal engine operating temperature is important for smooth, efficient operation of the engine.

Insufficient valve clearance can result in loss of compression, misfiring cylinders, and eventually burned valve seats and valve seat inserts. Excessive valve clearance will result in noisy operation, especially in the low speed range.

Whenever the cylinder head is overhauled, the exhaust valves reconditioned or replaced, or the valve operating mechanism is replaced or disturbed in any way, the valve clearance must first be adjusted to the cold setting to allow for normal expansion of the engine parts during the engine warm-up period. This will ensure a valve setting which is close enough to the specified clearance to prevent damage to the valves when the engine is started.

All of the exhaust valves may be adjusted, in firing order sequence, during one full revolution of the crankshaft. Refer to the *General Specifications* at the front of the manual for the engine firing order.

TWO CYLINDER VALVE HEADS

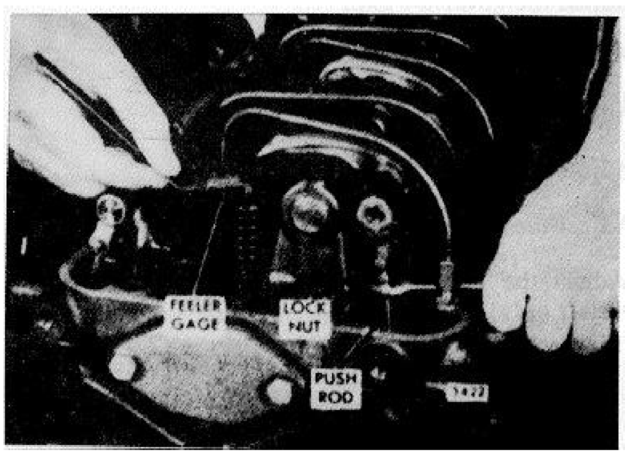


Fig 1. Adjusting Valve Clearance (Two-Valve Cylinder Head)

Cold Engine

1. Place the speed control lever in the *idle* speed position. If a stop lever is provided, secure it in the *no-fuel* position.
2. Remove the loose dirt from the valve rocker cover(s) and remove the cover(s).
3. Rotate the crankshaft, manually or with the starting motor, until the injector follower is fully depressed on the cylinder to be adjusted.

> **CAUTION:** If a wrench is used on the crankshaft bolt, do not turn the engine in a left-hand direction of rotation as the bolt will be loosened.

4. Loosen the exhaust valve rocker arm push rod lock nut.
5. Place a .012" feeler gage, J 9708, between the valve stem and the rocker arm (Fig. 1). Adjust the push rod to obtain a smooth pull on the feeler gage.
6. Remove the feeler gage. Hold the push rod with a 5/16"wrench and tighten the lock nut with a 1/2 "wrench.
7. Recheck the clearance. At this time, if the adjustment is correct, the .010" gage will pass freely between the end of the valve stem and the rocker arm and the .012" gage will not pass through.
8. Check and adjust the remaining valves in the same manner as outlined above.

Hot Engine

Maintaining normal engine operating temperature is particularly important when making the final valve clearance adjustment. If the engine is allowed to cool off before setting any of the valves, the clearance, when running at full load, may become insufficient.

1. With the engine at normal operating temperature (160-185°F or 71-85°C), recheck the exhaust valve clearance with feeler gage J 9708. At this time, if the valve clearance is correct, the .008"gage will pass freely between the end of the valve stem and the rocker arm and the .010"gage will not pass through. Readjust the push rod, if necessary.

2. After the exhaust valve clearance has been adjusted, check the fuel injector timing.

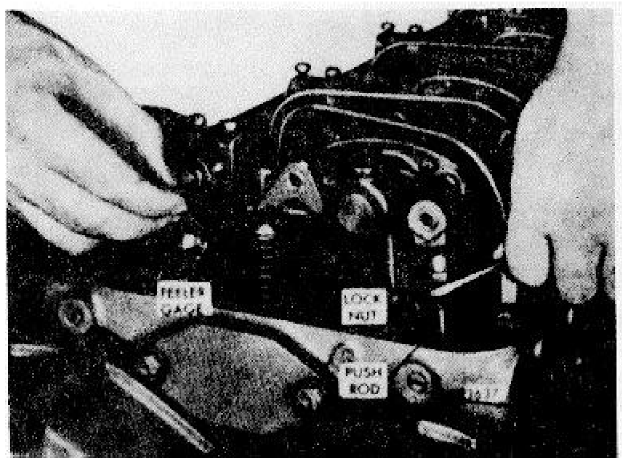


Fig. 2 - Adjusting Valve Clearance (Four-Valve Cylinder Head)

Cold Engine

1. Place the speed control lever in the *idle* speed position. If a stop lever is provided, secure it in the *no-fuel* position.

2. Remove the loose dirt from the valve rocker cover(s) and remove the cover(s).

3. Rotate the crankshaft until the injector follower is fully depressed on the cylinder to be adjusted.

> **CAUTION:** If a wrench is used on the crankshaft bolt, do not turn the engine in a left-hand direction of rotation as the bolt will be loosened.

4. Loosen the exhaust valve rocker arm push rod lock nut.

5. Place a .027" feeler gage, J 9708, between the end of one valve stem and the rocker arm bridge (Fig. 2). Adjust the push rod to obtain a smooth pull on the feeler gage.

6. Remove the feeler gage. Hold the push rod with a *5/16"*wrench and tighten the lock nut with a 1/2 " wrench.

7. Recheck the clearance. At this time, if the adjustment is correct, the .025" gage will pass freely between the end of one valve stem and the rocker arm bridge and the .027" gage will not pass through. Readjust the push rod if necessary.

8. Check and adjust the remaining exhaust valves, in the same manner as above.

Hot Engine

Maintaining normal engine operating temperature is particularly important when making the final valve clearance adjustment. If the engine is allowed to cool off before setting any of the valves, the clearance, when running at full load, may become insufficient.

1. With the engine at normal operating temperature (160-185°F or 71-85°C), recheck the exhaust valve clearance with gage J 9708. At this time, if the valve clearance is correct, the .023" gage should pass freely between the end of one valve stem and the rocker arm bridge and the .025" feeler gage should not. Readjust the push rod, if necessary.

2. After the exhaust valve clearance has been adjusted, check the fuel injector timing.

TIMING FUEL INJECTOR

Injector	Timing Dimension	Tool Number
*35	1.508	J 8909
35	1.484	J 1242
40	1.484	J 1242
45	1.484	J 1242
S40	1.460	J 1853
S45	1.460	J 1853
S50	1.460	J 1853
L40	1.460	J 1853
N40	1.460	J 1853
N45	1.460	J 1853
N50	1.460	J 1853

*Reefer Car

To time a fuel injector properly, the injector follower must be adjusted to a definite height in relation to the injector body. All of the injectors can be timed, in firing order sequence, during one full revolution of the crankshaft.

Time Fuel Injector

After the exhaust valve clearance has been adjusted, time the fuel injector as follows:

1. Place the speed control lever in the *idle* speed position. If a stop lever is provided, secure it in the *no-fuel* position.
2. Rotate the crankshaft, manually or with the starting motor, until the exhaust valves are fully depressed on the particular cylinder to be timed.

> **CAUTION:** If a wrench is used on the crankshaft bolt at the front of the engine, do not turn the crankshaft in a left-hand direction of rotation or the bolt will be loosened.

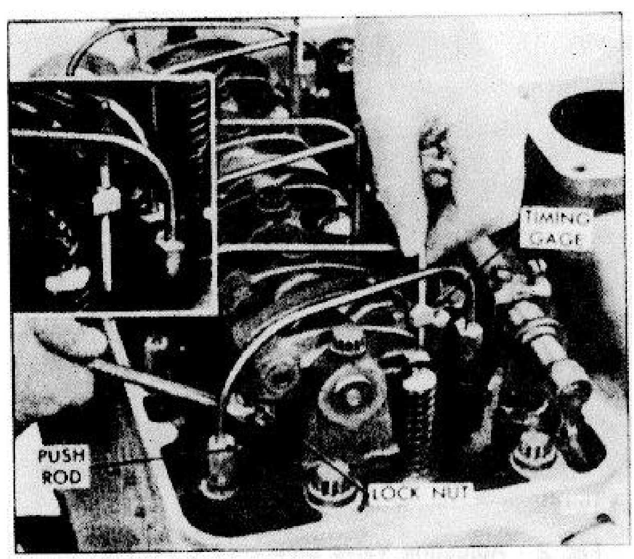


Fig. 3 - Timing Fuel Injector

3. Place the small end of the injector timing gage (see table for correct timing gage) in the hole provided in the top of the injector body, with the flat of the gage toward the injector follower as shown in Fig. 3.
4. Loosen the push rod lock nut.
5. Turn the push rod and adjust the injector rocker arm until the extended part of the gage will just pass over the top of the injector follower.
6. Hold the push rod and tighten the lock nut. Check the adjustment and readjust, if necessary.
7. Time the remaining injectors as outlined above.
8. If no further engine tune-up is required, use a new gasket(s) and install the valve rocker cover(s).

LIMITING SPEED MECHANICAL GOVERNOR AND INJECTOR RACK CONTROL ADJUSTMENT

IN-LINE ENGINES

The double-weight limiting speed governor is mounted on the rear end plate of the engine and is driven by a gear that extends through the end plate and meshes with either the camshaft gear or the balance shaft gear, depending upon the engine model.

After adjusting the exhaust valves and tithing the fuel injectors, adjust the governor and position the injector rack control levers.

> **NOTE:** Before proceeding with the governor and injector rack adjustments, disconnect any supplementary governing device. After the adjustments are completed, re-connect and adjust the supplementary governing device.

Adjust Governor Gap
With the engine stopped and at operating temperature, adjust the governor gap as follows:

1. Remove the high-speed spring retainer cover.
2. Back out the buffer screw (Fig. 8) until it extends approximately 5/8" from the lock nut.
3. Start the engine and adjust the idle speed screw (Fig. 7) to obtain the desired engine idle speed. Hold the screw and tighten the lock nut to hold the adjustment.

> **NOTE:** The recommended idle speed for non-EPA certified engines is 500-600 rpm, but may vary with special engine applications.

4. Stop the engine, clean and remove the governor cover and the valve rocker cover. Discard the gaskets.
5. Start and run the engine, between 800 and 1000 rpm by manual operation of the injector control tube lever.

> **CAUTION:** Do not overspeed the engine.

6. Check the gap between the low-speed spring cap and the high-speed spring plunger with a .0015 " feeler gage. If the gap setting is incorrect, reset the gap adjusting screw (Fig. 1). If the setting is correct, the .0015" movement can be seen by placing a few drops of oil into the governor gap and pressing a screw driver against the gap adjusting screw. Movement of the cap toward the plunger will force the oil from the gap in the form of a small bead.

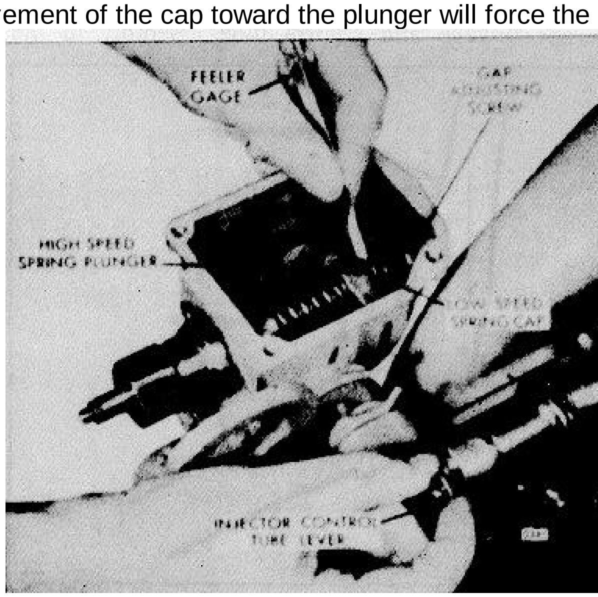


Fig. 1 Adjusting Governor Gap

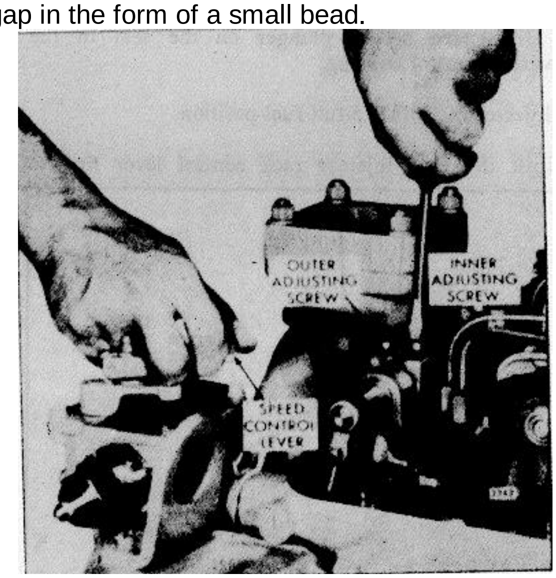


Fig. 2 Positioning the Rear Injector Rack Control Lever

7. Hold the gap adjusting screw and tighten the lock nut.
8. Recheck the gap and readjust if necessary.
9. Stop the engine and, using a new gasket, install the governor cover. The governor cover should be placed on the housing with the pin of the speed control lever projecting into the slot of the differential lever.
10. Install screws and lock washers finger tight. Pull the cover away from the engine and tighten the screws. This step will properly locate the cover on the governor housing.

Position Injector Rack Control Levers

The position of the injector racks must be correctly set in relation to the governor. Their position determines the amount of fuel injected into each cylinder and ensures equal distribution of the load. Properly positioned injector rack control levers with the engine at full-load will result in the following:

1. Speed control lever at the full-fuel position.
2. Governor low-speed gap closed.
3. High-speed spring plunger on the seat in the governor control housing.
4. Injector racks in the full-fuel position.

Adjust the rear injector rack control lever first to establish a guide for adjusting the remaining injector rack control levers.

1. Disconnect any linkage attached to the speed control lever.
2. Turn the idle speed adjusting screw until 1/2"of the threads (12-14 threads) project from the lock nut, when the nut is against the high-speed plunger.

> **CAUTION:** A false fuel rack setting may result if the idle speed adjusting screw is not backed out as noted above.
>
> **NOTE:** This adjustment lowers the tension of the low-speed spring so it can be easily compressed. This permits closing the low speed gap without bending the fuel rods or causing the *yield mechanism springs to yield or stretch.*

3. Back out the buffer screw approximately 5/8", if it has not already been done.
4. Loosen all of the inner and outer injector rack control lever adjusting screws (Fig. 2). Be sure all of the levers are free on the injector control tube.

5. Move the speed control lever to the maximum speed position. Turn the inner adjusting screw down on the rear injector rack control lever until a step-up in effort is noted. This will place the rear injector rack in the full-fuel position. Turn down the outer adjusting screw until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws. This should result in placing the governor linkage and control tube assembly in the same positions that they will attain while the engine is running at full-load.

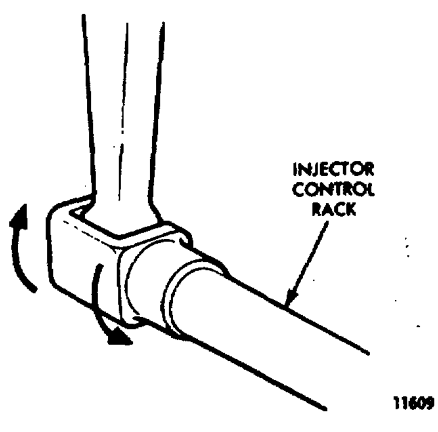


Fig. 3 - Checking Rotating Movement of Injector Control Rack

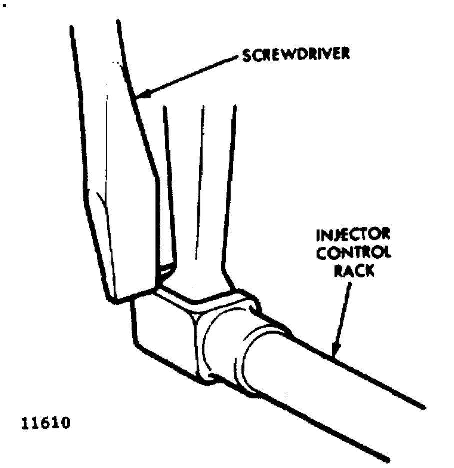


Fig. 4 - Checking Injector Rack "Spring'

6. To be sure of the proper rack adjustment, hold the speed control lever in the full-fuel position and press down on the injector rack with a screw driver or finger tip and note "rotating" movement of the injector control rack (Fig. 3) when the speed control lever is in the maximum speed position. Hold the speed control lever in the maximum speed position and, using a screw driver, press downward on the injector control rack. The rack should tilt downward (Fig. 4) and when the pressure of the screw driver is released, the control rack should "spring" back upward.

If the rack does not return to its original position, it is too loose. To correct this condition, back off the outer adjusting screw slightly and tighten the inner adjusting screw slightly.

The setting is too tight if, when moving the speed control lever from the no-speed to the maximum speed position, the injector rack becomes tight before the speed control lever reaches the end of its travel (as determined by the stop under the governor cover). This will result in a step-up in effort required to move the speed control lever to the end of its travel. To correct this condition, back off the inner adjusting screw slightly and tighten the outer adjusting screw slightly.

> **NOTE:** Overtightening of the injector rack control lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 in-lbs (3-4 Nm).
>
> **IMPORTANT:** The above step should result in placing the governor linkage and control tube assembly in the same position that they will attain while the engine is running at full load.

7. To adjust the remaining injector rack control levers, remove the clevis pin from the fuel rod and the injector control tube lever, hold the injector control racks in the full-fuel position by means of the lever on the end of the control tube. Turn down the inner adjusting screw on the injector rack control lever of the adjacent injector until the injector rack has moved into the full-fuel position and the inner adjusting screw is bottomed on the injector control tube. Turn the outer adjusting screw down until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws.

8. Recheck the rear injector rack to be sure that it has remained snug on the ball end of the injector rack control lever while adjusting the adjacent injector. If the rack of the rear injector has become loose, back off, the inner adjusting screw slightly on the adjacent injector rack control lever. Tighten the outer adjusting screw. When the settings are correct, the racks of both injectors must be snug on the ball end of their respective rack control levers.

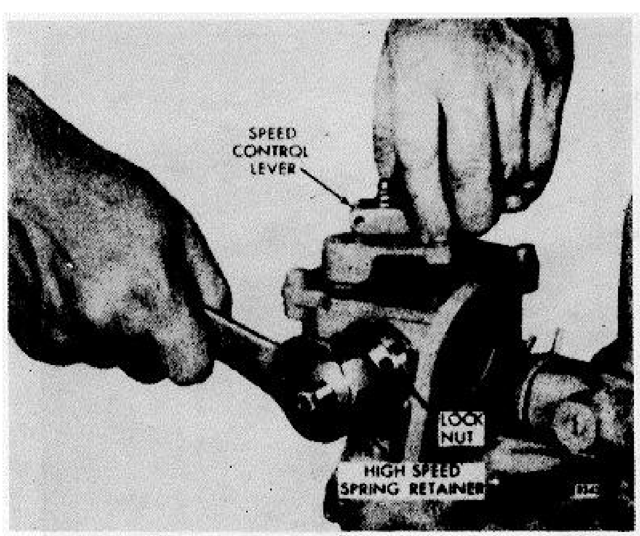


Fig. 5 - Adjusting Maximum No-Load Engine Speed (Type A)

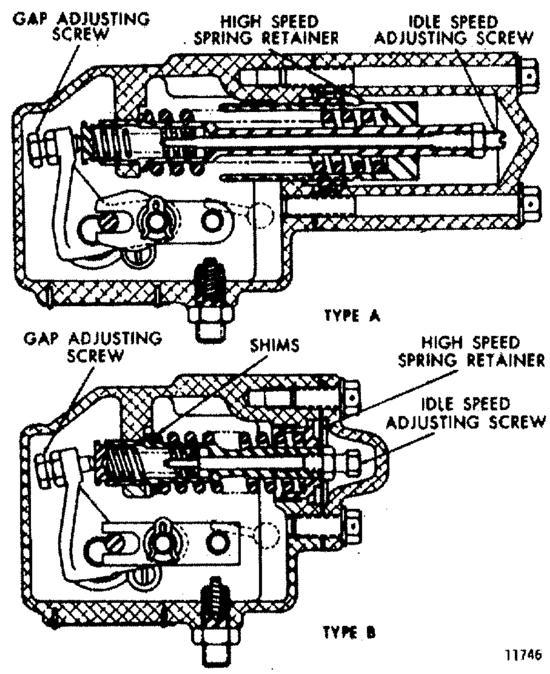


Fig. 6 - Governor Spring Assemblies

9. Position the remaining injector rack control levers as outlined in Steps 6 and 7.
10. Connect the fuel rod to the injector control tube lever.
11. Turn the idle speed adjusting screw in until it projects 3/16" from the lock nut to permit starting the engine. Tighten the lock nut.
12. Use a new gasket and replace the valve rocker cover.

Adjust Maximum No-Load Engine Speed

All governors are properly adjusted before leaving the factory. However, if the governor has been reconditioned or replaced, and to ensure the engine speed will not exceed the recommended no-load speed as given on the engine option plate, set the maximum no-loadspeed as follows:

TYPE A GOVERNOR SPRINGS (Fig. 6):

1. Loosen the lock nut (Fig. 5) and back off the high-speed spring retainer approximately five turns.
2. With the engine at operating temperature and no-load on the engine, place the speed control lever in the full-fuel position. Turn the high-speed spring retainer IN until the engine is operating at the recommended no-load speed.

The best method of determining the engine speed is with an accurate tachometer.

3. Hold the high-speed spring retainer and tighten the lock nut.

TYPE B GOVERNOR SPRINGS (Fig. 6):

1. Start the engine and after it reaches normal operating temperature, remove the load from the engine.
2. Place the speed control lever in the maximum speed position and note the engine speed.
3. Stop the engine and, if necessary, adjust the no-load speed as follows:
   a. Remove the high-speed spring retainer, high-speed spring and plunger.

   CAUTION: To prevent the low-speed spring and cap from dropping into the governor, be careful not to jar the assembly while it is being removed.

   b. Remove the high-speed spring from the high-speed spring plunger and add or remove shims (Fig. 6) as required to establish the desired engine no-load speed.

   NOTE: For each .010" shim added, the engine speed will be increased approximately 10 rpm.

   c. Install the high-speed spring on the plunger and install the spring assembly in the governor housing. Install the spring retainer in the governor housing and tighten it securely.
   d. Start the engine and recheck the engine no-load speed. Repeat the procedure as necessary to establish the no-load speed.

Adjust Idle Speed

With the maximum no-load speed properly adjusted, adjust the idle speed as follows:

1. With the engine running at normal operating temperature and with the buffer screw backed out to avoid contact with the differential lever, turn the idle speed adjusting screw (Fig. 7) until the engine is operating at approximately 15 rpm below the recommended idle speed.

   NOTE: The recommended idle speed for non-EPA certified engines is 500-600 rpm, but may vary with special engine applications.

2. Hold the idle speed adjusting screw and tighten the lock nut.

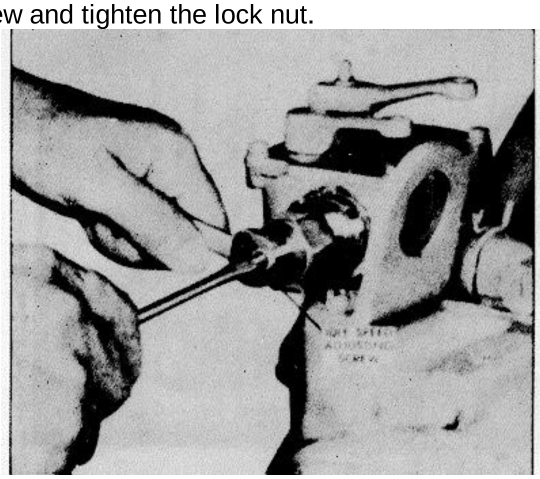


Fig. Adjusting Engine Idle Speed

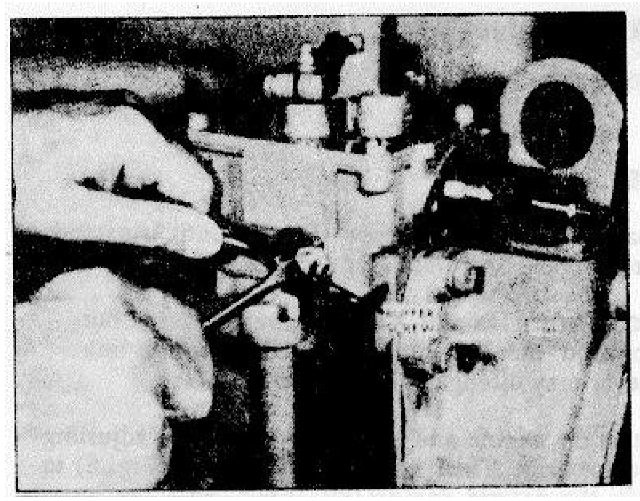


Fig. 8 - Adjusting Buffer Screw

3. Install the high-speed spring cover and tighten the two bolts.

Adjust Buffer Screw

With the idle speed properly set, adjust the buffer screw as follows:

1. With the engine running at normal operating temperature, turn the buffer screw in (Fig. 8) so it contacts the differential lever as lightly as possible and still eliminates engine roll.

NOTE: Do not increase the engine idle speed more than 15 rpm with the buffer screw.

2. Recheck the maximum no-load speed. If it has increased more than 25 rpm, back off the buffer screw until the increase is less than 25 rpm.

3. Hold the buffer screw and tighten the lock nut.

LIMITING SPEED MECHANICAL GOVERNOR AND INJECTOR RACK CONTROL ADJUSTMENT

The limiting speed mechanical governor is mounted at the rear of the engine, between the flywheel housing and the blower (Fig. 1). The governor is driven by the right blower rotor drive gear. The left blower rotor drive gear is driven by a shaft, that passes through the governor housing, from the engine gear train. There are two types of limiting speed governor assemblies. The difference in the two governors is in the spring mechanism (Fig. 7). One has a long spring mechanism, the other has a short spring mechanism.

After adjusting the exhaust valves and timing the fuel injectors, adjust the governor and position the injector rack control levers.

NOTE: Before proceeding with the governor and injector rack adjustments, disconnect any supplementary governing device. After the adjustments are completed, re-connect and adjust the supplementary governing device.

Adjust Governor Gap

With the engine stopped and at operating temperature, adjust the governor gap as follows:

1. Remove the high-speed spring retainer cover.
2. Back out the buffer screw (Fig. 9) until it extends approximately 5/8" from the lock nut.

CAUTION: Do not back the buffer screw out beyond the limits given, or the control link lever may disengage the differential lever.

3. Start the engine and loosen the idle speed adjusting screw lock nut. Then adjust the idle screw (Fig. 8) to obtain the desired engine idle speed. Hold the screw and tighten the lock nut to hold the adjustment.

NOTE: The recommended idle speed for non-EPA certified engines is 500-600 rpm, but may vary with special engine applications.

4. Stop the engine, clean and remove the governor cover and the valve rocker covers. Discard the gaskets.
5. Start and run the engine, between 800 and 1000 rpm, by manual operation of the differential lever.

CAUTION: Do not overspeed the engine.

6. Check the gap between the low-speed spring cap, and the high-speed spring plunger with a .0015 " feeler gage. If the gap setting is incorrect, reset the gap

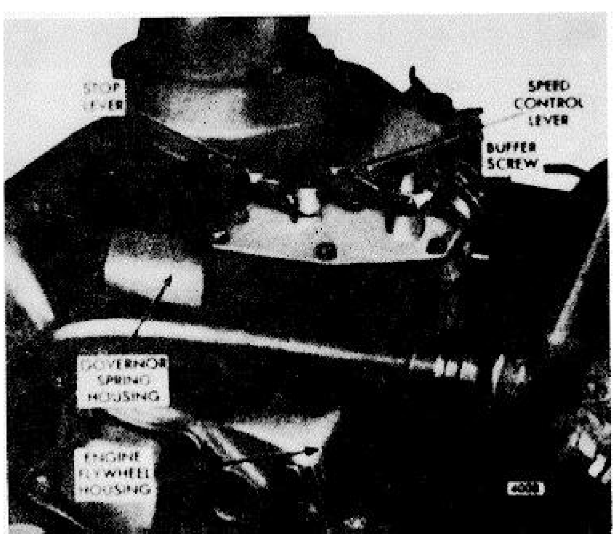


Fig. 1 - Limiting Speed Governor Mounting

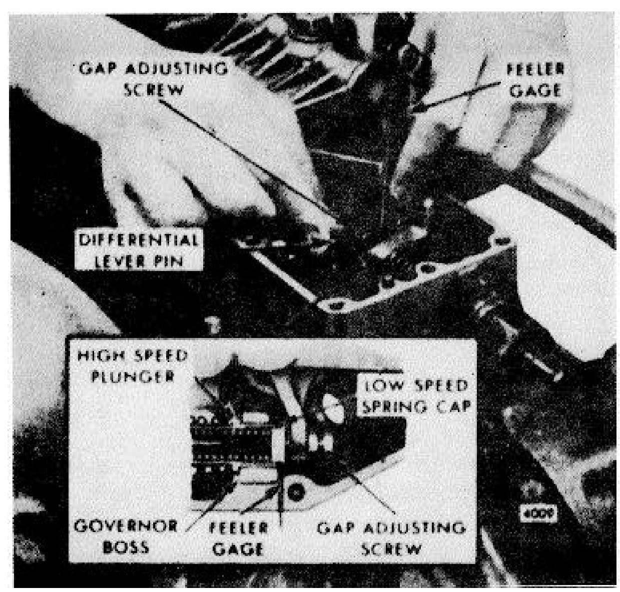


Fig. 2 - Adjusting Governor Gap

adjusting screw (Fig. 2). If the setting is correct, the .0015" movement can be seen by placing a few drops of oil into the governor gap and pressing a screw driver against the gap adjusting screw. Movement of the cap toward the plunger will force the oil from the gap in the form of a small bead.

7. Hold the gap adjusting screw and tighten the lock nut.

8. Recheck the gap and readjust if necessary.

9. Stop the engine and, using a new gasket, install the governor cover.

Position Injector Rack Control Levers

The position of the injector racks must be correctly set in relation to the governor. Their position determines the amount of fuel injected into each cylinder and ensures equal distribution of the load. Properly positioned injector rack control levers with the engine at full-load will result in the following:

1. Speed control lever at the maximum speed position.
2. Governor low-speed gap closed.
3. High-speed spring plunger on the seat in the governor control housing.
4. Injector fuel control racks in the full-fuel position.

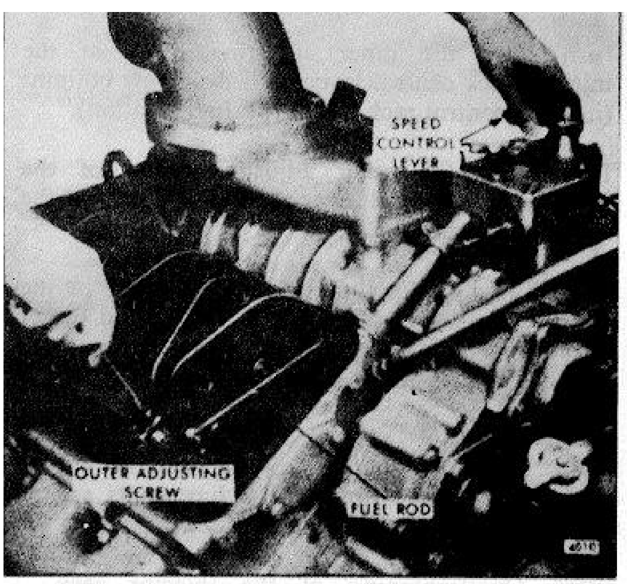


Fig. 3 - Positioning No. 3L Injector Rack Control Lever

The letters R or L indicate the injector location in the right or left cylinder bank, viewed from the rear of the engine. Cylinders are numbered starting at the front of the engine on each cylinder bank. Adjust the No. 3L injector rack control lever first to establish a guide for adjusting the remaining injector rack control levers.

1. Disconnect any linkage attached to the speed control lever.

2. Turn the idle speed adjusting screw until 1/2" of the threads (12-14 threads) project from the lock nut when the nut is against the high-speed plunger.

> **CAUTION:** A false fuel rack setting may result if the idle speed adjusting screw is not backed out as noted above.

> **NOTE:** This adjustment lowers the tension of the low-speed spring so it can be easily compressed. This permits closing the low speed gap without bending the fuel rods or causing the *yield mechanism springs to yield or stretch.*

3. Back out the buffer screw approximately 5/8", if it has not already been done.

4. Remove the clevis pin from the fuel rod and the right cylinder bank injector control tube lever.

5. Loosen all of the inner and outer injector rack control lever adjusting screws on both injector control tubes. Be sure all of the injector rack control levers are free on the injector control tubes.

6. Move the speed control lever to the maximum speed position; hold it in that position with light finger pressure. Turn the inner adjusting screw on the

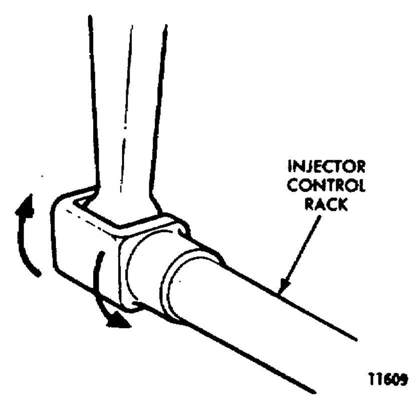


Fig. 4 · Checking Rotating Movement of Injector Control Rack

No. 3L injector rack control lever down as shown in Fig. 3 until a slight movement of the control tube lever is observed or a step-up in effort to turn the screw driver is noted. This will place the No. 3L injector in the full-fuel position. Turn down the outer adjusting screw until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws.

NOTE: Overtightening of the injector rack control lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 **in-lbs** (3-4 Nm).

IMPORTANT: The above step should result in placing the governor linkage and control tube assembly in the same position that they will attain while the engine is running at full-load.

7. To be sure of the proper rack adjustment, hold the speed control lever in the maximum speed position and press down on the injector rack with a screw driver or finger tip and note "rotating" movement of the injector control rack (Fig. 4) when the speed control lever is in the maximum speed position. Hold the speed control lever in the maximum speed position and, using a screw driver, press downward on the injector control rack. The rack should tilt downward (Fig. 5) and when the pressure of the screw driver is released, the control rack should "spring" back upward.

If the rack does not return to its original position, it is too loose. To correct this condition, back off the outer adjusting screw slightly and tighten the inner adjusting screw slightly.

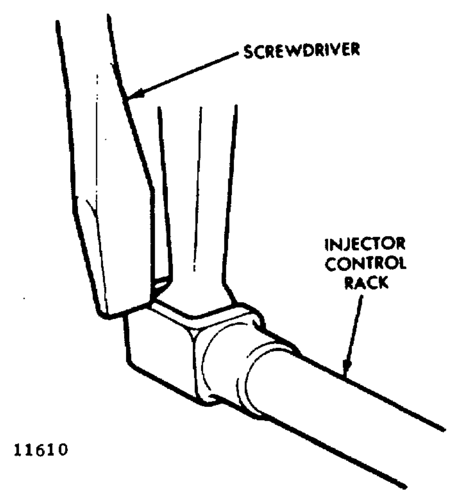


Fig. 5 - Checking Injector Control Rack Spring

The setting is too tight if, when moving the speed control lever from the no-speed to the maximum speed position, the injector rack becomes tight before the speed control lever reaches the end of its travel (as determined by the stop under the governor cover).

This will result in a step-up in effort required to move the speed control lever to the end of its travel. To correct this condition, back off the inner adjusting screw slightly and tighten the outer adjusting screw slightly.

8. Remove the clevis pin from the fuel rod and the left bank injector control tube lever.

9. Insert the clevis pin in the fuel rod and the right cylinder bank injector control tube lever and position the No. 3R injector rack control lever as previously outlined in Step 6 for the No. 3L injector rack control lever.

10. Insert the clevis pin in the fuel rod and the left cylinder bank injector control tube lever. Repeat the check on the 3L and 3R injector rack control levers as outlined in Step 7. Check for and eliminate any deflection which may occur at the bend in the fuel rod where it enters the cylinder head.

11. To adjust the remaining injector rack control levers, remove the clevis pin from the fuel rods and the injector control tube levers, hold the injector control racks in the full-fuel position by means of the lever on the end of the control tube, and proceed as follows:

a. Turn down the inner adjusting screw of the injector rack control lever until the screw bottoms (injector control rack in the full-fuel position).

b. Turn down the outer adjusting screw of the injector rack control lever until it bottoms on the injector control tube.

c. While still holding the control tube lever in the full-fuel position, adjust the inner and outer adjusting screws to obtain the same condition as outlined in Step 7. Tighten the screws.

CAUTION: Once the No. 3L and No. 3R injector rack control levers are adjusted. do not try to alter their settings. All adjustments are made on the remaining control racks.

NOTE: Overtightening of the injector rack control tube lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 **in-lbs** (3-4 Nm).

12. When all of the injector rack control levers are adjusted, recheck their settings. With the control tube lever in the full-fuel position, check each control rack as in Step 7. All of the control racks must have the same "spring" condition with the control tube lever in the full-fuel position.

13. Insert the clevis pin in the fuel rod and the injector control tube levers.

14. Turn the idle speed adjusting screw in until it projects 3/16" from the lock nut to permit starting the engine.

15. Use new gaskets and replace the valve rocker covers.

Adjust Maximum No-Load Engine Speed

All governors are properly adjusted before leaving the factory. However, if the governor has been reconditioned or replaced, and to ensure the engine speed will not exceed the recommended no-load speed as given on the engine option plate, set the maximum no-load speed as follows:

TYPE A GOVERNOR SPRINGS (Fig. 7):

1. Loosen the lock nut with a spanner wrench and back off the high-speed spring retainer several turns. Then start the engine and increase the speed slowly. If the speed exceeds the required no-load speed before the speed control lever reaches the end of its travel, back off the spring retainer a few additional turns.

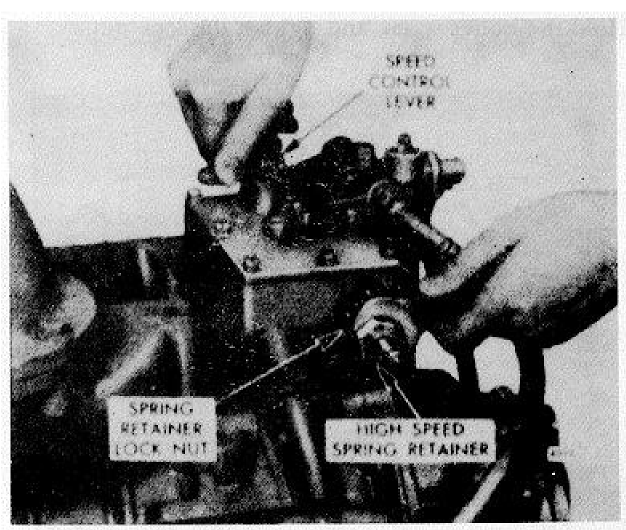


Fig. 6 - Adjusting Maximum No-Load Engine Speed

2. With the engine at operating temperature and no-load on the engine, place the speed control lever in the maximum speed position. Turn the high-speed spring retainer in (Fig. 6) until the engine is operating at the recommended no-load speed. Use an accurate hand tachometer to determine the engine speed. The maximum no-load speed varies with the full-load operating speed.

3. Hold the spring retainer and tighten the lock nut.

TYPE B GOVERNOR SPRINGS (Fig. 7):

1. Start the engine and after it reaches normal operating temperature, remove the load from the engine.

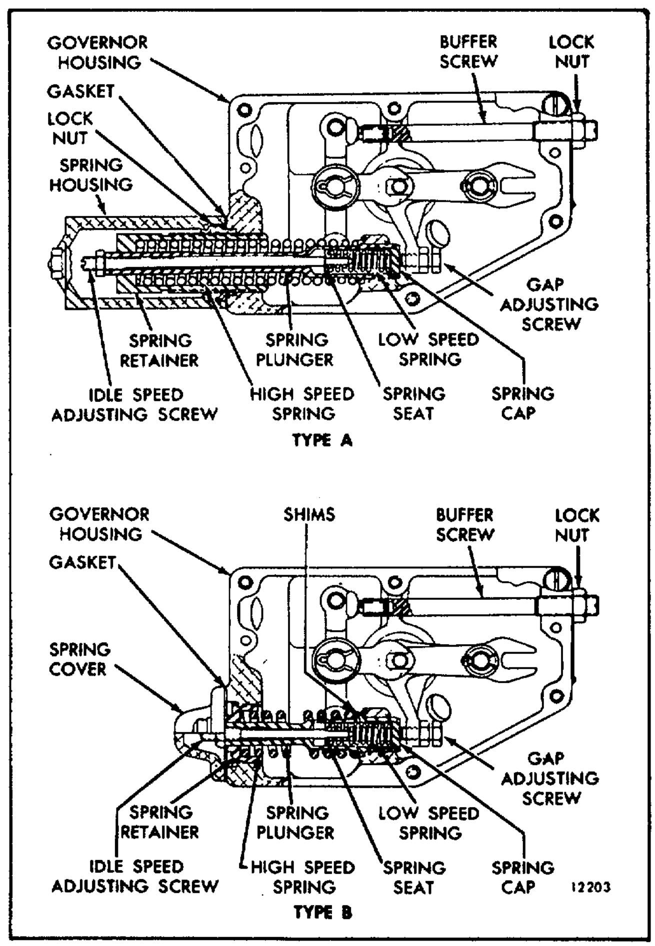


Fig. 7 - Governor Spring Assemblies

3. Stop the engine and, if necessary, adjust the no-load speed as follows:

a. Remove the high-speed spring retainer with tool J 5895 and withdraw the high-speed spring and plunger assembly.

CAUTION: To prevent the low-speed spring and cap from dropping into the governor, be careful not to jar the assembly while it is being removed.

b. Remove the high-speed spring from the high-speed spring plunger and add or remove shims as required to establish the desired engine no-load speed.

NOTE: For each .010"in shims added, the engine speed will be increased approximately 10 rpm.

c. Install the high-speed spring on the plunger and install the spring assembly in the governor housing. Install the spring retainer in the governor housing and tighten it securely. The maximum no-load speed varies with the full-load operating speed desired.

d. Start the engine and recheck the no-load speed. Repeat the procedure as necessary to establish the no-load speed required.

Adjust Idle Speed

With the maximum no-load speed properly adjusted, adjust the idle speed as follows:

1. With the engine running at normal operating temperature and with the buffer screw backed out to

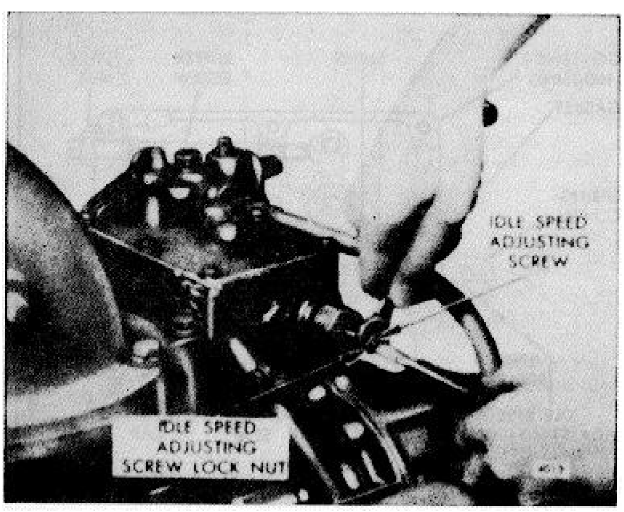


Fig. 8 - Adjusting Engine Idle Speed

avoid contact with the differential lever, turn the idle speed adjusting screw (Fig. 8) until the engine is operating at approximately 15 rpm below the recommended idle speed.

NOTE: The recommended idle speed for non-EPA certified engines is 500-600 rpm, but may vary with special engine applications.

If the engine has a tendency to stall during deceleration, install a new buffer screw. The current buffer screw uses a heavier spring and restricts the travel of the differential lever to the off (no-fuel) position.

2. Hold the idle screw and tighten the lock nut.

3. Install the high-speed spring retainer cover and tighten the two bolts.

Adjust Buffer Screw

With the idle speed properly set, adjust the buffer screw as follows:

1. With the engine running at normal operating temperature, turn the buffer screw in (Fig. 9) so it contacts the differential lever as lightly as possible and still eliminates engine roll.

NOTE: Do not increase the engine idle speed more than 15 rpm with the buffer screw.

2. Recheck the maximum no-load speed. If it has increased more than 25 rpm, back off the buffer screw until the increase is less than 25 rpm.

3. Hold the buffer screw and tighten the lock nut.

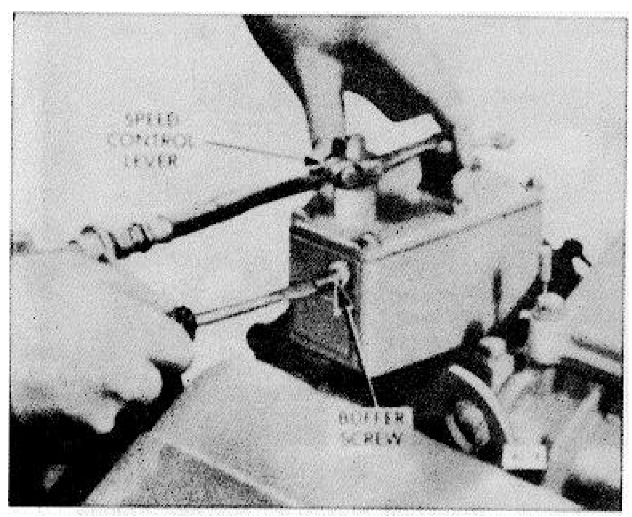


Fig. 9 - Adjusting Buffer Screw

VARIABLE SPEED MECHANICAL GOVERNOR (OPEN LINKAGE) AND INJECTOR RACK CONTROL ADJUSTMENT

IN-LINE ENGINES

After adjusting the exhaust valves and timing the fuel injectors, adjust the governor (Fig. I) and the injector rack control levers.

Preliminary Governor Adjustments

1. Clean the governor linkage and lubricate the ball joints and bearing surfaces with clean engine oil.

2. Back out the buffer screw until it projects 9/ 16" from the boss on the control housing.

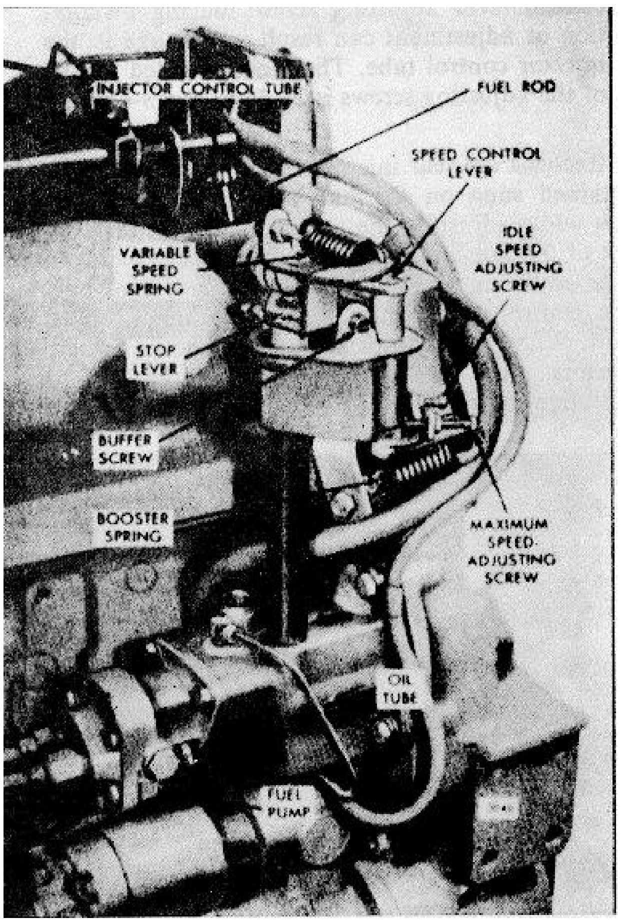


Fig. 1 - Variable Speed Open Linkage Governor Mounted on Engine

3. Back out the booster spring eye bolt until it is flush with the outer lock nut.

Adjust Variable Speed Spring Tension

1. Adjust the variable speed spring eye bolt until 1/8" of the threads project from the outer lock nut .(Fig. 2).

2. Tighten both lock nuts to retain the adjustment.

> **NOTE:** This setting of the eye bolt will produce approximately 7% droop in engine speed from no-load to full-load.

Position Injector Rack Control Lovers

The position of the injector control racks must be correctly set in relation to the governor. Their position

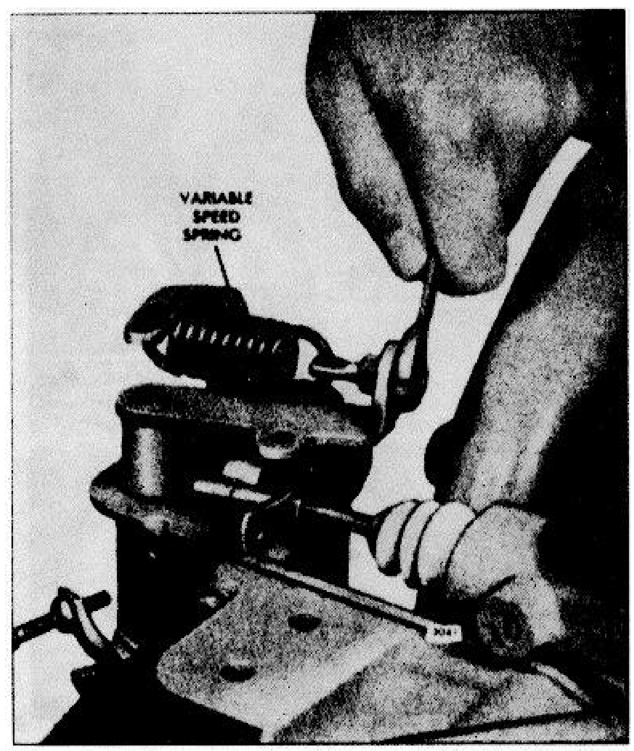


Fig. 2 - Adjusting Governor Spring Eye Bolt

determines the amount of fuel injected into each cylinder and ensures equal distribution of the load. Adjust the rear injector rack control lever first to establish a guide for adjusting the remaining levers.

1. Clean and remove the valve rocker cover. Discard the gasket.

2. Disconnect the fuel rod at the stop lever.

3. Loosen all of the inner and outer injector rack control lever adjusting screws. Be sure all of the injector rack control levers are free on the injector control tube.

4. Move the speed control lever to the maximum speed position.

5. Adjust the rear cylinder injector rack control lever adjusting screws (Fig. 3) until both screws are equal in height and tight on the injector control tube.

6. Move the rear injector control rack into the full-fuel position and note the clearance between the fuel rod and the cylinder head bolt. The clearance should be 1/32 " or more. If necessary, readjust the injector rack adjusting screws until a clearance of at least 1/32" to 1/16" exists. Tighten the adjustment screws.

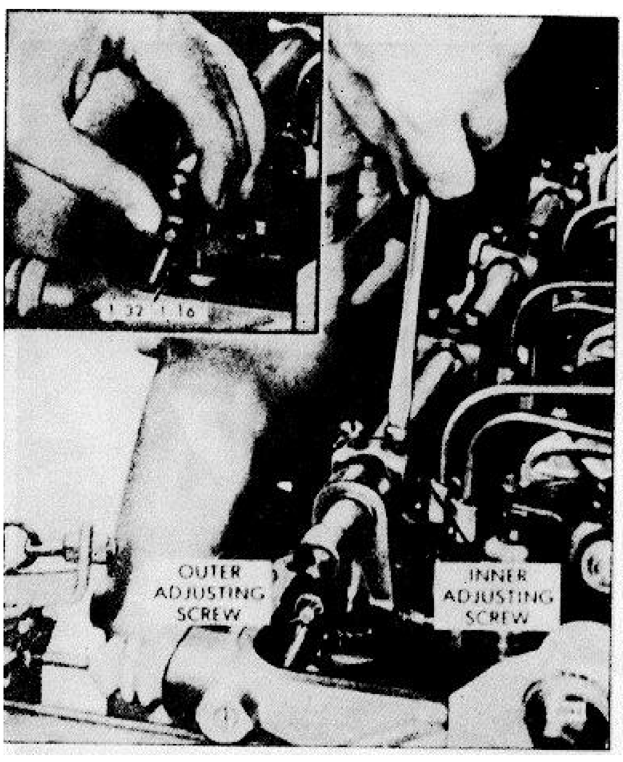


Fig. 3 - Adjusting Injector Rack Control Lever Adjusting Screws

7. Loosen the nut which locks the ball joint on the fuel rod. Hold the fuel rod in the full-fuel position and adjust the ball joint until it is aligned and will slide on the ball stud on the stop lever (Fig. 4). Position the shutdown cable clip and tighten the fuel rod lock nut to retain the adjustment.

8. Check the adjustment by pushing the fuel rod toward the engine and make sure the injector control rack is in the full-fuel position. If necessary, readjust the fuel rod.

9. Manually hold the rear injector rack in the full-fuel position, with the lever on the injector control tube, and turn the inner adjusting screw of the adjacent injector rack control lever down until the injector rack moves into the full-fuel position. Turn the outer adjusting screw down until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws.

> **NOTE:** Overtightening of the injector rack control lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 in-lbs (3-4 Nm).

10. Recheck the rear injector rack to be sure that it has remained snug on the ball end of the rack control lever while adjusting the adjacent injector rack. If the rack of the rear injector has become loose, back off the inner adjusting screw slightly on the adjacent injector rack control lever and tighten the outer adjusting screw. When the settings are correct, the racks of both injectors must be snug on the ball end of their respective control levers.

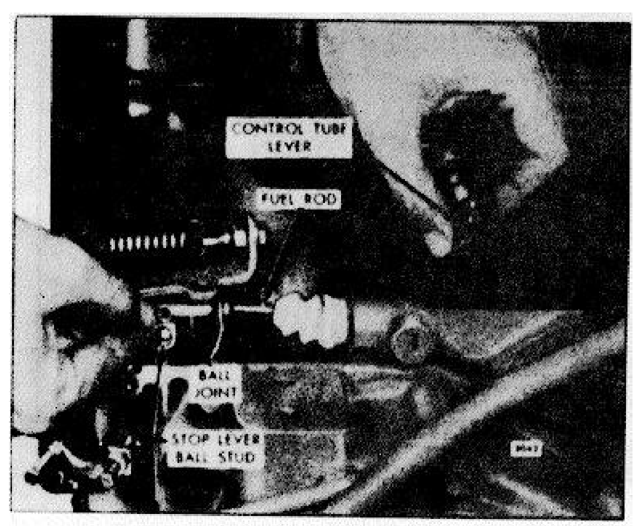


Fig. 4 - Adjusting Fuel Rod Length

11. Position the remaining injector rack control levers as outlined in Steps 9 and 10.

Adjust Maximum No-Load Speed

1. With the engine running, move the speed control lever to the maximum speed position. Use an accurate tachometer to determine the no-load speed of the engine.

> **NOTE:** Do not overspeed the engine.

2. Loosen the lock nut and adjust the maximum speed adjusting screw (Fig. 5) until the required no-load speed is obtained.

3. Hold the adjusting screw and tighten the lock nut.

Adjust Engine Idle Speed

1. Make sure the stop lever is in the run position and place the speed control lever in the idle position.

2. With the engine running at normal operating temperature, loosen the lock nut and turn the idle speed adjusting screw (Fig. 6) until the engine idles at the recommended speed. The recommended idle speed is 500 rpm. However, the idle speed may vary with special engine applications.

3. Hold the idle speed adjusting screw and tighten the lock nut.

Fig. 5 - Adjusting Maximum No-Load Engine Speed

Adjust Buffer Screw

1. With the engine running at idle speed, turn the buffer screw in (Fig. 7) so that it contacts the stop lever as lightly as possible and still eliminates engine roll.

> **NOTE:** Do not raise the engine idle speed more than 20 rpm with the buffer screw. Check the maximum no-load speed to make sure it has not increased over 25 rpm by the buffer screw setting.

Adjust Governor Booster Spring

The governor booster spring is used on some engines to reduce the force necessary to move the speed control lever from the idle speed position to the maximum speed position. Adjust the booster spring as follows:

1. Move the speed control lever to the idle speed position.

2. Reduce the tension on the booster spring, if not

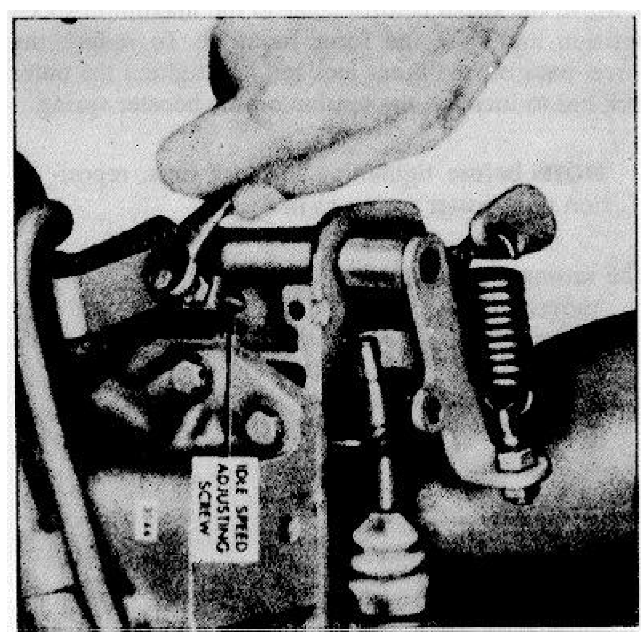


Fig. 6 - Adjusting Idle Speed

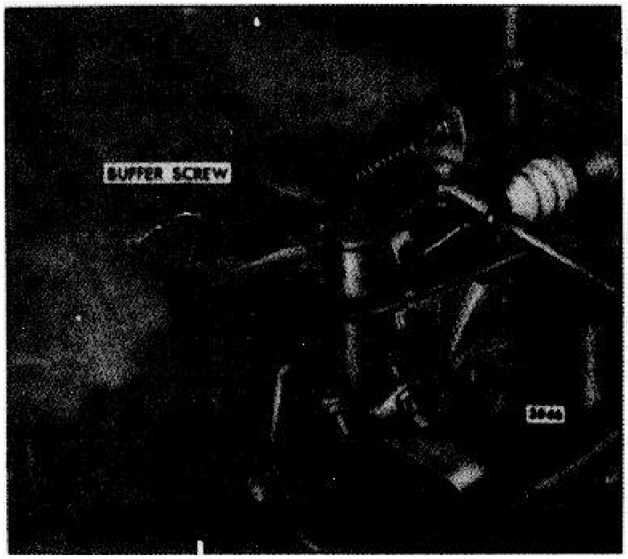


Fig. 7 - Adjusting Buffer Screw

previously performed, to the minimum by backing off the outer lock nut (Fig. 8) until the end of the booster spring eye bolt is flush with the end of the nut.

3. Adjust the eye bolt in the slot in the bracket so that an imaginary line through the booster spring will align with an imaginary center line through the speed control shaft. Secure the lock nuts on the eye bolt to retain the adjustment.

4. Move the speed control lever to the maximum speed position and note the force required. To reduce the force, back off the inner lock nut and tighten the outer lock nut to increase the tension on the booster spring.

> **NOTE:** Before tightening the lock nuts, reposition the booster spring as in Step 3.

The setting is correct when the speed control lever can be moved from the idle speed position to the maximum speed position with a constant force, while the engine is running, and when released it will return to the idle speed position.

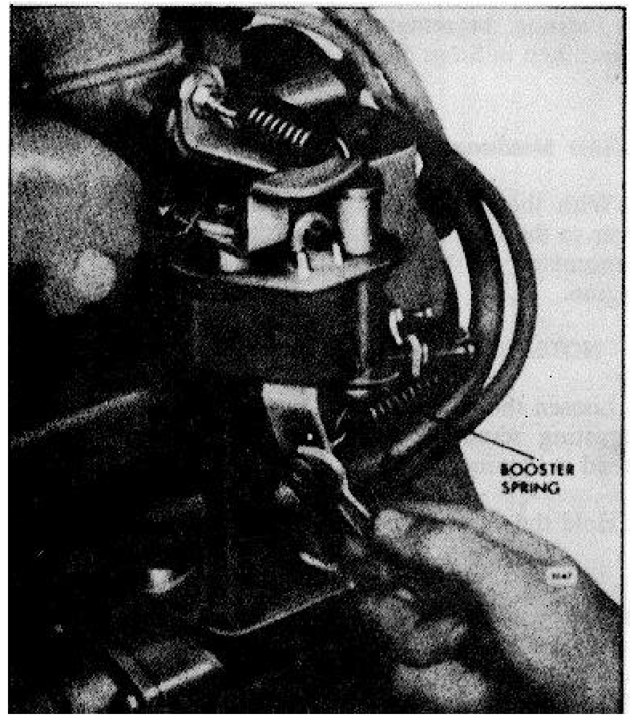


Fig. 8 - Adjusting Booster Spring

Adjust Engine Speed Droop

The adjustment of the spring tension as outlined under *Adjust Variable Speed Spring Tension* will result in approximately 7% droop from the maximum no-load speed to the full-load speed. This is the optimum droop setting for most applications. However, the droop may be changed as necessary for a particular engine application.

1. Lower the speed droop by increasing the spring tension.

2. Raise the speed droop by decreasing the spring tension.

> **NOTE:** A change in the variable speed spring tension will change the maximum no-load speed and the engine idle speed which must also be readjusted.

VARIABLE SPEED MECHANICAL GOVERNOR (ENCLOSED LINKAGE) AND INJECTOR RACK CONTROL ADJUSTMENT

IN-LINE ENGINES

The single-weight variable speed governor is mounted on the rear end plate of the engine and is driven by a gear that extends through the end plate and meshes with either the camshaft gear or the balance shaft gear, depending upon the engine model.

After adjusting the exhaust valves and timing the fuel injectors, adjust the governor and position the injector rack control levers.

> **NOTE:** Before proceeding with the governor and injector rack adjustments, disconnect any supplementary governing device. After the adjustments are completed, reconnect and adjust the supplementary governing device.

Adjust Governor Gap

With the engine stopped and at operating temperature, adjust the governor gap as follows:

1. Disconnect any linkage attached to the governor levers.
2. Back out the buffer screw until it extends approximately 5/8" from the lock nut.
3. Clean and remove the governor cover and valve rocker cover. Discard the gaskets.
4. Place the speed control lever (Fig. 1) in the maximum speed position.
5. Insert a .006" feeler gage between the spring plunger and the plunger guide as shown in Fig. 1. If required, loosen the lock nut and turn the gap adjusting screw in or out until a slight drag is noted on the feeler gage.
6. Hold the adjusting screw and tighten the lock nut. Check the gap and readjust if necessary.
7. Use a new gasket and install the governor cover as follows:
   a. Place the cover on the governor housing, with the

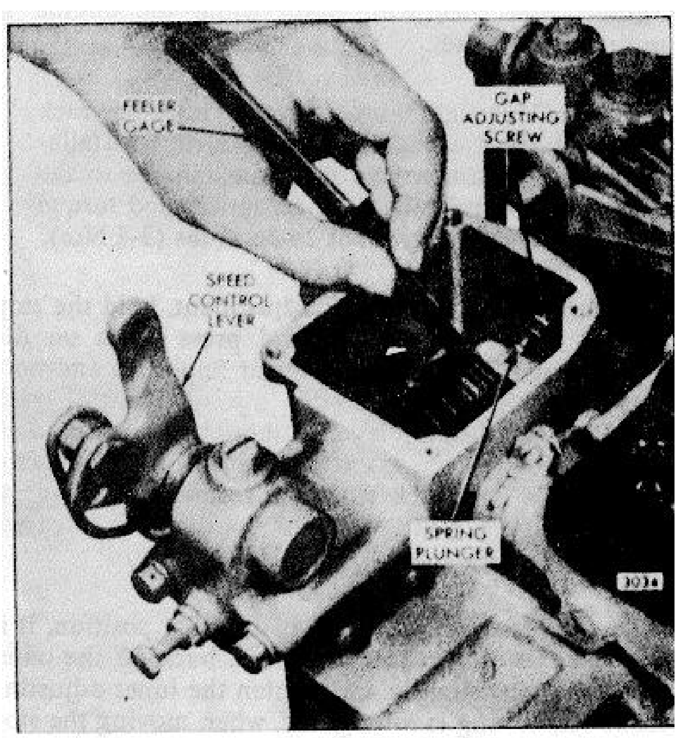


Fig. 1 - Checking Governor Gap

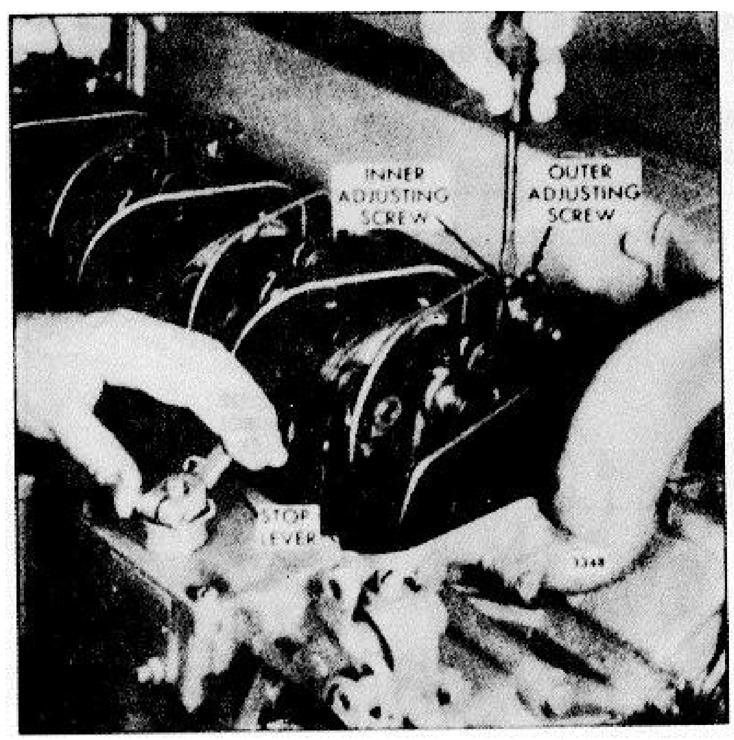


Fig. 2 - Positioning the Rear Injector Rack Control Lever

pin in the throttle shaft assembly entering the slot in the differential lever.

b. Install the four cover screws and lock washers finger tight.

c. Pull the cover assembly in a direction away from the engine, to take up the slack, and tighten the cover screws.

NOTE: This step is required since no dowels are used to locate the cover on the housing.

Position Injector Rack Control Levers

The position of the injector control rack levers must be correctly set in relation to the governor. Their position determines the amount of fuel injected into each cylinder and ensures equal distribution of the load. Properly positioned injector control rack levers with the engine at full-load will result in the following:

1. Speed control lever at the maximum speed position.
2. Stop lever in the RUN position.
3. Injector fuel control racks in the full-fuel position.

Adjust the rear injector rack control lever first to establish a guide for adjusting the remaining levers.

1. Loosen all of the inner and outer injector rack control lever adjusting screws (Fig. 2). Be sure all of the levers are free on the injector control tube.
2. Move the speed control lever to the maximum speed position.

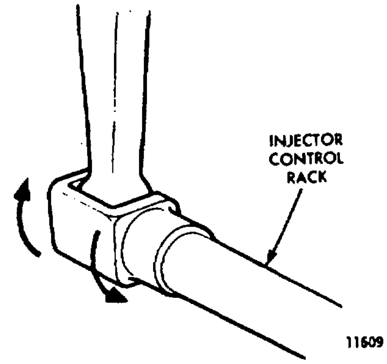


Fig. 3 - Checking Rotating Movement of Injector Control Ra

3. Move the stop lever to the RUN position and hold it in that position with light finger pressure. Turn the inner adjusting screw of the rear injector rack control lever down until a slight movement of the control tube is observed or a step-up in effort to turn the screw driver is noted. This will place the rear injector rack in the full-fuel position. Turn the outer adjusting screw down until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws. This should result in placing the governor linkage and control tube in the respective positions that they will attain while the engine is running at full load.

   NOTE: Overtightening of the injector rack control lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 in-lbs (3-4 Nm).

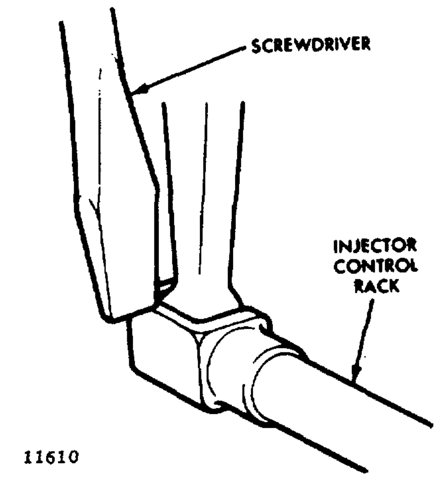


Fig. 4 - Checking Injector Control Rack "Spring"

4. To be sure of proper rack adjustment, hold the stop lever in the RUN position and press down on the injector rack with a screw driver or finger tip and note "rotating" movement of the injector control rack (Fig. 3). Hold the stop lever in the RUN position and, using a screw driver, press downward on the injector control rack. The rack should tilt downward (Fig. 4) and, when the pressure of the screw driver is released, the control rack should "spring" back upward.

If the rack does not return to its original position, it is too loose. To correct this condition, back off the outer adjusting screw slightly and tighten the inner adjusting screw. The setting is too tight if, when moving the stop lever from the STOP to the RUN position, the injector rack becomes tight before the stop lever reaches the end of its travel. This will result in a step-up in effort required to move the stop lever to the RUN position and a deflection in the fuel rod (fuel rod deflection can be seen at the bend). If the rack is found to be too tight, back off the inner adjusting screw slightly and tighten the outer adjusting screw.

5. To adjust the remaining injector rack control levers, remove the clevis pin from the fuel rod and the injector control tube lever, hold the injector control racks in the full-fuel position by means of the lever on the end of the control tube. Turn down the inner adjusting screw on the injector rack control lever of the adjacent injector until the injector rack has moved into the full-fuel position and the inner adjusting screw is bottomed on the injector control tube. Turn the outer adjusting screw down until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws.

6. Recheck the rear injector rack to be sure that it has remained snug on the ball end of the rack control lever while adjusting the adjacent injector rack. If the rack of the rear injector has become loose, back off the inner adjusting screw slightly on the adjacent injector rack control lever and tighten the outer adjusting screw. When the settings are correct, the racks of both injectors must be snug on the ball end of their respective control levers.

7. Position the remaining injector rack control levers as outlined in Steps 4, 5 and 6.

8. When all of the injector rack control levers are adjusted, recheck their settings. With the control tube lever in the full-fuel position, check each control rack as in Step 4. All of the control racks must have the same "spring" condition with the control tube lever in the full-fuel position.

9. Insert the clevis pin in the fuel rod and the injector control tube levers.

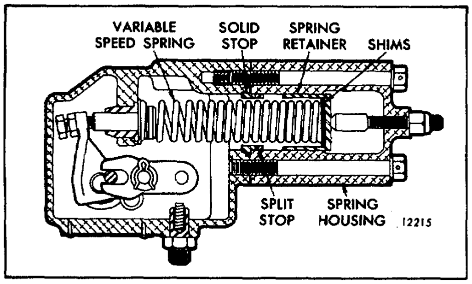


Fig. 5 - Locating of Shims and Stops

10. Use a new gasket and replace the valve rocker cover.

Adjust Maximum No-Load Speed

All governors are properly adjusted before leaving the factory. However, if the governor has been reconditioned or replaced, and to ensure the engine speed will not exceed the recommended no-load speed as given on the option plate, the maximum no-load speed may be set as follows:

Start the engine and, after it reaches normal operating temperature, determine the maximum no-load speed of the engine with an accurate tachometer. Then stop the engine and make the following adjustments, if required.

1. Refer to Fig. 8 and disconnect the booster spring and the stop lever retracting spring.

2. Remove the variable speed spring housing and the variable speed spring retainer located inside of the housing.

3. Refer to Table 1 and determine the stops or shims required for the desired full-load speed. Do not use more than four thick and one thin shim. A split stop can only be used with a solid stop (Fig. 5).

4. Install the variable speed spring retainer and housing and tighten the two bolts.

5. Connect the booster spring and stop lever spring. Start the engine and recheck the maximum no-load speed.

6. If required, add shims to obtain the necessary operating speed. For each .001 " in shims added, the operating speed will increase approximately 2 rpm.

IMPORTANT: If the maximum no-load speed is raised or lowered more than 50 rpm by the

Full Load Speed RPM	STOPS		SHIMS
	Solid Ring	Split Ring	
2575-2800	0	0	As Required
2101-2575	1	0	As Required
1701-2100	1	1	As Required
1200-1700	1	2	As Required

TABLE 1

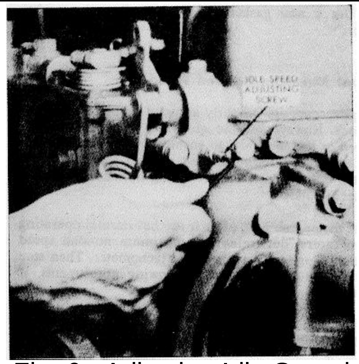


Fig. 6 · Adjusting Idle Speed

installation or removal of shims, recheck the governor gap. If readjustment of the governor gap is required, the position of the injector racks must be rechecked.

> **NOTE:** Governor stops are used to limit the compression of the governor spring which determines the maximum speed of the engine.

Adjust Idle Speed

With the maximum no-load speed properly adjusted, adjust the idle speed as follows:

1. Place the stop lever in the RUN position and the speed control lever in the IDLE position.
2. With the engine running at normal operating temperature, back out the buffer screw to avoid contact with the differential lever.
3. Loosen the lock nut and turn the idle speed adjusting screw (Fig. 6) until the engine is operating at approximately 15 rpm below the recommended idle speed.

The recommended idle speed is 550 rpm, but may vary with special engine applications.

4. Hold the idle speed adjusting screw and tighten the lock nut.

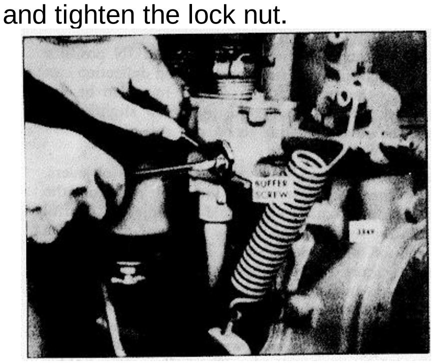


Fig. 7 - Adjusting Buffer Screw

Adjust Buffer Screw

1. With the engine running at normal operating temperature, turn the buffer screw in (Fig. 7) so that it contacts the differential lever as lightly as possible and still eliminates engine roll.

> **NOTE:** Do not increase the engine idle speed more than 15 rpm with the buffer screw.

2. Hold the buffer screw and tighten the lock nut.

Adjust Booster Spring

With the engine idle speed adjusted, adjust the booster spring as follows:

1. Move the speed control lever to the idle speed position.
2. Refer to Fig. 8 and loosen the booster spring retaining nut on the speed control lever. Loosen the lock nuts on the eye bolt at the opposite end of the booster spring.
3. Move the spring retaining bolt in the slot of the speed control lever until the center of the bolt is on or slightly over center (toward the idle speed position) of an imaginary line through the bolt, lever shaft and eye bolt. Hold the bolt and tighten the lock nut.
4. Start the engine and move the speed control lever to the maximum speed position and release it. The lever should return to the idle speed position. If it does not, reduce the tension on the booster spring. If it does, continue to increase the spring tension until the point is reached where it will not return to idle. Then reduce

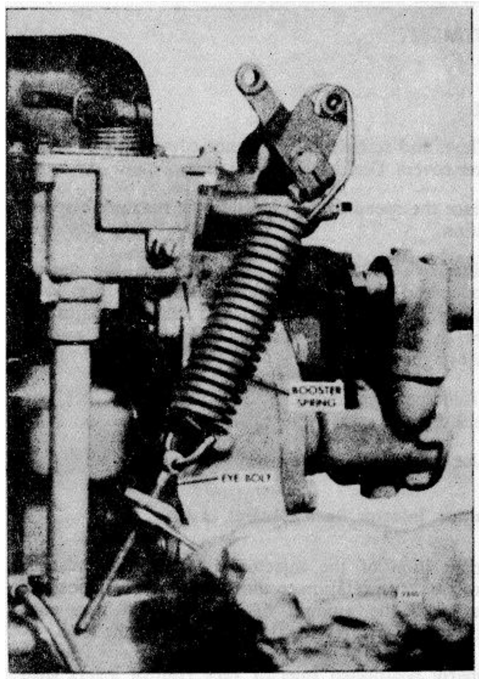


Fig. 8 - Adjusting Booster Spring

the spring tension until the lever does return to idle and tighten the lock nuts on the eye bolt. This setting will result in the minimum force required to operate the speed control lever.

5. Connect the linkage to the governor levers.

VARIABLE SPEED MECHANICAL GOVERNOR AND INJECTOR RACK CONTROL ADJUSTMENT

The variable speed mechanical governor assembly is mounted at the rear of the 6V engine, between the flywheel housing and the blower (Fig. 1). The governor is driven by the right-hand blower rotor drive gear.

After adjusting the exhaust valves and timing the fuel injectors, adjust the governor and position the injector rack control levers.

> **NOTE:** Before proceeding with the governor and injector rack adjustments, disconnect any supplementary governing device. After the adjustments are completed, reconnect and adjust the supplementary governing device.

Adjust Governor Gap

With the engine stopped and at normal operating temperature, adjust the governor gap as follows:

1. Disconnect any linkage attached to the governor levers.
2. Back out the buffer screw until it extends approximately 5/8" from the lock nut.

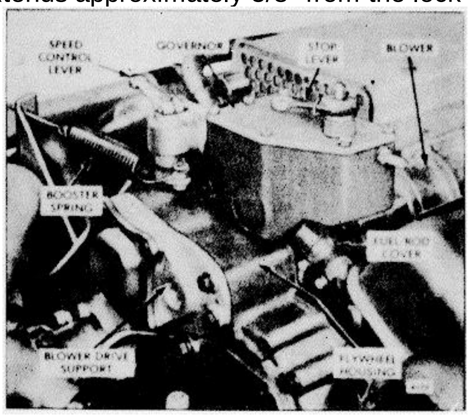


Fig. 1 - Variable Speed Governor Mounting

3. Clean and remove the governor cover and the valve rocker covers. Discard the gaskets.
4. Place the speed control lever in the maximum speed position.
5. Insert a .006" feeler gage between the spring plunger and the plunger guide as shown in Fig. 2. If required, loosen the lock nut and turn the adjusting screw in or out until a slight drag is noted on the feeler gage.
6. Hold the adjusting screw and tighten the lock nut. Check the gap and readjust if necessary.
7. Use a new gasket and install the governor cover.

Position Injector Rack Control Levers

The position of the injector control racks must be correctly set in relation to the governor. Their position determines the amount of fuel injected into each cylinder and ensures equal distribution of the load.

Properly positioned injector rack control levers with the engine at full-load will result in the following:

1. Speed control lever at the maximum speed position.

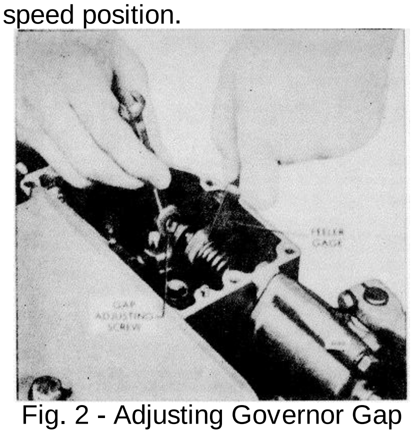


Fig. 2 - Adjusting Governor Gap

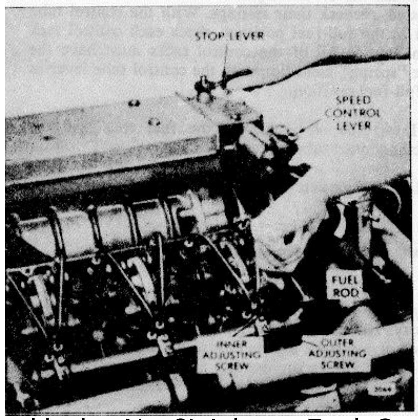


Fig. 3 - Positioning No. 3L Injector Rack Control Lever

2. Stop lever in the RUN position.

3. Injector fuel control racks in the full-fuel position.

The letters R or L indicate the injector location in the right or left cylinder bank, viewed from the rear of the engine. Cylinders are numbered starting at the front of the engine on each cylinder bank. Adjust the No. 3L injector rack control lever first to establish a guide for adjusting the remaining levers.

1. Remove the clevis pin from the fuel rod and the right cylinder bank injector control tube lever.

2. Loosen all of the inner and outer injector rack control lever adjusting screws on both injector control tubes. Be sure all of the injector rack control levers are free on the injector control tubes.

3. Move the speed control lever to the maximum speed position.

4. Move the stop lever to the *run* position and hold it in that position with light finger pressure. Turn the inner adjusting screw of the No. 3L injector rack control lever down (Fig. 3) until a slight movement of the control tube is observed, or a step-up in effort to turn the screw driver is noted. This will place the No. 3L injector rack in the *full-fuel* position. Turn the outer adjusting screw down until it bottoms lightly on

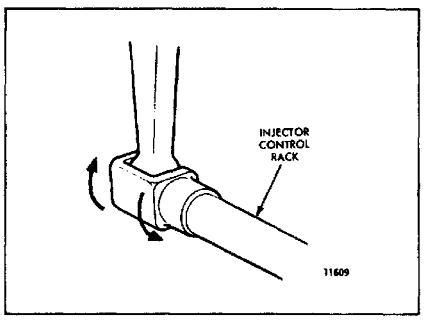


Fig. 4 - Checking Rotating Movement of Injector Control Rack

the injector control tube. Then alternately tighten both the inner and outer adjusting screws.

> **NOTE:** Overtightening the injector rack control lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 in-lb (3-4 Nm).

The above steps should result in placing the governor linkage and control tube in the respective positions that they will attain while the engine is running at full load.

5. To be sure of proper rack adjustment, hold the stop

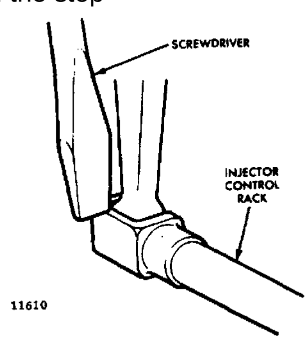


Fig. 5 - Checking Injector Control Rack "Spring”

lever in the *run* position and press down on the injector rack with a screw driver or finger tip and note the "rotating" movement of the injector control rack (Fig. 4). Hold the stop lever in the *run* position and, using a screw driver, press downward on the injector control rack. The rack should tilt downward (Fig. 5) and when the pressure of the screw driver is released, the control rack should "spring" back upward. If the rack does not return to its original position, it is too loose. To correct this condition, back off the outer adjusting screw slightly and tighten the inner adjusting screw. The setting is too tight if, when moving the stop lever from the *stop* to the *run* position, the injector rack becomes tight before the governor stop lever reaches the end of its travel. This will result in a step-up in effort required to move the stop lever to the *run* position and a deflection in the fuel rod (fuel rod deflection can be seen at the bend). If the rack is found to be too tight, back off the inner adjusting screw slightly and tighten the outer adjusting screw.

6. Remove the clevis pin from the fuel rod and the left bank injector control tube lever.

7. Insert the clevis pin in the fuel rod and the right cylinder bank injector control tube lever and position the No. 3R injector rack control lever as previously outlined in Step 4 for the No. 3L control lever.

8. Insert the clevis pin in the fuel rod and the left bank injector control tube lever. Repeat the check on the 3L and 3R injector rack control levers as outlined in Step 5. Check for and eliminate any deflection which may occur at the bend in the fuel rod where it enters the cylinder head.

9. To adjust the remaining injector rack control levers, remove the clevis pin from the fuel rods and the injector control tube levers, hold the injector control racks in the full-fuel position by means of the lever on the end of the control tube and proceed as follows:

   a. Turn down the inner adjusting screw of the injector rack control lever until the screw bottoms (injector control rack in the full-fuel position).

   b. Turn down the outer adjusting screw of the injector rack control lever until it bottoms on the injector control tube.

   c. While still holding the control tube lever in the full-fuel position, adjust the inner and outer adjusting screws to obtain the same condition as outlined in Step 5. Tighten the screws.

   CAUTION: Once the No. 3L and No. 3R injector rack control levers are adjusted, do not try to alter their settings. All adjustments are made on the remaining control racks.

10. When all of the injector rack control levers are adjusted, recheck their settings. With the control tube lever in the full-fuel position, check each control rack as in Step 5. All of the control racks must have the same "spring" condition with the control tube lever in the full-fuel position.

11. Insert the clevis pin in the fuel rods and the injector control tube levers.

12. Use new gaskets and install the valve rocker covers.

Adjust Maximum No-Load Speed

All governors are properly adjusted before leaving the factory. However, if the governor has been reconditioned or replaced, and to ensure the engine speed will not exceed the recommended no-load speed as given on the engine option plate, the maximum no-load speed may be set as follows:

Start the engine and after it reaches normal operating temperature, determine the maximum no-load speed of the engine with an accurate tachometer. Then stop the engine and make the following adjustments, if required.

1. Refer to Fig. 9 and disconnect the booster spring and the stop lever retracting spring.

2. Remove the variable speed spring housing and the spring retainer, located inside of the housing, from the governor housing.

3. Refer to Table I and determine the stops or shims required for the desired full-load speed. A split stop can only be used with a solid stop (Fig. 6).

4. Install the variable speed spring retainer and housing and tighten the two bolts.

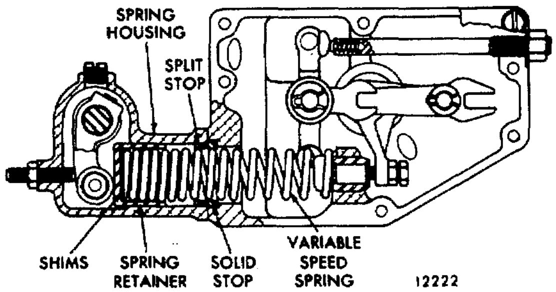


Fig. 6 - Location of Shims and Stops

Fig. 7 - Adjusting Idle Speed

Full-Load Speed	Stops		Shims*
	Solid	Split	
1200-2100	1	1	As Required
2100-2500	1	0	As Required
2500-2800	0	0	As Required

*Maximum amount of shims .325"

TABLE 1

5. Connect the booster spring and the stop lever spring. Start the engine and recheck the maximum no-load speed.

6. If required, add shims to obtain the necessary operating speed. For each .001 1"in shims added, the operating speed will increase approximately 2 rpm.

IMPORTANT: If the maximum no-load speed is raised or lowered more than 50 rpm by the installation or removal of shims, recheck the governor gap. If readjustment of the governor gap is required, the position of the injector racks must be rechecked.

NOTE: Governor stops are used to limit the compression of the governor spring, which determines the maximum speed of the engine.

Adjust Idle Speed

With the maximum no-load speed properly adjusted, adjust the idle speed as follows:

1. Place the stop lever in the *run* position and the speed control lever in the *idle* position.

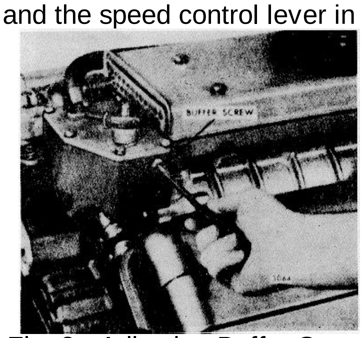


Fig. 8 - Adjusting Buffer Screw

2. With the engine running at normal operating temperature, back out the buffer screw to avoid contact with the differential lever.

3. Loosen the lock nut and turn the idle speed adjusting screw (Fig. 7) until the engine is operating at approximately 15 rpm below the recommended idle speed. The recommended idle speed is 550 rpm, but may vary with special engine applications.

4. Hold the idle speed adjusting screw and tighten the lock nut.

Adjust Buffer Screw

1. With the engine running at normal operating temperature, turn the buffer screw in (Fig. 8) so that it contacts the differential lever as lightly as possible and still eliminates engine roll.

NOTE: Do not raise the engine idle speed more than 15 rpm with the buffer screw.

2. Hold the buffer screw and tighten the lock nut.

Adjust Booster Spring

With the idle speed adjusted, adjust the booster spring as follows:

1. Move the speed control lever to the idle speed position.

2. Refer to Fig. 9 and loosen the booster spring

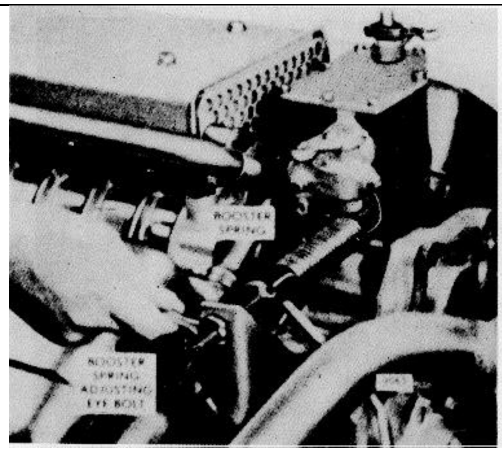


Fig. 9 - Adjusting Booster Spring

retaining nut on the speed control lever. Loosen the lock nuts on the eye bolt at the opposite end of the booster spring.

3. Move the spring retaining bolt in the slot of the speed control lever until the center of the bolt is on or slightly over center (toward the idle speed position) of an imaginary line through the bolt, lever shaft and eye bolt. Hold the bolt and tighten the lock nut.

4. Start the engine and move the speed control lever to the maximum speed position and release it. The speed control lever should return to the idle position. If it does not, reduce the tension on the booster spring. If the lever does return to the idle position, continue to increase the spring tension until the point is reached that it will not return to idle. Then reduce the tension until it does return to idle and tighten the lock nut on the eye bolt. This setting will result in the minimum force required to operate the speed control lever.

5. Connect the linkage to the governor levers.

SUPPLEMENTARY GOVERNING DEVICE ADJUSTMENT
ENGINE LOAD LIMIT DEVICE

Engines with mechanical governors may be equipped with a load limit device (Fig. 1) to reduce the maximum horsepower.

This device consists of a load limit screw threaded into a plate mounted between two adjacent rocker arm shaft brackets and a load limit lever clamped to the injector control tube.

The load limit device is located between the No. 2 and No. 3 cylinders of a three or four cylinder engine or between the No. 1 and No. 2 cylinders of *each* cylinder head on a V-type engine. However, when valve rocker covers with a breather are used, the load limit device is installed between the No. 1 and No. 2 cylinders on in-line engines and between the No. 2 and No. 3 cylinders on V-type engines to avoid interference with the rocker cover baffles.

When properly adjusted for the maximum horsepower desired, this device limits the travel of the injector control racks and thereby the fuel output of the injectors.

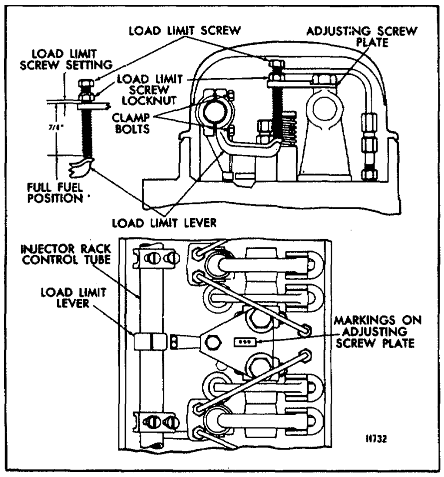


Fig. 1 - Engine Load Limit Device

Adjustment

After the engine tune-up is completed, make sure the load limit device is properly installed as shown in Fig. 1. Make sure the counterbores in the adjusting screw plate are up. The rocker arm shaft bracket bolts which fasten the adjusting screw plate to the brackets are tightened to 50-55 lb-ft (68-75 Nm) torque. Then adjust the load limit device, on each cylinder head, as follows:

1. Loosen the load limit screw lock nut and remove the screw.

2. Loosen the load limit lever clamp bolts so the lever is free to turn on the injector rack control tube.

3. With the screw out of the plate, adjust the load limit screw lock nut so the bottom of the lock nut is 7/8" from the bottom of the load limit screw (Fig. 1) for the initial setting.

4. Loosen the load limit lever clamp bolts so the lever is free to turn on the injector rack control tube.

4. Thread the load limit screw into the adjusting screw plate until the lock nut *bottoms* against the top of the plate.

5. Hold the injector rack control tube in the full-fuel position and place the load limit lever against the bottom of the load limit screw. Then tighten the load limit lever clamp bolts.

6. Check to ensure that the injector racks will just go into the full-fuel position -- readjust the load limit lever if necessary.

7. Hold the load limit screw to keep it from turning, then *set* the lock nut until the distance between the bottom of the lock nut and the top of the adjusting screw plate corresponds to the dimension (or number of turns) stamped on the plate. Each full turn of the screw equals .042", or .007" for each flat on the hexagon head.

> **NOTE:** If the plate is not stamped, adjust the load limit screw while operating the engine on a dynamometer test stand and note the number of turns required to obtain the desired horsepower. Then stamp the plate accordingly.

8. Thread the load limit screw into the plate until the lock nut *bottoms* against the top of the plate. Be sure the nut turns with the screw.

9 Hold the load limit screw to keep it from turning, then tighten the lock nut to secure the setting.

The throttle delay mechanism is used to retard full-fuel injection when the engine is accelerated. This reduces exhaust smoke and also helps to improve fuel economy.

The throttle delay mechanism (Fig. 2) is installed between the No. I and No. 2 cylinders on three cylinder engines, between the No. 2 and No. 3 cylinders on four cylinder engines, or between the No. 1 and No. 2 cylinders on the right-bank cylinder head of V-type engines. It consists of a special rocker arm shaft bracket (which incorporates the throttle delay cylinder), a piston, throttle delay lever, connecting link, oil supply plug, ball check valve and U-bolt.

A yield lever and spring assembly replaces the standard lever and pin assembly on the rear end of the injector control tube on In-line engines (Fig. 3). A yield lever replaces the standard operating lever in the governor of the 6V-53 engine (Fig. 4).

Operation

Oil is supplied to a reservoir above the throttle delay cylinder through a special plug in the drilled oil passage in the rocker arm shaft bracket (Fig. 2). As the injector racks are moved toward the no-fuel position, free movement of the throttle delay piston is assured by air drawn into the cylinder through the ball check valve. Further movement of the piston uncovers an opening which permits oil from the reservoir to enter the cylinder and displace the air. When the

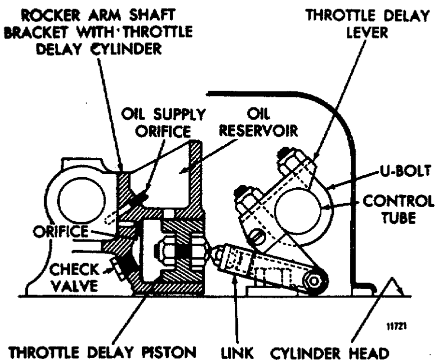


Fig. 2 - Throttle Delay Cylinder

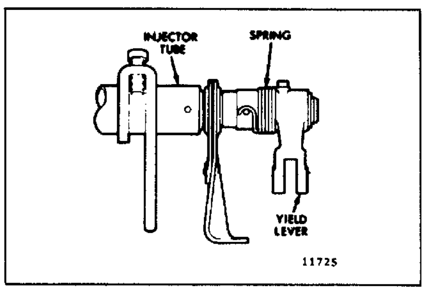


Fig. 3 - Throttle Delay Yield Lever (In-Line Engine)

engine is accelerated, movement of the injector racks toward the full-fuel position is momentarily retarded while the piston expels the oil from the cylinder through a .016" orifice. To permit full accelerator travel, regardless of the retarded injector rack position, a spring loaded yield lever or link assembly replaces the standard operating lever connecting link to the governor.

Inspection

When inspecting the throttle delay hydraulic cylinder, it is important that the check valve be inspected for wear. Replace the check valve if necessary.

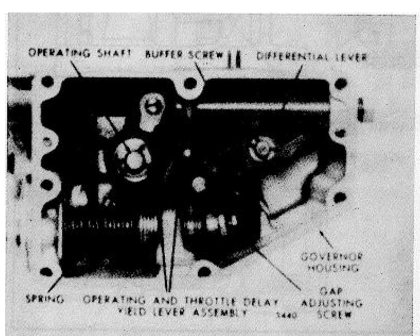


Fig. 4 - Throttle Delay Yield Lever (6V Engine)

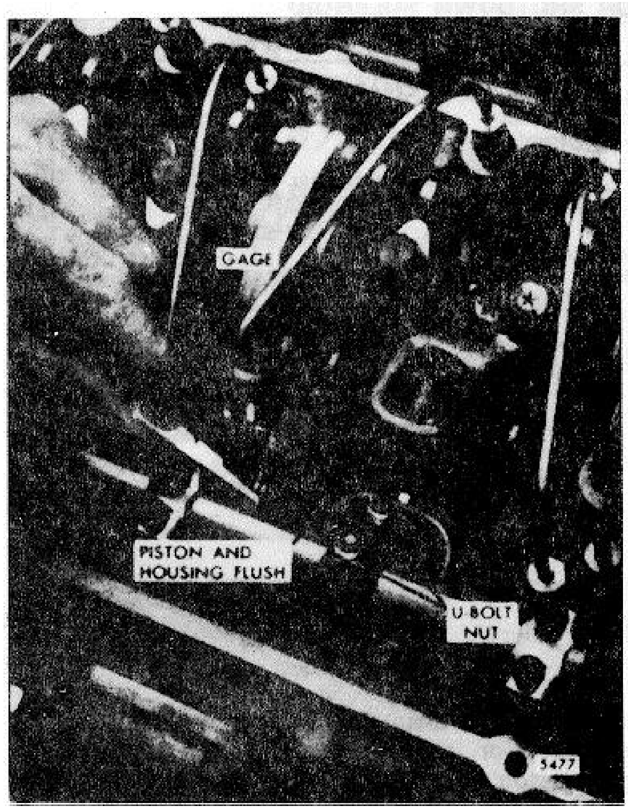


Fig. 5 - Adjusting Throttle Delay Cylinder

To inspect the check valve, fill the throttle delay cylinder with diesel fuel oil and watch for check valve leakage while moving the engine throttle from the idle position to the full fuel position.

Adjustment

Whenever the injector rack control levers are adjusted, disconnect the throttle delay mechanism by loosening the U-bolt which clamps the lever to the injector control tube. After the injector rack control levers have been positioned, the throttle delay mechanism must be re-adjusted. With the engine stopped, proceed as follows:

1. Refer to Fig. 5 and insert gage J 23190 (.454" setting) between the injector body and the shoulder on the injector rack. Then exert a light pressure on the injector control tube in the direction of full fuel.

2. Align the throttle delay piston so it is flush with the edge of the throttle delay cylinder.

3. Tighten the U-bolt on the injector control tube and remove the gage.

4. Move the injector rack from the no-fuel to full-fuel to make sure it does not bind.

ADJUSTMENT OF MECHANICAL GOVERNOR SHUTDOWN SOLENOID

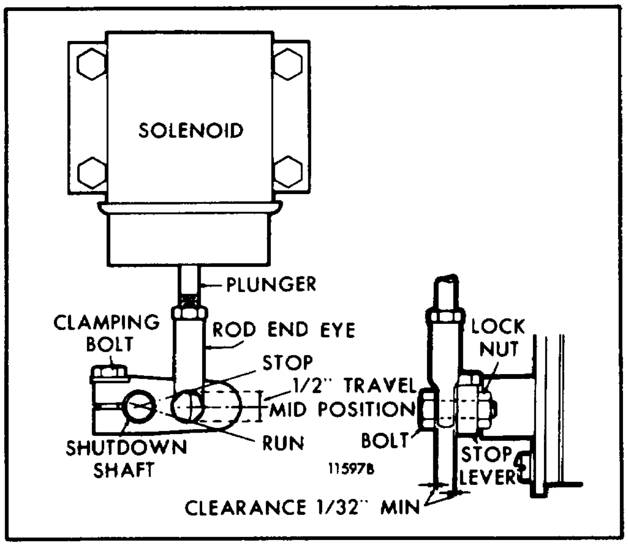


Fig. 6 - Typical Speed Governor Lever Position

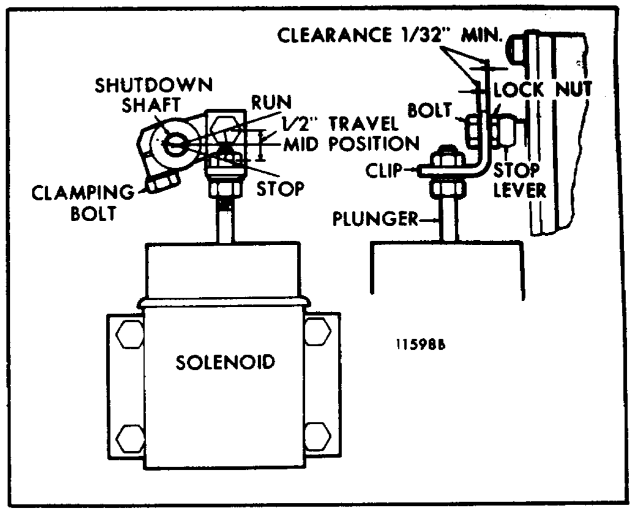


Fig. 7 - Typical Limiting Speed Governor Lever Position

When a governor shutdown solenoid is used on an engine equipped with a mechanical governor, the governor stop lever must be properly adjusted to match the shutdown solenoid plunger travel.

The solenoid plunger can be properly aligned to the governor stop lever as follows:

1. Remove the bolt connecting the rod end eye (variable speed governor), or the right angle clip (limiting speed governor) to the stop lever (Figs. 6 and 7). Align and clamp the lever to the shutdown shaft in such a way that, at its mid-travel position, it is perpendicular to the solenoid plunger. This assures that the linkage will travel as straight as possible. The solenoid plunger has available 1/2" travel which is more than adequate to move the injector control racks from the full-fuel to the complete no-fuel position and shutdown will occur prior to attaining complete travel.

2. With the stop lever in the run position, adjust the rod end eye or right angle clip for minimum engagement on the solenoid plunger when the connecting bolt is installed. The oversize hole in the eye or clip will thereby permit the solenoid to start closing the air gap, with a resultant build-up of pull-in force prior to initiating stop lever movement.

3. The bolt through the rod end eye or the right angle clip should be locked to the stop lever and adjusted to a height that will permit the eye or clip to float vertically. The clearance above and below the eye or clip and the bolt head should be approximately 1/32 " minimum.

NOTE: The lock nut can be either on top of or below the stop lever.

4. Move the lever to the stop position and observe the plunger for any possible bind. If necessary, loosen the mounting bolts and realign the solenoid to provide free plunger motion.

HYDRAULIC GOVERNOR AND INJECTOR RACK CONTROL ADJUSTMENT

The hydraulic governor is mounted on the 3 and 4-33 engines as shown in Fig. 1. The terminal lever return spring and the fuel rod are attached to an external terminal shaft lever. The maximum fuel position of the governor load limit is determined by the internal governor terminal lever striking against a boss that projects from the governor cover.

Adjust engines having a hydraulic governor assembly after adjusting the exhaust valve clearance and timing the fuel injectors.

Adjust Fuel Rod and Injector Rack Control Levers

1. Adjust the inner and outer adjusting screws (Fig. 2) on the rear injector rack control lever until both screws are equal in height and tight on the control tube. Check the clearance between the fuel rod and the cylinder head casting (below the bolt) for at least 1/16" clearance when the injector rack is in the *full-fuel* position and the rack adjusting screws are tight. If the fuel rod contacts the bolt or cylinder head casting, readjust the screws to obtain the 1/16" clearance.

> **NOTE:** Overtightening the injector rack control lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 in-lbs (3-4 Nm).

2. Remove the governor terminal lever return spring.

3. Remove the fuel rod end bearing or ball joint from the terminal shaft lever and the terminal lever from the terminal shaft.

4. Place the terminal lever on the terminal shaft so that the hole for attaching the fuel rod end bearing or ball joint is in line vertically above the terminal lever shaft at one half the arc of travel. Do not tighten the clamping bolt.

5. Hold the injector rack control tube and the terminal lever in the *full-fuel* position and adjust the length of the fuel rod until the end bearing or ball joint will slide freely into the hole of the terminal lever as shown in Fig. 3. Tighten the lock nut to retain the ball

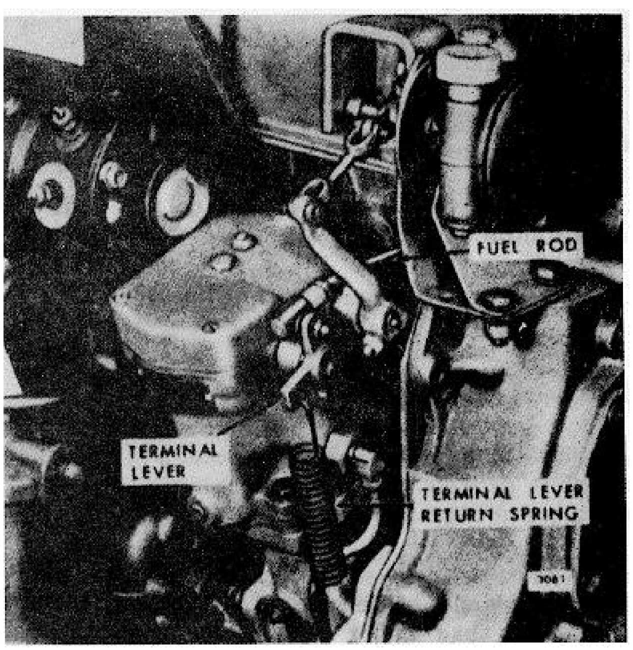


Fig. 1-Hydraulic Governor mounted on Engine

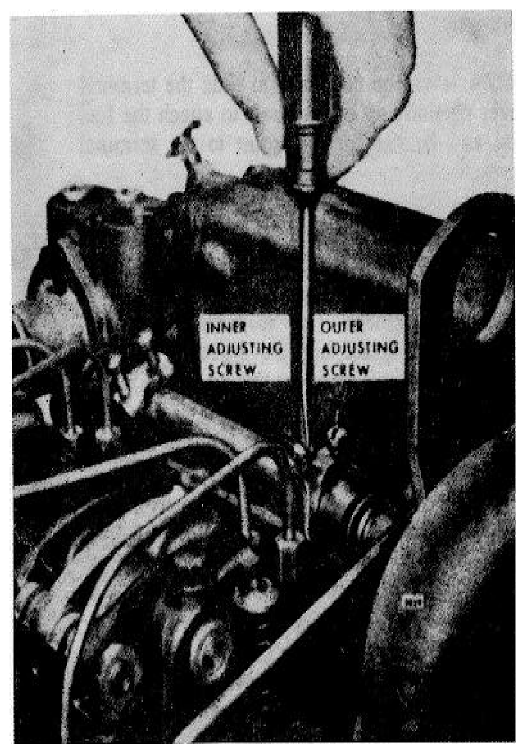


Fig. 2-Adjusting Height of Rack Control Lever Adjusting Screws.

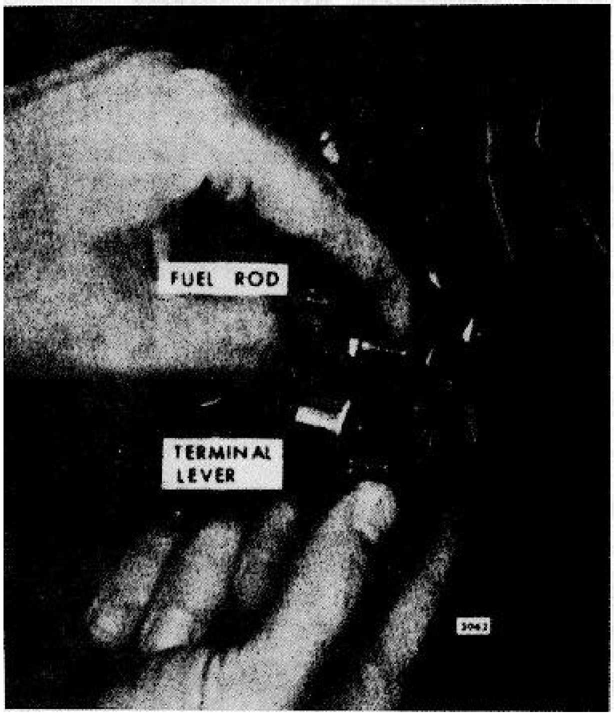


Fig. 3 - Adjusting Length of Fuel Rod

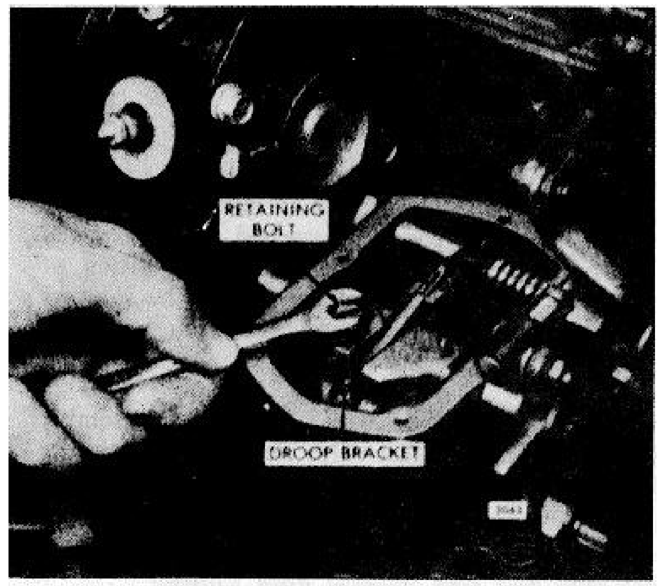


Fig. 4 - Adjusting Droop Bracket

joint or end bearing and the terminal lever clamping bolt securely.

> **NOTE:** It will be necessary to slide the terminal lever partially off of the shaft to attach the fuel rod end bearing or ball joint to the terminal lever.

6. Hold the terminal lever in *the full-fuel* position and loosen the inner adjusting screw 1/8 of a turn and tighten the outer adjusting screw 1/8 of a turn to retain the adjustment. This is done to prevent the governor from bottoming the injector racks, since there is no load limit screw on this governor.
7. Remove the clevis pin between the fuel rod and the injector control tube lever.

   NOTE: Cover the cylinder head oil drain back hole, located under the control lever, when removing the fuel rod clevis pin to prevent its loss and possible damage to the engine.
8. Manually hold the rear injector in the *full-fuel* position and turn down the inner rack control lever adjusting screw of the adjacent injector until the injector rack of the adjacent injector has moved into t*he full-fuel* position and the inner adjusting screw is bottomed on the injector control tube. Turn the outer adjusting screw down until it bottoms lightly on the Fig. 4 - Adjusting Droop Bracket injector control tube. Then alternately tighten both the inner and outer rack control lever adjusting screws.
9. Recheck the rear injector fuel rack to be sure that it has remained snug on the ball end of the rack control lever while adjusting the adjacent injector. If the rack of the rear injector has become loose, back off slightly on the inner adjusting screw on the adjacent injector rack control lever. Tighten the outer adjusting screw. When the settings are correct, the racks of both injectors must be snug on the ball end of their respective rack control levers.
10. Position the remaining rack control levers as outlined in Steps 8 and 9.
11. Insert the clevis pin between the fuel rod and the injector control tube lever.
12. Install the terminal lever return spring.

Adjust Speed Droop

The purpose of adjusting the speed droop is to establish a definite engine speed at no load with a given speed at rated full load.

The governor droop is set at the factory and further adjustment should be unnecessary. However, if the governor has had major repairs, the speed droop should be readjusted.
The best method of determining the engine speed is with an accurate hand tachometer.

Full Load	No-Load
50 cycles 1000 rpm	52.5 cycles 1050 rpm
60 cycles 1200 rpm	62.5 cycles 1250 rpm
50 cycles 1500 rpm	52.5 cycles 1575 rpm
60 cycles 1800 rpm	62.5 cycles 1875 rpm

TABLE 1

If a full-rated load can be established on the engine and the fuel rod, injector rack control levers and load limit have been adjusted, the speed droop may be adjusted as follows:

I. Start the engine and run it at approximately one-half the rated no-load speed until the lubricating oil temperature stabilizes.

NOTE: When the engine lubricating oil is cold, the governor regulation may be erratic. The regulation should become increasingly stable as the temperature of the lubricating oil increases.

Figure 5 - Adjusting Maximum Engine Speed

2. Stop the engine and remove the governor cover. Discard the gasket.
3. Loosen the lock nut and back off the maximum speed adjusting screw (Fig. 5) approximately *5/8"*

4. Refer to Fig. 4 and loosen the droop adjusting bolt. Move the droop bracket so that the bolt is midway between the ends of the slot in the bracket. Tighten the bolt.

5. With the throttle in the *run* position, adjust the engine speed until the engine is operating at 3% to 5% above the recommended full-load speed.

6. Apply the full-rated load on the engine and readjust the engine speed to the correct full-load speed.
7. Remove the rated load and note the engine speed after the speed stabilizes under no-load. If the speed droop is correct, the engine speed will be approximately 3% to 5% higher than the full-load speed.

If the speed droop is too high, stop the engine and again loosen the droop bracket retaining bolt and move the droop adjusting bracket *in* toward the engine. Tighten the bolt. To increase the speed droop, move the droop adjusting bracket *out,* away from the engine.

The speed droop in governors which control engines driving generators in parallel must be identical, otherwise, the electrical load will not be equally divided.

Adjust the speed droop bracket in each engine governor to obtain the desired variation between the engine no-load and full-load speeds shown in Table 1.
The recommended speed droop of generator sets operating in parallel is 50 rpm (2-1/2 cycles) for units operating at 1000 and 1200 rpm and 75 rpm (2-1/2 cycles) for units operating at 1500 rpm and 1800 rpm full load. This speed droop recommendation may be varied to suit the individual application.

Adjust Maximum No- Load Speed
With the speed droop properly adjusted, set the maximum no-load speed as follows:
1. Loosen the maximum speed adjusting screw lock nut and back out the maximum speed adjusting screw three turns.
2. With the engine operating at no-load, adjust the engine speed until the engine is operating at approximately 8% higher than the rated full-load speed.
3. Turn the maximum speed adjusting screw (Fig. 5) in lightly until contact is felt with the linkage in the governor.
4. Hold the maximum speed adjusting screw and tighten the lock nut.
5. Use a new gasket and install the governor cover.

HYDRAULIC GOVERNOR AND INJECTOR RACK CONTROL ADJUSTMENT

6V-53 Engine

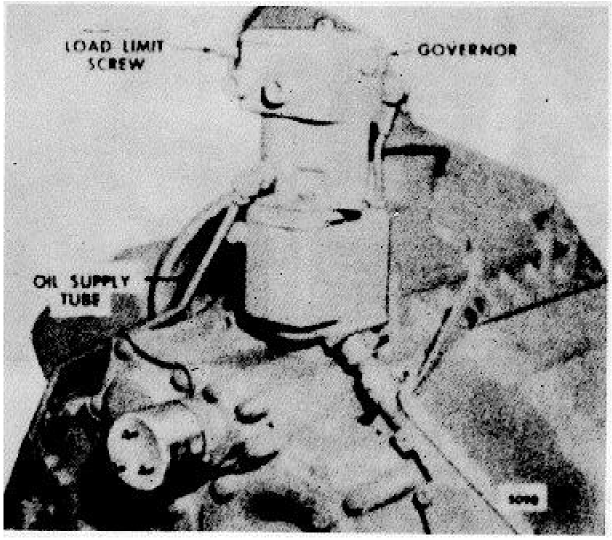


Fig. 1 - Hydraulic Governor Mounting

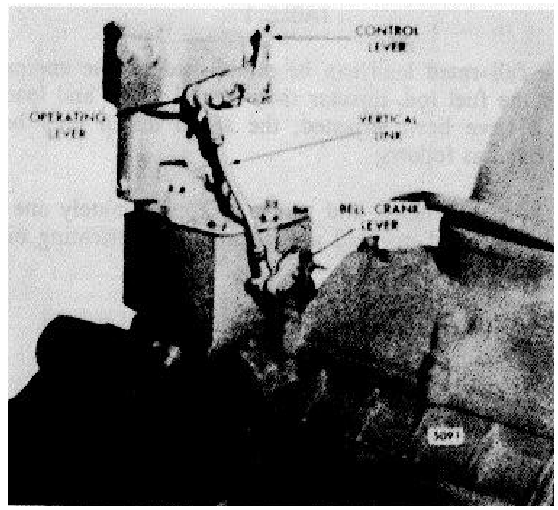


Fig. 2 - Hydraulic Governor Controls

The hydraulic governor Is mounted between the blower and the rear end plate as shown in Fig. 1. The vertical control link assembly is attached .to the governor operating lever and the bell crank lever on the governor drive housing (Fig. 2).

After adjusting the exhaust valves and timing the fuel injectors, adjust the governor as follows:

1. Disconnect the vertical control link assembly from the governor operating lever.

2. Loosen all of the injector rack control lever adjusting screws.

3. While holding the bell crank lever (on the governor drive housing) in a horizontal position (full-fuel), set the No. 3 injector rack control levers on each bank to full-fuel.

4. Position the remaining rack control levers to the No. 3 control levers.

5. Remove the governor cover. Discard the gasket.

6. To determine the full-fuel position of the terminal lever, adjust the load limit screw to obtain a distance of 2" from the outside face of the boss on the governor sub-cap to the end of the screw.

7. Adjust the operating lever (on the governor) so that it is horizontal, or slightly below (as close as the serrations on the shaft will permit) when the shaft is rotated to the full-fuel position, or clockwise when viewed from the front of the engine.

8. Loosen the lock nut and adjust the length of the vertical link assembly, attached to the bell crank lever, to match the full-fuel position of the governor operating lever and the injector rack control levers. This length should be approximately *6*-5/*16".* Tighten the lock nut.

9. With the governor operating lever held in the *full-fuel* position, turn the load limit screw ((Fig. 1) inward until the injector racks just loosen on the ball end of the control levers, to prevent the injector racks from bottoming.

10. Release the governor operating lever and hold the adjusting screw while tightening the lock nut.

11. Use new gaskets and install the governor cover and the valve rocker covers.

STORAGE
PREPARING ENGINE FOR STORAGE

When an engine is to be stored or removed from operation for a period of time, special precautions should be taken to protect the interior and exterior of the engine, transmission and other parts from rust accumulation and corrosion. The parts requiring attention and the recommended preparations are given below.

It will be necessary to remove all rust or corrosion completely from any exposed part before applying a rust preventive compound. Therefore, it is recommended that the engine be processed for storage as soon as possible after removal from operation.

The engine should be stored in a building which is dry and can be heated during the winter months. Moisture absorbing chemicals are available commercially for use when excessive dampness prevails in the storage area.
To protect an engine for a temporary period of time, proceed as follows:
1. Drain the engine crankcase.
2. Fill the crankcase to the proper level with the recommended viscosity and grade of oil.
3. Fill the fuel tank with the recommended grade of fuel oil. Operate the engine for two minutes at 1200 rpm and no load.

NOTE: Do not drain the fuel system or the crankcase after this run.

4. Check the air cleaner and service it, if necessary, as outlined under *Air System.*
5. If freezing weather is expected during the storage period, add a high boiling point type antifreeze solution in, accordance with the manufacturer's recommendations. Drain the raw water system and leave the drain cocks open.
6. Clean the entire exterior of the engine (except the electrical system) with fuel oil and dry it with air.
7. Seal all of the engine openings. The material used for this purpose must be waterproof, vaporproof and possess sufficient physical strength to resist puncture and damage from the expansion of entrapped air.

An engine prepared in this manner can be returned to service in a short time by removing the seals at the engine openings, checking the engine coolant, fuel oil, lubricating oil, transmission, and priming the raw water pump, if used.
When an engine is to be removed from operation for an extended period of time, prepare it as follows:

1. Drain and thoroughly flush the cooling system with clean, soft water.
2. Refill the cooling system with clean, soft water.
3. Add a rust inhibitor to the cooling system (refer to *Corrosion Inhibitor* under *Cooling System).*
4. Remove, check and recondition the injectors, if necessary, to make sure they will be ready to operate when the engine is restored to service.
5. Reinstall the injectors in the engine, time them, and adjust the valve clearance.
6. Circulate the coolant through the entire system by operating the engine until normal operating temperature is reached (160-185 F or 71-85 ° C).
7. Stop the engine.
8. Remove the drain plug and completely drain the engine crankcase. Reinstall and tighten the drain plug. Install new lubricating oil filter elements and gaskets.
9. Fill the crankcase to the proper level with a 30-weight preservative lubricating oil MIL-L-21260, Grade 2 (P10), or equivalent.
10. Drain the engine fuel tank.
11. Refill the fuel tank with enough rust preventive fuel oil such as American Oil Diesel Run-In Fuel (LF

4089), Mobil 4Y17, or equivalent, to enable the engine to operate 10 minutes.

12. Drain the fuel filter and strainer. Remove the retaining bolts, shells and elements. Discard the used elements and gaskets. Wash the shells in clean fuel oil and insert new elements. Fill the cavity between the element and shell about two-thirds full of the same rust preventive compound as used in the fuel tank and reinstall the shell.
13. Operate the engine for 10 minutes to circulate the rust preventive throughout the engine.
14. Refer to *Air System* and service the air cleaner.
15. MARINE GEAR
    a. Drain the oil completely and refill with clean oil of the proper viscosity and grade as is recommended. Remove, clean or replace the strainer and replace the filter element.
    b. Start and run the engine at 600 rpm for 5 minutes so that clean oil can coat all of the internal parts of the marine gear. Engage the clutches alternately to circulate clean oil through all of the moving parts.

16. TORQMATIC CONVERTER
    a. Start the engine and operate it until the temperature of the converter oil reaches 150°*F* (66 0 C).
    b. Remove the drain plug and drain the converter.
    c. Remove the filter element.
    d. Start the engine and stall the converter for twenty seconds at 1000 rpm to scavenge the oil from the converter. *Due to lack of lubrication, do not exceed the 20 second limit.*
    e. Install the drain plug and a new filter element.
    f. Fill the converter to the proper operating level with a commercial preservative oil which meets Government specifications MIL-L-2 1260, Grade 1. Oil of this type is available from the major oil companies.
    g. Start the engine and operate the converter for at least 10 minutes at a minimum of 1000 rpm. Engage the clutch; then stall the converter to raise the oil temperature to 225 0 F (107 ° C).

    CAUTION: Do not allow the oil temperature to exceed 225 F (107°C). If the unit does not have a temperature gage, *do not stall the converter for more than thirty seconds.*

    h. Stop the engine and permit the converter to cool to a temperature suitable to touch.
    i. Seal all of the exposed openings and the breather with moisture proof tape.
    j. Coat all exposed, unpainted surfaces with preservative grease. Position all of the controls for minimum exposure and coat them with grease. The external shafts, flanges and seals should also be coated with grease.
17. POWER TAKE-OFF
    a. With an all purpose grease such as Shell Alvania No. 2, or equivalent, lubricate the clutch throwout bearing, clutch pilot bearing, drive shaft main bearing, clutch release shaft, and the outboard bearings (if so equipped).
    b. Remove the inspection hole cover on the clutch housing and lubricate the clutch release lever and link pins with a hand oiler. Avoid *getting oil* on the clutch facing.
    c. If the unit is equipped with a reduction gear, drain and flush the gear box with light engine oil. If the unit is equipped with a filter, clean the shell and replace the filter element. Refill the gear box to the proper level with the oil grade indicated on the name plate.
18. TURBOCHARGER

The turbocharger bearings are lubricated by pressure through the external oil line leading from the engine cylinder block while performing the previous operations above and no further attention is required. However, the turbocharger air inlet and turbine outlet connections should be sealed off with moisture-resistant tape.

19. HYDROSTARTER SYSTEM

Refer to *Hydraulic Starting System* in the section on *Engine Equipment* for the lubrication and preventive maintenance procedure.

20. Apply a *non-friction* rust preventive compound, to all exposed parts. If it is convenient, apply the rust preventive compound to the engine flywheel. If not, disengage the clutch mechanism to prevent the clutch disc from sticking to the flywheel.

CAUTION: Do not apply oil, grease or any wax base compound to the flywheel. The cast iron will absorb these substances which can "sweat" out during operation and cause the clutch to slip.

21. Drain the engine cooling system.
22. The oil may be drained from the engine crankcase if so desired. If the oil is drained, reinstall and tighten the drain plug.
23. Remove and clean the battery and battery cables with a baking soda solution and rinse them with fresh water. Do not allow the soda solution to enter the battery. Add distilled water to the electrolyte, if necessary, and fully charge the battery. Store the battery in a cool (never below 32 ° F or 0°C) dry place. Keep the battery fully charged and check the level and the specific gravity of the electrolyte regularly.
24. Insert heavy paper strips between the pulleys and belts to prevent sticking.
25. Seal all of the openings in the engine, including the exhaust outlet, with moisture resistant tape. Use cardboard, plywood or metal covers where practical.
26. Clean and dry the exterior painted surfaces of the engine. Spray the surfaces with a suitable liquid automobile body wax, a synthetic resin varnish or a rust preventive compound.
27. Cover the engine with a good weather-resistant tarpaulin or other cover if it must be stored outdoors. A clear plastic cover is recommended for indoor storage. The stored engine should be inspected periodically. If there are any indications of rust or corrosion, corrective steps must be taken to prevent damage to the engine parts. Perform a complete inspection at the end of one year and apply additional treatment as required.

PROCEDURE FOR RESTORING AN ENGINE TO SERVICE WHICH HAS BEEN IN EXTENDED STORAGE

1. Remove the covers and tape from all of the openings of the engine, fuel tank, and electrical equipment. *Do not overlook the exhaust outlet.*
2. Wash the exterior of the engine with fuel oil to remove the rust preventive.
3. Remove the rust preventive from the flywheel.
4. Remove the paper strips from between the pulleys and the belts.
5. Remove the drain plug and drain the preservative oil from the crankcase. Re-install the drain plug. Then refer to *Lubrication System* in the *Operating Instructions* and fill the crankcase to the proper level with the recommended grade of lubricating oil.
6. Fill the fuel tank with the fuel specified under *Diesel Fuel Oil Specifications.*
7. Close all of the drain cocks and fill the engine cooling system with clean soft water and a rust inhibitor. If the engine is to be exposed to freezing temperatures, add a high boiling point type antifreeze solution to the cooling system (the antifreeze contains a rust inhibitor).
8. Install and connect the battery.
9. Service the air cleaner as outlined under *Air System.*
10. POWER GENERATOR

    Prepare the generator for starting as outlined under *Operating Instructions.*
11. MARINE GEAR

Check the Marine gear; refill it to the proper level, as necessary, with the correct grade of lubricating oil.

12. TORQMATIC CONVERTER
    a. Remove the tape from the breather and all of the openings.
    b. Remove all of the preservative grease with a suitable solvent.
    c. Start the engine and operate the unit until the temperature reaches 150°F (66°C). Drain the preservative oil and remove the filter. Start the engine and stall the converter for twenty seconds at 1000 rpm to scavenge the oil from the converter.

    CAUTION: A Torqmatic converter containing preservative oil should only be operated enough to bring the oil temperature up to 150°F (66 0 C).

    d. Install the drain plug and a new filter element.

e. Refill the converter with the oil that is recommended under *Lubrication and Preventive Maintenance.*

13. POWER TAKE-OFF

Remove the inspection hole cover and inspect the clutch release lever and link pins and the bearing ends of the clutch release shaft. Apply engine oil sparingly, if necessary, to these areas.

14. HYDROSTARTER

a. Open the relief valve on the side of the hand pump and release the pressure in the system.

b. Refer to the filling and' purging procedures outlined in *Hydraulic Starting System.* Then, drain, refill and purge the hydrostarter system.

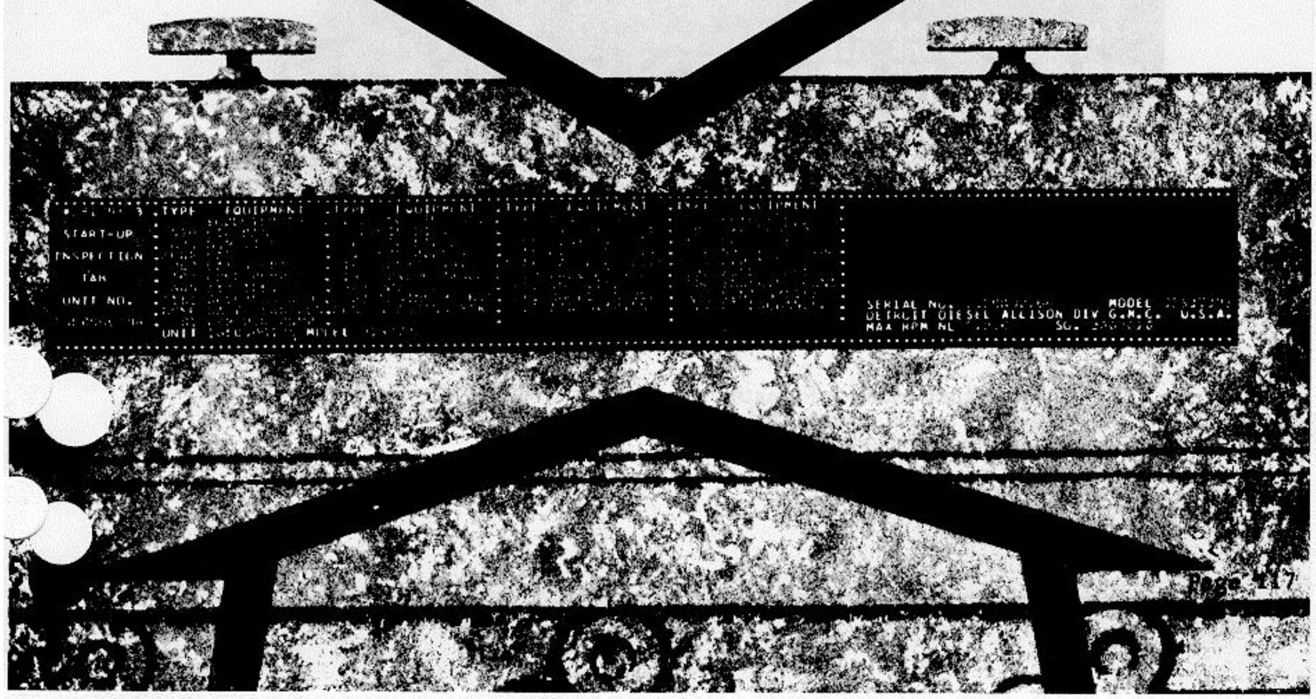
15. TURBOCHARGER

Remove the covers from the turbocharger air inlet and turbine outlet connections. Refer to the lubricating procedure outlined in *Preparation for Starting Engine First Time.*

16. After all of the preparations have been completed, start the engine. The small amount of rust preventive compound which remains in the fuel system will cause a smoky exhaust for a few minutes.

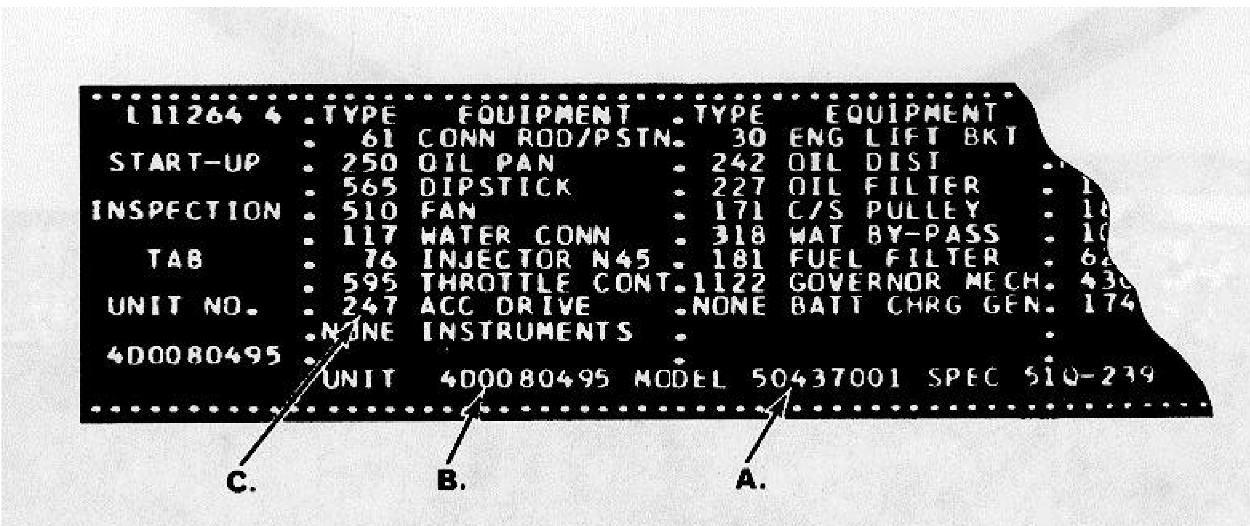
NOTE: Before subjecting the engine to a load or high speed, it is advisable to check the engine tune-up.

BUILT-IN PARTS BOOK



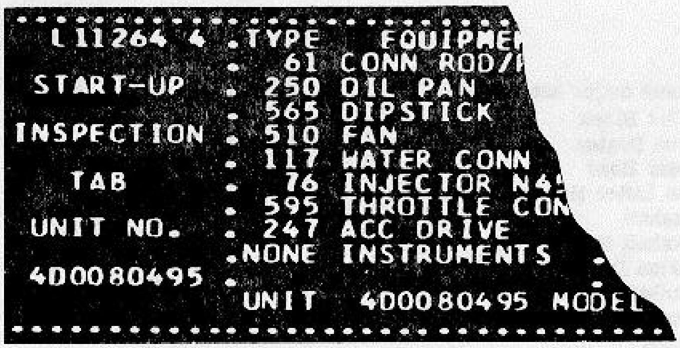
Progress in industry comes at a rapid pace. In order for the engine manufacturer to keep pace with progress he needs a versatile product for the many models and arrangements of accessories and mounting parts needed to suit a variety of equipment. In addition, engine refinements and improvements are constantly being introduced. All of this dynamic action must be documented so that the equipment can be serviced if and when it's needed. It is fully documented in the manufacturer's plant and in dealer Parts Departments with Master Files and adequate supporting records. But, what about YOU the user of this equipment? You have neither the time nor the inclination to ferret out specific part number data. What is the answer?-It is Detroit Diesel's exclusive BUILT-IN PARTS BOOK which is furnished with each engine. It takes the form of an "Option Plate" mounted on the rocker cover of the engine. With it, ordering parts becomes as simple as A, B, C. You have merely to provide the Dealer with ...

A. The "Model" number **B.** The "UNIT" number **C.** The "TYPE" number

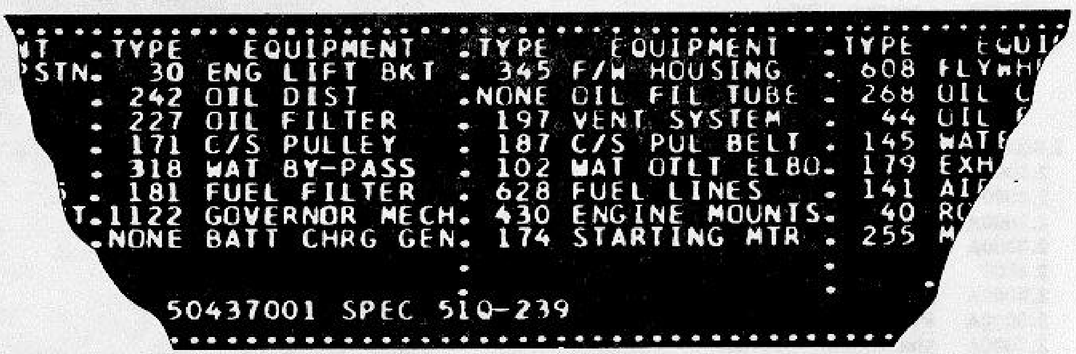


From that much information, the dealer with his complete records on all engine models, can completely interpret your parts requirements.

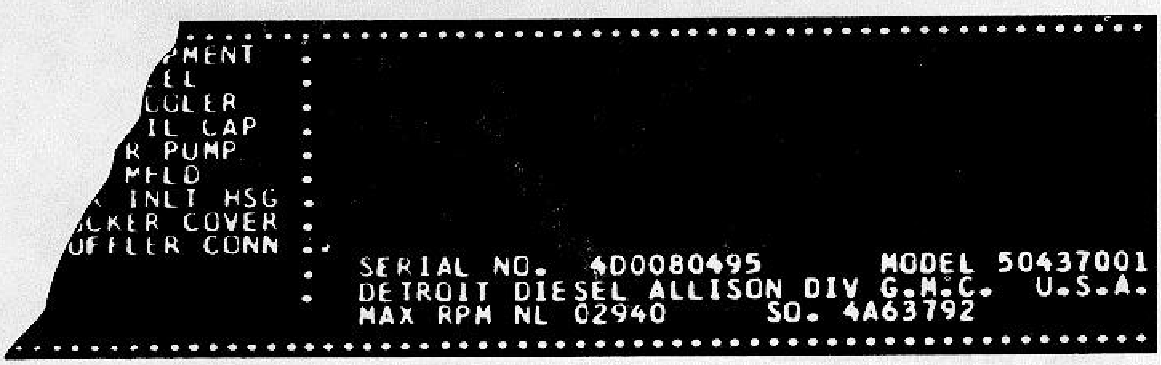
What is this "built-in" book? It is a photo etched aluminum plate that fits into a holding channel on the engine rocker cover.



ON THE LEFT SIDE of the plate is the Start-up Inspection Tab which is removed by the dealer when he has completed the inspection.



NEXT is the type number and the equipment description. On the left is the type number. The type number designates all service parts applicable to the equipment. On the right is a brief description of the equipment.



ON THE RIGHT SIDE of the plate is shown the model number, serial number and the related governor setting.

All engine components are divided into groups of functionally related parts. A complete listing of the twelve major groups and their many sub-groups is shown below.

GROUP NOMENCLATURE

1.0000 ENGINE (less major assemblies)

1.1000	Cylinder Block
1.1000A	Air Box Drains
1.2000	Cylinder Head
1.2000A	Engine Lifter Bracket
1.3000	Crankshaft
1.3000A	Crankshaft Front Cover
1.3000B	Vibration Damper
1.3000C	Crankshaft Pulley
1.3000D	Crankshaft Pulley Belt
1.4000A	Flywheel
1.5000A	Flywheel Housing
1.5000B	Flywheel Housing Adaptor
1.6000	Connecting Rod and Piston
1.7000	Camshaft and Gear Train
1.7000A	Balance Weight Cover
1.7000B	Accessory Drive
1.8000	Valve and Injector Operating Mechanism
1.8000A	Rocker Cover

2.0000 FUEL SYSTEM

2.1000A	Fuel Injector
2.2000	Fuel Pump
2.2000A	Fuel Pump Drain
2.3000A	Fuel Filter
2.4000	Fuel Manifold and/or Connections
2.5000A	Fuel Lines
2.6000A	Fuel Tank
2.7000A	Mechanical Governor
2.8000A	Hydraulic Governor
2.9000	Injector Controls
2.9000A	Throttle Controls

3.0000 AIR SYSTEM

3.1000A	Air Cleaner and/or Adaptor
3.2000A	Air Silencer
3.3000A	Air Inlet Housing
3.4000	Blower
3.4000A	Blower Drive Shaft
3.5000A	Turbocharger

4.0000 LUBRICATING SYSTEM

4.1000A	Oil Pump
4.1000B	Oil Distribution System
4.1000C	Oil Pressure Regulator
4.2000A	Oil Filter
4.3000A	Oil Filter Lines
4.4000A	Oil Cooler
4.5000A	Oil Filler
4.6000A	Dipstick
4.7000A	Oil Pan
4.8000A	Ventilating System

5.0000 COOLING SYSTEM

5.1000	Fresh Water Pump
5.1000A	Fresh Water Pump Cover
5.2000A	Water Outlet Manifold and/or Elbow
5.2000B	Thermostat
5.2000C	Water By-pass Tube
5.3000A	Radiator
5.3000B	Water Connections
5.4000A	Fan
5.4000B	Fan Shroud
5.5000A	Heat Exchanger or Keel Cooling
5.6000A	Raw Water Pump
5.7000A	Water Filter

6.0000 EXHAUST SYSTEM

6.1000A	Exhaust Manifold
6.2000A	Exhaust Muffler and/or Connections

7.0000 ELECTRICAL-INSTRUMENTS

7.1000A	Battery Charging Generator
7.2000B	Automatic Starting
7.3000A	Starting Motor
7.4000A	Instruments
7.4000B	Tachometer Drive
7.4000C	Shut-off or Alarm System
7.5000A	Power Generator
7.6000A	Control Cabinet
7.7000A	Wiring Harness
7.8000A	Air Heater

8.0000 POWER TAKE-OFF

8.1000A	Power Take-off and/or Clutch
8.3000A	Torque Converter
8.3000B	Transmission Lines

9.0000 TRANSMISSION AND PROPULSION

9.1000A	Hydraulic Marine Gear
9.3000A	Power Transfer Gear
9.4000	Transmission-Highway
9.7000	Transmission-Off-highway

10.0000 SHEET METAL

10.1000A	Engine Hood

11.0000 ENGINE MOUNTING

11.1000A	Engine Mounting and Base

12.0000 MISCELLANEOUS

12.2000A	Bilge Pump
12.3000A	Vacuum Pump
12.4000A	Air Compressor
12.5000A	Hydraulic Pump
12.6000A	Gasoline Starter
12.6000B	Air Starter
12.6000C	Cold Weather Starting Aid
12.6000D	Hydraulic Starter
12.6000E	Hydraulic Starter Accessories

Within each of these sub-groups, various designs of similar equipment are categorized as "Types" and identified by a Type Number.

The Distributor/Dealer has an Index for each engine model. The Index lists all of the "Standard" and "Standard Option" equipment for that model.

DETROIT DIESEL 53 MPC 5063-5000 (RA)

STANDARD AND STANDARD OPTION EQUIPMENT

GROUP NAME	GROUP NO.	TYPE
CYLINDER BLOCK	1.1000	31
AIR BOX DRAINS	1.1000A	62
CYLINDER HEAD (4 VALVE)	1.2000	26
ENGINE LIFTER BRACKET	1.2000A	44
CRANKSHAFT	1.3000	44
CRANKSHAFT FRONT COVER	1.3000A	65
CRANKSHAFT PULLEY (2 GROOVES)	1.3000C	171
CRANKSHAFT PULLEY BELT	1.3000D	121
FLYWHEEL	1.4000A	328
FLYWHEEL HOUSING (SAE #3)	1.5000A	350
CONNECTING ROD AND PISTON	1.6000	68
CAMSHAFT AND GEAR TRAIN	1.7000	35
VALVE OPERATING MECHANISM	1.8000	33
ROCKER COVER	1.8000A	64
FUEL INJECTOR N50	2.1000A	74
FUEL PUMP	2.2000	73
FUEL FILTER	2.3000A	358
FUEL MANIFOLD CONNECTIONS	2.4000	48
FUEL LINES	2.5000A	786
GOVERNOR—MECHANICAL	2.7000A	514

NOTE The Distributor/Dealer uses his model index to interpret the standard equipment. The plate, therefore, lists only the non-standard or choice items.

So, from the plate, give the dealer the

A-Model No. __________
B-Unit No. __________
***C-Type No.** __________

*(If not shown, indicate "NONE". The dealer knows the "standard" for the model).

FOR READY REFERENCE, Transfer the information on the Option Plate to this record.

MODEL NO.__________________ **UNIT NO.**__________________

EQUIPMENT	TYPE	EQUIPMENT	TYPE	EQUIPMENT	TYPE
Engine Base		Water Bypass Tube		Battery Chrg. Generator	
Engine Lifter Brkt.		Thermostat		Starter	
Flywheel Housing		Water Filter		Hyd. Starter Acces.	
Vibration Damper		Exhaust Manifold		Starting Aid	
Flywheel		Air Cleaner or Silencer		Marine Gear	
Flywheel Hsg. Adptr.		Fuel Pump		Torque Converter	
Oil Pan		Injector		Torque Converter Lines	
Oil Pump		Blower		Muffler & Conn.	
Oil Distribution		Blower Drive Shaft		Engine Hood	
Dipstick		Fuel Filter		Wiring Harness	
Oil Pan Drain Tube		Fuel Lines		Instruments	
Oil Filler Tube or Cap		Air Inlet Housing		Tach. Drive	
Oil Cooler		Alarm or Shutoff		Radiator	
Oil Filter		Overspeed Governor		Heat Ex. or Keel Cooling	
Oil Lines		Throttle Controls		Raw Water Pump	
Ventilating System		Injector Controls		Power Generator	
Crankshaft Cover		Governor Mech or Hyd		Control Cabinet	
Balance Wgt. Cover		Engine Mounts		Cylinder Head	
Fan		Power Take-off		Conn Rod & Piston	
Crankshaft Pulley		Hydraulic Pump		Valve Mechanism	
Crankshaft Pulley Belt		Air Compressor		Fuel Manifold Conn	
Fan Shroud		Camshaft & Gear Train			
Water Connections		Rocker Cover			
Water Pump Cover		Accessory Drive			
Water Manifold					

OTHER USEFUL INFORMATION:

Each fuel and lube oil filter on your engine has a decal giving the service package part number for the element. It is advisable to have your own personal record of these part numbers by filling in the chart provided below:

TYPE	LOCATION	PACKAGE PART NO.
Fuel Strainer		
Fuel Filter		
Lube Oil Filter Full-Flo		
Lube Oil Filter By-Pass*		

*Not Standard

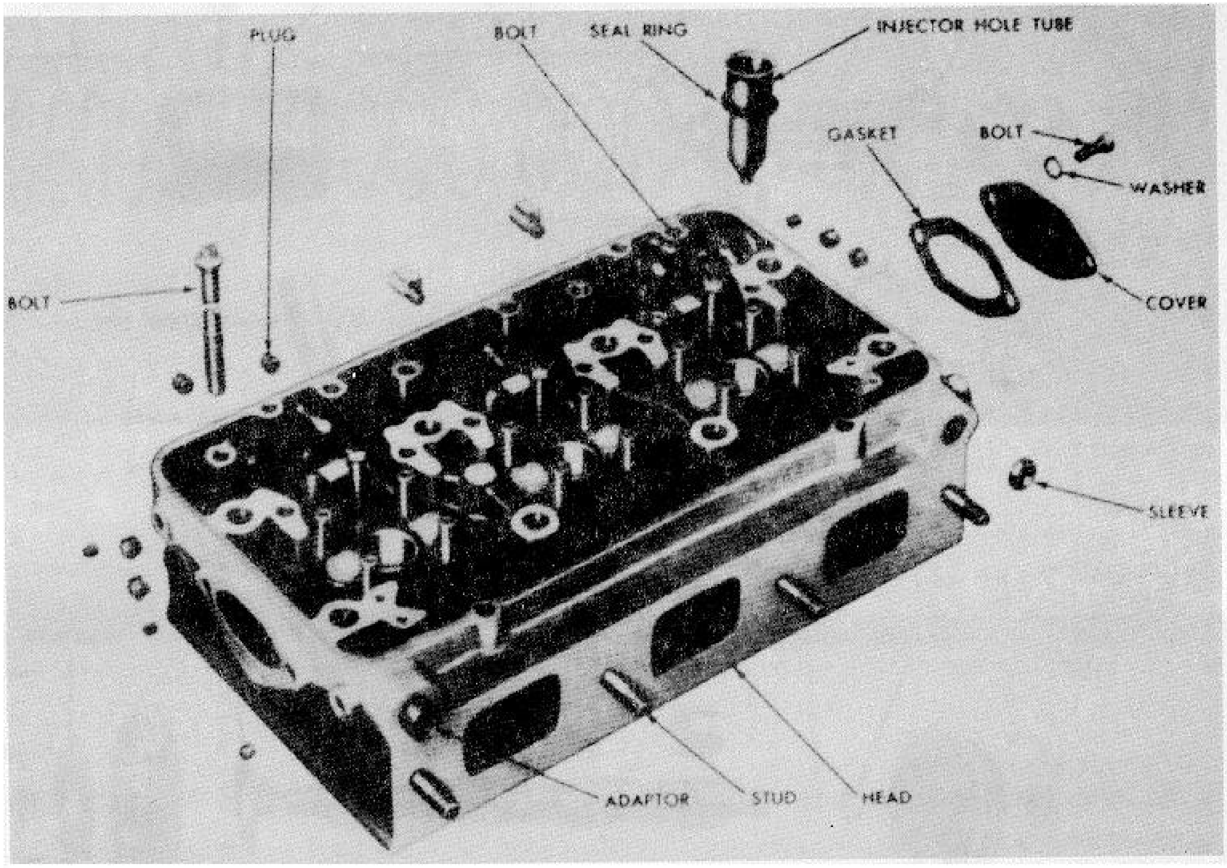
AIR CLEANER

If dry-type, indicate make and number of filter element:

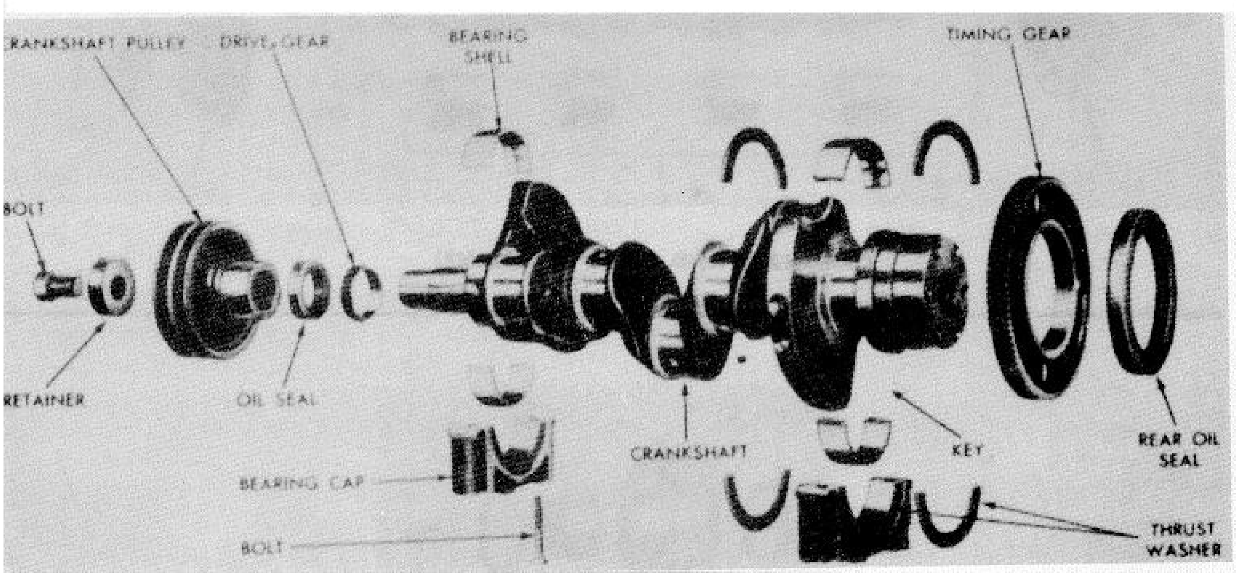
____

____

Wet type, indicate capacity ____________ qts.



CYLINDER HEAD



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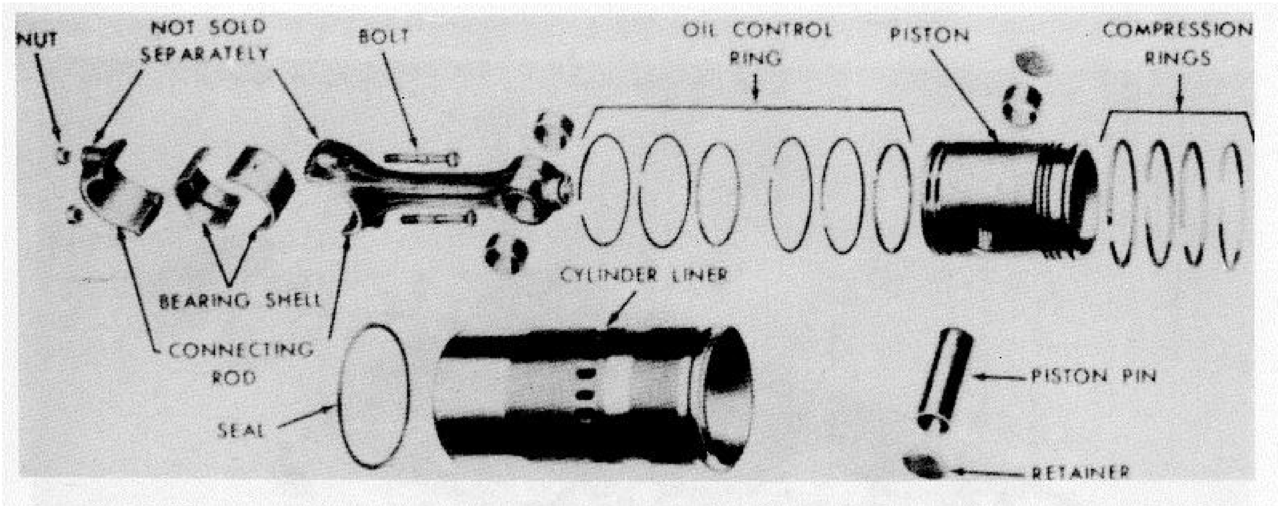
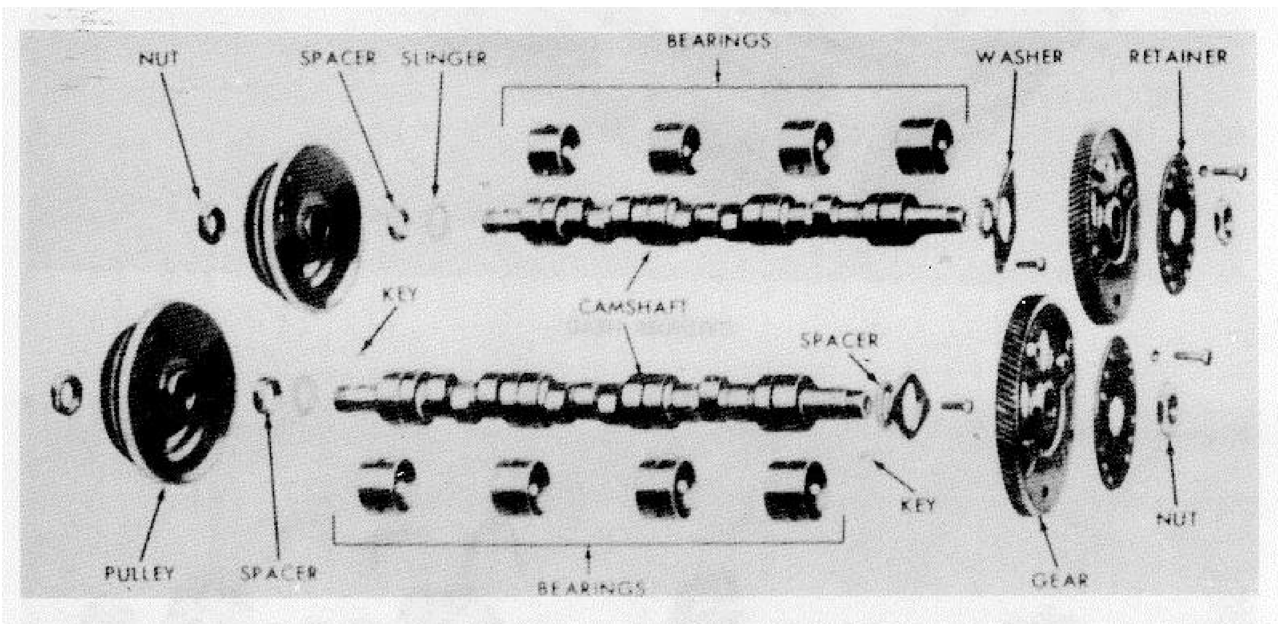


CONNECTING ROD, PISTON AND LINEAR



CAMSHAFT AND GEAR (V-ENGINE)

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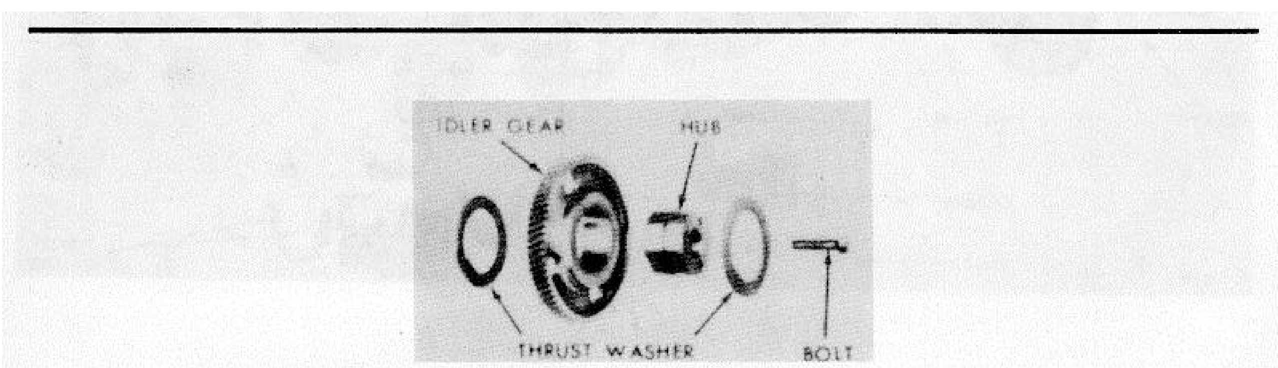
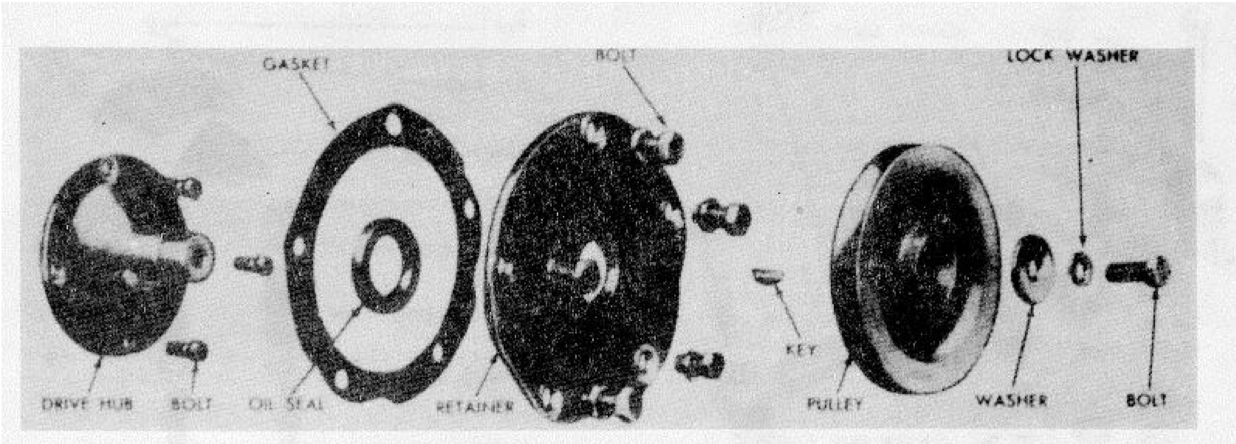
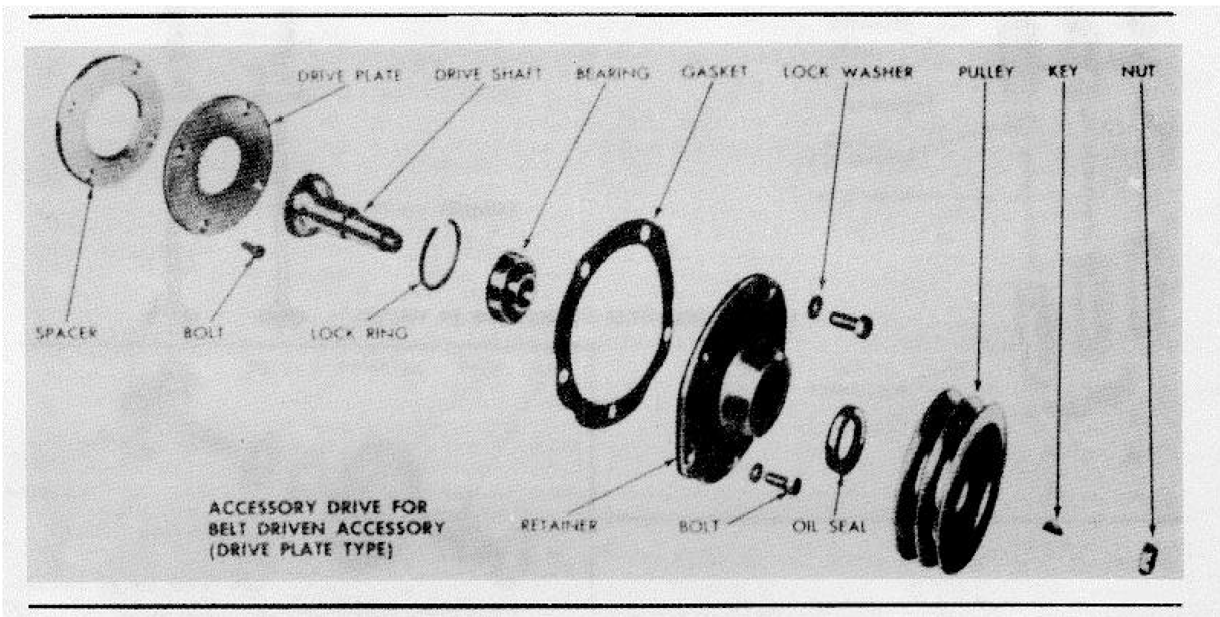
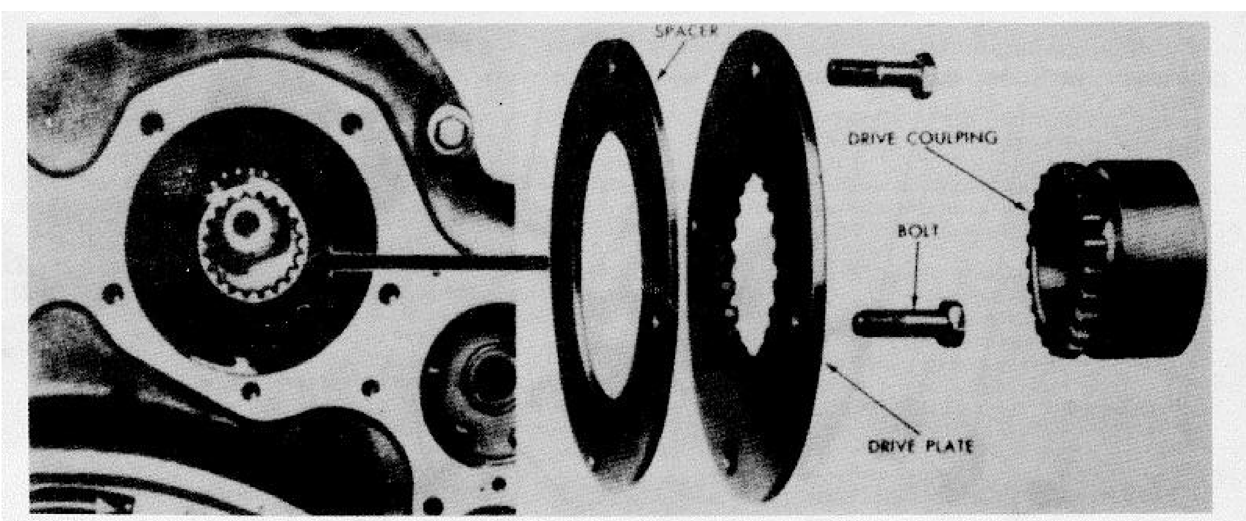


IDLER GEAR

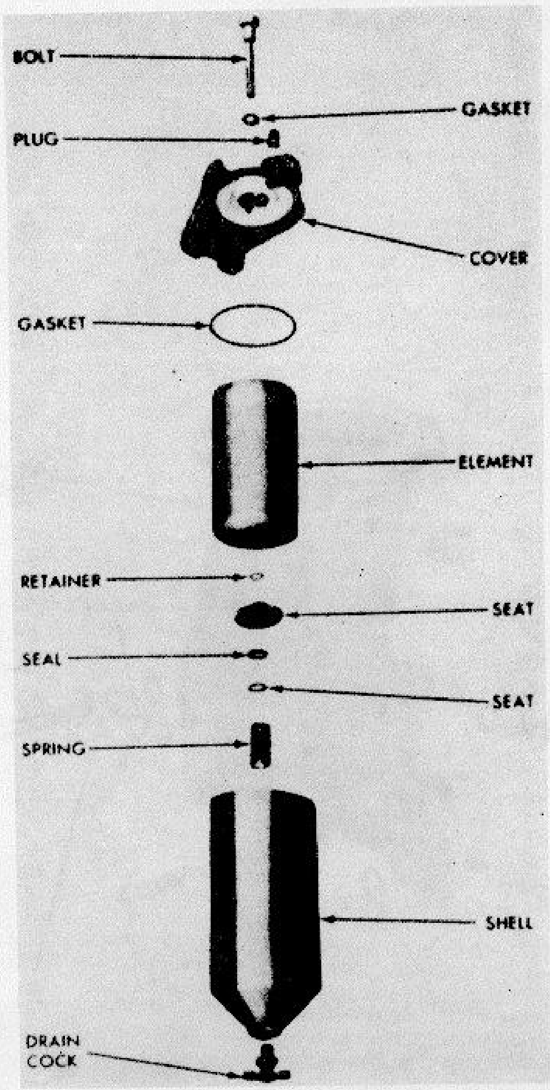


ACCESSORY DRIVE FOR BELT DRIVEN ACCESSORY (DRIVE HUB TYPE)

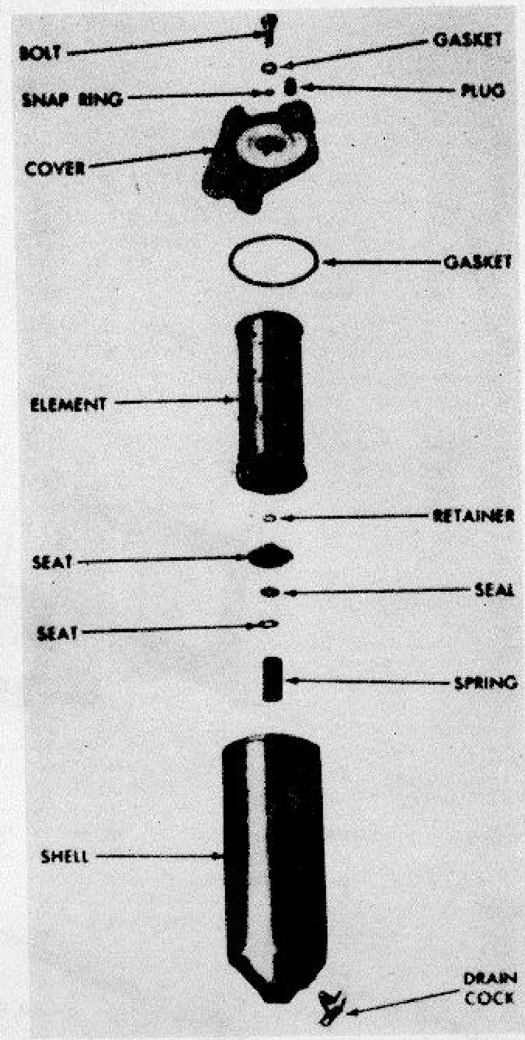




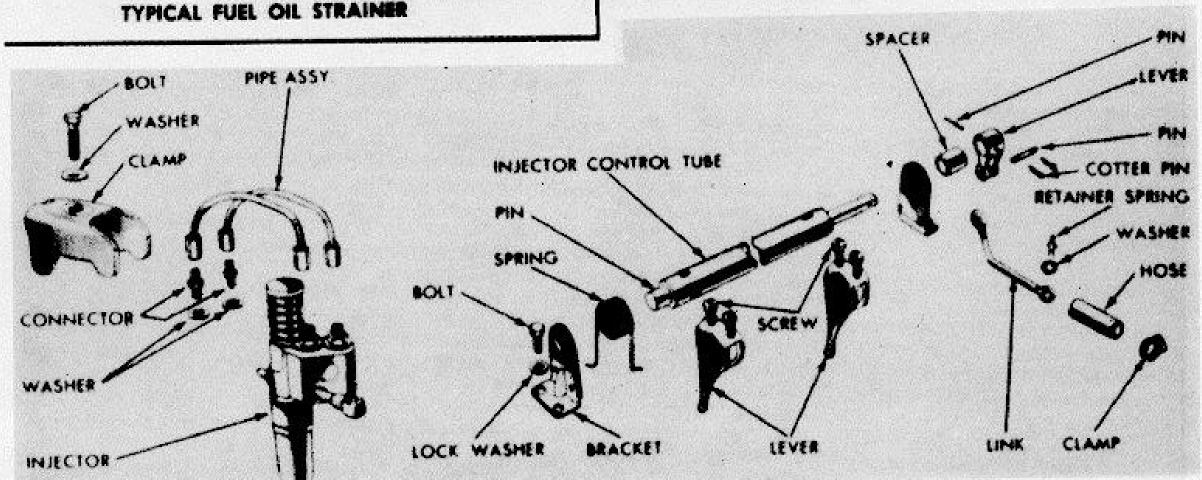
ACCESSORY DRIVE FOR DIRECT DRIVEN ACCESSORY (CAMSHAFT GEAR)



TYPICAL FUEL OIL STRAINER



TYPICAL FUEL OIL FILTER



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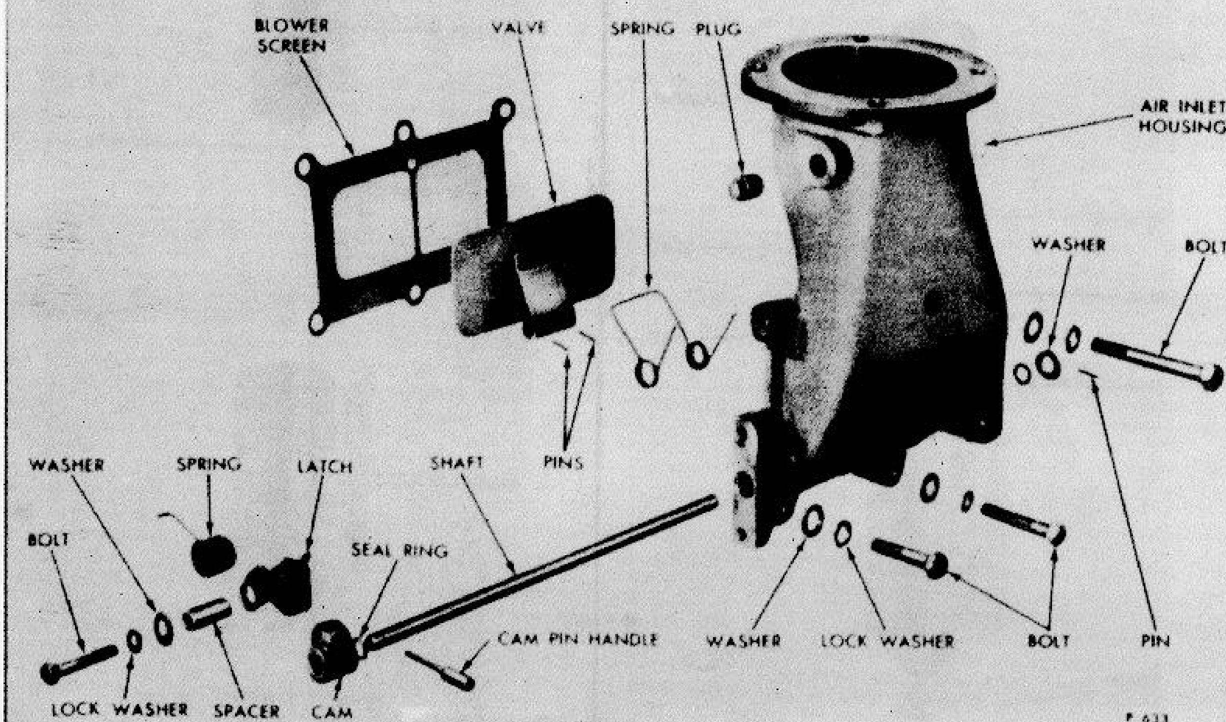
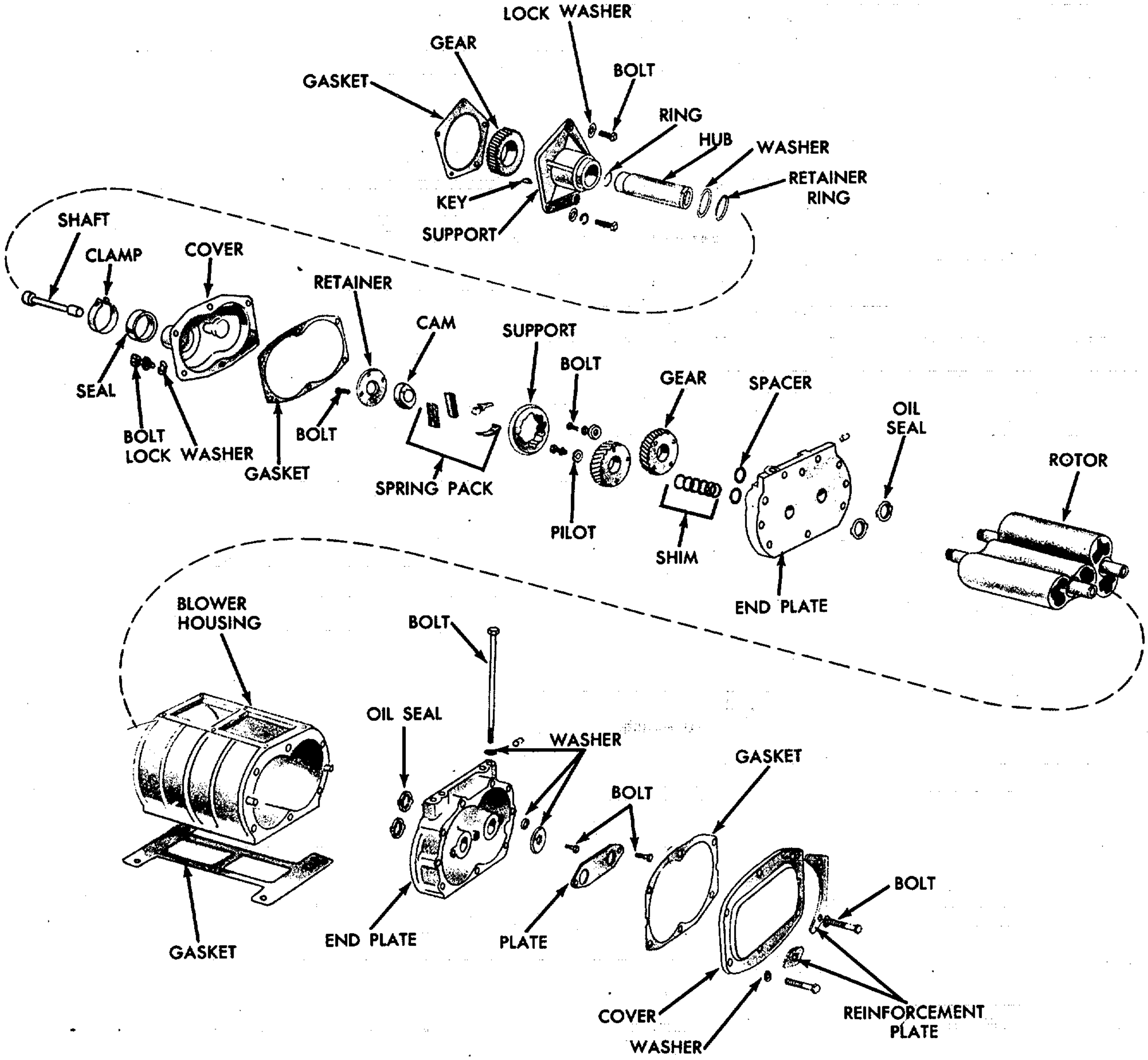
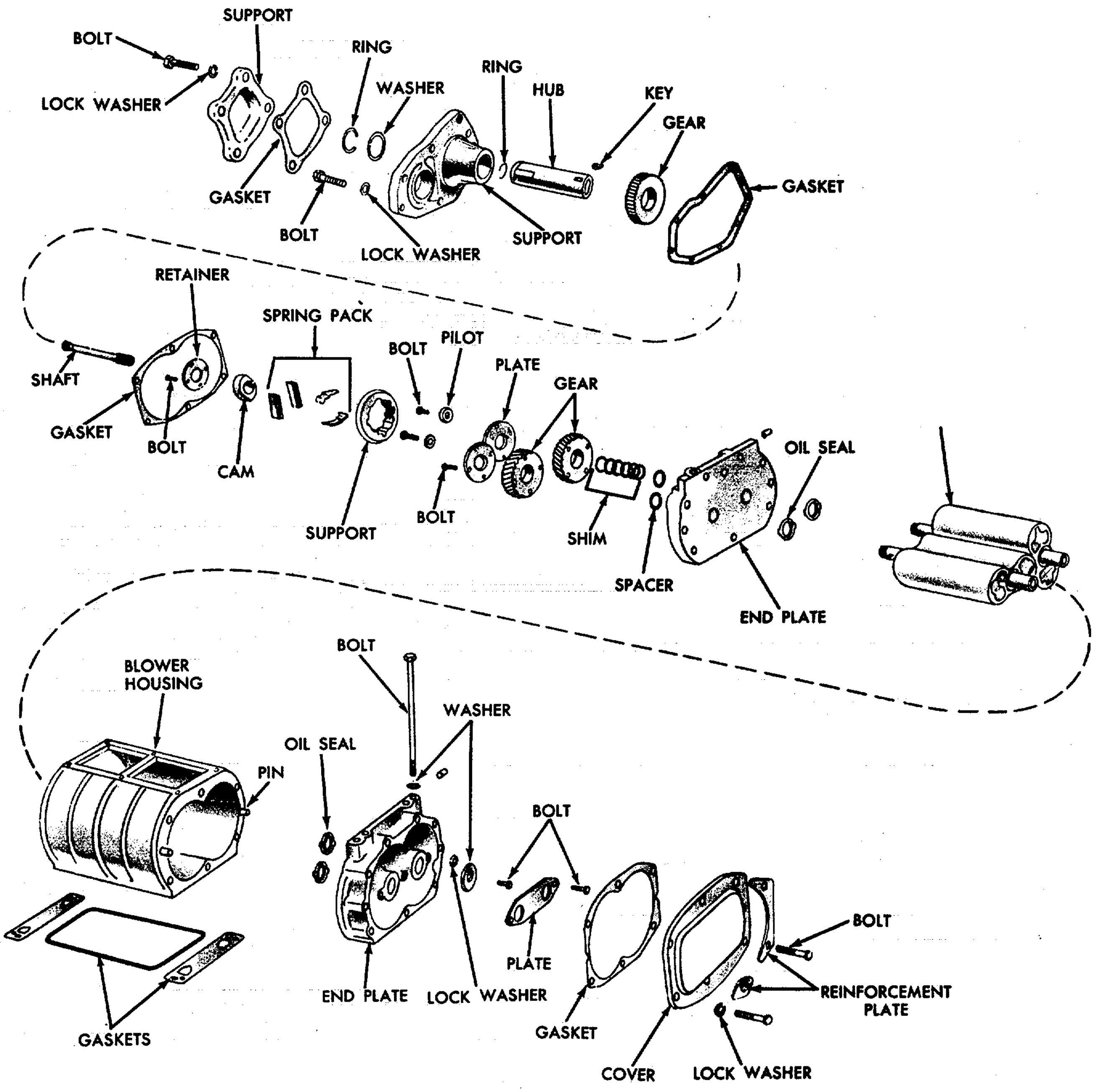
INJECTOR AND CONTROLS



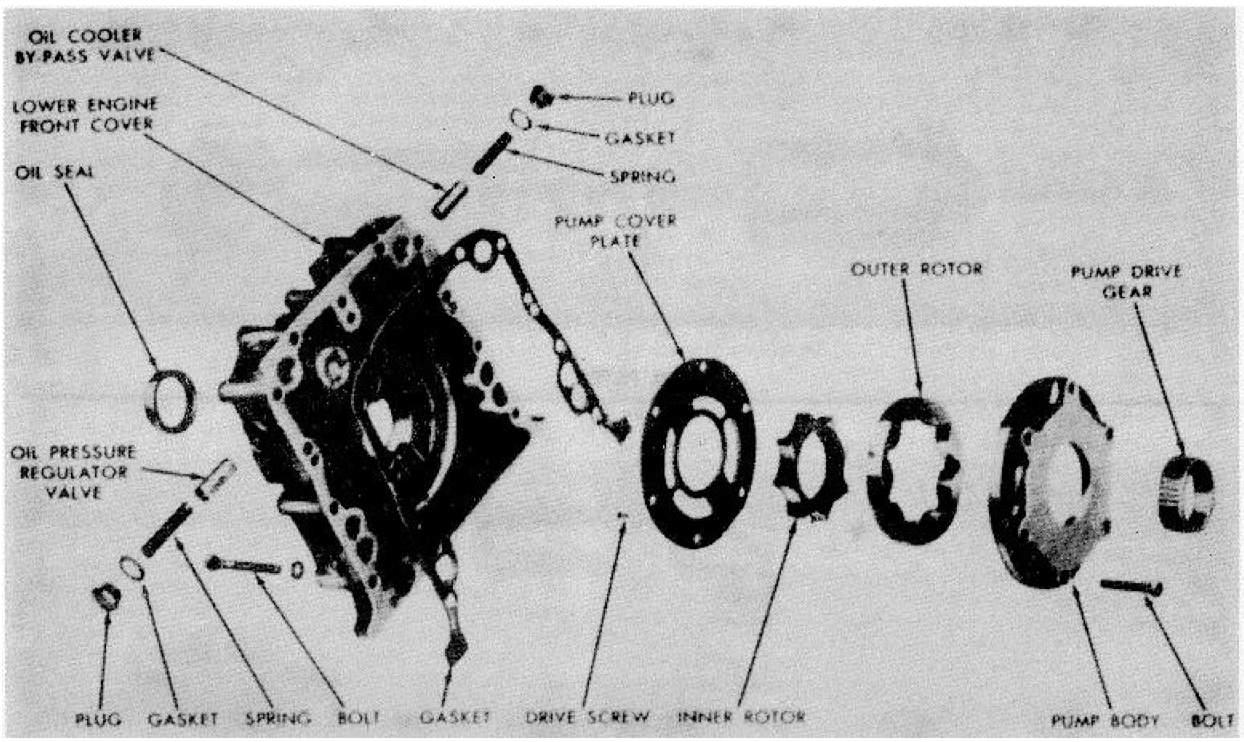
AIR SHUT-DOWN HOUSING



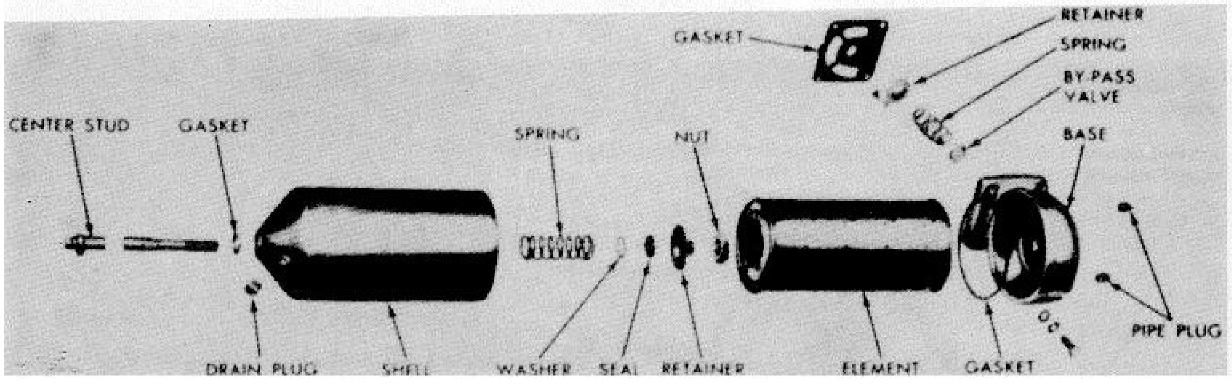
BLOWER ASSEMBLY AND DRIVE
(4 CYL.)



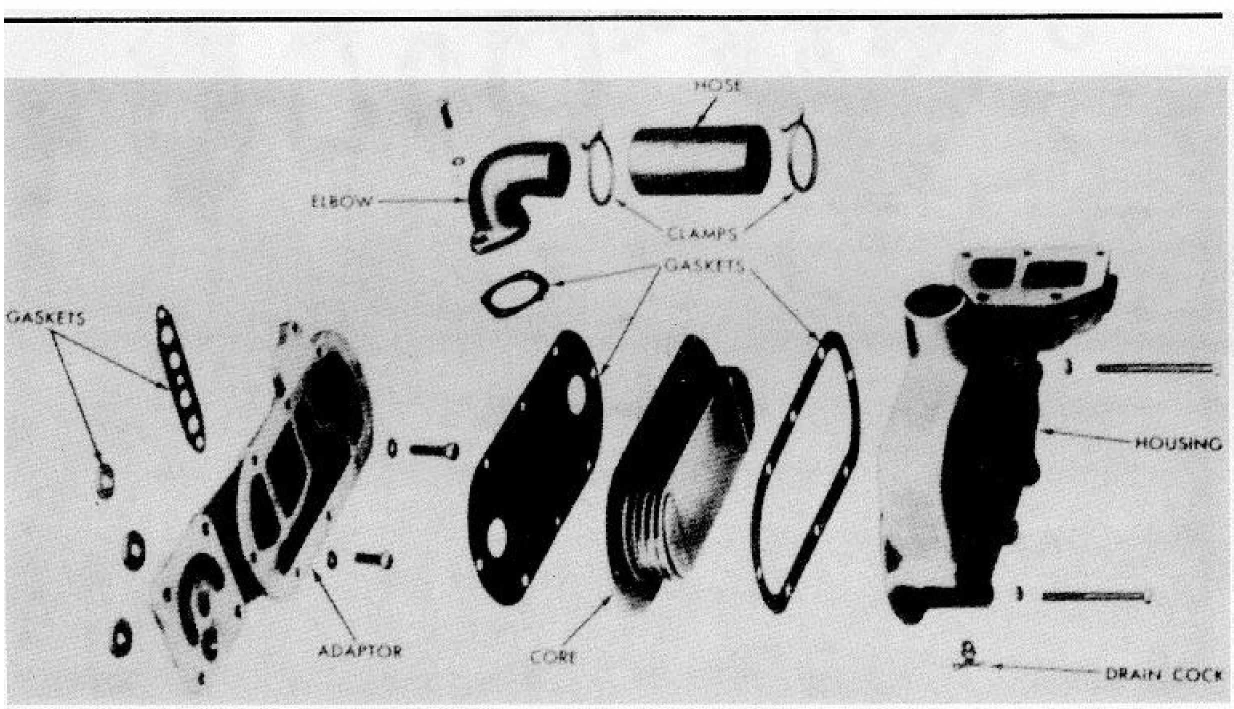
BLOWER ASSEMBLY AND DRIVE (6 CYL.)



OIL PUMP AND REGULATOR

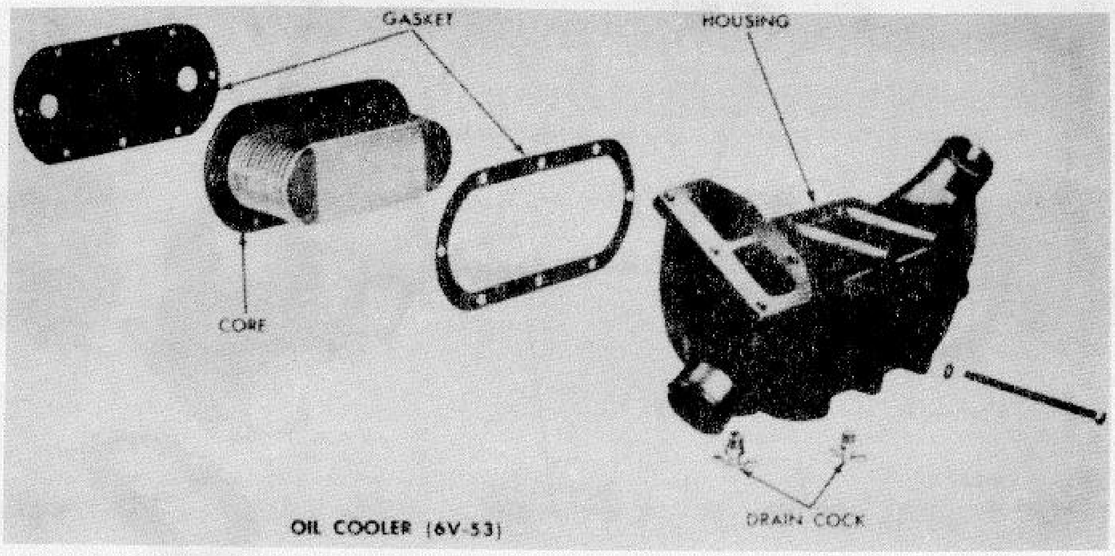


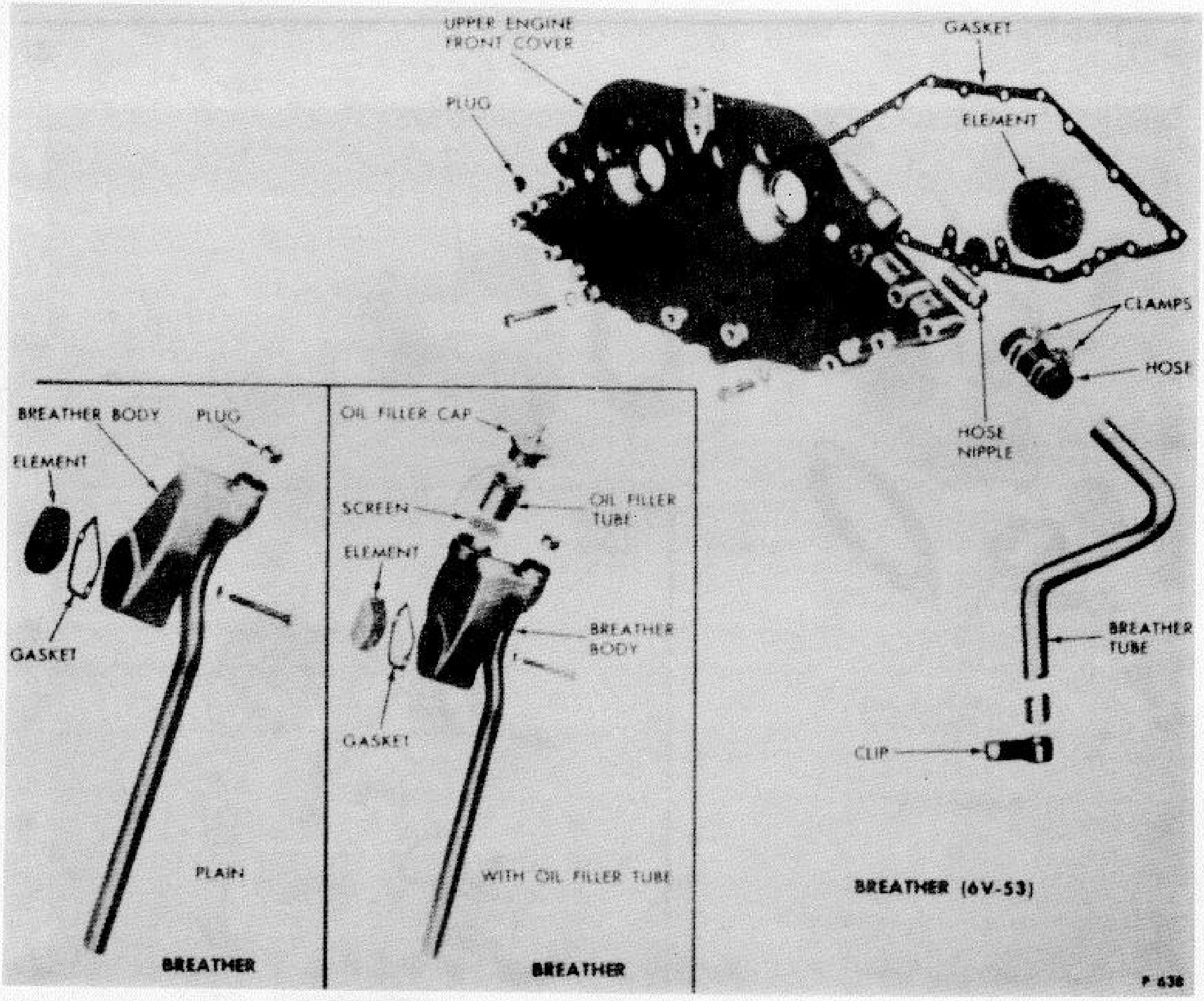
OIL FILTER



OIL COOLER

P 637


GASKET
HOUSING
CORE
DRAIN COCK
OIL COOLER (6V-53)


UPPER ENGINE FRONT COVER
GASKET
PLUG
ELEMENT
CLAMPS
HOSE
HOSE NIPPLE
BREATHER BODY
PLUG
ELEMENT
GASKET
PLAIN
BREATHER
OIL FILLER CAP
SCREEN
OIL FILLER TUBE
ELEMENT
BREATHER BODY
GASKET
WITH OIL FILLER TUBE
BREATHER
BREATHER TUBE
CLIP
BREATHER (6V-53)
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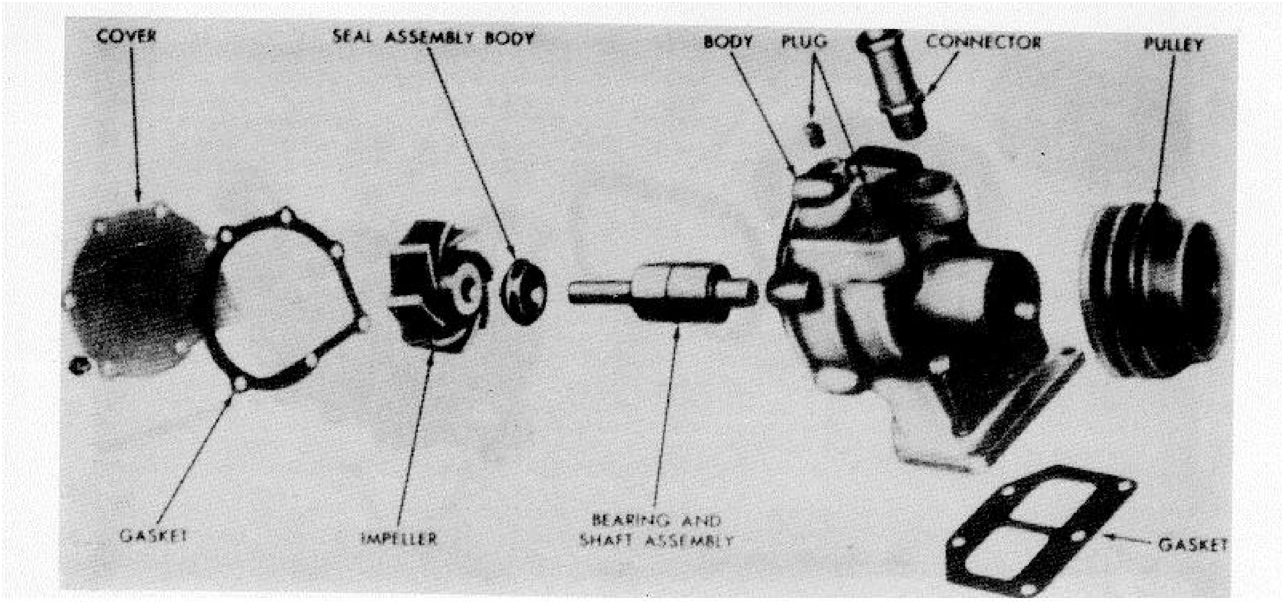
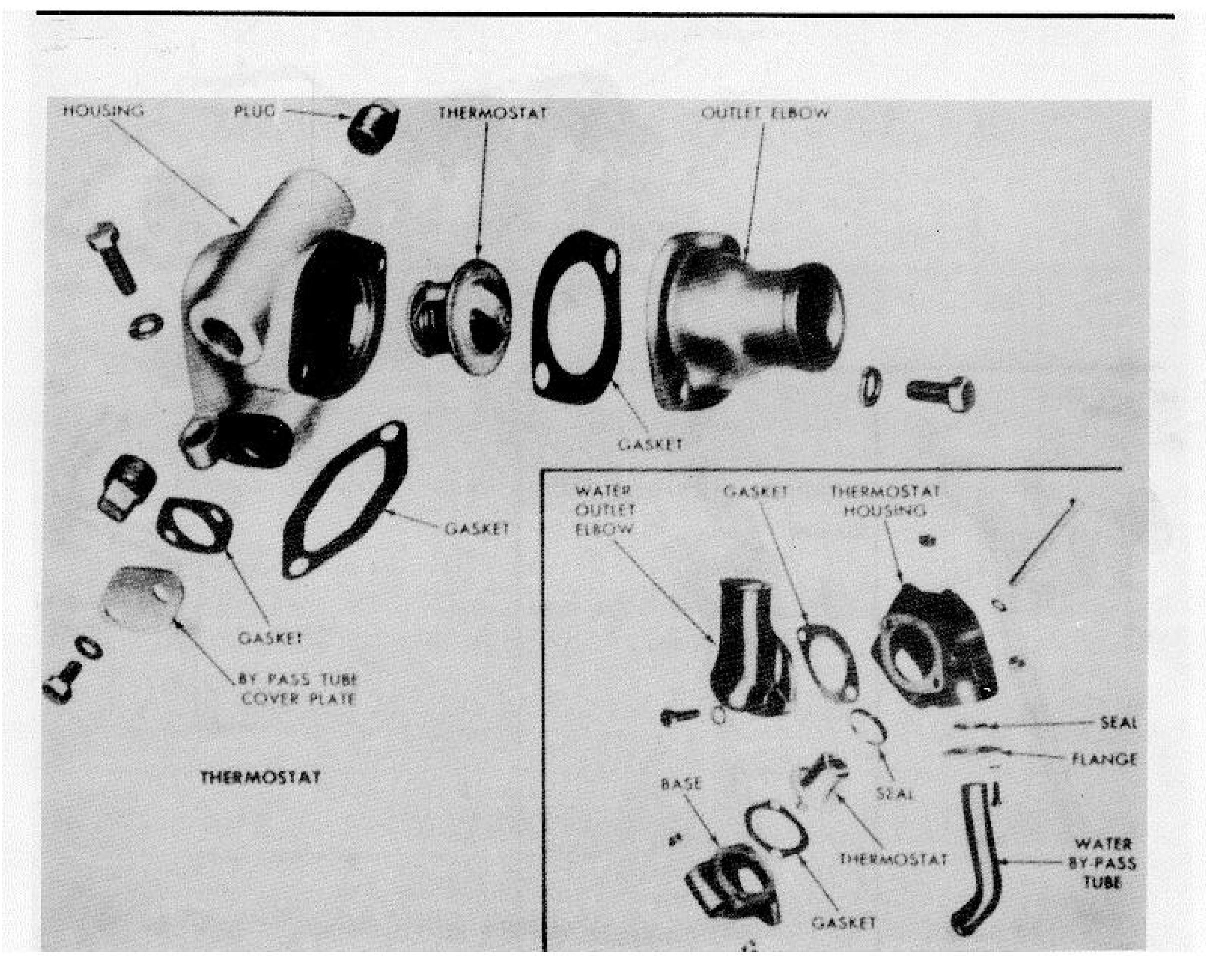


FRESH WATER PUMP



THERMOSTAT (6V-53

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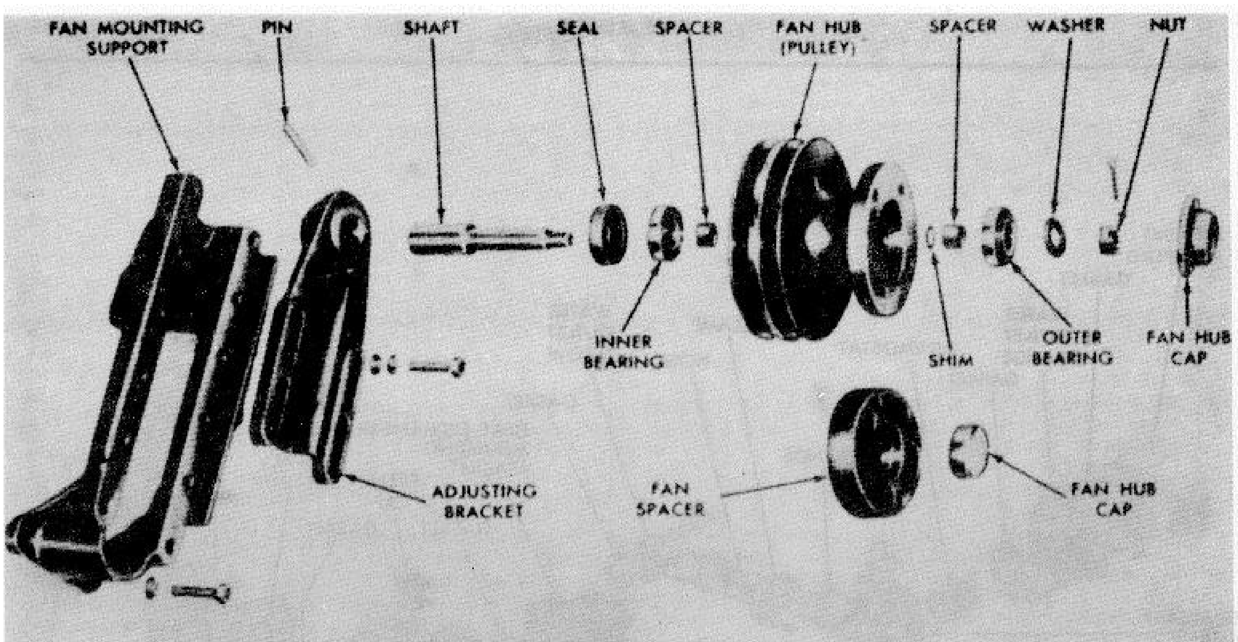
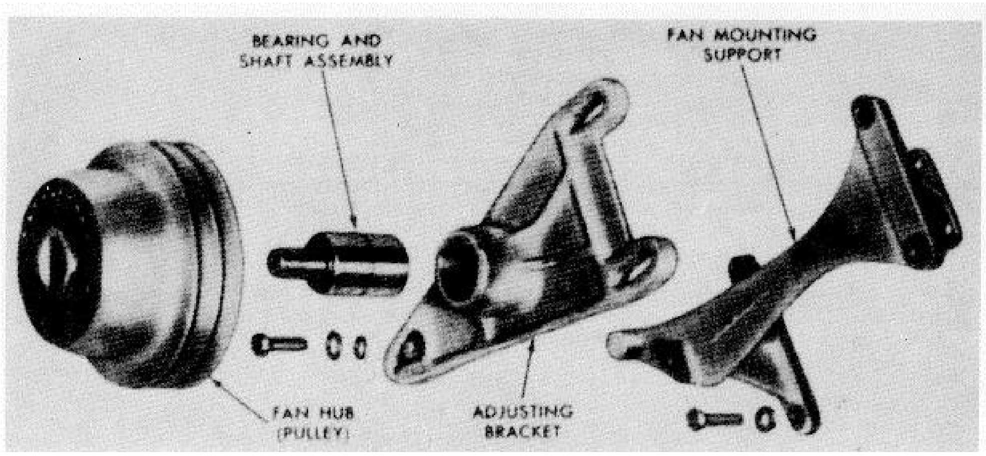
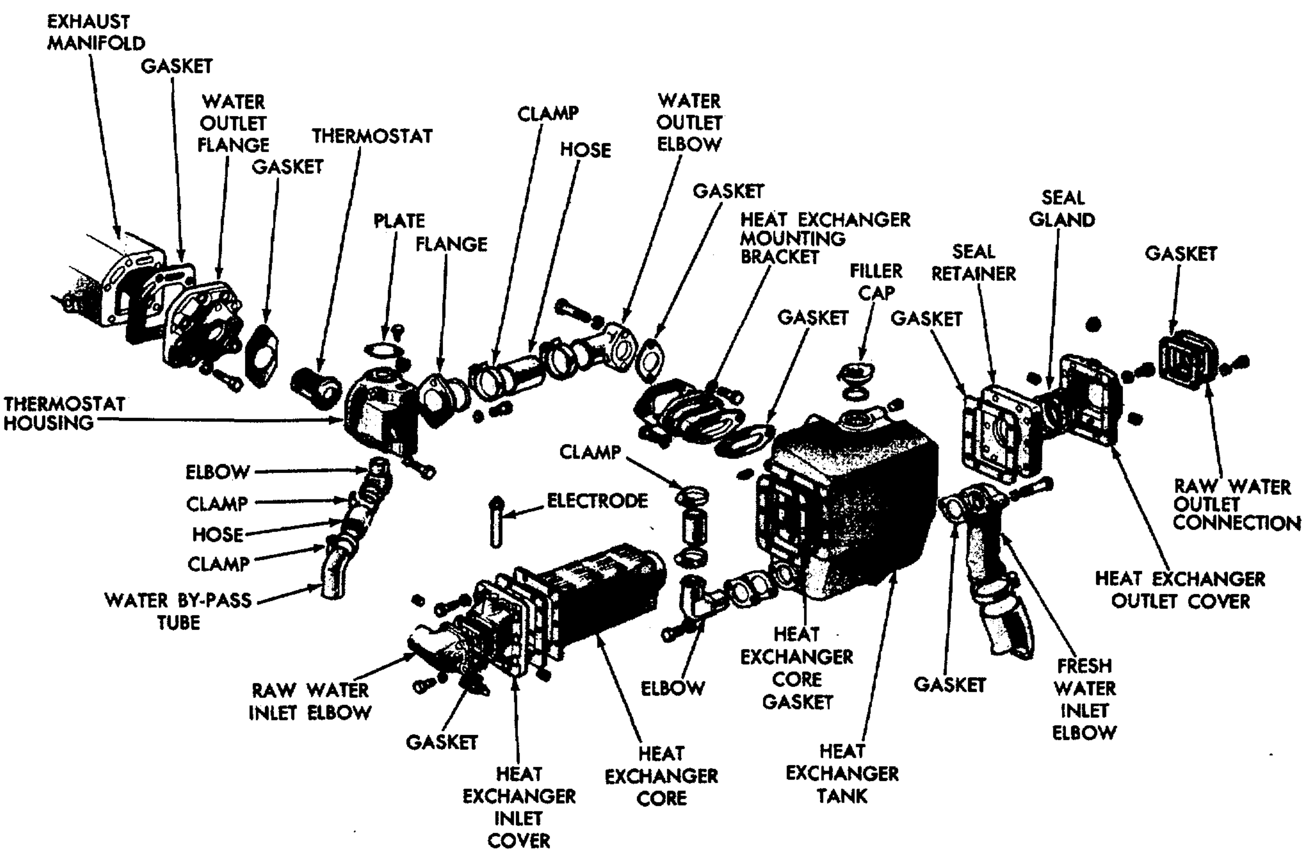


FAN MOUNT (6V-53)



FAN MOUNT



HEAT EXCHANGER

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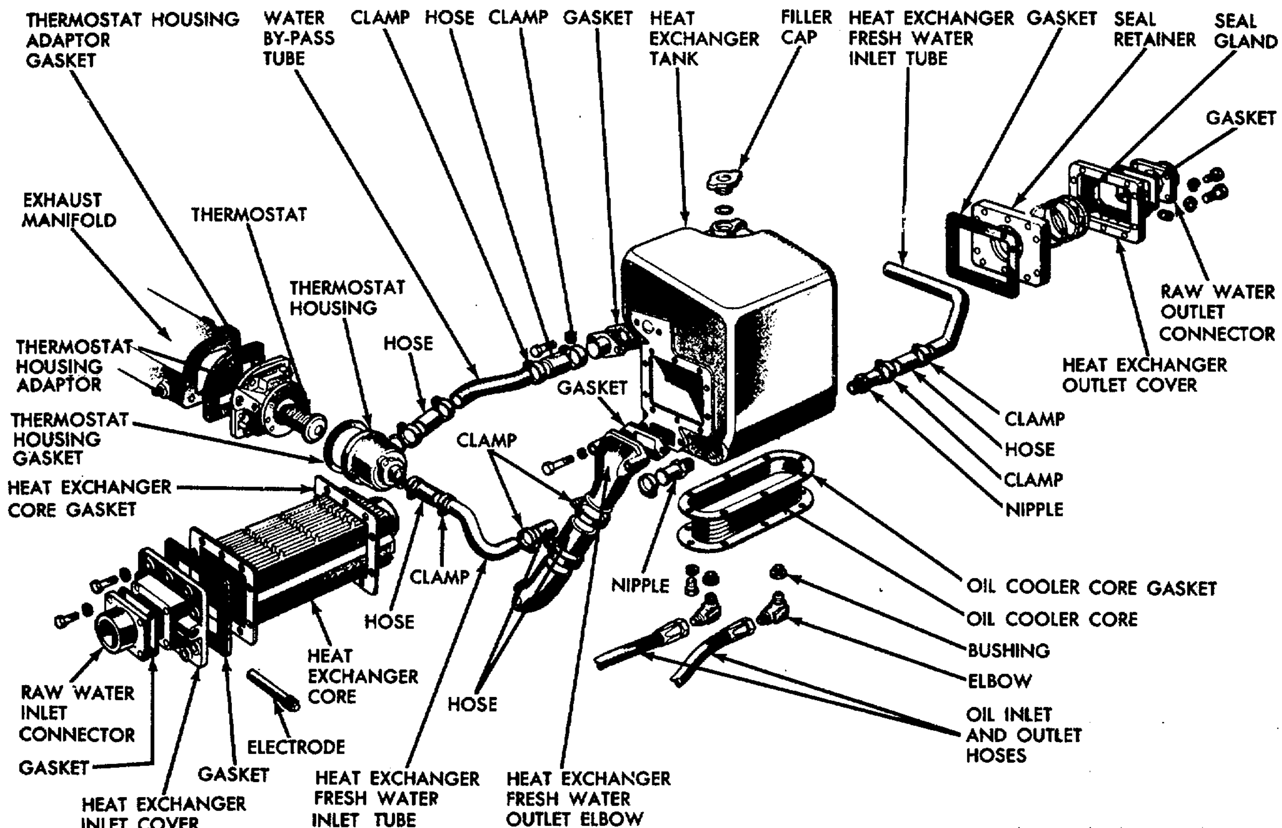
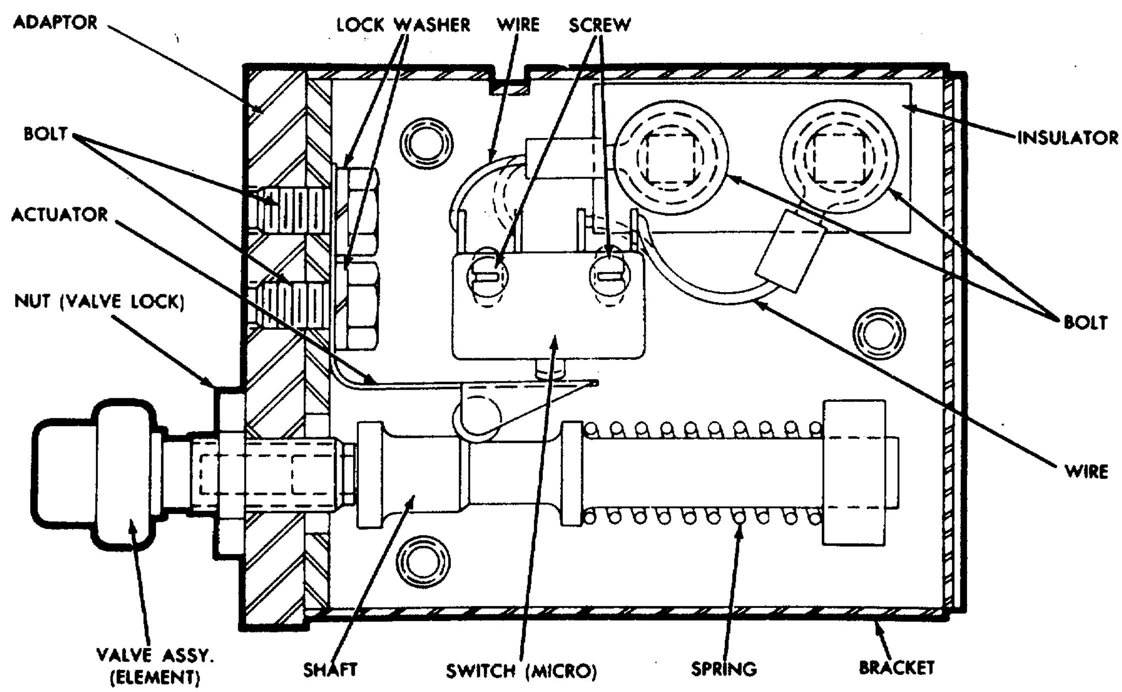
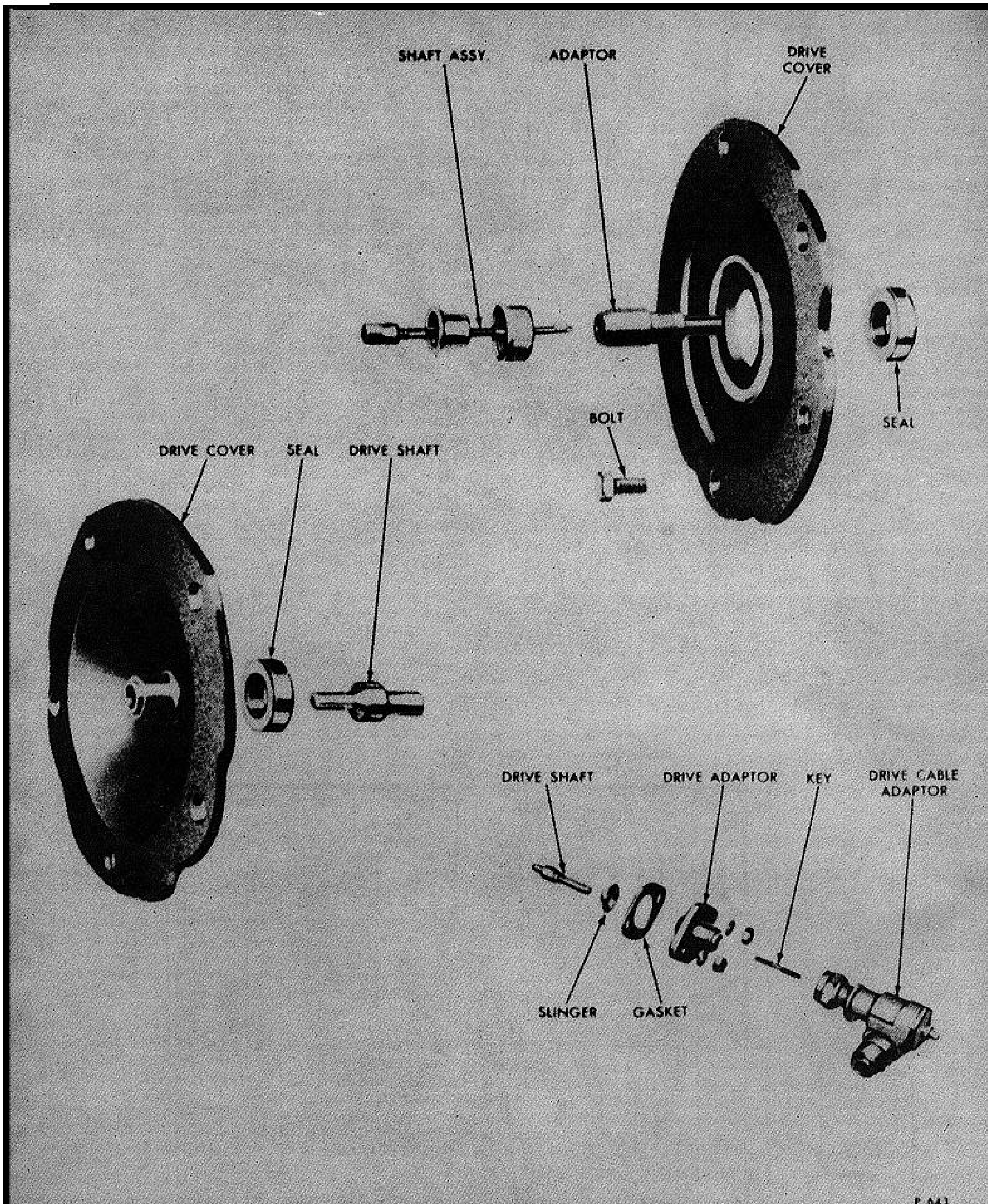


HEAT EXCHANGER (6V-53)

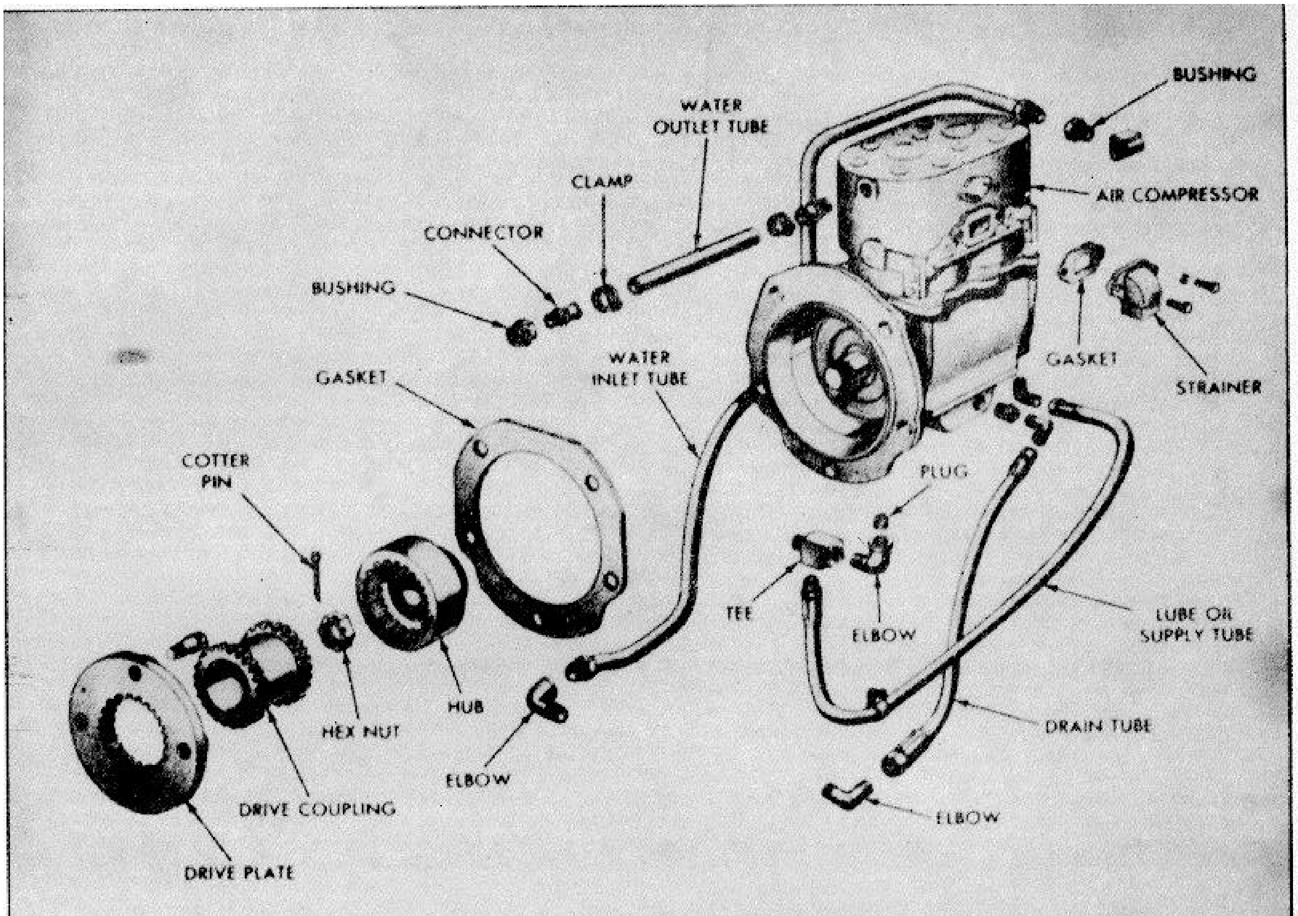


WATER TEMPERATURE SHUTDOWN SWITCH

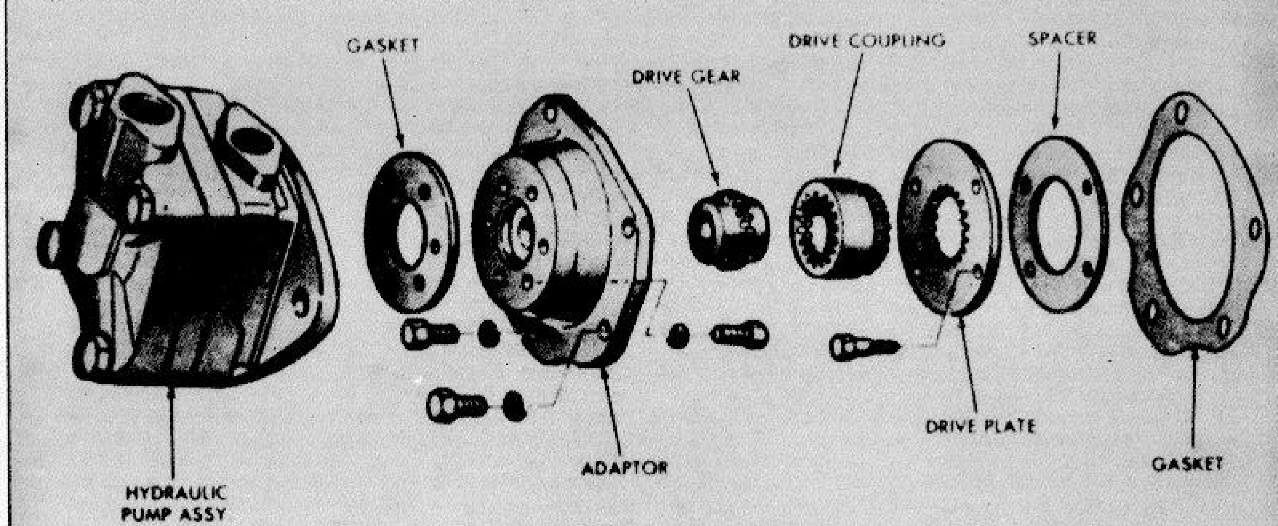
12734



TACHOMETER DRIVE COVERS AND ADAPTORS



AIR COMPRESSOR AND DRIVE



HYDRAULIC PUMP AND DRIVE

P 644

OWNER ASSISTANCE

The satisfaction and goodwill of the owners of Detroit Diesel engines are of primary concern to the Detroit Diesel Allison Division, its distributors and their dealers.

As an owner of a Detroit Diesel engine, you have a complete network of over 2300 Detroit Diesel Allison Distributors and Dealers in the U.S. and Canada, plus many outlets worldwide that are prepared and anxious to meet your parts and service needs:

Expert service by trained personnel.

Emergency service 24 hours a day.

Complete parts support, including reliabilt components.

Sales teams to help determine your power requirements.

Product information and literature.

We recognize, however, that despite the best intentions of everyone concerned, misunderstandings may occur. Normally, any such situation that arises in connection with the sale, operation or service of your engine will be handled by the distributor or dealer in your area (check the Yellow Pages for the Detroit Diesel Allison Service Outlet nearest you).

To further assure your complete satisfaction, we have developed the following three-step procedure to be followed in the event you have a problem that has not been handled satisfactorily.

Step One - **Discuss your problem with a member of management from the distributorship or dealership.** Frequently, complaints are the result of a breakdown in communication and can quickly be resolved by a member of management. If you have already discussed the problem with the Sales or Service Manager, contact the General Manager. If your problem originates with a dealer, explain the matter to a management member of the distributorship with whom the dealer has his service agreement.

Step Two - When it appears that your problem cannot readily be resolved at the distributor level without additional assistance, **contact the Detroit Diesel Allison Regional Office nearest you** listed below:

Eastern Region
Suite 202
10 Parsonage Road
Edison, New Jersey 08817
Phone: (201) 246-5074
Regional Manager: S. F. Zappia
Service Manager: D. P. Friedrich

Southeastern Region
5730 Glenridge Drive, N.E.
Atlanta, Georgia 30328
Phone: (404) 252-3310
Regional Manager: L. R. Kirby
Service Manager: B. D. Robison, Jr.

Great Lakes Region
Garrison Place
19855 Outer Drive
Dearborn, Michigan 48124
Phone: (313) 565-0411
Regional Manager: A. W. Christy
Service Manager: R. Schwaller

Midwestern Region
Suite 618
2021 Spring Road
Oak Brook, Illinois 60521
Phone: (312) 654-6619
Regional Manager: C. O. Zimmerman
Service Manager: T. F. Chope

Southwestern Region
Suite 130
2655 Villa Creek Drive
Dallas, Texas 75234
Phone: (214) 241-7721
Regional Manager: F. A. Skells
Service Manager: W. C. Kaphengst

Northwestern Region
Suite 250
20380 Town Center Lane
Cupertino, California 95014
Phone: (408) 255-7700
Regional Manager: W. C. Edwards
Service Manager: J. P. Miles

Western Region
Suite 823
Crocker Bank Building
15760 Ventura Blvd.
Encino, California 91436
Phone: (213) 981-7300
Regional Manager: G. J. Dunneback
Service Manager: W. K. Clark, Jr.

Prior to this call, have the following information available:

- Name and location of distributor or dealer.
- Type and make of equipment.
- Engine model and serial number.
- Engine delivery date and accumulated miles or hours of operation.
- Nature of problem.
- Chronological summary of unit's history.

Step Three - If you are still not satisfied, **present the entire matter in writing or by phone to the Home Office:**

Diesel Operations - J. E. Fisher, Manager Customer Services, Detroit Diesel Allison, 13400 W. Outer Drive, Detroit, Michigan 48228, Phone (313) 592-5608.

Canada Operations - E. A. Kobe, Manager of Product Service, Diesel Division, General Motors of Canada, Ltd., P.O. Box 5990, 847 Highbury Avenue, London, Ontario N6A 4L6, Phone (519) 455-7110.

If at this point your problem is still not resolved to your satisfaction, call or write J. P. Lewis, Manager, Diesel Engine Service, Diesel Operations (313) 592-7279; D. F. Downham, Sales Manager, Diesel Operations (313) 592-7276.

When contacting the Regional or Home Office, please keep in mind that ultimately your problem will likely be resolved at the distributorship or dealership utilizing their facilities, equipment and personnel. Therefore, it is suggested that you follow the above steps in sequence when experiencing a problem.

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PART II. PARTS LISTING FOR DETROIT

Diesel Series 53 Engine

GENERAL INFORMATION

General Information

All engine components are divided into twelve major groups of functionary related parts. A list of the groups appears in the index of this manual.

Within each group different design of similar equipment are shown, each group uses a type number. The type number in one group has no relationship to the type number of another group.

All optional material type numbers are shown on the engine Option Plate. The plate is shown in the illustration below.

The names and type numbers of optional equipment built into the unit at the factory are listed on, this plate, along with the unit model, serial number and custom specification (if any). Material not listed on the Option Plate is standard equipment. (Copies of the information, on the Option Plate Work Sheet, are furnished to distributors for their files.)

To locate a part establish the group where the part is used (see index page). Turn to the page listed for that group. Locate the part on the illustration. Locate the item number in the parts list and the part number will be listed along with an item description. The quantity column is the number of times the part is used in the assembly shown.

YOUR PARTS ORDER WILL BE HANDLED MORE EFFICIENTLY IF:

1. The following information is provided for the item ordered:
   - A. Group in the parts book in which it is listed
   - B. Quantity desired
   - C. Item part number
   - D. Complete item description
   - E. Complete unit model identification and serial number
2. "TYPE" rather than "WRITE" the above information

MISCELLANEOUS

Unless otherwise specified, standard bolts in the parts list are hexagon head. Other standard parts are described in detail.

The information and illustrations in this publication are based on the information in effect at the time of printing.

ENGINE OPTION PLATE

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Cylinder Head	1.2000	23	5
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Crankshaft Front Cover	1.3000A	119	10
Crankshaft Pulley	1.3000C	111	8
Crankshaft Pulley Belt	1.3000D	176	3
Flywheel	1.4000A	327	12
Flywheel Housing (SAE #3)	1.5000A	349	12
Connecting Rod and Piston	1.6000	61	13
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Oil Pressure Regulator	4.1000C	9	36
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Oil Cooler	4.4000A	230	40
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Oil Pan	4.7000A	584	42
Fresh Water Pump	5.1000	145	43
Water Outlet Elbow	5.2000A	67	45
Thermostat	5.2000B	72	45
Water By-Pass Tube	5.2000C	318	45
Radiator	5.3000A	64	46
Water Connections	5.3000B	135	47
Fan	5.4000A	290	48
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Exhaust Muffler Flange	6.2000A	234	50
Starting Motor	7.3000A	174	51
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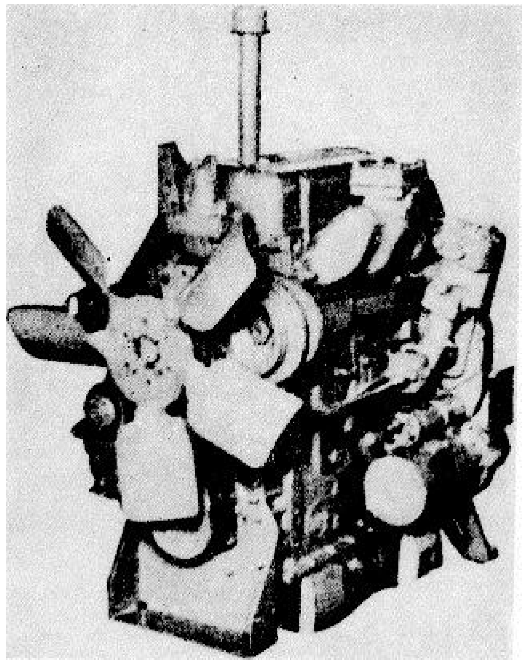
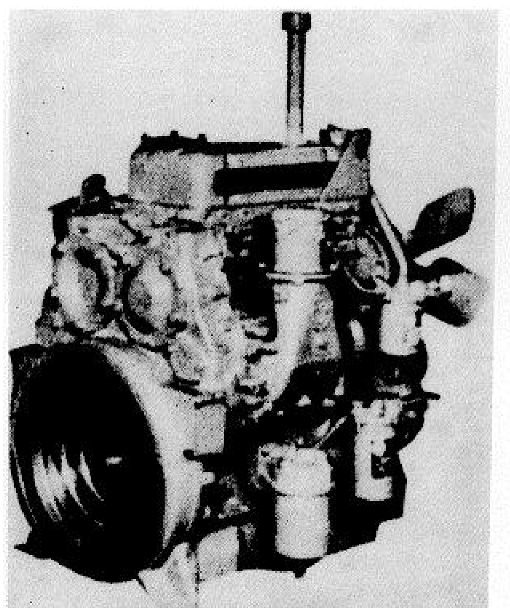
DETROIT DIESAL ENGINE
MODEL 353

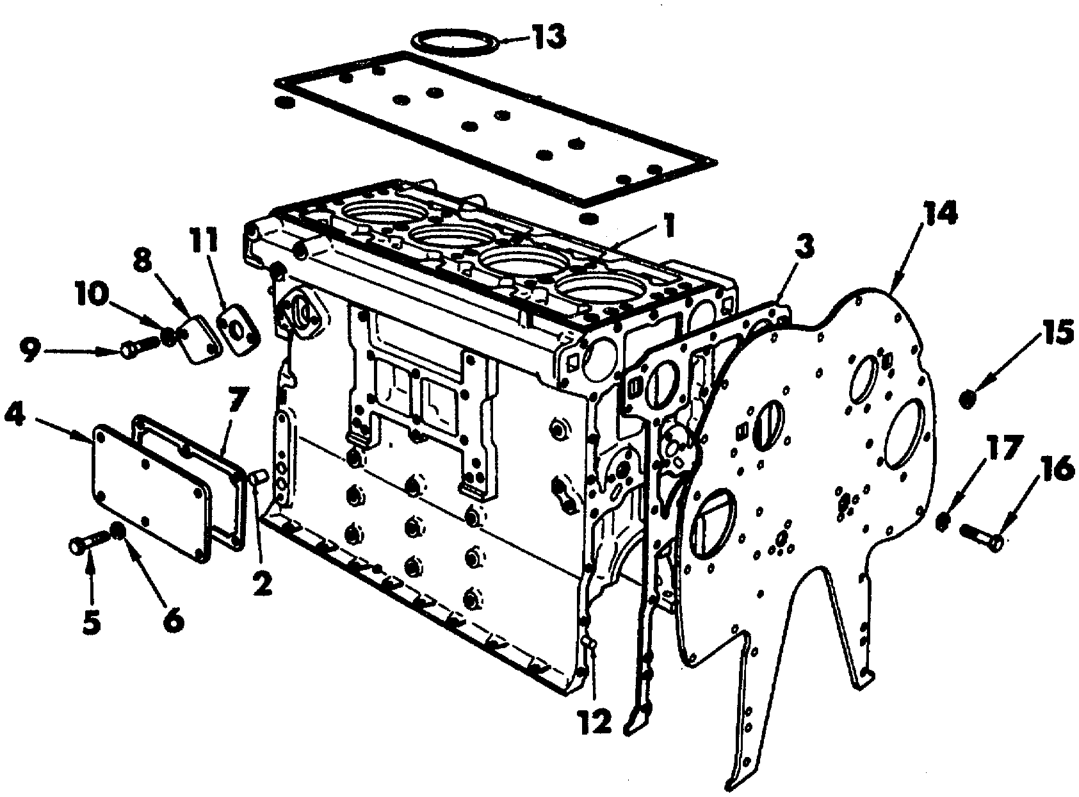


FRONT, LEFT HAND VIEW



REAR, RIGHT HAND VIEW

CYLINDER BLOCK
(GROUP NO. 1.1000)



(FIG. NO. 1)

CYLINDER BLOCK
(GROUP NO. 1.1000)

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
1-1	5196490	Block Assy.	1
3-1	5116142	Cap, Main Bearing	3
8-1	5198209	Bearing Set, Camshaft	1
3-2	5116199	Bolt, Main Bearing Cap	6
*	5146437	Elbow, Air Box Drain Tee	1
*	3231135	Tee, 1/4" Inv. Fl.	1
1-12	141346	Pin, 3/16" x 1/2" Dowel	4
1-2	5146900	Pin, 3/8" x 1-1/8" Dowel	4
*	114981	Draincock, 1/8"	1
3-4	5145009	Plug, 1/8" Pipe	7
*	5121182	Plug, 1/4" Pipe	1
*	5150131	Plug, 7/16" Cup	2
*	5121316	Plug, 5/8" x 13/32"	2
1-14	5121366	Plate Assy.	1
1-15	5121459	Nut, Plug 3/8" - 24	8
1-16	454813	Bolt, 3/8" - 16 x 7/8"	13
1-17	103321	Lockwasher, 3/8"	AR
1-3	5116354	Gasket	1
1-4	5116373	Cover	1
1-5	180120	Bolt, 3/8" - 16 x 3/4"	6
1-6	103321	Lockwasher, 3/8"	6
1-7	5116380	Gasket	1
1-8	5150023	Cover (Plain)	1
1-9	186618	Bolt, 5/16" - 18 x 5/8"	2
1-10	103320	Lockwasher, 5/16"	2
1-11	5116357	Gasket	1

* Not Shown

AIR BOX DRAINS
(GROUP 1.1000A)

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
*	5132286	Tube	1
*	137421	Elbow, 1/4" Inv. Fl. Tube 90 Deg.	1
*	137397	Nut, 1/4" Inv. Fl. Tube	1

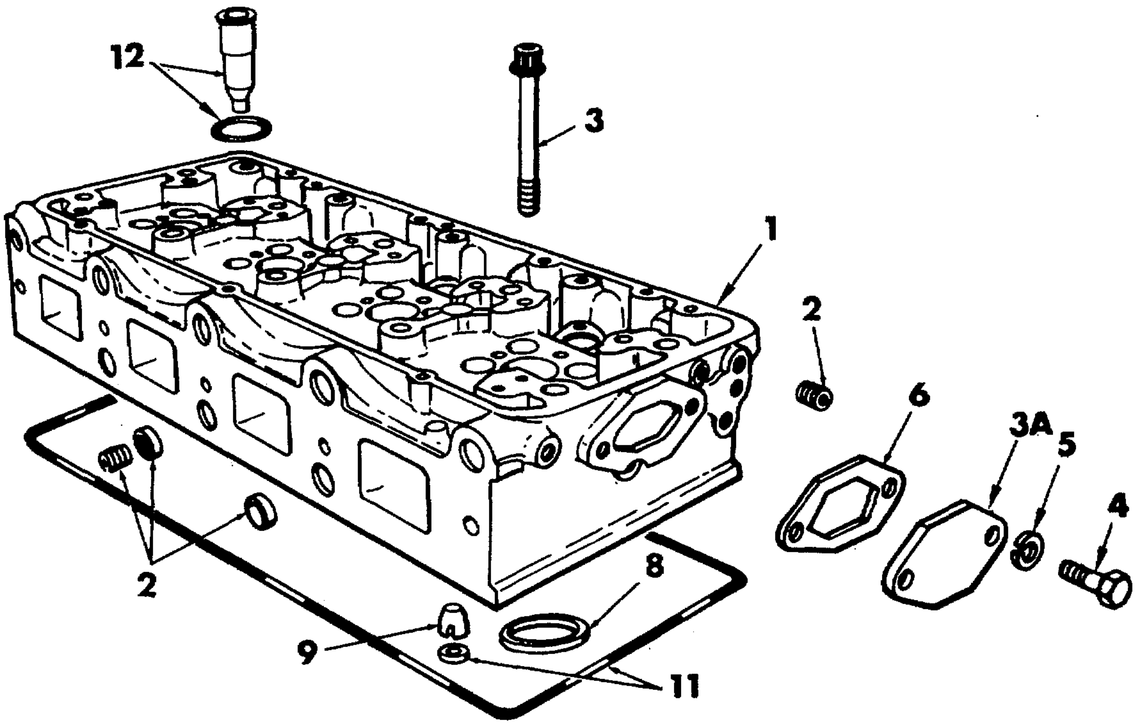
* Not Shown

CRANKSHAFT PULLEY BELT
(GROUP NO. 1.3000D)

FIG/ITEM	PART NO.	DFSCRIPTIDN	QTY.
*	5131395	Belt Set (2 Belts) (41.00" L., .500" W.)	1

* Not Shown

CYLINDER HEAD
(GROUP NO. 1.2000)



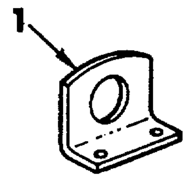
(FIG. NO. 2)

CYLINDER HEAD
(GROUP NO. 1.2000)

FIG/ITEM	PART NO	DESCRIPTION	QTY.
2-	5198203	Head Assy.	1
2-2	5198655	Plug, Fuse	1
2-2	5154453	Plug, 3/8" - 16 Special	4
2-2	5145009	Plug, 1/8" Pipe	2
2-12	5199527	Tube Kit (Includes Ring 5160037)	3
*	5116361	Insert, Exhaust Valve	12
*	5131961	Guide, Exhaust Valve	12
*	5121182	Plug, 1/4" Pipe	6
*	5151449	Plug, 13/16" Cup Special	3
*	5144425	Adaptor, Fuse Plug (Outside of Head Assy.)	1
*	5116262	Adaptor, Cylinder Head Governor Control Link	1
*	5121252	Adaptor, Cylinder Head Governor Control Link	1
10-1	5111467	Seat, Exhaust Valve Spring	12
*	5139997	Plug, 7/8" Dia. Cup Stn. Stl.	3
2-9	5119293	Nozzle	4
2-8	5121254	Gasket	3
2-11	5116290	Ring, Seal (End Water Hole)	4
2-11	5121207	Ring, Seal (Center Water Hole)	4
2-11	5116122	Ring, Seal (Oil Hole)	2
2-11	5116292	Ring, Seal	1
2-3	5121263	Bolt, 5/8" - 11 x 6-1/4" (12 Pt. Hd.)	8
2-3	5136610	Cover (Use 3/8" - 16 x 1" Bolt)	1
2-4	179839	Bolt, 3/8" - 16 x 1"	2
2-5	103321	Lockwasher, 3/8"	2
2-6	5116242	Gasket	1

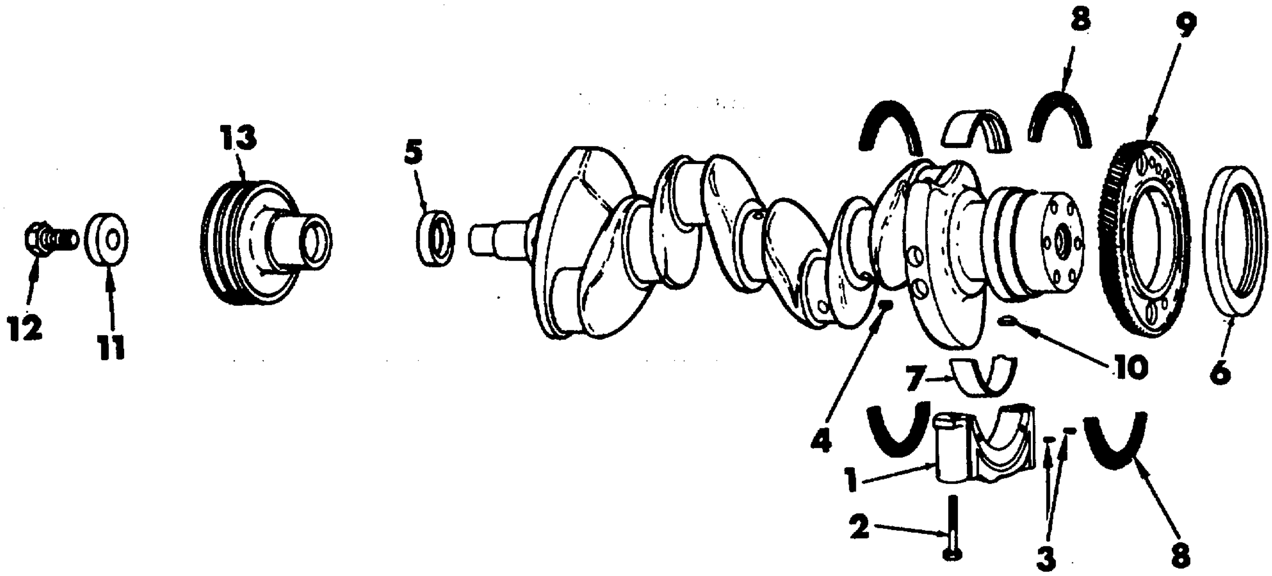
* Not Shown

ENGINE LIFTER BRACKET
(GROUP NO. 1.2000A)

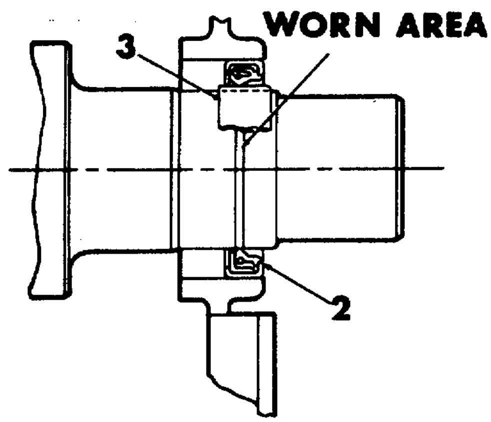


FIG/ITEM	PART NO.	DESCRIPTION	QTY.
*	5100428	Bracket (Front R.H.)	1
*	5164294	Spacer, 1/8" Thick	2
*	179839	Bolt, 3/8" - 16 x 1" AA Lock	3
-1	5119379	Bracket (Also Fig 5 Item 2) (Rear)	1
*	9409028	Bolt, 3/8" - 16 x 1"	2
*	103341	Washer, 318" Flat	2
*	103321	Washer, 3/8" Lock	3

*Not Shown



(FIG. NO. 3)



(FIG. NO. 4)

CRANKSHAFT
(GROUP NO. 1.3000)

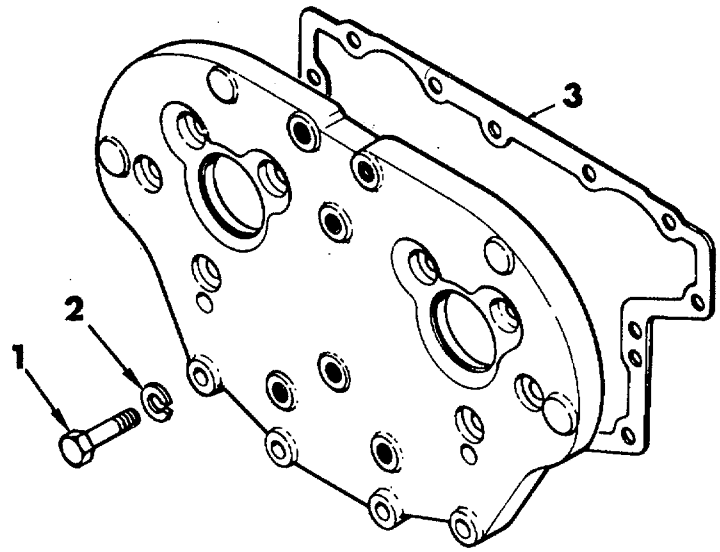
FIG/ITEM	PART NO.	DESCRIPTION	QTY.
3-	5116447	Crankshaft Assy.	1
3-4	444687	Plug, 1/8" Pipe	3
3-5	5116224	Seal	1
4-2	5198503	Seal, Single Lip O.S. - Use with 5198502 Sleeve	1
4-2	5148314	Seal	1
4-3	5198502	Sleeve (Use with 5198503 Seal)	1
6-4	5116224	Seal	1
3-6	5116229	Seal (Single Lip, Standard)	1
3-6	5128917	Seal (Double Lip, Standard)	1
3-6	5196852	Seal (Single Lip, O.S., Use with 519685	1
		Sleeve)	AR
3-65	199477	Seal (Double Lip, O.S., Use with 519685	1
		Sleeve)	AR
*	5196851	Sleeve (With O.S. Oil Seal)	AR
3-7	5195928	Shell Set (Std.)	4
3-7	5196660	Shell Set (.002" U.S.)	4
3-7	5196661	Shell Set (.010" U.S.)	4
3-7	5196662	Shell Set (.020" U.S.)	4
3-8	5116197	Washer	4
3-8	5196755	Washer (.005" O.S.)	AR
3-8	5196756	Washer (.010" O.S.)	AR
3-3	141346	Pin, 3/16" x 1/2" Dowel (Std.)	4
3-3	5149149	Pin, 7/32" x 1/2" Dowel (O.S.)	AR
3-1	5195935	Cap (Std.)	4
3-2	5116199	Bolt	8
3-9	5116195	Gear	1
3-10	127559	Key, 1/4" x 3/4" Woodruff	1

* Not Shown

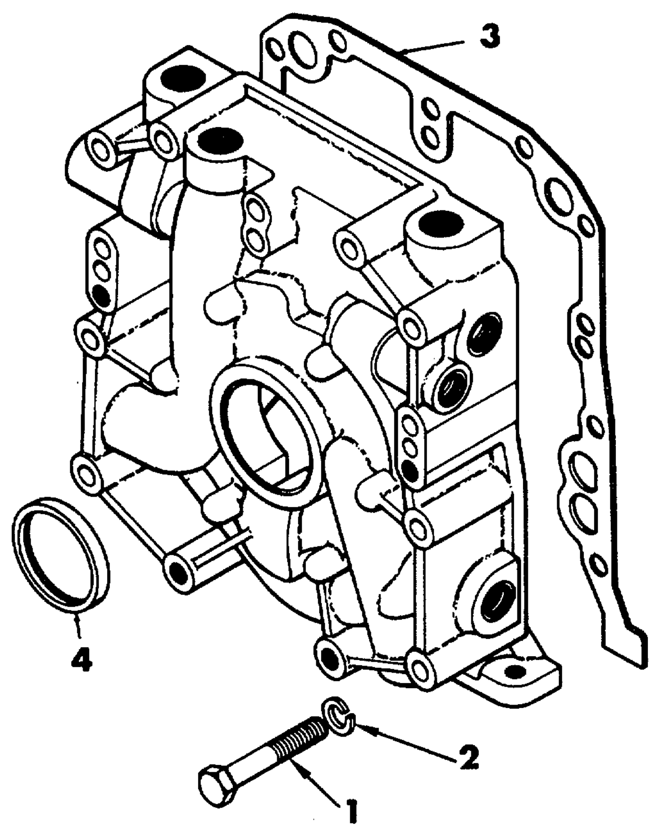
CRANKSHAFT PULLEY
(GROUP NO. 1.3000C)

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
3-13	5116484	Pulley (5.38" Dia., 2 Grooves)	1
3-11	5180291	Retainer (Washer)	1
3-12	5180629	Bolt, 3/8" - 16 x 1-3/4" L.	1

CRANKSHAFT FRONT COVER
(GROUP NO. 1.3000A)



(FIG. NO. 5)



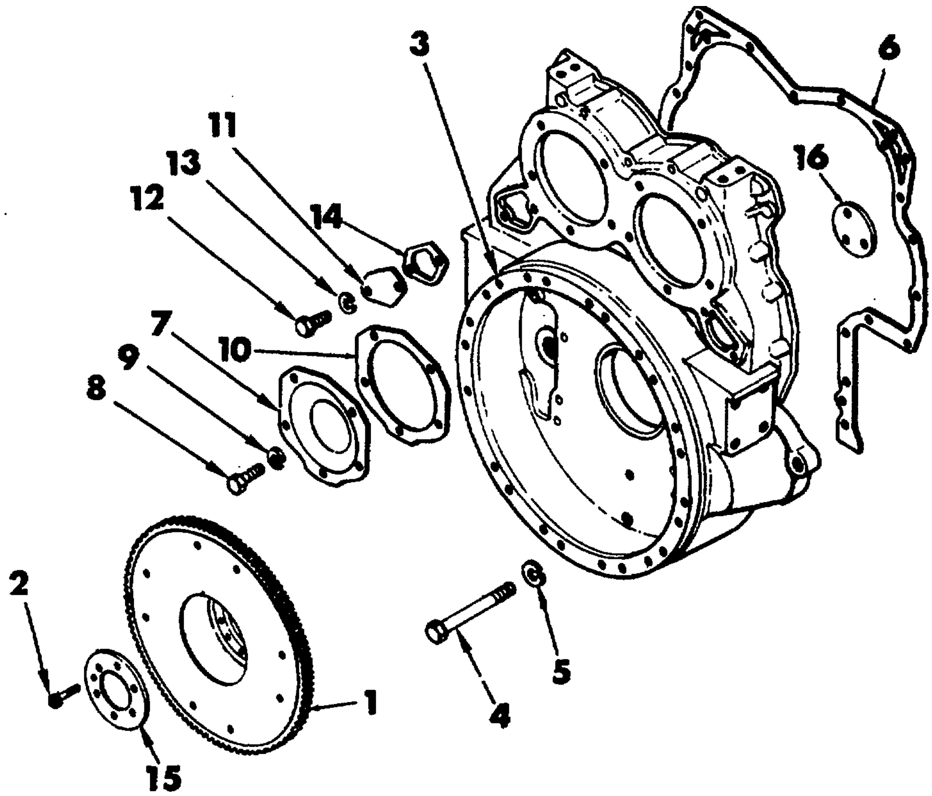
(FIG. NO. 5)

CRANKSHAFT FRONT COVER
(GROUP NO. 1.3000A)

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
5-	5101347	Cover Assy., Engine Front Upper	1
*	5146900	Pin, 3/8" x 1-1/8" Dowel	2
5-1	186622	Bolt, 3/8" - 16 x 1-1/4"	9
5-1	179844	Bolt, 3/8" - 16 x 1-5/8"	4
*	9414322	Washer, 3/8" I.D. x .744 O.D. x .63 Thick	13
5-2	103321	Lockwasher, 3/8"	13
6-	5197415	Cover Assy., Engine Front Lower	1
*	5145009	Plug, 1/8 Pipe	1
*	5146648	Plug, 1/2 Pipe	7
6-1	186282	Bolt, 3/8" - 16 x 3-1/4"	7
6-2	103321	Lockwasher, 3/8"	7
5-3	5121082	Gasket, Upper	1
6-3	5116386	Gasket, Lower	1
6-4	5116224	Seal	1

* Not Shown

FLYWHEEL HOUSING (SAE #3)
(GROUP NO. 1.5000A)



(FIG. NO. 7)

FLYWHEEL
(GROUP NO. 1.4000A)

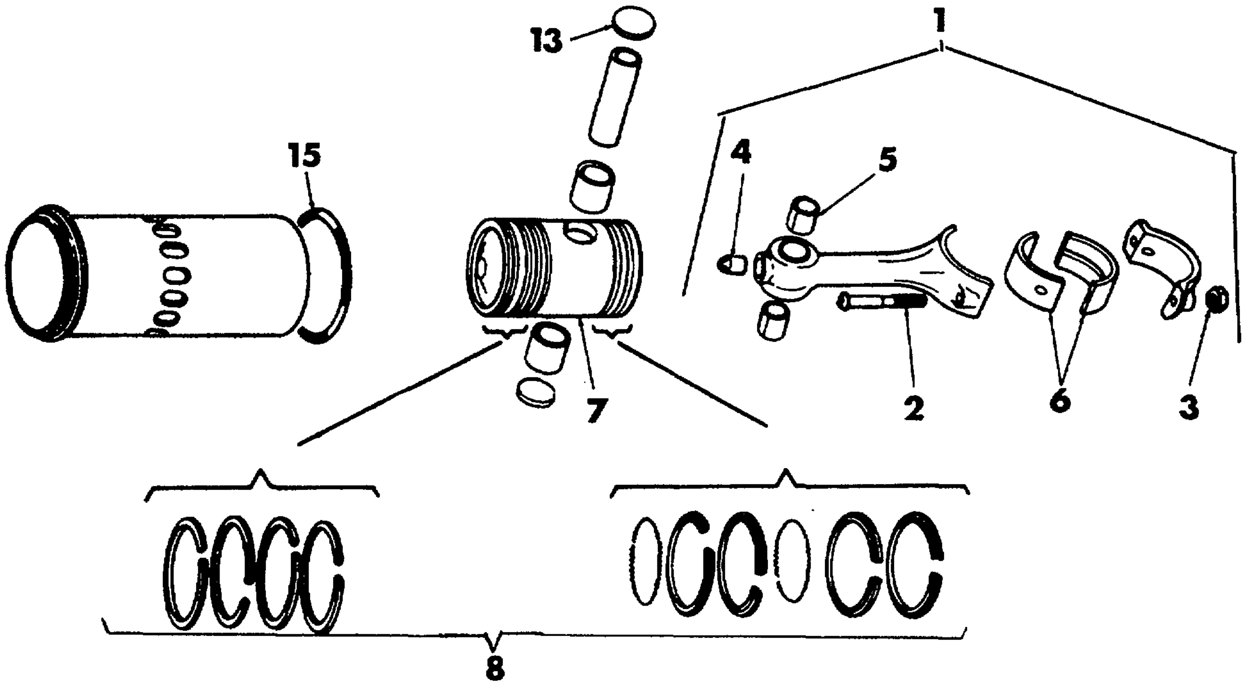
FIG/ITEM	PART NO.	DESCRIPTION	QTY.
7-	5119495	Flywheel Assy. (Sae #3, Non-Chamfered) Includes 5116301 Gear	1
7-2	9412018	Bolt, Lock (2-1/4" L.)	6
7-1	5116301	Gear (Sae #3-126 Teeth)	1
7-15	5126671	Plate, Scuff	1

FLYWHEEL HOUSING (SAE #3)
(GROUP NO. 1.5000A)

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
7-3	5132260	Housing, (Sae #3) (Also Fig 5 Item 3)	1
*	5145011	Plug, 3/8" Pipe	1
*	5145012	Plug, 1/2" Pipe	1
7-4	9409126	Bolt, 5/16 - 18 x 2-1/2	2
7-4	5101779	Bolt, 3/8" - 16 x 7/8"	1
7-4	9414215	Bolt, 3/8 - 16 x 2-1/2	4
7-4	427588	Bolt, 3/8" - 16 x 2-1/2	6
7-4	5170489	Bolt, 3/8 - 24 x 3 9-16 Lock	3
7-5	103321	Lockwasher, 3/8"	AR
7-16	5123802	Shim, Flywheel (Hsg. to End Plate)	1
7-6	5121334	Gasket	1
7-7	5122281	Cover	2
7-8	179857	Bolt, 7/16" - 14 x 7/8"	2
7-8	122408	Bolt, 1/2" - 13 x l"	8
*	5150568	Washer, (7/16" Copper)	2
7-9	103323	Lockwasher, 1/2"	8
7-10	5117061	Gasket	2
7-11	5116411	Cover	2
7-12	186625	Bolt, 5/16" - 18 x 7/8"	4
7-13	103320	Lockwasher, 5/16"	4
7-14	5116391	Gasket	2
*	5130995	Gasket	1

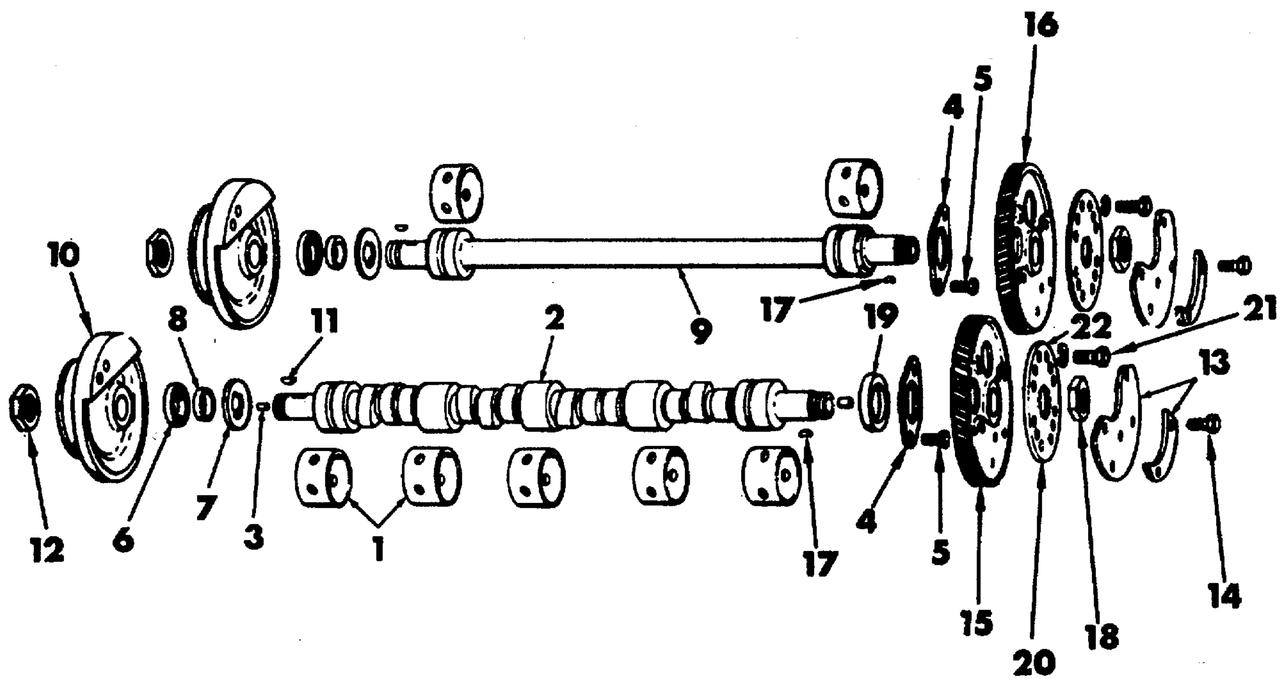
* Not Shown

CONNECTING ROD & PISTON
(GROUP NO. 1.6000)

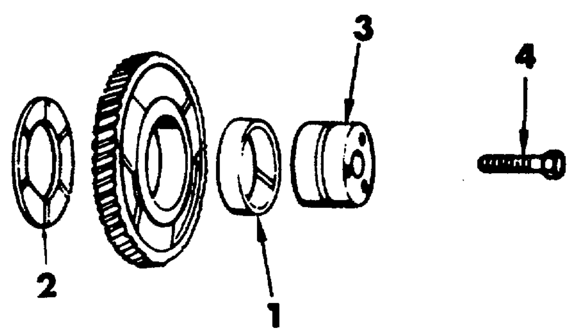


FIG/ITEM	PART NO.	DESCRIPTION	QTY.
-1	5122262	Rod Assy. (Includes Cap and Orifice Not Sold Separately)	3
-2	5197852	Bolt, 3/8" - 24 x 2.76" L.	6
-3	839103	Nut (3/8" - 24 Hex.)	3
-4	5150140	Nozzle	3
-5	5116181	Bushing	6
-6	5195929	Shell Set (Standard) (Shell Sets Have (1) Upper and (1) Lower Shell)	3
-6	5196664	Shell Set (.002" U,S.)	3
-6	5196665	Shell Set (.010" U.S.)	3
-6	5196666	Shell Set (.020" U.S.)	3
-7	5198877	Piston Assy. (Contains (1) 5116181 Bushing and (1) 5180250 Retainer (Series "N")	3
-8	5198822	Ring Set (Sufficient Rings for One Cylinder)	3
-11	5116189	Pin	3
-12	5116181	Bushing	6
-13	5180250	Retainer	6
-14	5132803	Liner (Standard)	3
-14	5101016	Liner (.010" O.S., O.D.)	AR
-15	5121256	Seal	1

CAMSHAFT & GEAR TRAIN
(GROUP NO. 1.7000)



(FIG. NO. 8)

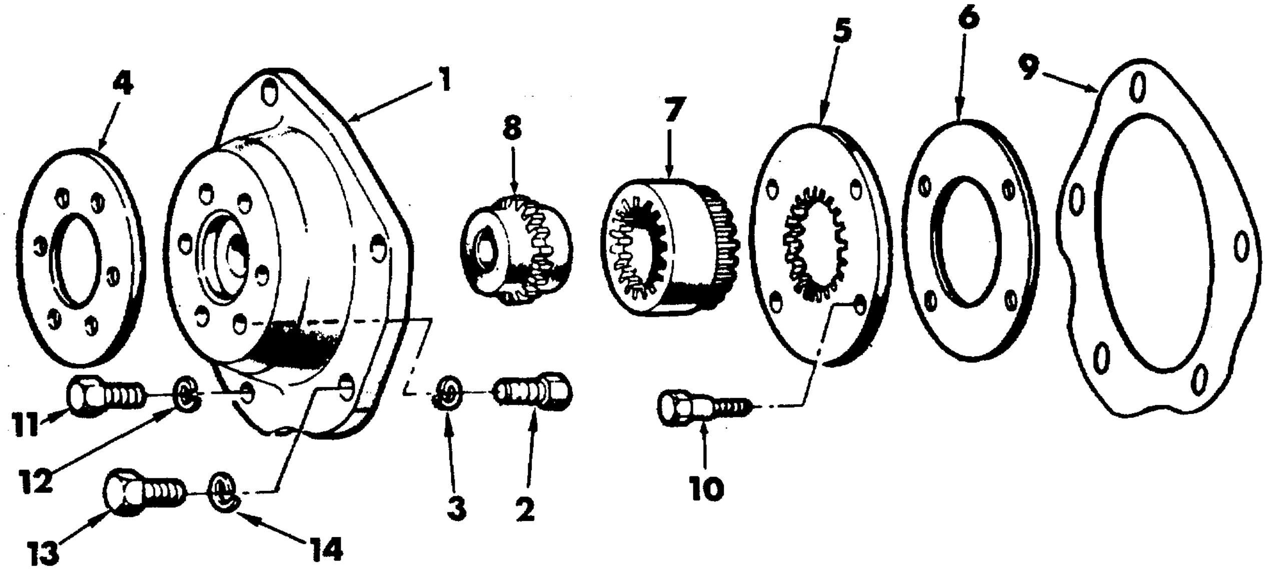


(FIG. NO. 9)

CAMSHAFT & GEAR TRAIN
(GROUP NO. 1.7000)

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
8-2	5126929	Camshaft Assy.	1
8-3	5151277	Plug (1/2" Drive)	2
8-1	5198209	Bearing Set Std.	1
8-1	5198980	Bearing Set (Std. I.D., .010" O.S. O.D.)	AR
8-1	5198470	Bearing Set (.010" U.S., I.D., Std. O.D.)	AR
8-1	5198471	Bearing Set (.020" U.S., I.D., Std. O.D.)	AR
8-4	3116198	Washer	2
8-5	9409028	Bolt, 3/8" - 16 x 1"	4
8-6	5106223	Seal, Oil (Front)	2
8-7	5134388	Slinger	2
8-8	5121071	Spacer	2
8-9	5121073	Shaft	1
8-10	5121108	Pulley	2
8-11	218217	Key, 3/16 x 5/8" Woodruff	2
8-12	5150087	Nut	2
8-13	5119277	Weight	2
8-14	9409028	Bolt, 3/8" - 16 x 1" Lock	4
8-15	5133387	Gear (R.H. Helix)	1
8-16	5133388	Gear (L.H. Helix)	1
8-17	218217	Key, 3/16" x 5/8" Woodruff	2
8-18	5150087	Nut	2
8-19	5121077	Spacer	1
8-20	5172734	Retainer	2
8-21	181360	Bolt, 3/8" - 24 x 3/4"	4
8-22	103321	Lockwasher, 3/8"	4
9-	5135227	Gear Assy., Idler	1
9-1	5196793	Bearing	1
9-2	5132504	Washer (Thrust)	2
9-3	5124458	Hub	1
9-4	5157244	Bolt	1

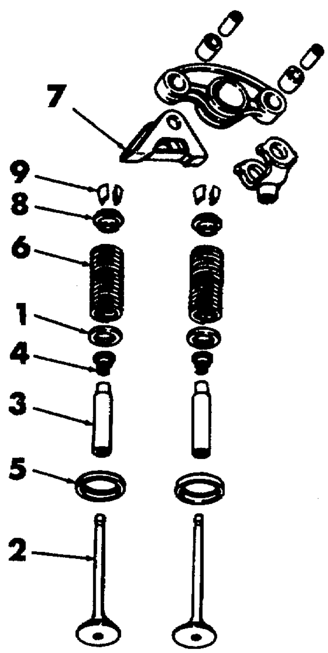
ACCESSORY DRIVE (HYDRAULIC PUMP)
(GROUP NO. 1.7000B)



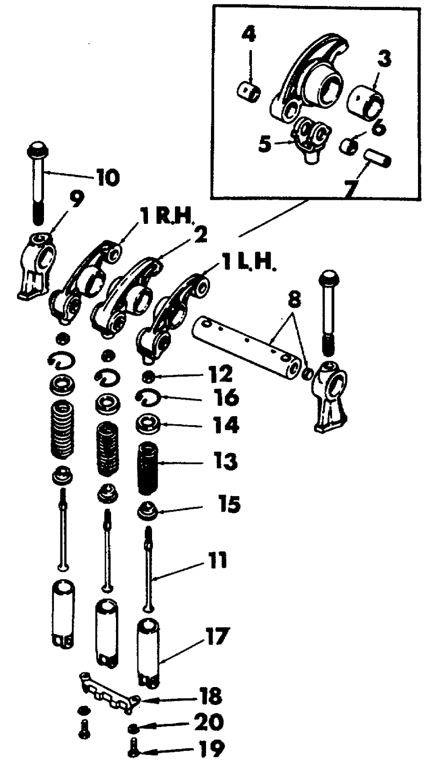
FIG/ITEM	PART NO.	DESCRIPTION	QTY.
-1	5123814	Adapter, Hydraulic Pump	1
-2	179839	Bolt, 3/8" - 16 x 1"	6
-3	103321	Washer, 3/8" Lock	6
-4	5168852	Gasket, Hyd. Pump to Adapter	1
-5	5170450	Plate	1
-6	5140814	Spacer	1
-7	5143616	Coupling	1
*	103375	Pin, 3/32" x 1-1/4"	1
-8	5188848	Gear, Hyd. Pump Drive	1
-9	5117061	Gasket	1
-10	5145091	Bolt, Special	4
-11	122408	Bolt, 1/2" - 13 x 1"	4
-12	103323	Washer, 1/2" Lock	4
-13	179858	Bolt, 7/16" - 14 x 1"	1
-14	103322	Washer, 7/16" Lock	1

* Not Shown

VALVE OPERATING MECHANISM
(GROUP NO. 1.8000)



(FIG. NO, 10)



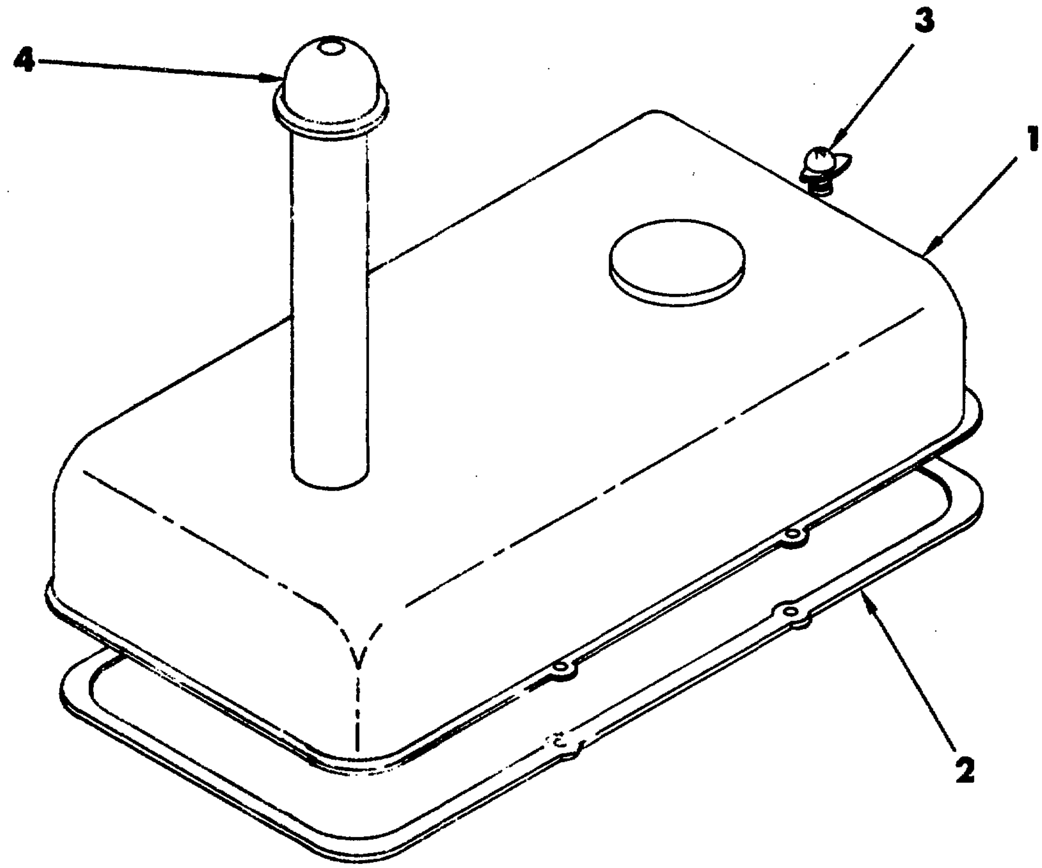
(FIG. NO. 11)

VALVE OPERATING MECHANISM
(GROUP NO. 1.8000)

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
11-1	5135268	Arm Assy., Rocker Exhaust R.H.	3
11-1	5135267	Arm Assy., Rocker Exhaust L.H.	3
11-2	5179954	Arm Assy., Rocker Injector	3
11-3	5150318	Bushing	3
11-4	5150311	Bushing	3
11-5	5150312	Clevis	9
11-6	5123700	Bushing	15
11-7	5150314	Pin (Clevis End)	9
11-7	5123711	Pin (Bridge End)	6
11-8	5116072	Shaft Assy.	3
11-8	5151272	Plug	3
11-9	5116128	Bracket	6
11-10	5119198	Bolt	6
11-11	5128640	Rod, Push	9
11-12	5151601	Locknut	9
11-13	5108918	Spring	9
11-14	5108919	Seat (Valve and Injector)	9
11-15	5123250	Seat	9
11-16	5150303	Retainer (Snap Ring)	9
11-17	5115087	Follower Assy. (Includes Roller Set)	9
*	5195220	Roller Set (Standard) (Includes Roller W/Bushing and Pin)	9
11-18	5116125	Guide	3
11-19	443603	Bolt, 1/4" - 20 x 3/4"	6
11-20	103319	Lockwasher, 1/4"	6
10-2	5199323	Valve	12
10-3	5131961	Guide	12
*	5198529	Kit, Valve Guide and Seal	12
10-4	5131973	Seal, Valve Guide (Use with 5131961)	12
*	5199912	Installer, Exhaust Valve Seal	AR
10-5	5116361	Insert (Standard)	12
10-5	5196752	Insert (.010" Oversize on O.D.)	AR
10-6	5144019	Spring (Red and Green Stripe)	12
10-7	5135262	Bridge	6
10-8	5123330	Cap	12
*	5125922	Seat (.150" Thick)	12
10-9	5116341	Lock (Halves)	24

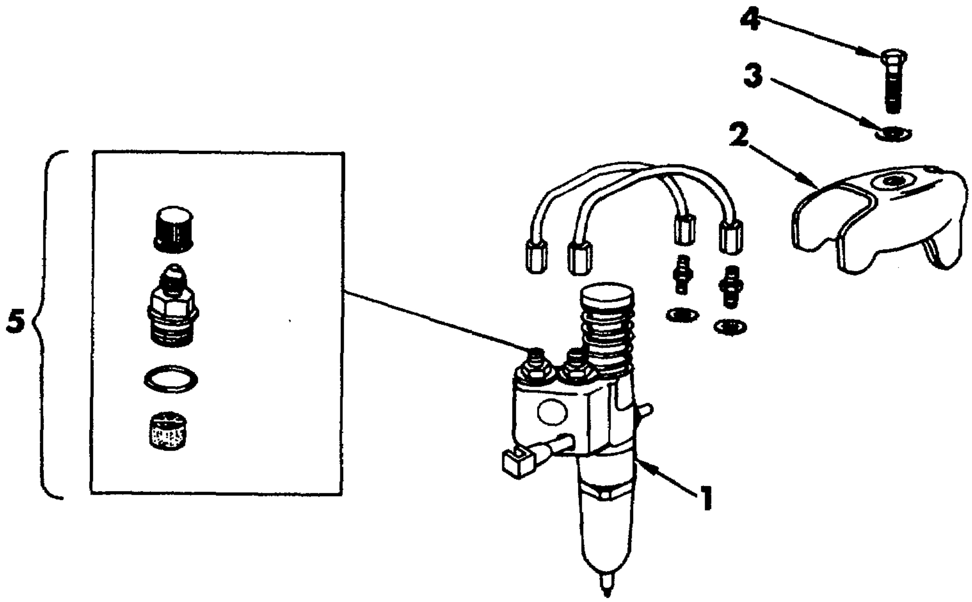
* Not Shown

ROCKER COVER
(GROUP NO. 1.8000A)



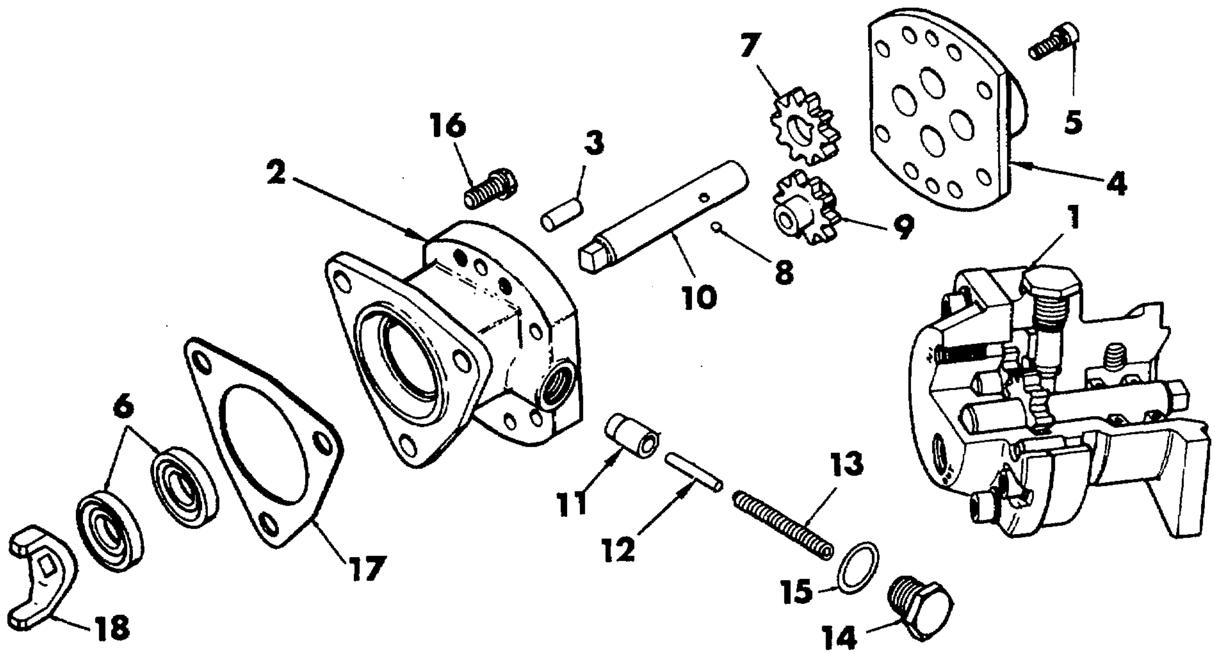
FIG/ITEM	PART NO.	DESCRIPTION	QTY.
-1	18C001	Cover (IMCO Special)	1
-2	5147994	Gasket	1
-3	5100104	Screw Assy	4
-4	1528732	Cap - Oil Filler & Breather	1

FUEL INJECTOR (N-45)
(GROUP NO. 2.1000A)



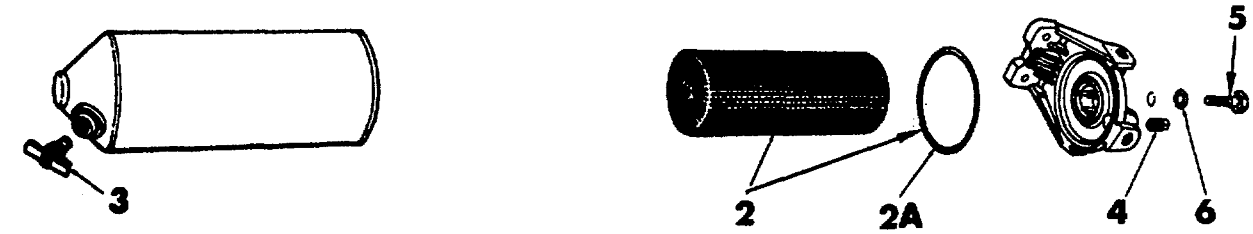
FIG/ITEM	PART NO.	DESCRIPTION	QTY.
-1	5228773	Injector Assy. (Includes P.N. 5229649 thru 5228594)	3
-5	5229649	Service Kit: (1) Seal Ring, (2) AR Filter Cap Gaskets, (2) Filter Elements & (2) Shipping Caps	AR
-2	5121259	Clamp	1
-3	5150250	Washer	1
-4	180130	Bolt, 3/8" - 16 x 2"	1

FUEL PUMP
(GROUP NO. 2.2000)

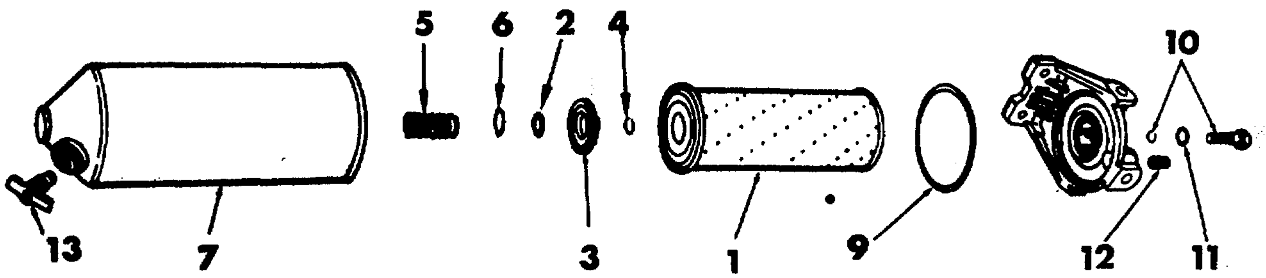


FIG/ITEM	PART NO.	DESCRIPTION	QTY.
-1	5146341	Pump Assy. No Serviced; Use Part No. 5199560	1
-2	5146337	Body	1
-3	141195	Pin, 1/4" x 5/8" Dowel	2
-4	5134560	Cover	1
-5	3719219	Bolt, i/4" - 20 x 3/4" (With Lockwasher)	8
-6	5230007	Seal	2
-7	5174975	Gear	1
-8	147481	Ball, 1/8" Dia. Steel	1
-9	5181747	Shaft Assy. (Includes Gear)	1
-10	5181746	Shaft Assy. (Includes Gear and Ball)	1
-11	5174973	Valve	1
-12	103709	Pin, 5/32" x 1" Straight	1
-13	5184530	Spring	1
-14	5174971	Plug	1
-15	5161003	Gasket	1
-16	5131685	Bolt, 5/16" - 18 x 3/4" (With Nyloc Insert)	3
	5195078	Overhaul Kit, Fuel Pump (Includes Items 17, 6, 8, 10, 9, 11, 12, 13, 15	AR
-17	5150193	Gasket	1
-18	5154216	Coupling	1

FUEL FILTER
(GROUP NO. 2.3000A)



(FIG. NO. 12)

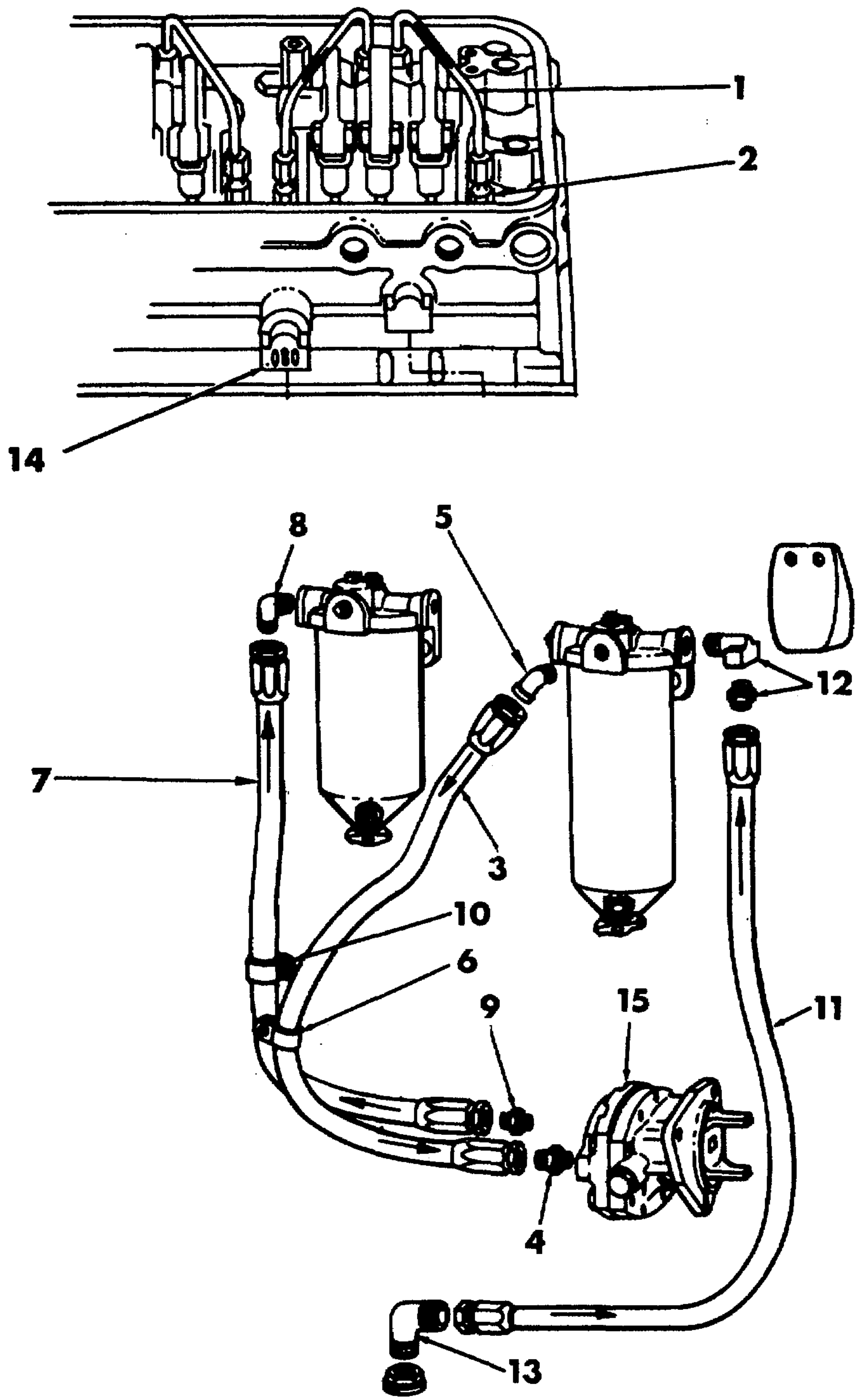


(FIG. NO. 13)

FUEL FILTER
(GROUP NO. 2.3000A)

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
12-1	AC-T-60	Strainer Assy. (Fuel)	1
12-2	5574961	Element (6", Felt Sock Type)(AC-T-553)	1
12-2A	5574161	Gasket Only	1
12-3	103647	Draincock, 1.4"	1
12-4	5121182	Plug, 1/4" Pipe	2
12-4	5145011	Plug, 3/8" Pipe	2
12-5	6435793	Bolt	1
12-6	6435794	Gasket	1
*	5575197	Decal (With AC-T-60 Strainer)	1
*	444692	Plug, 1/4"	2
*	186619	Bolt, 3/8" - 16 x 1-1/2"	2
*	133341	Washer, 3/8" Flat	2
**	103321	Lockwasher, 3/8"	2
13-	AC-T-58	Filter Assy. (4")	1
13-1	5573261	Element (4")(AC-TP-509)	1
13-2	5574123	Seat	1
13-3	5574126	Seal	1
13-4	5574120	Retainer (Ring)	1
13-5	5574124	Spring	1
13-6	5574122	Seat, Spring (Washer)	1
13-7	5574125	Shell Assy.	1
13-9	5574161	Gasket	1
13-10	5574118	Screw	1
13-11	1503537	Gasket	1
13-12	5121182	Plug, 1/4" Pipe	2
13-13	103647	Draincock, 1/4"	1

* Not Shown



(FIG. NO. 14)

FUEL MANIFOLD CONNECTIONS
(GROUP NO. 2.4000)

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
14-1	5116204	Pipe Assy. (Inlet & Outlet) (Qty. is two times Cylinder Count)	6
14-2	5152138	Connector (Quantity is two times Cylinder Count)	6
*	5152148	Washer (Quantity is two time Cylinder Count)	6

* Not Shown

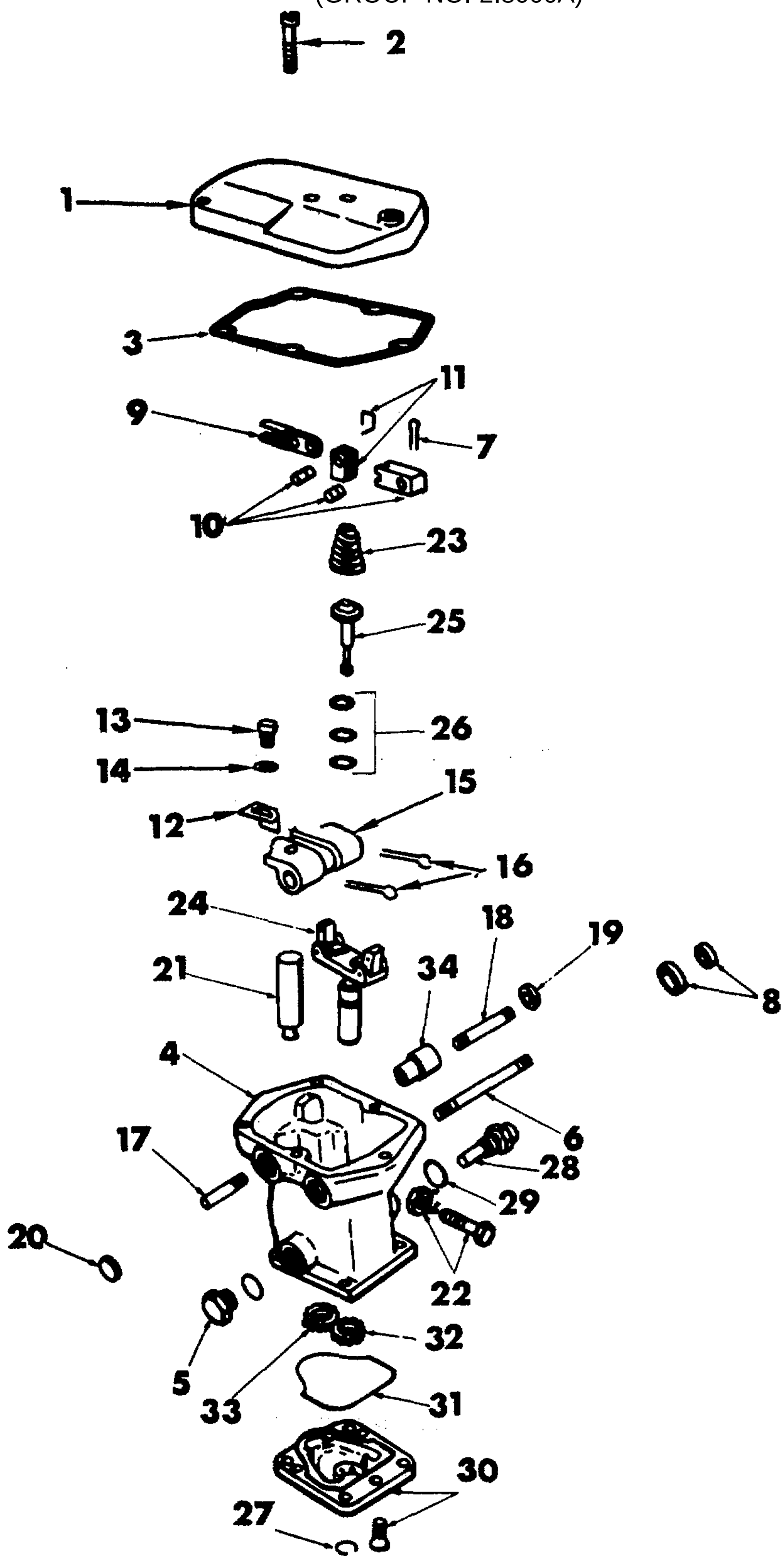
FUEL LINES
(GROUP NO. 2.5000A)

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
14-3	5121149	Tube Assy. (Dev. L. 39.76")	1
14-4	442323	Connector, 3/8" Inv. Fl. Tube	1
14-5	143338	Elbow, 3/8" Inv. Fl. Tube 45 Deg.	1
14-6	5177623	Clip, 3/8" Tube	2
*	5160388	Clip, 3/8" Tube 1-3/8" Long	1
*	3224539	Clip, 3/8" Tube	1
14-7	5134897	Tube Assy. (Dev. L. 36.90")	1
14-9	442323	Connector, 3/8" Inv. Fl. Tube	1
14-8	193004	Elbow, 3/8" Inv. Fl. Tube 90 Deg.	1
14-10	5112241	Clamp	6
*	110502	Bolt, #10 - 24 x 3/4"	3
*	120217	Lockwasher, #10 Med	3
*	110633	Nut, #10 - 24 Hex.	3
14-11	5129623	Tube (Dev. L. 12.68")	1
14-12	442323	Connector, 3/8" Inv. Fl. Tube	1
14-13	193004	Elbow, 3/8" Inv. Fl. Tube 90 Deg.	2
14-14	5127911	Elbow, Restricted (.070")	1

* Not Shown

GOVERNOR HYDRAULIC

(GROUP NO. 2.8000A)



(FIG. NO. 15)

GOVERNOR HYDRAULIC
(GROUP NO. 2.8000A)

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
15	5136998	Governor Assembly	1
15-1	5199864	Cover	1
15-2	5197603	Screw #10 - 32 x 1" W/Lock Washer	3
15-3	3249110	Gasket'	1
*	192484	Screw, 1/4" - 28 x 1-1/4"	1
*	114492	Nut, 1/4" - 28 Hex (Thin)	1
15-4	5197105	Housing Assembly	1
15-4	444687	Plug 1/8" Pipe, Hex Soc. Hd.	1
15-5	5197052	Plug	1
*	5197066	Gasket	1
15-6	5197080	Shaft	1
15-7	5197846	Pin, Roll	1
15-8	5197065	Seal	1
*	5197059	Bushing 1-7/8" L.	1
*	5197078	Bushing 1-1/2" L.	1
*	5197060	Plug, Cup	1
15-9	5197013	Lever	1
15-9	5199196	Stop	1
15-9	5194069	Washer, 1/4" Copper	1
15-9	5194495	Nut 1/4" - 28 Hex Stop	1
5-10	5197015	Lever	1
15-10	5197016	Clip, Spring	1
15-11	5197014	Fork	1
15-12	5197046	Bracket, Droop (Includes Pin)	1
15-13	100659	Screw #10 - 32 x 3/8"	1
15-14	446142	Washer #10 Flat	1
15-15	5198332	Plate, Lever Support	1
15-16	137171	Pin, 3/32" x 1" Cotter	2
15-17	5197045	Shaft 1-11/32" L.	1
15-18	5197084	Shaft 2-3/8" L.	1
15-19	5197065	Seal	1
15-20	5197060	Plug, Cup	1
15-21	5197019	Piston	1
15-21	5197062	Pin, Piston 2-1/4" L.	1
15-22	3304053	Screw #10 - 32 x 1-1/4"	1
15-22	5194070	Washer #10 Copper	1
15-22	120614	Nut, #10 - 32 Hex	1
15-23	5198398	Spring	1
15-24	5198397	Ball Head Assembly	1
15-25	5197010	Plunger	1
15-26	5157328	Bearing	1

- Continued -

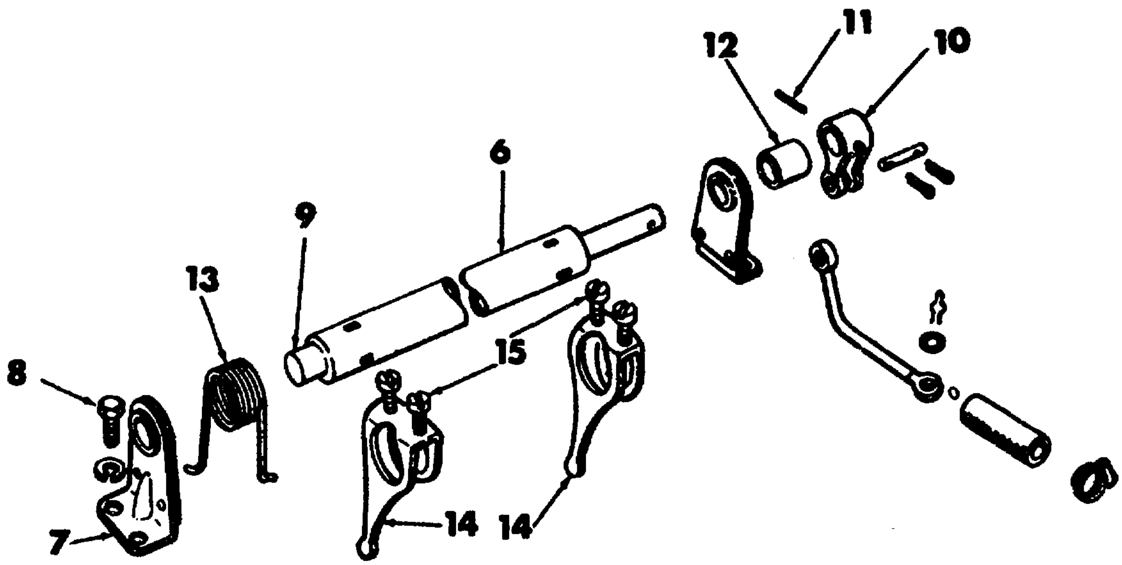
GOVERNOR HYDRAULIC
(GROUP NO. 2.8000A)

2.8000 A (Continued)

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
15-27	274271	Ring, Retaining	1
15-28	5198627	Plunger Kit	1
15-29	5197066	Gasket	1
*	5197068	Spring (Inner)	1
*	5197067	Spring (Outer)	1
*	5197056	Plug 11/16" - 16	1
15-30	5192760	Base	1
15-30	5197847	Pin #2 x 5/8" Tapper Dowel	2
15-30	132188	Screw #12 - 24 x 1/2"	3
15-31	3307753	Ring	1
15-32	3249119	Gear	1
15-33	3249118	Gear (Includes Bushing)	1
15-34	5197058	Bushing	2
*	3249147	Stud	1

* Not Shown

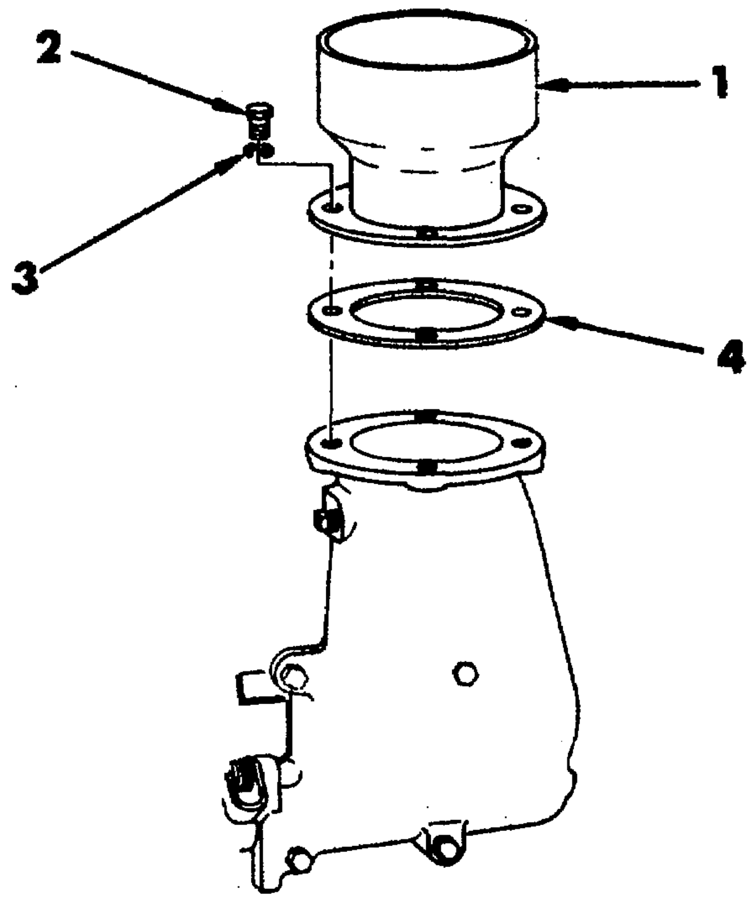
INJECTOR CONTROLS
(GROUP NO. 2.9000)



FIG/ITEM	PART NO.	DESCRIPTION	QTY.
-6	5195968	Tube Assy.	1
-7	5116264	Bracket	2
-8	9422203	Bolt, 1/4" - 20 x 5/8" (12 Pt. Hd.)	4
-9	5150259	Shaft (1-1/16" L.)	1
-10	5116267	Lever	1
-11	142486	Pin, 1/8" x 3/4" Groove	1
-12	5116266	Spacer	1
-13	5116265	Spring	1
-14	5115322	Lever	3
-15	5176228	Screw	6
*	2090519	Arm	1
*	213546	Bolt, 1/4" - 20 x 1"	2
*	120380	Lockwasher, 1/4"	2
*	5146554	Plate	1
*	5129913	Screw	1
*	114493	Nut, 5/16" - 24 Hex. Lock	1

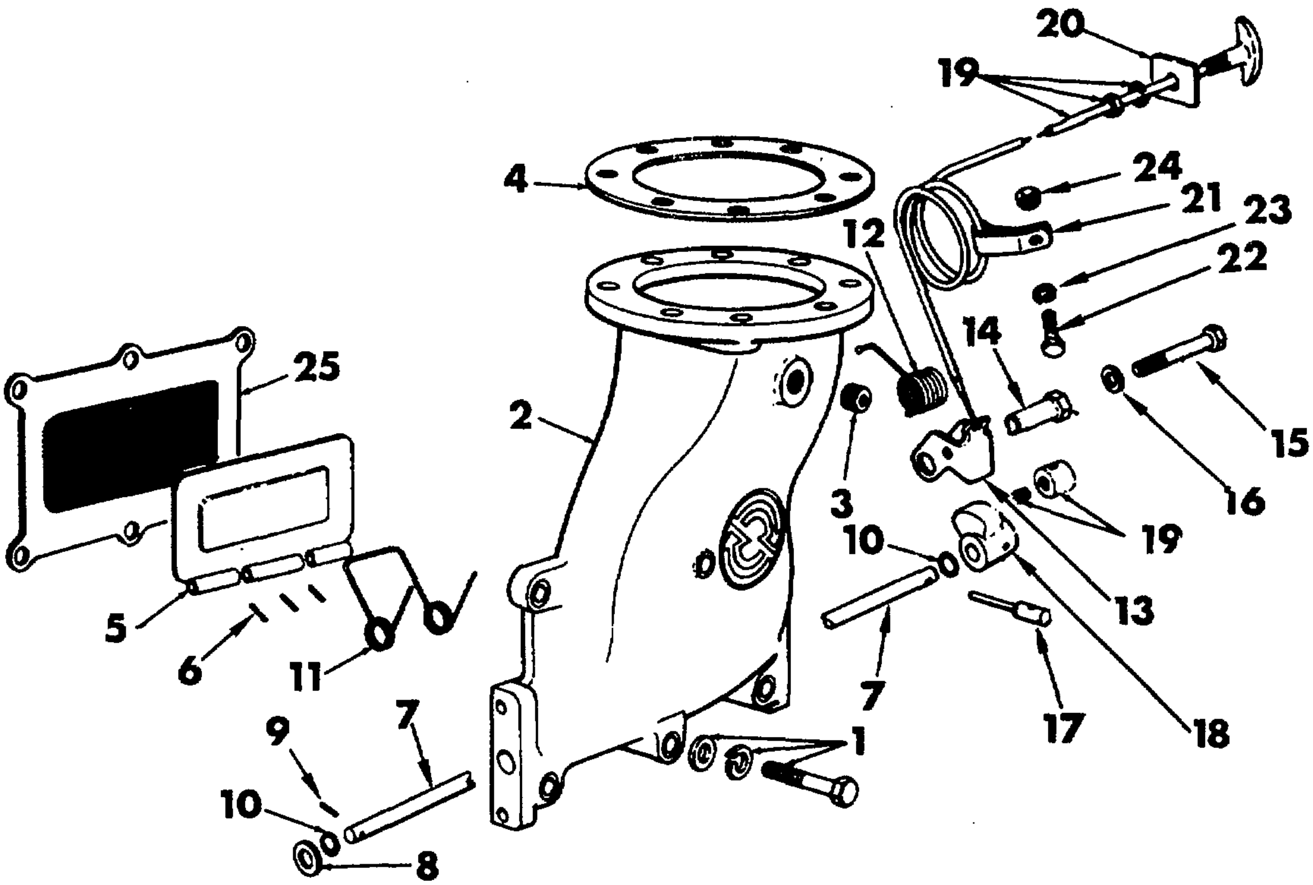
* Not Shown

AIR CLEANER ADAPTOR
(GROUP NO. 3.1000A)



FIG/ITEM	PART NO.	DESCRIPTION	QTY.
-1	5122195	Adaptor	1
-2	186625	Bolt, 5/16" - 18 x 7/8"	4
-3	103320	Washer, 5/16" Lock	4
-4	5124405	Gasket	1

AIR INLET HOUSING
(GROUP NO. 3.3000A)



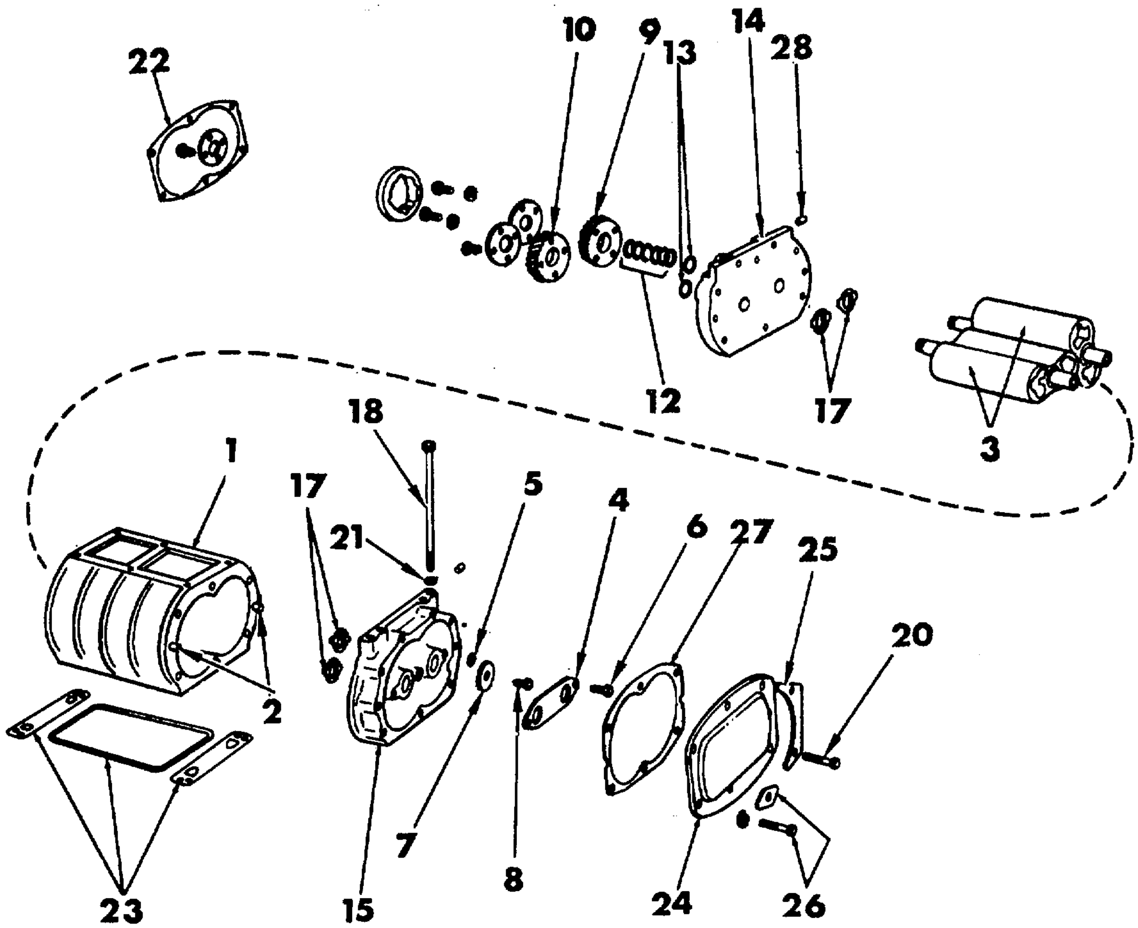
(FIG. NO. 16)

AIR INLET HOUSING
(GROUP NO. 3.3000A)

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
16	5121181	Housing Assembly	1
16-1	5157244	Bolt, 3/8" - 16 x 1-3/4"	4
16-1	179847	Bolt, 3/8" - 16 x 2"	1
16-1	179851	Bolt, 3/8" - 16 x 3"	1
16-1	103341	Washer, 3/8" Flat	6
16-1	103321	Washer, 3/8" Lock	6
16-2	5116383	Housing	1
16-3	5121182	Plug, 1/4" Pipe	1
16-4	5124405	Gasket	1
16-5	5116456	Valve	1
16-6	273436	Pin, 1/8" x 11/16" Roll	2
16-7	5116444	Shaft	1
16-8	103341	Washer, 3/8" Flat	1
16-9	273436	Pin, 1/8" x 11/16" Roll	1
16-10	5182977	Seal Ring	2
16-11	5111904	Spring (Valve, Internal)	1
16-12	5112787	Spring (Latch, R.H. Helix)	1
16-13	5114727	Latch	1
16-14	5143836	Bushing - Eccentric	1
16-15	179803	Bolt, 1/4" - 20 x 1-3/4"	1
16-16	120380	Washer, 1/4" Lock	1
16-17	5114974	Handle	1
16-18	5122623	Cam	1
*	5146239	Wire, Assembly (90" L.)	1
16 -19	3796374	Guide	1
16-19	140855	Screw, #8 - 32 x 5/16" Hex, Socket	1
16-19	110730	Washer, 3/8" Lock	1
16-19	124925	Nut, 3/8" - 24 Hex	1
16-20	5186687	Plate, Instruction	1
16-21	3290569	Clip	1
16-22	123298	Bolt, 1/4" - 28 x 3/8"	1
16-23	120380	Washer, 1/4" Lock	1
16-24	121902	Nut, 1/4" - 28 Hex	1
16 -25	5196053	Screen	1

* Not Shown

BLOWER
(GROUP NO. 3.4000)

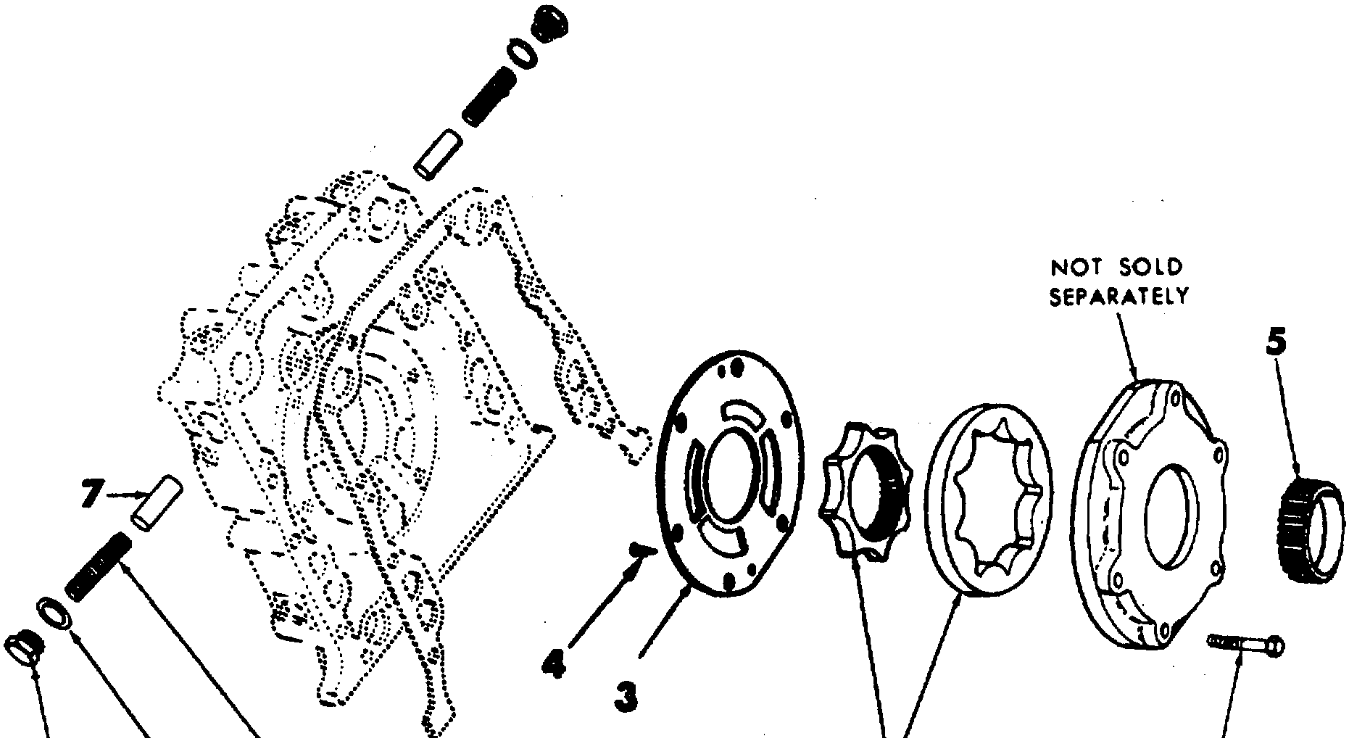


(FIG. NO. 17)

BLOWER
(GROUP NO. 3.4000)

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
17-	5139305	Blower Asm.	1
17-1	5119391	Housing (Includes Pins)	1
17-2	141242	Pin, 3/8" x 7/8" Dowel	4
17-3	5139297	Rotor Assy.	2
17-4	5134179	Plate	1
17-5	5116170	Spacer	3
17-6	9409062	Bolt, 1/4" - 20 x 1"	3
17-7	5127077	Washer, 25/64 I.D.	2
17-8	9409034	Bolt, 3/8" - 24 x 7/8"	2
17-9	5119194	Gear (R.H. Helix)	1
17-10	5119195	Gear (L.H. Helix)	1
*	9409018	Bolt, 5/16" - 24 x 7/8"	2
*	5121403	Washer, 21/64" x 1" x 3/16"	2
17-12	5116164	Shim (.002")	AR
17-12	5116165	Shim (.003")	AR
17-12	5116166	Shim (.004")	AR
17-12	5116167	Shim (.005")	AR
17-13	5116168	Spacer	2
17-14	5134914	Plate, Front	1
17-15	5139299	Plate, Rear	1
17-28	5145009	Plug, 1/8" Pipe	2
*	117297	Screw, 5/16" - 18 x 1-3/4" Fil. Hd.	4
17-17	5142266	Seal (Lip Type)	4
17-18	9433110	Bolt, 7/16 - 14 x 6-11/16"	4
*	5121464	Bolt (10-3/16" L.)	2
17-20	5116150	Bolt (10-11/16" L.)	4
17-21	5131913	Washer (7/16") (Flat)	4
*	5198041	Blower Installation Kit	AR
*	5198684	Repair Kit Not Serviced, Use 5198683 Kit	AR
17-22	5119433	Gasket (To End Plate)	1
17-23	5116295	Gasket (To Block)	1
17-24	5119429	Cover	1
17-25	5119394	Plate, Reinforcement (Large)	2
17-26	5119395	Plate, Reinforcement (Small)	2
17-27	5119433	Gasket	1

* Not Shown



(FIG. NO. 18)

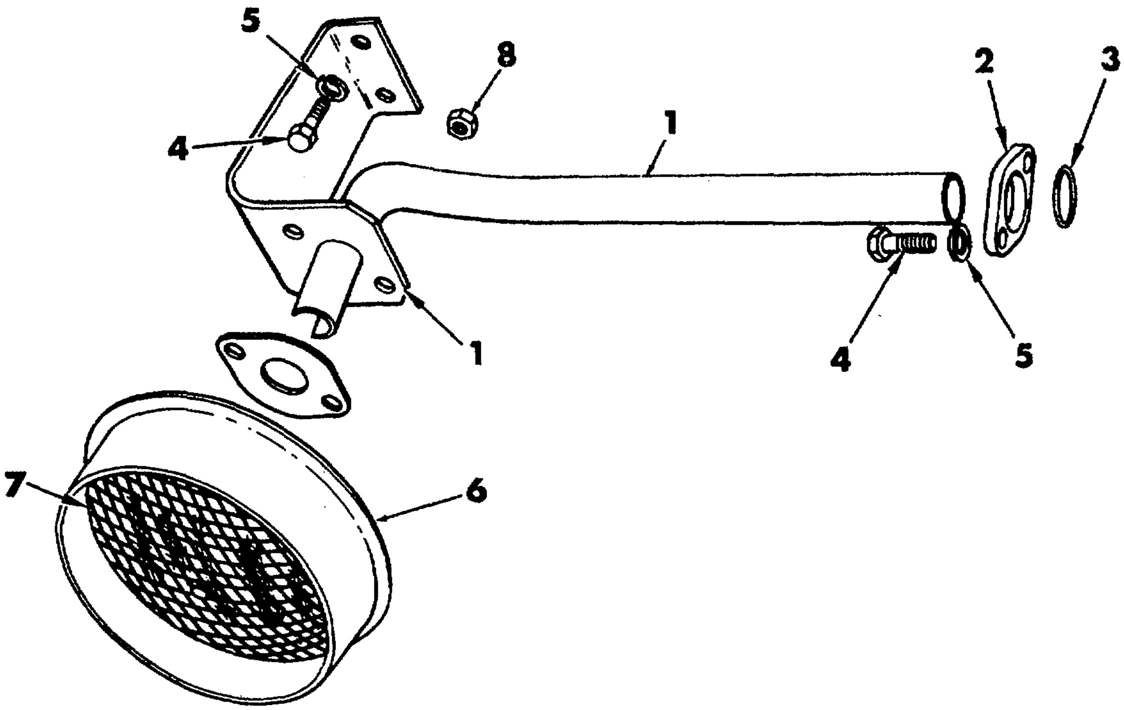
OIL PUMP
(GROUP NO. 4.1000A)

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
18-	5116110	Pump Assy.	1
18-1	193942	Bolt, 5/16" - 18 x 1-5/8" (AA Lock)	6
18-2	5195714	Rotor Set (Includes Inner and Outer Rotors)	1
18-3	5195685	Cover	1
18-4	145067	Screw, #6 x 3/8" Drive	2
18-5	5144375	Gear	1

OIL PRESSURE REGULATOR
(GROUP NO. 4.1000C)

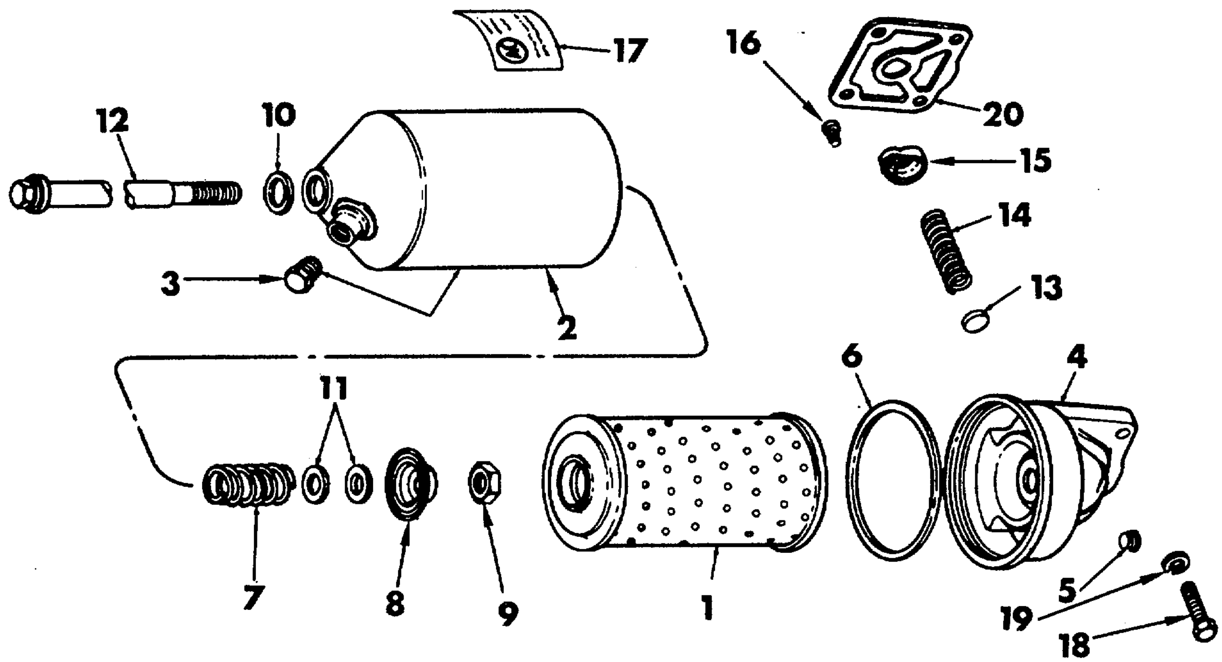
FIG/ITEM	PART NO.	DESCRIPTION	QTY.
18-6	5126436	Spring	2
18-7	5177777	Valve	2
18-8	5113657	Plug	2
18-9	5177773	Gasket	2

OIL DISTRIBUTION SYSTEM
(GROUP NO. 4.1000B)



FIG/ITEM	PART NO.	DESCRIPTION	QTY.
-1	5126211	Pipe (Includes Support 5125947 Not Serviced Separately)	1
-2	5119425	Flange	1
-3	5127175	Seal Ring	1
-4	179816	Bolt, 5/16" - 18 x 3/4"	4
-5	103320	Lockwasher, 5/16"	4
-6	5126456	Screen Assy.	1
-7	5152385	Screen	1
-8	274558	Nut, 5/16" - 24 Hex, Lock	2

OIL FILTER
(GROUP NO. 4.2000A)



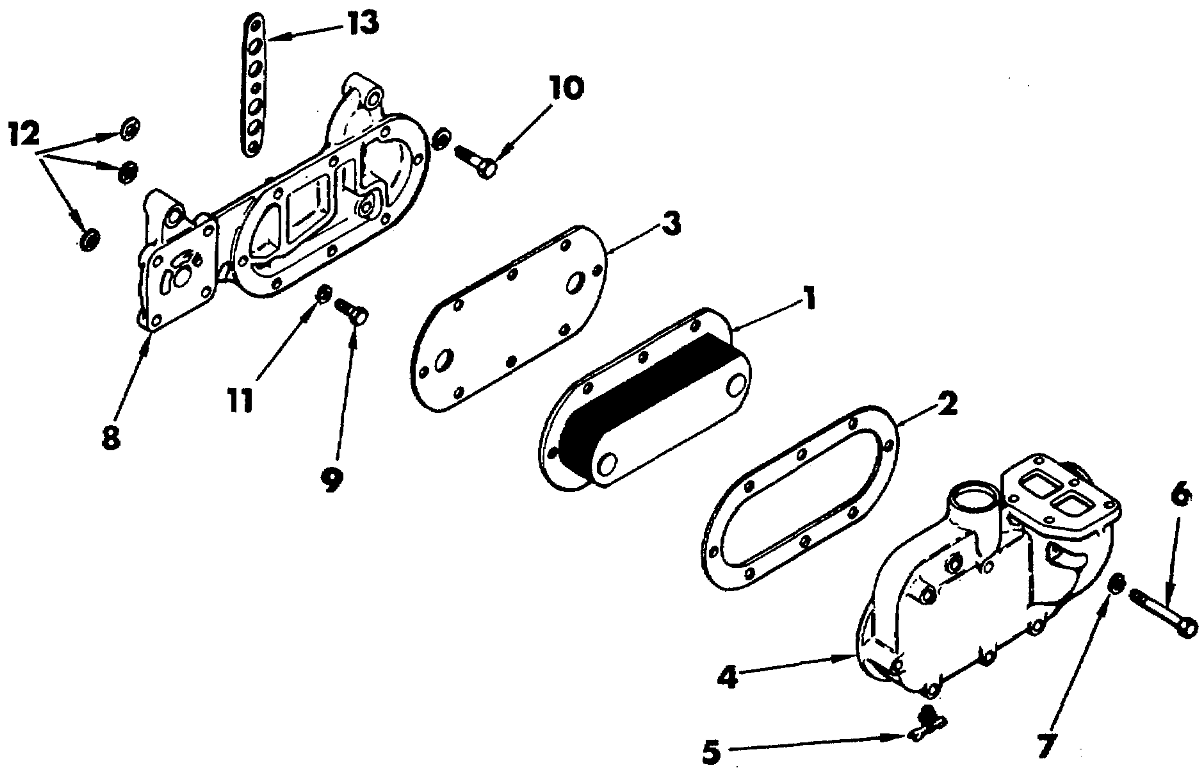
(FIG. NO. 19)

OIL FILTER
(GROUP NO. 4.2000A)

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
19-	5134393	Filter Assy. Not Serviced; For Replacement	1
		Use Assembly (5100 757)	1
19-1	5574978	Element (6") (AC-PF-147)	1
19-2	5574906	Shell (Includes Plug)	1
19-3	5570480	Plug	1
19-4	5100818	Adapter	1
19-5	4544557	Plug, 1/4" Pipe	1
19-6	5573711	Gasket	1
19-7	5187308	Spring	1
19-8	5187309	Retainer	1
*	5120602	Retainer (Snap Ring)	1
19-9	122366	Nut, 5/8" - 18 Hex.	1
19-10	5187310	Gasket, Retainer	1
19-10	6437298	Gasket	1
19-11	5154538	Washer	1
19-12	5130740	Stud	1
*	5198303	Valve Kit	1
19-13	5133431	Valve	1
19-14	5134477	Spring	1
*	5134456	Retainer	1
*	450865	Screw Rnd. Hd.	1
*	5134920	Gasket	1
19-17	5575213	Decal	1
19-18	454906	Bolt, 3/8" - 16 x 1-1/2"	4
*	103341	Washer, 3/8" Flat	4
19-19	103321	Lockwasher, 3/8"	4
19-20	5121205	Gasket	1

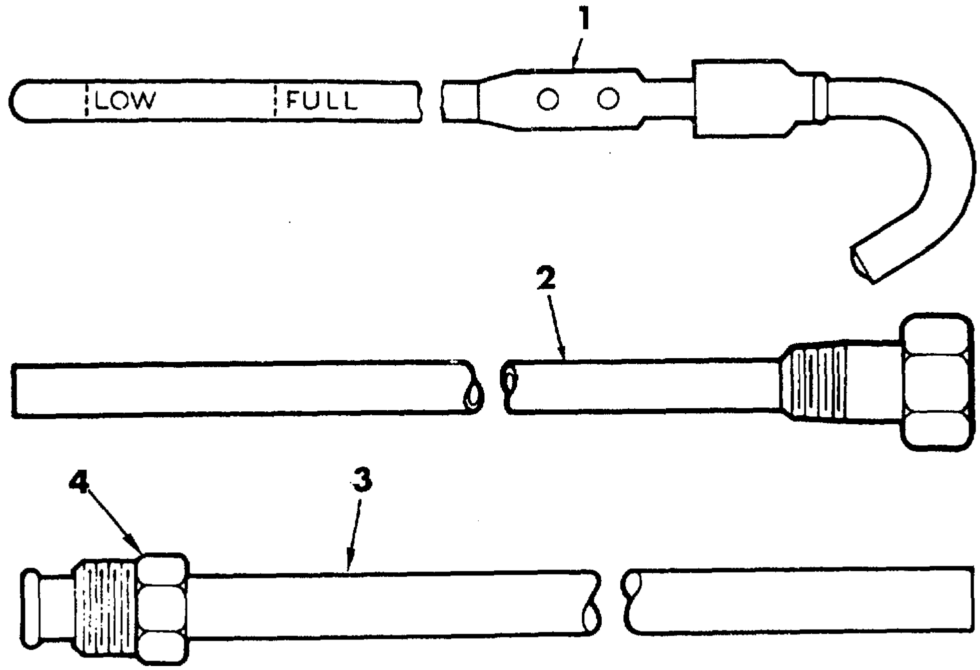
* Not Shown

OIL COOLER
(GROUP NO. 4.4000A)



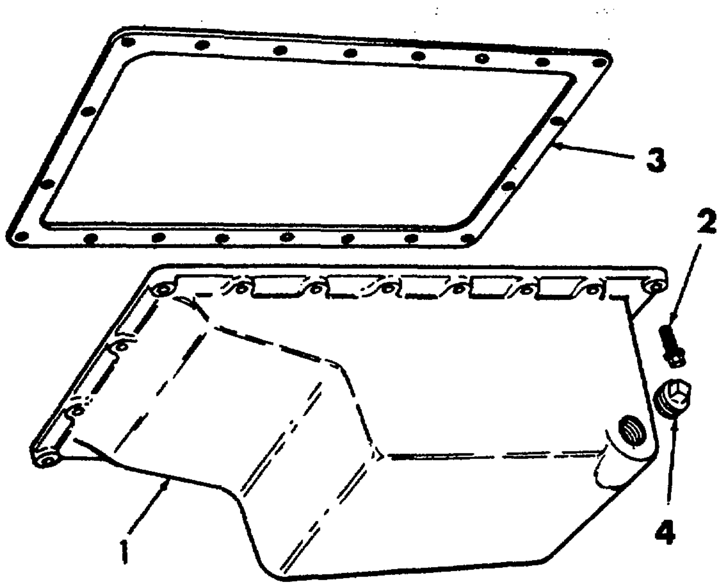
FIG/ITEM	PART NO.	DESCRIPTION	QTY.
-1	8501328	Core Assy. (6 Plate)	1
-2	5150155	Gasket, Inner	1
-3	5154215	Gasket, Outer	1
-4	5119451	Housing	1
-5	103647	Draincock, 1/4"	1
-6	179830	Bolt, 5/16" - 18 x 3"	7
*	186270	Bolt, 5/16" - 18 x 3-1/2"	1
-7	103320	Lockwasher, 5/16"	8
-8	5123413	Adaptor	1
-9	186622	Bolt, 3/8" - 16 x 1-1/4"	4
-10	179847	Bolt, 3/8" - 16 x 2"	2
-11	103321	Lockwasher, 3/8"	AR
-12	5152904	Gasket (Ring)	3
-13	5119286	Gasket (Strip)	1

DIPSTICK
(GROUP NO. 4.6000A)



FIG/ITEM	PART NO.	DESCRIPTION	QTY.
-1	5109253	Dipstick (X-12", Y-.94", Z-10.54") Not Svcd. Use 5146680	1
-2	5121062	Guide (1-1/8" L.)	1
-3	5109621	Adaptor (8.50" L.) (Also Fig 5 Item 6)	1
-4	137401	Nut, 1/2 Inv. Fl. Tube	1

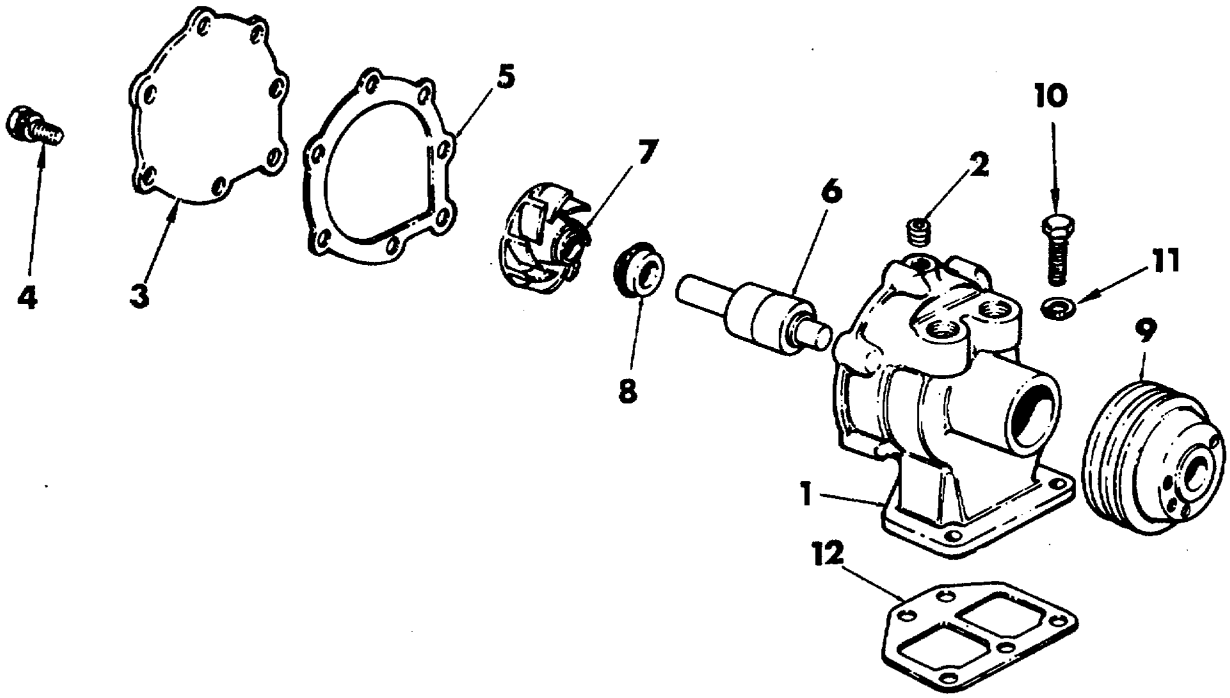
OIL PAN
(GROUP NO. 4.7000A)



FIG/ITEM	PART NO.	DESCRIPTION	QTY.
-1	5146360	Pan	1
-2	5148437	Bolt, 5/16" - 18 x 1"	20
-3	5116256	Gasket	1
*	5145012	Plug, 1/2" - 14 Hex. Skt.	3
-4	5142549	Plug, 3/4" Pipe Sq. Skt.	1

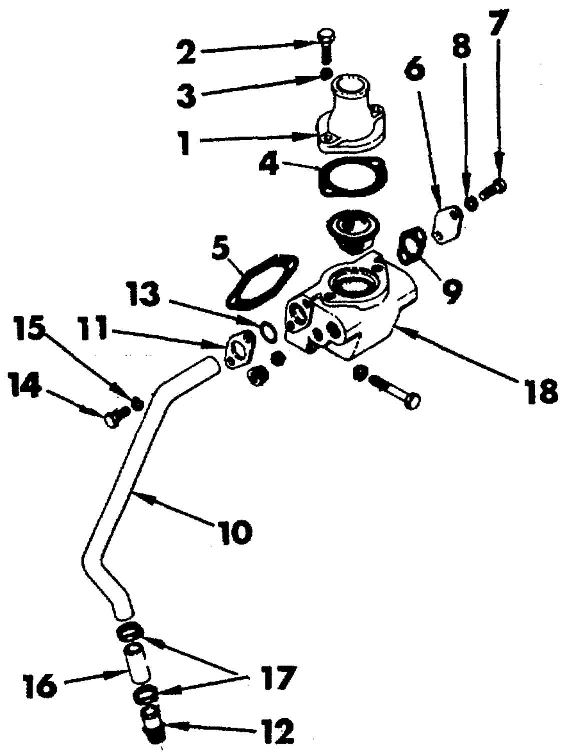
* Not Shown

FRESH WATER PUMP
(GROUP NO. 5.1000)



FIG/ITEM	PART NO.	DESCRIPTION	QTY.
-	5144685	Pump Assy. (Also Fig 5 Item 4)	1
-1	5144688	Body	1
-2	5145009	Plug, 1/8" Pipe	1
-3	5119283	Cover	1
-4	5148436	Bolt, 5/16" - 18 x 3/4"	7
-5	5119282	Gasket	1
-6	904827	Shaft Assy.	1
-7	5113800	Impeller	1
-8	5130959	Seal	1
-9	5144503	Pulley	1
-10	186625	Bolt, 5/16" - 18 x 7/8"	5
-11	103320	Lockwasher, 5/16"	5
-12	5133107	Gasket	1
*	5197279	Replacement Kit, Impeller Insert	AR

*Not Shown



(FIG. NO. 20)

WATER OUTLET ELBOW
(GROUP NO. 5.2000A)

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
20-1	5116409	Flange, (2-1/2" L.)	1
20-2	186619	Bolt, 3/8" - 16 x 1-1/8"	2
20-3	103321	Lockwasher, 3/8"	2
20-4	5116092	Gasket	1

THERMOSTAT
(GROUP NO. 5.2000B),

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
20-	33041379	Thermostat Assy.	1
20-18	5123247	Housing	1
*	5145014	Plug, 3/8" Pipe	2
*	5115214	Plug, 1/2" Pipe	2
*	108608	Bolt, 3/8" - 16 x 2-1/8"	2
*	103321	Lockwasher, 3/8"	AR
20-5	5116242	Gasket	1
20-6	5119426	Flange	1
20-7	186618	Bolt, 5/16" - 18 x 5/8"	2
20-8	103320	Lockwasher, 5/16"	AR
20-9	5128139	Gasket	1

* Not Shown

WATER BY-PASS TUBE
(GROUP NO. 5.2000C)

FIG/ITEM	PART NO,	DESCRIPTION	QTY.
20-10	5108944	Tube	1
20-11	5119425	Flange	1
20-12	5144702	Connector	1
20-13	5184301	Seal Ring	1
*	5142549	Plug, 3/4" Pipe	1
20-14	186625	Bolt, 5/16" - 18 x 7/8"	2
20-15	103320	Lockwasher, 5/16"	2
20-16	5169721	Hose, 7/8" I.D. x 1.74" L. Std. Length Hose; Cut to Length Shown	1
20-17	5186840	Clamp, 1" Dia. Hose	2

* Not Shown

RADIATOR
(GROUP NO. 5.3000A)

FIG/ITEM!	PART NO.	DESCRIPTION	QTY.
*	5122879	Radiator Assembly	1
*	103647	Draincock	1
*	5145010	Plug, 1/4" Pipe	1
*	181360	Bolt, 3/3" - 24 x 3/4"	8
*	103321	Washer, 3/8" Lock	8
*	5135963	Shell Assembly	1
*	5126065	Support, Radiator Shell (Upper, Blower Side)	1
*	5126064	Support, Radiator Shell (Upper, Exhaust Side)	1
*	5126066	Support, Radiator Shell (Upper, Blower Side)	1
*	5131200	Support, Radiator Shell (Upper, Exhaust Side)	1
*	5126062	Support, Radiator Shell (Lower, Exhaust Side)	1
*	5126061	Support, Radiator Shell (Lower, Blower Side) 1	
*	181360	Bolt, 3/8" - 24 x 3/4"	7
*	186627	Bolt, 3/8" - 24 x 1"	2
*	103341	Washer, 3/8" Flat	6
*	103321	Washer, 3/8" Lock	AR
*	117049	Nut, 3/8" - 24 Hex	9
*	5197822	Cap	1

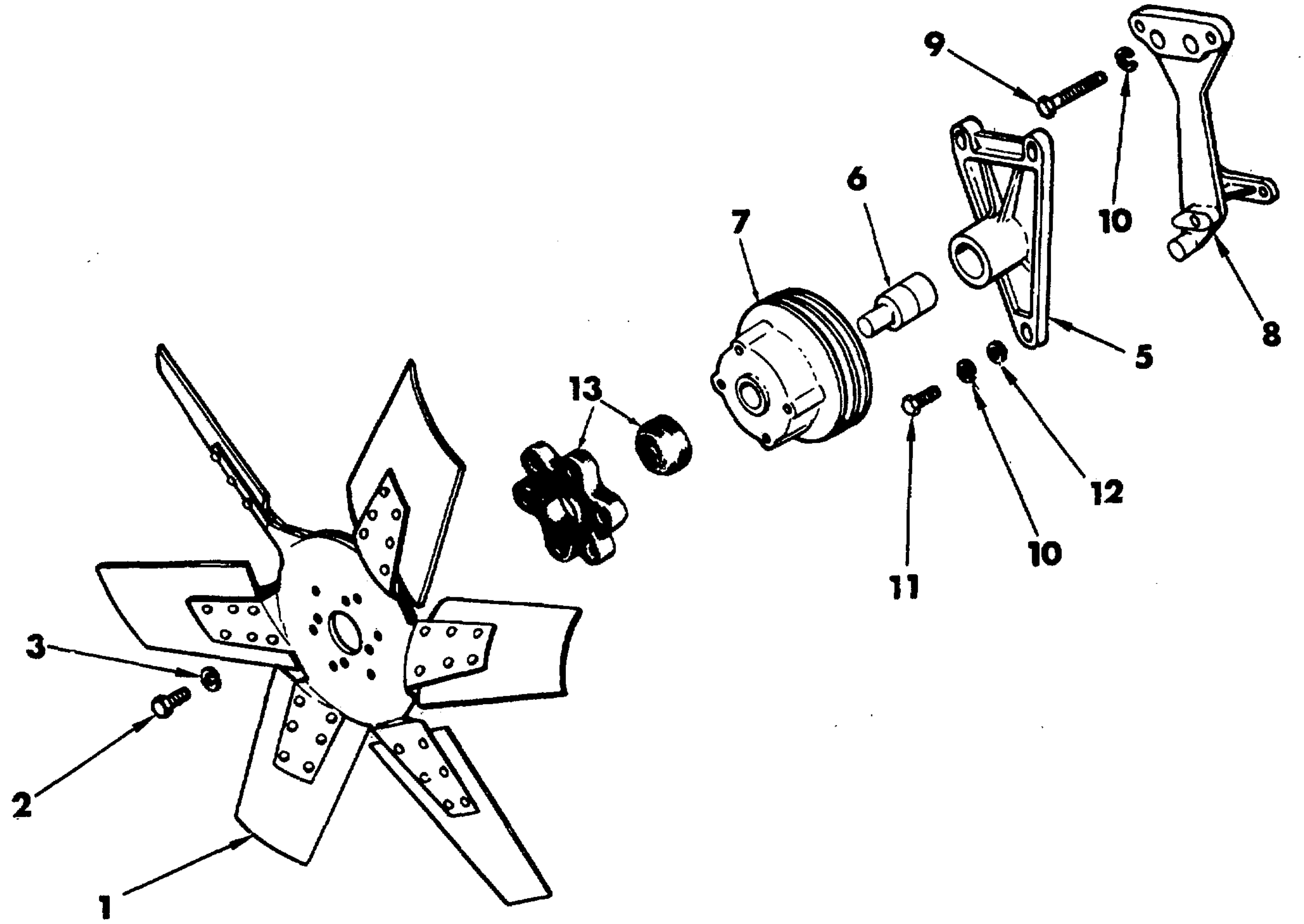
* Not Shown

WATER CONNECTIONS
(GROUP NO. 5.3000B)

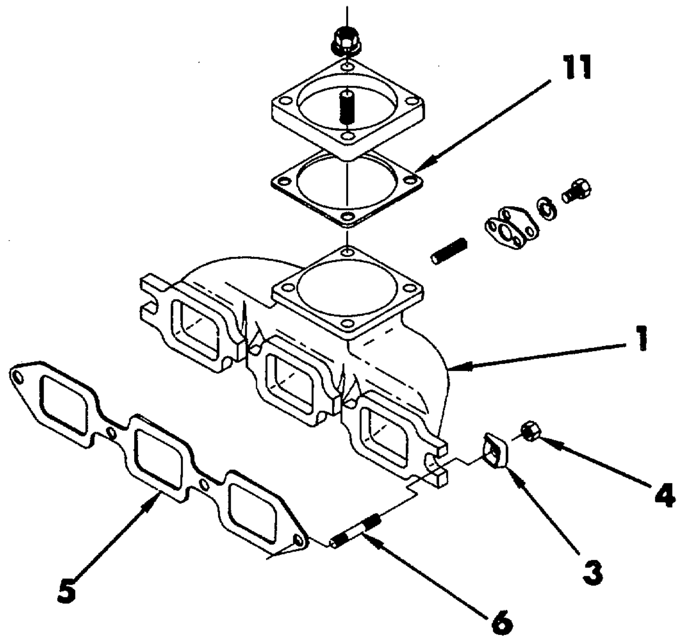
FIG/ITEM	PART NO.	DESCRIPTION	QTY.
*	5119026	Elbow, Not Serviced, Use 5138275 Plus (2) 5145014.	1
*	179819	Bolt, 5/16" - 18 x 1-1/8"	2
*	103320	Lockwasher, 5/16"	2
*	5116357	Gasket	1
*	5199777	Hose (17/8" I.D. x 4-3/4") Std. Length Hose, Cut to Length Shown	1
*	5186841	Clamp, 1-9/16" - 2-1/2" Dia. Hose	2

* Not Shown

FAN
(GROUP NO. 5.4000A)



FIG/ITEM	PART NO.	DESCRIPTION	QTY.
-1	5162837	Blade, 22-5 Blade, Suction	1
-2	179824	Bolt, 5/16" - 18 x 1-3/4"	4
-3	103320	Lockwasher, 5/16"	4
-4	5122869	Pulley Assy.	1
-5	5116477	Bracket	1
-6	905619	Shaft Assy.	1
-7	5148420	Pulley (4.30" Dia.)	1
-8	126868	Support	1
-9	186619	Bolt, 3/8" - 16 x 1-1/8"	2
-9	186282	Bolt, 3/8" - 16 x 3-1/4"	2
-10	103321	Lockwasher, 3/8"	7
-11	186612	Bolt, 3/8" - 16 x 1-3/8"	3
-12	103341	Washer, 3/8" Flat	3
-13	5125022	Cap & Spacer Assy. (Includes Cap P, N. 5125021)	1



(FIG. NO. 21)

EXHAUST MANIFOLD
(GROUP NO. 6.1000A)

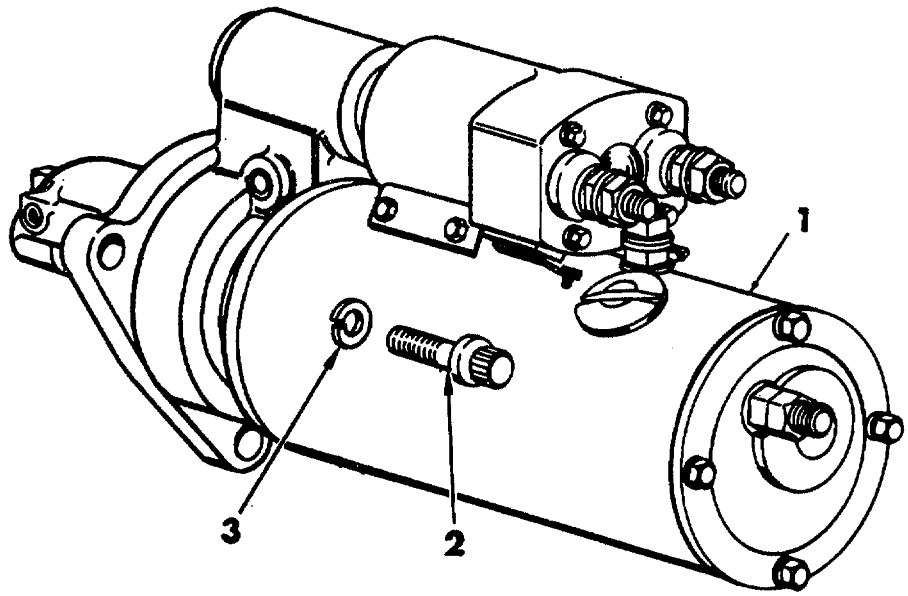
FIG/ITEM	PART NO.	DESCRIPTION	QTY.
21-1	5130330	Manifold	1
21-2	113175	Plug, 1/8" Pipe	1
21-3	5188273	Washer (Dished, 1-1/4" O.D.)	4
21-4	127855	Nut, 7/16" - 20	4
21-5	5116205	Gasket	1
21-6	5112899	Stud, 7/16" x 2-3/32" L.	4

EXHAUST MUFFLER FLANGE
(GROUP NO. 6.2000A)

FIG/ITEM	PART NO.	DESCRIPTION	QTY.
*	51108632	Flange (Customer Furnished)	1
21-11	5108377	Gasket	1
*	103321	Lock Wash 3/8	4
*	1145447	Nut 3/8" - 24 Hex (Brass)	4
*	5109158	Stud 3/8 - 16-3/8 - 24 x 1-1/2" L.	4

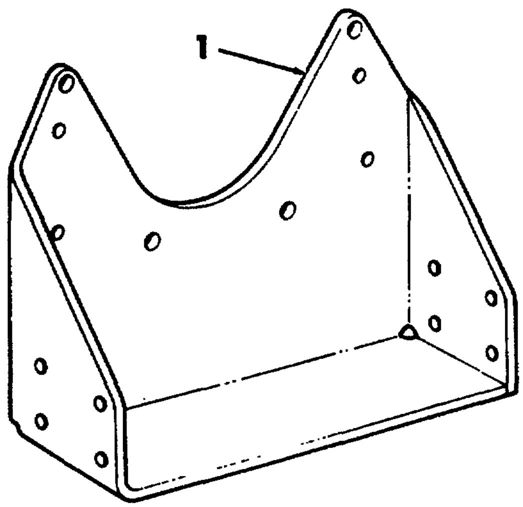
* Not Shown

STARTING MOTOR
(GROUP NO. 7.3000A)



FIG/ITEM	PART NO.	DESCRIPTION	QTY.
-1	1113216	Motor Assy., 12 V., C.W., Grd. Sprag	1
-2	9418228	Bolt, 5/8" - 11 x 1-3/4", 12 Pt.	1
-2	223435	Bolt, 5/8" - 11 x 1-3/4"	2
-3	103325	Lockwasher, 5/8"	3

ENGINE MOUNT
(GROUP NO. 11.1000A)



FIG/ITEM	PART NO.	DESCRIPTION	QTY.
-1	5123945	Support	1
*	186283	Bolt, 3/8" - 16 x 3-1/2"	4
*	454933	Bolt, 7/16" - 14 x 1-1/8"	4
*	103321	Washer, 3/8" Lock	4
*	103322	Washer, 7/16" Lock	4

* Not Shown

PAVING MACHINE

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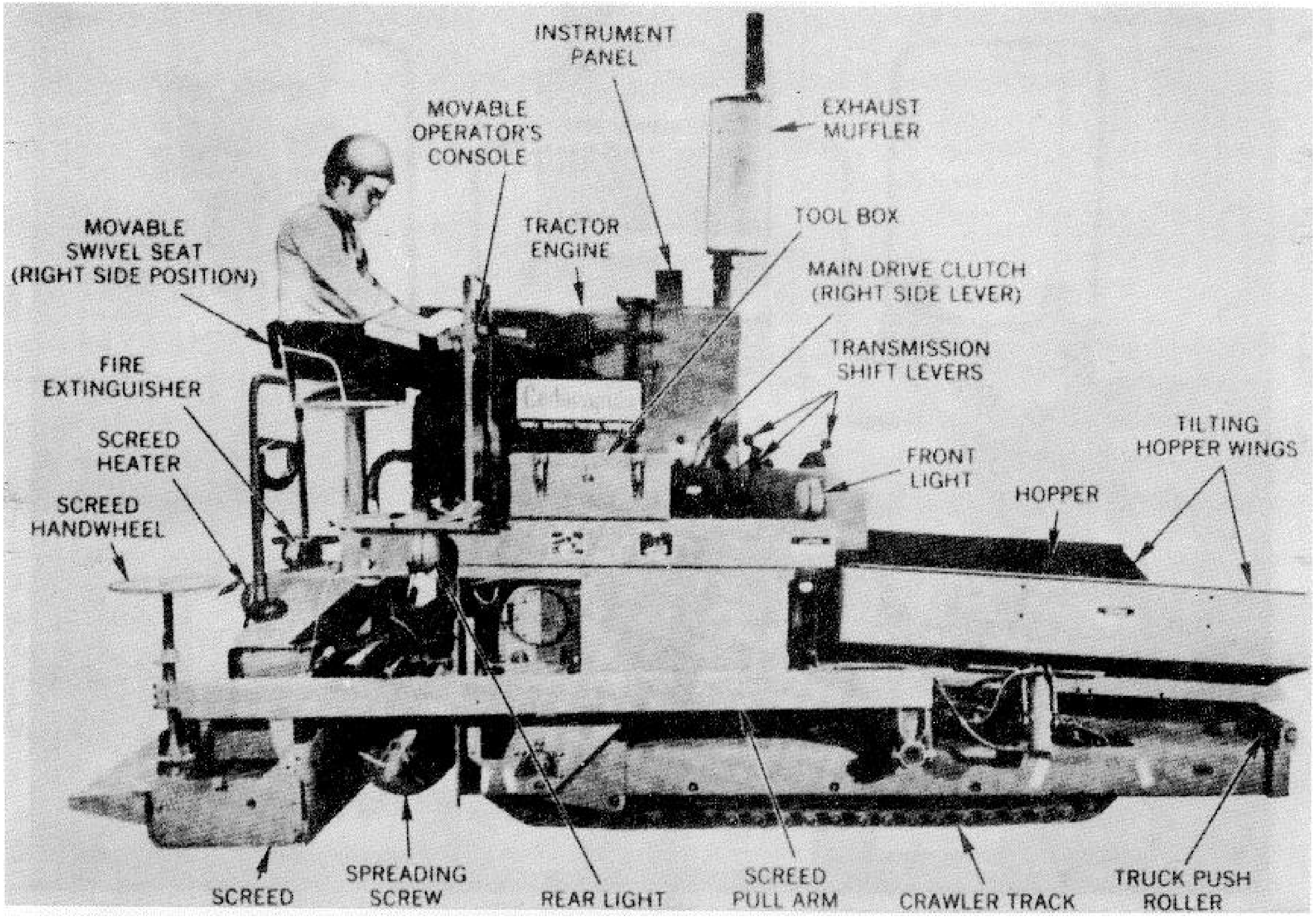
SECTION II
GENERAL INFORMATION



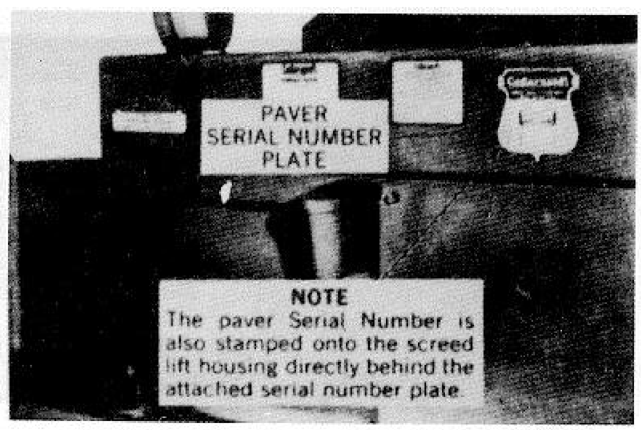
Identification Of Paver Components
Figure 1

INSPECTION UPON ARRIVAL

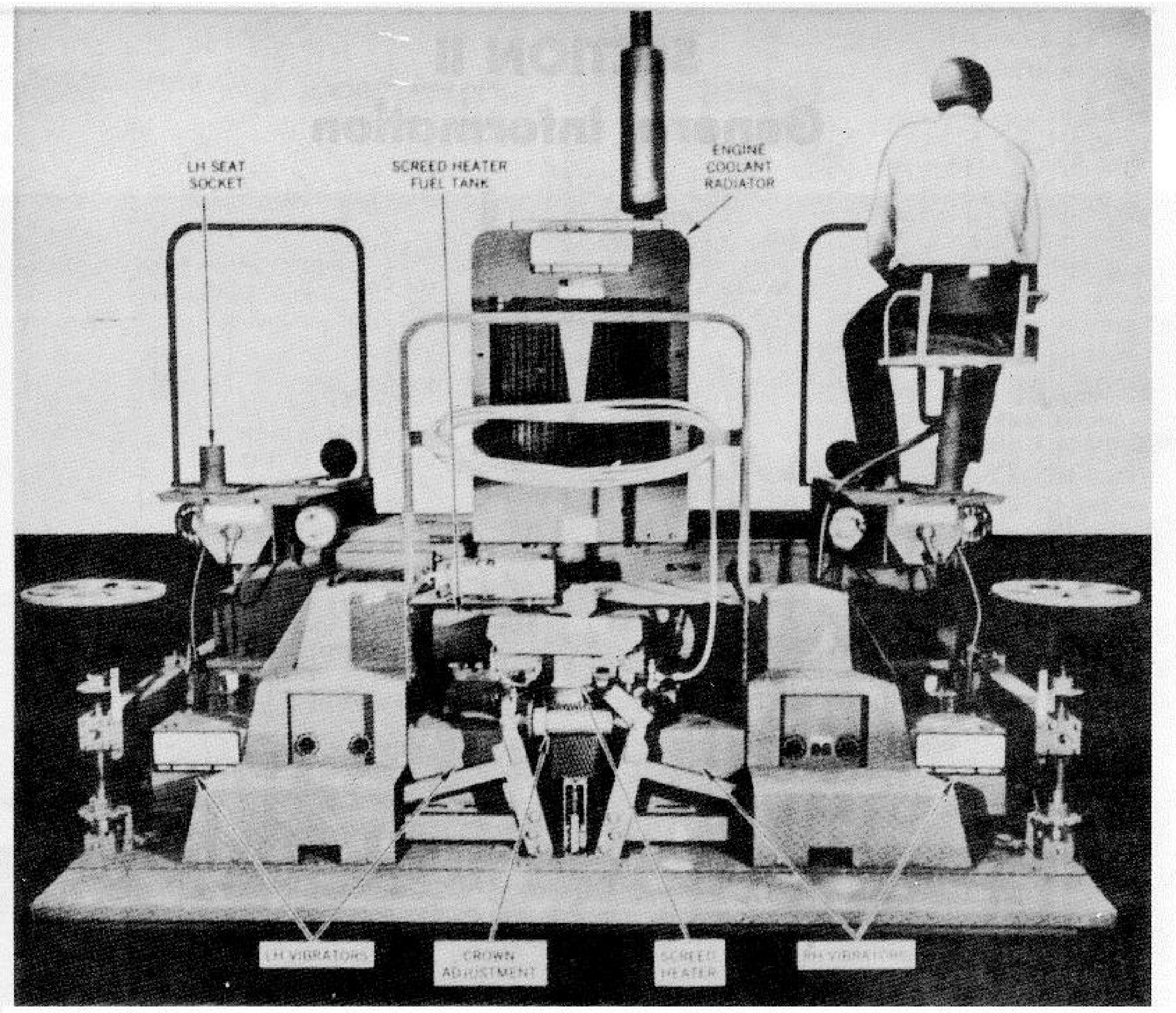
1. As soon as the paver arrives it should be thoroughly inspected for visible damage.
2. Check the freight bill or packing list against all parts packed in boxes shipped with the paver.
3. Install all parts which were removed for shipment. Some of these will be found inside the paver tool box. (See Figure 1)

INSTRUCTIONS FOR MOVING PAVER

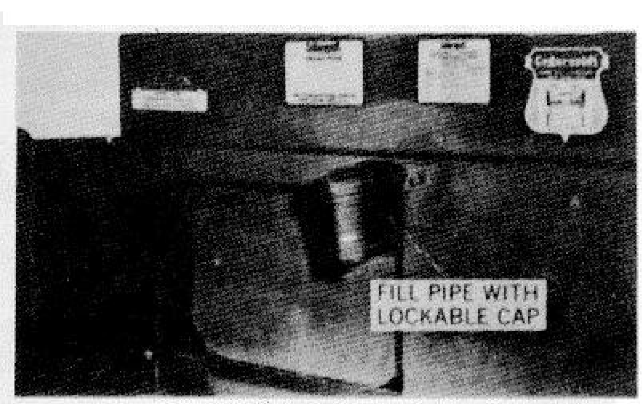
Explicit instructions covering the proper procedure for moving the paver under it's own power are printed inside the protective cover for the operator's console. These instructions should be studied before any attempt is made to start the engine and move the paver in either direction.



Paver Serial Number Location
Figure 2

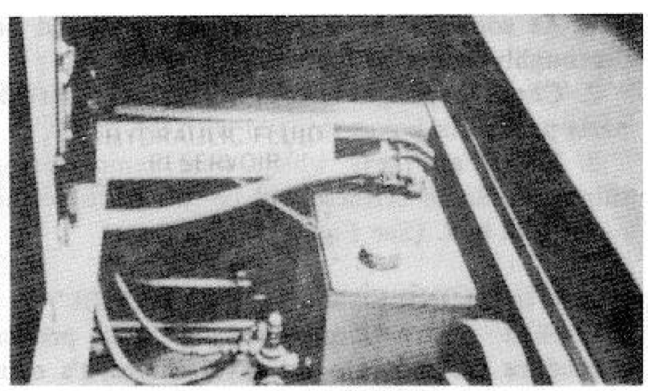


Identification Of Paver Components
Figure 3



Diesel Fuel Tank - LH Side of Paver

Figure 4



Hydraulic Fluid Reservoir - RH Side

Figure 5

DIMENSIONS AND SPECIFICATIONS

Capacities:

Mat Width....................................6'to 10' standard
Mat Width....................................10' to 20'optional
(For paving widths over 20' - consult factory)
Mat Thickness....................................to 10"
Paving Speeds....................................11 FPM to 132 FPM
Travel Speed ....Up to 3.8 MPH
Hopper Capacity....................................10 Tons

Weight:

Standard width paver (diesel engine) . 24,000 lbs.
Extensions to 20' paving widths....................................2225 lbs.

Overall Dimensions: (Also see page 8)

Length ....16'-5"
Width (without extension)....................................10'-3"
Height (to top of engine)....................................8'-1½/"
Ground Clearance to Screws....................................4 5/8"

Supply Tank Capacities:

Engine Fuel ....33 gallons
Hydraulic System Oil ....10 gallons
Screed Heater Fuel (Oil) ....12.5 gallons

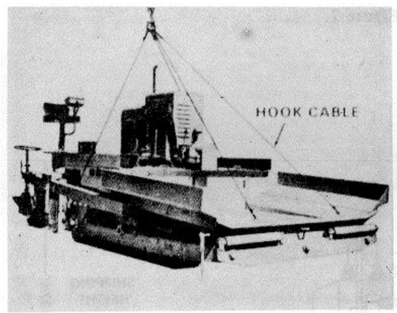


Figure 6 - Correct Lifting Points (Four)

LOADING AND UNLOADING PAVER

The self-propelled paver can be loaded or unloaded by constructing a ramp or by using a dock or a platform.

CAUTION! **Be sure all support methods used will safely carry the full weight of the paver.** The Diesel driven unit weights 24,000 lbs.

If a crane with 30,000 lbs. lifting capacity is available it can be used to load or unload the paver. Attach lifting cables at the four points shown in Figure 6.

SHIPPING BRACE & FASTENER REMOVAL

Important! Before attempting to move the paver either by hoisting or driving be sure all shipping blocks, cables, braces, and other fasteners have been completely removed.

CLEARANCE FOR UNLOADING & TRAVEL

The clearance from ground level of the paver to the bottom of its spreader screws is 45/8". All loading and unloading ramps must be built so that the spreader screws will not drag and be damaged at any point. In traveling, care must be taken not to bring the screws into contact with any firm object.

IMPORTANT! Before attempting to start the paver engine and to move it under its own power, read and comply with all instructions given under "Pre-Start Check" in Section 8 - Operation.

Instructions for moving the paver are also printed inside the protective cover of the operator's console.

SCREED ELEVATION **FOR UNLOADING** AND TRAVEL

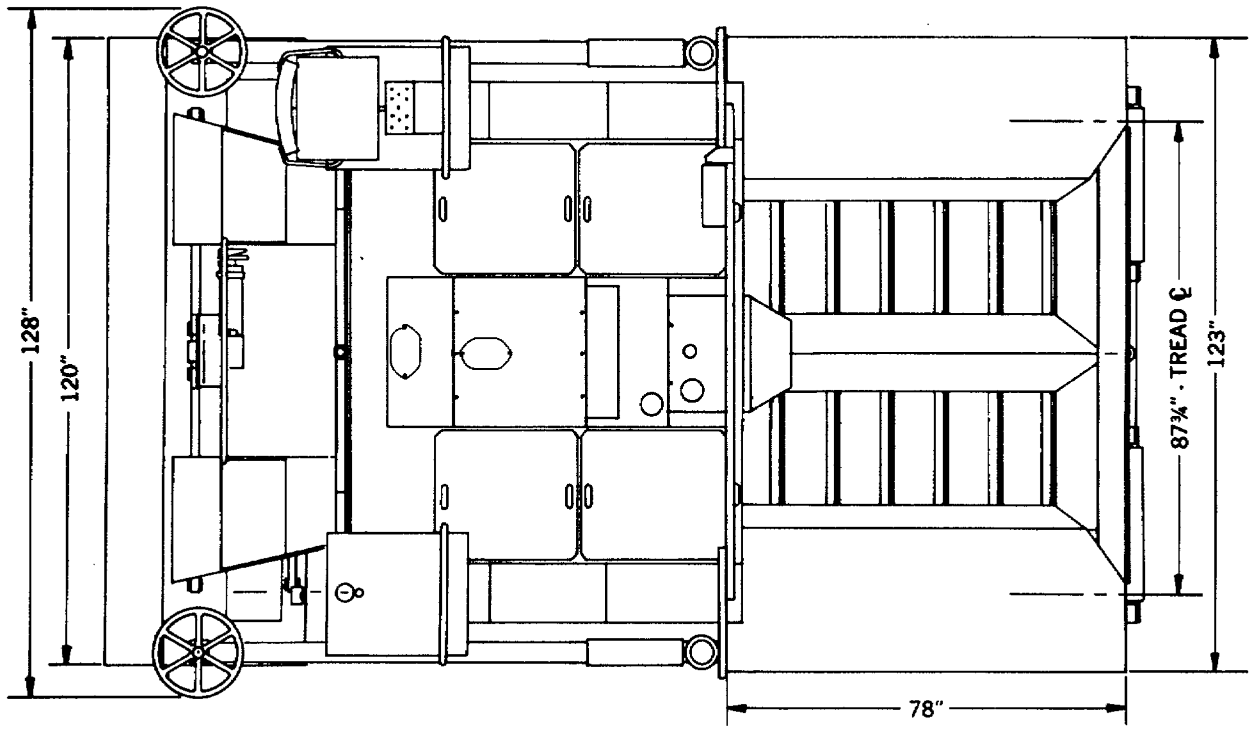
(For explanation of the term "Screed" read following page.)

The screed must always be raised for unloading or travel. Normally it will be suspended by two safety cables for this type of paver movement. (Refer to Screen Section 7 for details.) When the paver is to be loaded and transported a lengthy distance, provide smooth wood blocks for three point support on the truck bed. Lower the screed to these blocks, located at each end and at the center. **Important!** Never rest the screed bottom on bolts, rivets, nails, etc. which could scratch and gouge the bottom surface.

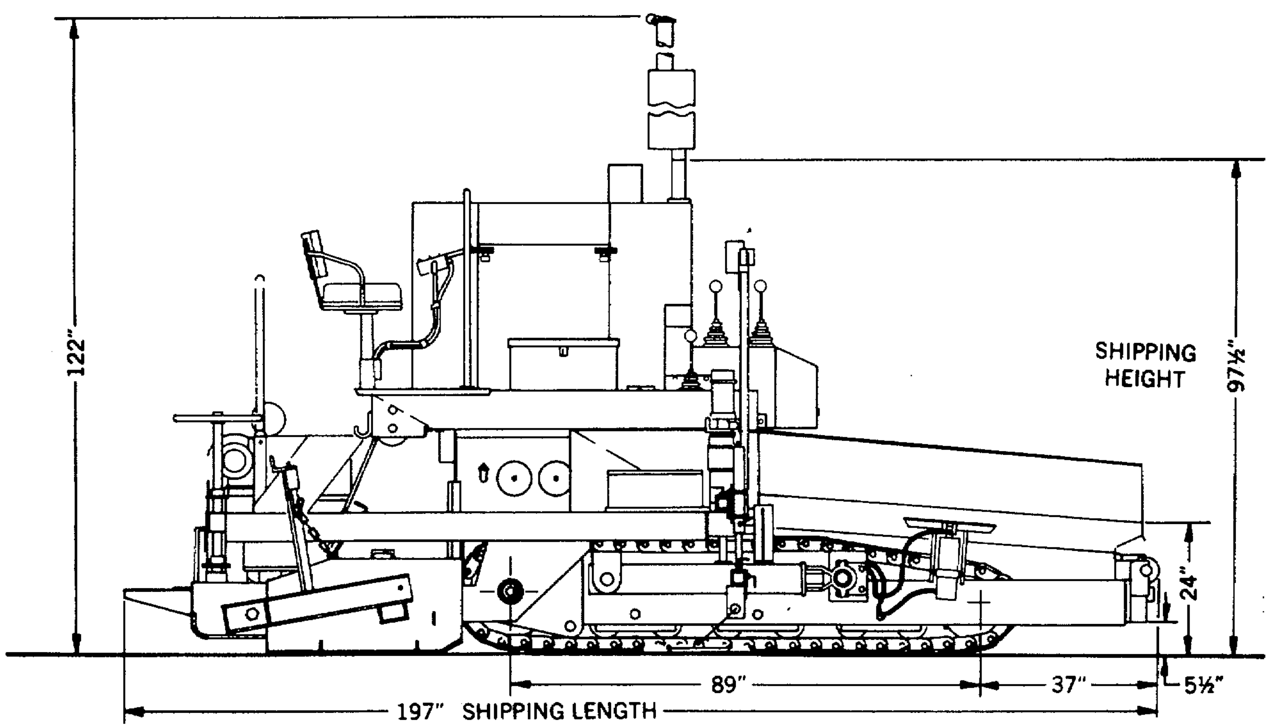
TRAVEL SPEED

The paver has a top travel speed of approximately 3.8 MPH. It can be driven from one paving location to another when practical. If considerable traveling is done the track rollers should be lubricated properly at least **twice daily.** (See Lubrication Instructions, Section 10.)

MODEL BSF-400 ASPHALT PAVER DIMENSIONS



TOP VIEW-FIGURE 7



SIDE VIEW-FIGURE 8

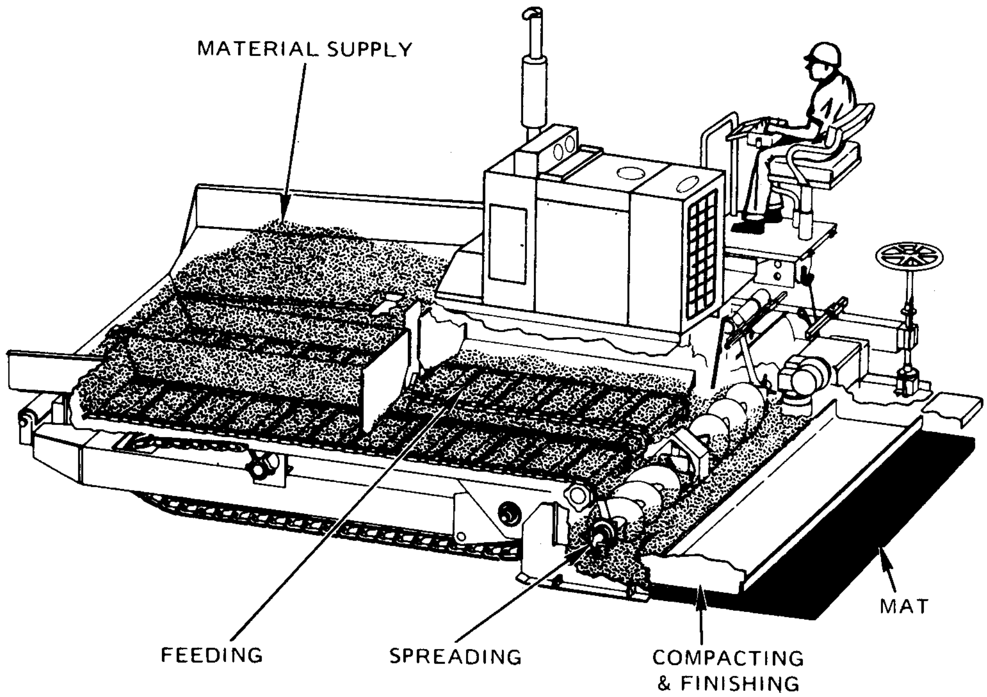


Figure 9. Material Flow Diagram

FUNCTION AND APPLICATION

The Cedarapids crawler mounted paver is designed to lay a uniform high density mat of asphalt material on highways, roadways, airport-runways, parking lots and driveways. It is cap able of performing jobs having strict control specifications and high production requirements. The paver will level and compact asphalt material up to 10 inches in depth, with mat widths varying from 6 to 20 feet. Mat depth and width variations are accomplished by adjustment of feed controls and by arrangement and adjustment of the finishing and compacting device called the "Screed."

OPERATING PRINCIPLE

The uniformly mixed, hot asphalt material is dumped by truck loads onto the hopper of the paver at a rate suitable for spreading and finishing. During this unloading process the paver contacts the rear wheels of the truck and pushes the vehicle ahead with it's own power as the paving progresses.

The hot material from the hopper is metered by two separate slat conveyors to the two spreading screws which are at the rear of the tractor unit and ahead of the screed. The feed of material may be either manually or automatically regulated to obtain a properly proportioned distribution. The attached "screed" assembly which is a full floating unit drawn by the tractor, "rides up" on the asphalt to the degree set on the adjustable controls and in so doing varies the thickness and contour of the mat deposited beneath it. The screed controls can be adjusted either manually or automatically to create a new surface which is minus the undesirable irregularities of the old. The screed unit which performs the "ironing" job on the asphalt is equipped with electric vibrators which assist in the initial compaction and smoothing of the high density mat.

Final compaction of the newly laid asphalt mat is accomplished by separate rolling equipment according to established compaction specifications.

The paver screed can be fitted with special attachments for paving of highway shoulders which are not simple extensions of the roadway. Numerous cut-off and beveling attachments meet the need for varying width and contour requirements.

The screed is equipped with an oil or gas fired heater which is operated prior to paving in order to bring the screed temperature up to the temperature of the asphalt, so that no sticking and dragging will occur.

The raising and lowering of the full floating screed for either paving or travel is done hydraulically by toggle switch control.

SECTION III

Tractor and Drives

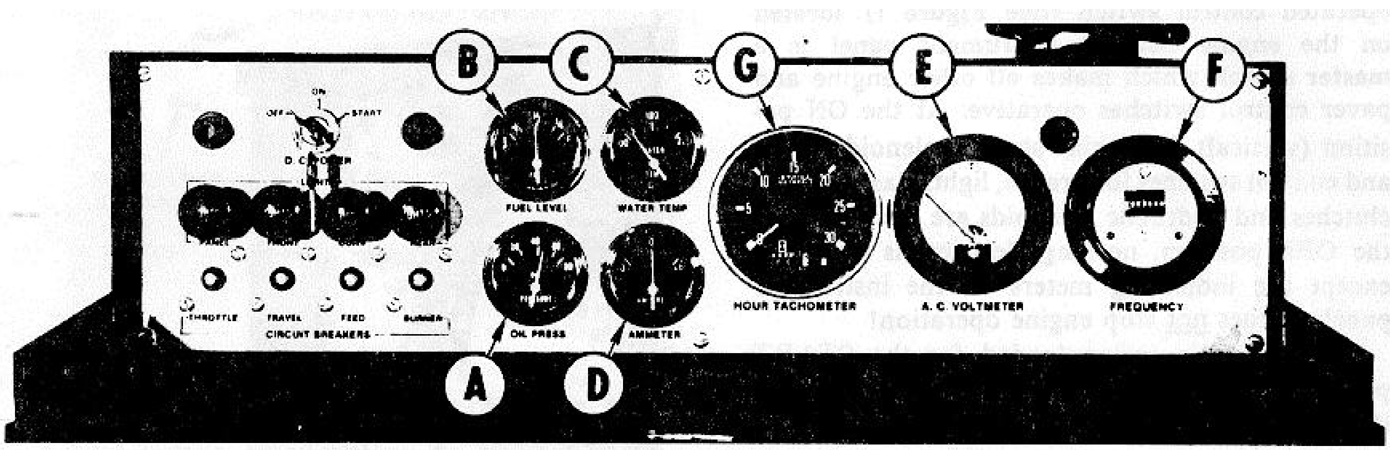


Figure 1. Instrument Panel - (Protective Cover In Unlocked Position)

ENGINE DATA

The paver engine is a GMC Model 3-53N Diesel with 4 Valve Head, Specification No. 5033-7201, Rating: 74 HP @ 2000 RPM, Compression Ratio: 21 to 1, Injectors: N-45, Governor Setting: 2100 RPM-Full Load, 2200 RPM Max. Hi Idle, 500 RPM Lo Idle, with selected custom features. This engine complete with custom features is supplied by Hicklin GM Diesel Corporation, Des Moines, Iowa per Iowa Manufacturing Company Specification No. 45924-008-02.

ENGINE SPEED

The GM 3-53 diesel engine is equipped with a speed governor which should be set at 2000 RPM when the engine is at full throttle. Important! Engine speed should not vary more than 3% **regardless of load.**

Engine speed is directly proportional to the output of the Frequency Meter (Figure I above) which indicates the speed of the 120 VAC belt driven generator unit (Section IV). At the 2000 RPM engine speed, the generator will produce a 61 cycle reading on the Frequency Meter. **When the meter is at 61 cycles the engine speed (at full throttle and no load) may be considered correct.**

PAVER INSTRUMENTS

All paver instruments are mounted in the lockable enclosure on top of the engine housing. (Figure 1) A description of the instrument functions follows.

A. Oil Pressure Gauge: Indicates engine oil pressure (Refer to engine manufacturers manual for details).

B. Engine Fuel Level Gauge: Indicates level of Diesel fuel in the 33 gallon supply tank. Gauge markings are in quarter-tank increments. Gauge sensor in tank is shown in Figure 3, page 18.

C. Water Temperature: Indicates temperature of coolant flowing through engine block and radiator.

D. Ammeter: Verifies proper function of the 12 VDC battery charging circuit. Power is supplied by the belt driven generator unit on the side of the engine (See Section IV). At full throttle the ammeter reading should be positive, indicating a charging of the battery.

E. Voltmeter: Indicates voltage output of belt driven AC generator unit which as 120 VAC rating. (See Section IV). With Engine at full throttle voltage must not be less than 120 V. nor more than 135 V.

F. Frequency Meter: Indicates speed (in cycles per second) of 120 VAC generator. When the engine is at full throttle the meter should show no less than 59 CPS nor more than 61 CPS.

G. Hour-tachometer: Indicates engine speed on dial and registers the number of engine operating hours accumulated (on counter) since paver left factory. This combination tachometer and time recording instrument operates whenever oil pressure developed by engine operation closes a pressure switch. (See wiring diagram in Section IV).

ENGINE CONTROLS

1. Control Key Switch: The three-position key-operated control switch (See Figure 1) located on the engine housing instrument panel is a **master switch** which makes all other engine and paver control switches operative. At the ON position (vertical) the engine starter solenoid switch and control switches for brakes, lights flashers, feed clutches and hydraulic solenoids are operative. At the OFF position, nothing electrical is operative except the indicating meters on the instrument panel. It does <u>not</u> stop engine operation!

The switch is spring loaded for the START position and must be held in that' position to start the engine, in the manner of automobile engine starting.

2. Fuel Cut-off Lever

This lever stops the flow of fuel to the engine injectors to stop operation. It is located on the side of the engine housing (See Figure 2).

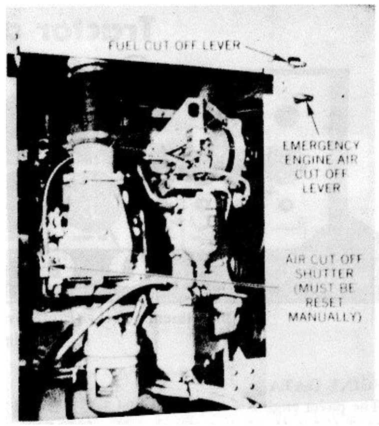


Figure 2. Diesel Engine - Left Side

3. Emergency Stop Lever

This lever trips an air shutter to the Closed position, thereby cutting off all air flow to the engine fuel system which brings engine operation to a positive stop. It is located on the side of the engine housing (See Figure 2). **IMPORTANT!** When ever the Emergency Stop Lever is used it is necessary that the spring loaded air shutter be **reset manually,** otherwise the engine cannot be restarted. The louvered engine cover on the left side must be raised to reach the reset point. (See Figure 2). **If at anytime the engine cannot be started, be sure to see that the air shutter is properly reset for operation, as the air shutter may have been tripped without the knowledge of the operator.**

4. Speed Governor: An adjustable speed governor located on the side of the engine maintains the correct operating speed at the full throttle setting. (See Figure 3) Correct engine speed is 2000 RPM.

5. Engine Throttle Solenoid: An electric solenoid unit mounted on the engine moves the throttle. mechanism from Idle to Full Throttle setting. (See Figure 3) The solenoid is actuated by a toggle switch on the operator's console. A spring returns the throttle to Idle when the solenoid is not energized. (Refer to the Soft Start information in the paragraphs covering the Control Console in Section 8).

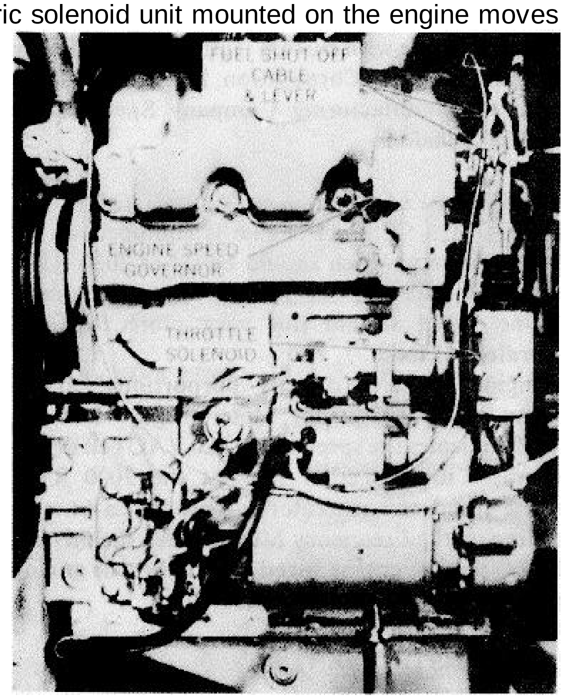


Figure 3. Diesel Engine - Right Side

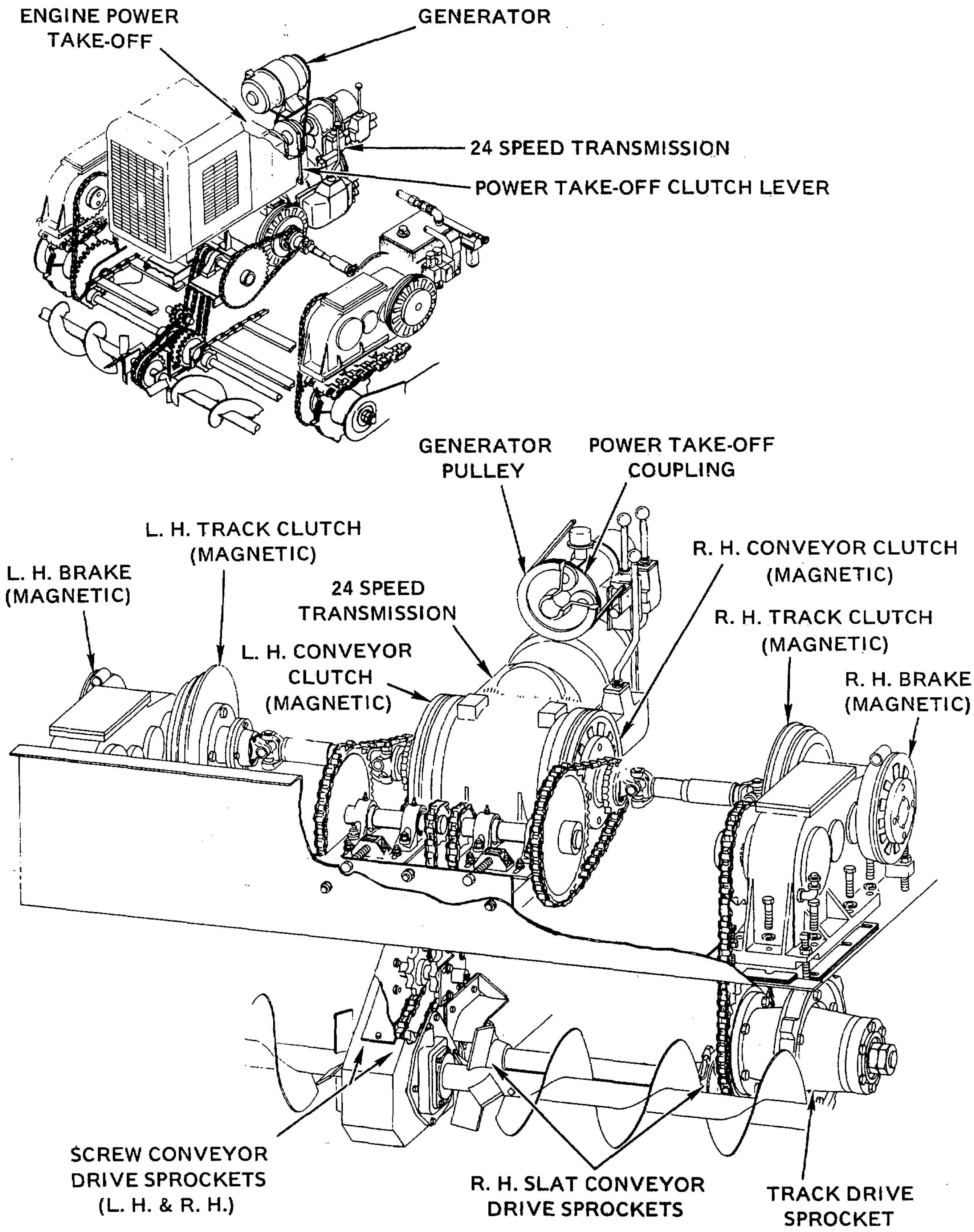


Figure 4. Travel & Conveyor Drive Arrangements

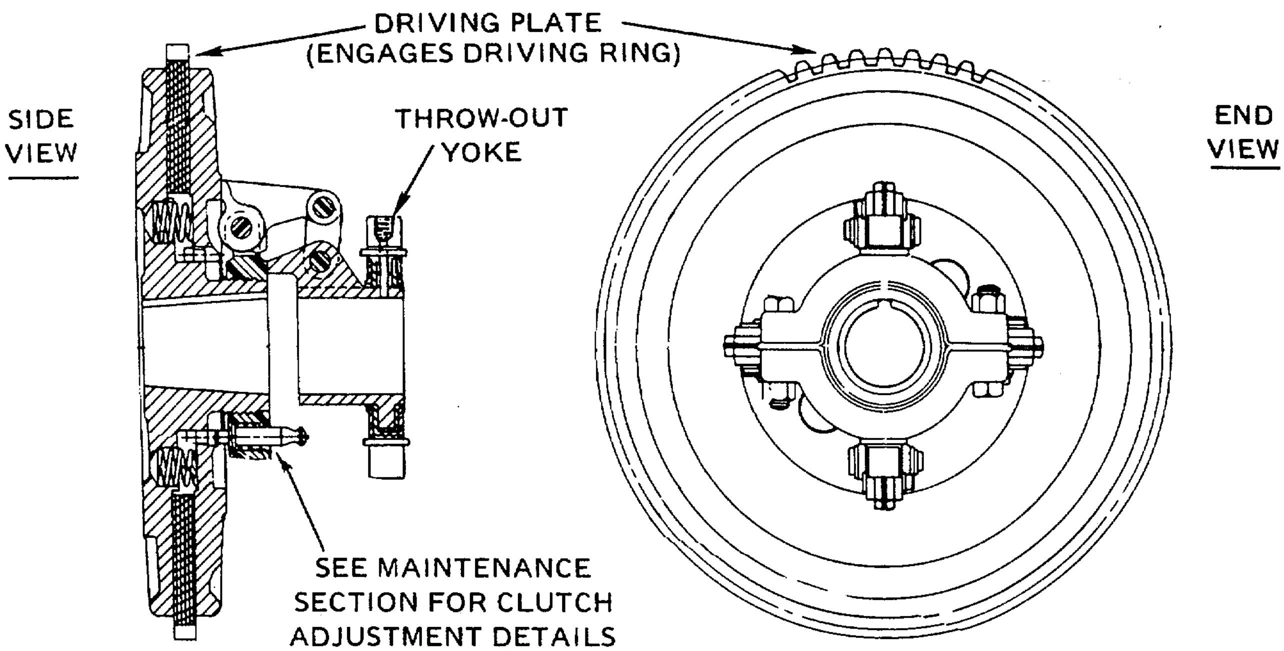


Figure 5. Friction Clutch- Main Drive

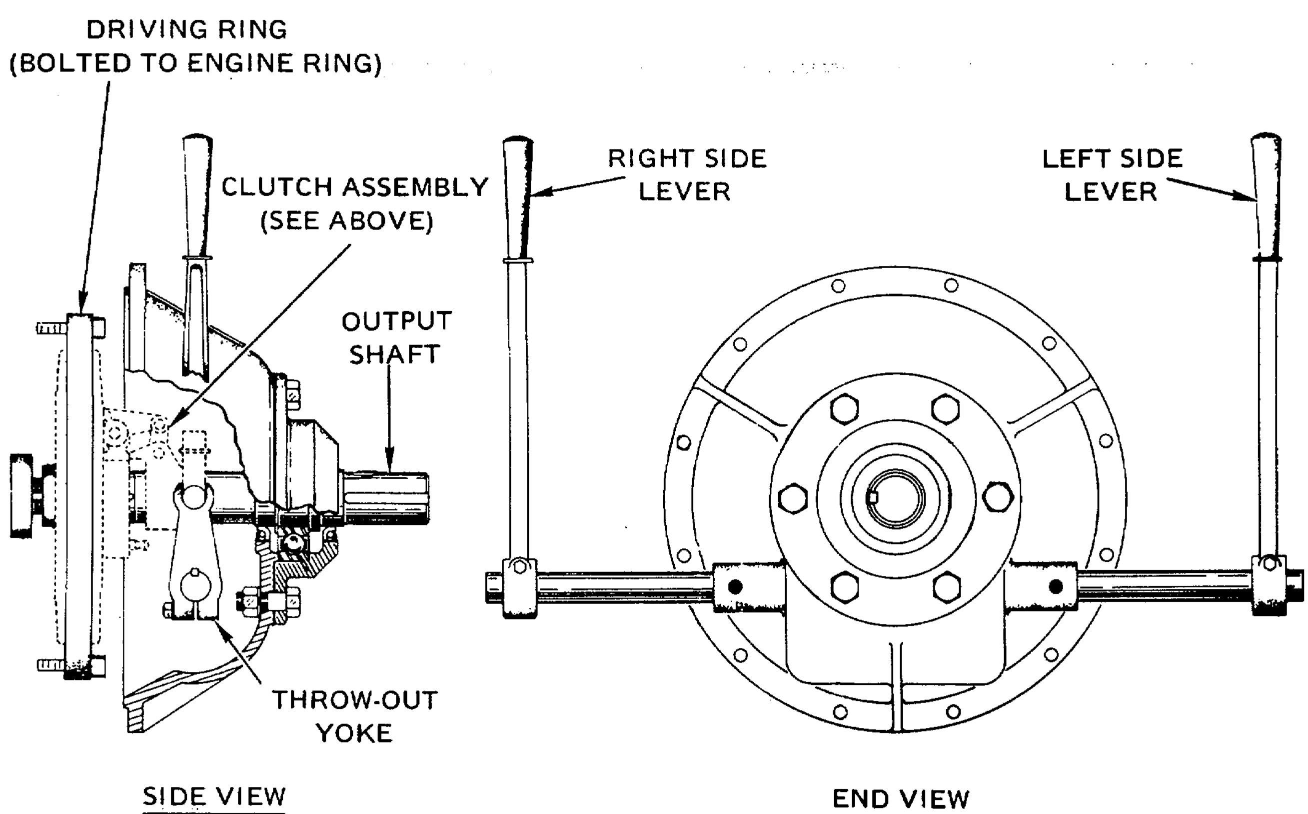


Figure 6. Dual Throw-Out Control For Main Drive Clutch

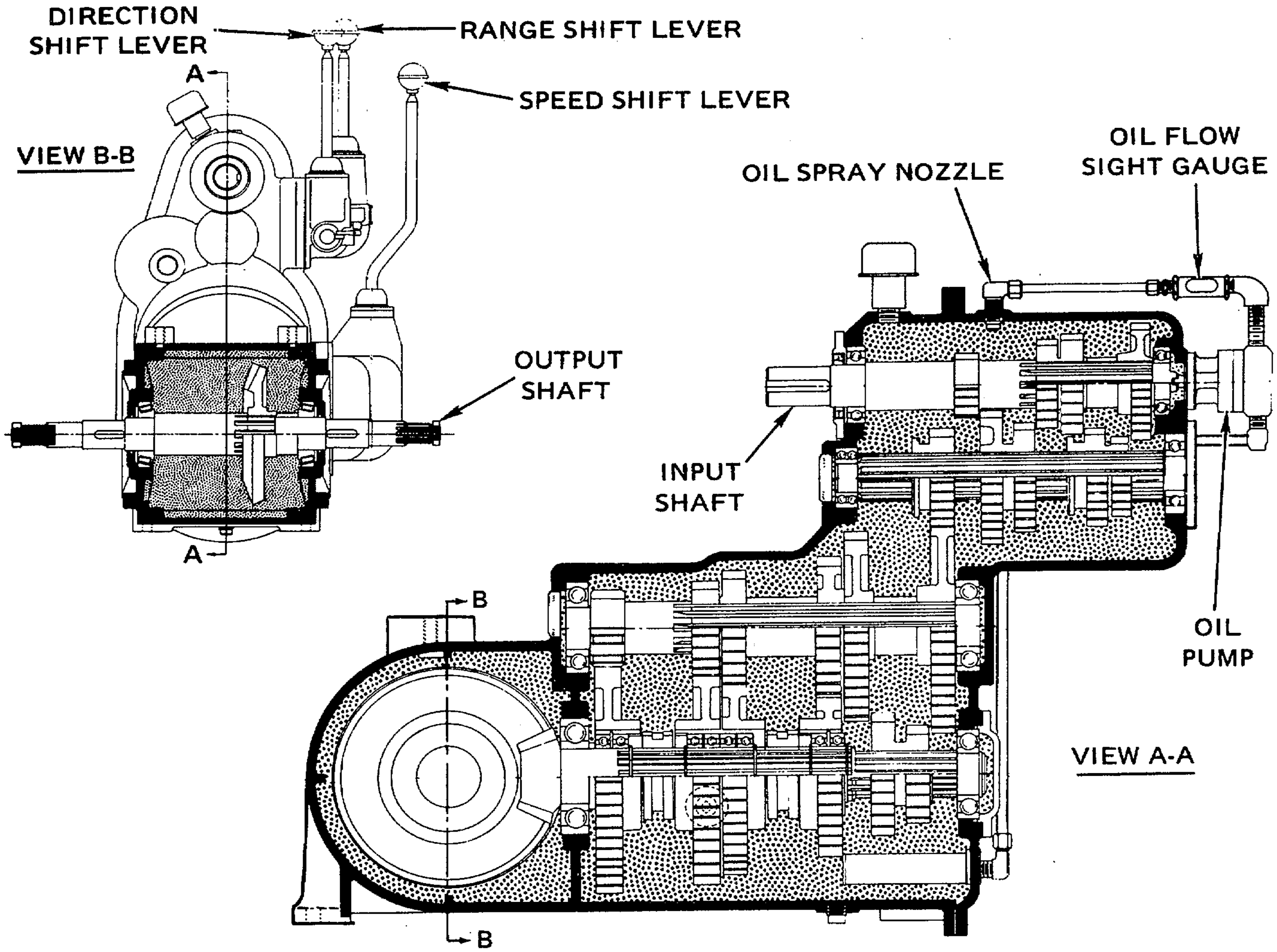


Figure 7. 24 Speed Transmission-Manual Shifts

TRANSMISSION

The paver transmission will permit movement in either forward or reverse directions at 24 different speeds ranging from 11 to 336 feet per minute. The four highest speeds (153 thru 336 FPM) are for travel only, not for paving! The top travel speed at full throttle is 4 miles per hour (aprox.) All movement is accomplished with the engine either at IDLE speed or FULL throttle (2000 RPM). -There is no other engine speed adjustment.

The transmission has three shift levers (See Figure 7)..

1. Direction Lever—Two positions: Forward, Reverse
2. Range Lever—Four positions: 1st (Low Speed), 2nd, 3rd, 4th (High Speed)
3. Speed Lever—Six Positions: 1st (Low Speed), 2nd, 3rd, 4th, 5th, 6th (High Speed)

By selecting combinations of shift lever positions as shown on the Speed Selection Plate (Figure 8) the paver speed is determined by the operator. The Selection Plate decal is located on. The top surface of the engine cover for convenient reference.

An electrical system limit switch is operated by a shaft extension from the Direction Lever gearbox. When the direction lever is shifted into REVERSE, the switch contacts are opened so that the material feed conveyors and the screed vibrator units cannot operate when the paver is moving in reverse.

WARNING! Do not stand in the hopper to shift the paver transmission levers. This is dangerous, due to the possibility of slat conveyor movement.

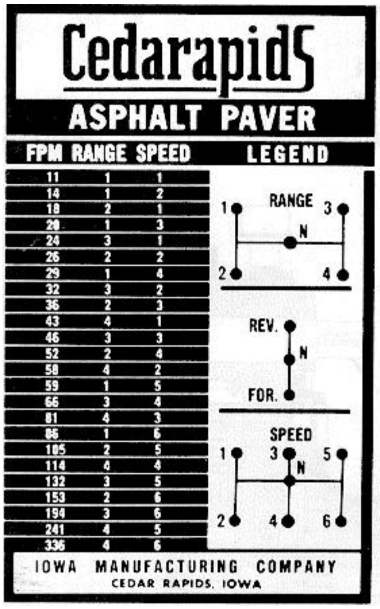


Figure 8. 24-Speed Transmission Selection Plate (This plate is located on the top of the engine cover)

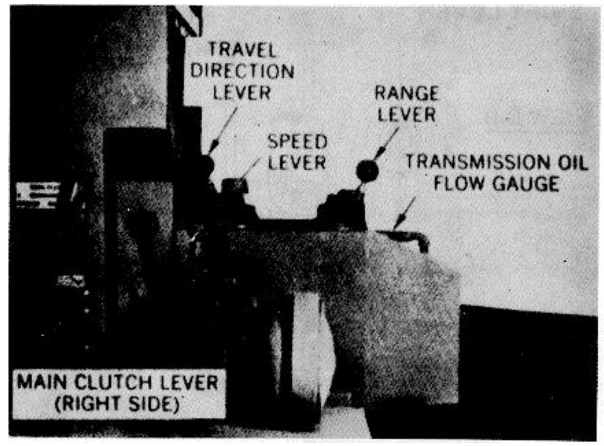


Figure 10. Location Of Controls, Gauge & Limit Switch

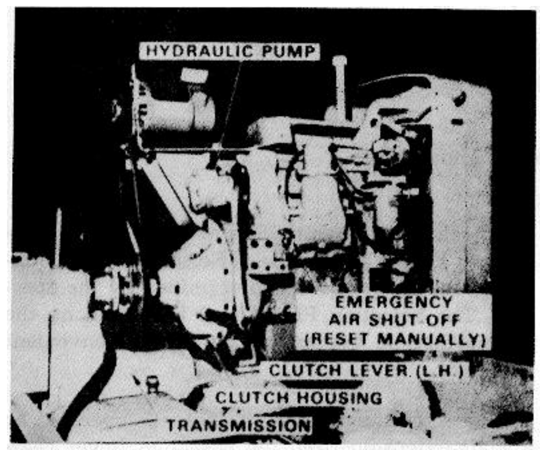


Figure 9. Detroit Diesel Engine (Cover Removed)

MAIN CLUTCH

A main clutch, which is part of the engine assembly, is manually engaged and disengaged by means of the levers on the side of the engine (See Figure 9). The clutch lever shaft extends through the engine housing so that one of the levers is accessible on each side, for operator convenience.

TRANSMISSION OIL FLOW GAUGE

Indicates that oil is flowing from pump unit to spray nozzle in the top of the transmission case. Gauge glass will appear clear when engine is stopped and dark when engine is running and oil is flowing. (See Figure 10)

TO SHIFT TRANSMISSION

With Engine running:

1. Disengage main clutch. **IMPORTANT!** The transmission is **not** synchro mesh. If easy engagement cannot be achieved, momentarily engage clutch to change gear tooth alignment then disengage clutch and try shifting again. **Never force a shift lever!**
2. Check the TRAVEL toggle switches on the operator's console to be sure they are in the BRAKE position.
3. Shift the Direction Lever.
4. Shift the Range Lever.
5. Shift the Speed Lever.
6. Just before moving the paver, engage the Main Clutch.

PAVER TRACK CLUTCHES

The electro magnetic clutch for each of the two track drives is operated by toggle switch from the paver console. These switches are labeled "L.H. Track" and "R.H. Track". When a switch is moved to the "Travel" position the clutch discs (Figure 11) for that track are magnetically engaged and that side of the paver moves. When both clutches are engaged the paver travels in a straight line. An electrical interconnection of clutch and throttle solenoid circuits is used to produce a "Soft Start" movement of the paver for a smooth take-off after each stop. Complete instructions covering the care and adjustment of the electric clutches are contained in Mechanical Maintenance Section 11.

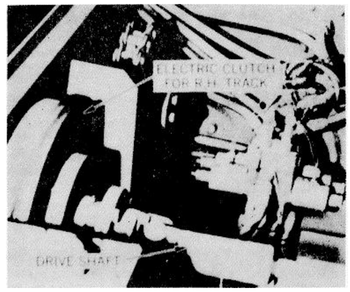


Figure 11. Location Of Clutch For RH Track

PAVER BRAKES

The electro-released brake for each of the two tracks is operated by toggle switch from the paver console. These switches are labeled "L.H. Track" and "R.H. Track". When a switch is moved to the "Brake" position, the armature plate on the input shaft of the track gear case is magnetically attracted to the stationary friction plate on the gear case. This locks the shaft so that no movement of the track can occur. Each track brake operates independent of the other. (See Figure 12).

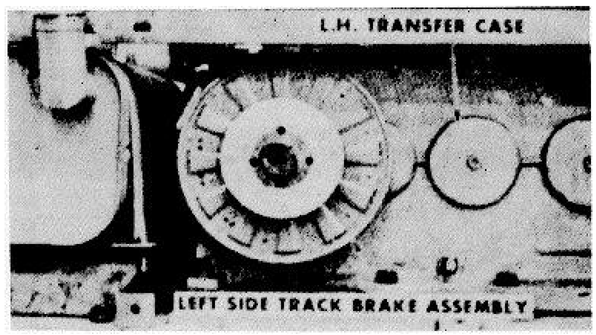


Figure 12. Location Of Brake For LH Track

Depending upon the condition of the 12 VDC Battery, the electric brakes can be released whenever the control key switch is in the ON position. When all power is OFF, both brakes are locked ON. Complete instructions covering **the care,** clearance checking, and repair of the electric brake are contained in the Mechanical Maintenance Section 11.

ASPHALT FEED CLUTCHES (Slat and Screw Conveyors)

The two slat conveyors and the two screw conveyors which combine functions to move asphalt from the hopper to the area ahead of the trailing screed, are operated by means of two electromagnetic clutches. Each clutch starts or stops the movement of one side of the feed system (Right hand or Left hand). By chain and sprocket connection, one slat conveyor and one screw conveyor operate simultaneously to feed one side. (See Figure 13) Each clutch is operated by means of a toggle switch on the operator's console.

Complete information on the care and adjustment of electric clutches is contained in the Mechanical Maintenance Section 11)

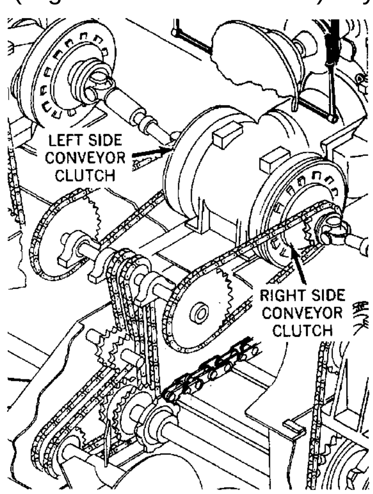


Figure 13. Electric Clutches For Material Conveyors

SECTION IV

Electrical System

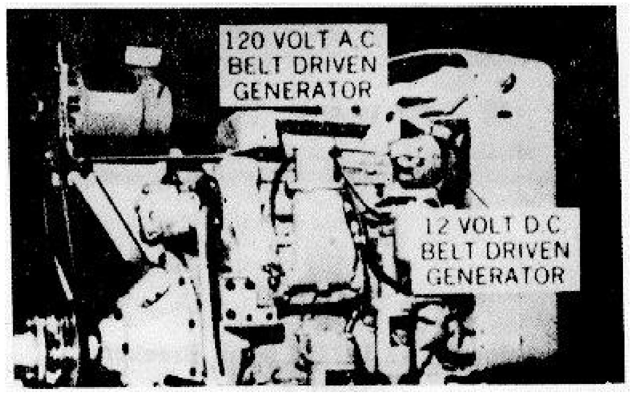


Figure 1. 12 VDC & 120 VAC Generators Detroit Diesel Engine

GENERATOR - 120 VOLT AC

Two belt driven electrical power producing units are used on the paver, one for 12 volt DC current and one for 120 volt AC current. (See Figure 1) The 120 volt AC generator is capable of supplying 26 amperes when the paver engine is at full throttle. This power is used for the screed vibrators and the plug-in electric service outlet. There is no power output unless the Throttle switch on the console is at Full or Soft Start position.

'When the paver is under load, the voltmeter should read not less than 115 volts. During no-load operation it should read no more than 130 volts. The cycle readings on the frequency meter should be no less than 59 or more than 61. If cycles and voltage are not within this range, first check V-belt tension, clutch slippage, and then adjust governor to increase or decrease RPM if necessary. (See engine speed paragraph in Section 2.)

120 VOLT AC PLUG-IN OUTLET

A plug-in type power supply outlet (receptacle) is provided on the paver for convenient availability of 120 Volt AC current. This makes possible the use of small power tools such as drills and grinders for maintenance or repair work, and provides a power source for extra lighting with plug-in extension cord, etc.

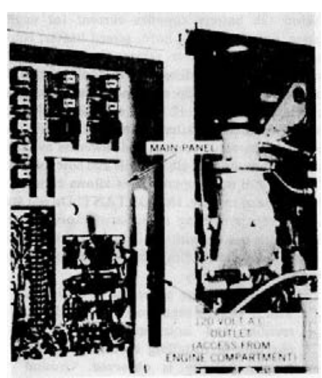


Figure 2. Main Panel - L.H. Side Of Engine Housing

The outlet is located inside the engine housing enclosure. It is necessary to remove the L.H. engine housing panel to make the plug-in connection. (See Figure 2) **CIRCUIT BREAKER FOR 120 VOLT AC SYSTEM**

A circuit breaker for the 120 volt AC electrical system is located in the main power panel on the left side of the engine housing. (See Figure 2) It must be manually reset.

12 VOLT STORAGE BATTERY

The paver battery is an Electric Storage Battery Co. No. 6TN-23, Military Part No. MS-35000-3. It is rated as follows: Ampere hour capacity (20 hour rate) 100 AH Cold cranking (300 Ampere discharge @ 400 F), 5 Sec. Voltage - 7.20 volts, Minutes run to 6V-1.25 minutes.

The battery is contained in a wood-lined metal box in the LH sub-deck area of the tractor. (See Figure 3)

GENERATOR: (12 VDC) - See Figure 1

The generator, driven by pulley and V-belt arrangement from the engine's electrical accessory drive shaft, is dependent upon correct engine speed to produce the required voltage. This unit supplies 12 Volt DC current for the paver Control System and battery charging. In standard automobile fashion the battery supplies current for engine starter, ignition, lights, horn, screed heater, etc. It also supplies current to release the paver brakes (magnetic). **It is therefore vitally important that the battery be kept in top efficiency condition at all times so that a full 12 volts are delivered to all control circuits!** A battery with bad cells will draw so much generator current and lower its available voltage so much that clutch coils and solenoid coils will not "pull in" properly. This allows clutches to slip and burn rapidly. **IMPORTANT!** Do **not** start a paver by jumping an unsatisfactory battery! Replace the battery with one in top condition so that when the engine is idling the electric clutches and brakes work properly.

> **CAUTION!** The generator is equipped with a voltage regulator which includes rectifier and isolation diodes. When charging or installing a battery **be sure** proper polarity is observed. Ground polarity of the battery and ground polarity of the generator must be the same. **Reversal of polarity will destroy the diodes in the generator voltage regulator!**

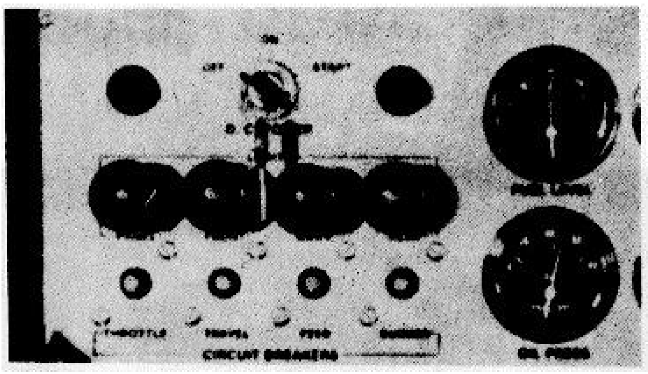


Figure 3. 12 Volt Battery Location - LH Walkway Removed

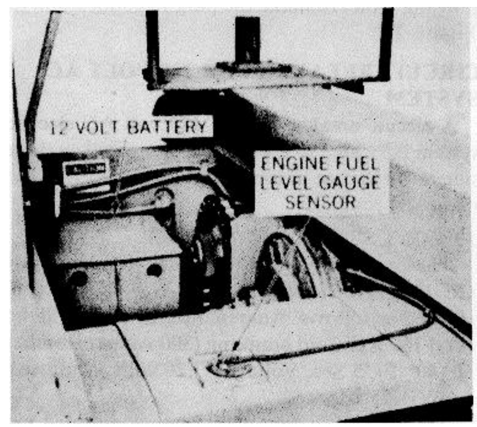


Figure 4. Location Of 12 VDC Circuit Breakers

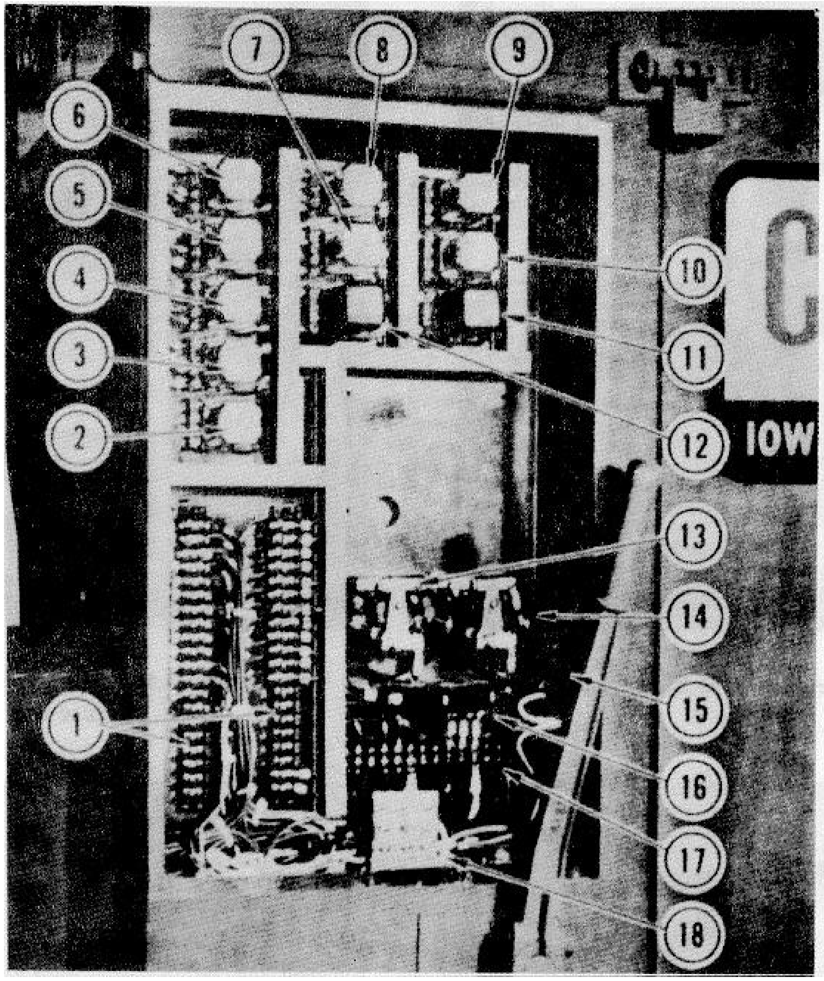
CIRCUIT BREAKERS FOR 12 VOLT DC SYSTEM

There are eight circuit breakers for the 12 volt DC electrical system. Four of them require manual reset after overload cut-off. Four are automatic reset units. These automatic breakers have no overload indicator to show their status. The circuit breaking function simply repeats until the overload situation in that circuit is corrected. The circuit, rating and location of each breaker is as follows:

Circuit	Rating	Reset	Location
Throttle Solenoid	15A	Manual	Instru. Panel
Travel Clutches	15A	Manual	Instr. Panel
Feed Clutches	15A	Manual	Instr. Panel
Screed Burner	30A	Manual	Instr. Panel
Gauge Lights	IOA	Auto	Instr. Box
Front Flood Lights	15A	Auto	Instr. Box
Conveyor Flood Lights	15A	Auto.	Instr. Box
Rear Flood Lights	5SA	Auto	Instr. Box

RE-SETTING CIRCUIT BREAKERS

IMPORTANT! Whenever a circuit breaker is tripped by an overload **do not** reset the breaker until a thorough check has been made to locate the cause of the overload. The tell-tale odor of over-heated electrical equipment and discolored or melted wire insulation often help to locate a trouble source. It is best that someone with good electrical system knowledge perform this trouble check and reset the breaker.



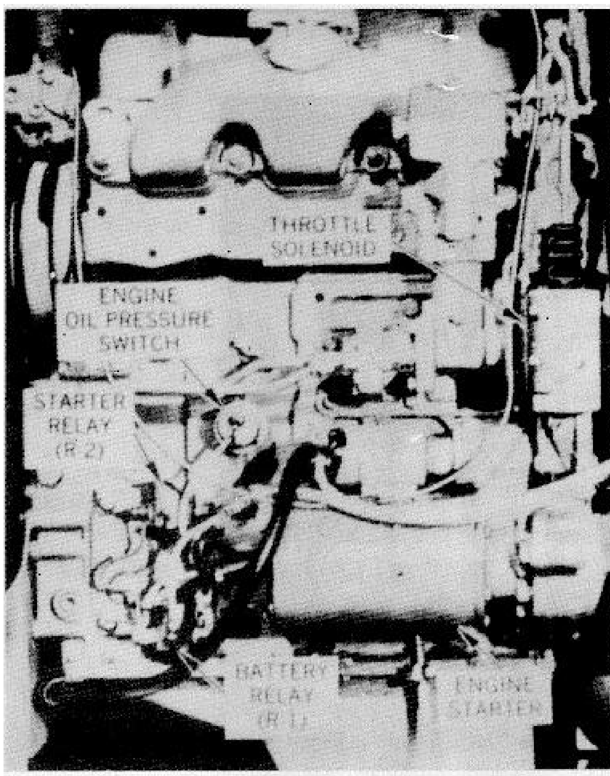
MAIN ELECTRIC PANEL COMPONENTS
Figure 5

12 Volt D.C. Systems

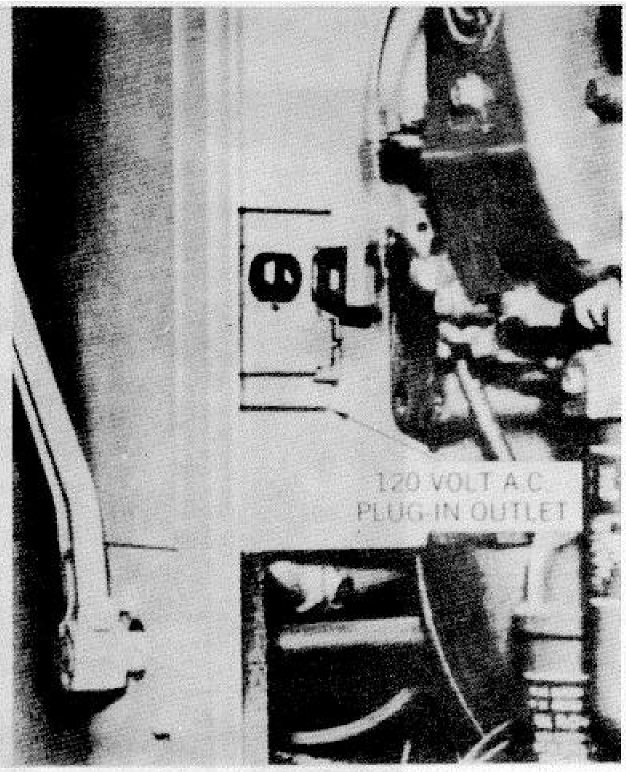
Item No.	Description
1	Terminal Strips - 12 VDC Systems
2	Spare Relay
3	RH Track Clutch Relay - R7
4	LH Track Clutch Relay - R6
5	Engine Throttle Solenoid Relay - R4
6	Horn Relay - R3
7	RH Brake Relay - R8
8	LH Brake Relay- R5
9	LH Conveyor Clutch Relay - R12
10	RH Conveyor Clutch Relay - R13
11	Bleeder for Conveyor Clutch Circuits
12	Bleeder for Track Clutch and Brake Circuits
18	Ground Terminal

12 Volt A.C. Systems

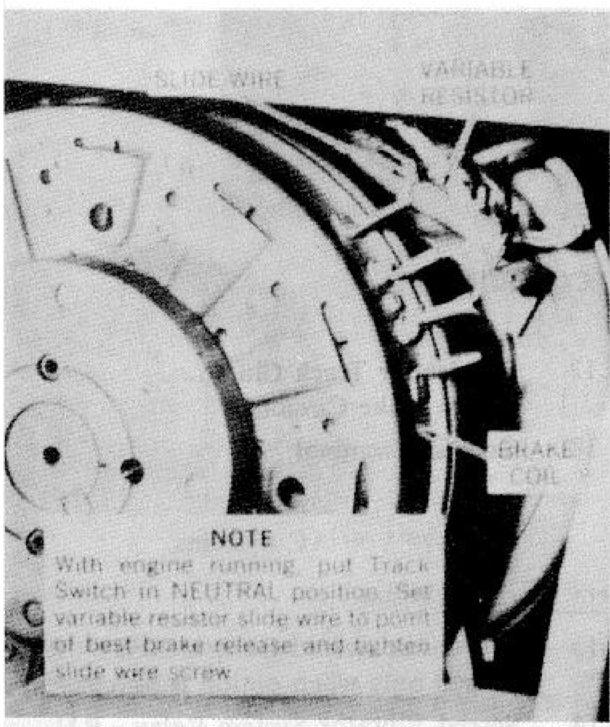
Item No.	Description
13	Duomatic Screed Control Relay - R10 (Wired only when option is purchased)
14	Screed Vibrator System Relay- R 11
15	Plug-in Outlet
16	Circuit Breaker (Manual Reset)
17	Terminal Strip - 120 VAC Systems
18	Ground Terminal



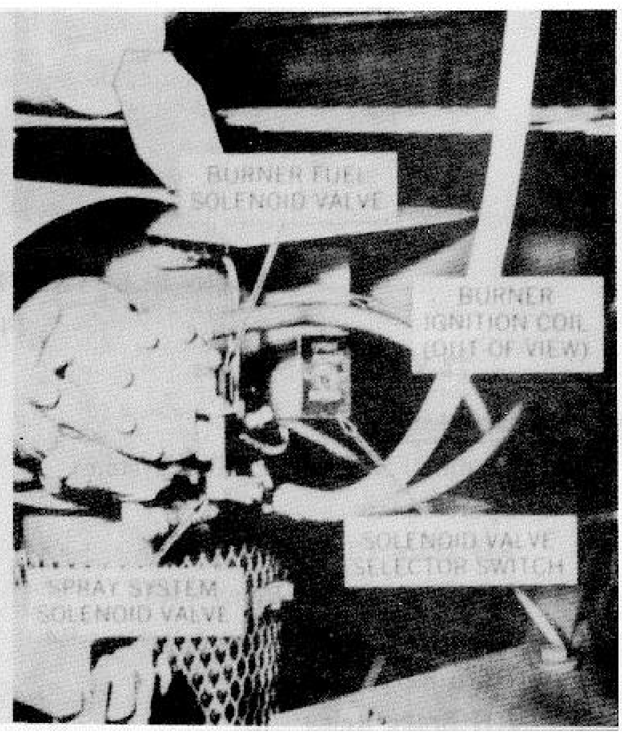
Electrical Details - RH Side Of Frame
Figure 6



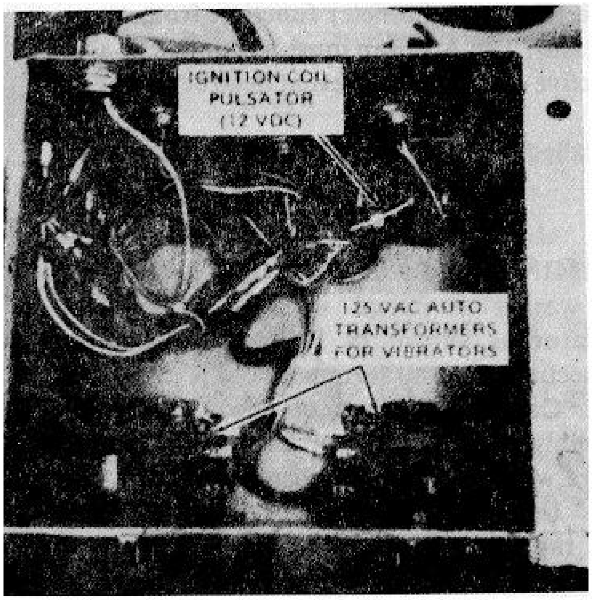
120 VAC Outlet - LH Side Of Engine Compartment
Figure 8



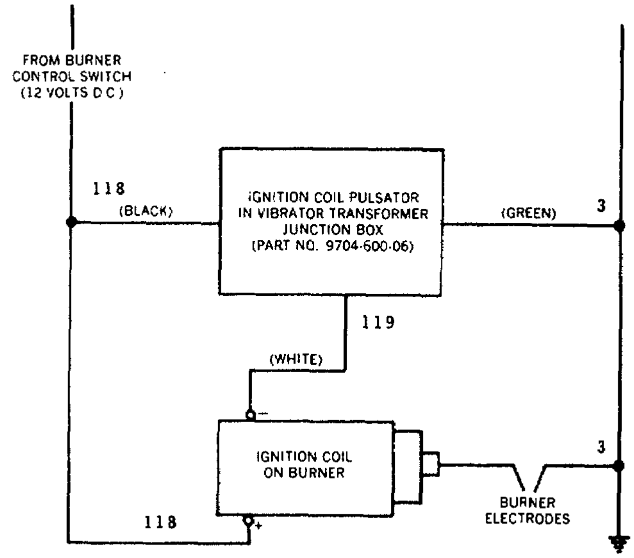
Adjustment Of Brake Release Current
Figure 7



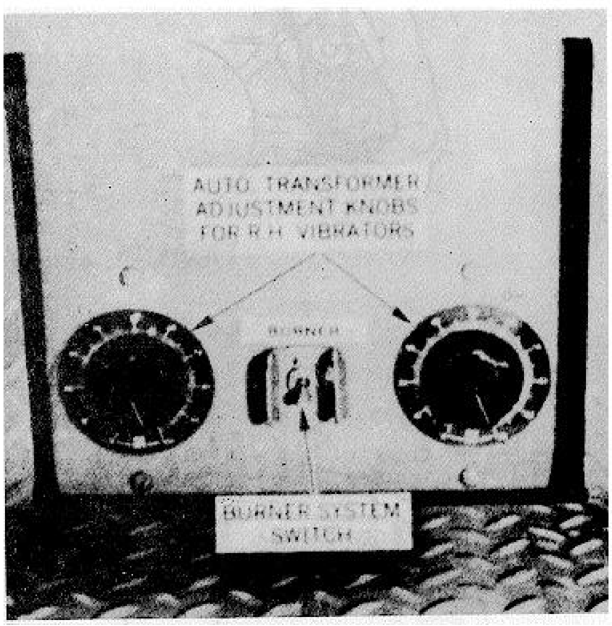
Screed Burner Solenoid Valves & Switch
Figure 9



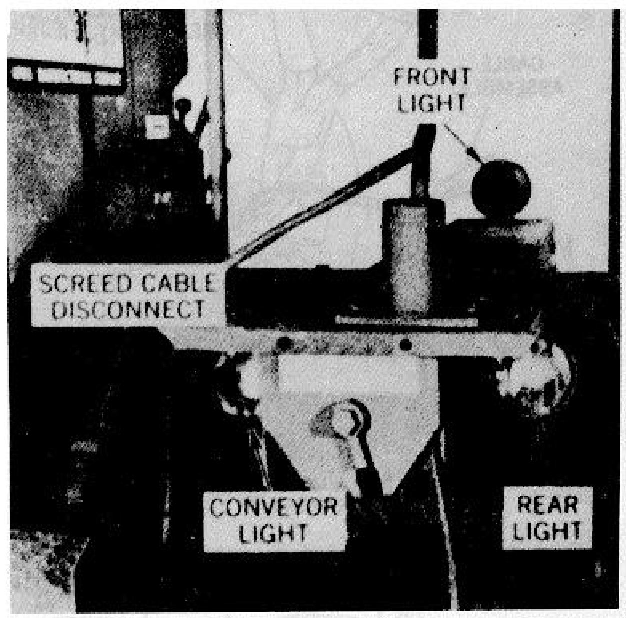
Top View of Screed Junction Box
Figure 10



Wiring Color Code For Pulsator
Figure 12



Rear View Of Screed Junction Box - RH
Figure 11



Screen Cable Disconnect & Lights
Figure 13

VOLTAGE REGULATOR FOR 12 VDC GENERATOR

The Motorola Model RA Generator which supplies current for the 12 volt D.C. control system, track clutches, brake release, hydraulic solenoids, lights and horn is equipped with a special type 8RF2011A voltage regulator which has a high voltage supression feature. Motorola Type R3-1 and Type R3-2 Regulators cannot be used on paver generators as they will not last in this application.

ATTACHMENT OF A.C. TAP TO D.C. GENERATOR

The hourmeter-tachometer on the instrument panel which indicates engine speed and records the number of hours of engine operation derives its tachometer function from an alternating current (A.C.) tap on the 12 V.D.C. generator. The A.C. tap must be applied to a diode lead on the 12 V.D.C. generator, using an effective heat sink to prevent destruction of the diode.

In the event that a new 12 V.D.C. generator is installed, transfer the A.C. tap kit from the old unit to the new in the following manner.

1. Form tight loop on stripped end of cable assembly and slip over lead of diode as shown in Figure 14.

2. Solder-cable assembly to diode lead.

CAUTION

Use long nose pliers as heat sink to prevent damage to diode. (See Figure 14)

3. Remove all nuts and washers (and connecting wires, if generator is already installed) from insulating fiber washer on terminal.

4. Mount terminal insulator to REGULATOR TERMINAL and secure with nut, lockwasher and flat washer (supplied in Kit). Align terminal insulator as shown in Figure 16. Reconnect all connecting wires to terminal.

5. Connect terminal of newly soldered cable assembly to A.C. tap on terminal insulator and secure with lockwasher and nut provided.

6. Use keps nut removed from generator on REGULATOR TERMINAL of generator. Leave A.C. tap.

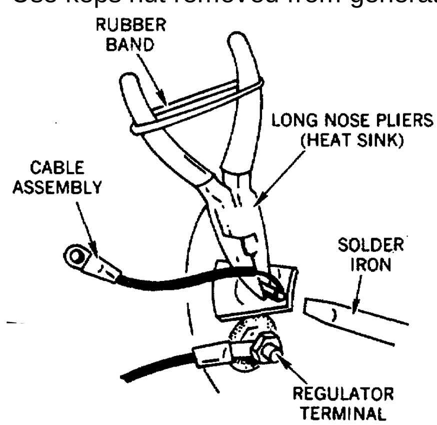


Figure 14

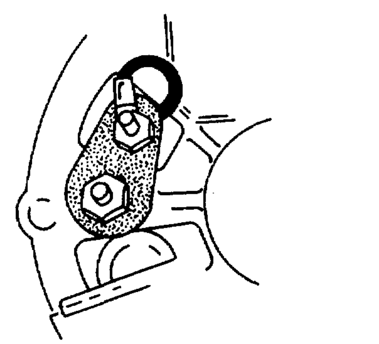


Figure 16

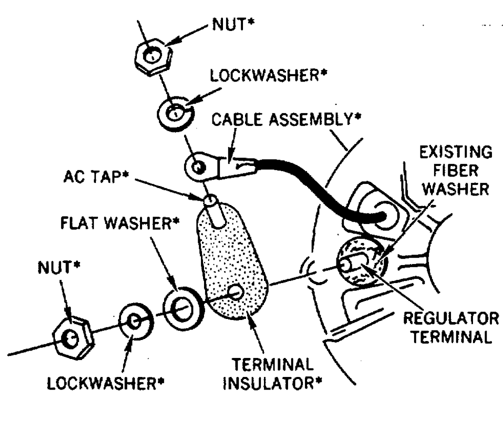


Figure 15

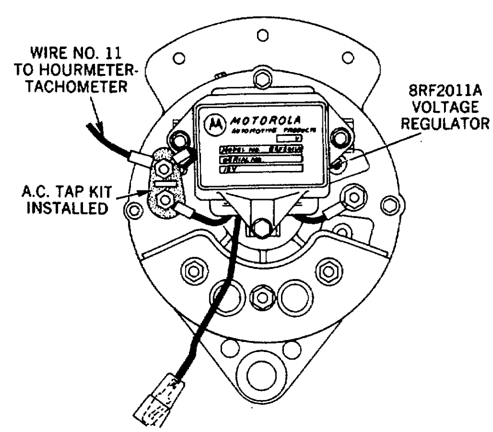


Figure 17

ELECTRICAL TROUBLESHOOTING

To ease troubleshooting and repair of electrical problems, it is necessary to have a reliable AC-DC volt-ohm meter and to have a thorough understanding of the meter and how the paver electrical system operates. Instructions on proper use of the volt-ohm meter are usually furnished with the instrument and should be read carefully before first use. Improper use can quickly render the meter inoperative.

The paver electrical system is made up basically of two different voltage supplies: 12 volts DC and 120 volts AC.

The 12 VDC circuit is powered by a 12 volt battery. It is recharged by a Motorola generator with built-in voltage regulator. (**IMPORTANT:** Regulator must be an R3-3 or 8RF201 IA with high voltage suppression feature.)

The 120 volt AC circuit supplies power for the screed vibrators and the AC convenience outlet. Output of the AC generator should be 130 volts - 61 hz with no load applied. Double check the frequency by "taching" the generator shaft. Speed should be 3660 RPM.

TROUBLESHOOTING METHOD

When the following troubleshooting guide is used, check out the possibility of a defective unit listed by substituting a spare or by interchanging two identical units to see what change in operation (if any) occurs.

Refer to the schematic diagram when making voltage checks listed in the following charts. Wire numbers referred to are shown on the schematic. All voltages should be 12 volts DC, unless otherwise specified. <u>A voltage at one point, but not at the following point indicates that there is difficulty in that area.</u> The numbers listed will suggest the area of remedy such as loose connections, broken wire, switch in wrong position, relay missing, dirty contacts, etc.

When taking a voltage reading, the first number listed in the chart is for the positive meter lead, and the second number listed is for the negative meter lead.

For example: Check 17 to 3

Positive meter lead on 17
Negative meter lead on 3

<u>IMPORTANT FIRST STEP!</u>

DC POWER

To begin checks, make sure there is 12 VDC from I to 3. Turn DC power switch to ON and check for 12 VDC from 17 to 3. All circuit breakers are to be ON and 12 VDC should be present on load side of breakers. If not, check for a faulty breaker.

TROUBLESHOOTING STARTING CIRCUIT

DC power switch held in start position. Track switches in brake position.

Engine does not start

Voltage check:

(1) 13 to 3 - defective start-stop switch
(2) 2 to 3 - defective R2 relay - voltage present indicates faulty starter or starter solenoid

TROUBLESHOOTING THROTTLE CIRCUIT

Engine does not throttle up in full throttle position

Voltage checks:

(1) 48 to 3 - defective throttle switch or open wire 48 to relay R4
(2) 4 to 3 - defective throttle breaker or breaker tripped - if tripped, check for bind in throttle linkage
(3) 5 to 3 - defective R4 relay or relay socket - if voltage is present on throttle solenoid, check for faulty solenoid

Throttle works in full but not in soft-start

One or both track switches in travel FWD-REV limit switch in FWD.

Voltage checks:

(1) 46 to 3 - defective FWD-REV limit switch
(2) 47 to 3 - defective R6 and/or R7 relay or relay socket
(3) 48 to 3 - defective soft-start side of throttle switch

TROUBLESHOOTING TRAVEL CIRCUIT

Brakes do not release

Track switches in neutral position.

Voltage checks: (LH side)

(1) 35 to 3 - if present, LH track switch is defective or 35 is shorted to 12 VDC
(2) 25 to 3 - defective R5 relay or relay socket
(3) Check for approximately 6 VDC from 26 to 27 - if not, adjust 5 ohm resistor until 6 VDC is present or release begins
(4) Check for 6 VDC from 26 to 27 on brake coil - if present, check for defective brake coil - coil should have 3 ohms resistance

Voltage check: (RH side)

(1) 38 to 3 - if present, RH track switch is defective or 38 shorted to 12 VDC
(2) 31 to 3 - defective R8 relay or relay socket
(3) Check for approximately 6 VDC from 32 to 30 - if not, adjust 5 ohm resistor until 6 VDC is present or release begins
(4) Check for 6 VDC from 32 to 30 on brake coil - if present, check for defective brake coil - coil should have 3 ohms resistance

Brakes do not energize

Track switches in brake position

Voltage checks: (LH side)

(1) 35 to 3 - defective LH track switch
(2) 27 to 3 - defective R5 relay or relay socket
(3) Check for 6 VDC from 27 to 26 - defective or misadjusted 5 ohm resistor
(4) Turn travel circuit breaker OFF to see if permanent magnet in brake works

Voltage checks: (RH side)

(1) 38 to 3 - defective RH track switch
(2) 30 to 3 - defective R8 relay or relay socket
(3) Check for 6 VDC from 27 to 26 - defective or misadjusted 5 ohm resistor
(4) Turn travel circuit breaker OFF to see if permanent magnet in brake works.

(CONTINUED)

Clutches do not pull in

Track switches in travel position.

Voltage checks: (LH side)

(1) 36 to 3 - defective LH travel switch
(2) Relay R6 should be energized - if not, check for bad relay coil or socket, or lack of continuity from 39 to 3.
(3) 21 to 3 - defective R6 relay contact or socket
(4) Check for defective clutch coil - should have 3.5 ohm resistance for standard torque and 1 ohm resistance for hi-torque

Voltage checks: (RH side)

(1) 37 to 3 - defective RH travel switch
(2) Relay R7 should be energized - if not, check for faulty relay, socket, or lack of continuity from 39 to 3
(3) 23 to 3 - defective R7 relay contact or socket
(4) Check for defective clutch coil - should have 3.5 ohm resistance

TROUBLESHOOTING FEED CIRCUIT

LH Feed Conveyor does not run

LH feed conveyor switch in MANUAL. FWD-REV limit switch in FORWARD.

Voltage checks:

(1) 46 to 3 - defective FWD-REV limit switch
(2) 52 to 3 - defective LH conveyor switch
(3) Relay R12 should be energized - if not, check for defective R12 relay coil or socket
(4) 56 to 3 - defective R12 relay contact
(5) If voltage present - check for defective clutch coil

LH Feed Conveyor runs in MANUAL but not in AUTO.

FWD-REV limit switch in FORWARD. One or both track switches in travel.

Voltage checks:

(1) 47 to 3 - defective R6 and/or R7 relay contact
(2) 51 to 3 - defective LH conveyor switch or defective diode
(3) 52 to 3 - defective or tripped LH feed limit switch

RH Feed Conveyor does not run

RH feed conveyor switch in MA NUA L. FWD- REV limit switch in FOR WA RD.

Voltage checks:

(1) 46 to 3 - defective travel switch
(2) 54 to 3 - defective RH conveyor switch
(3) Relay R13 should be energized - if not, check for defective R13 relay coil or socket
(4) 58 to 3 - defective R13 relay contact
(5) If voltage present - check for defective clutch coil

RH Feed Conveyor runs in MANUAL but not in AUTO.

FWD-REV limit switch in FORWARD. One or both track switches in travel.

Voltage checks:

(1) 47 to 3 - defective R6 and/or R7 relay contact
(2) 53 to 3 - defective RH conveyor switch or defective diode
(3) 54 to 3 - defective or tripped RH feed limit switch

Should be 12 VDC from 45 to 3.

Screed does not go up

Screed lift switch held in UP position

Voltage checks:

(1) 63 to 3 - defective switch
(2) 63 to 3 at solenoid - open wire to solenoid - if present, check for defective solenoid coil

Screed does not go down

Screed lift switch held in DOWN position

Voltage checks:

(1) 64 to 3 - defective switch
(2) 64 to 3 at solenoid - open wire to solenoid - if present, check for defective solenoid coil

Hopper Wings do not go up

Hopper wing switch in UP position

Voltage checks:

(1) 65 to 3 - defective switch
(2) 65 to 3 at solenoid - open wire to solenoid - if present, check for defective solenoid coil

Hopper Wings do not go down

Hopper wing switch held in DOWN position.

Voltage checks:

(1) 66 to 3 - defective switch
(2) 66 to 3 at solenoid - open wire to solenoid - if present, check for defective solenoid coil

TROUBLESHOOTING DC BURNER ON SCREED

Burner Motor and Pulsator do not run

Burner breaker ON. Burner-spray down switch in BURNER position.

Voltage checks:

(1) 115 to 3 - defective burner breaker or wiring from meter box
(2) 116 to 3 - defective burner switch
(3) Check for good ground on entire system

Burner motor checkout (motor does not run)

Voltage checks:

(a) 116 to 3 at motor - open motor cable
(b) Check for defective burner motor

Pulsator checkout (No spark across ignitor points)

Points adjusted properly. High tension lead from coil to one point in place.

Voltage checks:

(a) 118 to 3 - defective burner switch
(b) 119 to 3 - if the same as 118 to 3 - pulsator is not working. If no voltage is present - check coil resistance (1.5 ohm)-if coil is okay, make sure wire 119is not grounded. If not - replace pulsator.

No fuel at nozzle of burner

Check for 12 VDC at fuel oil solenoid (Wire #118). If present, check for defective solenoid. If solenoid is working check for defective fuel pump.

TROUBLESHOOTING VIBRATOR CIRCUIT

Disengage main clutch. FWD-REVY limit switch in FOR WARD, one or both track switches in TRAVEL, engine at FULL throttle, vibrator switch ON, AC main breaker ON.

Vibrators do not work

DC Control Section Voltage checks: (If relay R 11 does not pull in)

(1) 46 to 3 - defective FWD-REV limit switch
(2) 47 to 3 - defective R6 and/or R7 relay contact or socket
(3) 50 to 3 - defective vibrator switch
(4) Check wire #3 on relay R 11 coil for good ground - if so, defective relay coil

AC Power Section Voltage checks: (Relay RI I does pull in)

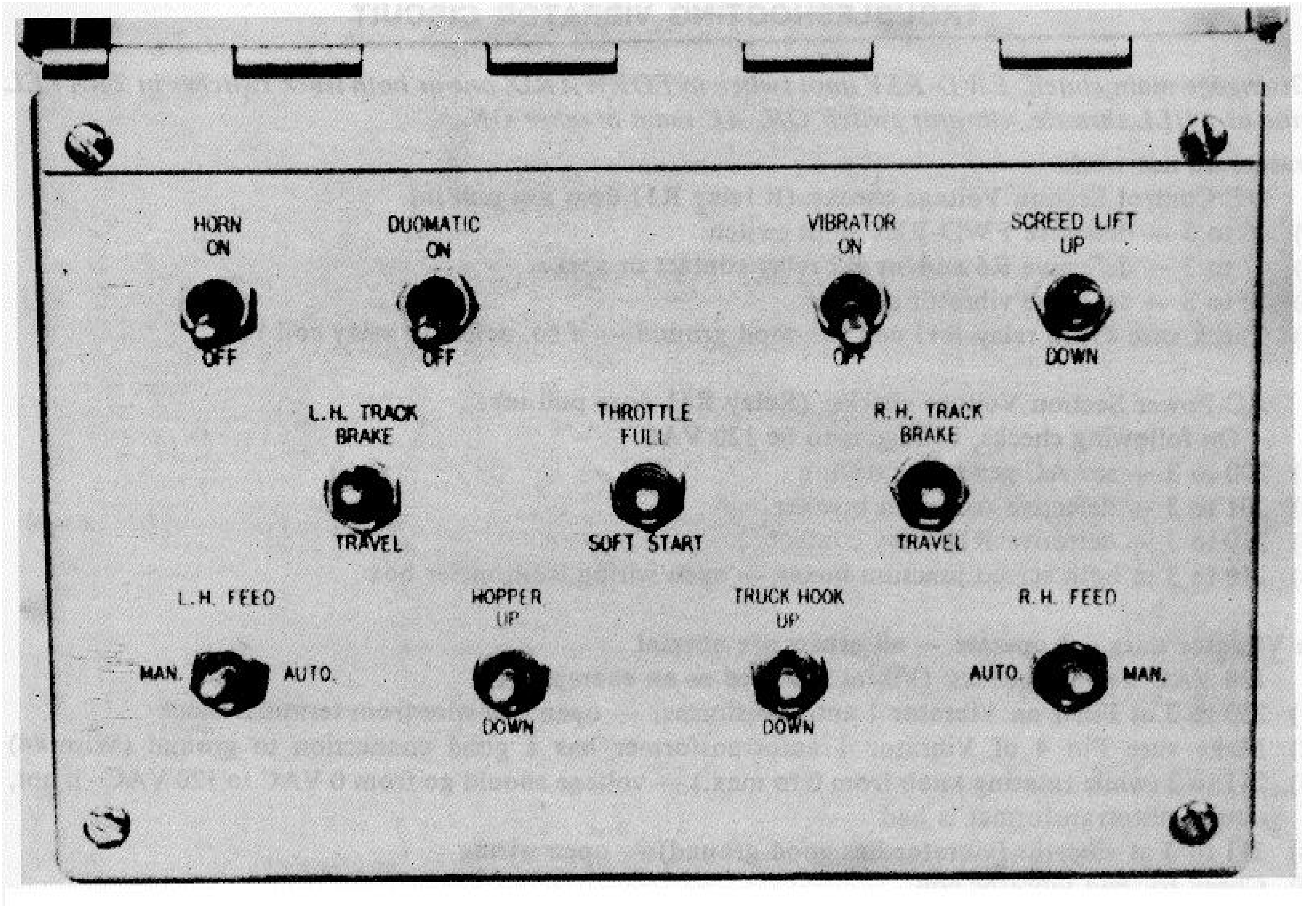
On following checks, voltage is to be 120 VAC

(1) 200 to 3 - see AC generator section
(2) 201 to 3 - defective AC main breaker
(3) 210 to 3 - defective RI 1 relay contact
(4) 210 to 3 in both screed junction boxes - open wiring from meter box

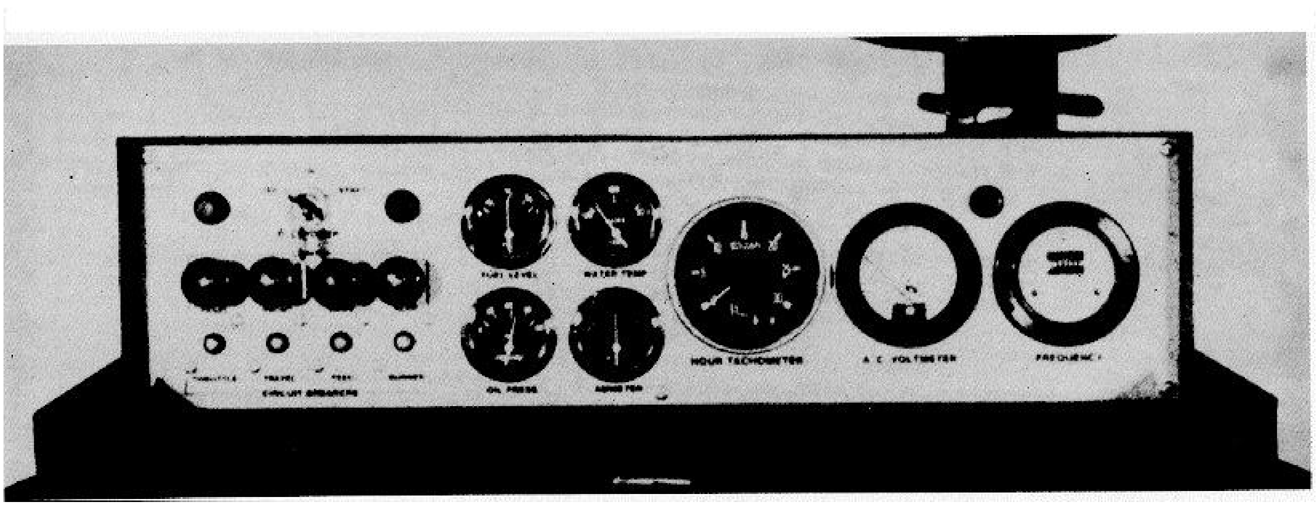
One Vibrator does not operate - all others are normal

120 VAC Voltage checks: (Vibrator 1 used as an example)

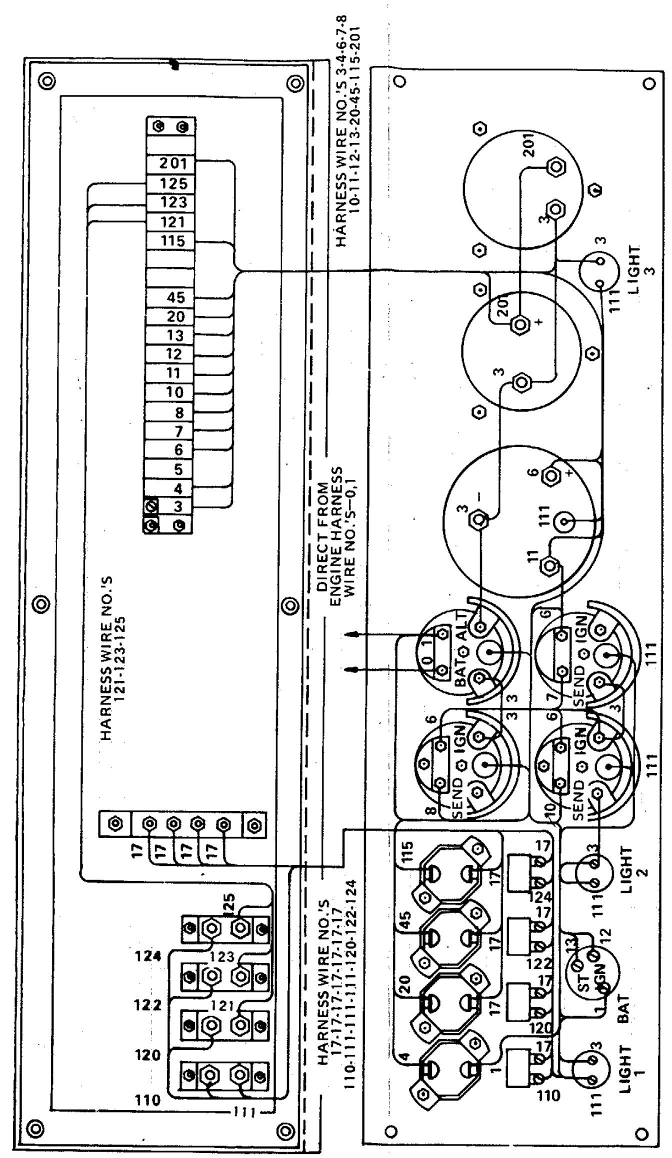
(1) 210 to 3 at Pin 1 on Vibrator 1 autotransformer - open 210 wire from terminal block
(2) Make sure Pin 4 of Vibrator 1 autotransformer has a good connection to ground (Wire #4)
(3) 211 to 3 (while rotating knob from 0 to max.) - voltage should go from 0 VAC to 120 VAC - if not, output autotransformer is bad
(4) 211 to 3 at vibrator (vibrator has good ground) - open wiring
(5) Check for bad vibrator coil

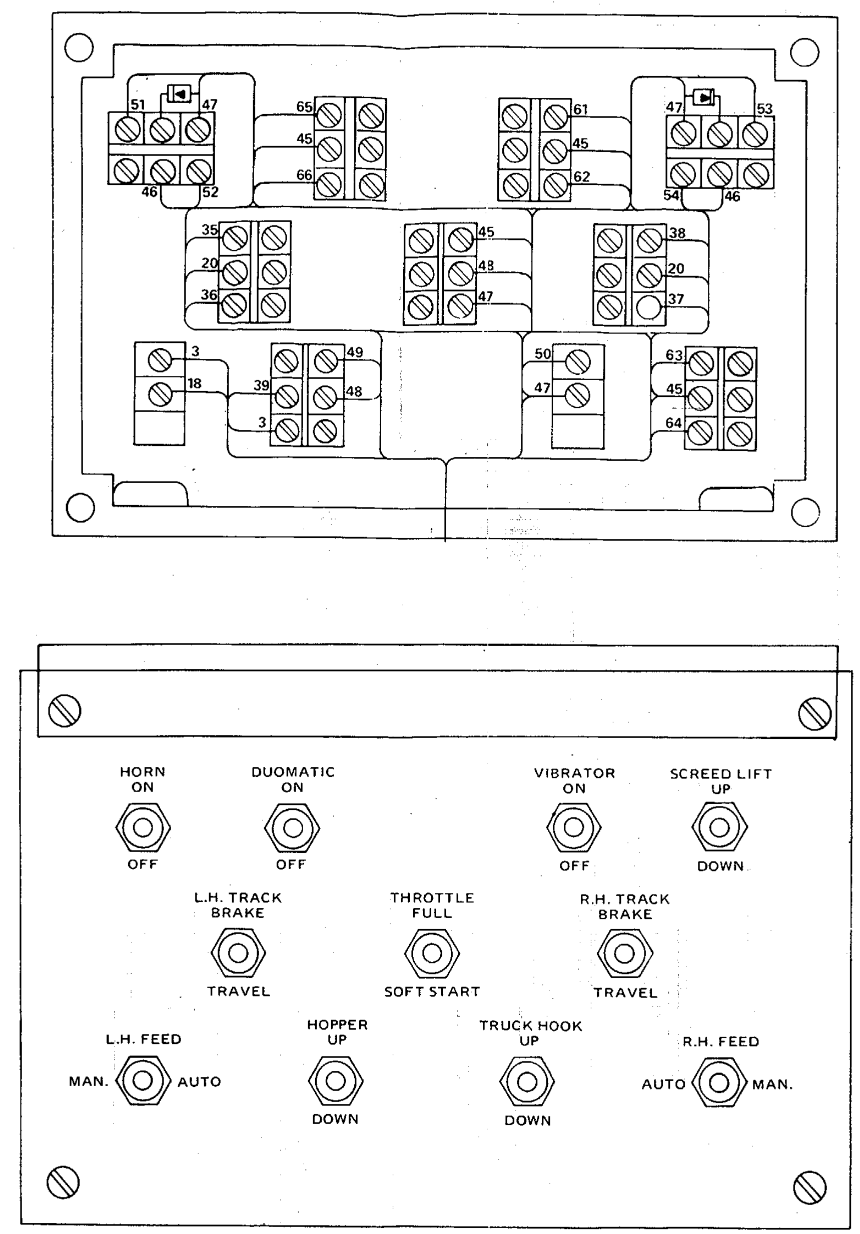


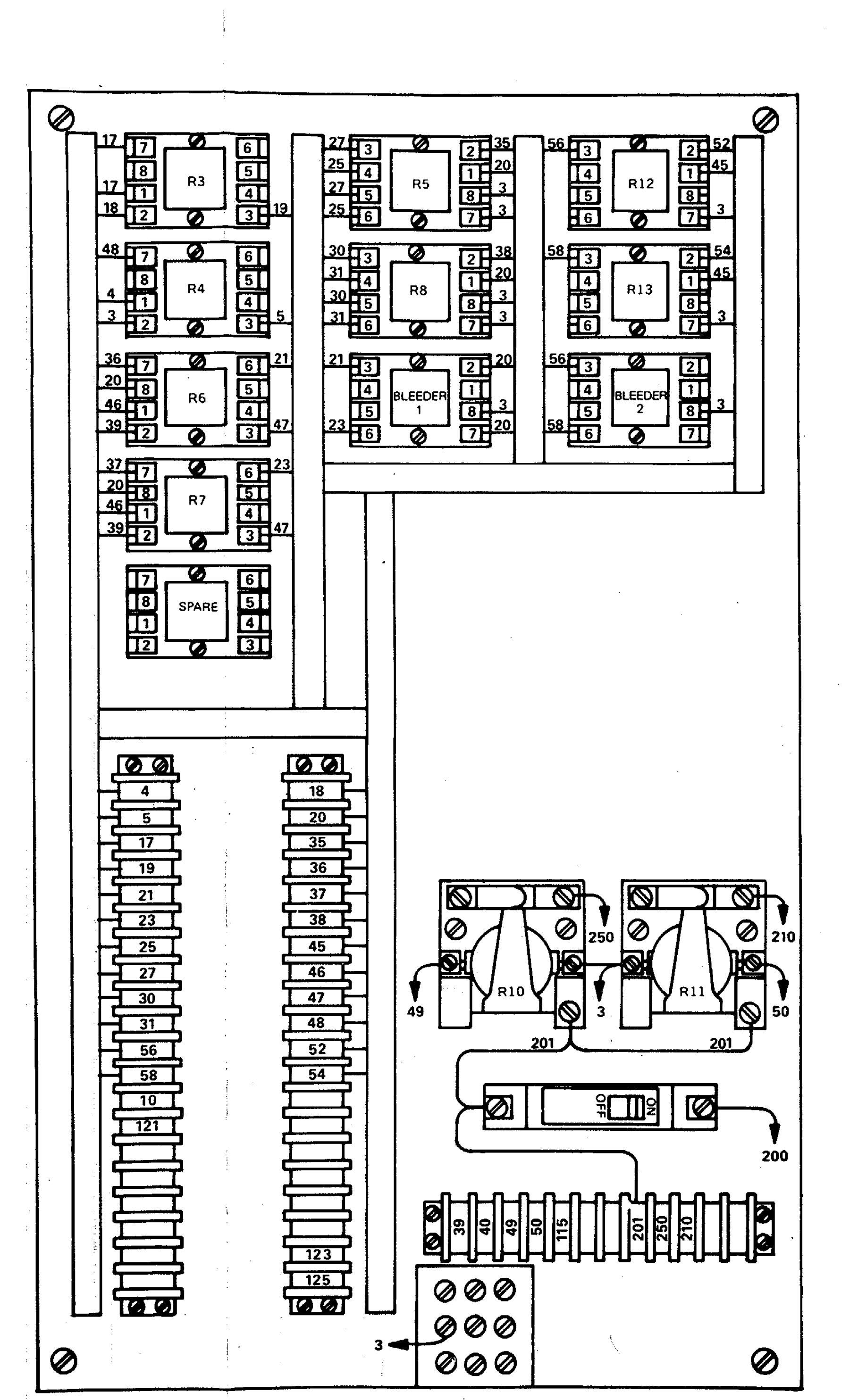
Operator's Console
Figure 18

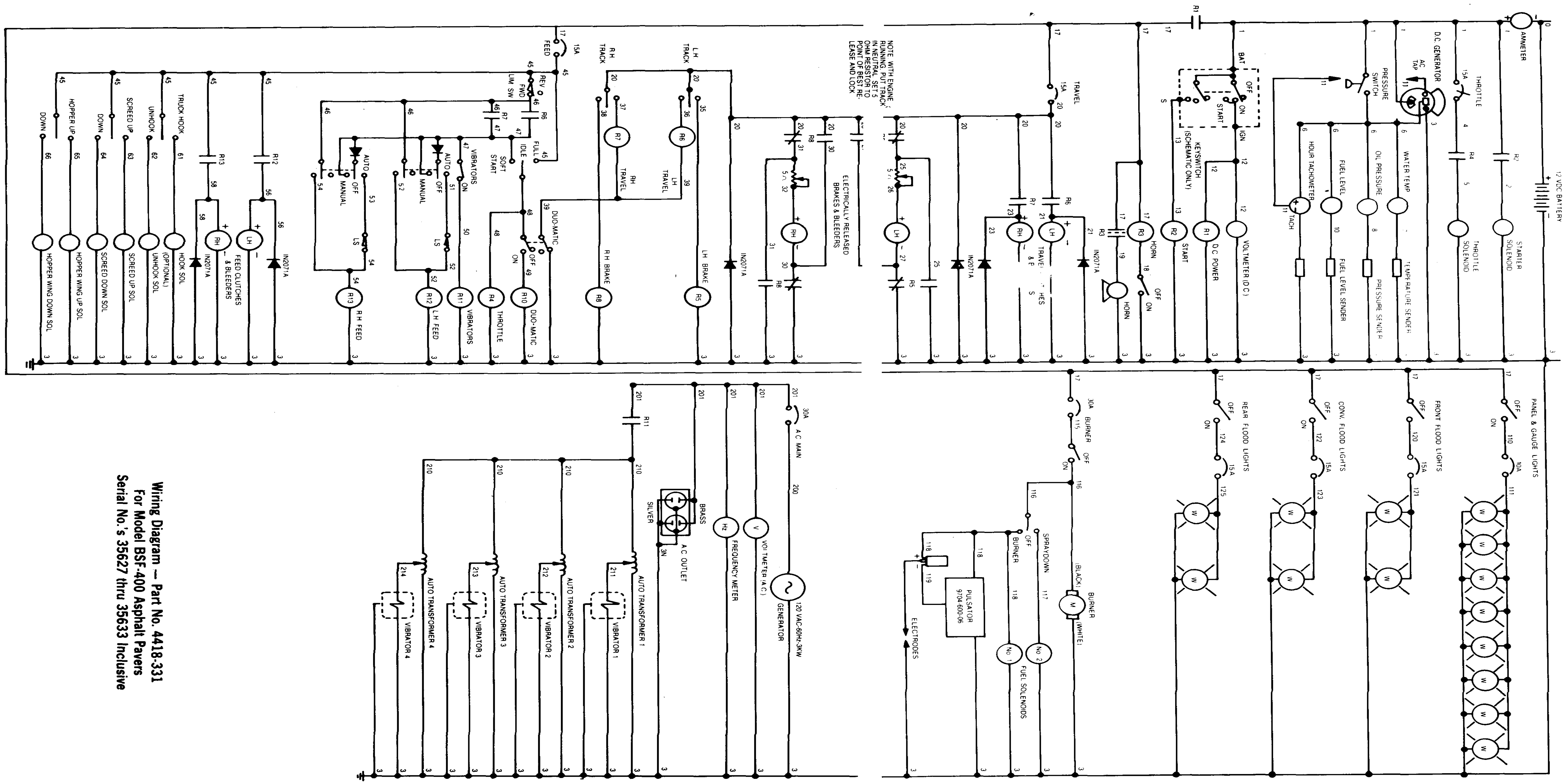


Instrument Panel
Figure 19




HORN
ON
OFF
DUOMATIC
ON
OFF
VIBRATOR
ON
OFF
SCREED LIFT
UP
DOWN
L.H. TRACK
BRAKE
TRAVEL
THROTTLE
FULL
SOFT START
R.H. TRACK
BRAKE
TRAVEL
L.H. FEED
MAN.
AUTO
HOPPER
UP
DOWN
TRUCK HOOK
UP
DOWN
R.H. FEED
AUTO
MAN.





Wiring Diagram — Part No. 4418-331
For Model BSF-400 Asphalt Pavers
Serial No.'s 35627 thru 35633 Inclusive

SECTION V

Hydraulic System

(FOR OPERATION OF SCREED LIFT & HOPPER WINGS)

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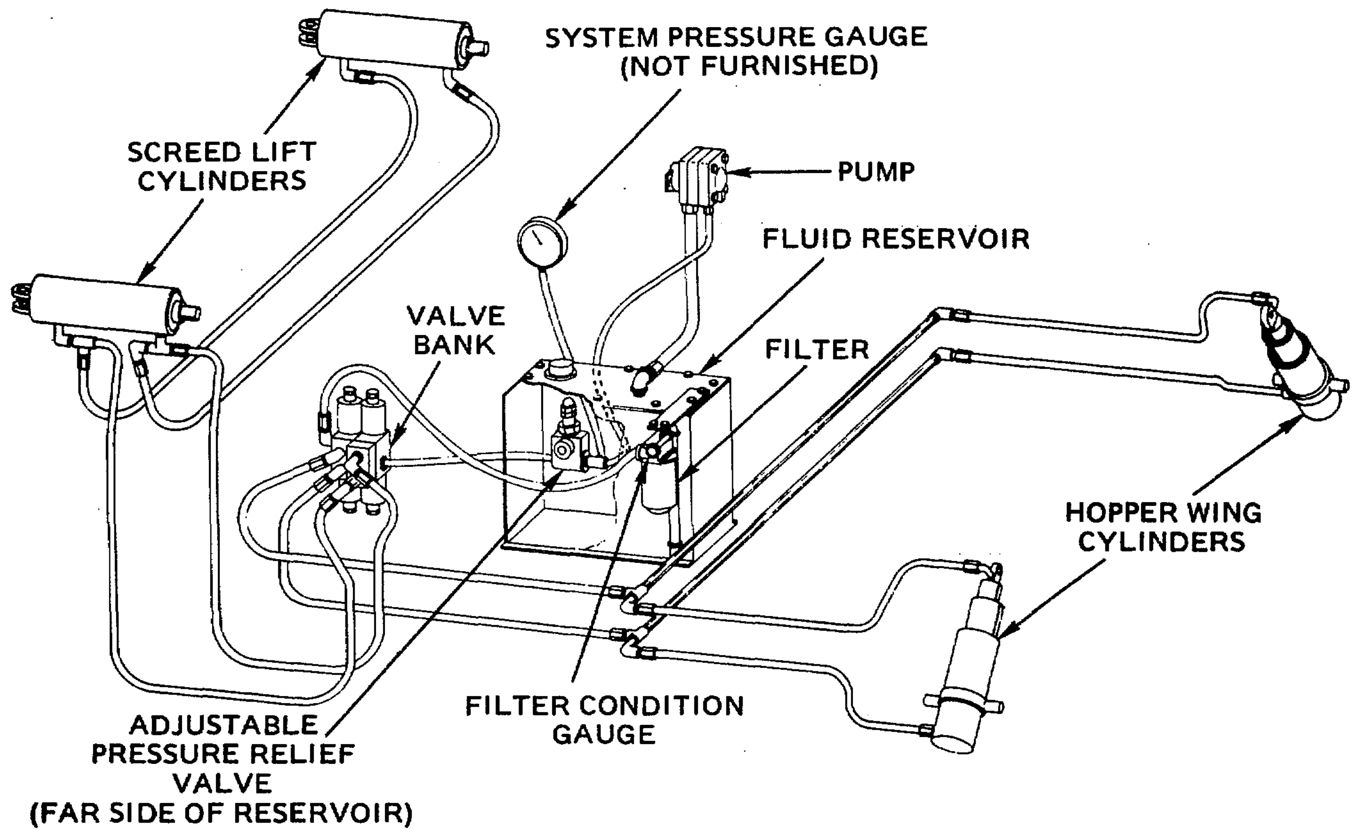
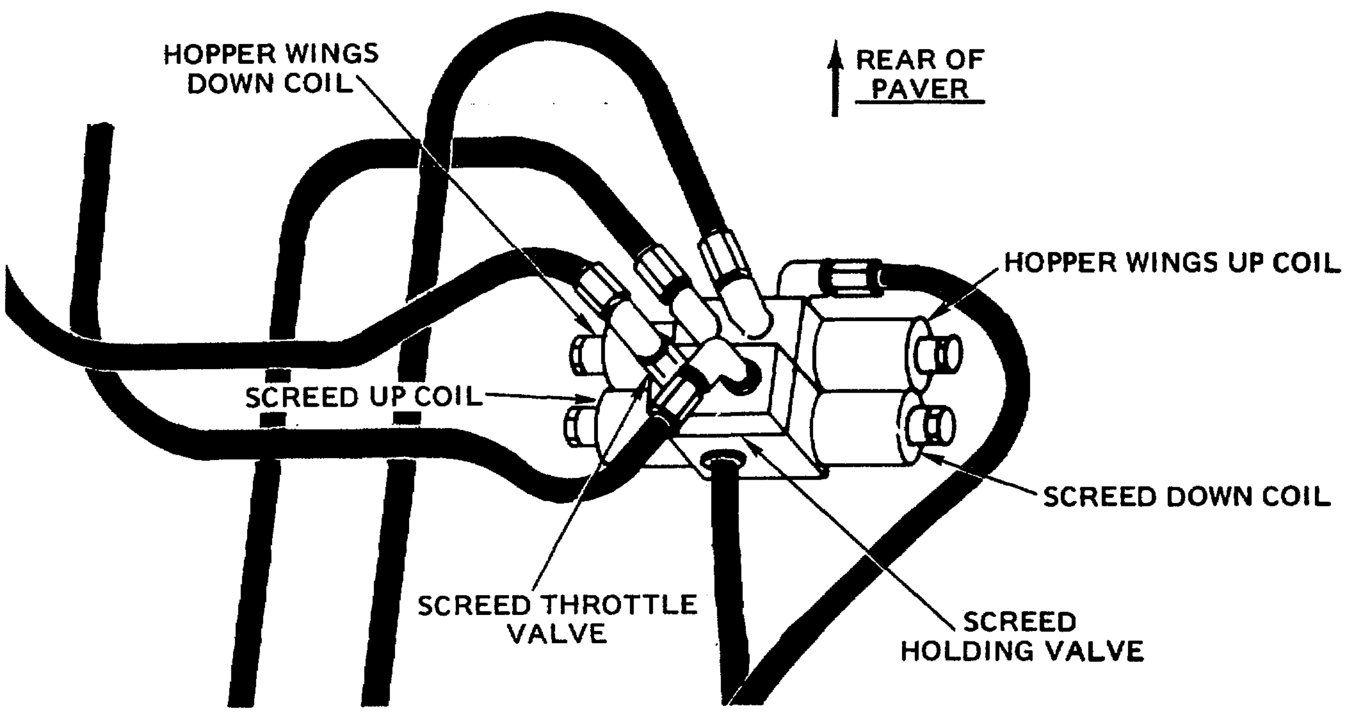


Representative Drawing of Hydraulic System Components
Figure 1



Top View of Valve Bank
Figure 2

HYDRAULIC SYSTEM - General (Figures 1 & 2)

(1) The **hydraulic pump** which maintains the flow of hydraulic fluid through the paver system is a direct driven unit. The engine must be at **full** throttle in order to develop the pump speed required for satisfactory fluid delivery. The pump draws fluid from the reservoir and circulates it through the solenoid bank and filter unit back to the reservoir.

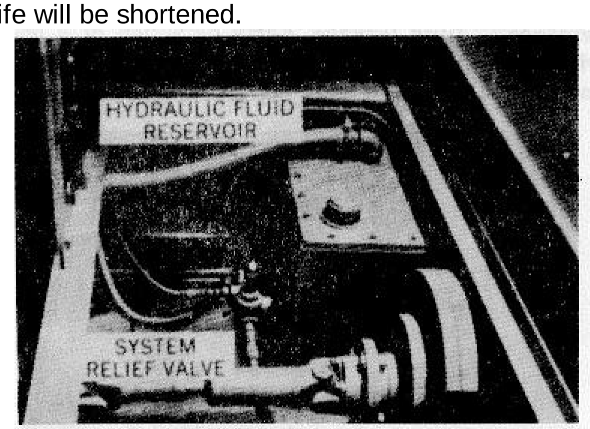
The **solenoid operated hydraulic valves** which make up the valve bank are controlled by toggle switches on the operator's console. These spool type valves direct the flow to and from the various hydraulic cylinders which operate the Screed Lift and Hopper Wings. When a spool is shifted to direct flow to a cylinder, pressure builds in that system sufficient to move the cylinder piston and operate the assembly.

A **pressure relief valve** attached to the reservoir limits the build-up of system pressure to approximately 1500 P.S.I. any time the free return of fluid is restricted by diversion to a cylinder.

A **holding valve** in the screed lift system locks the screed hydraulically at any degree of elevation so that it cannot creep downward due to its weight. Pump pressure is required to unlock this valve and the screed should be lowered with the engine running fast enough to prevent a jerky descent of the screed due to intermittent "unlocking" of the holding valve.

A **throttle valve** in the screed lift system limits the speed of screed descent to a safe rate.

A filter condition **gauge** on the **filter** unit in the fluid return line to the reservoir gives a visible indication of the renewable element's condition. This gauge indicates the relative pressure required to force returning fluid through the 10 micron element. The gauge is only intended for this purpose and does **not** show paver system operating pressures. (For recommended gauge readings see "Filter Gauge Readings" paragraph, Item 5) A by-pass feature is included in the filter assembly so that a clogged element cannot stop the return flow of hydraulic fluid to the reservoir and interrupt system operation. **Important!** The paver should not be operated with a clogged filter as an accelerated wearing of vital working parts may occur and their service life will be shortened.

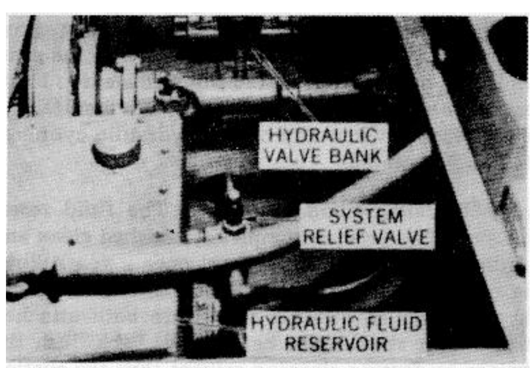


RH Sub-deck Area - (Walkway Removed)
Figure 3

The components which make up the hydraulic system will perform efficiently and have a long service life if the following basic service requirements **are** consistently met.

(2) Fluid Level Check - (Figure 5) Maintain hydraulic fluid supply in reservoir **at sight glass** level. Fluid capacity with all lines, components, and reservoir properly filled is approximately 10 gallons.

Use Texamatic Type F automatic transmission fluid only! Do not substitute other fluids. IMPORTANT - All fluid being added to the reservoir must be completely free of foreign particles and contaminants. All maintenance work performed on the system must be accomplished **without introducing any solid particles** which can find their way into vital operating components.



RH Sub-deck Area - (Walkway Removed)
Figure 4

(3) Inspection For Leakage. - During each day's run the operator should take the time to make a visual check of the exposed parts of the system for evidence of fluid leakage. Early detection of a leak will prevent extensive loss of fluid and unnecessary down-time.

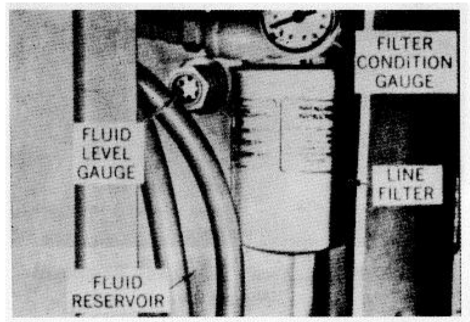


Figure 5 - Line Filter & Filter Condition Gauge

(4) Filter Element Change - (Figure 5.) The 10 micron filter element on the side of the fluid reservoir should be changed after the first **month** of operation or when gauge reading indicates a filtering restriction as explained in Paragraph (5). Subsequent element changes should be made each 250 engine hours to assure good fluid passage.

(5) Filter Gauge Readings - A new filter element produces a reading of less than 5 when the engine is at **full throttle,** the hydraulic fluid is **hot** (150° F or above) and no **hydraulic component** is being operated. As the element becomes restricted by contaminants from hours of normal paver operation the gauge reading will rise. **When the reading stays above 15 at all times during operation, with the same conditions as listed above, the filter element is badly restricted and should be changed!** Do **not** take a gauge reading when any of the hydraulic cylinders are being operated.

(6) Hydraulic Fluid Change - The fluid reservoir should be drained completely, flushed clean and re-filled with fresh fluid at least once a year. When the reservoir is empty the fill screen and the large 100 mesh suction strainer which are both attached to the cover should also be cleaned. Back-flush the strainer by forcing cleaning solvent thru the suction pipe in the cover. (See Figure 6.) Use clean hydraulic fluid to rinse all components after they are cleaned with solvent.

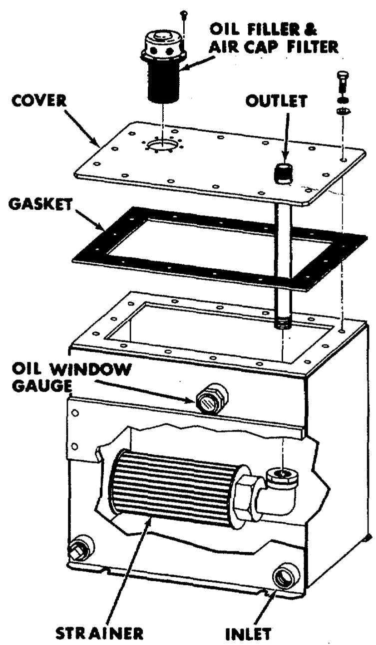


Figure 6 - Reservoir - Exploded View

(7) Hydraulic Pump - The hydraulic pump is capable of delivering 10 to 12 G.P.M. of hydraulic fluid to the valve bank at the required pressure when the paver engine speed is 2000 r.p.m. At slower speeds the pump output flow rate and pressure capability is reduced.

The pump requires no adjustment, however, V-belt driven units will lose efficiency if belt tension is not correct and slippage around the pulleys occurs. Belt tension should be checked at regular intervals.

The pump must be able to build 1,200 PSI pressure on a test gauge installed in the pressure line to the valve bank when engine is at full throttle and screed switch is held in "UP" position. (Pressure relief valve must be working properly). Replace or repair a pump which cannot maintain this pressure.

(8) Toggle Switches and Electrical Connections - A common cause of hydraulic system problems is electrical failure due to a broken wire, loose connection, or an inoperative toggle switch. When a single hydraulic function fails to occur while another works normally it is wise to check the wiring and switch details first before performing more complex troubleshooting work.

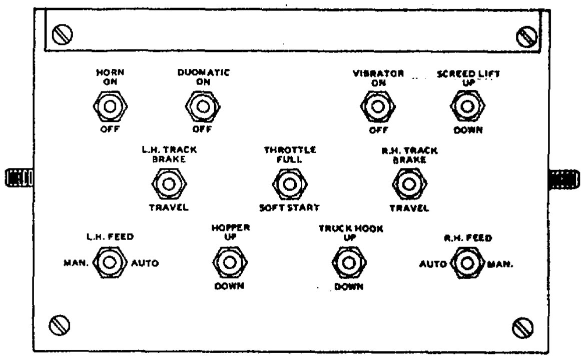


Figure 7 - Paver Control Console

The recommended way to make a fast accurate check of the hydraulic system electrical components and the valve units they control is as follows:

A - With paver engine stopped, set Control Key Switch to ON.

B - Using a small probe such as an Allen wrench (See Figure 8) exert finger pressure on the manual operating pin of the solenoid valve for the troublesome system. (Refer to Figure 2 for correct coil location). Have the correct switch toggle moved back and forth through all positions and feel for the "throw" of the valve plunger and spool. If a definite back and forth movement is felt it is unlikely that any electrical or solenoid trouble is causing the problem. If no movement can be felt in that solenoid, but can be felt in other solenoids you test, proceed as follows:

The entire solenoid valve control system is 12 Volt D.C. and can be worked on safely. When a suspected system has been checked out as described in paragraph above and found to be bad, make the following elementary checks of the wiring in order to restore a troublesome system to normal operation.

With the paver engine stopped and the Control Key Switch ON,

1 - Disconnect the hot wire from the coil at the quick connector.

2 - With the console toggle switch set to operate the troublesome function of the system, make a quick, light, brushing contact of the hot wire with the ground wire screw to which the ground wire of the coil is connected. There should be a visible sparking if electrical current is flowing to the end of the wire.

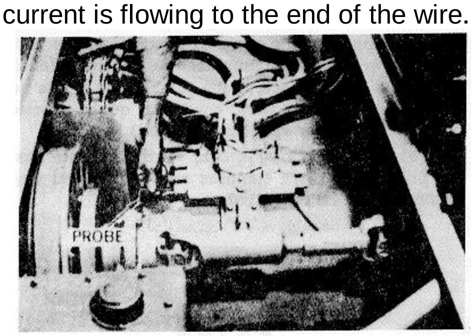


Figure 8 - Method Of Probe Testing Solenoid Valves

CAUTION: If a firm steady grounding contact is made the control system overload protector will function and will have to be re-set.

(a) If there is a spark, check the ground wire connection of the coil for a break or loose connection.

(b) If there is no spark, proceed with Step 3.

3 - If the hot wire does not spark when tested as described in Step 2 above, loosen the four screws in console switch panel and carefully tilt the panel to make the switch terminals and wiring accessible. Using a short piece of single conductor insulated wire with ends bared, jumper from the center terminal to each of the outer terminals of the switch which operates the troublesome unit. As this is done a second person should be making the spark test with the loose hot wire at the solenoid.

(a) If there is a spark at the solenoid hot wire when one combination of switch terminals is jumpered the toggle switch is defective and should be replaced.

(b) If there still is no spark at the solenoid hot wire despite the switch terminal jumpering, proceed with Step 4.

4 - If no sparking occurs at the solenoid hot wire when the switch terminals are jumpered, carefully touch the short jumper wire to the center terminal of the switch and make a quick, light, brushing contact of the wire with a bare area of the console case.

(a) If sparking occurs at the console case the cause of unit failure is probably an "open" or break in the wiring from the operator's console to the junction box or from the junction box to the solenoid valve. If a visual check of the junction box does not disclose any broken wire, consult a qualified electrician. (Use paver electrical manual)

(b) If no sparking occurs at the console case, the problem is more complex and a qualified electrician should be consulted.

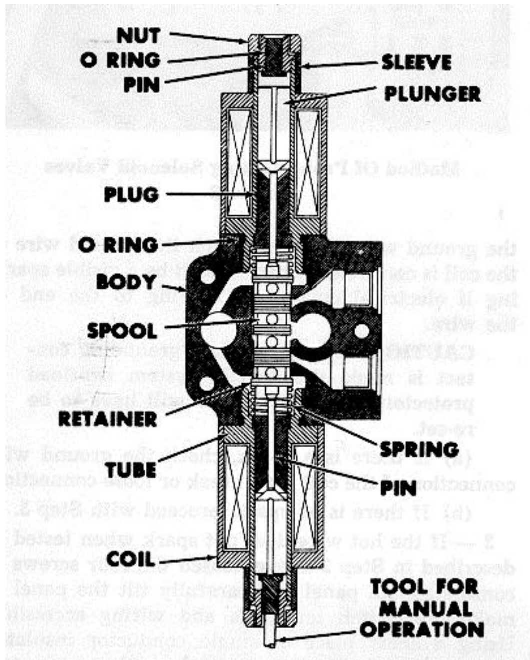


Figure 9 - Solenoid Valve - Cross Section

(9) Solenoid Valves - All of the 4-way solenoid operated directional valves used on the paver are identical units (See Figures 9 and 10). They are double acting valves with spring return of the spool to the neutral position. The operation of each valve is controlled by a double throw toggle switch on the operator's console. When one of the switch contacts is closed, a 12 V.D.C. valve coil is energized and the spool position is shifted by the plunger to connect internal porting so that hydraulic fluid under pressure flows to one end of the hydraulic cylinder(s). Fluid displaced by the moving cylinder piston flows through aligned ports of the same solenoid valve to the reservoir. When the toggle switch is moved to the opposite position, the opposite coil is energized and the spool is shifted to reverse the pressure and return flow ports so that the cylinder moves in an opposite direction. When the switch is at the central "OFF" position the spool is centered in the valve body by coil spring action and all ports connected to cylinders are closed so that no flow to or from the cylinders can occur.

(10) Solenoid Coil Testing by Substitution - If a coil is suspected to be the cause of a hydraulic system's failure, exchange the questionable coil with an adjacent coil which is known to be functioning properly.

METHOD: (See Figure 10)

A - Remove Nut (1) and Sleeve (2) from each coil.

B - Grasp Coil (3) and twist gently back and forth while pulling unit away from valve body.

C - When both coils are clear of their tubes (6) slip the good coil onto the tube of the inoperative system and the questionable coil onto the tube of the functioning system. Install the sleeves and nuts.

D - Do not change the wiring connections. Operate the toggle switches with the exchange of coils in mind.

Example: If the screed lift was inoperative and the hopper wing coil is substituted, operate the Hopper Wing toggle switch to test the screed lift system (and vice versa). If the substitute coil will not operate the screed lift system, but the coil removed from it will operate the hopper wing system, then the screed lift valve may be jammed internally so that it cannot be operated electrically. Put coils back in original locations and make a manual actuation test as outlined in Paragraph (11).

If the substitute coil operates the troublesome system properly, interchange only the hot wire of each coil (quick disconnect type). See if the substitute coil will still operate the valve when connected to the troublesome system's wiring circuit. If the system again works properly, the suspected coil is truly defective and should be replaced. If the system fails to work with the original wiring or if the suspected coil operates the other system, a bad toggle switch or a broken wire are the actual cause of the failure. Refer to Paragraph (8).

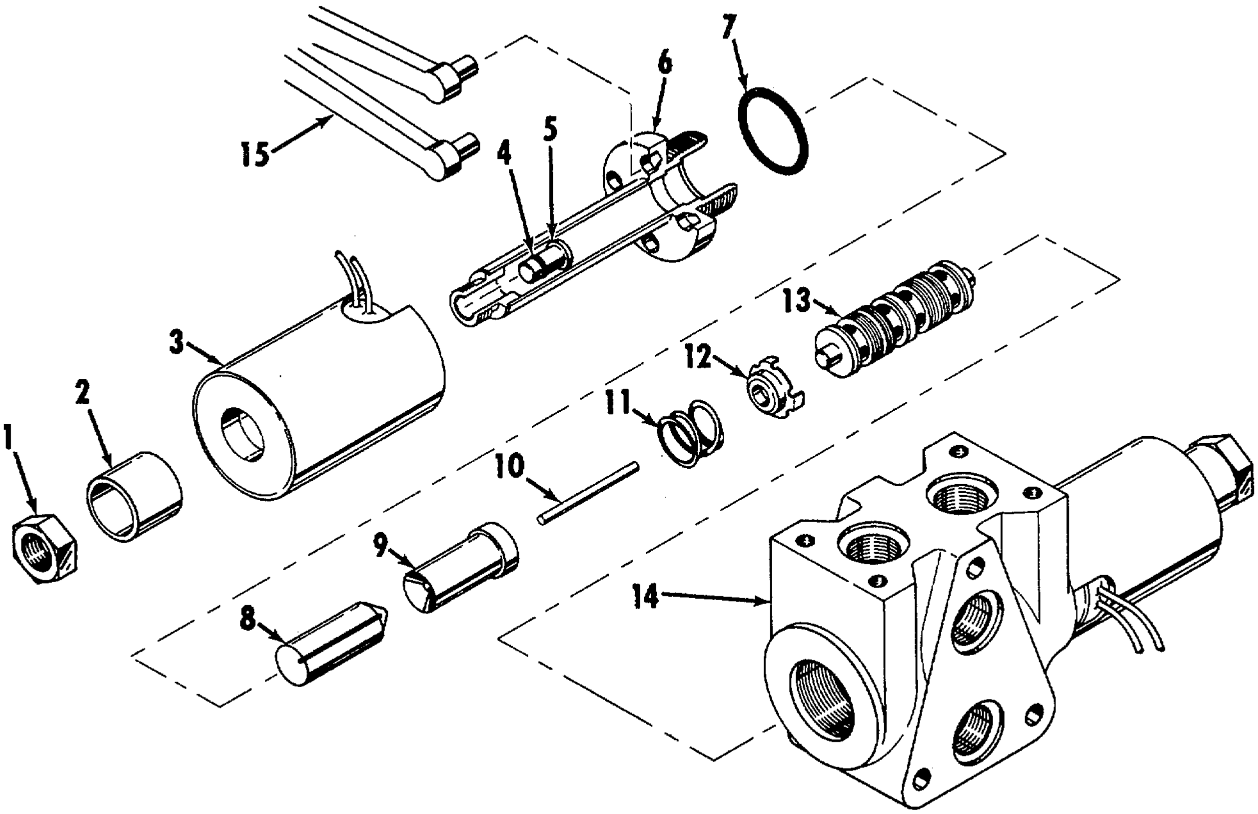


Figure 10 - 4 Way Solenoid Operated Hydraulic Valve - Exploded View

(11) Manual Test Operation of Solenoid Valve - If a properly tested substitute coil and electrical wiring system fails to operate a valve, a means is provided for manual shifting of the spool which may be temporarily jammed. (See Figures 9 & 11).

METHOD:

Use a ¼" diam. X 1 ½" long steel pin or similar tool which will enter the bore of the valve tube. With the paver engine at full throttle, and all hydraulic system toggle switches in the OFF of center position, depress the pin in the bore of the valve tube so that it contacts and moves the plunger, pin, and spool toward the opposite end of the valve. The first 1/8" movement will require nearly 25 pounds of force. As long as the valve is held manually depressed the cylinder operated by the valve receives hydraulic fluid. If the spool has been jammed by dirt particles the flushing action of flow through the valve may permanently correct the problem and normal operation can be resumed. **Do not use unreasonable pressure for manual shifting!** If the spool cannot be manually shifted or fails to return by spring action to the OFF position, the valve should be completely dismantled, inspected, cleaned, and test operated. (See following paragraph) If manual shifting succeeds in operating the system, try electrical operation again to see whether the coil's magnetic force is strong enough to consistently move and hold the plunger.

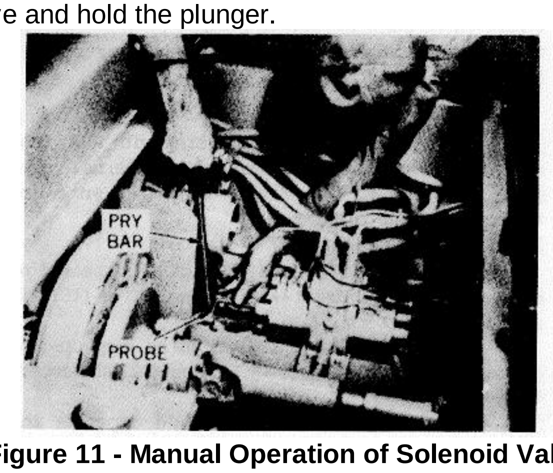


Figure 11 - Manual Operation of Solenoid Valve

(12) Preparation For Dismantling Valve Bank - When it is necessary to detach and dismantle any of the valves which make up the Valve Bank Assembly (Figure 12) it is necessary that the bank be disconnected from hydraulic hoses, unbolted from the mounting brackets and moved to a totally clean work bench area free of wind borne particles and surface dirt. The detached unit should also be plugged and washed clean externally before any dismantling is started. Always support screed before uncoupling.

METHOD:

A - Remove electric coils according to Paragraph (10). If no coil exchange is to be made mark each coil and each valve tube assembly from which it is taken so that a correct return will be assured. Remove the coils and lay them in a safe area leaving the hot wires connected. If a coil change is to be made mark the hot wire number on the valve tube to assure correct connection of the new coil.

B - Mark each hose and it's companion fitting on the valve bank with a code that will assure correct re-coupling when the bank is installed. **It is possible to accidentally connect hoses improperly if they are not marked.** (Should marking be forgotten or erased, refer to system diagrams Figures 1 and 2 for correct connection details.)

C - Disconnect hoses properly as described in Paragraph (22). As each hose is loosened plug the exposed end with a clean plastic plug or wrap with a clean cloth cover and fasten securely. Do the same to the open fitting on the valve bank. **Do not leave any open hydraulic connector unprotected against wind borne particles.**

D - Unbolt and remove the valve bank. Important! Scrub and rinse the exposed surfaces of the entire valve bank to remove all dirt particles **before** the assembly is placed on a clean working surface and dismantled.

(13) Dismantling Valve Bank - The dismantling job must be performed in a clean area with tools that are free of loose dirt particles. As the internal valve parts are removed they should be placed on a lint and particle free surface.

METHOD. (See Figure 12)

A - If a Throttle Valve (20) is to be inspected or cleaned unscrew it from the Holding Valve (19). Be sure to retain O Ring (22).

B - If Holding Valve (19) is to be inspected or cleaned remove Cap Screws (24) and Lockwashers (28).

C - Remove Tie Bolt (25) and separate the valves. Be sure to retain all O Rings (23) which seal the bodies against leakage.

D - See individual valve dismantling details, Paragraphs (14), (15), (16), and (17).

IMPORTANT - When assembling valve bank, tighten screws alternately, evenly, and **with not more than 150 inch pounds of** torque. It is important that the machined contact surfaces and O rings make a leak-free contact without excessive screw tightness which can warp bodies and cause binding of the spool.

(14) Dismantling Solenoid Valve (See Figure 10).

A - Unscrew and remove Hex Nut (1).

B - Remove Sleeve (2).

C - Carefully pull Coil (3) off tube Assembly (6). Never use a pry tool against the plastic wire protector.

D - Place housing (14) in a vise exerting only slight jaw pressure on the rough sides of the body casting to keep it from turning when tube is unscrewed. Have the tube assemblies (6) horizontal so that loose parts will not fall out.

E - Using the special spanner wrench (15) provided in the paver tool box carefully unscrew the tube (6) from the body (14). Note: It may be necessary to remove the paint and some metal from the spanner wrench pins to make them fit the tube holes.

F - When the tube is removed, the loose parts; plug (9), pin (10), and plunger (8), can be emptied from the tube interior.

G - Push pin (5) out of tube.

H - Remove spring (11) from housing.

I - If spool (13) is to be removed, both coil and tube assemblies should be removed first. Then pull out the retainer (12) from each end of the spool and work spool (13) carefully out of housing (14). Important! The matched spool and housing are precision parts which fit together with very little clearance. When removing or installing spool, gently work it in or out with the fingers by small increments being careful not to bind it. Never use force other than a gentle tap with the plunger (8).

Clean all parts except electric coils in a good solvent being certain to flush all particles out of the housing, spool, tube, etc. Re-lubricate parts with **clean** hydraulic fluid. Re-use O Ring seals only if they are in near new condition, otherwise a steady loss of hydraulic fluid will occur. Spool (inside the body) should be free of binding when moved laterally. Free movement should not be affected by a 360° rotation of the spool while it is being moved laterally. If spool movement is not free a replacement valve is recommended.

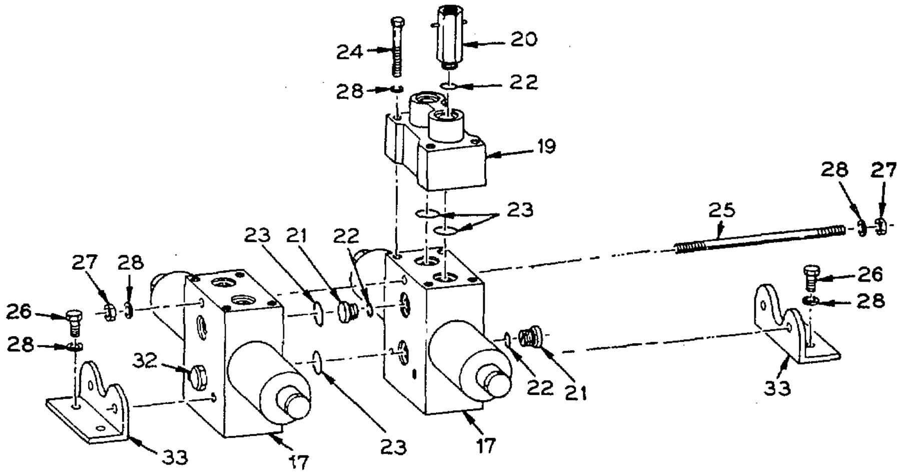


Figure 12 - Exploded View Of Valve Bank

Ref. No.	Part Description	Quantity
17	4-Way Solenoid	2
19	Holding Valve	1
20	Valve Throttle	1
21	Plug, Banking	2
22	O-Ring	3
23	O-Ring	6
24	Capscrew	4
25	Bolt, Tie	3
26	Capscrew	4
27	Nut	2
28	Lockwasher	4
33	Bracket	2

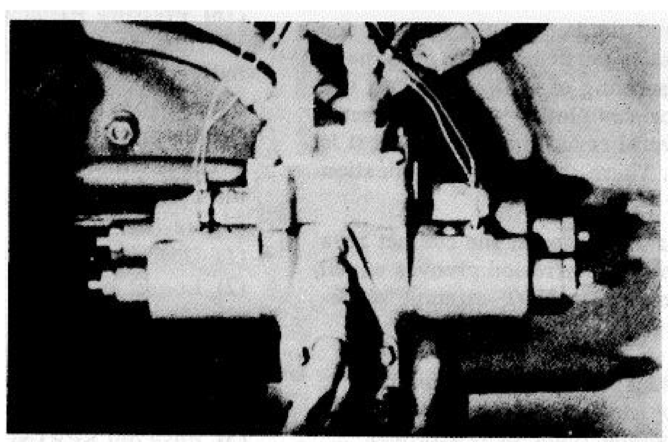


Figure 13 - Hydraulic Valve Bank Assembled

(15) Holding Valve - (See Figure 14)

The holding valve is a double acting check valve assembly with a floating piston for power unseating of the two spring loaded check valves. When pressure is applied to one of the actuating ports the spring loaded check valve on the pressure side of the housing is unseated and fluid passes to the hydraulic cylinder. The piston is moved by the same pressure to mechanically lift the opposite check valve off its seat, permitting the return flow from the cylinder to pass through the valve to the reservoir. When there is no pressure applied to either actuating port, both check valves are seated and no flow to or from the cylinder can occur. The cylinder piston is therefore locked in position and the unit it is powering is "held."

The holding valve can be dismantled and checked internally or repaired as follows:

A - Unscrew and remove Plugs (4).

B - Remove Springs (2) and Check Valves (9).

> **IMPORTANT!** Each Check Valve (9) must be reassembled in its match fit Cage (8). Keep these parts separated from the duplicate set on the opposite side of the valve so that no accidental interchange can occur.

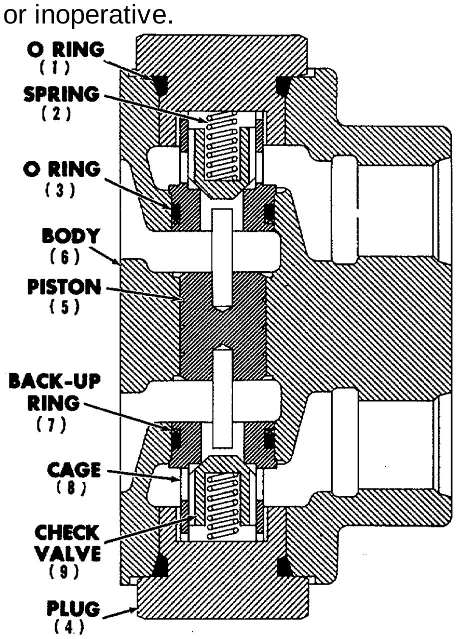
C - Using a short length of rod small enough in diameter to pass through the bore of one of the Cages (8) carefully drive the Floating Piston (5) against the opposite Cage to force it out of the housing. The piston will follow the cage out of the housing.

D - Carefully re-install the piston in its bore, with the opposite cage downward. Use the rod again to drive the piston against the cage until it is also clear of the body.

Inspect the piston and the bore of the housing for scratches, score marks, or particles which may have caused a binding or jamming of the piston. Test the piston in the bore for completely free movement, turning it through several revolutions slowly as it is drawn back and forth. There should be no indication of binding.

Inspect check valves and cages at the contact area for nicks, scratches, and fluid erosion grooves which can permit fluid passage. Do NOT attempt to re-machine these parts. Obtain replacements.

> **IMPORTANT!** When replacing cages be sure to use reliable O Rings (3) and Back Up Rings (7) and arrange them in the proper order as shown in Figure (14).
>
> **IMPORTANT!** When re-attaching the assembled valve to the valve bank, tighten mounting screw evenly and **use not more than 150 inch pounds of tightening force.** Uneven or excessive tightening can distort the housing and bind the piston in its bore making the valve erratic or inoperative.



(16) Pressure Relief Valve (See Figure 15)

The system pressure relief valve is a spring loaded ball type assembly which is externally adjustable. A new valve is adjusted by the manufacturer to limit system pressure to approximately 1200 PSI.

Dis-assembly: The valve can be dismantled for inspection, cleaning and part replacement. (Refer to Figure 15)

(1) Unscrew and remove CAP (A).
(2) Loosen and remove LOCKNUT (B).
(3) Unscrew and remove ADJUSTING SCREW (C).
(4) Unscrew and remove HOUSING (E) from BODY (F).
(5) Push out SPRING (D), GUIDE (G) and BALL (H).

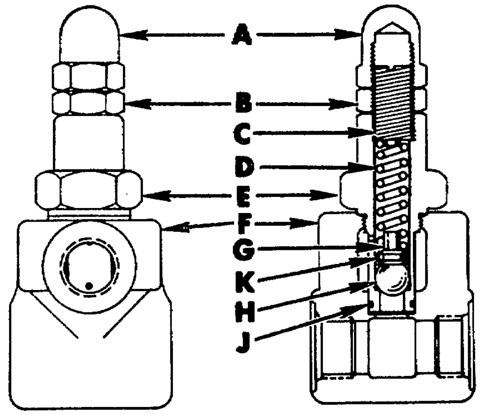


Figure 15 - Pressure Relief Valve - Cross Section

(6) Inspect all parts for wear, burrs, etc. Be sure all gaskets and seals are in good condition. Replace if questionable.

(7) Before re-assembling, clean all parts thoroughly so that no foreign particles are introduced into the valve and hydraulic system.

Re-setting Relief Pressure

IMPORTANT!

To re-set the valve for 1500 PSI relief, proceed as follows:

(a) Back-off (counterclockwise) adjusting screw (C) so that the valve will by-pass fluid at low pressure.

(b) Install an accurate pressure gauge in the gauge port at the rear corner of the engine radiator shroud.

(c) Run engine at Full speed.

(d) Hold hopper wing switch at UP position and turn valve adjusting screw (C) inward (clockwise) to slowly raise gauge pressure to 1500 PSI. Hold screw (C) and tighten locknut (B). Re-check gauge for 1500 PSI after tightening locknut.

(e) Hold hopper wing switch at DOWN position to re-check relief setting. Repeat test several times.

(f) Install valve cap (A).

(17) Throttle Valve - (See Figure 16) - Throttle valves are used in the "down" phase of the screed lift system and in both phases of the optional truck hook system. The throttle valve in a two directional line allows unrestricted flow in one direction and metered or restricted flow in the opposite direction. In the case of the screed lift, the flow in the RAISE direction is unrestricted while the return flow in the LOWER direction is restricted by a 3/32" DIAM. orifice. This permits the screed to raise at moderate speed but to descend at a slower safe rate. A drilled poppet is the only moving part. The valve can be easily disconnected for examination of the orifice for presence of foreign matter. The orifice can be probed clear using a piece of 1/16" diam. wire. If probing succeeds in clearing a blockage the valve should then be removed from the line and flushed clean of particles.

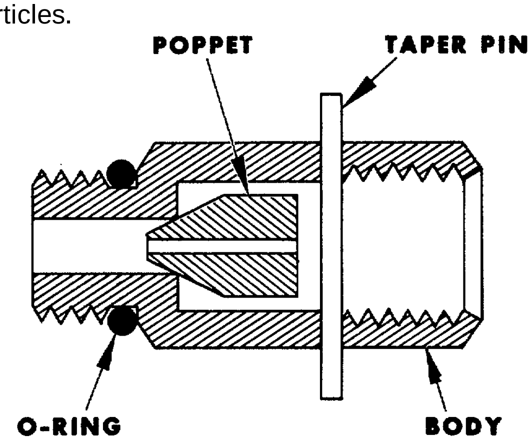
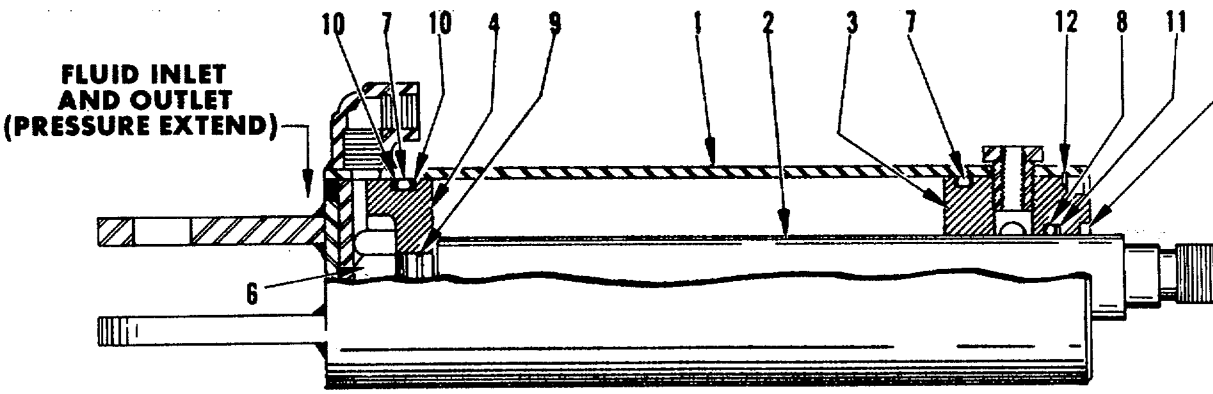


Figure 16 - Throttle Valve - Cross Section

(18) Hydraulic Cylinders - (See Figures 17 & 18) The hydraulic cylinders used on Cedarapids pavers are selected for efficient service and maximum durability. Very little trouble is normally experienced unless the hydraulic fluid is contaminated by foreign particles which find their way into cylinders and cause rapid seal wear. Heavy duty wiper type seals for the exposed rods help to minimize contamination. These parts should be maintained in top condition.

If severe contamination of the hydraulic fluid has occurred and it is likely that a large quantity of particles has reached the cylinders, it is wise to flush them thoroughly with a suitable solvent. Replace seals when worn so that leakage is not a threat to efficient system operation.

A worn piston seal will permit leakage of fluid around the seal from the pressure to the discharge side of the cylinder. The result is sluggish movement of the piston rod or a failure to maintain rod position. Seal replacement is the only solution.

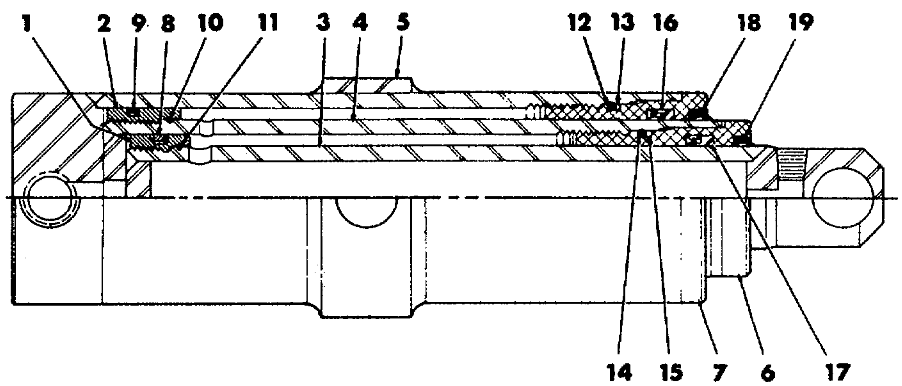


Typical Screed Lift Cylinder — Double Acting, Single Stage Type

Figure 17

Ref. No.	Description	Ref. No.	Description
1	Body, Cylinder	* 8	O-Ring
2	Rod, Piston	* 9	O-Ring
3	Guide, Piston Rod	*10	Washer, Back-Up
4	Piston	*11	Washer, Back-Up
6	Hex Nut, ⅞" N.F.	*12	Ring, Retaining
*7	O-Ring	*13	Wiper, Rod

*These Parts Can Be Ordered as a Complete Packing Kit



Typical Hopper Wing Cylinder — Double Acting, Double Stage Type

Figure 18

Item	Description	Quantity	Item	Description	Quantity
1	Piston	1	11	*O-Ring	1
2	Piston	1	12	*O-Ring	1
3	Tube, 2nd Stage	1	13	*Back Up Washer	1
4	Tube, 1st Stage	1	14	*O-Ring	1
5	Case	1	15	*Back Up Washer	1
6	Head	1	16	*U-Cup and Load O-Ring	1
7	Head	1	17	*U-Cup and Load O-Ring	1
8	*Piston Ring	1	18	*Seal, Wiper	1
9	*Piston Ring	1	19	*Seal, Wiper	1
10	*O-Ring	1			

*NOTE: These Parts Purchased as a Repair Kit

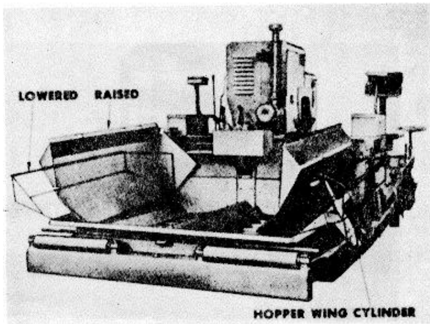


Figure 19 - Tilting Hopper Wings

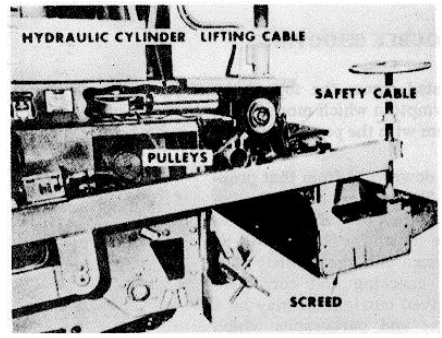
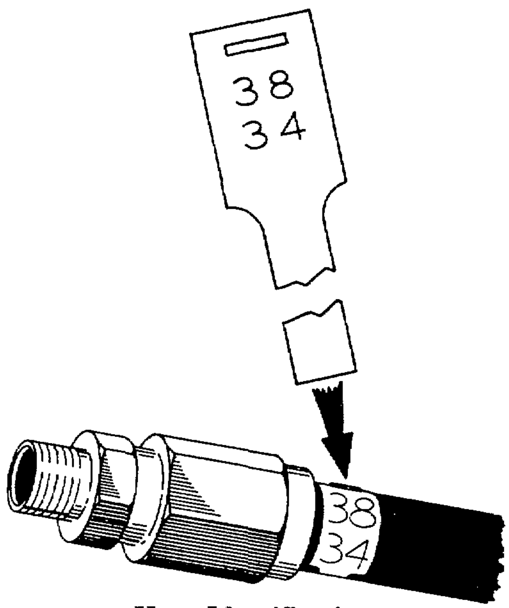


Figure 20 - Screed Lift Cylinder - Cut-away View

(19) Screed Lift Cables - Raising and lowering of the heavy screed assembly is accomplished through an arrangement of hydraulic cylinders, flexible cables, and pulleys. (See Figure 20). Because of the mechanical portion of the system which is for the most part hidden from the operator's view, it is wise to examine the cylinder operated pulley through the under side opening in any event of uneven screed movement. This will eliminate unnecessary hydraulic system trouble-shooting in the event the actual cause is the binding or jamming of a cable.

(20) Hose and Tube Identification - Each hose and tube is identified with a tag on one end as shown in Figure 21. The number shown 38-34 corresponds with the last four numbers of the hose or tube assembly part number 5032-201-38-34.



Hose Identification

Figure 21

(21) Hose Assembly - The rubber-covered wire braid hoses used throughout the hydraulic system will give trouble-free service and long life if properly maintained.

Periodically check hose position to make sure they are not rubbing against moving parts or supported on sharp steel edges.

The hose end fittings are (no skive) re-usable hose fittings, to make it possible to repair the hose on the job site.

Replace rubber-covered hose as follows:

(1) Disassemble fitting nipple by turning it out of hose socket.
(2) Disassemble hose socket by turning it off the rubber hose.
(3) Clean steel socket and nipple.
(4) Dip ends of new hose into hoze-oil lubricant and then thread the socket onto the rubber hose.

Do not cut inner or outer covering for assembly.

(5) Thread nipple to socket.
(6) Clean fitting and interior of hose. **CAUTION: Flush hose with solvent before installing into system.**

(22) Hose Couplings - The swivel nut at the end of each hose assembly is a free turning part which holds the nipple tightly against the companion fitting. There will be some binding as the nut bears tight against the flare of the nipple. Always hold the Hex Collar of the nipple stationary as the swivel nut is tightened or loosened. This prevents damage to the hose.

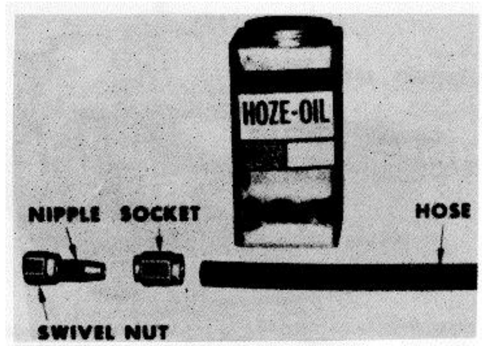


Figure 22 - Hose Assembly

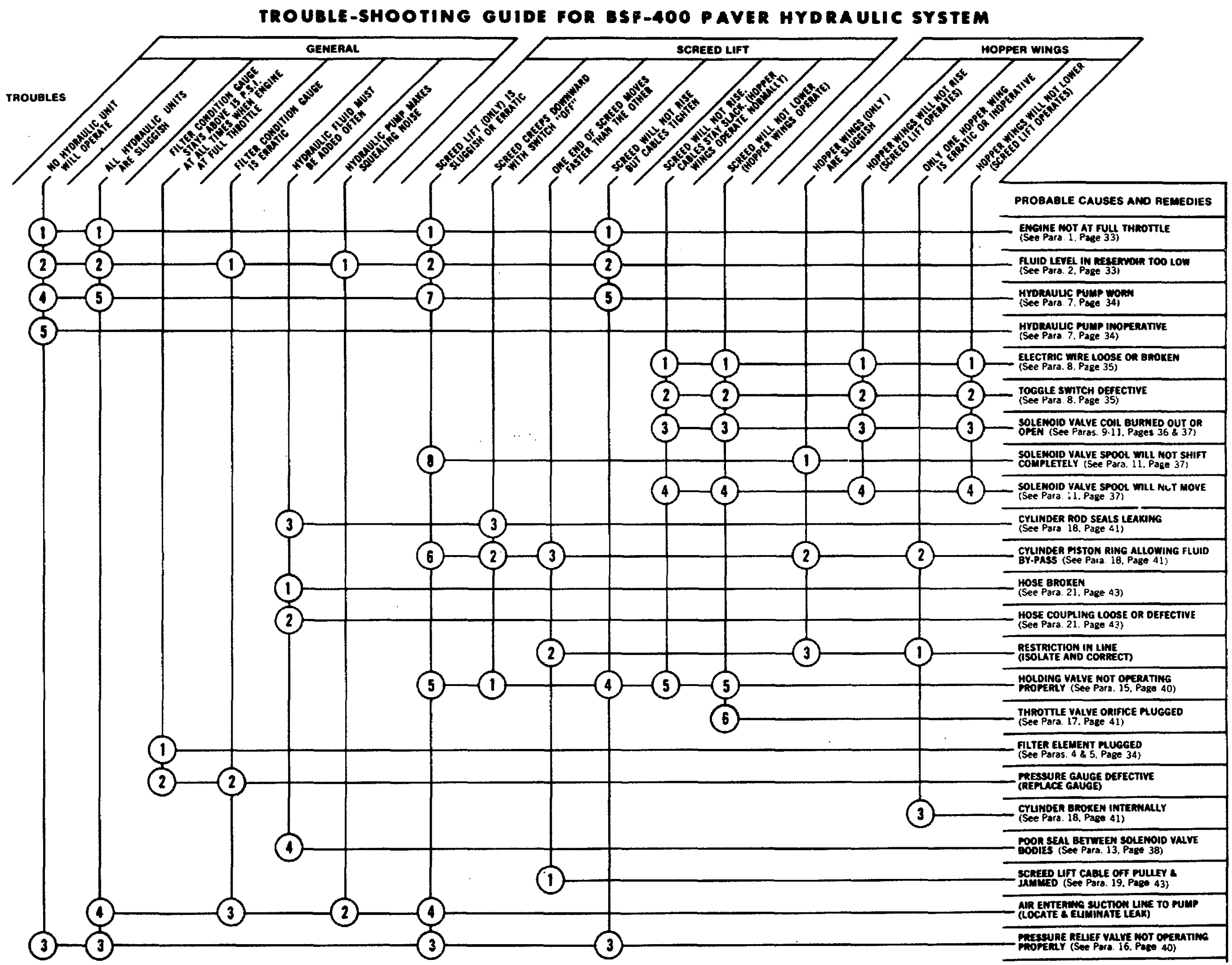
HOW TO USE THE TROUBLE SHOOTING GUIDE ON PAGE 45

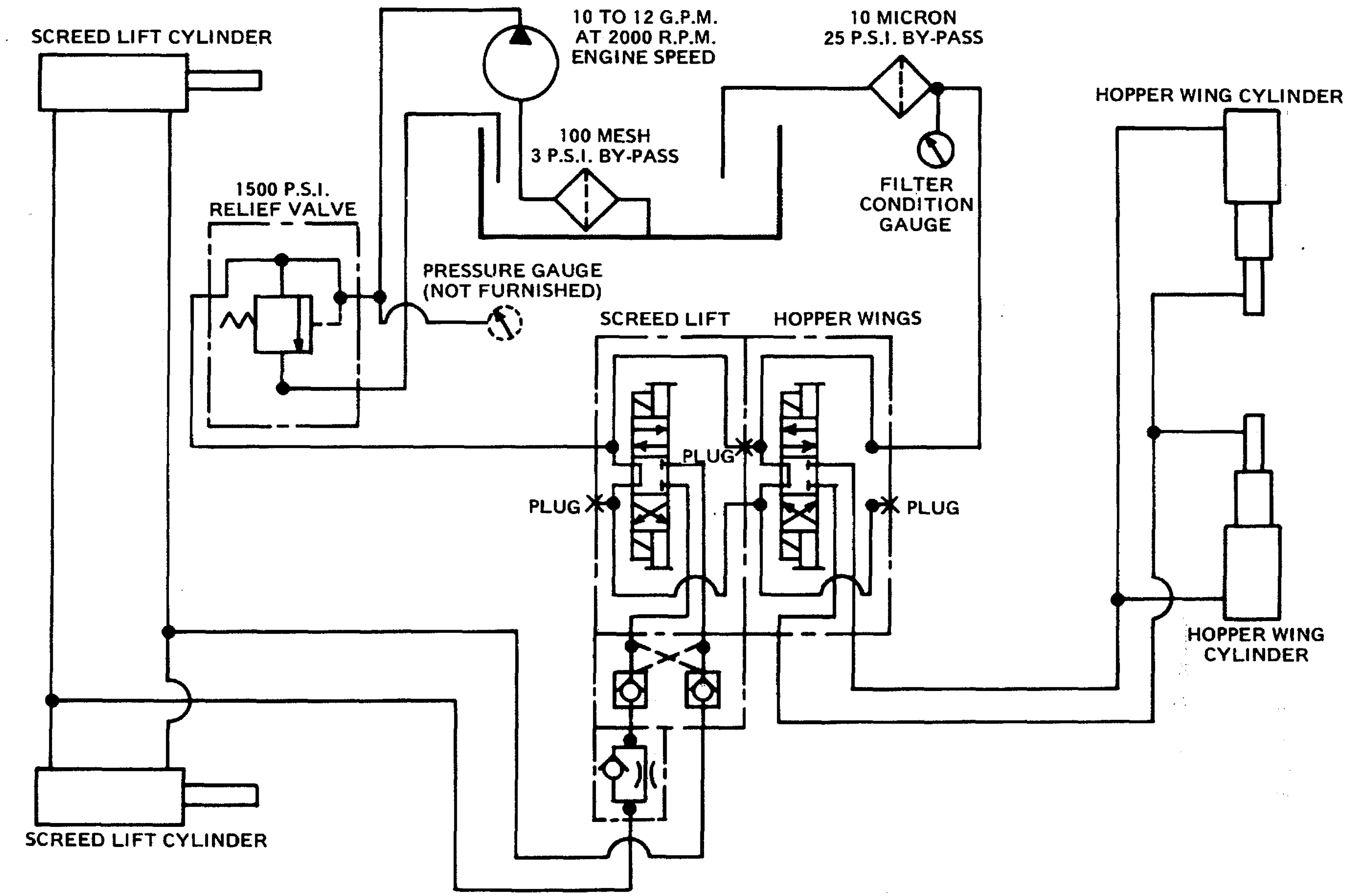
1. In the "Troubles" listed across the top of the following page, find the symptom which most closely describes the actual problem with the paver hydraulic system.

2. Follow the guide line downward from that problem to the circled No. ①. Then follow the guide line to the right hand column where a probable cause and remedy is listed. The cause shown for No. ① will be the most common occurrence and the remedy will often require the easier checking and corrective work. A remedy may be given outright, or may be a reference to manual pages and paragraphs which give complete details on function, maintenance, test, or repair of the component part suspected of malfunction.

3. If the No. ① cause is not the actual problem proceed to the No. ② on that same vertical guide line and-make the check or correction suggested. If that also fails to produce the solution proceed to No. ③ etc.

As the circled number of a cause and remedy goes higher, the work required for making the check and correction usually increases. The higher numbered possibilities are also less common in occurrence. For these reasons it is wise to start with ① and progress numerically.


TROUBLE-SHOOTING GUIDE FOR BSF-400 PAVER HYDRAULIC SYSTEM
TROUBLES
GENERAL
NO HYDRAULIC UNIT WILL OPERATE
ALL HYDRAULIC UNITS ARE SLUGGISH
FILTER CONDITION GAUGE STAYS ABOVE 15 P.S.I. AT ALL TIMES WHEN ENGINE AT FULL THROTTLE
FILTER CONDITION GAUGE IS ERRATIC
HYDRAULIC FLUID MUST BE ADDED OFTEN
HYDRAULIC PUMP MAKES SQUEALING NOISE
SCREED LIFT
SCREED LIFT (ONLY) IS SLUGGISH OR ERRATIC
SCREED CREEPS DOWNWARD WITH SWITCH "OFF"
ONE END OF SCREED MOVES FASTER THAN THE OTHER
SCREED WILL NOT RISE BUT CABLES TIGHTEN
SCREED WILL NOT RISE, CABLES STAY SLACK. (HOPPER WINGS OPERATE NORMALLY)
SCREED WILL NOT LOWER (HOPPER WINGS OPERATE)
HOPPER WINGS
HOPPER WINGS (ONLY) ARE SLUGGISH
HOPPER WINGS WILL NOT RISE (SCREED LIFT OPERATES)
ONLY ONE HOPPER WING IS ERRATIC OR INOPERATIVE
HOPPER WINGS WILL NOT LOWER (SCREED LIFT OPERATES)
PROBABLE CAUSES AND REMEDIES
ENGINE NOT AT FULL THROTTLE (See Para. 1, Page 33)
FLUID LEVEL IN RESERVOIR TOO LOW (See Para. 2, Page 33)
HYDRAULIC PUMP WORN (See Para. 7, Page 34)
HYDRAULIC PUMP INOPERATIVE (See Para. 7, Page 34)
ELECTRIC WIRE LOOSE OR BROKEN (See Para. 8, Page 35)
TOGGLE SWITCH DEFECTIVE (See Para. 8, Page 35)
SOLENOID VALVE COIL BURNED OUT OR OPEN (See Paras. 9-11, Pages 36 & 37)
SOLENOID VALVE SPOOL WILL NOT SHIFT COMPLETELY (See Para. 11, Page 37)
SOLENOID VALVE SPOOL WILL NOT MOVE (See Para. 11, Page 37)
CYLINDER ROD SEALS LEAKING (See Para. 18, Page 41)
CYLINDER PISTON RING ALLOWING FLUID BY-PASS (See Para. 18, Page 41)
HOSE BROKEN (See Para. 21, Page 43)
HOSE COUPLING LOOSE OR DEFECTIVE (See Para. 21, Page 43)
RESTRICTION IN LINE (ISOLATE AND CORRECT)
HOLDING VALVE NOT OPERATING PROPERLY (See Para. 15, Page 40)
THROTTLE VALVE ORIFICE PLUGGED (See Para. 17, Page 41)
FILTER ELEMENT PLUGGED (See Paras. 4 & 5, Page 34)
PRESSURE GAUGE DEFECTIVE (REPLACE GAUGE)
CYLINDER BROKEN INTERNALLY (See Para. 18, Page 41)
POOR SEAL BETWEEN SOLENOID VALVE BODIES (See Para. 13, Page 38)
SCREED LIFT CABLE OFF PULLEY & JAMMED (See Para. 19, Page 43)
AIR ENTERING SUCTION LINE TO PUMP (LOCATE & ELIMINATE LEAK)
PRESSURE RELIEF VALVE NOT OPERATING PROPERLY (See Para. 16, Page 40)

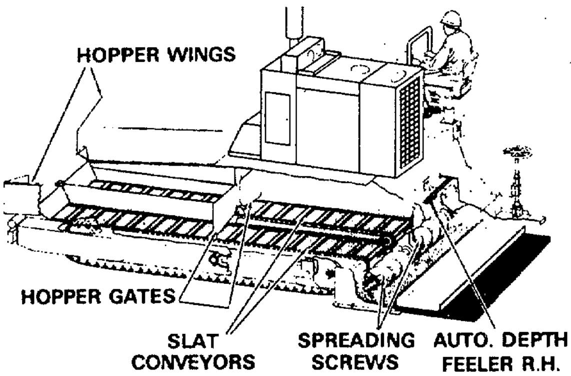


Schematic Diagram-BSF-400 Paver Hydraulic System
Figure 23

Asphalt Spreading System (Feed)

MATERIAL FEED SYSTEM

The feed system is arranged to give the operator good control of material movement and distribution. From his seat almost directly over the spread-screws, the operator has an unobstructed view of material distribution ahead of the screed.

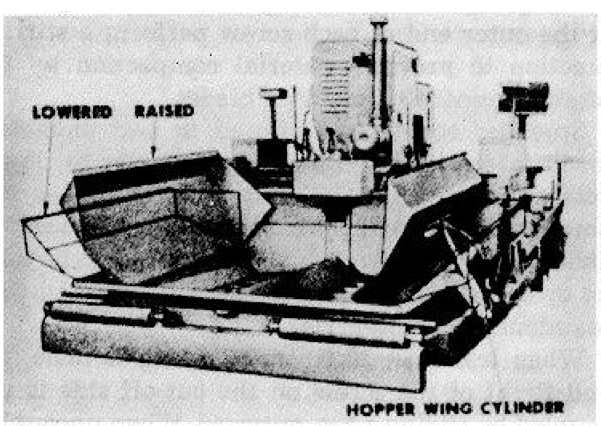


Material Flow Diagram
Figure 1

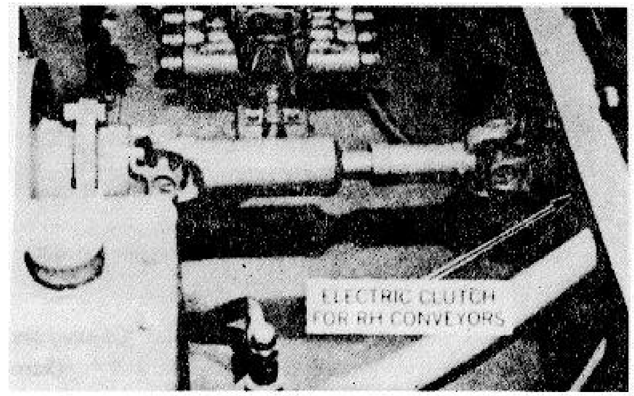
HOPPER WINGS

The two hinged hopper wings which can be raised and lowered hydraulically to permit complete emptying of the large hopper should be operated after each supply truck has pulled away and cleared the hopper area. They should **never** be raised when a truck is at the paver. (See Figure 2)

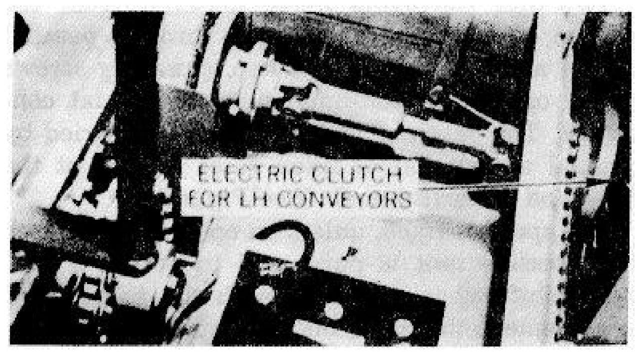
The hydraulic cylinders which raise each of the hopper wings are powered from the same hydraulic pressure line and **one will normally preceed the other** in reaching the fully raised and fully lowered attitude.



Tilting Hopper Wings
Figure 2



Electric Clutches - R.H. Walkway Removed
Figure 3

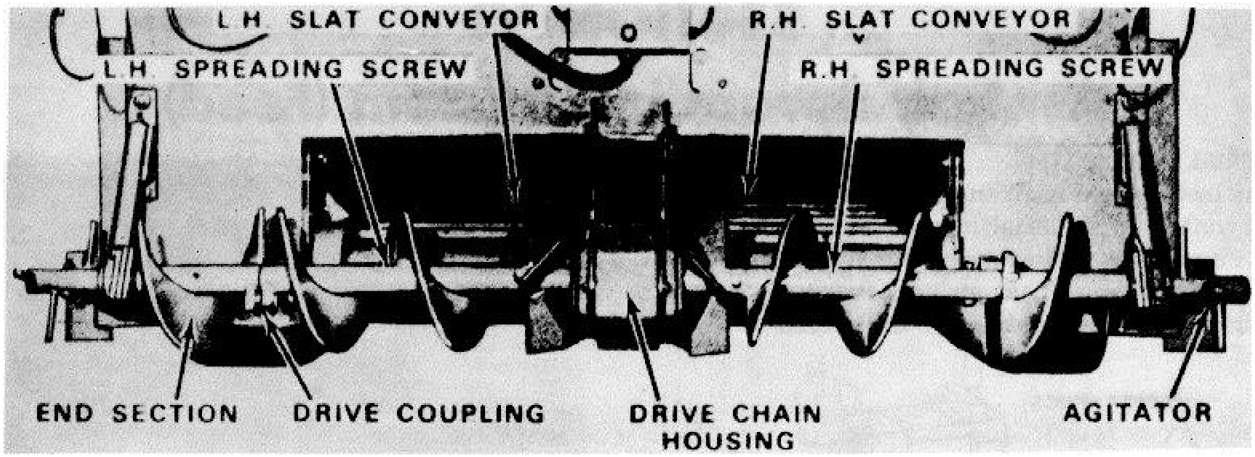


Electric Clutches - L.H. Walkway Removed
Figure 4

ASPHALT FEED CLUTCHES (Slat and Screw Conveyors)

The two slat conveyors and the two screw conveyors which combine functions to move asphalt from the hopper to the area ahead of the trailing screed, are operated by means of two electromagnetic clutches. Each clutch starts or stops the movement of one side of the feed system (Right hand or Left hand). By chain and sprocket connection, one slat conveyor and one screw conveyor operate simultaneously to feed one side. (See Figures 3 and 4) Each clutch is operated by means of a toggle switch on the operator's console, or by an auxiliary switch on the paver deck beneath the operator's seat. (The auxiliary switch is for the convenience of the screed man when he chooses to control the feed manually for some special requirement).

Complete information on the care and adjustment of electric clutches is contained in the Mechanical Maintenance Section 11)



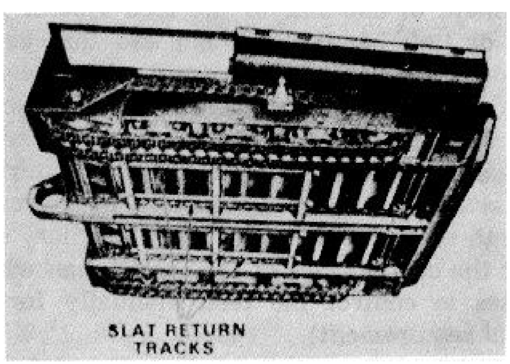
Slat Conveyors and Spreading Screws
(Screed Removed)
Figure 5

SLAT CONVEYORS

Two slat conveyors move material from the bottom of the receiving hopper through parallel tunnel areas to each of the two spreading screws which operate in conjunction with the slat conveyors. The depth of material moved is varied by manual adjustment of fixed gates located at the head end of each tunnel. (See Figure 5)

Slat speed is fixed, unless an optional two-speed transmission unit is purchased to permit a 30% speed shift when required. With the fixed speed arrangement the drive may be either the high or the low range.

Each slat conveyor and its companion spreading screw are controlled by electric clutch action. The clutches can be engaged manually by toggle switch movement at the operators console, or can be controlled automatically by a material depth feeler if the console toggle switch is set at AUTO. (See details of automatic operation in following paragraphs covering conveyors).



Bottom View of Tractor Assembly
Figure 6

IMPORTANT! The slat conveyors are built to run in only one direction. When the paver is shifted into Reverse gear for backing, a micro switch at the gear box is actuated to open the conveyor clutch circuits so that no reverse movement of the slats can occur. This limit switch (Section 8, Figure 4) **must always be** kept in adjustment!

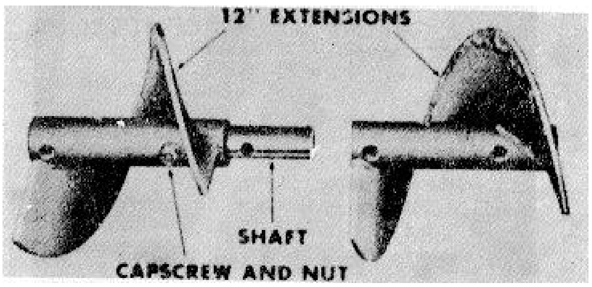
SPREADING SCREWS

The two spreading screws which operate in conjunction with the slat conveyors receive material as it is brought through the tunnel areas near the center of the tractor unit. The opposing pitch of the screw blades forces the material outward toward the ends of the screed. A set of special blades on each spreader screw at its inner end has a reverse slant which assures placement of adequate material in the center area. Agitators at the outer end of each screw perform a stirring function to prevent material compaction by the screws against the retaining blades.

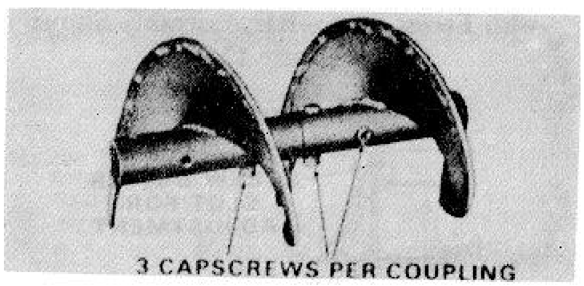
Spreader screws are offered in two diameters for different feeding rates; 12" diameter for lower volume feeding and 14" diameter for higher volume feeding. Whenever extreme wear reduces the diameter of a screw by ½ the tips should be built up or the blades refaced to the original O.D. (See Maintenance Section 11).

When less than 10 ft. wide paving is done, the end flight of the screw on the cut-off side is uncoupled by sliding a key outward. When uncoupled the outer flight no longer moves material. (See Figure 5).

When extra wide paving is done, the spreader screws must be extended to match the extensions added to the screed. Screw extensions are 12" Long (See Figure 7) and each includes a drive shaft extension for coupling purposes.



Screw Conveyor Extensions (Uncoupled)
Figure 7



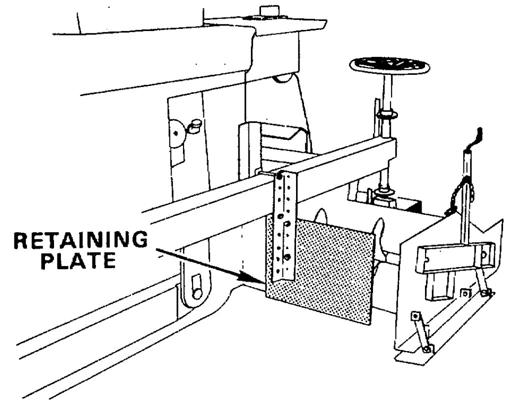
EXTENDING SPREADER SCREWS

When screed extensions are added and screws are to be extended, proceed as follows:

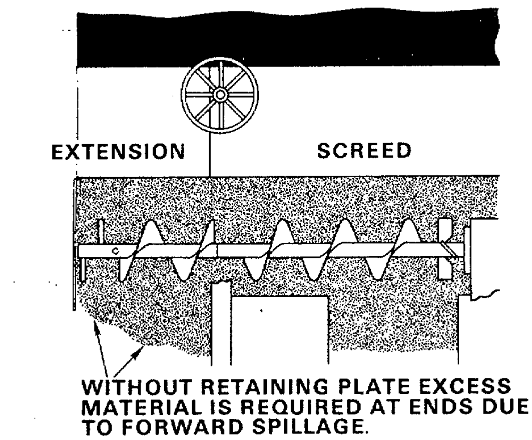
1. Remove nut and bolt which holds agitator section and slide agitator off the shaft.
2. Assemble as many screw extensions as needed. (See Figures 7 and 8).
3. Slide the socket end of the new assembly onto the drive shaft and install the bolt and nut. **Always use hardened bolts which have maximum shear strength.**
4. Install the agitator on the end of the outer extension shaft.

MATERIAL RETAINING PLATE

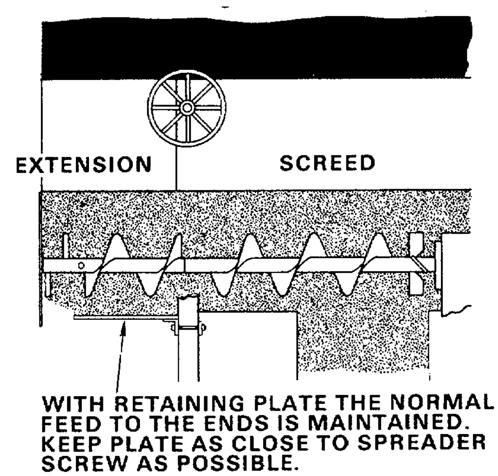
When screed extensions are added a Retaining Plate should be attached to the pull arm to prevent material from spilling forward. With the retaining plate placed as close to the screw as possible, material moves outward to the end of the screw and the material depth sensor works more effectively to keep just the right amount of material ahead of the screed. (See Figure 9).



Retaining Plate used with Screed Extension
Figure 9



Paving with Extensions - No Retaining Plate
Figure 10



Paving with Extensions and Retaining Plate
Figure 11

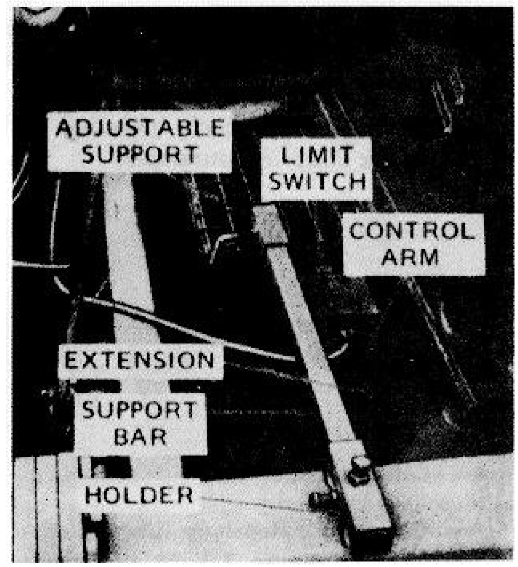
MANUAL OPERATION OF MATERIAL FEED

The two parallel but separate material feed systems are controlled by toggle switches on the operators console. These switches engage and disengage electric clutches. (See Figures 3 and 4). The switches are three position; MANUAL-OFF-AUTO. When the paver is in Forward gear with engine running each feed system combination of one slat conveyor and one screw conveyor will operate whenever the toggle switch is set to MANUAL. The **operator** must observe the feed and operate the switch to keep material ahead of the screed but not flowing over the mold board.

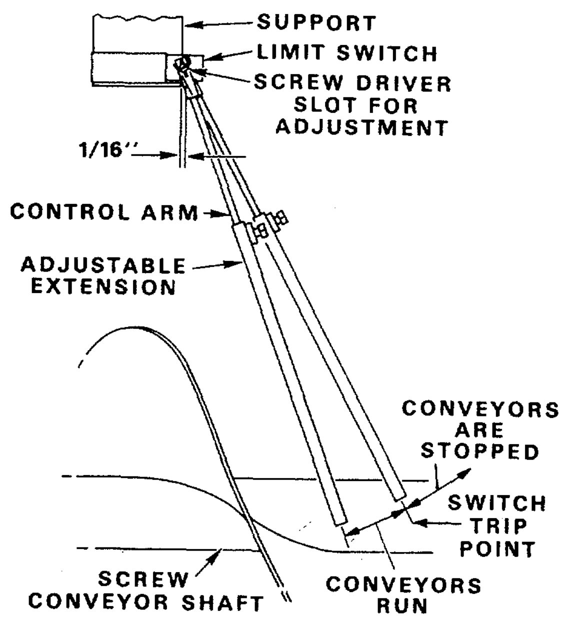
AUTOMATIC OPERATION OF MATERIAL FEED

The depth feeler assembly can be quickly set for automatic operation as follows: (See Fig. 12 & 13)

1. Loosen the control arm clamp so that it is loose on the switch shaft.
2. Lower the arm to within A" of the positive stop which keeps it from swinging farther downward. (A spacer can be used to hold the 1/16 setting).
3. Turn the switch shaft until an audible click indicates that the internal contacts have closed, then while holding that setting, tighten the clamp on the control arm.
4. Start engine and move feed switch on the console to AUTO.
5. Manually raise and lower control arm to make sure switch starts and stops conveyor at the point set.
6. To set the depth of material desired, move the Extension which is clamped to the Control Arm. When the extension is moved **closer** to the switch a **higher** level of material at that point will



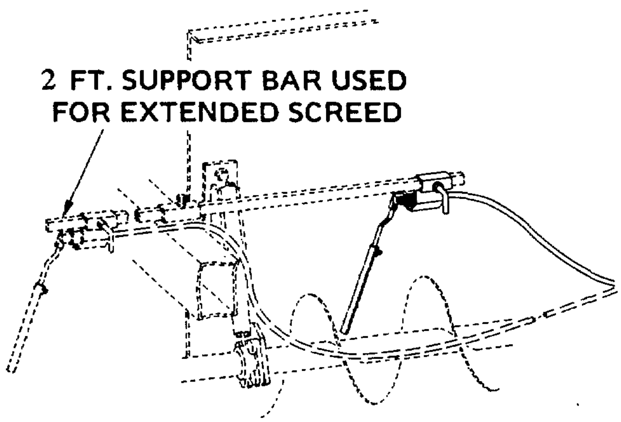
Adjustable Material Depth Control Switch with Feeler Arm - RH Assembly Shown
Figure 12



Recommended Setting Of Control Assemblies
Figure 13

be maintained. When the Extension is moved **farther** from the switch a **lower** level of material will be maintained.

IMPORTANT! This adjustment should be made during an actual paving run so that the efficiency of the setting can be tested. Different materials will require different settings of the Extension, as there is a great variation in the way materials move. **WARNING!** Do not set extensions unless the Console Feed Switch is in the OFF position.

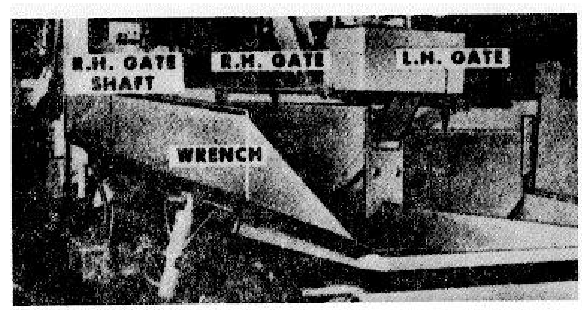


Range of Depth Feeler Switch Location
Figure 14

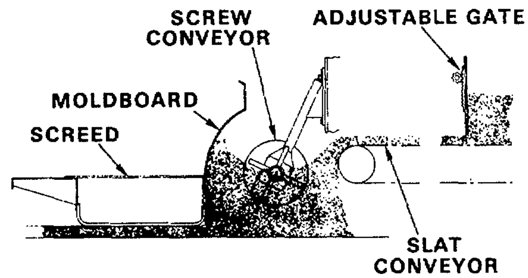
TO ADJUST HOPPER GATES

A hopper gate for each half of the material conveying system regulates the depth of material moved from the hopper to the spreader screw. The height of each gate is adjusted separately by manual turning of the gate shaft which operates a pinion gear to drive the rack attached to the gate (See Figure 15).

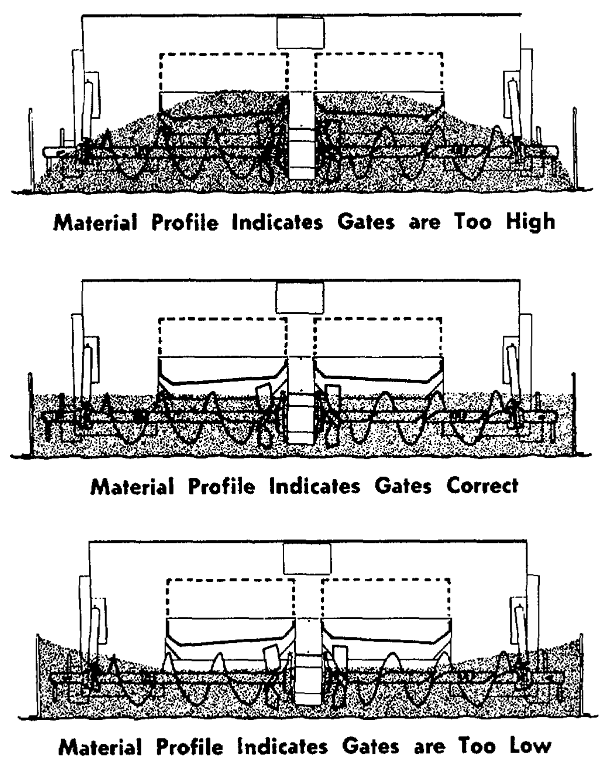
Correct adjustment of the gates is important to good paving. Best paving results are achieved when the material level is approximately even with, or slightly below the tops of the spreader screws. If material is deep near the center of the screed and there is very little near the ends, the gates are **too high**. If material is deep at the ends of the screed and there is very little near the center, the gates are **too low.** This tell-tale "material profile" is the best way for an operator to judge the gate settings. (See Figure 17). Usually a lower gate setting will produce a smoother run than too high a gate setting.



Adjusting RH Hopper Gate Height
Figure 15



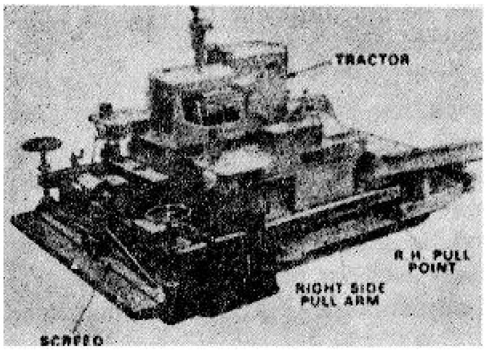
Schematic Side View Of Material Feed System
Figure 16



Comparison Of Gate Height To Material Feed
Figure 17

SECTION VII

Screed System

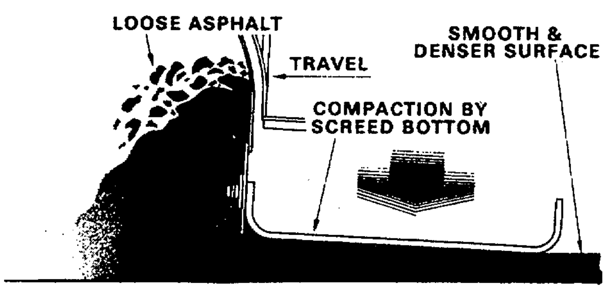


Floating Screed Assembly
Figure 1

SCREED PRINCIPAL

The screed is a free floating attachment to the paver which strikes-off and smooths the fresh asphalt after it is spread by the screws. It is attached to the tractor unit by means of two pull arms which are free to pivot at the pull points located close to the forward end of the tractor. (See Figure 1).

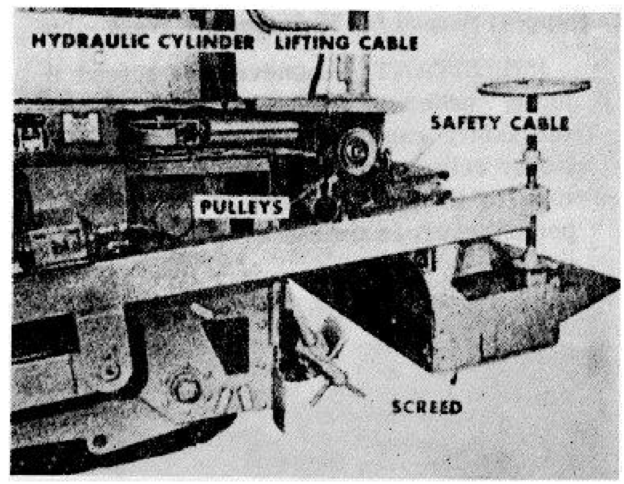
The height of the two pull-points for the screed, and the angle of the screed bottom in relation to the pull arms, are the factors which control the amount of asphalt deposited on a roadway. The handwheels at the ends of the screed which change the angle of "screed bottom to pull arm," are the operator's means of making adjustments of asphalt deposit (mat thickness) whenever necessary.



Cross-section thru Screed and Material
Figure 2

The screed is equipped with electric vibrators which help to obtain the initial compaction of the fresh mat. It is also equipped with a heater which is capable of bringing the temperature of the screed up to the temperature of the asphalt supply prior to paving start-up. When the screed is pre-heated, asphalt does not stick to the metal as the first strike-off and smoothing begins.

The flat screed bottom can be bent at its midpoint so that the single plane becomes two connected planes which can be adjusted into a slight V-shape or into a slight inverted-V (^) shape. Such adjustment produces a positive (^) or a negative (V) crowning contour on the mat for the specified water drainage requirement. The contour adjustment linkage is called the crown adjustment. (See Figure 9)



Cut-away View - L.H. Screed Lift Cylinder
Figure 3

RAISING AND LOWERING SCREED

The raising and lowering of the screed is accomplished by two double acting hydraulic cylinders connected to the screed by cable and pulley arrangement (See Figure 3). Cylinder movement is controlled by a toggle switch on the console which operates a hydraulic system flow control valve.

When the engine is at full throttle and the console toggle switch is moved to UP, the screed will be raised to its maximum elevation. When the switch is moved to DOWN the screed will slowly descend to the ground. The rate of descent is limited by a flow valve so that the screed will not sustain damage and personnel in the area will not be endangered.

When the toggle switch i. in the central position the existing screed elevation is held by a hydraulic holding valve.

To Support Screed for Travel

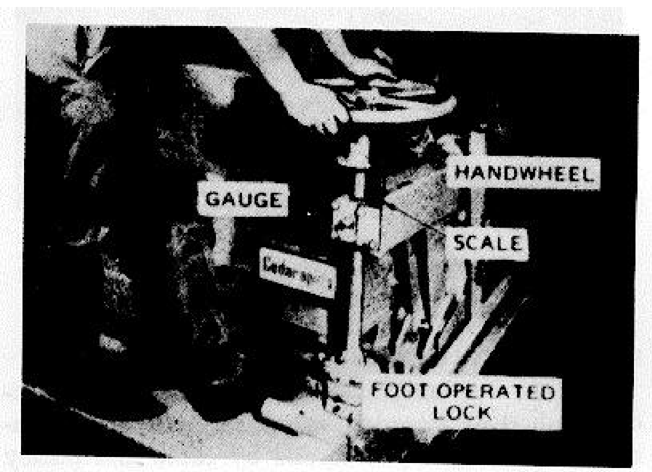
1. Short Distance Travel - The screed lift hydraulic system includes a locking or holding valve which will maintain any screed elevation established by the operator with a centering of the console switch toggle. The paver can travel short distances safely with the screed hydraulically "held" in the raised position.

2. Long Distance Travel - Safety cables are provided for long distance travel. It is recommended that for **all** travel other than short on-the-job paver movement, the safety cables be attached to the support hooks.

To hook the cables, raise screed to upper limit until cables can be hooked. Then lower screed until slack can be observed in both lifting cables.

To Support Screed for Maintenance Work

IMPORTANT! Whenever the screed is to be worked-on while it is elevated, **use the safety cables to support its weight.** Never rely upon the hydraulic lock feature to keep the screed elevated when personnel are in the screed area.



Making Mat Thickness Adjustment - R.H. Side
Figure 4

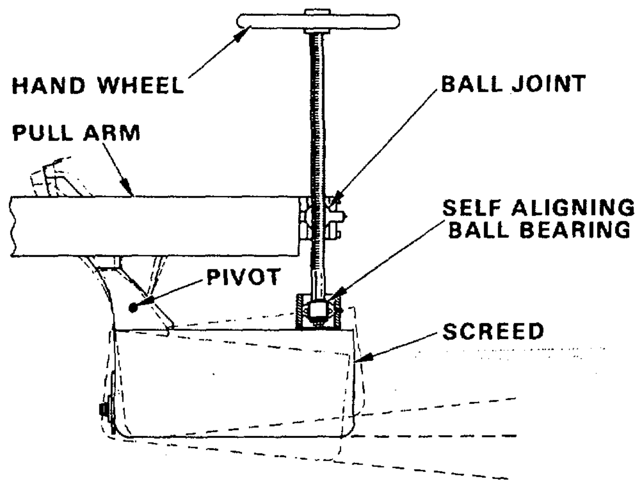
MAT THICKNESS CONTROL (MANUAL)

The thickness of the material deposit or mat left by the paver is determined by two factors;

(1) The height of the screed pull points on the tractor unit.

(2) The screed angle in relation to the pull arm. **The screed angle adjustment, made by turning the handwheel at each end of the screed, is the intended manual control of mat thickness during a paving run.** When the handwheels are turned to force the rear edge of the screed downward, a thicker mat is produced. When the rear edge of the screed is raised, a thinner mat is produced. (See Figures 4 and 5) Mat thickness at each end of the screed is controlled independently so that a tapered mat can be laid in order to level or to super-elevate a roadway.

The pull point height adjustment is made prior to the paving job start-up when the normal mat thickness for that job has been established. (A Table of pull point heights recommended for various mat thickness is shown in following paragraphs). It should be noted that a difference in materials used for paving will have a great affect on all adjustments of pull points and handwheels.



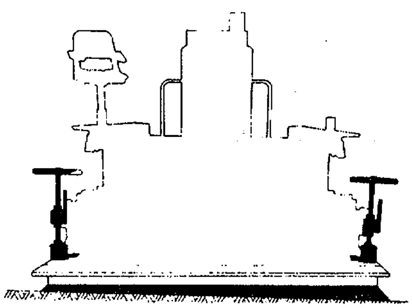
Effect of Handwheel Adjustment on Screed
Figure 5

A foot operated lock keeps the handwheel adjustment fixed. The operator must step on the pedal and release the lock before the handwheel can be turned. When released the lock engages automatically.

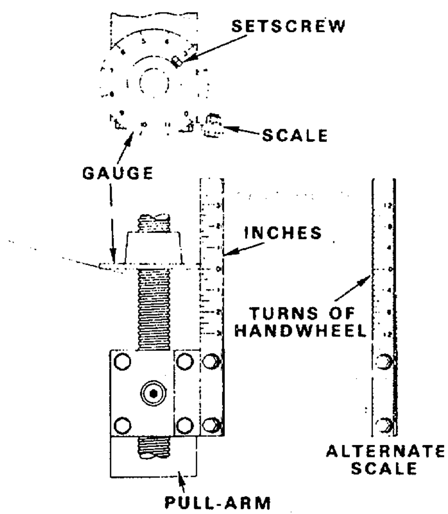
Each end of the long screed can be adjusted so that the mat thickness is far from equal when measured at each edge. (See Figure 6)

HANDWHEEL GAUGE AND SCALE

A gauge and scale on each handwheel screw serve as a **reference** for the operator. The vertical scale, graduated in inches, is fixed to the pull arm. The disc type gauge is held in place on the handwheel screw by means of a setscrew and can be moved up or down, to establish the desired reference. It is marked to show 12 equal divisions of one complete turn. (See Figure 7)



Handwheels Set to Level Inclined Roadway
Figure 6



Handwheels Set to Level Inclined Roadway
Figure 6

The scale is graduated vertically from a central zero marking. The graduations may be in inches, with increments of 1/4¼", 3" each way from the zero, so that the total range is 6". Or the graduations may be in turns of the handwheel, with increments of 1 turn, 12 turns each way from zero, so that the total range is 24 turns.

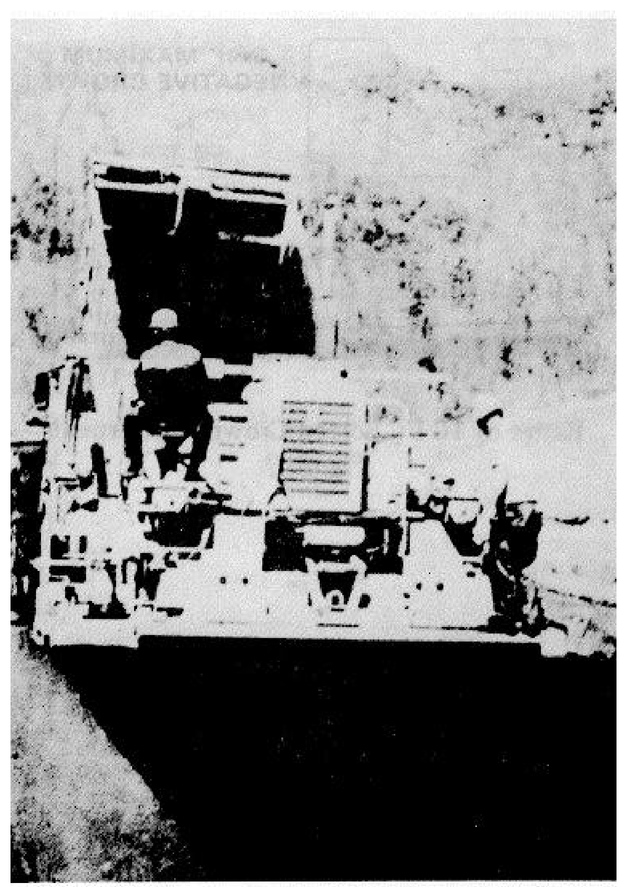
The disc-like gauge which is attached to the handwheel screw has 12 equally space markings which can be indexed from the edge of the vertical scale to show the division of 1 turn.

The scale reading is taken by holding a small straight edge upward against the bottom of the gauge disc and across the scale face.

When an operator has established the best hand wheel setting for paving a specific thickness with a specific material, he will zero the two gauge and scale readings then tighten the gauge setscrews. He then makes a record of the conditions and gauge settings for future reference. Whenever a new paving job is to be started, or when an extensive thickness change is to be made on a job, the operator can adjust the handwheels to the reference marks and start-off very close to the mat thickness desired, if he has recorded reference close to the new requirement. Without a reference he must guess at the setting and make corrections on the first several feet of the new mat. Eventually an operator's reference record will cover most of the common mat thicknesses and types of material used

Change of material specifications will usually cause a different screed behavior and a different handwheel setting, even though the mat thickness is a common one.

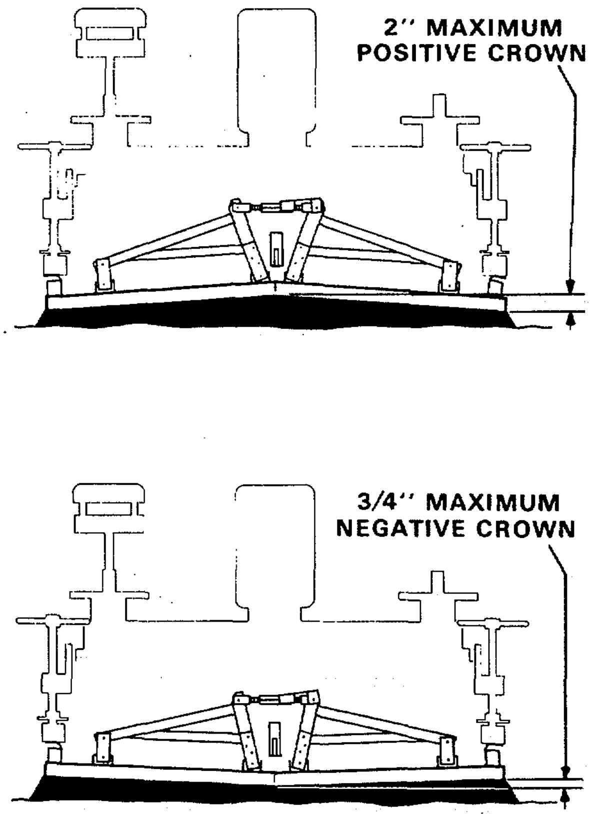
To obtain a smooth mat, the screed adjustment controls should be gradually changed, one notch at a time, and the **screed should travel a few feet before an additional adjustment is made.** This will allow the screed the proper distance of travel required to seek the new level of operation.



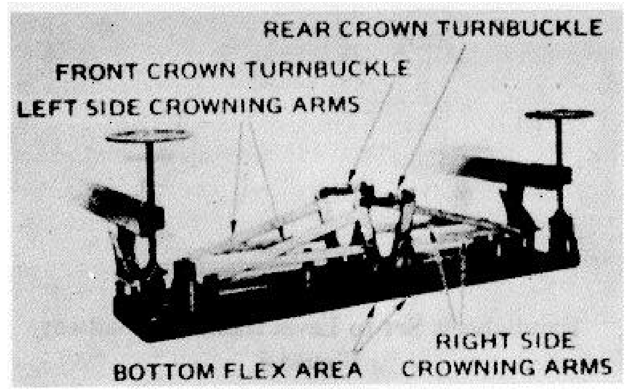
Screed Man Making Handwheel Adjustment
Figure 8

MAT CROWN ADJUSTMENT

The flat screed bottom can be flexed as its center area to produce a finished mat having a positive or negative crown for water drainage. (See Figure 10) For 10 ft. wide paving the maximum positive crown is 2". The maximum negative crown is 3/4".



Screed Bottom with Crowning Arms
Figure 9

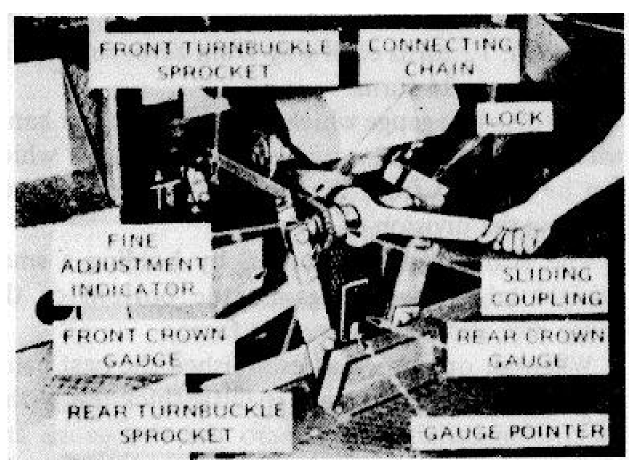


Screed Bottom with Crowning Arms
Figure 10

Crown adjustment is accomplished by means of four crowning arms which are located on top of the screed but are bolted to the screed bottom. A turn buckle adjustment joining each pair of crowning arms permits screed bottom flexing in either direction. A separate adjustment is made for the leading edge and for the trailing edge, so that the "lead" crown is slightly higher than the trailing or "finish" crown. As material moves under the screed during paving this differential between crowns increases the density of the surface and imparts a smooth texture.

> **NOTE**: The crown adjustment is one of the more important adjustments on the paver. **Mat imperfections can often** be **corrected by changing the adjustment of the lead crown!**

Two gauges on the screed provide a crown referencing ability for the operator. A more accurate fine-adjustment gauge is located on the rear crown turnbuckle screw. (See Figure 11).



Crown Adjustment Gauges
Figure 11

START-UP ADJUSTMENT

The initial crown adjustments should be made when the screed is on the wood blocks at the starting point and has been **heated** to paving temperature. Stretch a taut string line between the ends of the hot screed at both front and rear edges. Adjust the crown turnbuckles (Figures 10 and 11) alternately a little at a time and use a ruler to measure the distance from the exact center of the screed bottom to the taut string line. Use the front and rear gauges as rough references only! Set the front crown 1/16" higher than the specified rear crown to start the paving.

FINAL ADJUSTMENT

The final crown adjustment is made when the paving has been started and the actual mat crown can be accurately checked by taut string line. The front crown can be varied slightly in order to obtain the very best mat surface. **The front crown will always be higher than the rear crown. The final adjustment is always made after checking the actual asphalt mat when enough has been laid to be certain the screed has stabilized.**

The lead crown is normally 1/16" above the finish crown.

If any change is made in the final (trailing edge) crown adjustment the front (leading edge) crown setting must be made simultaneously to maintain the 1/16" differential.

The Dual Adjustment Assembly, which links the two turnbuckles by the chain and sprocket method permits separate or simultaneous adjustment of the two crown settings.

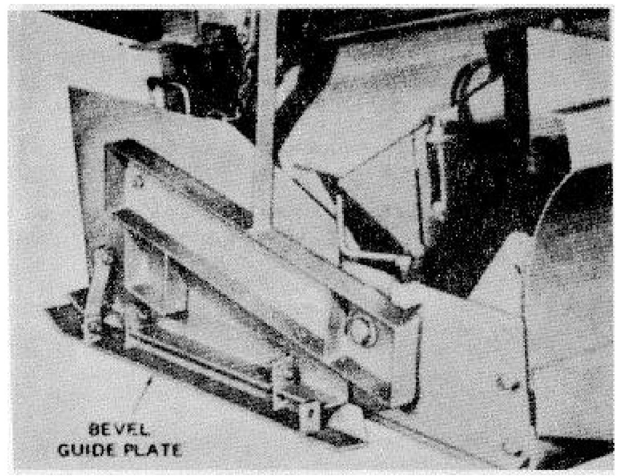
If only one crown needs adjusting, the coupling of the assembly can be disengaged from the sprocket so that each crown turnbuckle can be adjusted separately. (See Figure 11)

Two gauges on the screen provide a crown referencing ability for the operator. An indicator on the rear turnbuckle shaft also provides means of determining fine adjustments. (See Figure 11)

INSTALLING ATTACHMENTS

Side Plates (Refer to Figures 12 thru 1 5)

A side plate assembly is attached to each end of the screed to limit the movement pf material. These plates (A) are bolted to a support arm (B) attached to the screed. Both parts can move in parallel planes so that when desirable, the side plate can rest upon

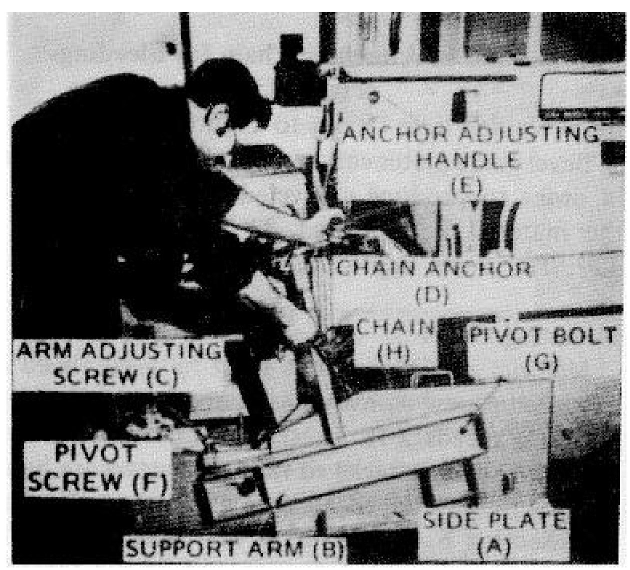


Screed Side Plate & Bevel Guide Plate
Figure 12

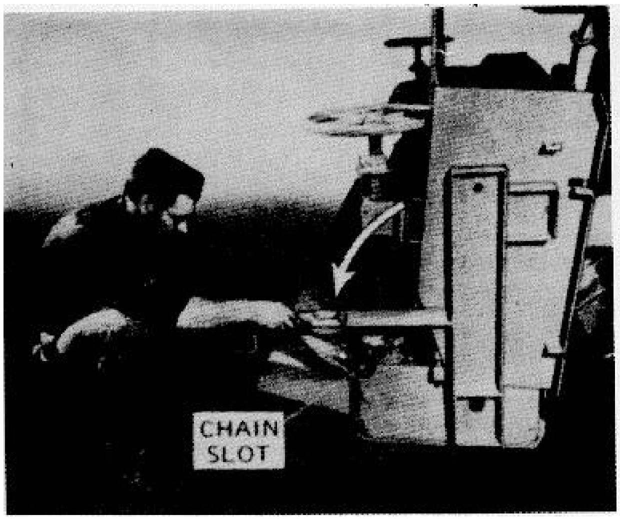
and follow the contour of the base surface. If the operator wishes to restrict the downward movement of the plate, he adjusts the screw (C) which limits the travel of the support arm, and adjusts the chain (H) or chain anchor handle (E).

When bleeding material to the outside, the side plate is raised until the end of the support arm passes over center. The chain is hooked to the screed end plate to hold the assembly in the elevated position. (See Figures 14 & 15)

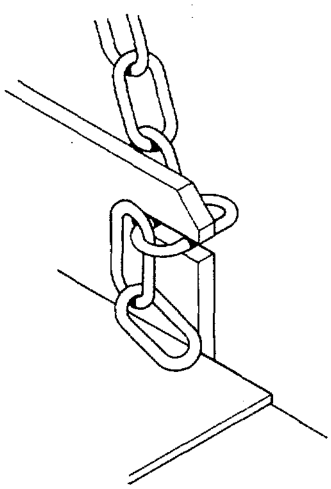
When the screed is to be raised, the support-arm adjusting screws (C) should be adjusted to hold the side plates in line with the screed bottom. The chain (H) is adjusted so that the rear end of the side plate cannot drop downward as the screed is raised.



Adjusting Side Plate Chain Anchor
Figure 13



Swinging Side Plate to Vertical Position & Anchoring to Permit Material Bleeding
Figure 14



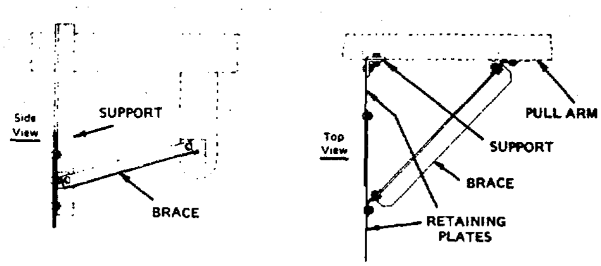
Method of Attaching Chain for Bleeding
Figure 15

Bevel Guide Plates (Refer to Figure 12)

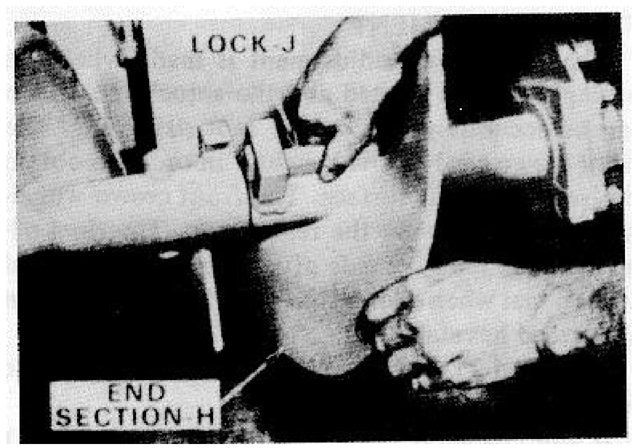
Bevel guide plates can be bolted to the side plates in order to produce a beveled edge on the mat as the material is deposited. The degree of bevel is 4$^{50°}$. The bevel depths available are 1½/2" and 3".

Retaining Plates

Material retaining plates must be used ahead of extended screw conveyors whenever the mat extension exceeds 2 ft. These plates prevent the forward spread of material so that the screws are handling a uniform depth all the way out to the ends (See Section 6, Figures 10 & 11). When up to 4 ft. of extension is added to one end of the screed a retaining plate support angle is attached to the screed pull arm and when the number of plates ex-



Typical 36” Retaining Plate Arrangement
Figure 16



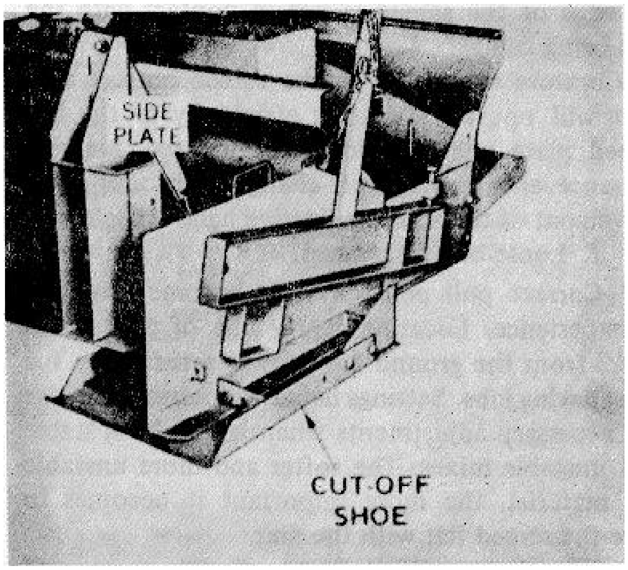
Disengaging Coupling to Stop Screw End Section
Figure 17

ceeds two, an extra brace is added. (See Figure 16).

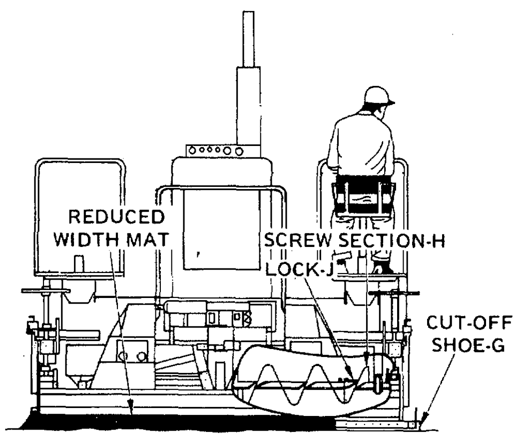
Cut-off Shoes (Refer to Figure 18)

Standard cut-off shoes which fit the paver extensions reduce the paving width in varying amounts in 112" increments, down to the minimum of 10 ft. They slide under the side plates and are bolted in place. Bolt holes are spaced 1 /2" apart.

(1) To install cut-off shoe, block up screed to shoeheight.
(2) Raise side plate and slide cut-off shoe "G" under screed as much as required for desired mat width reduction. (See Figure 19)
(3) Bolt cut-off shoe to side plate. (Shoe fits either end of screed.)
(4) Release lock (J) on spreader screw to allow tip screw section (H) to become idle. To prevent material from being fed onto the top of the cut-off shoe and spilling onto the road base, fashion pieces



Cut-Off Shoe Installed on L.H. Side Plate
Figure 18



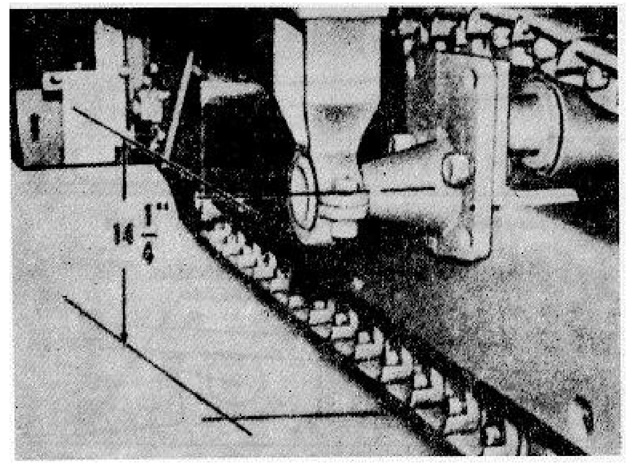
Laying Reduced Width Mat Using
Cut-off Shoe
Figure 19

of wood to block off that area between screed moldboard and the tractor.

IMPORTANT NOTE! Always remove cut-off shoe before raising screed.

SCREED PULL ARM POSITIONS

The long screed pull arms which are attached to the crawler frame with a ball-joint connection provide maximum floating action, allowing screed to



Screed Pull-point Height Adjustment
Figure 20

Typical pull point settings:	
Distance from base	**Mat Depth**
16 3/4" (High)	31/2" or thicker
14 1/4" (Normal)	1/2" to 3 1/2" inclusive
13" (Low)	Minimum to 1 1/2"
10 1/2" (Lowest)	Minimum to 3/4" (optional)

minimize irregularities found in the grade or base material.

1. The screed pull-arms. can be raised or lowered by moving the ball-joint connection up or down or by rotating it and lining up bolt holes. With the usual type of material and mat thickness encountered, the distance of 141/¼ inches from center of joint to the ground, as shown in Figure 20 and the chart following it.

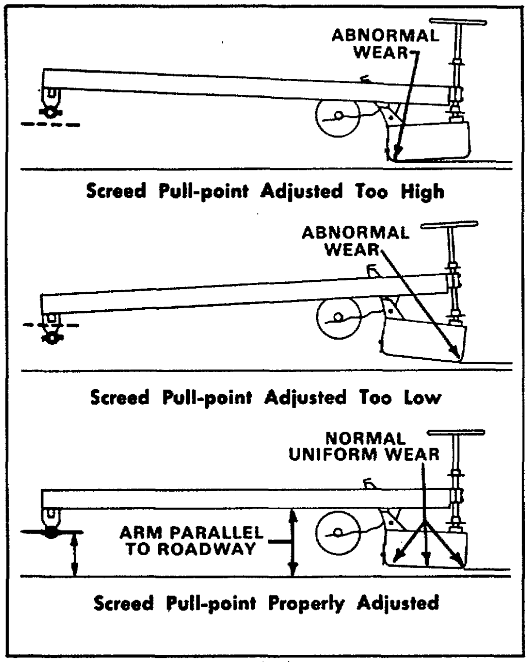
In nearly all types of material, the straighter the pull on the screed, the more satisfactory it will operate. The most critical settings are with low stability sandy mixes.

2. If the screed tends to sink and ride on the trailing edge, due to unstable mix, or if a very thick mat is required, the long screed pull arms can be raised to improve the mat.

3. When the paver is required to lay a very thin mat, the screed pull arms can be lowered to give the screed better flotation and more initial density to the mat.

4. Two bolts in each ball-joint connection are sufficient for all positions.

5. When the pull points are too low and the **front of the screed is tilted up,** in order to maintain the correct mat thickness, the following wear and op-



Effect of Pull-point Height on Screed Wear
Figure 21

erational difficulties will be encountered.

a. Premature wear on the trailing edge of the the screed.

b. A tendency for the screed to climb each time the paver starts with normal hand wheel setting. Poor control of mat thickness will exist and good transverse joints will be difficult' to make.

c. Possible tearing of the mat because of excessive ironing effect of the screed.

d. Loose or worn screed.

6. When the pull points are too high and the front of the screed is tilted down, in order to maintain the correct mat thickness, the following wear and operational difficulties will be encountered.

a. Premature wear on the leading edge of screed and possibly deformation of the strike-offs because of the excessive pressures exerted against it when operating in this manner.

b. Bumpy, wavy road caused by the screed riding on its leading edge.

c. Tendency for screed to dip each time the paver starts with normal hand wheel setting.

d. Tearing the mat, caused by the "digging in" action of screed.

e. Loss of compaction will result as the trailing edge of the screed is not in contact with the mat being laid.

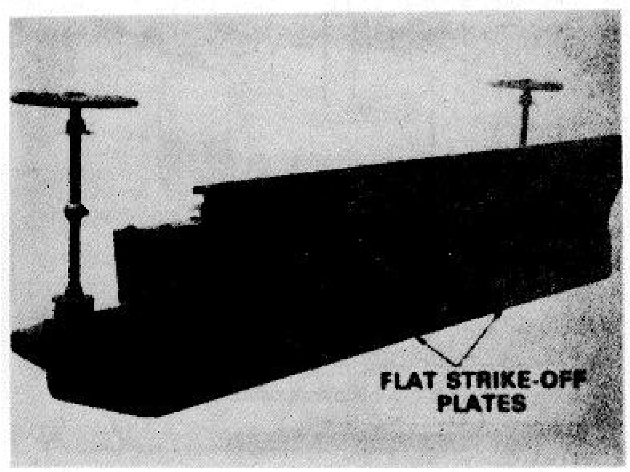
Vibrators connected to the screed bottom support will not be operating efficiently as the full screed plate width is not being utilized. Mat appearance and texture will change with only slight movement of the screed adjusting hand wheels.

f. Loose or worn screed.

7. Correct pull point settings become a matter of experience. Locating center line of pull points **14 1/4" from the ground** has **proven satisfactory for most paving jobs.** Settings listed will normally cover the necessary adjustments when laying both stable and unstable mixes. The softer and more unstable the material, the more important it becomes to have the screed flat with the mat.

NOTE: Unstable mixes can be caused by too much asphalt in the mix, poor gradation, poor quality asphalt, excessive temperature, moisture in the material and insufficient dust.

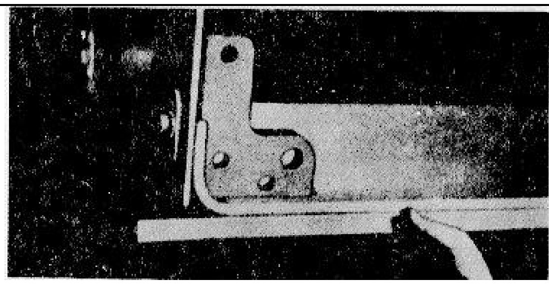
IMPORTANT: Both pull points must be located equal distance from the ground.



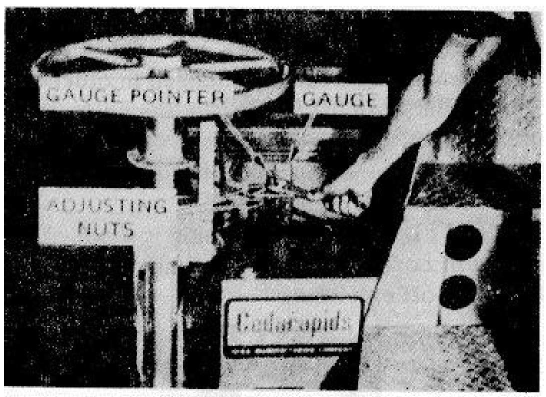
Flat Strike-off Installed on Screed
Figure 22

STRIKE-OFF

The strike-off located ahead of the screed plate, is a metering, pre-compactor, and pre-screeding device, that when properly positioned provides the exact amount of material to the screed. It also absorbs wear which would otherwise take place on the leading edge of the screed bottom. If this strike-off is not properly adjusted and maintained, it can cause operational difficulties.



Checking Height of Flat Strike-off
Figure 23



Adjusting Height of Strike-off
Figure 24

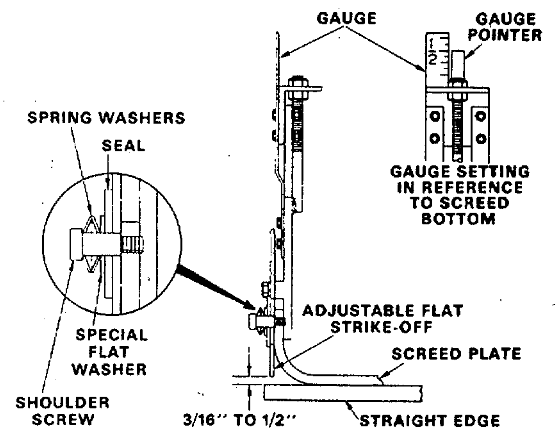
ZEROING AND ADJUSTING STRIKE-OFFS

1. After strike-offs are properly assembled to sereed. lower strike-offs until flush with screed bottom. Use the template straight edge to check position of strike-offs. See Figure 23.

2. Then, adjust gauges to "0" setting with gauge pointers.

3. Raise strike-offs above screed bottom according to the chart. (Shown below.) Make the final adjustment for the mat texture while paving. **Never lower strike-offs below screed bottom. Important! Always make strike-off adjustments when screed and asphalt are hot. If the asphalt is cold, adjusting bolts and brackets will bend before the strike-off moves and the entire adjustment assembly is damaged.**

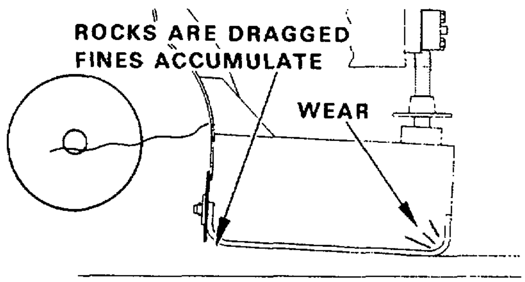
4. Whenever strike-offs are to be re-adjusted, it is best to lower both sides, then use the top adjusting nut at each of the four adjustment points to pull the strike-offs up to the desired gauge readings. This is a uniform movement of the strike-offs and



Cross-section - Flat Strike-off Assembly
Figure 25

Height of Flat Strike-off	Characteristics of Asphalt
"+1/16" 1/4" - 0"	Standard (Normal Mat Conditions) Aggregate Size; Sand to 1" Minus Aggregate Mat Thickness: 1¼" to Maximum Thickness
3/16" + 1/16"	Alternate (Fines Materials with Thin Mat) Aggregate Size: Fines to 1/4" minus sand Mat Thickness: Minimum 1/2" to 1" mat
3/8" + 1/8" 3/8" __- 1/16"	**Alternate (Coarse Materials with Thick Mat) *Aggregate Size: 1" minus 1½" maximum Recommended Mat Thickness: 2" to maximum thickness

*Pavers have laid top size material of 3" minus, however accelerated wear can be expected.
**Only if tearing due to flats in aggregate. With flat plate strike-off it is possible to raise to 1½",therefore, no strike-off effect.



Flat Strike-off Adjusted Too Low

Flat Strike-off Adjusted Too Low

Figure 26

RESULTS OF IMPROPER STRIKE-OFF

When the strike-offs are too low the following wear and operational difficulties will be encountered. (See Figure 26).

1. Insufficient amount of material will be metered to the screed. Therefore, in order to maintain mat thickness, it is necessary to tip the front of the screed up. Continued operation of the screed in this manner may cause wear on the trailing edge of the screed.

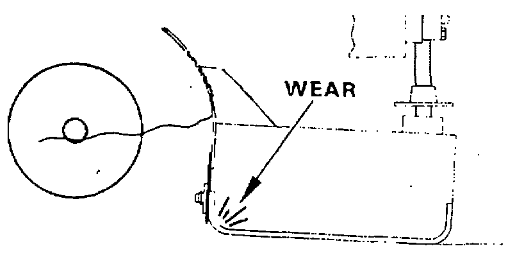
2. Fines will collect at the front edge of the screed directly behind the strike-offs which will build up and cause tearing and voids in the mat. The strike-off will frequently catch and drag large stone, with the result that a streak is made in the mat. When this occurs often, stop paving, raise the strike-off, and try again.

When the strike-offs are too high the following wear and operational difficulties will be encountered. (See Figure 27).

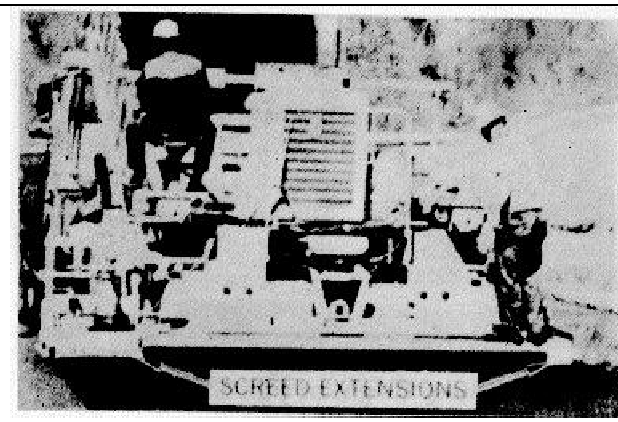
1. Too much material will be metered to the screed. Therefore, in order to maintain a relatively thin mat thickness, it is necessary to tip the front of the screed down with the hand wheel adjustments. With the screed in this position for any length of time, rapid wear on the leading edge of the screed will occur.

2. Poor mat textures and low compaction of the mat will prevail under these conditions.

3. Erratic control of the screed will be noticeable when making minor adjustments.



Flat Strike -off Adjusted Too High
Figure 27

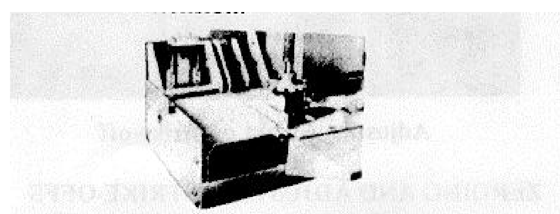


Paving With Extended Screed
Figure 28

EXTENSION OF SCREED

The screed length can be extended in order to lay a mat wider than 10 ft. Mat widths up to and including 20 ft. can be laid. Screed extensions come in various widths and can be attached to either end of the screed.

Each 6", 12" and 24" extension is supplied complete with cover, moldboard extension, and adjustable strike-off extension.



12 Inch Extension On LH End Of Screed
Figure 29

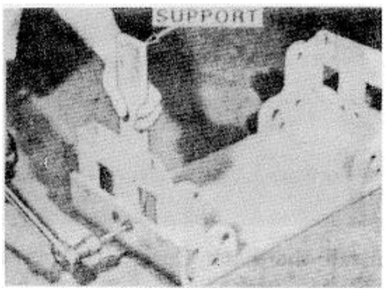
All parts of the extension are shipped loose and must be assembled in the field. Some careful work is required to align each extension bottom to the screed bottom, the moldboard extension to the moldboard, and the strike-off plate extension to the strike-off plate.

A double set of shim packs is supplied with each extension so that an adjusted shim pack can be kept inside the extension at its proper corner location. (See Figure 30). **The lengthy job of fitting the extension bottom to the screed bottom need not be repeated each time the extensions are installed.** Re-installation of the two correct shim packs will quickly restore alignment and no time is lost. The moldboard shims can also be attached at their respective locations to save time aligning the extension moldboard.

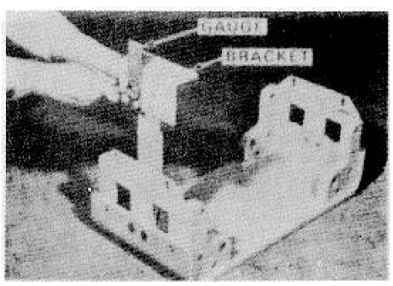
A step by step procedure for assembly and installation of an extension is shown on the following pages.

ASSEMBLY OF SCREED EXTENSION

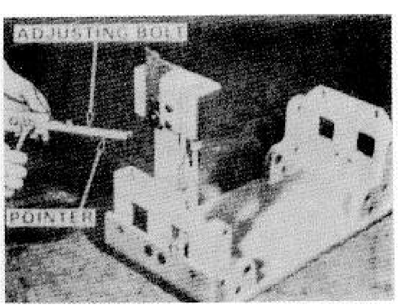
1. Run a ½" NC tap through the screw holes for strike-off plate to clean out paint and dirt.
(The special screws are not locally available.)



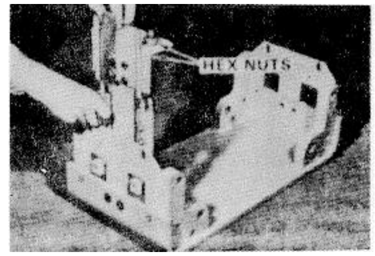
2. Install the Support. Tighten the two flat-head
* socket screws.



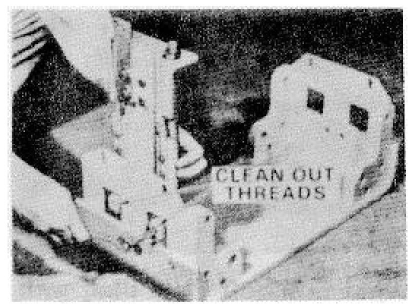
3. Install the Bracket and the Height Gauge.



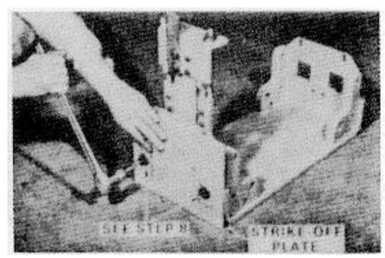
4. Install a Gauge Pointer on each of the two Adjusting Bolts.



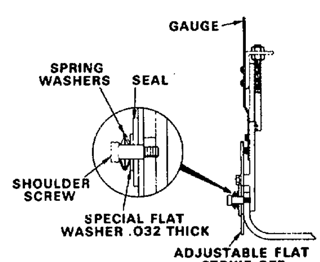
5. Install the two Adjusting Bolt assemblies using
* a hex nut above the bracket and one below.



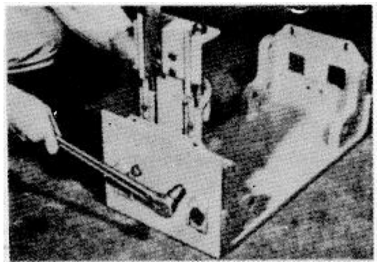
6. Run a ½/2" NC tap through the screw hole in each Adjusting Bolt assembly to clean out paint and dirt.



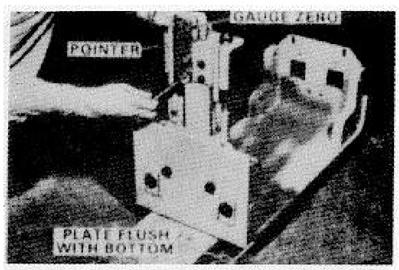
7. Install the Strike-Off Plate using all of the special parts shown in Illustration 8, arranged exactly as shown! Tighten Shoulder Screws.



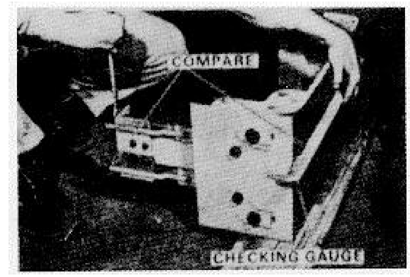
8. Arrange the Seal and the three Washers on each Shoulder Screw as shown above



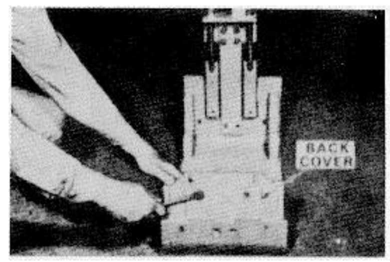
9. Install the capscrews which attach the Strike-
* off Plate to the Adjusting Bolts. Tighten the screws.



10. Adjust Strike-off Plate flush with screed extension bottom, then adjust Gauge zero (0) even with top of Pointer.

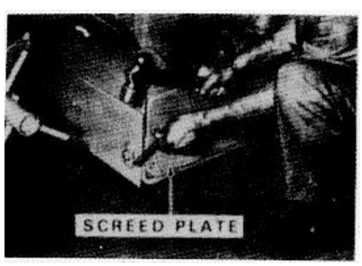


11. Use gauge tool to check accuracy of Gauge and Pointer read-out when strike-off plate is raised.

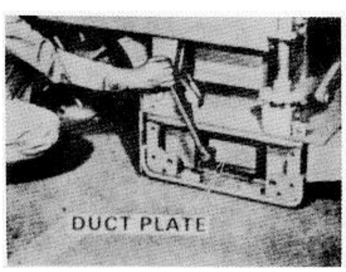


12. Install the Back Cover. Tighten the screws.

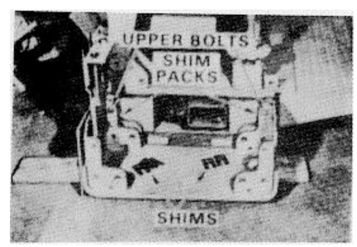
INSTALLATION OF SCREED EXTENSION



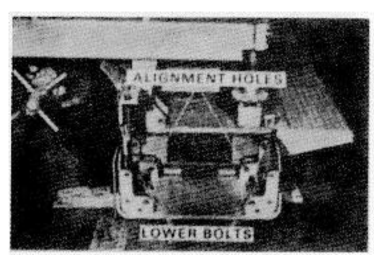
1. Remove Screed Plate.



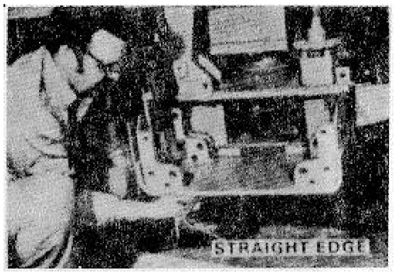
2. Remove Plate from heat duct.



3. Set extension with bottom tight against **and** nearly flush with screed bottom. Make up approximate shim packs for top bolts.

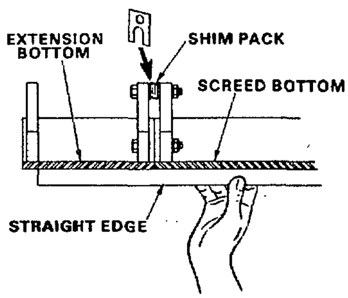


4 Install the four bolts in the lower positions.
* Draw up a loose tension. (finger tightness)

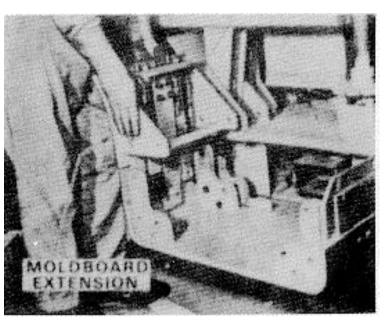


5 Suspend screed on its safety cables. Check across the two bottom surfaces with straight edge to align flush.

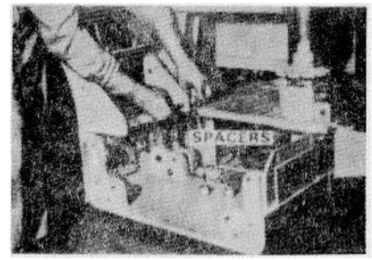
6. Adjust the two shim packs to align the bottom surfaces and draw all six bolts very tight. Recheck alignment.



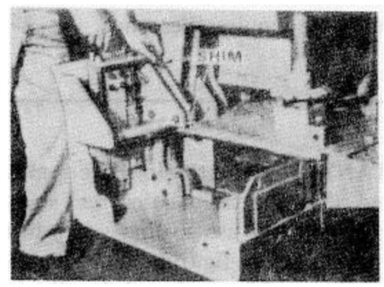
7. Re-check alignment.



8 Fit Moldboard Extension into place between strike-off plate and extension.

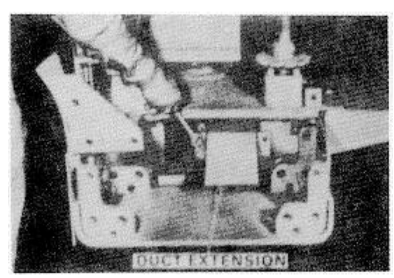


9. Install bolts and tubular spacers.

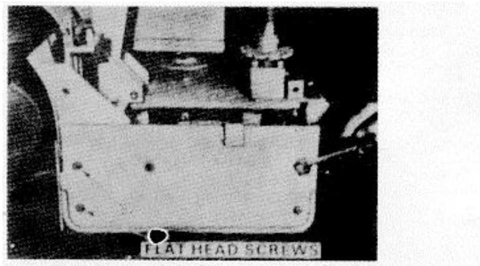


10. Add shims at all top bolt positions as necessary * to align the moldboard and the moldboard extension. Tighten all three bolts.

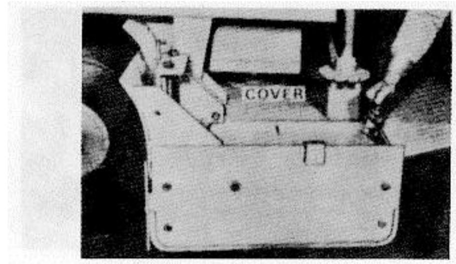
11. Use a straight edge and adjust the extention strike-off plate exactly in line with the adjacent strike-off plate



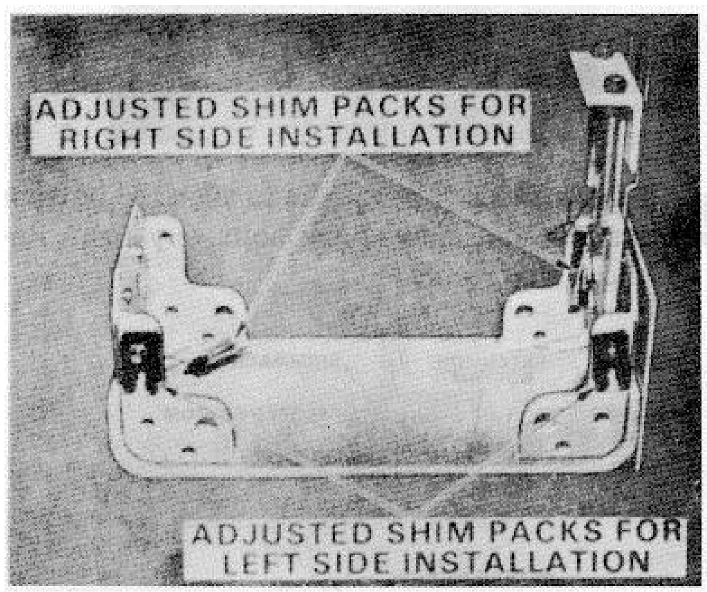
12 Install the Heat Duct Deflector whenever an extension longer than 1 foot is added. For 1 foot extension leave duct cover plate off.



13. Install screed plate. Use hex head screws at rear and flat head screws at front, where the side plate requires clearance



14. Install the extension cover

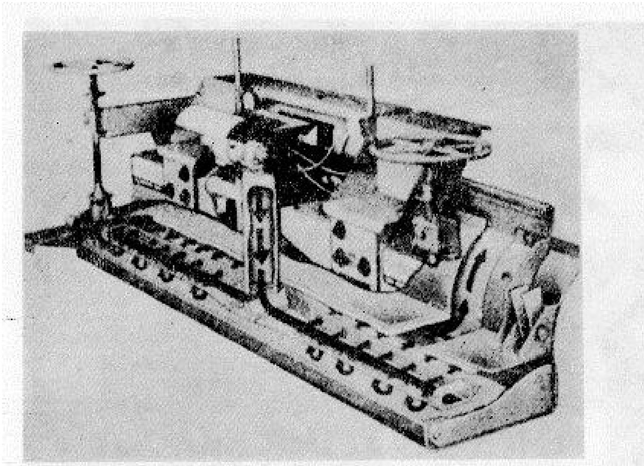


Extension With Adjusted Shim Packs Attached
Figure 30

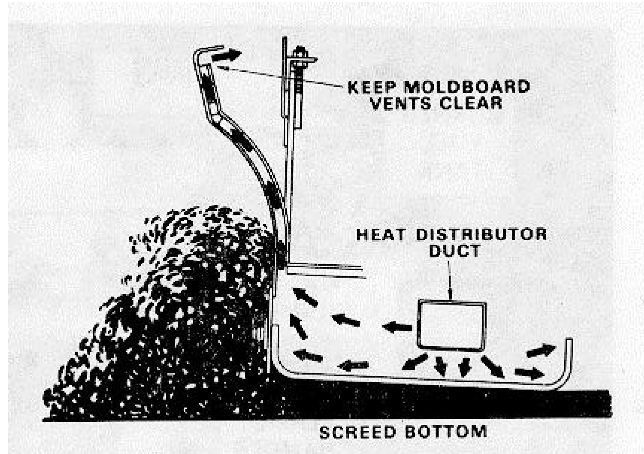
IMPORTANT! When extensions are removed from the screed always attach the correct shim pack at the correct point of use so that you will nlot have to delay the job by re-figuring the two packs. **Merely use the former shim pack** and **the** alignment **will be correct.** (See Figure 30).

When more than one extension is used at one end of the screed, **be sure** to mark each extension for re-installation in the same order as before. Mark the extension attached to the screed as No. 1, the second from the screed, No. 2, etc. This will keep the adjusted shim packs correct for straight bottom alignment.

The bottom of an **outer** extension should be checked for wear frequently particularly when over lap paving is done. An extension is **always recommended** for use at the point of overlap so that the short length of bottom section will absorb the extra wearing tendency of the overlap operation.



Cut-away Of Screed Showing Heating System
Figure 31



Cross-section Showing Heat Flow Thru Screed
Figure 32

SCREED HEATER

The fuel oil or LP gas fired screed heating system is switch operated at the burner unit. Fuel ignition is automatic and fan operation is continuous. The fan forces the hot fumes of combustion downward through the flame chamber and into a distributor duct which extends to each end of the screed. The heat passes across the entire screed bottom surface, then travels upward through the curved hollow moldboard assembly to vents along its upper edge.(See Figures 31 and 32).

The main purpose of the heater is to raise the temperature of a cold screed to approximately 3000 F. before first contact with the hot asphalt mix. This assures a non-sticking flow of material along the moldboard and screed bottom and imparts a smoother more uniform mat surface texture. When paving begins the heater is usually shut off, as the hot asphalt material will normally maintain the proper screed temperature.

If material delivered to the paver hopper has cooled too much, the surface texture of the mat may be improved by running the screed heater. The excessive cooling of material may be caused by delays in hauling, however, if the material was dumped into the truck at too low a temperature a correction must be made at the mixing plant to restore efficient production of a high quality mat.

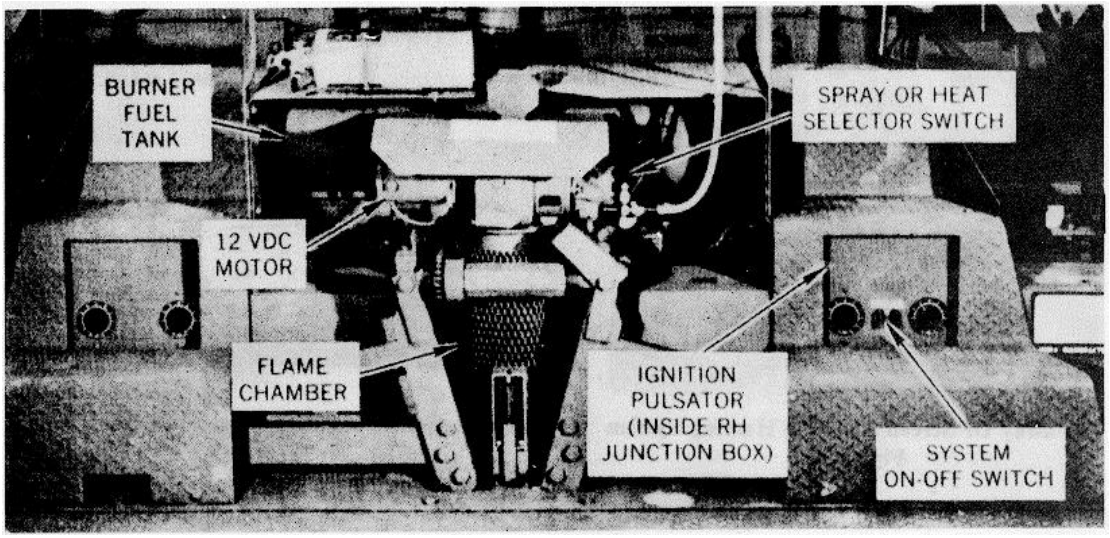
The temperature recommended for material delivered to the paver is 2500 F. minimum when medium and high penetration asphalt is used. The minimum is 3000 F. for low penetration (40 to 50) asphalts. Many mat defects can be caused by incorrect material temperature at the time of paving.

Usually a screed bottom will be heated sufficiently by running the heater for 20 to 30 minutes. When the screed is hot enough, close the burner fuel valve but leave the switch at ON to keep the blower motor running for at least 15 minutes to dissipate the heat. On oil fired units also open the vent door at the top to speed the cooling. Excessive heat can cause the screed to warp. Do Not Heat the Screed Above 3500°!

> **IMPORTANT:** When specifications require heat on the material at all times the heater should be set as low as possible.

A check for accumulation of asphalt in the heat vent holes the moldboard can be made by placing a hand near these openings behind the top of the moldboard and checking the full length for even exhaust of warm air. These vents become plugged when material is carried too high over the conveyor screws and falls between the moldboard and backing plate. A stiff wire can be used to clean small accumulations of material, or the moldboard can be removed for cleaning.

Periodically remove the screed plate as described in the Maintenance Section 11 and clean the inside of the screed plate and heat duct of all asphalt, sand the fine material which has sifted in over a period of time. Failure to keep the inside of screed plate clean will cause uneven distribution of heat to a cold screed and consequently lead to tearing of the mat surface when the paving operation begins.



Rear View Of Screed And Burner Assembly
Figure 33

12VDC SCREED HEATER OPERATION AT ENGINE IDLE SPEED

12 VDC screed heater system can be put into operation as soon as the paver engine is running at Idle speed for warm-up. This permits the simultaneous warm-up of both engine and screed in preparation for paving.

At the end of the paving run when the paver is to be spray cleaned and lubricated with fuel oil, the engine speed can be reduced to Idle while the screed heater motor is being used to operate the fuel oil pump.

PULSATOR AND COIL

The 12 V.D.C. ignition system for the oil fired screed heater includes a pulsator unit which interrupts the flow of D.C. current to the ignition coil in order to create a sparking at ignition electrodes. The pulsator is mounted inside the box which houses the auto. transformer for the right hand vibrators. (See Figure 33)

The ignition coil is mounted on the inner side of the fuel oil pump and fan housing, under the heater cover. (See Figure 35)

CIRCUIT BREAKER FOR 12 V.D.C. SCREED HEATER SYSTEM

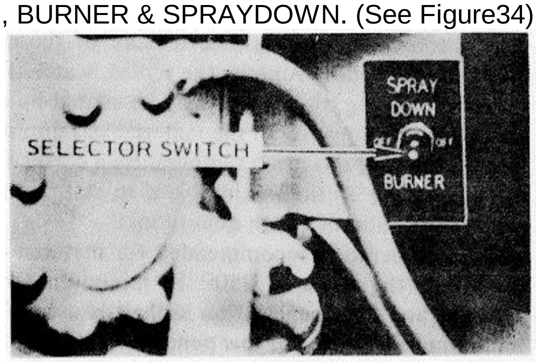
A burner system power switch on the instrument panel is also the circuit breaker for the system. If the switch trips to OFF automatically during operation, look for the cause of the overload before re-setting.

A second burner system power switch for ground level accessibility is located on the R.H. junction box for the screed. (See Figure 33)

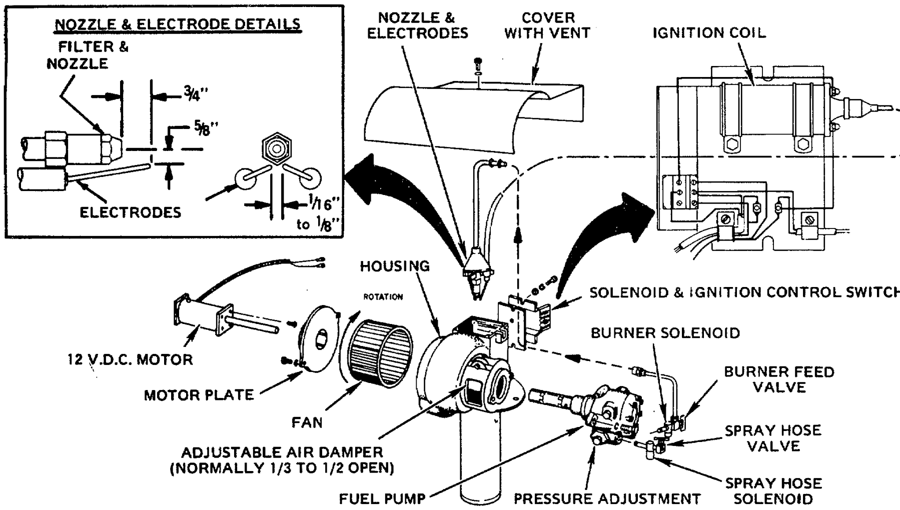
A third switch in the screed heater system is described in the following paragraph.

SOLENOID VALVES

Two solenoid operated shut-off valves and a selector switch are used to direct fuel oil flow to burner or to spray nozzle. A manual shut-off valve is provided in each feed line. They are intended as positive shut- in case of eventual solenoid valve leakage. Normally they should remain fully open. The toggle type selector switch has three positions - OFF, BURNER & SPRAYDOWN. (See Figure34)



Right Side View Of Burner
Figure 34



Exploded View of Screed Heater
Figure 35

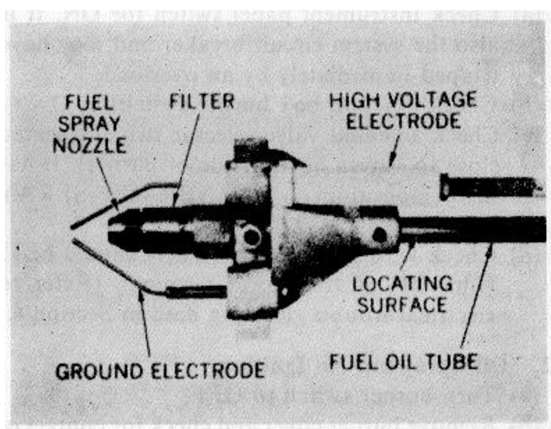
TO OPERATE SCREED HEATER (OIL FIRED)

1. Set engine operation at idle speed.
2. Close air vent cover & adjustable air damper.
3. Open the supply tank valve. (If closed)
4. Open burner feed valve. (If closed)
5. Set solenoid selector switch to BURNER.
6. Push burner switch to ON (*) at instrument panel. Turn junction box burner switch to ON.
7. Check sight hole in flame chamber for flame.
8. Adjust air damper on burner to obtain bright, clean fire. (Approximately 1/3 to 1/2 open.)

To Turn Burner Off

1. Set solenoid selector switch to OFF.
2. Open air vent cover.
3. Run burner blower for approximately 15 minutes or until fumes and heat are dissipated in screed.
4. Turn junction box burner switch to OFF (*). Pull instrument panel switch to OFF.
5. Close air vent cover at end of day's run to prevent moisture from entering screed.

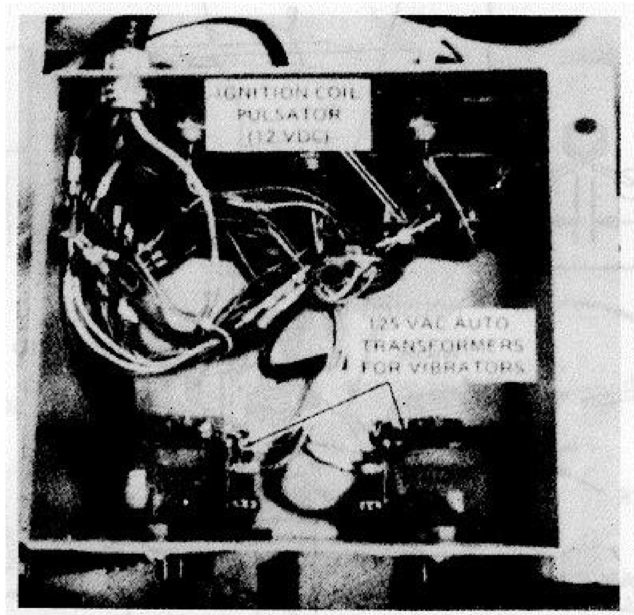
(*) NOTE: Burner will re-light quicker when switch has been at "OFF' for two or three minutes, and air damper is closed.



Burner Nozzle & Ignition Electrodes
Figure 36

To Use Spray Hose

1. Run engine at idle speed.
2. Open supply tank valve. (If closed)
3. Open spray hose valve. (If closed)
4. Set solenoid selector switch to Spray Down.
5. Push burner switch ON at instrument panel.
6. Turn junction box burner switch to ON.



Top View of Screed Junction Box
Figure 37

Trouble and Remedies for Oil Burner

1. No Oil Spray and No Ignition

(a) Check instrument panel switch for ON. It is also the system circuit breaker and may have tripped immediately by an overload.
(b) Check junction box burner switch for ON.
(c) Check solenoid valve selector switch (located close to valves on RH side of burner). It has three positions, BURNER-OFF-SPRAY DOWN.
(d) Check wiring to switches. There should be 12 volts DC at the power terminal. (Refer to electrical trouble shooting data in Section 4.)

2. Oil Spray but No Ignition

(a) Turn burner switch to OFF.
(b) Remove burner cover and check for contact of ignition coil wire to electrode contact strip.
(c) Remove electrode assembly. Clean electrode points and insulator and determine if insulator is cracked or broken. Check setting of electrode points to specifications in Figure 35.
(d) Check wiring from switch to pulsator and from pulsator to coil. (Refer to Electrical Section 4.)
(e) Re-install electrode assembly in burner. Install cover. Turn burner switch to ON. If there is still no ignition, check pulsator. (Refer to Burner Electrical System Troubleshooting Instructions in Section 4.)

3. Ignition but No Spray from Burner Nozzle

(a) Be sure hand valve in burner fuel line is open.
(b) Check fuel oil tank for level. Be sure sediment filter element is not plugged.
(c) Turn burner switch ON and make sure fan is running. Turn solenoid selector switch to SPRAY DOWN and squeeze spray nozzle lever to see if normal spraying occurs. (Be sure hand valve in hose line is open.)
(d) If normal spraying occurs turn switch to BURNER and check at burner solenoid wire terminals for 12 VDC with voltmeter. If no voltage, the toggle switch or wiring is faulty.
(e) If 12 VDC is present, turn switch to OFF. Disconnect burner fuel line at shut-off valve. Hold a container in such a way that a spurt of oil can be safely caught. With pump running, jog switch to BURNER position. If no oil spurts into container, solenoid valve is inoperative.
(f) If oil spurts from valve, re-connect fuel line. Clean burner nozzle and the strainer ahead of it.

Note: Pump must develop 100 PSI pressure in feed line for proper operation. Replace pump if gauge installed in feed line does not show 100 PSI.

SCREED VIBRATORS

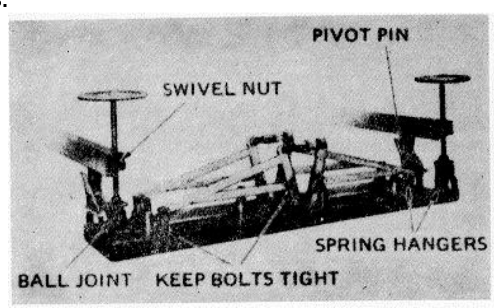
The electric vibrators on the screed which help with the initial compaction and smoothing of a high density mat are operated by toggle switch

Figure 38 Adjusting Screed Vibrator Intensity

from the control console. **The vibrators will only operate when the paver is at full throttle and either Track Switch is in the Travel position**. This prevents extra compaction in one place on the mat when the paver is temporarily stopped. (Note: Vibrators can be test-operated when paver is not moving by first moving the clutch lever on the side of the engine housing to DISENGAGED position. Transmission must be in FORWARD.) The operating intensity of each unit can be varied to produce more or less vibration. An adjusting knob is located on the variable transformer connected to each vibrator (See Figure 38). A recommended start-up setting is 3/4 of the range between zero and the highest dial marking.

SCREED MAINTENANCE

It is important that the screed be kept in good condition so that wear, looseness, or breakage of parts does not begin to produce poor paving results before a noticeable defect exists. The hand wheel assemblies which adjust the screed angle must be kept in good condition. Crown adjustment and **spring hanger bolts must be kept tight.** There are numerous places where wear can be compensated by shimming and adjusting. See Maintenance Section 11 for details.



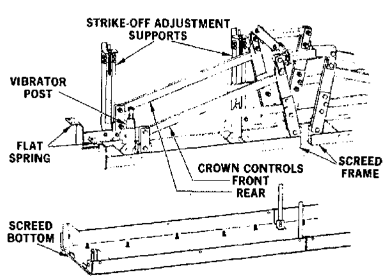
Screed Bottom With Crowning And Pull Arms
Figure 39

QUICK-CHANGE SCREED BOTTOM:

The asphalt finishing surface of the full floating screed should be kept in good condition. The quickchange bottom features makes replacement of this vital part relatively easy. If all paving is done with the correct adjustment of the pull arm "pull-point" and strike-off, and without extensive bridging when mat overlap is required, the screed bottom will wear uniformly.

If either the leading or trailing edge does wear first, the bottom can be reversed to interchange the leading and trailing edges.

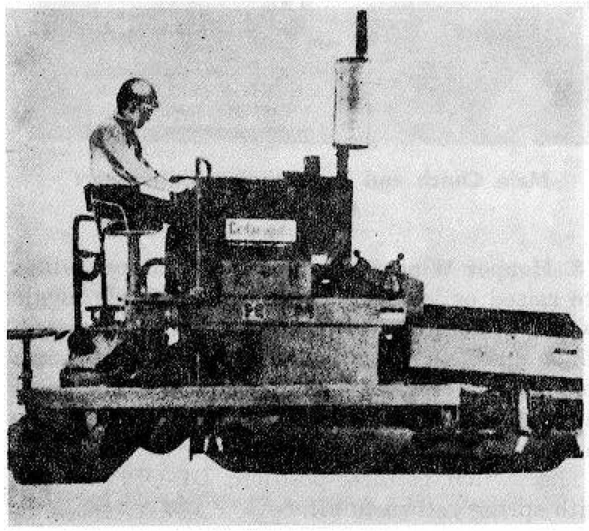
Always replace the screed bottom before it wears completely through!



Quick-change Screed Bottom With Frame And Crowning Arms
Figure 40

SECTION VIII

Operating the Paver



Paving with Operator in Right Hand Seat Position
Figure 1

CONTROL SWITCHES

Movement of the paver and all paving function is controlled from the operator's console (See Figure 1). This electrical unit is mounted on a support which can be picked up and shifted from one side of the paver to the other along with operator's seat. The electrical cable is long enough to reach both positions. All of the operators controls are toggle switches except the main clutch and the transmission shift levers. The individual switch functions are follows: (Refer to Figure 2).

1. Horn Switch: Used mainly to signal truck drivers and crew members. The horn switch is two position; ON-OFF with spring loading to OFF.

2. Duo-matic Switch: Used as main power switch for automatic screed control system (when purchased). If the system is not supplied the switch is not connected.

3. Throttle Switch: Adjusts engine speed to the following,

(a) Idle speed (center position)

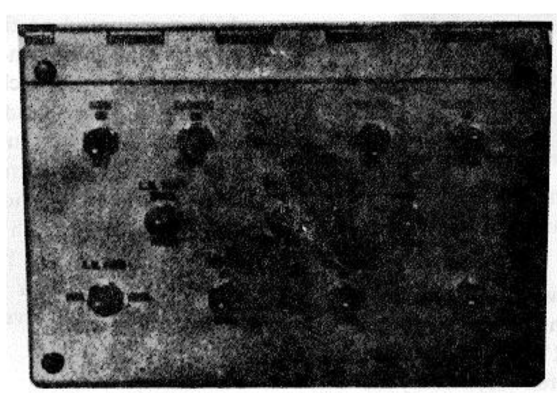
(b) Immediate full throttle (forward position)

(c) Gradual full throttle if travel switches are in TRAVEL position so that a Soft Start of paver movement occurs (rear position). The switch has three positions; FULL-IDLE-SOFT START.

4. Vibrator Switch: Starts and stops **screed** vibrators used for initial compaction, **if the paver is moving forward.**

The switch has two positions; ON-OFF.

5. Track Switches (Right Hand and Left Hand): Engage electric clutches in paver track drive system and electric brakes. Each track has its own control switch so that the paver can be turned by operating only one track drive. The machine pivots on the opposite track. If an abrupt turn is to be made the switch for the pivot track can be

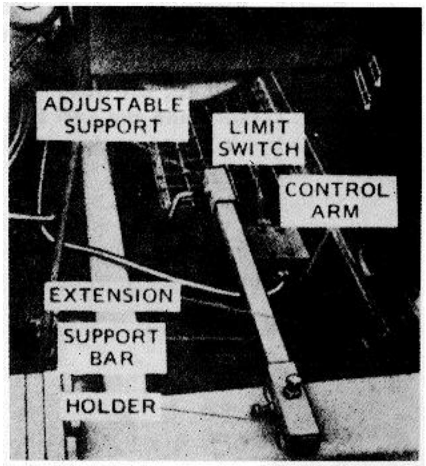


Operator's Control Console
Figure 2

moved to the BRAKE position and the paver turns sharply. If both switches are moved to the BRAKE position the paver stops instantly. In its center position the switch is OFF. Each switch has three positions: TRAVEL-OFF-BRAKE.

6. Screed Lift Switch: Raises, holds, or lowers screed assembly by hydraulic power. In the center position, the screed position is held hydraulically locked so that no downward creep can occur. The switch is three position; UP-HOLD-DOWN with spring return to HOLD.

7. Feed Switches (Right and Left Hand): These two switches individually start and stop each pair of combined slat and screw conveyors which feed material ahead of each half of the screed. Conveyor operation can be controlled manually with the operator observing the amount of feed, or it can be done automatically using two auxiliary "feeler switches" which are operated by material build-up near the ends of the screws. Each type of operation engages or dis-engages the electric clutches which drive the conveyors. Each switch has three positions; MANUAL-OFF-AUTOMATIC.



Adjustable Material Depth Control Switch with Feeler Arm - R.H. Assembly Shown
Figure 3

NOTE: The conveyors will not run unless the paver transmission shift lever for travel direction .is in the FORWARD position. (See Figure 4) A limit switch actuated by the transmission opens the conveyor electrical circuit when the paver is shifted for reverse travel.

Main Clutch and Transmission Shift Levers
Figure 4

8. Hopper Wing Switch: The two hopper wings are raised or lowered by operation of this toggle switch. It controls valves in the hydraulic system which direct the action of two hydraulic cylinders connected to the wings. The wings are raised when material at the sides of the hopper needs to be moved toward the slat conveyors. The switch is three-position; UP-OFF-DOWN, with spring return to off.

> **(NOTE**: The movement of hopper wings is normally irregular because a single hydraulic pressure line powers both cylinders and the wing offering the least resistance moves first).

9. Truck Hook Switch: Used as control switch for hydraulically powered truck hook system (when purchased). If system is not supplied the switch is not connected.

10. Screed Heater Switches:

Three switches are used to control operation of the oil fired screed heater and oil spray-down unit which is mounted on the screed.

The burner pump and fan motor is controlled by the burner power switch and circuit breaker on the instrument panel, and the ground level burner switch on the screed junction box.

The selection of burner operation or oil spray for clean-up and lubrication is made by setting the 3-position toggle switch on the side of the burner housing. The switch has three positions, OFF - BURNER - SPRAY DOWN. It controls two solenoid operated valves in the fuel oil distribution lines.

Three small hand-operated shut-off valves in the fuel oil distribution lines are provided as positive shut-off means in the event of leakage through solenoid valves, etc. They are normally open.

See Screed Section 7 for screed heating and fuel oil spray details.

PRE-START CHECK (DAILY REQUIREMENT)

Before starting a paver for a regular run the operator should check the following details personally.

1- Engine oil level. It will be somewhat below hot oil level, (Dipstick gauge).
2 - Transmission oil level (14" on Dipstick).
3 - Engine fuel level.
4 - Coolant supply. (Radiator).
5 - Hydraulic fluid level (Reservoir sight gauge).
6 - Battery water level.
7 - Screed Heater fuel level.
8 - V-Belt Tightness and condition.
9 - Engine air filter condition. (Especially Diesel.)
10 - Air Filter Hose for loose clamps or leaks.

Before starting a paver for a regular run, the operator should make sure that the following requirements have been attended to:

1 - Oil level in both transfer cases is adequate.
2 - Grease fittings have been attended as recommended for daily lubrication requirement.

TO START ENGINE:

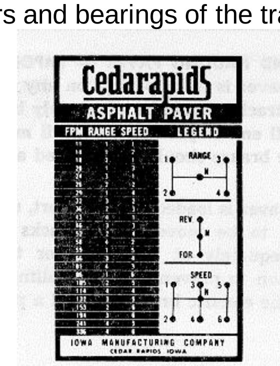
The following procedure is recommended for start-up of a paver in preparation for a paving run.

1 - Disengage main clutch.
2 - Turn main control key switch to ON.
3 - Set both Track switches to BRAKE. Set all other switches on console to OFF.
4 - Start engine by turning and holding the key switch to ON. (Also see Engine Operator's Manual).
5 - Check to make sure the transmission oil pump is operating in the following way:

(a) Look at the oil line Sight Glass on the top of the transmission. (Section 3, Fig. 10) With the main clutch disengaged and the transmission pump not turning the sight glass will be clear, indicating no oil flow.

(b) Engage the Main Clutch.

(c) Look at the sight glass **to be sure it is darkened by the oil flow** which indicates that the pump is working properly to lubricate the upper gears and bearings of the transmission.



Selection Plate for 24-Speed Transmission
Figure 5

PAVER TRAVEL (NOT PAVING)

With the engine idling and main clutch disengaged;

1. Move both Track Switches to BRAKE position, and Follower Switch to OFF position.
2. Set the three transmission levers to produce the speed and direction of movement you wish. (If gears do not mesh, jog main clutch and try again).
   (a) Range Lever - #1 (slowest) through #4 (fastest).
   (b) Direction Lever - Forward or Reverse.
   (c) Speed Lever - #1 (slowest) through #6 (fastest).
3. Engage main clutch.
4. If slow movement is desired, as for unloading the paver or moving through a narrow area, leave the Throttle Switch at idle and move the track switches to TRAVEL. Steer the paver by moving the switch of the pivot track to OFF or BRAKE depending upon how sharp a turn is needed.
5. When fast movement is desired, move the Throttle Switch to SOFT START and move both Track Switches to TRAVEL. Steer the paver by moving the switch of the pivot track to OFF or BRAKE depending on how sharp a turn is needed.

STOPPING PAVER

A paver is normally stopped by moving both Track Switches to the OFF (center) position. If an emergency stop is required, move both track switches all the way forward to BRAKE position. **CAUTION! An operator should be braced for sudden stoppage if brakes are applied when the paver is moving at top speed.**

PARKING AND HAULING PAVER - IMPORTANT!

When a paver is to be parked on any degree of slope, both tracks **should be adequately blocked at the downhill end to prevent downhill movement!** The electric brakes should **not** be used as parking brakes! When a paver is loaded for transport, regardless of distance to be moved, both tracks must be blocked adequately at each end, or the paver chained down to prevent it from rolling. Do **not** rely upon the electric brakes to hold a paver during transit.

ANGULARITY RESTRICTIONS

The constant need for proper engine lubrication makes it necessary to restrict the slope at which the paver may operate. These restrictions which are imposed by the engine manufacturers are as follows:

1. Paving Uphill (See Figure 6) - Do not exceed a 53% slope (28°).
2. Paving Downhill (See Figure 7) - Do **not** exceed a 36%o slope (20°).
3. Paving With One End of Screed Elevated (See Figure 8) - Do not exceed a 57% slope (30°).

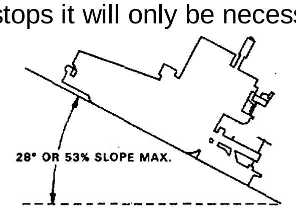
NOTE: The angularity shown represents t**he engine operating restriction only!** If a paver is to operate near this slope limitation some satisfactory method of holding the paver on the slope must be devised by the owner.

CLEANING PAVER

It is important that the paver be thoroughly cleaned at the end of each day's operation. A long spray nozzle hose is attached to the heater fuel oil supply valve and will reach any part of the paver for spray cleaning and lubricating. (See Figure 9. Refer to Maintenance Section for details.) Every time the paver is cleaned, the tracks should be sprayed with fuel oil. There is enough lubricant in the fuel oil to keep the track pins from rusting and binding.

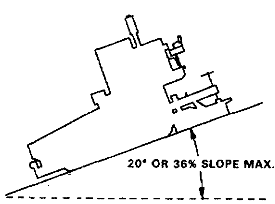
TIGHTENING NEW TRACKS

IMPORTANT! A new paver or one having a new set of tracks will require **daily tightening** of the tracks until all link pins have "worn in" and stretching of the track no longer occurs. When this initial stretching stops it will only be necessary to check and tighten the tracks occasionally. (See Section 11)



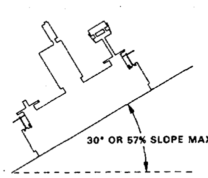
Slope Limitation for Engine Operation when Paver is Headed Uphill

Figure 6



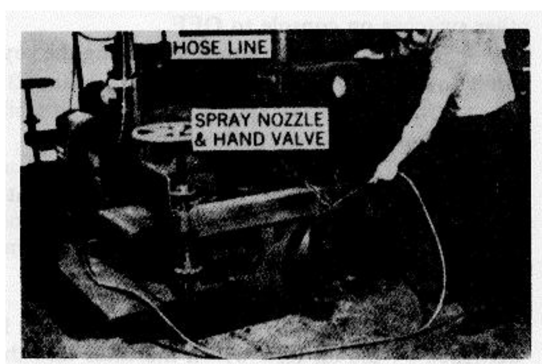
Slope Limitation for Engine Operation when Paver is Headed Downhill

Figure 7



Slope Limitation for Engine Operation when One End of Screed is Super-elevated

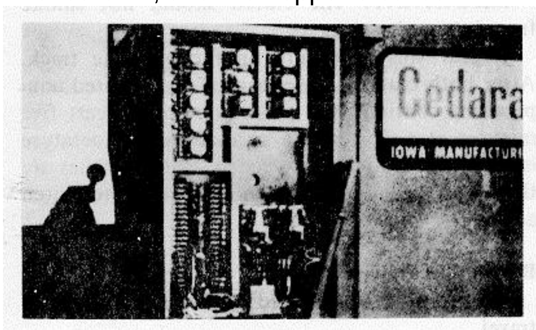
Figure 8



Cleaning paver with Screed Heater Fuel Spray Accessory
Figure 9

OPERATING CAUTION

When a paver has been out of service for a lengthy period, such as during the Winter months, **be sure to clear the hopper of all items such as shovels, tools, and personnel before starting the engine!** Under certain conditions rust will build up on feed clutch surfaces to the extent that slat and screw conveyor movement will take place even when both Feed Switches are OFF. As soon as the rust wears away, operation becomes normal. Always start the paver after a long shut down with the main clutch disengaged, track switches at BRAKE, both Feed Switches OFF, and the hopper **cleared.**



Main Electrical Panel
Figure 10

REVERSING DIRECTION OF SLAT CONVEYOR TO RELIEVE JAMMED OBJECT

1. Remove cover of main electrical panel on the front of the engine to expose the paver wiring. (See Figure 10)
2. Connect a jumper wire between terminals No. 45 & No. 46 at any convenient point. (This eliminates the function of the limit switch on the transmission.)
3. Start the engine and run at IDLE speed.
4. Shift the transmission Direction Lever to REVERSE. (The limit switch opens but the circuit remains unbroken due to the jumper wire.)
5. Move the appropriate console switch for the conveyor involved to the MANUAL position just long enough to move the slat conveyor in the reverse direction and release the jammed object. Do **not** run it longer so that the chain starts to ride-up on the sprockets due to reversed tension. The slat bars can also catch on the return rails if the chain happens to be quite slack.
6. Stop the engine. Shut-off all power and remove the jumper wire.

VIBRATOR OPERATION WITH PAVER STOPPED

Whenever it is desirable to operate the vibrators when the paver is stationary, proceed as follows:

1. Disengage main clutch.
2. Shift transmission into FORWARD gear. (This will close the circuit limit switch.)
3. Set engine throttle switch to FULL.
4. Set one of the two track switches to TRAVEL.
5. Set vibrator switch to ON.

   IMPORTANT! When test operating the vibrators, set the screed bottom on a flat surface with no stones or similar objects under it so that the bottom is not scored and scratched as the bottom vibrates.

BURNISHING TRACK CLUTCH & BRAKE FACINGS TO IMPROVE PERFORMANCE

The facing material on the two electric track clutches and on the two electric track brake assemblies can become glazed from operation so that excessive slippage occurs. Poor clutch operation will result in both R.H. & L.H. drives slipping, or in one track consistently failing to keep up with the other so that an abnormal amount of steering is required to maintain a straight course.

Poor brake operation will result in an inability to hold position on uphill paving run.

When poor performance of a clutch or brake is suspected, the unit in question should first be 'checked for armature "hang-up" on the drive pins, oil on the friction faces, improper electrical function, or worn-out friction faces. (See details of dimension checking in preceding paragraphs.) Slippage can also be due to an overload condition. The drive train and tracks should be inspected for mechanical binding.

If none of the above factors seem to be the cause of clutch slippage, the performance of the clutches may be improved by carrying out a burnishing operation to remove "glaze" from the friction surfaces. (The same effect cannot be obtained by using a solvent, as during an oil removal effort, nor by "roughing-up" the friction surfaces by hand!)

Burnishing Track Clutches

(1) Move paver to where center of main frame front edge is in direct contact-with a suitable immovable object, which can safely withstand the full force of paver drive power. **IMPORTANT!** Be sure that no truck hook or other part of the paver will make contact and be damaged by the full force of the paver drive. The tracks should be resting on hard dry soil or other dry surface which will not break-up or be badly damaged by the full force of the paver drive.

(2) When paver is in place, arrange electric system so that brakes will be on when the Track switches are at the Travel position. (For early model paver brakes the brake coil must be energized. For pavers with electrically released brakes the coil must be de-energized.)

(3) Arrange track speed controls for high speed travel.

(4) Move the track switches to the center position (neutral).

(5) Move throttle switch to Full position.

(6) Intermittently move one track switch to Travel position then back to neutral so that the clutch is momentarily engaged and the clutch surfaces heat-up rapidly to above their normal operating temperature. (150 F - approx.).

IMPORTANT! The clutch should not smoke from intense heating.

Repeat this procedure on the opposite track. After both clutches have reached the elevated temperature continue the procedure for at least five minutes at <u>a slower rate</u> so that the temperature is maintained <u>but not exceeded</u>. Both clutches are then burnished at the same time by alternate switch actuation.

Burnishing Track Brakes

(1) Arrange track speed controls for high speed travel.

(2) With track switches at Brake position, move throttle switch to Full position. When engine is warmed up for operation move both track switches to Travel and when paver has attained its maximum forward speed, move one track switch to Brake then back to Travel as quickly as possible. When this is done fast enough, the brake does not "grab", but
does make sufficient contact to the heat surfaces.

Caution! The operator should however, be braced for sudden deceleration.

Repeat this procedure until the brake is hotter than during normal operation (I 500 to 2000 F) but not smoking. Then repeat the same burnishing effort on the opposite brake.

(NOTE: If this procedure presents a problem, the same effect can be obtained by blocking-up the paver so that both tracks are completely off the ground, and there is no actual paver movement).

(3) When the brakes have cooled completely, test paver steering to see that normal operation of the brakes has been restored.

SECTION IX

PLANNING THE PAVING JOB

PLANNING THE PAVING JOB

The careful planning of a paving job is essential to fast, efficient, and low cost operation. Some of the planning factors related to general paving are covered in the following paragraphs:

(a) Material Delivery - The steady delivery of hot material to the paver will often have a bearing on how a multiple width mat will be divided. The accessibility of roadway to the delivery trucks could possibly override the advantages gained by laying portions of the mat in the more desirable way from the standpoint of paver operation.

(b) Two or More Different Mat Widths - When two or more mats of different widths are laid, the **narrow** mat which requires the use of a cut-off shoe should be laid **first**. The final mat can then be laid at full screed width without the complication of cut-off parts.

(c) Matching One Mat to Another - When matching one mat to another use a 6" or 1 foot screed extension on the joining end. This will provide a small separate screed bottom surface to absorb the extra wear that occurs when the slight overlap for matching is made. The extra wear would otherwise take place on one tip of the long screed bottom and destroy its uniformity.

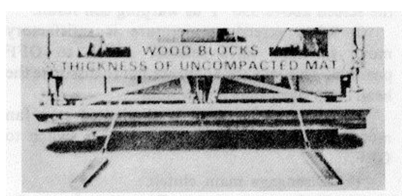
(d) Straight Center Crown Requirement - When it is necessary to maintain a straight crown in the middle of a wide multiple mat roadway, it is best to lay the crown section first, then match the adjoining mats to it.

(e) Narrow Roadways requiring Multiple Mats When planning to pave a narrow roadway which does not have a shoulder area for screed overhang past the cut-off shoe, pave the narrow mat first with the screed overhang on the inside. If this road is to have a crown, the cut-off will be made at the center for both mats with the shoe actually riding on the first mat when the second mat is laid.

(f) Overlapping Mats - Do not overlap mats extensively unless it is required. If required, keep the overlap to the minimum requirement. Excessive overlap can cause a bridging and tearing of the mat. If a large overlap is required use a cut-off shoe to block material from coming too far under the screed in the overlap area. It is the excess material allowed to build up under a screed that eventually supports the end of the screed to cause bridging and holes in the mat. It also causes very rapid wearing of the screed bottom in the area that is supporting most of the screed weight.

(g) Maximum Stone Size in Material - The intended mat thickness **must be** at **least 11/2 times the dimension of the largest stone size in the material.** Fewer problems will be experienced if the mat is **twice or three times** thicker than the largest stone dimension.

Example: If the roadway specification calls for a 3" thick rolled mat, the largest stone used in the material **should not exceed 11/2" to 2"!** If 1" stone can be the maximum size it will cause fewer problems than the larger stone.



Positioning Screed for Paving Start-up
Figure 1

PAVING

(a) Move the paver into position so that the steering guide marker is aligned and the screed can be lowered to the exact point at which the mat is to begin. Move both Track Switches to the BRAKE position when the paver is in place.

(b) Make a careful check of the screed to make sure it is ready for paving. Extensions, cut-off shoes, etc., should be properly installed. Crown adjustment should be checked with stringline as a start-up setting. Strike-off should be accurately measured and adjusted.

(c) Set wood support blocks under the ends and center of the screed at the correct mat thickness height and level for proper screed take-off when paving begins. With engine at full throttle unhook screed safety cables and lower screed to blocks allowing both lift cables to go completely slack before moving screed lift switch to center (HOLD) position.

(d) Raise each hopper gate to the 1/4 open position for start-up. When paving starts adjust them as necessary. See Figure 4.

(e) For manual adjustment of mat thickness control, turn each handwheel until **no load** is felt on the screw. Turn the handwheels clockwise until a load is felt, then turn them an additional 1/3 revolution in the same direction to set a slight screed angle for start-up.

(f) Make a visual check of engine speed by reading the Frequency Meter. If the engine speed is holding at 2000 RPM the frequency will be steady at 61 cycles (Adjust engine speed governor if necessary to obtain this reading).

(g) Set throttle switch at IDLE and engage the main clutch.

(h) With engine at IDLE speed, start screed heater. Heater should run from 20 to 30 minutes in order to bring the temperature of the screed bottom to approximately 3000 F. CAUTION! Do **not** heat the screed above 3500 F as warping can result.

(i) When screed temperature is satisfactory move solenoid valve selector switch to OFF position. This will allow burner fan to dissipate the heat. Also open upper vent door.

(j) When intense heat is eliminated stop fan motor by turning junction box burner switch to OFF.

(k) Disengage main clutch.

(l) Shift transmission Direction Lever to FORWARD.

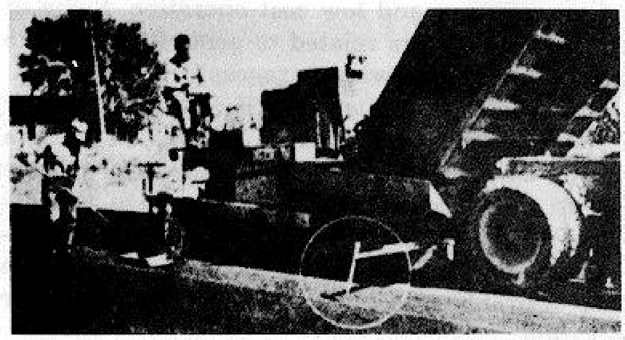
(m) Shift transmission Range Lever and Speed Lever to produce the paving speed selected. This selection should be based primarily on the rate at which hot material can be delivered to the paving site. A chart showing paving speeds for 1" mat thickness, as related to tonnage of material required, is shown near the end of this Section. (New operators should use slow speed for gaining first experience).

(n) Set both Track Switches to BRAKE position.

When the first truck arrives with material, the paving operation can be started as follows:

(o) Have truck back-up to within 1" (approx.) of the paver push rollers.

IMPORTANT! The trucks should never be allowed to bump the paver, as this will cause marks on the finished mat as paving progresses.



Using Guide Marker, Reference Line and Cut-off Shoe
Figure 2

Have the trucker set his brake so that the truck will not roll away from the paver when the material is dumped. **IMPORTANT!** Do **not** allow material to be spilled in front of the paver. If this occurs, shovel the spillage into the hopper. **Do not** attempt to bulldoze it with the front of the paver! Material will jam up the return side of the slat conveyors and pack into the track links. If material is left in front of the tracks it may cause waves in the mat.

(p) Dump material Into Paver Hopper.

(q) When ready to pave, engage master clutch.

(r) Set engine Throttle Switch to FULL position.

(s) Move both Feed Switches to the MANUAL position. When the slat conveyors have fed the material to the spreader screws and it is spread across the full length of the screed to the proper depth, move the Feed Switches to OFF.

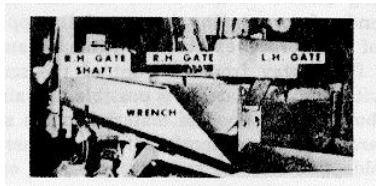
(t) Set Vibrator Switch to ON. (Vibrators will not start until paver moves forward. Adjust the four Vibrator Intensity Control Knobs on the transformers to about 3/4 range to start. When some mat is laid re-adjust the vibrator intensity for the best mat surface appearance. Once properly set, little or no additional adjustment will be necessary).

(u) Set engine throttle switch to SOFT START position.

(v) Set both Track Switches to TRAVEL simultaneously to start paver movement and operate the Feed Switches manually to keep the material spread ahead of the screed.

(w) Correct the direction of paver movement by moving 'the Track Switch of the pivot track to OFF momentarily.

(x) After some experience is gained with manual feed control, set both Feed Switches to AUTO. and observe the level of material maintained by the two depth sensors. If necessary, stop paving and re-set each sensor by loosening the control arm and sliding it inward or outward to maintain a different material height on the screws.



Adjusting Right Hand Hopper Gate
Figure 3

MATERIAL CONTROL

Adjust hopper gates, Figure 3, so the material flows almost constantly to the spreader screws. **The spreader screws should be kept a little more than half covered with material** (Refer to Material Feed, Section 6)

(1) The ends of the spreader screws should not be filled too full. This causes the material to pack against the end plates and in some cases may spill over the sides. **IMPORTANT:** When operating with automatic feed control, **never starve the screw conveyors** to the extent that there is not enough material in the screws for the cut-off switches to operate. It is important to check to see that material does not build up in switches and control arms, causing improper operation. KEEP CLEAN AT ALL TIMES.

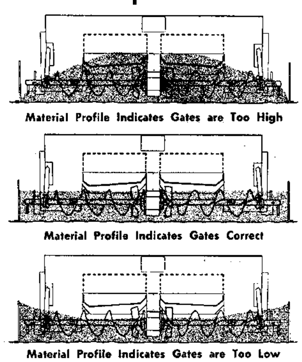
(2) When too much material is carried in the spreader screws, excessive wear will occur on the screws, and the material will spill over the end plates and screed moldboard.

(3) When operating under manual control the operator will have to watch the material level across the length of the screed because uneven or excessive amounts of material cause a poor appearing and wavy mat.

ADJUSTMENT OF HOPPER GATES

The material gates, Figure 4, located to the rear of the hopper, control the flow of material to the spreader screws.

(**1) Gates should be regulated so that the spreader screws operate 80% (minimum) of the time.**



Comparison of Gate Height to Material Feed
Figure 4

(2) When bleeding out material on one side of paver, the operator should and may have to adjust the gate on that side to increase the amount of material flowing to the spreader screws. Switch from automatic to manual feed.

OPERATING SUGGESTIONS

(1) Mat Thickness - The screed man should check the depth being laid at each side of the mat and make whatever adjustments necessary to maintain a uniform depth of mat.

(2) The adjustment of the screed control should not be made too rapidly. The screed should always be allowed to seek the new level of operation.

(3) The operator should make sure that the proper amount of material is being fed to the spreader screws.

(4) The operator should check the speed the paver is traveling. The paver should move fast enough to lay the material without delaying the trucks, and not so fast that he has to wait for trucks.

(5) The operator should never run the slat conveyors out of material and starve the spreader screws, but he should allow the hopper to empty out to some extent before the next truck dumps its material.

(6) When controlling the paver, the operator should be careful **not** to push either right or left toggle switch all the way forward. This would apply the brakes and cause over correction and an impression on the finished mat. Quickly dis-engage and re-engage track clutches as many times as becomes necessary to correct the direction of paver movement.

NOTE: One of the most common mistakes made by a new operator is over-control in steering. A quick snap of one switch to OFF is all that is necessary to correct the direction of the paver.

(**7) IMPORTANT:** Clutches should be inspected after the first week of operation and every 30 days thereafter.

Selecting Proper Operating Speeds

The paver should not travel any faster than necessary. The operation should run smooth at all times. Even though the paver will travel at speeds that exceed the production of the mixing plant, the operator will not gain by running at the faster speed. Always operate at a constant speed, and let the production of the mixing plant determine this speed.

If necessary higher paver speeds can be used to expedite the unloading of a backlog of trucks which may be caused when the paver is making a joint or similar time-consuming operations.

(1) **Operating Speed Ranges** (Refer to Material Feed, Section 6)

When operating at high speed ranges, it may be necessary to adjust the rheostat controls for the screed vibrators; increasing the amplitude of the two outside, middle, or all four vibrators.

Correct operating speed of paver should be selected to handle the output from asphalt plant without long delays between trucks

(2) Job specifications may determine the paver speed.

Laying a Wide Mat

When the paver is required to lay mats of extreme widths or an extra deep mat, the following adjustments and changes must be made.

(1) Make sure screed plate extensions and screws are assembled according to recommended procedure. See Installation Of Attachments, Section 7.

(2) Measure screw conveyor diameter, and weld screw up to its original diameter (14" Standard Auger) if necessary. Also, check paddles on screw conveyor (14" Diameter standard, and reweld if necessary.

(3) Check to make sure strike-offs are positioned correctly on front of screed plate. THIS IS VERY IMPORTANT. (See Screed Section 7.)

(4) Usually it is necessary to **lower the gates** to feed more material to the ends of the screed.

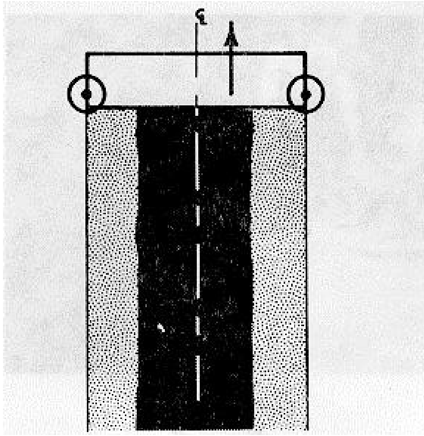
(5) Install material retaining plates, so that spreading screws readily move the mix to the outer ends of screed. This keeps a full supply in front of the screed extensions, rather than letting it flow away from in front of the screws. Also, with retainer plates it is possible to maintain **a low but uniform level of material in the moldboard area,** and consequently better movement **off** the moldboard into the screws and better operation of the automatic depth sensors.

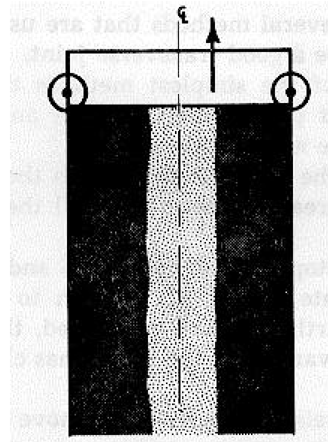
CAUTION: Avoid too much material in spreader screws as excess material will not roll off the moldboard efficiently. Adjust depth control feelers to maintain desired level of material.

CROWN ADJUSTMENT

Some of the conditions that can be corrected by proper front crown adjustments are loose edges with sandy streaks in the center of the mat, or tight edges with a marking in the center of the mat. (See Figure 5)

Loose mat edges for approximately the last 18" on each side, and a tight sandy center strip indicates too much crown. To correct this condition, back off the front crown adjusting nut until the front crown is only 1/16" greater than the rear crown or less. Then





Edges Loose - Decrease Front Crown

Center Loose - Add More Front Crown

Effect of Crown on Mat Uniformity

Figure 5

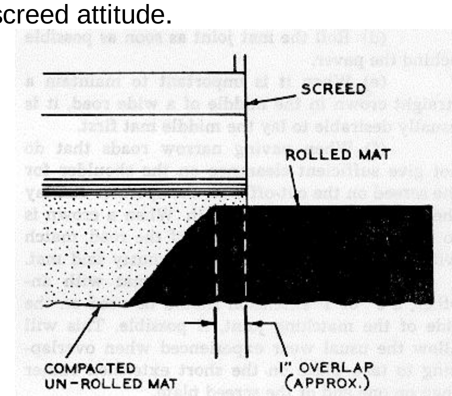
add front crown by turning the nut 1/6th turn at a time until the mat has the desired appearance. Adjustment should be made slowly, waiting each time for the effects of the new setting.

Tight mat edges and a marking or looseness at the center of the mat indicates a need for more front crown. Add crown to the front edge of the screed 1/6-th turn of the adjusting nut at a time, waiting each time for the effects of the new setting, until the mat has the desired appearance.

The rear crown adjustment should not be changed unless a new or different degree of crown is desired in the finished mat. Front crown adjustment does not affect the road crown, it only helps to get proper distribution of material under the screed. The front crown must always be adjusted after the rear crown adjustment is correct.

The initial crown settings are 1/16 to 1/8" more in the front crown than in the rear crown. For example: The rear crown setting is for 1/4" crown in the road, therefore the front crown would be 1/16"more or 5/16" total.

Final adjustment must be made when the paver is actually laying mat. This eliminates the possibility of crown error and enables the operator to observe the quality of the surface. If the density and texture are not uniform, adjustment of the lead crown differential should be made to determine whether the mat can be improved by this simple change in screed attitude.



Matching Mats

In any paving operation where two or more mats are joined together, this procedure is called matching a joint (Figure 6). The joint may be either parallel or transverse, depending upon the phase of operation. When matching any joint the operator should always have sufficient thickness so when the mat is rolled it will be the same depth as adjoining mat. Extra thickness depends upon how thick a mat is being laid. Example: a 4" black base mat may require 5" of fresh material in order to measure 4" after final rolling. A 1½2" mat may require only 13,14" of material.

(1) Parallel Joints-The "CEDARAPIDS" Bituminous Paver is designed to match one mat to another mat by overlapping the previously laid mat. The amount of overlay will depend some upon skill of the operator. (Refer to Figure 6.) The operator should also consider the following examples when laying mats with parallel joints.

(a) Match the mats when possible before the asphalt sets up. If it is possible to do this, the roller should be kept away from the first mat approximately 6" to 1'.

Then roll the joint when rolling the second mat.

(b) When laying one mat some distance ahead, so that the material sets up or traffic causes compaction the second mat should be thick enough to allow for compaction. The full width of this mat should be rolled.

(c) When matching a previously rolled mat, allow for the compaction of the roller. The screed should never ride on the first mat. (Refer to Figure 6)

(d) Roll the mat joint as soon as possible behind the paver.

(e) When it is important to maintain a straight crown in the middle of a wide road, it is usually desirable to lay the middle mat first.

(f) When paving narrow roads that do not give sufficient clearance on the shoulder for the screed on the cut-off side, the operator can lay the first mat the narrow width. When a crown is to be maintained in the center of the road, match with cut-off shoe riding the previously laid mat.

(g) When matching one mat with another, a 6" or 1' extension should be used on the side of the matching joint, if possible. This will allow the usual wear experienced when overlapping to take place on the short extension rather than on one end of the screed plate.

(2) Transverse Joints-When making a transverse joint, the operator should take into consideration whether or not the material will set up before the paver is returned to make this joint.

(a) If the joint will be made before the asphalt sets up, the roller should not roll the last two yards of the mat.

(b) When making the joint, raise the screed and back up, *so* the entire screed will rest on the mat.

(c) Then lower the screed, fill up the screw conveyor with material and start normal operation.

(d) The screed should be adjusted to the same position as when this mat was ended. Screed can be adjusted while resting on mat.

(e) When a transverse joint is being made to a compacted mat, the same procedure is followed, and the operator should allow for the roller compaction of the new mat.

Ending A Mat

When ending a mat of asphaltic paving where a transverse joint will be made, a vertical edge should be left to accomplish a good bond in the transverse joint.

Ending A Mat
Figure 7

There are several methods that are used to end a mat to insure a good transverse joint.

(1) One of the simplest methods used is to use a piece of paper about 3' wide and a little longer than the width of the mat.

(a) The operator should run the slat conveyors and spreader screws until all the material is used up.

(b) Stop the slat conveyors and spreader screws. Operate screed lift enough to snug lift cables and partly support the screed, then move the paver forward until the screed has cleared the mat.

(c) Raise the screed and move the paver forward to allow working room.

(d) Rake the material evenly across the width of the mat.

(e) Lay paper across the width of mat, Figure 7

(f) Rake the material evenly onto the paper the same thickness as the mat.

CONDITIONS ENCOUNTERED IN PAVING

The following information is designed to aid the operator when faced by various conditions that are encountered during paving operations. While it would be impossible to cover all conditions, the following are the most common in everyday operation.

General

Inspect the road ahead of the paver; watch for grade changes, and adjust screed thickness controls gradually to compensate for these changes in grade.

(1) Mat thickness cannot be held to a fine measurement. Material will be thinner over high spots and thicker over low spots. Always maintain a level surface.

(2) When resurfacing, specifications may call for a mat too thin to cover the high spots, thus the screed will drag. The operator should watch for such high spots and have them bladed down be- fore paving. Extreme trouble will be experienced if large stone has been used in the material. This is an important reason why the mat should be at least 1 1/2 times the largest stone size.

(3) When laying a binder course on a base with holes, best results will be obtained by filling these holes with binder ahead of the paver.

(4) Screed should be adjusted to follow the contour of intersections when laying city pavements. More material may be required to obtain this contour.

(5) Never cover catch basins. Always decrease mat thickness if basins are lower at intersections, to give proper slope for collecting water. When paver travels care should be taken not to hook the screed on any rigid object which could damage the strike-off plate or other parts of the assembly.

(6) When changing to faster speeds the screed operator should make any adjustments necessary to maintain proper mat thickness.

(7) When resurfacing city streets, the operator should watch for manholes.

(a) Mark the pavement at one side of the manhole so it can be uncovered after paver passes.

(b) When necessary, the screed thickness control should be changed to allow more material to cover manhole.

(c) If crawler is in line with manhole, adjust thickness control to correct the rising of paver.

(d) If manhole is more than an inch high, a few shovels full of material will enable the crawler to climb over it.

(e) When material covers manhole, it should be cleaned off before roller passes over it.

Mat Conditions

There are various conditions that will affect the finished mat or surface. These conditions are usually an indication of improper adjustment, operation, temperature, crown or material. When these conditions are evident, they can be eliminated by proper corrections made by the operator.

(1) Proper Crown Adjustment - The leading edge or front of the screed should be set with a crown of at least 1/16" more than the trailing edge or rear of the screed. When making final adjustment on mat, do not turn the hex nut more than of a turn at a time. Observe results and make further correction if needed.

(a) If the mat is loose or coarse in the center and the edges are firm, there is not enough crown on the leading edge of the screed.

(b) If a sandy line is present in the center of the mat and the edges are loose, this indicates too much crown on the leading edge of the screed. It can also be due to an incorrect strike-off plate adjustment.

(2) Voids in Mat - When any form of holes show up across the mat surface, these may be due to any of the following:

(a) Material in the form of lumps that are rich in asphalt will not break up and pass under the screed. This starves the mat.

(b) Any foreign object in the material that will not pass under the screed also starves the mat.

(c)Material partially set up due to long hauls is the most common cause of tearing. A mix that is short of solvents also acts the same as a cold load.

NOTE: To correct this type of tearing to the mat surface, first try to remove the cause. When it is impossible to hold the heat in the material due to long hauls, a higher plant mixing temperature should be used. Also, covering loads and insulating truck bodies will help hold the heat. Adding heat to the screed helps to smooth out the mat, because material will not stick to a hot screed.

(3) Tearing of Mat Surface - This tear looks like some object has been dragging or scuffing the surface. This is caused by material sticking to the screed and building up. Heat to the screed will generally take care of this condition. If this condition is not cleared up by heating the screed, the screed should be raised and cleaned. Asphalt containing excess moisture will not lay properly.

(a) If tears appear along the edges of the mat, there is too much material being forced out against the end plate. Adjust gates and automatic feed control to cut down the amount of material in front of the screed.

(b) If the screed surface is rough, or rusty, this condition will also cause tearing. to the mat surface. Also swab or spray screed plate at end of each day's operation.

(c) When mix gradation is low in small sizes of aggregates, the mix will cause an open- type surface texture. When this is not desirable in the mix, a sufficient amount of smaller aggregate sizes should be added.

(d) Always be careful not to overheat the screed when material requires a heated screed. Overheating may warp the screed.

(4) Cracks in the Mat -When cracks show up across the mat in various places, this is caused by the material being unworkable and dry. It is not being compacted properly under the screed. This can be corrected by one of the following:

(a) Increase the intensity of the vibrators.

(b) Add heat to the screed or change the specifications.

(c) Screed tear marks should not be confused with roller cracks, although they are similar in appearance. Roller cracks are the result of too much rolling.

APPLICATION OF ASPHALTIC MATERIALS

a. Equipment and Temperature Control -Whether or not a job is successful, depends in large measure upon the way the asphaltic materials are incorporated into the road surface. Good work requires good equipment and skillful operation.

b. Experience has demonstrated that the best results in asphalt construction are obtained when the work is done in summer temperatures.

c. Practically all asphaltic materials are applied at higher than atmospheric temperatures, which necessitates heating in most cases.

d. Temperature of Use - Following is a table of temperature limits which should govern the use of various asphaltic materials. These temperatures will insure a sufficiently liquid condition for the use which each material is to serve.

ASPHALTIC MATERIAL	Temperature ˚F
Asphaltic Cements	275-350
SC-O	50-120
SC-1	80-125
SC-2	150-200
SC-3	175-250
SC-4	175-250
SC-5	200-275
MC-0.	50-120
MC-1	80-125
MC-	150-200
MC-3.	175-250
MC-4	175-250
MC-5	200-275
RC-0	50-100
RC-1	80-125
RC-2	100-175
RC-3	150-200
RC-4	175-250
RC-5	200-275
Emulsified Asphalt	50-120

e. General Conditions Prior to Placement of Plant Mix - Plant mixtures should only be laid upon a base which is dry, or at least free from standing water and only when weather conditions are suitable. Prior to the delivery of mixture on the work, the prepared base should be cleaned of all loose or foreign material.

f. Spreading Asphalt Mixtures - All hot-laid mixtures should be delivered on the work at temperatures which will permit ready, spreading without segregation of aggregate or asphalt. For several types they are:

(1) Asphaltic surface course	225 to 325°F
(2) Asphaltic concrete base course	285 to 325°F
(3) Stone-filled sheet asphalt surface course	250 to 350°F
(4) Sheet asphalt binder course	225 to 350°F
(5) Cold-laid asphalt surface course	50 to -50°F

NOTE: The desired temperature should be set by the engineer for the particular mix employed. A variation of 20°F from this temperature, but within limits, may be permitted.

Temperature of Mix

(1) Mix temperature requirements will vary with the type of work being done, time of day, air temperature, type of asphalt being used, and distance material is hauled. By temperature testing and observation an operator can learn to tell whether the mix temperature should be increased or decreased to fit his particular job conditions.

(2) Usually the asphalt plant can produce the asphaltic mixture at temperatures below that which is determined by the paver operator to be best. Keep the temperature of the mix at the correct point to assure good mixing and coating of the aggregate particles in the plant as well as proper workability in placing on the road.

(3) From experience with the "CEDARAPIDS" Paver, the temperature that is usually recommended is a minimum of 250° for the medium and high penetration asphalts and a minimum of 300° for low penetration asphalts, such as 40 or 50 penetration.

NOTE: Many mat defects can be traced to incorrect temperature of mix at the Paver.

Silicone Additive for Hot Mixed Asphaltic Concrete

Excellent results have been obtained by adding a Silicone fluid to liquid asphalt prior to mixing with aggregate. This additive is Dow Corning 200 Fluid 1,000 CS manufactured by Dow Corning Corporation, Midland, Michigan. With the addition of a few ounces of this silicone into the asphalt tanks, very definite improvement was noticed in overcoming difficulty of spreading some types of hot asphalt paving mixtures. When critical conditions such as foaming, flushing, flatting of loads are occurring, and complete drying is border line this silicone additive will considerably improve the laying of mix by the paver.

Basically, silicone additive improves the laying characteristics of certain type of surface, or fine aggregate type mixes. Improvement is also noted where there is a predominance of native or natural sand materials used in a blended state, and also where drying of fines to eliminate internal moisture is borderline. Experience to date indicates coarse aggregate mixes (base and binder) do not respond as readily as fine aggregate surface mixes.

No claim is made that silicones provide a cure- all for all surface course laydown problems. Silicone will not replace drying of the aggregates but does provide some desirable reactions when critical conditions are encountered. Usually, the two main problems observed when lay-down was unsatisfactory before adding silicone were:

(a) Some slumping of the mix in the truck.

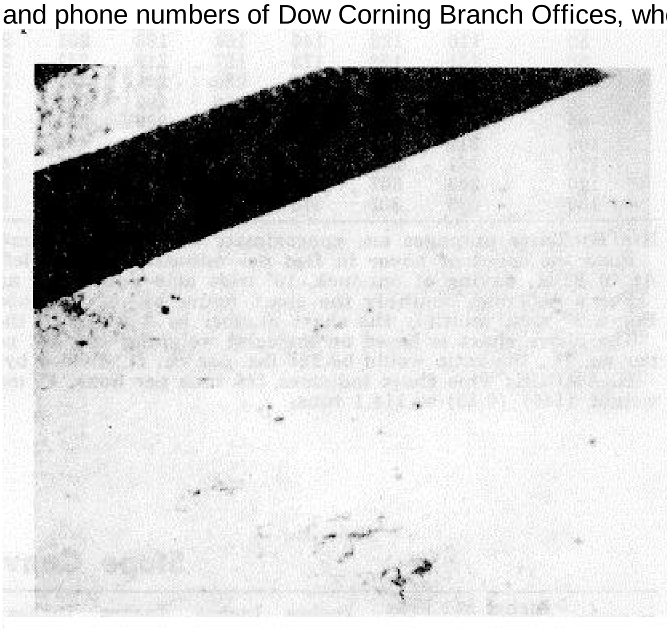
(b) Behavior of the Paver such as you get when there is moisture in the mix.

Both of these conditions changed to satisfactory after adding silicone. No detrimental effects to the quality of the asphaltic concrete was found in jobs reported. They passed all standard tests. Tests were made by the State Highway Commissions before and after treatment and mix was always within specifications.

It is important that the correct quantity of silicone be thoroughly mixed in the asphalt, and good results have been obtained by diluting two (2) ounces of silicone in two (2) gallons of kerosene or No. 1 diesel fuel. Then add this mixture to a 10,000 gallon tank of asphalt. This is equivalent to about two (2) parts per million (PPM) content. Some contractors add this to the asphalt transport trucks before it is pumped into the storage tanks at the plant. This helps provide the necessary mixing when pumped to the storage tanks. Some State specifications require that silicone be added at the refinery and be thoroughly mixed by mechanical means.

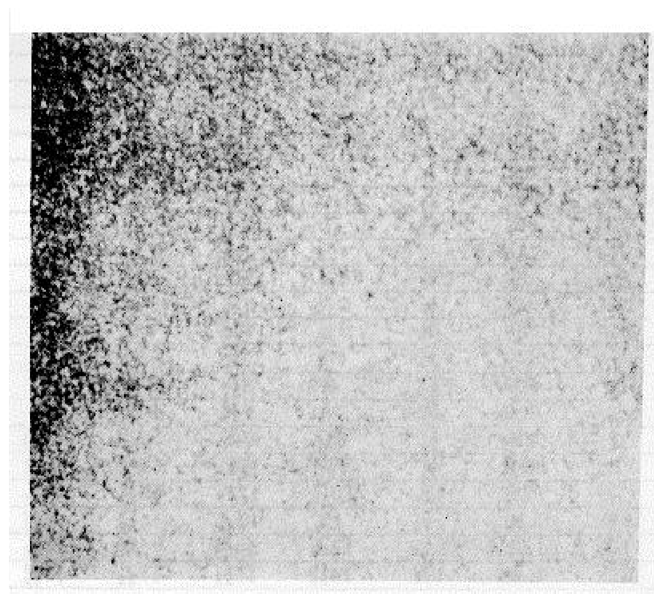
Dow Corning Corporation definitely specifies #200 Fluid Q 1000 CS (Centistrokes) viscosity for use with hot asphaltic mixes. Even though other viscosities are available, **the 1000 CS viscosity should be used!**

Iowa Manufacturing Company does not stock or sell this product, but will supply upon request the addresses and phone numbers of Dow Corning Branch Offices, where this product can b(purchased.



Mat Surface Before Adding Silicone Compound

Figure 8



Mat Surface After Adding Silicone Compound

Figure 9

Approximate Asphalt Paving Tonnage for 1" Mat in Tons Per Hour

(Based on Material Weighing 146 lbs. Per Cu. Ft.)

Speed in FPM	Paving Width in Feet 6′	7′	8′	9′	10′	11′	12′	13′	14′	15′	16′	17′	18′	19′	20′
10	22	26	29	33	37	40	44	48	51	55	58	62	66	69	73
20	44	51	58	66	73	80	88	95	102	109	116	124	131	139	146
30	66	77	87	99	110	120	131	142	153	164	175	186	197	208	219
40	88	102	116	131	146	161	175	190	204	219	233	248	263	277	291
50	110	128	146	164	183	201	219	238	256	273	291	310	329	347	365
60	131	153	175	197	219	241	263	285	307	328	349	372	394	416	438
70	153	179	204	230	256	281	307	332	358	383	407	434	460	485	511
80	175	204	233	263	292	321	350	380	409	437	466	496	526	555	584
90	197	230	261	296	329	361	394	427	460	492	524	558	591	624	657
100	219	256	291	329	365	402	438	475	511	547	582	620	657	694	731
110	241	281	320	361	402	442	482	522	562	601	640	681	723	763	803
120	263	307	349	394	438	482	526	569	613	655	698	743	788	832	876
130	285	332	378	427	475	522	569	617	664	710	757	805	854	902	949

NOTE: These tonnages are approximate and based on continuous feed. Also specific weights of asphalt mixes will vary.

Read the speed of paver in feet per minute down the left hand column and paving width across the top. For example: At 40 FPM, paving of one-inch, 10′ wide mat would take approximately 146 TPH.

For a ½" mat, multiply the chart figure by .5. The above example, for ½" mat, would be approximately 73 TPH. For a 2" mat, multiply the chart number by 2 which in the above example would be approximately 292 TPH.

The above chart is based on material weighing 146 lbs. per cu. ft. Therefore, if an actual material weight was 124 lbs. per cu. ft., the ratio would be 124 lbs. per cu. ft. divided by 146 lbs. per cu. ft., giving you 0.85 of the value shown.

EXAMPLE: This chart indicates 146 tons per hour, 1" mat at 40 FPM with 10′ width. At 124 lbs. per cu. ft. material weight (146) (0.85) = 114.1 tons.

Slope Conversion Table

Percent Slope	Inches Per Foot		Inches Per 10′	Inches Per 11′	Inches Per 12′	Inches Per 13′	Inches Per 14′	Inches Per 15′	Inches Per 16′	Inches Per 17′	Inches Per 18′	Inches Per 19′	Inches Per 20′
	Actual Decimal	Approx. Fraction											
0.10%	.012	1/64	1/8	1/8	5/32	5/32	5/32	3/16	3/16	7/32	7/32	7/32	1/4
0.13%	.015	1/64	5/32	5/32	3/16	3/16	7/32	7/32	1/4	1/4	9/32	9/32	5/16
0.20%	.024	1/32	1/4	1/4	9/32	5/16	11/32	3/8	3/8	13/32	7/16	15/32	15/32
0.26%	.031	1/32	5/16	11/32	3/8	13/32	7/16	15/32	1/2	17/32	9/16	19/32	5/8
0.30%	.036	3/64	3/8	13/32	7/16	15/32	1/2	17/32	9/16	5/8	21/32	11/16	23/32
0.40%	.048	3/64	1/2	17/32	9/16	5/8	11/16	23/32	25/32	13/16	7/8	29/32	31/32
0.50%	.060	1/16	19/32	21/32	23/32	25/32	27/32	29/32	31/32	1 1/32	1 3/32	1 1/8	1 3/16
0.52%	.062	1/16	5/8	11/16	3/4	13/16	7/8	15/16	1	1 1/16	1 1/8	1 5/32	1 1/4
0.60%	.072	5/64	23/32	25/32	7/8	15/16	1	1 3/32	1 5/32	1 7/32	1 9/32	1 3/8	1 7/16
0.78%	.093	3/32	15/16	1 1/32	1 1/8	1 7/32	1 5/16	1 13/32	1 1/2	1 19/32	1 11/16	1 25/32	1 7/8
0.80%	.096	3/32	31/32	1 1/16	1 5/32	1 1/4	1 11/32	1 7/16	1 17/32	1 5/8	1 23/32	1 13/16	1 29/32
1.0%	.120	1/8	1 3/16	1 5/16	1 7/16	1 9/16	1 11/16	1 13/16	1 29/32	2 1/32	2 5/32	2 9/32	2 13/32
1.5%	.180	3/16	1 13/16	1 31/32	2 5/32	2 11/32	2 17/32	2 11/16	2 7/8	3 1/16	3 1/4	3 13/32	3 19/32
2%	.240	1/4	2 7/16	2 5/8	2 7/8	3 1/8	3 3/8	3 19/32	3 27/32	4 3/32	4 5/16	4 9/16	4 13/16
3%	.360	3/8	3 5/8	3 31/32	4 5/16	4 11/16	5 1/32	5 13/32	5 3/4	6 1/8	6 15/32	6 27/32	7 3/16
4%	.480	15/32	4 13/16	5 9/32	5 3/4	6 1/4	6 23/32	7 3/16	7 11/16	8 5/32	8 5/8	9 1/8	9 19/32
5%	.600	19/32	6	6 19/32	7 3/16	7 13/16	8 13/32	9	9 19/32	10 3/16	10 13/16	11 13/32	12
6%	.720	23/32	7 3/16	7 29/32	8 5/8	9 3/8	10 3/32	10 13/16	11 17/32	12 1/4	12 31/32	13 11/16	14 13/32
7%	.840	27/32	8 13/32	9 1/4	10 3/32	10 29/32	11 3/4	12 19/32	13 7/16	14 9/32	15 1/8	15 31/32	16 13/16
8%	.960	31/32	9 19/32	10 9/16	11 17/32	12 15/32	13 7/16	14 13/32	15 3/8	16 5/16	17 9/32	18 1/4	19 3/16
9%	1.08	1 3/32	10 13/16	11 7/8	12 31/32	14 1/32	15 1/8	16 3/16	17 9/32	18 3/8	19 7/16	20 17/32	21 19/32
10%	1.20	1 3/16	12	13 3/16	14 13/32	15 19/32	16 13/16	18	19 3/16	20 13/32	21 19/32	22 13/16	24
11%	1.32	1 5/16	13 3/16	14 17/32	15 27/32	17 5/32	18 15/32	19 13/16	21 1/8	22 7/16	23 3/4	25 3/32	26 13/32
12%	1.44	1 7/16	14 13/32	15 27/32	17 9/32	18 23/32	20 5/32	21 19/32	23 1/32	24 15/32	25 29/32	27 3/8	28 13/16

All figures shown in feet are measured horizontally.

All figures shown in inches are measured vertically and are accurate to within 1/32 inch.

TROUBLE-SHOOTING CHART

POSSIBLE CAUSES \ MAT CONDITIONS	Bad Longitudinal Joints	Bad Transverse Joint	Bleeding	Brown Streaked Surface	Checking Under Roller	Deep Transverse Cracks Full Width of Strip	Fluctuating Surface Texture	Lean, Brown, Dead Appearance of Surface	Mat Shoving Ahead of Roller	Pockmarked Surface	Poor Leveling Control of Screed	Rich, Shiny Appearance of Surface	Roller Marks	Rough, Uneven Surface	Screed Marks	Surface Cracks At Edges of Strip	Surface Cracks In Center of Strip	Transverse Hair Cracks In Surface	Unsatisfactory Compaction	Varying Surface Cracks On Strip Surface	Water Pockets, Short Low Section In Surface	Wavy Surface (Long Waves)	Wavy Surface (Short Waves)
Too much lead crown in screed																X							
Not enough lead crown in screed																	X						
Loading screws too heavy																							X
End of screw disengaged																X				X			
End plates not square																X							
Vibrator not operating															X				X				
Worn out screed plate	X									X				X		X	X			X			
Too much raking and sanding behind machine							X			X													
Rolling too fast	X				X								X	X				X	X	X		X	
Reversing or turning too abruptly					X				X				X	X						X	X		
Roller too heavy					X				X				X	X									
Roller too light																			X				
Too much rolling					X									X							X		
Inadequate rolling													X	X				X	X	X	X		
Roller on fresh surface too soon									X				X	X				X		X	X	X	
Allowing roller to stand on new surface																					X		
Not rolling joint soon enough	X	X																			X		
Too much slack in roller drives													X	X				X		X	X		X
Water not used on rollers	X												X	X									
Incorrect height of screed pull point on tractor														X									
Loose screed pull arm ball joints														X									
Loose ball joints on screed depth adjusting mechanism														X									
Worn bushings in track lower rollers		X												X									X
Loose screed plate														X									
Screed pull point too low on track											X				X						X		X
Poor control of material in front of screed											X			X		X	X						
Improper material level in front of screed	X														X								
Improper operation of paver	X	X									X			X	X	X	X	X		X		X	X
Improperly graded mix	X		X	X	X	X	X	X	X		X	X		X		X	X		X	X	X		
Poor temperature control of mix	X					X	X	X			X	X				X	X	X	X	X		X	X
Poor preparation for joint		X																					
Too much asphalt in mix			X						X			X		X									
Poor asphalt product				X	X		X	X	X			X							X				
Lack of asphalt in mix					X			X											X				
Fluctuation of asphalt in mix											X												
Over-controlling of screed	X										X			X								X	
Material too cold										X													
Segregation in mix										X													
Soft stone or clay balls in mix										X												X	X
Excess moisture in mix								X	X														
Unstable mix	X				X	X			X		X		X	X				X		X	X		X
Poorly graded base surface											X			X					X		X		
Brakes set on truck															X							X	
Trucks bump paver															X								
Crawler drive clutches slipping	X																						
Segregation of mix in trucks							X							X							X		
Hydraulic screed lift not released											X			X					X			X	
Gas and oil spilled on surface				X						X													
Soft base					X	X			X		X			X					X	X	X		
Prime or tack coat too heavy			X		X				X														
Dusty or dirty base					X				X														
Prime or tack coat not used					X																		

SECTION X
CLEANING and LUBRICATING PAVER

Cleaning Paver

It is extremely important that the paver be thoroughly cleaned at the end of each day's operation!. A spray nozzle with 15 foot hose is attached to the pressure side of the screed heater fuel system. This permits the operator to reach all areas of the paver which require cleaning and lubricating.

Method:

(1) Run engine at IDLE speed.
(2) Set valve selector switch to SPRAY-DOWN
(3) Push panel circuit breaker to ON
(4) Turn junction box burner switch to ON
(5) Depress hose line valve lever

Clean all parts of the paver which come in con- tact with asphalt. The track and track rollers, hop- per, slat conveyors, spreader screws, screed, drive chains, etc. all require cleaning at the end of each day. This holds true even if the paver was actually used only a short time. **Many paver troubles can be traced to improper cleaning!** Fuel oil on the slat conveyors and tracks provides the needed lubrication which prevents rapid wear. The spray should reach all track link pins so that there is no squeaking as the paver moves. The slat conveyors should be operated during the spraying to be sure that all of the slats and chain are reached.

> **IMPORTANT!** Keep oil spray away from all electrical boxes, motors, generators, starters, etc. Do not spray paver when it is parked on an asphalt mat! Move it to the side of the road where drainage of oil and dissolved asphalt will not damage anything.

In addition to spray cleaning of the paver the following clean up practices should be routine.

1. Check for accumulation of asphalt in the heat vent holes along the top of the moldboard.

This check can best be made by feeling the exhaust of hot air when the heater is being operated (the upper vents become plugged when asphalt spills over the moldboard when a material level too high above the screw is allowed to build up. Use a stiff wire to clean out accumulated asphalt.

Cleaning Paver with Screed Heater Fuel Spray Accessory
Figure 1

2. Periodically remove the screed plate as de- scribed in Screed Section 7 and clean the interior of all asphalt, sand, and fine material. Failure to keep the inside of the screed plate clean will cause uneven distribution of heat to the screed bottom and possible tearing of the mat surface.

TRUCK ROLLERS

Two rollers located on the front of the hopper are lubricated before assembly and require no further lubrication. However, these rollers should be cleaned often during operation to eliminate material build-up.

LUBRICATION - GENERAL SUGGESTIONS

PROPER LUBRICATION:

Proper Lubrication helps obtain top equipment performance and minimum down-time from worn out bearings. Make it a daily practice. Be sure to comply with all lubrication instructions on the following Lubrication Chart. Do **not neglect any area or detail!**

TOO MUCH GREASE:

Too Much Grease pumped into bearing housings can overheat bearings and reduce their service life. Use good judgment.

TOO MUCH LUBRICANT PRESSURE

The use of too much pressure when lubricating **a sealed bearing** can blow-out the soft seal ring. Once the seal is blown, the bearing has no grease retention ability and no protection against the entry of dirt into the race area. Rapid failure results!

When using a hand operated grease gun, stop pumping as soon as the easy stroking begins to change to a hard pumping requirement. When using a pressurized grease system, develop a "feel" for the correct pressure of gun against fitting for automatic pressure relief in case the bearing be- comes filled.

SELECTION OF LUBRICANTS:

Texaco Lubricants are recommended on the lubrication chart following. Use only recommended lubricants.

GOOD HABITS:

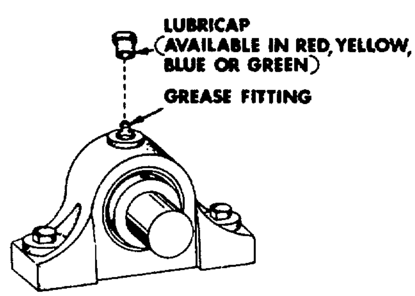
Cleanness when lubricating is vital! The grit which is always present around grease fittings and oil reserves can destroy a good bearing surface rapidly if it is forced inside with the lubricap.

When using a grease gun, wipe the nozzle clean before use.

Wipe grease fittings absolutely clean before each application or keep them covered with the special plastic Lubricaps which are on each paver fitting when it leaves the factory. Keep lubricaps clean while they are off the fittings. Leave an excess of grease on each fitting.

Don't wipe it off until the next greasing. It protects the fitting.

Use grease gun with cartridge type supply unit for positive elimination of dirt and abrasive particles in the new grease.



Plastic Lubricap for Bearing Grease Fittings

Figure 2

COLOR CODED LUBRICAPS

Lubricaps can be installed on all fittings to keep the area around the grease fittings free from dirt and dust. This Neoprene cap is easily removed and replaced. These inexpensive Lubricaps are available in quantities and can be ordered for placement on equipment in the field. Lubricaps are available in colors, so the customer can establish a coding system for different types and time intervals of lubrication. Grease guns and lubricant containers with matching color coding make correct lubricating routines easier.

Correct lubrication practices and continued use of the Lubricaps will insure the customer a longer bearing life, as well as eliminate many hours of unnecessary down time. It is important that the lubrication requirements be thoroughly under- stood and followed. **SCHOOL YOUR LUBRICATION MAN.**

(a) **Bearing Inspection**

Anti-friction bearing assemblies should be checked immediately after stopping the paver, whenever possible, as their failure is most easily detected by a high operating temperature. If a bearing is too hot to be touched, it is either running without any lubricant; with too much, or has failed.

(b) **Transmission**

The main transmission for the "CEDARAPIDS" Bituminous Paver has a capacity of 17 quarts and should be lubricated with Texaco Multigear or Universal Gear Lubricant EP 90. It is important that the operator check for a flow of oil through the sight gauge each day and check the **level of the transmission** when making general lubrication inspections. The transmission should be flushed with Rando AA oil every 1,000 hours or seasonally. (See lubrication chart.)

(c) **Transfer Gear Cases**

There are two transfer gear cases, one located on each side of the paver. Both have a capacity of 91/ quarts. Use Texaco Multigear or Universal Gear Lubricant EP 90. The same instructions for flushing and checking should be followed as for the main transmission. (See lubrication chart.)

(d) **Hydraulic System**

The system has a capacity of 10 gallons. Use Texaco Rando HD-C Oil. When filling the reservoir tank it is important that the fluid is allowed time to flow and fill the system. Every 1,000 hours this system must be drained, the strainer washed, and refilled with recommended lubricant. (See Section 5 for complete details).

(e) **Slat Conveyor Bearings**

Each of the two slat conveyors have four bearings. Two are mounted at the front of the paver and two at the back. The lubrication of these bearings is important. They should be lubricated every 8 hours of operation with Texaco Marfak O lubricant.

(1) To lubricate front slat conveyor bearings, remove front hopper cover plate. (See lubrication chart.)

(2) To lubricate rear slat conveyor bearings, see lubrication chart.

(f) **Conveyor Drive Chains**

The four conveyor drive chains should be lubricated once each week to minimize wear. To reach the chains connecting each conveyor drive shaft to the countershafts, remove the rear deck plate on each side of the engine. The two chains connecting the countershafts to the conveyor shafts are located directly beneath the rear end of the engine and are readily accessible. Lightly coat all chain links with Texaco EP90 Universal Gear Lubricant. (Also used in the paver gear cases).

(g) **Track Assembly**

(1) Crawler Track Link Pins - Spray fuel oil over crawler tracks when cleaning paver at the end of each day's operation to lubricate link pins and keep them from squeaking.

(2) Paver tracks are driven from the transfer cases with heavy duty chains and sprockets, that require cleaning and lubricating at the end of the day's operation. Remove the two rear deck plates and spray fuel oil over the chain and sprocket using the wash-off hose from the heater fuel tank. This will normally keep the asphaltic material soft so that it falls off during the following day's operation.

Failure to spray the chain can result in the asphaltic material building up in the chain and on the sprockets until the chain becomes so tight it will cause the chain to break.

CAUTION: When spraying chain and sprockets, use care not to spray the electric clutch on transfer case.

(3) Lower roller and track roller and pivot shaft assemblies are equipped with grease fittings to lubricate the pivot pins and each roller with Texaco Marfak O lubricant every 8 hours of operation. (See lubrication chart).

(4) Track rear sprocket or front idler - Once each year remove the fill plugs and install grease fitting. Add Texaco Marfak O lubricant until new lubricant appears at opposite pipe plug hole. Re- move fitting and replace both pipe lugs. (See illustrations in Maintenance Section II)

(h) **Spreader Screw Bearings**

All bearings for the spreader screws have grease fittings which are easily accessible and should be' lubricated every 8 hours of operation. It is important these fittings be cleaned before lubricant is applied. Use Texaco Marfak O lubricant. (See lubrication chart).

(i) **Travel and Feed Clutches** - All travel and feed clutch bearing assemblies must be disassembled and repacked with Texaco Marfak O lubricant every season.

(j) **Screed Adjusting Mechanism and Pull Arms**

Ball joint housings on screed adjusting mechanisms and pull arms are equipped with grease fittings to lubricate the ball joints with Texaco Marfak O lubricant every 8 hours of operation. (See lubrication chart).

(k) **Pulleys For Screed Lift Cables**

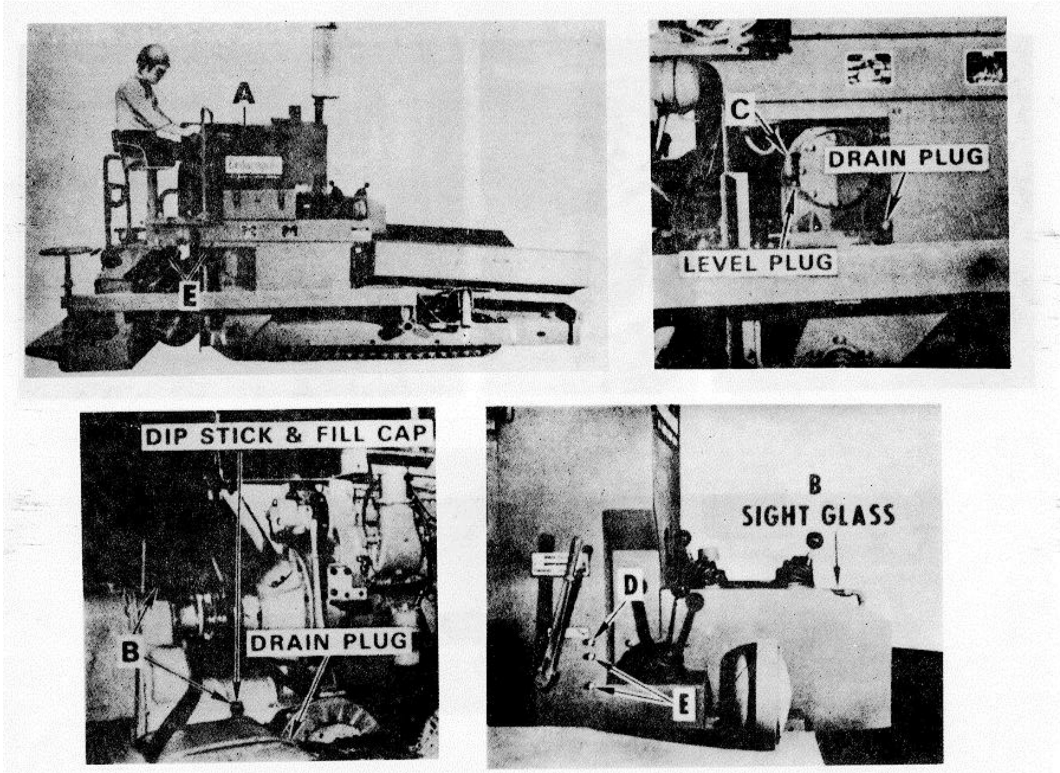
There are two pulleys for each screed lift cable and each has a grease fitting. The fitting of the enclosed pulley is not in plain sight. All four fittings should be greased once each month

(1) Power Unit

The diesel engine that powers the paver must be properly lubricated and maintained to insure the dependable and smooth performance needed in a paving operation.

An individual instruction manual is provided, carefully outlining intervals of time to lubricate, clean air filter, and change oil along with other points of preventative maintenance. More frequent replacement or cleaning of air filter will be required in dusty conditions.

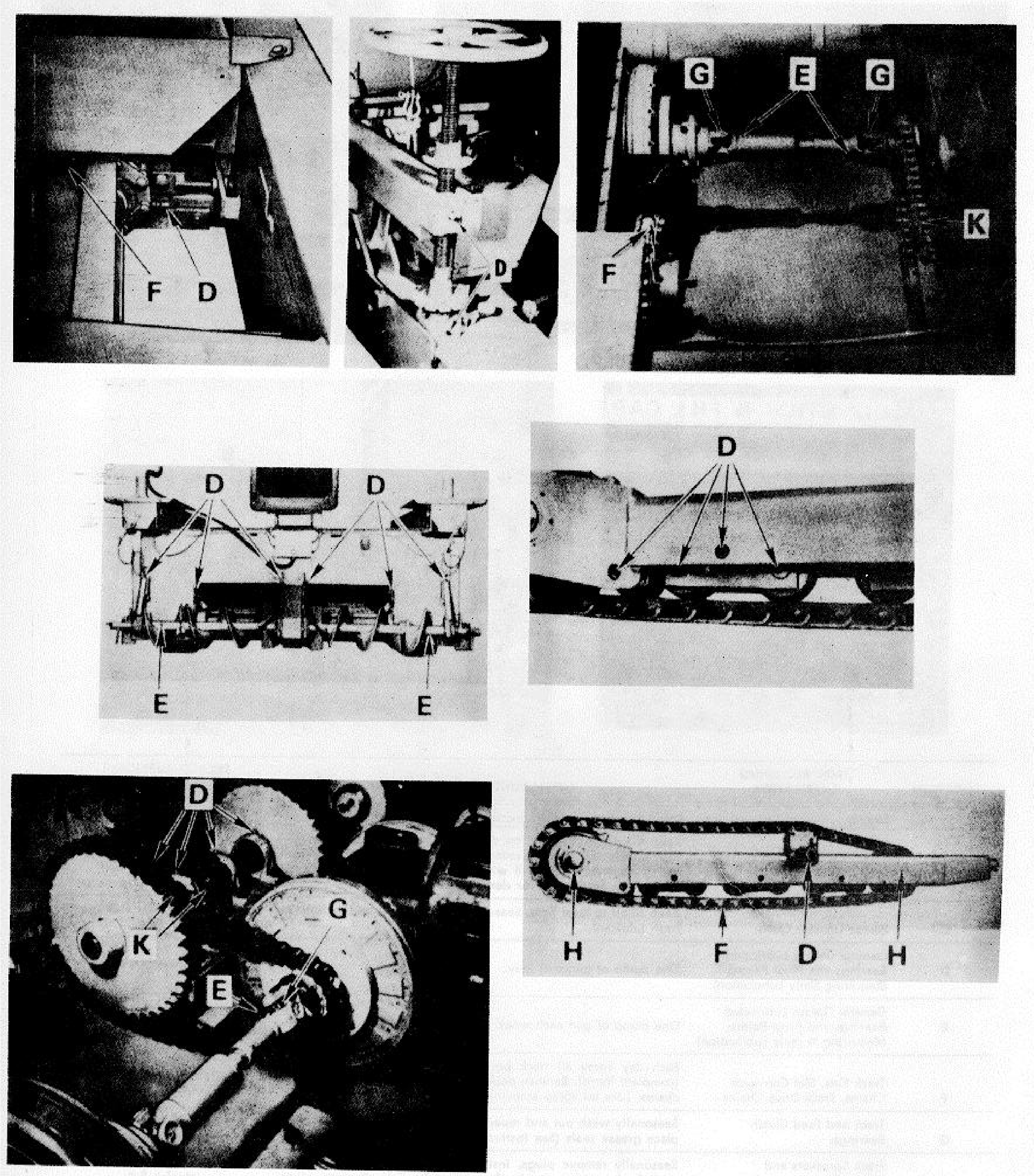
ASPHALT PAVER LUBRICATION CHART



LOCATION	ITEM REQUIRING LUBRICATION	LUBRICATING INSTRUCTIONS	TEXACO LUBRICANT RECOMMENDED
A	Engine:	Refer to Lubrication Requirements in Engine Instruction Manual.	
B	Main Transmission:	Keep filled to show ¼" on dipstick. Sight glass must show oil flow during operation. Seasonally, drain, back-flush filter screen and case. Drain and re-fill with fresh lubricant (See Instruction Manual - Section 11 for details}.	EP90 Universal Gear Lubricant* (Flush with Rando AA Oil)
C	Power Transfer Cases:	Keep filled to level hole. Seasonally, drain, flush and re-fill with fresh lubricant.	EP90 Universal Gear Lubricant* (Flush with Rando AA Oil)
D	General Grease Lubricated Bearings and Pivot Points: (Requiring Daily Lubrication)	One pump of gun each day.	Marfak # 0
E	General Grease Lubricated Bearings and Pivot Points: (Requiring Weekly Lubrication)	One pump of gun each week.	Marfak # 0
F	Track Pins, Slat Conveyor Chains, Track Drive Chains	Each day spray all track pins. Spray all slat conveyor chains Incomplete loops). Remove deck plates and spray both track drive chains. (Use oil spray accessories from screed heater system].	Fuel Oil
G	Track and Feed Clutch Bearings:	Seasonally wash out and repack bearings and lube chamber. Re-place grease seals (See Instruction Manual - Section 11).	Marfak # 0
H	Track Sprockets and Track Idlers:	Seasonally remove plugs, install temporary fitting, add grease until fresh grease extrudes from opposite hole. Remove plugs.	Marfak # 0
K	Conveyor Drive Chains:	Once each week coat all conveyor drive chains lightly.	EP 90 Universal Gear Lubricant

***IMPORTANT NOTE:**
Never mix brands of lubricant in paver gear cases. Chemical inter-action can occur to produce harmful, non-lubricating compounds. If uncertain of **lubricant** in a gear case, drain, flush and re-fill. DON'T JUST ADD MORE LUBRICANT!

(See Over)



(See Over)

SECTION XI
Mechanical Maintenance

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CRAWLER TRACKS

The most expensive mistake the owner of any track type piece of equipment can make is to assume that such an uncomplicated mechanism as a crawler **track** needs no care. An effective service life is built into the track, but without proper care its life will be shortened.

The track, rollers, sprockets and take up idlers should be inspected at least once a week. Lubrication should be according to recommendations. Everytime the paver is cleaned, the track should be sprayed with fuel oil. There is enough lubricant in the fuel oil to keep the track pins from rusting and binding.

Track tension is most important. The tension de- termination method shown in Figure 2 is a **guide. Proper track tension depends on the type of laying operation.** When the base is sandy there tends to be a buildup on the track bushings. This material will pack and the track tension will increase. The drive sprocket will jump in the track and cause excessive strain on the rear track sprocket bearings and front idler bearings.

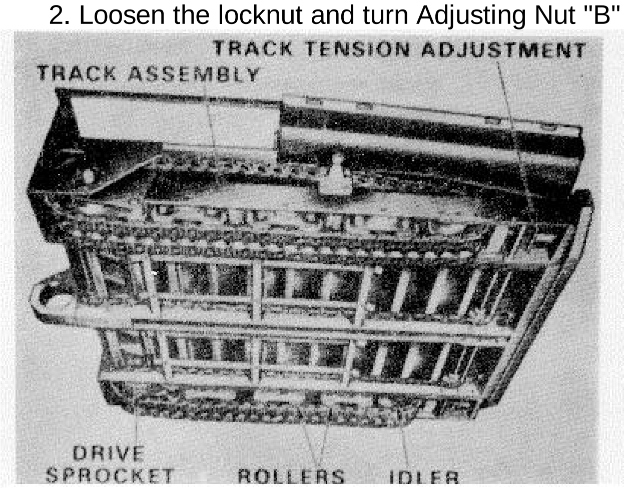
If the tracks are too tight, there is unnecessary strain on the drive assembly and the engine will lug excessively, and fuel consumption will be high.

A very loose track has a tendency to come off when the machine pivots or backs up an incline. Even if it does not come off a loose track still may cause wear on the rollers, sprocket teeth and track. Loose track will tend to whip at travel speeds, which will cause severe impact loads on all running gear parts and allow additional movement of the contacting surfaces, which consequently increases wear to all parts.

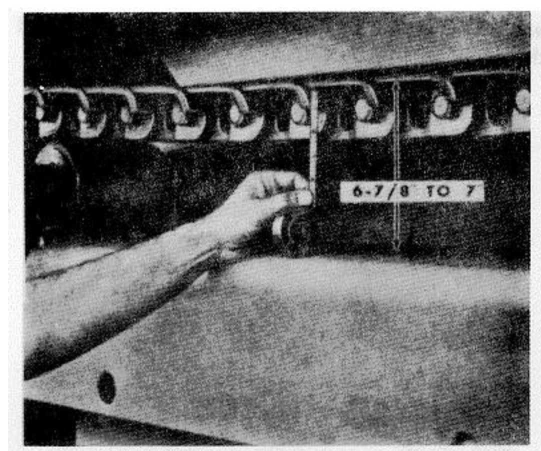
IMPORTANT! A new paver or one having a new set of tracks will require daily tightening of the tracks until all link pins have "worn in" and stretching of the track no longer occurs. When this initial stretching stops it will only be necessary to check and tighten the tracks occasionally.

Method of Adjusting Track Tension:

1. Drive the paver to a point where the front end overhangs the track support surface enough to allow the movement of a long handled wrench engaging the track adjusting Nut "B" on each side of the paver (See Figure 3).
2. Loosen the locknut and turn Adjusting Nut "B" in the normal way to tighten or loosen.



Bottom View of Tractor Assembly
Figure 1



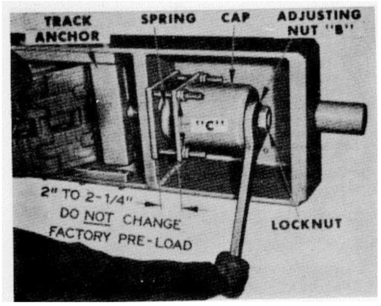
Measuring Track. Tension
Figure 2

3. Take a measurement of the sag in each track (See Figure 2) and adjust the tension accordingly to arrive at the 67/g" dimension shown. Be sure to measure at the **lowest point** of track sag.
4. Tighten the locknuts after making an adjustment.

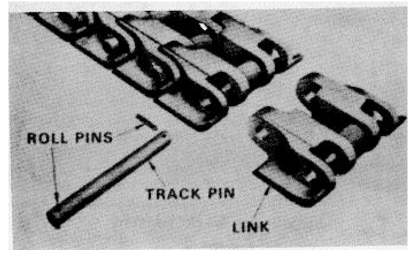
Tension Pre-load:

A minimum tension on the track is set at the factory by adjustment of the "pre-load". The spring is partly compressed by the Cap which is drawn to within 2" or 2¼¥4" of the Base Plate (See Figure 3) by adjustment of the stud Hex Nuts

"C". This Portion of the tension assembly requires no further adjustment! If a spring or other parts are replaced, adjust the Pre-load to this specified dimension.



Track Tension Adjustment (Factory assembly view)
Figure 3



Track Link and Pin Detail
Figure 4

CAUTION! Always take the proper precautions when making such an adjustment where parts are subjected to strong spring tension.

Replacing Crawler Track Assembly

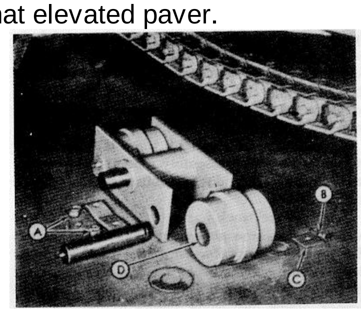
(1) Removing Crawler Assembly: (Figure 4)

a. Elevate paver to allow adequate working area under the hopper.
b. Release tension on track assembly.
c. Drive the roll pins out of each end of one of the track pins.
d. Drive track pin out of crawler link.
e. Attach a cable to the "broken" track and pull track off track frame.

(2) Replacing Crawler Assembly:

One complete track is shipped in two sections for ease of handling. One section of the track will have one (1) more link than the other section. Couple these two sections together with track pin for one complete track assembly.

a. Place blocking of sufficient height on top of track frame to support tracks level with upper roller assembly.
b. Attach cable to one end of the track assembly and pull tracks over top of track frame until loose ends of track are under track frame toward the hopper end.
c. Couple the two ends of tracks together with track pin.
d. Drive roll pin into each end of track pin.
e. Adjust track to the recommended tension.
f. Release and remove jacks that elevated paver.



Oscillating Track Roller (Partially dismantled)
Figure 5

Replacing Oscillating Roller Assembly

(Figure 5)

Three sets of oscillating track roller assemblies are part of each track assembly. When bushings and rollers require replacement, these assemblies can quickly be removed from the track frame by the following procedures:

IMPORTANT: Operating paver with worn track roller bushings will cause wavy surfaces on the laid mat, and unsatisfactory transverse joints, erratic depth control and marks on mat when paver stops. (1) Elevate machine until it is possible to loosen track take-up assembly allowing track to hang free.

(2) Remove the complete oscillating roller assembly by removing the four nuts "A" which hold it to the track frame.

(3) To further disassemble the rollers from the oscillating assembly, remove bolt and lock, Items "B" and "C." Then, push shaft through the roller.

(4) Press out worn bushings "D." Examine bore of roller to be sure that the bore is clean and free from wear marks.

(5) Press the new bushings into the rollers, being careful not to damage or distort the bushing while it is being pressed into position.

NOTE: On earlier model pavers, seals were installed on each end of roller. When installing seals in these assemblies, turn the lip of seals toward the outer edge of roller.

(6) Position roller in oscillating bracket and install shafts through bracket and rollers. Assemble both roller shafts so grease fittings are on the same side of bracket. Assemble the shaft lock "C."

(7) Assemble the oscillating roller assembly into track frame making sure grease fittings are turned to the outside of track.

(8) Lubricate with Texaco Marfax O until lubricant extrudes from assembly.

(9) After replacing all roller bushings the paver must be operated at slower travel speeds. **Do not** travel paver in excess of 129 feet per minute for the first 10 miles. This will only pertain to traveling with the screed raised. During "break in" period lubricate frequently. After "break in" lubricate every day as recommended in lubrication chart.

Track Drive Chain Take-up (Figure 6).

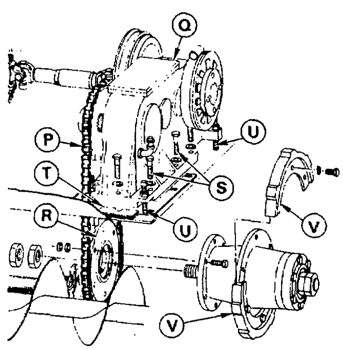
To tighten the right or left drive chain "P" between the transfer Gear Case "Q" and drive sprocket "R" use the following procedure.

(1) Loosen bolts "S" **that** hold transfer gear case "Q" in place.

(2) Loosen the jam nuts on adjusting screws **"**U" (four), then turn the screws downward to raise the transfer case. When the chain tension is correct and the case is parallel to the frame, slip shims "T" under each side of the case to retain the new position. **The chain should have M" deflection on the slack side.**

(3) Unscrew the four adjusting screws "U" so that they do not touch the frame and tighten their jam nuts to keep them in place.

(4) Tighten bolts **"S"** to hold the transfer case solidly in place. Re-check chain tension to be sure it did not change.



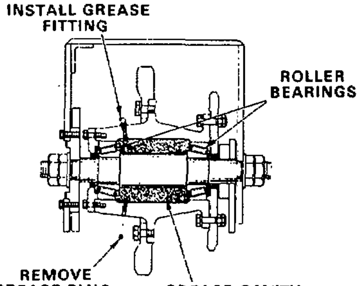
Crawler Track Drive Detail - R.H.
Figure 6

REPLACING TRACK DRIVE SPROCKETS

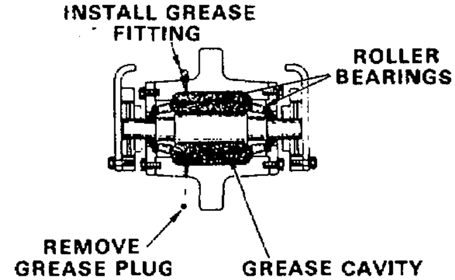
Track drive sprockets are made up of a hub assembly and two bolted-on tooth sections. When the sprocket teeth are worn, these removable sections can be replaced in order to restore the sprocket teeth to new condition. When attaching the new parts apply Locktite Sealant (Grade B) to the capscrew threads to help prevent loosening. Sprocket tooth sections can be replaced **without** disconnecting the track.

TRACK SPROCKET AND IDLER BREARING LUBRICATON

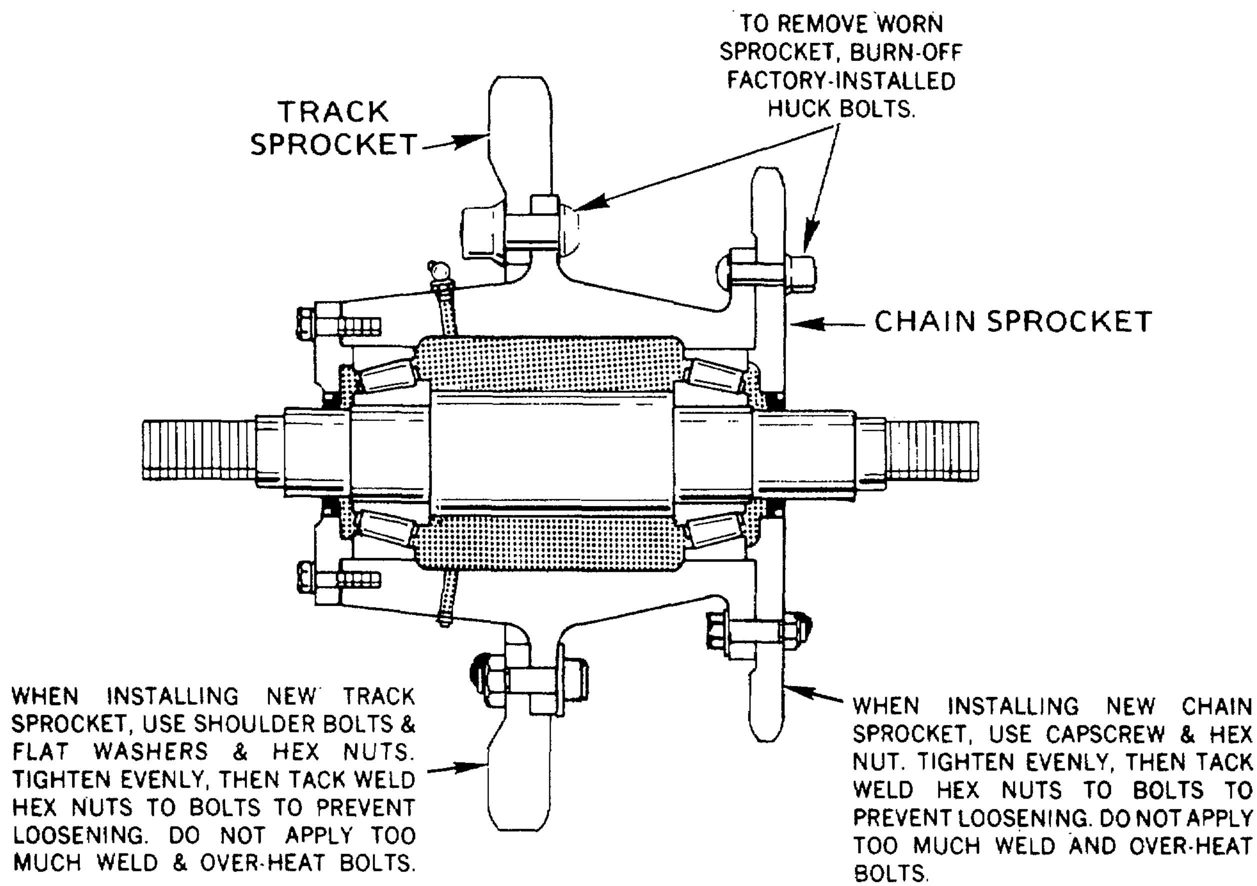
IMPORTANT! Once each seasons remove both grease plugs from the hubs of the two track sprockets and the two track idlers. (see Figures 7 and 8). Install a grease fitting in the upper hole. Pump in fresh grease until it is extruded steadily from the bottom hole. Replace hole plugs.



Cross-section thru Track Sprocket
Figure 7



Cross-section thru Track Idler
Figure 8



Cross-section Thru Track Drive Sprocket Assembly Showing Factory and Field Methods of Sprocket Attachment
Figure 9

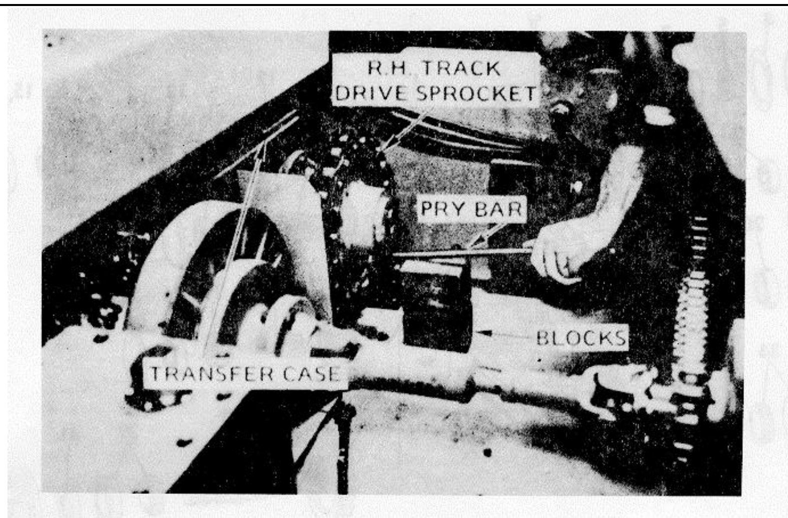
REPLACEMENT OF TRACK DRIVE & CHAIN SPROCKETS WHICH WERE HUCK-BOLTED TO HUB

The two-piece drive sprockets are attached to their hub assembly at the factory by means of "Huck Bolt" fasteners. These special bolts, which employ a high pressure swaging principal for application of the "nut" element, cannot be unfastened, but must be burned off when replacement of the sprocket halves is required. (See Figure 9) The special fastener is used at this point to prevent any loosening of sprockets.

When sprockets become worn and must be replaced, use shoulder bolts of the correct length and hex nuts, in place of the Huck Bolts. **Important! Be sure that the bolt shoulder does not contact the hex nuts when tightened.** Use flat washers under the bolt head, if necessary, to prevent this occurrence. When all bolts are tightened evenly, tack weld each nut to its bolt so that no loosening of the bolts is possible. (See Figure 9) Do not apply too much weld so that the bolt is overheated and stretched.

CHAIN SPROCKETS

The chain sprockets are also attached to the hub at the factory by means of "Huck Bolts". These special fasteners must be burned off and replaced by shoulder bolts when a new chain sprocket is required. Again it is recommended that the hex nuts be tack welded to the bolts after tightening, so that there is no chance of loosening during operation. Page 102



Checking Shaft Bearings For Looseness Figure 10

CHECKING & ADJUSTING TRACK DRIVE TRANSFER CASES

The two transfer cases for the track drive system can best be protected against shock loading and subsequent bearing wear by keeping the tracks and the drive chains properly tightened and well lubricated. When a paver is operated with loose tracks and drive chains, shock loading occurs each time the travel clutches and brakes are engaged. The tapered roller bearings and gears on the output shaft, and the ball bearings and pinion on the stub shaft, are subjected to extreme stress each time the paver starts and stops.

Extreme drive loading also occurs when tracks and drive chains are allowed to accumulate a coating of hardened asphalt. It is important that they be spray cleaned and lubricated thoroughly with fuel oil after each days operation so that the asphalt remains soft and drops off during subsequent operation. When excessive loading is allowed to occur due to inadequate spray cleaning, the drive chains are stretched and develop the looseness that increases shock loading.

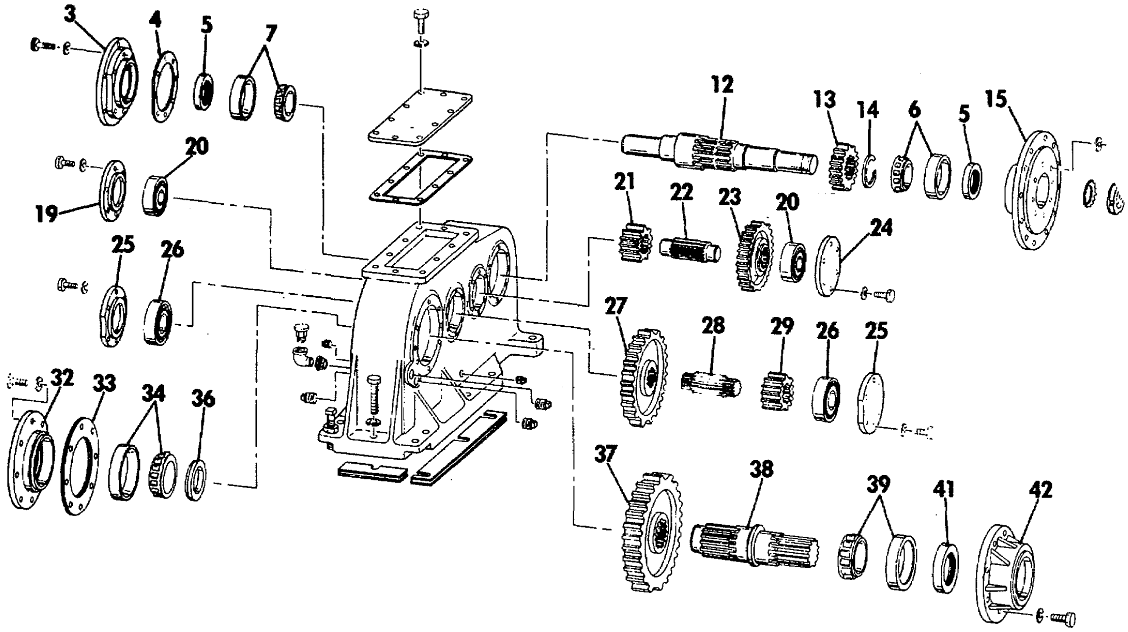
It is recommended that the tension of the drive chains be checked after each week of operation. When correctly tightened a drive chain can just barely be deflected by hand. It should not be drawn up "drum tight".

It is also recommended that anytime a loose chain is to be tightened, the output shaft of that transfer case be carefully checked for looseness.

This can be done as follows:

(1) With paver engine stopped and track brakes Off, turn the clutch rotor on the transfer case so that there is an equal amount of slack in the drive chain on both sides of the sprocket.

(2) Using a pry bar and some blocking as shown in Figure 10, put some upward pressure on the output shaft and see if any vertical movement of the shaft is noticeable. Exert some end wise pressure on the shaft in both directions and see if any horizontal movement of the shaft is noticeable. The output shaft bearings are pre-loaded at assembly and there should be no movement possible in any direction. If there is noticeable movement it is strongly recommended that the transfer case be repaired or adjusted so that a part failure does not occur during operation. The cost of inspection, adjustment, replacement, or field repair during an out-of-service maintenance period is far less than the cost of a break-down during paving.



L.H. Transfer Case (Current Model) - Exploded View Figure 11

TRANSFER CASE INSPECTION & ADJUSTMENT

A.- Remove the transfer case from the paver and move it to a shop area where the unit can be opened, cleaned and inspected internally without risk of contamination from wind borne dust, etc.

B.- Before opening a transfer case clean the outside surfaces of all loose dirt.

C.- Remove the case cover. Drain the oil and flush the interior with solvent to remove all oil and residue.

D.- Inspect the gears for their wear patterns. (See Figure 13) Pay particular attention to the wear patterns of gears (29) and (37), Figures 11 and 12, as the drive loading is greatest on these gears. If any gears in the case show signs of improper wear or if there is a looseness of any shaft or bearing, the case should be dismantled and checked for the following requirements:

(1) All bearings must be tight in the case or retainer. If they are loose due to an out-of-round bore, a new bearing will **not** correct the looseness. Pay particular attention to output shaft area. (Bearings 34 and 39).

(2) All bearings must be in good condition. Worn bearings cannot maintain the high degree of shaft alignment required.

(3) All shafts must be rigidly fixed in a parallel attitude.

(4) Input shaft should not have more than .003” end float. (See Step E)

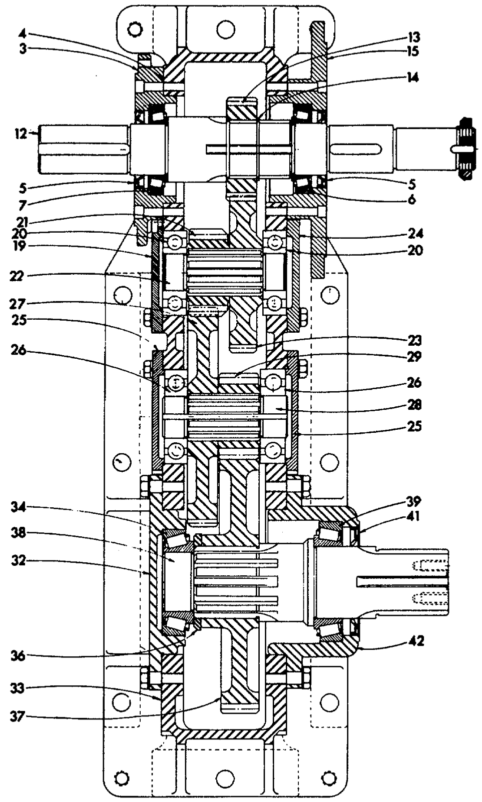
(5) Tapered roller bearings on output shaft must be accurately pre-loaded. (See Step H)

(6) Oil seals must be in good condition so that a rapid loss of oil does not occur.

E.- If necessary, make a micrometer check at the two critical points on each bearing retainer (3) and (15) for the input shaft (12). See Figure 16 for correct dimensions. In the event they are worn out- of-tolerance replace the retainers.

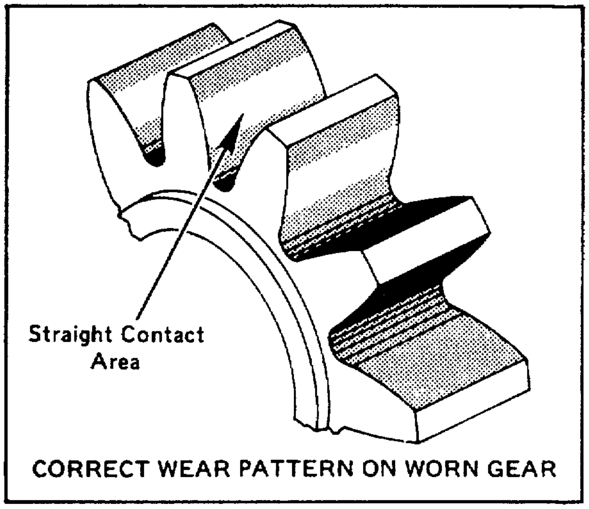
Adjust the clearance of the tapered bearings (6) and (7) on input shaft (12). This is done by adjusting shim kit (4) so that the shaft has .001" to .003" end float. **(Important! The installation of new bearings will help assure trouble-free performance.)**

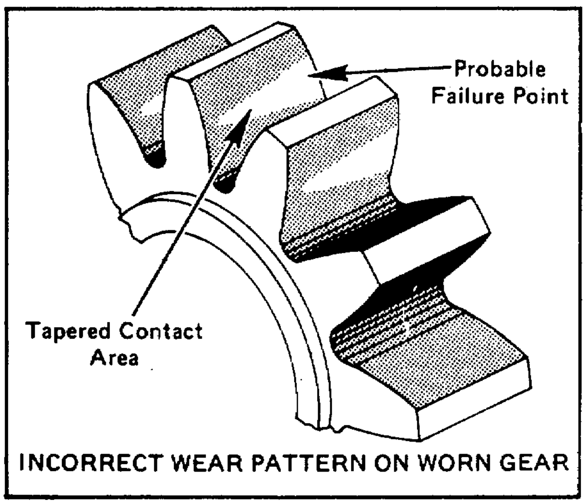
F. - Carefully check the two stub shafts for vertical looseness. If there is looseness in shafts(22) or (28)- replace the ball bearings (20) and (26). (There is no ball bearing adjustment.) However, before installing new bearings at these points check. The bores of the housing for size, roundness, and axial alignment. (See Figures 17 and 18 for correct



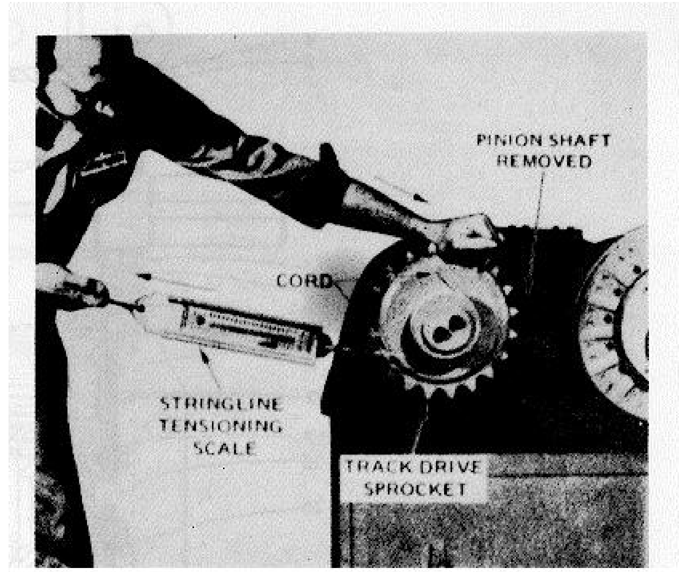
L.H. Transfer Case (Current Model) - Cross Section View Figure 12

Item	Part Description
3	Cover, Mounting
4	Shim Kit
5	Seal, Oil
6	Roller Bearing
7	Roller Bearing
12	Shaft, Input
13	Pinion, Input
14	Snap Ring
15	Cover, Mounting
19	Cover, Bearing
20	Ball Bearing
21	Gear, Drive
22	Shaft, Stub
23	Gear, Driven
24	Cover, Bearing
25	Cover, Bearing
26	Ball Bearing
27	Gear, Intermediate
28	Shaft, Stub
29	Gear, Drive
32	Retainer, Bearing
33	Shim Kit
34	Roller Bearing
35	Gasket
36	Spacer, Output Shaft
37	Gear, Output
38	Shaft, Output
39	Roller Bearing
40	Gasket
41	Seal, Oil
42	Carrier, Bearing

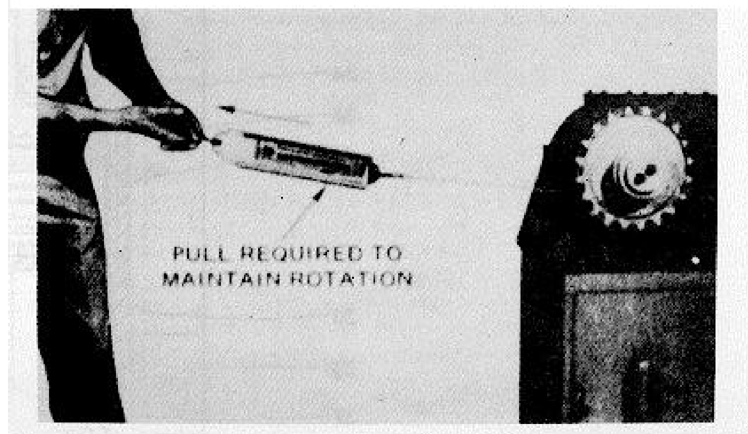




Examples Of Gear Tooth Wear Patterns Figure 13



Start Rolling Torque Test Rotation Figure 14



Reading Rolling Torque Test Scale Figure 15

dimensions.) This should be done with machinists gauges or micrometers. When bores are oversize or out-of-round, a shock loading occurs during operation and new bearings are quickly ruined. Refer to paragraph J headed "Case Repair" which follows.

Important! Leave the stub shaft (28) out of the case until after the rolling torque check is made on the output shaft as described in Step I.

G.- Check the bore of the housing for correct diameter, roundness, and axial alignment at the points where output shaft bearings (34) and (39) are installed. It is vitally important that these bores be correct as shown in Figures 17 and 18. If they do not conform to specifications, refer to Step J covering case repair.

H.- Adjust the clearance of the tapered bearings (34) and (39) to produce a .014" pre-load. This is done by adjusting shim pack (33) so that all end float is just barely eliminated, then removing .014" from shim pack (33) and again tightening the bearings retainer screws.

> **NOTE:** When normal deflection of the transfer case walls occurs, the pre-load will actually be considerably less than .014". The rolling torque check described in the following paragraph should be made to verify that an accurate pre-load has been set.

I.- Make a rolling torque check of the output shaft pre-load in the following manner:

(1) Remove pinion shaft assembly (28) from the case so that output shaft (38) will be free to rotate.

(2) Install the chain sprocket on the output shaft.

(3) Obtain a 10 ft. length of strong cord (50 lb. test) and a reliable hand-held spring scale such as the one supplied with each paver Duo-matic system for ade line tensioning. (0 to 100 lbs. capacity).

(4) Tie one end of the cord to a sprocket and tooth, then wind several wraps around the sprocket hub and attach the spring scale hook.

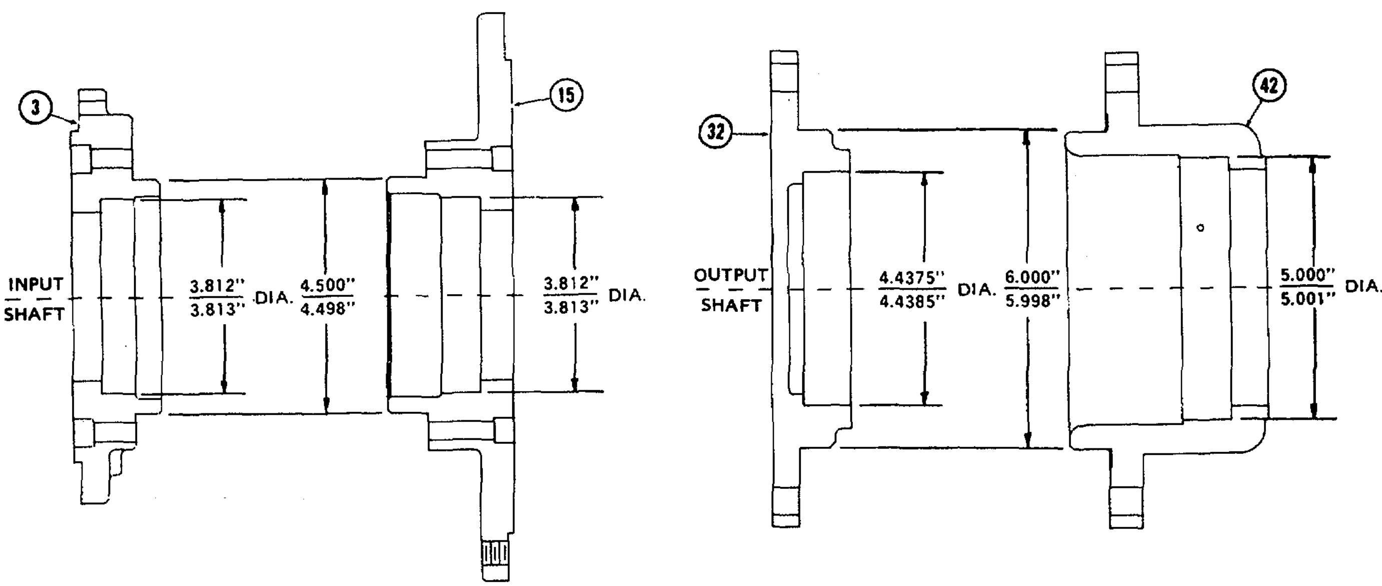
(5) Pull on the scale to tighten the cord and use your free hand to start rotation of the sprocket. (See Figure 14) Observe the amount of pull required **to keep the sprocket turning.(See** Figure 15)If the pre-load is correct, a pull of 16 to 24 lbs. will be required. (This equals 40 to 60 inch pounds of torque; 16 to 24 x 2.5" radius of sprocket hub). If more than 24 lbs. of pull is required, add some shim thickness to loosen the pre-load. If less than 16 lbs. is required, remove some shim thickness.

CASE REPAIR

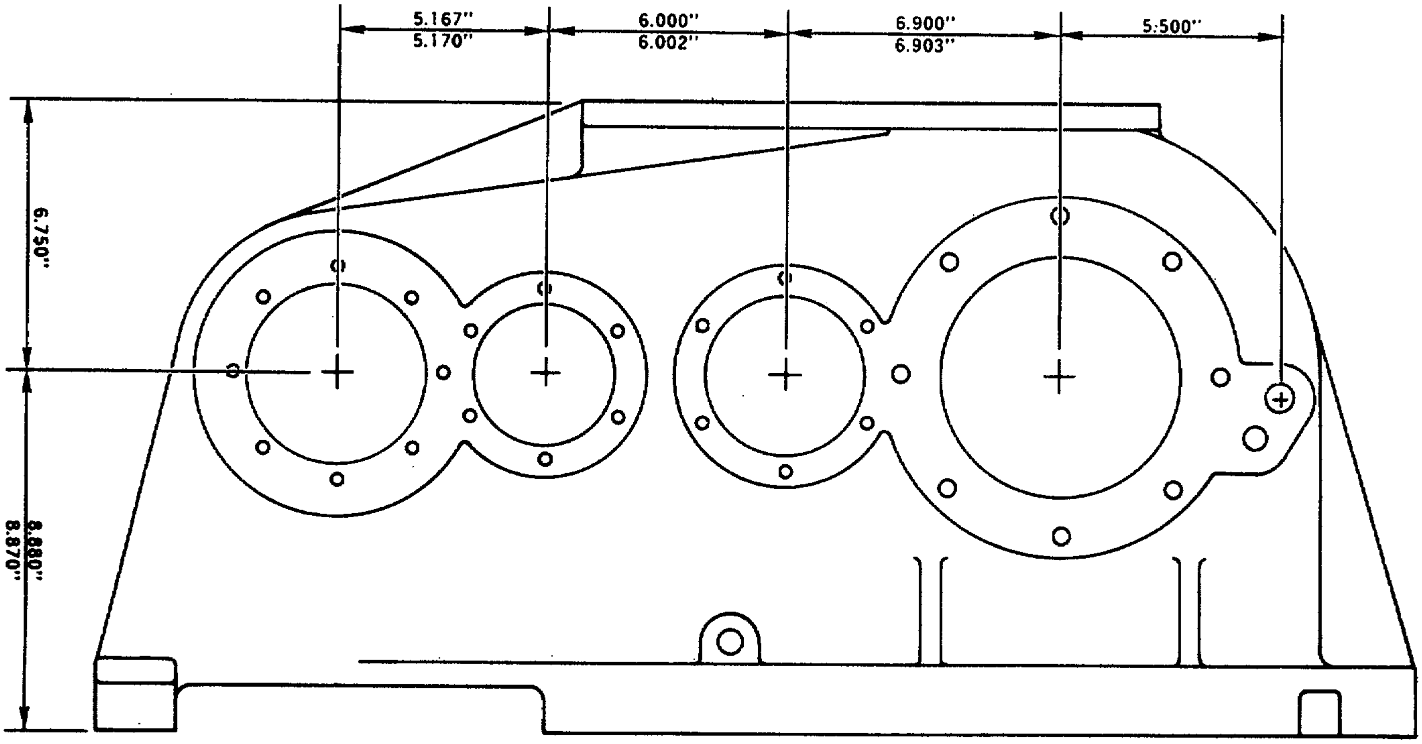
J.- It is vitally important that all bearing bores in the transfer case be in "new part" condition in order for bearings and shafts to be accurately aligned and rigidly held. If a bore is worn over-size or out-of- round by an old bearing, a replacement bearing will fail rapidly. This is due to the shock loading which results from a hammering action and from misalignment of the shaft.

If parts have failed in a case, or severe mismatch of gear teeth has produced a poor "wear pattern" the case bores **should be checked by a machinist,** using micrometers, dial indicators, etc. The factory dimensions given in Figures 16 thru 18 will provide the necessary checking details. If serious discrepancies are found, **the case should be replaced, or field re-built to new condition.**

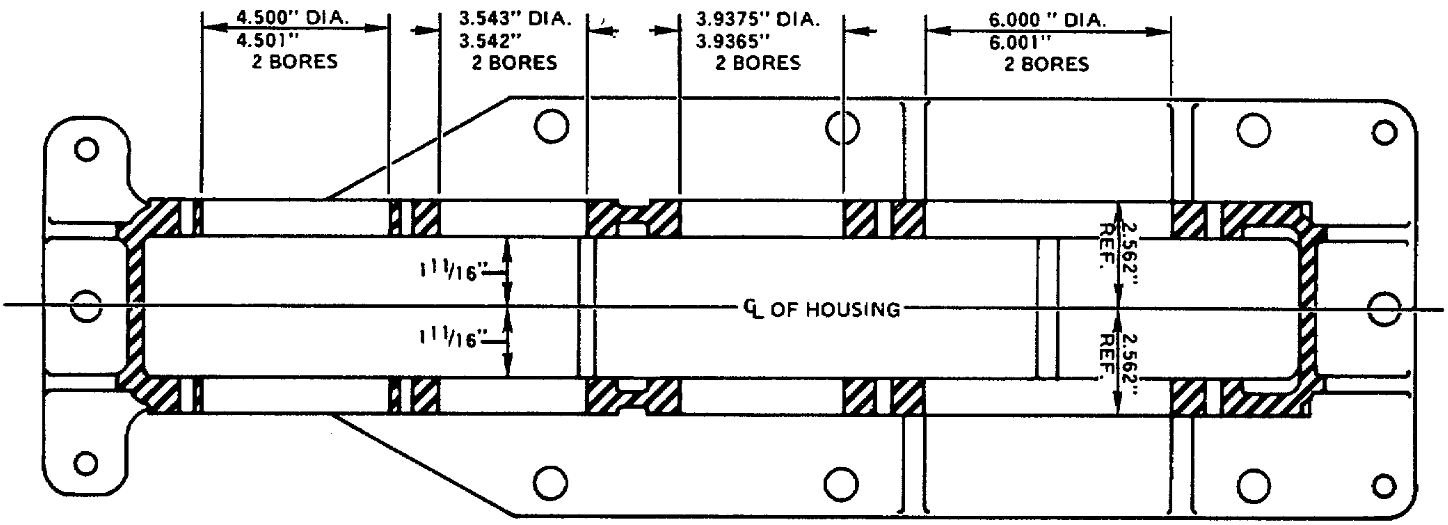
Bearing retainers and carriers as *shown* in Figure 16 must also have accurate bore and diameter. Re- place any ones that do not conform to specified tolerances.



Removable Bearing Supports Figure 16

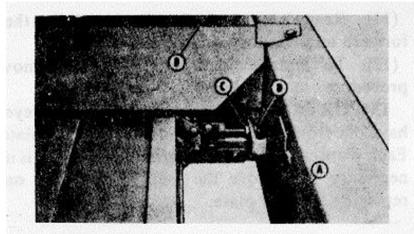


Transfer Case - Side View Figure 17



Transfer Case - Top View Figure 18

Note: Case bores must be axially aligned with mating bores.



Slat Conveyor Chain Tightener (Four Used) Figure 19

SLAT CONVEYORS

Inverting Slat Bars

The right and left slat conveyors consist of a series of bars, linked together by two continuous chains attached to the end of the bars. Either the right or left slat conveyor can be turned over to allow use of the other side as follows:

(1) Loosen chain (refer to following paragraph).
(2) Remove pin from chain link and break chain.
(3) Turn slat conveyor over and replace.
(4) Couple chain.
(5) Tighten chain.

Slat Conveyor Take-up

To adjust chain (Refer to Figure 19):

(1) Remove hopper end cover plate "B" from intake end of hopper "A".
(2) Loosen lock-nut "C" and tighten take-up.
(3) To loosen chain, loosen take-up nut "D".
(4) Tighten locknut "C" after proper adjustment.

IMPORTANT! Care should be taken that the two chains of each conveyor are tightened equally. The chain will be properly tightened when 1" sag is present between return track and front sprockets.

CAUTION: DO NOT OVER-TIGHTEN. THIS WILL CAUSE EXCESS WEAR ON CHAIN. Also be sure that chain cover guards are in good repairs for maximum protection to the chain from the feed materials.

(5) When chain is properly tightened, replace hopper end cover plate before operating.

Slat Conveyor & Spreader Screw Drive Chain Take-up (Refer to Figure 20)

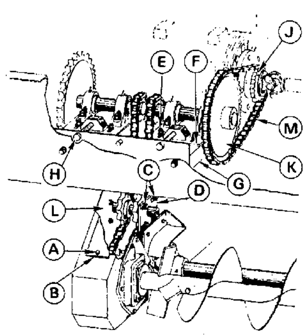
The right slat conveyor and spreader screw and the left slat conveyor and spreader screw are driven by individual chain drives.

To tighten chain **(be sure engine is not running):**

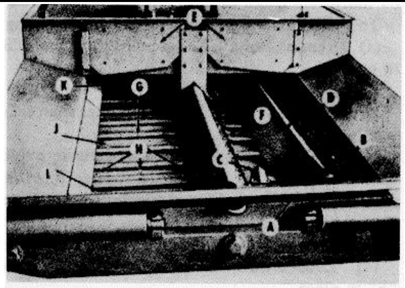
(1) Remove bolts "A" that holds cover plate "B" in place.
(2) Remove cover plate "B".
(3) Loosen bolts "C" that hold Idler shaft take-up plates "D" in place.

NOTE: Idler shaft take-up plates are slotted for chain adjustment. To tighten chains, slide idler shaft take-up plates forward and tighten bolts. When slots are used up in plates, slide plates back, tighten bolts "C" and make the following adjustments:

(4) Loosen nuts "E" that hold take-up plates "F" in place.
(5) Make chain adjustment with bolt "H".
(6) If the limit of adjustment is reached before the chains are tight, back off bolts "H" to relieve tension of carriage bolts "E".
(7) Shift carriage bolts E to the adjacent hole in Support "G" to obtain maximum adjustment, then readjust bolts "H".
(8) With sprockets "J" and "K" in line, tighten nuts "E".
(9) Check tightness at opening "L". When both chains are properly adjusted, there should be a deflection of approximately 1/2" on each chain. **It is important to maintain this tightness at all times!**
(10) Replace cover plate "B".
(11) If chain "M" is too loose (dragging on deck) break chain and remove link or /2 link until properly adjusted. This chain can run looser than those in Step 9.



Conveyor Drive Chain Tighteners Figure 20



Slat Conveyor Liner Detail Figure 21

Replacing Slat Conveyor Liners (Refer to Figure 21)

IMPORTANT! Before replacing liners, operator should advance the slat conveyor to the position where five chain links instead of the normal three, are in contact with the top of the rear slat conveyor sprockets. This will allow more working space for breaking the chain.

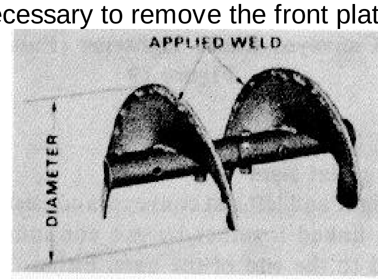
To remove liners:

(1) Elevate paver to allow safe and adequate working area under the hopper.
(2) Remove hopper end cover plate "B".
(3) Remove clamp "C" that holds center cover plate "D" in place.
(4) Remove center cover plate "D", and side covers "A".
(5) Raise flow control gates "E" for additional clearance.
(6) Loosen slat conveyor chain "F". (Refer to first paragraph of slat conveyor instructions for proper procedure in loosening chain.)
(7) Break both slat conveyor chains "F" at rear sprocket, by removing two cotter pins and pins on each chain extension link.
(8) Remove slat conveyor "G" by sliding it forward and out the bottom opening at the front of the hopper.

NOTE: It is only necessary to remove the top section of the slat conveyor. Leave the bottom section in place.

(9) Loosen and remove flat head bolts "H" that hold the liner plates "J" in place.
(10) Slide front liner plate "J" forward and out the top of hopper to remove.
(11) Rear plates are also removed by sliding them forward and out top of hopper.
(12) To replace liner plates, reverse removal procedure.

IMPORTANT! The right and left slat conveyors have one front, two center and one rear liner plates. Each plate can be removed individually, and it is not necessary to remove the front plate when only replacing the rear plate.



Build-up Of Worn Screw Conveyor Figure 22

RESTORING WORN SPREADING SCREWS TO ORIGINAL DIAMETER

(1) When effective diameter of spreader screws is less than 11/2" for *12"* original screw diameter or 131/2" for 14" original screw diameter, remove and build up by hard facing with welding rod. (See Figure 22)

(2) Add hard surface weld in a spiral direction only when rebuilding the spreader screws. Welding in this manner considerably reduces drive load incurred when rebuilt screws are reinstalled, and allows for most efficient feed control.

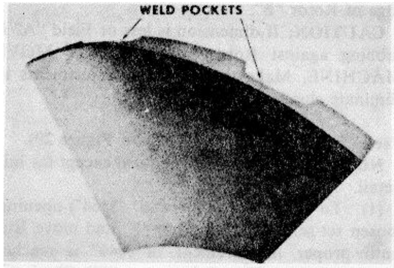
NOTE: It is recommended that an extra set of spreader screws be available for use while repairs are being made.

(3) The paddles on the screw shafts which move material inward toward the center of the screed should also be built-up with weld to their original diameter.

RE-FACING WORN SCREW CONVEYORS

When screw conveyors are severely worn they can be re-faced with special contoured liners made from Ni-hard alloy. The application of these liners restores the screw to near new condition. To apply genuine CEDARAPIDS Ni-hard liners to a screw conveyor section proceed as follows:

(1) Remove screw conveyor from paver.
(2) Clean screw sections as much as possible, particularly in the weld areas.

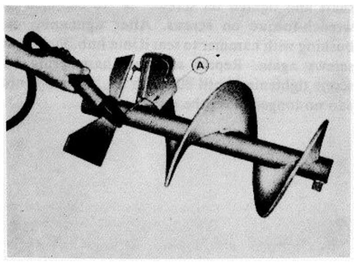


Formed Ni-hard Liner For Screw Conveyors Figure 23

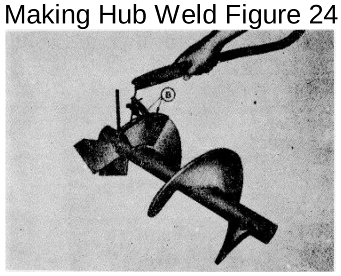
(3) Using several C-clamps attach the pieces of liner to the screw face starting at the **drive shaft end** as shown in Figure 24. By starting at this end, the main wear surface of the section will be covered and any small area not covered will be at the discharge end. Adjust liner pieces to extend about 1/8" above the edges of the screw flight as shown in Figure 27. Be sure that the first piece applied is accurately aligned so that the remaining liners will fit properly along the flight.

(4) Using only a **low hydrogen weld rod** make a continuous weld along the inside edge ("A" Figures 24 and 27). Make welds at each of the two Pockets ("B" Figures 25 and 27). On the first and last liners of each flight make a weld at the exposed edge ("C" Figure 26) for extra strength.

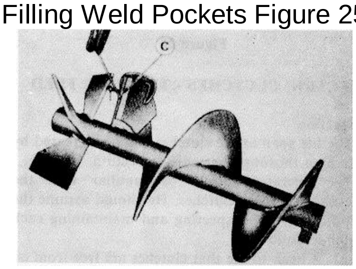
NOTE: The small cracks which develop in the liners from the welding process are normal and should not be considered defects.



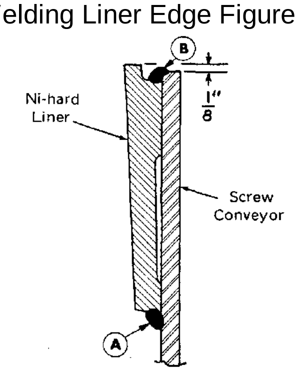
Making Hub Weld Figure 24



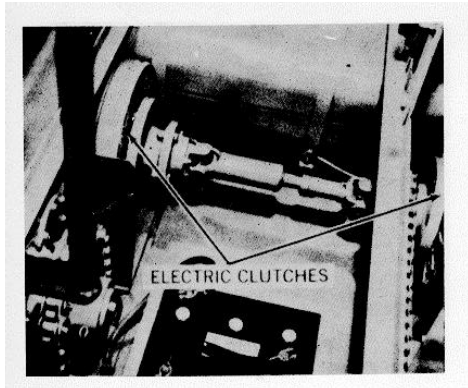
Filling Weld Pockets Figure 25



Welding Liner Edge Figure 26



Cross-section Thru Screw Flight & Liner Figure 27



Electric Clutches - RH Side
Figure 28

ELECTRIC CLUTCHES - TRAVEL & FEED

Inspection

The life span of the clutches will be increased by making a thorough periodic inspection.

The operator should be familiar with the operation of these clutches. He should assume the responsibility of inspecting and maintaining each clutch as follows:

(1) Check to see that clutches are free from oil and grease.

(2) Clean clutches with oil-free solvents.

(3) Keep clutches covered by walkways.

IMPORTANT! Keep walkways in place except when servicing.

(4) Check electrical wiring for all clutches to see if there are any loose connections or broken wires.

(5) Maintain a minimum opening of .046" (3/64") between the Armature "C" and Rotor "B". (See Figure 29) This dimension should be checked simultaneously at 3 points, 120° apart. All present paver clutches have a Scribe Line on the OD of the field "A" for assembly purposes, align the inward edge of the outer pole of the Rotor "B" with this Scribe Line visually to a tolerance of plus 1/32" minus .000". This setting will provide proper clearance internally between the Rotor and the field.

(6) Pavers in the field without Scribe Line maintain the measurement of 3/4" .008" between the outer edge of the Field Mounting Flange "A" and edge of Rotor "B".

CAUTION: If dimension is less or Field "A" is rubbing against Rotor "B", DO NOT MOVE MACHINE. Make the following adjustments to eliminate clutch damage.

Feed Clutch Adjustment (Refer to Figure 29)

NOTE: Travel *clutch* is identical except *for* hub detail.

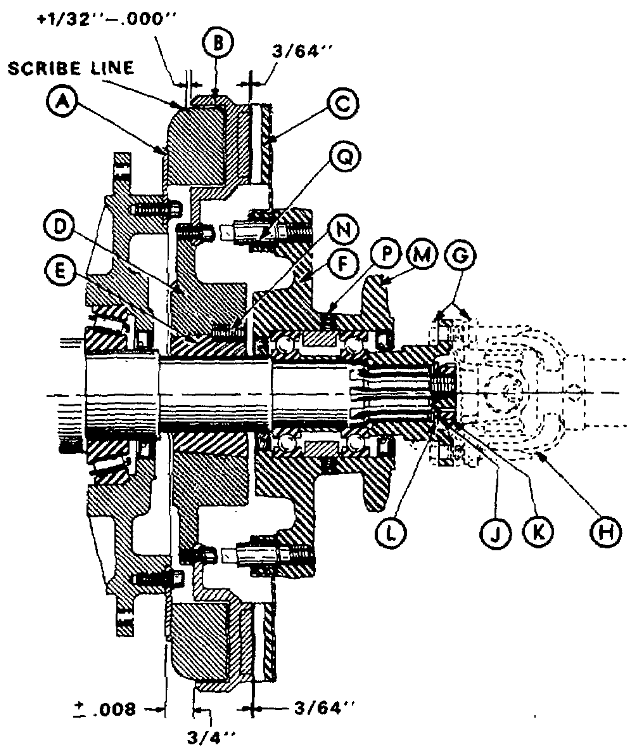
(1) To adjust clutch for .046" (3/64*")* opening, loosen set screws "P" on Hub "F" and move Hub until proper measurement of .046" is reached between Rotor "B" and Armature "C". Check this measurement at three points around the circumference of the clutch. Tighten set screws "P" and be sure Armature "C" slides free on pin "Q".

(2) To adjust clutch for alignment to the Scribe Mark within + 1 / 32" minus .000", remove bolts "G" that hold Drive Assembly "H" in place. Detach Drive Assembly "H". Free Lock Washer "J" from Nut "K" and remove Nut "K". Remove Washer "J" and "L". Remove Chain from Sprocket "M". Use Bearing Puller to remove Hub and Armature Assembly from Shaft. Remove Two Set Screws "N" that hold Taper-lok Bushing "E" and Rotor Hub
"D" in place.

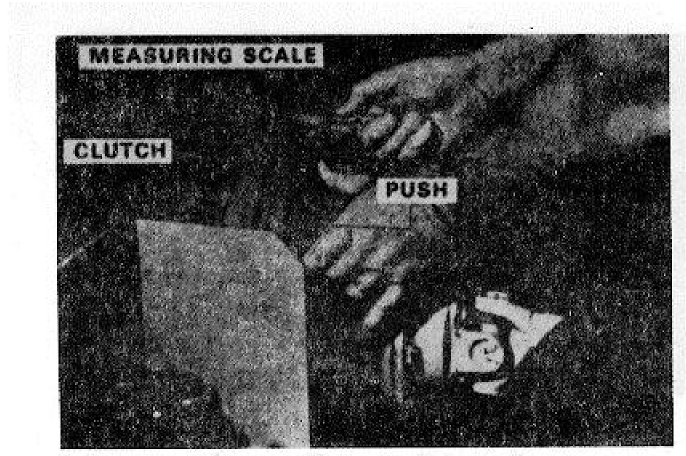
CAUTION: DO NOT DETACH Hub "D", from Rotor "B" for this particular clutch adjustment. LEAVE HUB "D" INPLACE.

(3) By adjusting Taper-lok Bushing "E" the alignment of the Rotor "D" can be obtained. Before assembling Rotor Hub "D" to Tapered Bushing "E", rinse mating parts and shaft with *solvent to* remove any oil film on parts to be assembled.

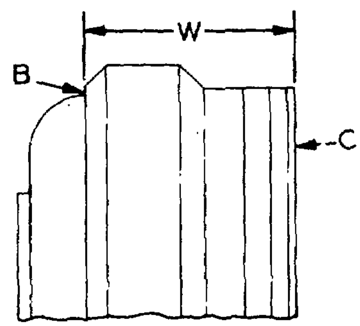
(4) Assemble Rotor and Taper-lok Bushing on shaft and tighten set screws "N" to 800-inch lbs. wrench-torque on screws. After tightening, rap bushing with hammer to seat it into hub. Tighten set screws again. Repeat alternate hammering and screw tightening until 800-inch lbs. wrench-torque can no longer move the screws.



Cross-section Thru Electric Feed Clutch
(Travel clutch identical except for hub)
Figure 29



Method Of Measuring Wear Of Electric Clutch
Figure 30



Side View Of Clutch Showing Wear-check Dimensions
Figure 31

IMPORTANT! Use a machinists dial gauge on the face of Rotor "B" to be sure that surface is running true as it is turned through 360° of rotation. This will assure 100% contact of the friction face with the friction face of Armature "C". If the dial gauge indicates more than .010" total variation, Bushing "E" must be tapped on the side that will true-up the Rotor, and the set screws re-tightened to hold the alignment. If the Rotor is not adjusted in this way and fails to run true, serious clutch slippage will result.

CAUTION: DO NOT POUND ON POLES OF ROTOR.

(5) When clutch is assembled and drive is in place, check .046" opening between Armature "C" Rotor "B". Make adjustment if necessary.

(6) For other alignment checks, refer to separate clutch manual.

NOTE: Care should be taken to keep clutch clean when assembling.

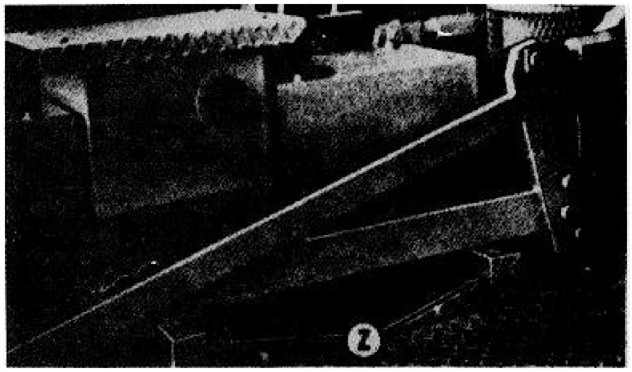
Travel Clutch Adjustment

Refer to Feed Clutch adjustment details in preceding paragraphs. The travel clutch is identical except for the hub area. Use Figure 29.

When To Replace Worn Out Armature & Rotor

The clutch armature-rotor set is completely worn-out when 9/32" of the combined friction faces has been worn away. When this occurs the two parts must be replaced in order to avoid a breakdown at a critical time.

The simple and accurate wear check is made by measuring the combined thickness of the Rotor "B" and Armature "C", when the movable armature is pressed tight against the rotor. (See Figures 30 and 31) When both parts are new, dimension "W" will be 2 1/8". **When completely worn-out, "W" will be 1 27/32".** Be sure that the armature is held tight against the rotor when the measurement is taken.



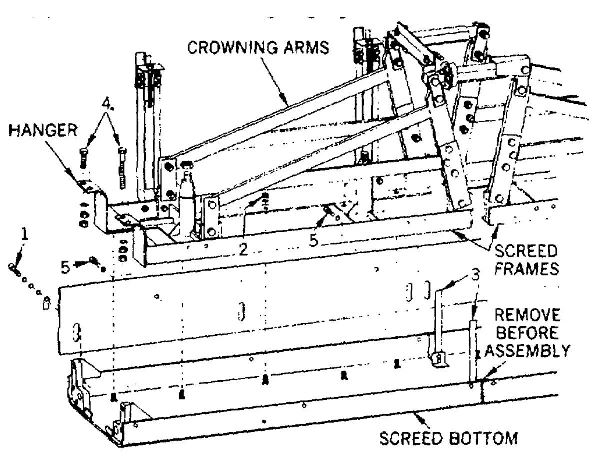
Supporting Crowning Arms For
Screed Bottom Removal
Figure 32

SCREED UNIT

Removing Quick-Change Screed Bottom (Refer to Figure 33)

1) Adjust screed crown to "O" crown. Then place wood blocks as shown in Figure 32, Item "Z" to support crowning mechanism. These blocks must extend under both front and rear crowning arms and on both right and left hand side of screed. This will hold frame level and allow studs to align with support frame bolts.

(2) Remove walk-way
(3) Remove Strike-off bolts No. 1 and No. 5.
(4) Remove Screed bottom GRIPCO Nuts No. 2. (5/8” GRIPCO Corrosion Resist - Center Lock).
(5) Remove crown guage pointers No. 3



Screed Bottom and Frames - Exploded View

Screed Bottom and Frames-Exploded View
Figure 33

Install Screed Bottom as follows:

(1) Check tightness of bolts No. 4 that fasten frame spring hangers to top frame. If screed frames are operated with loose fastening bolts, it will take only one-half the load (in comparison to properly tightened frames) to deform the spring hangers. If spring should be deformed, straighten or replace before attaching new screed bottom. Loose or deformed spring hangers can be a cause for poor screed control.

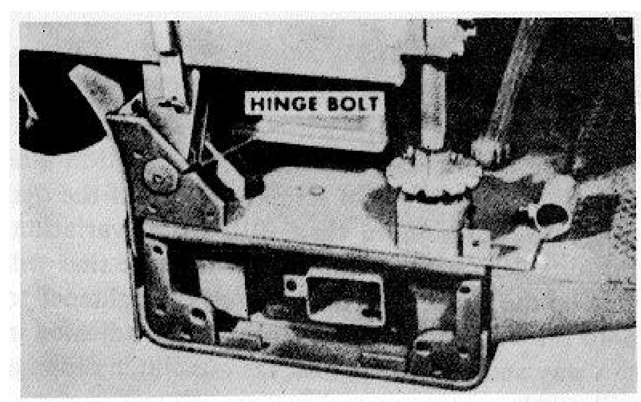
(2) Install crown gauge pointers No. 3.

(3) Position new screed bottom so that studs align with holes in the screed frame. Then, lower screed unit onto Screed Bottom and fasten with GRIPCO Center Lock Corrosion Resist Nuts. Before tightening GRIPCO Nuts, push screed bottom as far forward as possible. Then, tighten Screed Bottom fastening nuts to 90 Ft./lbs. torque.

(4) Install strike-offs to screed bottom. Check to make sure that strike-offs are not gouging or locking against mold board. Also check for excessive clearance between strike-offs and mold board. If clearance is excessive, tack weld a 1/4" rod of required length to top of strike-offs. Failure to properly seal this area will allow asphalt to seep into screed bottom making the change in the screed bottom more time-consuming.

(5) Install walkway.

CAUTION: If screed bottom is to be reversed the inside of screed must be thoroughly clean, to insure proper seating of frame to screed bottom, and consequently obtain the maximum tightness with fastening studs and nuts.

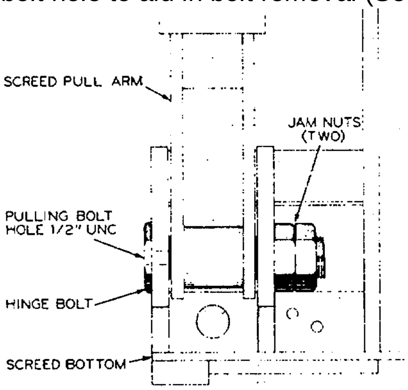


Location Of Screed Hinge Bolt
Figure 34

SCREED BOLTS

The bolts which attach the screed bottom to the frame and the frame tc the pull arms must be kept tight at all times. When bolts become loose and the screed bottom is no longer rigidly held, waves may appear in the finished mat. **Check all screed bolts frequently for tightness.**

In the event that the hinge bolts (Figure 34) become worn, they should be replaced so that no play develops at that critical point to produce a waviness in the mat. Hinge bolts are made with "1/2' UNC pulling bolt hole to aid in bolt removal (See Figure 35).



Detailed Of Screed Hinge Bolt In-place Figure 35).

HANDWHEEL SCREW MAINTENANCE

Both handwheel screw assemblies should be kept in good operating condition so that they hold the screed rigidly at the desired setting. Looseness at the two pull arm coupling points or at the two screed coupling points will allow free up and down movement of the screed and corresponding waves in the mat surface. **There must never be more than three notches of play (free handwheel movement, without affect on the screed).**

Swivel Nut Adjustment (Refer to Figure 36)

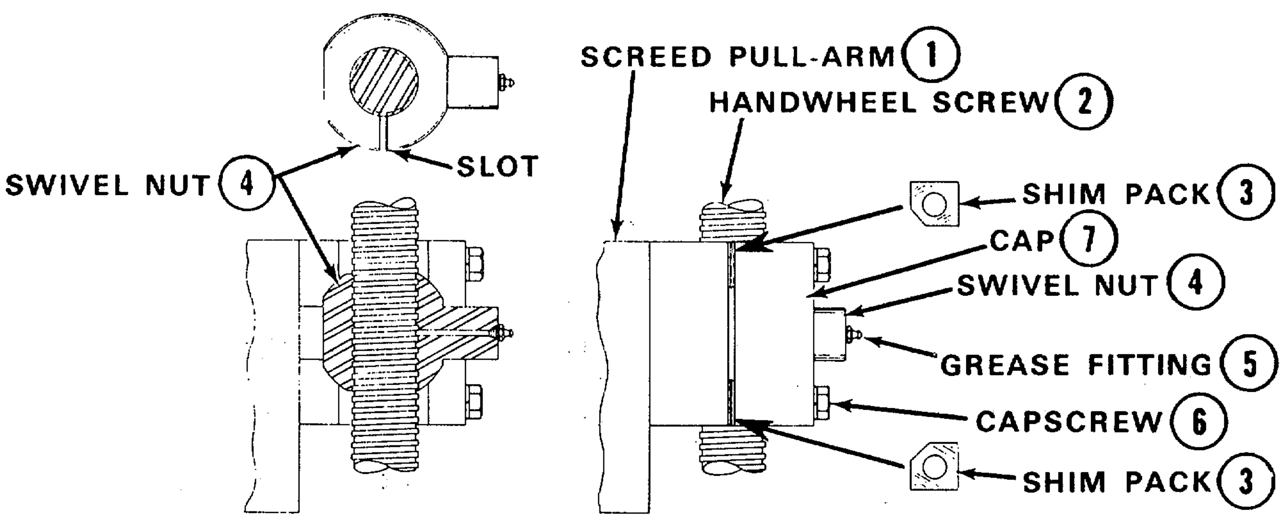
The pull arm couplings are slotted Swivel Nuts (4) which utilize the ball and socket principle. The socket is made up of the pull arm (1) and Cap (7) with four Shim Packs (3) used for adjustability. Adjustment of the Shim Pack thickness changes the amount of "squeeze" exerted on the slotted Swivel Nut (4) and the corresponding tightness of fit against the Screw (2) threads.

Whenever looseness is felt, first check the four Capscrews (6) for tightness. If they are tight, remove them and Cap (7). Remove an equal amount of Shim Pack (3) stock from the four packs and reassemble.

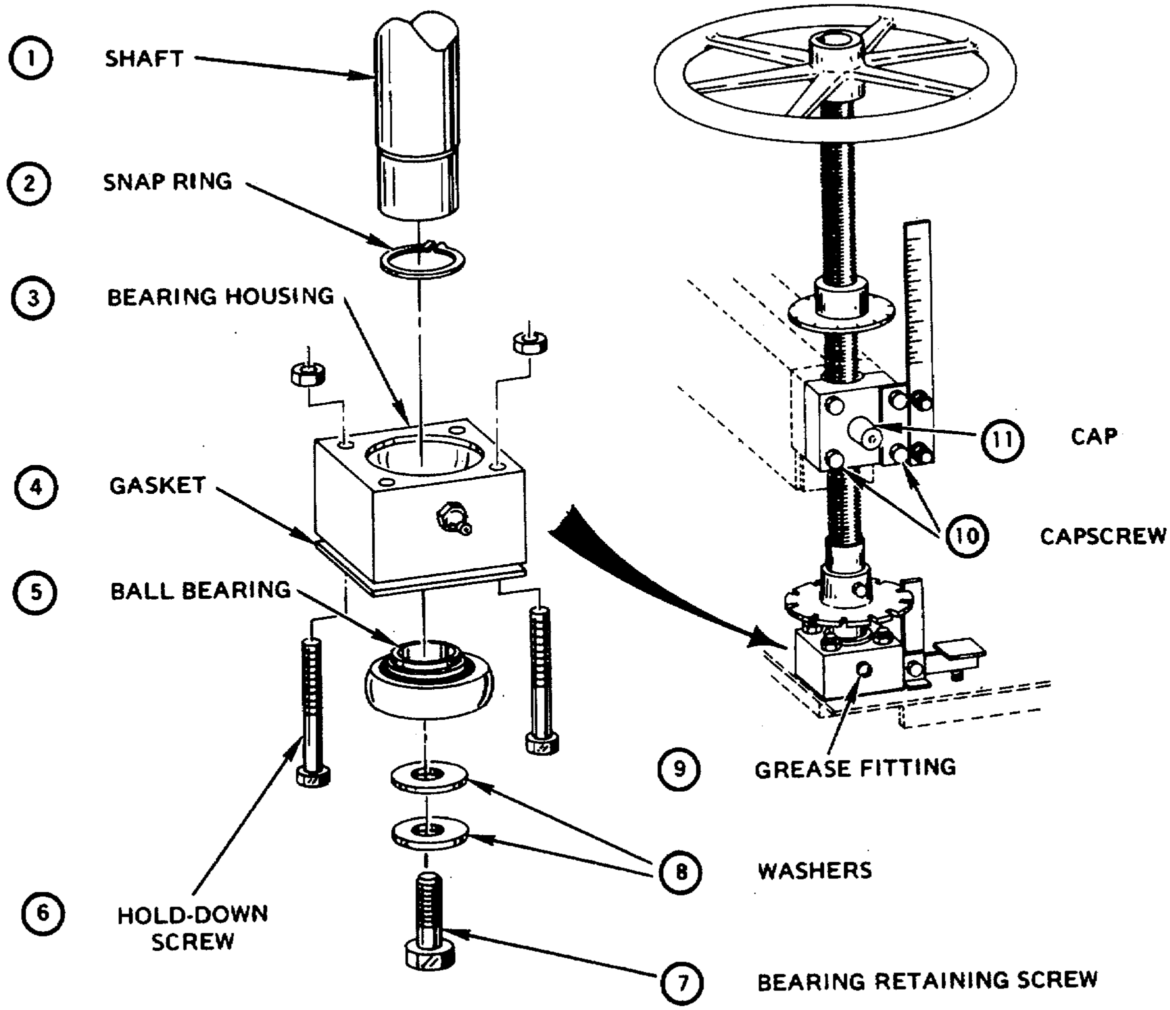
Replace worn Swivel Nuts (4) when adjustment no longer corrects looseness.

Ball Coupling (Refer to Figure 37)

Normally handwheel screw looseness will be due to clearance at the two Swivel Nuts (4). It can, however, be due to badly worn ball bearings at the lower end coupling point. If it is determined that the screed couplings are at fault, refer to following paragraphs for replacement instructions.



Detail Of Screed Handwheel Screw And Pull-arm Swivel Nut Coupling
Figure 36



Handwheel Coupling With Ball Bearing & One-piece Bearing Housing
Figure 37

REPLACEMENT OF BALL BEARING IN HANDWHEEL COUPLING (See Figure 37)

The handwheel screw ball bearing (5) with one piece bearing housing (3) is a non-adjustable coupling arrangement. In the event of ball bearing wear the bearing (5) for each handwheel screw (1) should be replaced as follows: (Refer to the above illustration for numbered items.)

A. Remove the screed end plate. Drive out wedge keys and remove the small access late under the screed walkway to expose the hold-down screws (6).

B. Remove the four capscrews (6) which attach the housing (3) to the deck plate.

C. Remove the four capscrews (10) which secure the upper ball joint. Remove cap (I 1) so that the entire handwheel screw assembly can be lifted off the screed.

D. Unscrew and remove retaining screw (7) and washers (8).

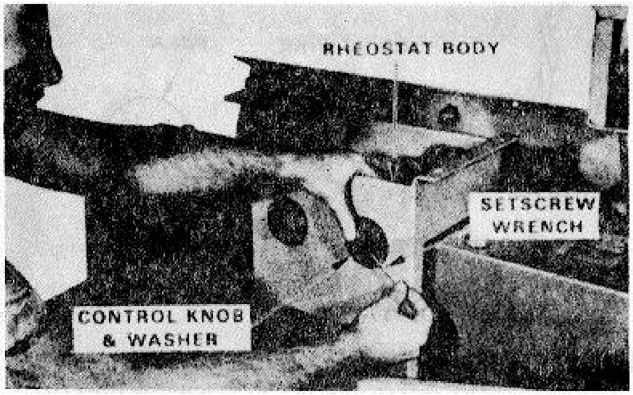
E. Pull the screw shaft (1) out of the ball bearing (5).

F. Turn ball bearing (5) 900 in the housing so that it can be aligned with the slots in the housing and driven out the bottom opening.

G. Replace the snap ring (2) on the screw shaft if necessary.

H. Install the new ball bearing and re-assemble all parts by reversing the dismantling procedure.

I. Pump bearing chamber full of grease.



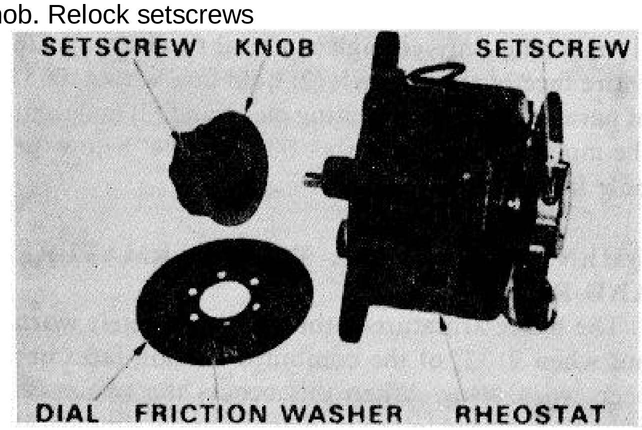
Tightening Vibrator Control Knob
Figure 38

VIBRATOR CONTROL KNOB INSTALLATION

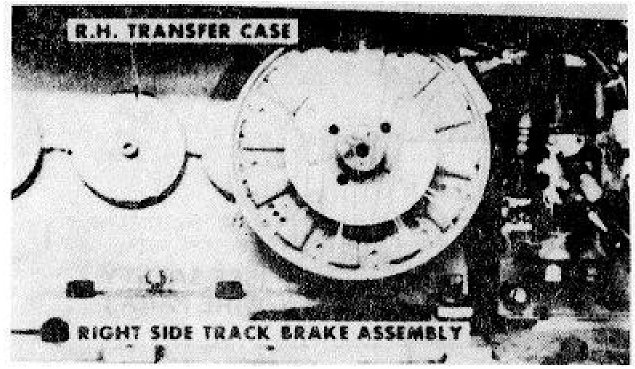
The black plastic knob which adjusts the intensity of vibration for each vibrator, is equipped with a neporene friction washer to prevent vibration from rotating the knob during the paving operation.

To correctly assemble a knob to a transformer, remove walkway cover and loosen the allen setscrews in knob, and push knob with washer tightly against dial on control box, while holding opposite end of shaft. (See Figure 38) Lock Allen setscrews tightly to the shaft. Rotate knob to check for sufficient resistance to insure that the knob will remain in any desired position.

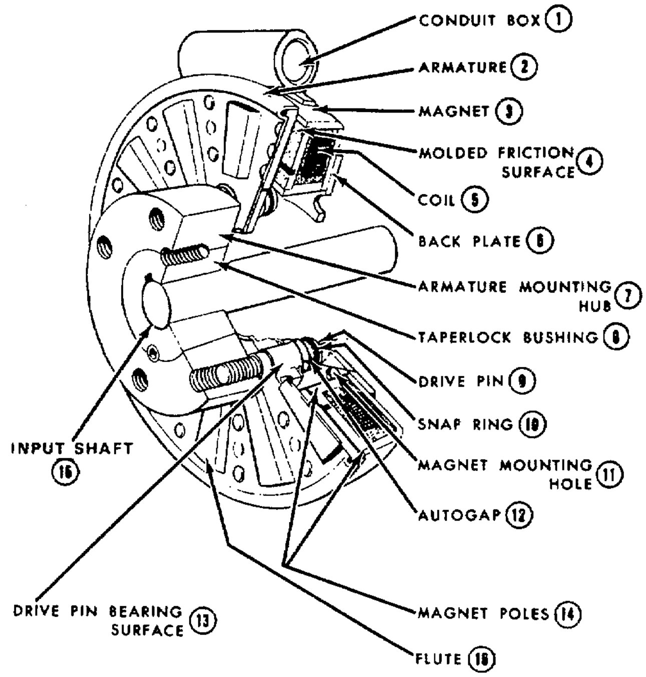
IMPORTANT! If the shaft "bottoms" in control knob before the required friction is obtained between washer and dial, it will be necessary to loosen the setscrews at- the back of the rheostat inside the housing, and to move the shaft farther into the rheostat to reduce the amount of shaft in the knob. Relock setscrews



Vibrator Rheostat, Dial And Knob
Figure 39



Electric Brake For Right Hand Crawler Track
Figure 40

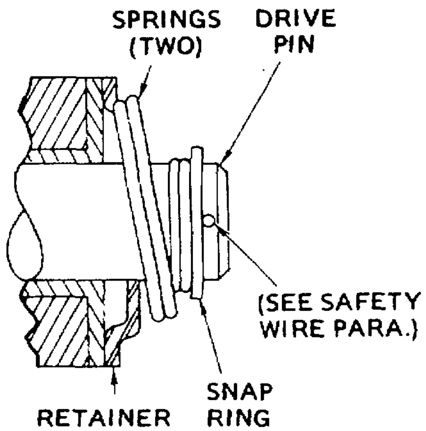


Cut-away Showing Electric Brake Components
Figure 41

ELECTRICALLY RELEASED BRAKES

The two electrically released brake assemblies are of the dry friction disc type. Braking force is applied by permanent magnets in the stationary ring which attracts the movable disc attached to the gear reducer shaft. The brake is released when electric current is passed through a coil surrounding the permanent magnets to neutralize their magnetic fields. The movable disc on the shaft is moved away from the stationary ring by small coil springs and is then free to revolve. Electric current for brake operation is controlled by toggle switch from the operator's console.

(Continued)



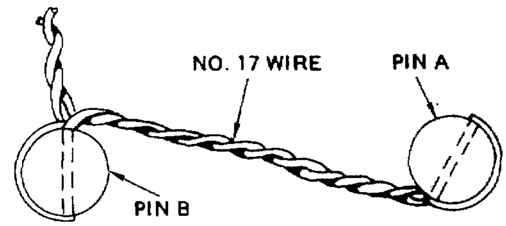
Detail Of Brake Auto-gap Drive Pin
Figure 42

(Refer to Figures 41 & 42 for Part Identification)

The magnet ring (3) is bolted to the paver track drive gear case, with the case input shaft extension (16) passing through the ring but not attached to it. This ring contains the permanent magnets and the windings of the electro magnet. Its outer face includes the friction surface (4). Armature (2) is the movable disc which is loosely held by four drive pins (9) and coil springs. These pins project from hub (7) which is keyed to the input shaft extension from the gear case. The armature (2) is free to move laterally along the shaft but is slaved to the shaft by the drive pins. The permanent magnets therefore draw the armature tight against the friction face (4) of the stationary magnet ring (3). This prevents any movement of the armature and consequently any rotation of the gear case shaft.

Small coil springs on the drive pins (9) are compressed when the armature is held by the permanent magnets. When the brakes are to be released the operator moves the console toggle switch to Neutral or Travel. Electric current then energizes the electro magnetic coil in the magnet ring (3) and neutralizes the magnetic attraction of the permanent magnets. The coil springs on the drive pins force the armature (2) away from the frictioi face on the magnet ring and the armature and gear case shaft are then free to rotate. When the brake switch is at Neutral or Travel there must always be a clearance between the armature and the magnet ring friction face.

As the friction faces wear from repeated application of the brake, the gap between them increases. **The desired gap of 1/16" should be maintained by adjustment of the armature hub (7) and its taper-lock bushing (8) on shaft (16).**



Detail Of Drive Pin Safety Wiring
Detail Of Drive Pin Safety Wiring
Figure 43

DRIVE PIN SAFETY WIRING

Whenever the safety wire on brake drive pins (9) is removed, it should be restored before the brake is again operated. See details in Figure 43.

Brake Armature Clearance

Automatic wear adjustment, or armature follow-up, is provided by allowing the armature to slide freely axially on the drive pins. (See Figure 42). This provides maximum armature life with a minimum amount of care and attention. As the friction surfaces "wear in" the armature advances on the pins so full contact with magnet is maintained at all times.

Wear Pattern

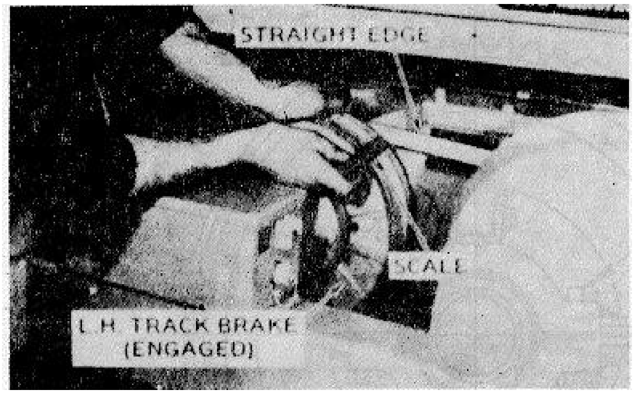
Wear grooves appear on the armature and magnet surfaces after extended service, (Figure 41). This is a **normal wear condition** and will not impair functioning of the unit or cause it to lose torque. In fact, a new brake may require burnishing, or **running-in,** before maximum rated torque may be developed. Never machine the armature or magnet contact surfaces to remove **grooving or scoring.**

Remachining the face of a worn armature is never recommended. But a worn magnet face should always be machined if it is to be used with a replacement armature. In refacing a worn magnet:

(1) machine only enough material to clean up the entire face of the magnet; (2) hold face within .005" of parallel with the mounting plate; and (3) undercut the molded facing material .002" to .004" below the pole faces.

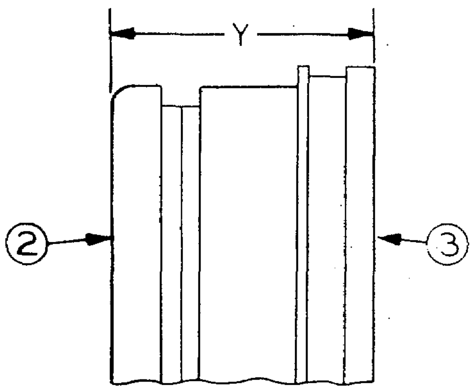
WHEN TO REPLACE WORN ARMATURE AND ROTOR

The brake armature-rotor set is completely worn out when 9/32" of the combined friction faces has been worn away. When this occurs the two parts must be replaced in order to avoid brake slippage at a critical time.

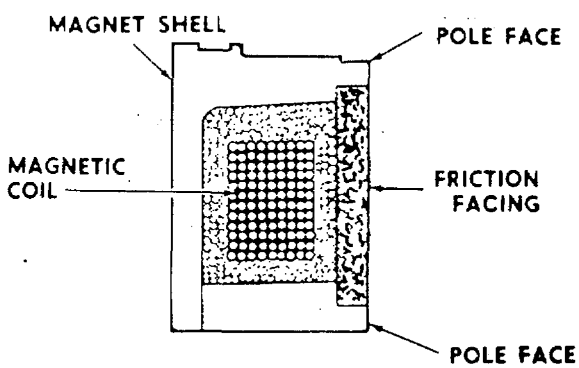


Method Of Measuring Wear Of Electric Brake
Figure 44

The simple and accurate wear check is made by measuring the combined thickness of Magnet (3) and Armature (2) when the armature is pressed tight against the magnet. (See Figures 44 & 45) When both parts are new, dimension Y will be 3-1/16". When completely worn-out, Y will be 2-3/4". Be sure that the console switch is at, BRAKE so that the armature is held tight against the rotor when the measurement is taken.



Side View Brake Showing Wear-check Dimension
Figure 45

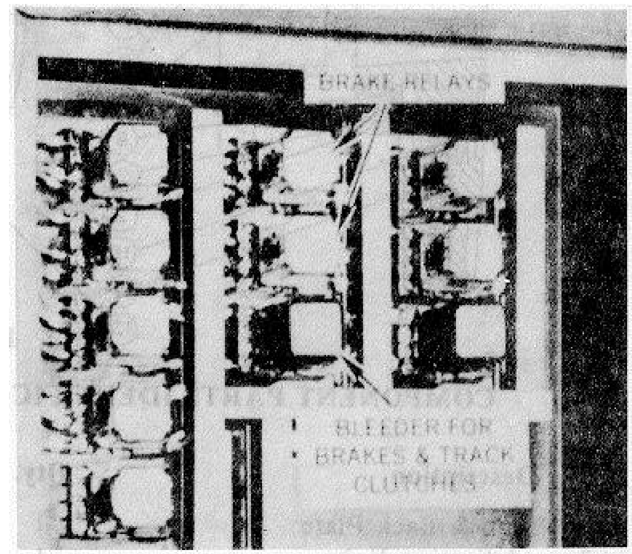


Cross-section Thru Electric Brake Magnet Assembly
Figure 46

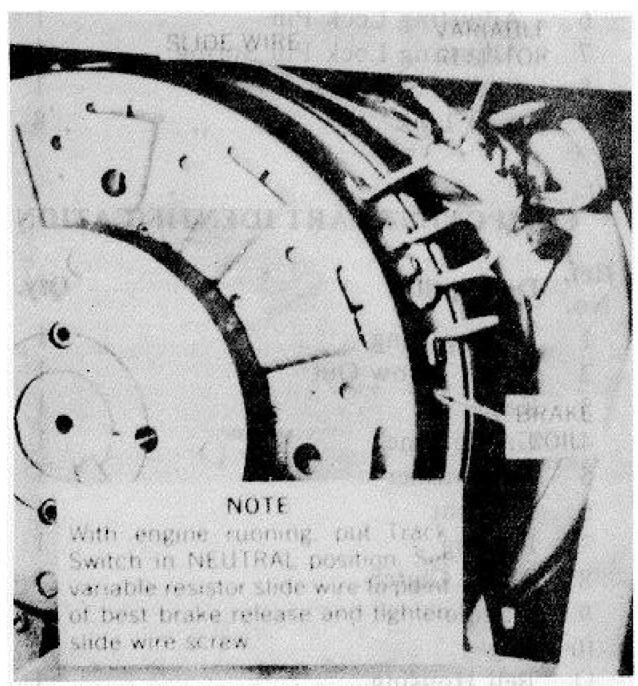
BRAKE ELECTRICAL MODULE

The electrically released brake system includes a plug-in relay and E.M.F. bleeder module located in the main electric panel. The relay is for ON-OFF power application by remote control switch. The bleeder is for electromotive force dissipation when the power contacts open. (See Figure 47)

Adjustment of the brake release point is covered by Figure 48.



Location Of Brake Relays & E.M.F. Bleeder
Figure 47



Variable Resistor For Brake Release Adjustment
Figure 48

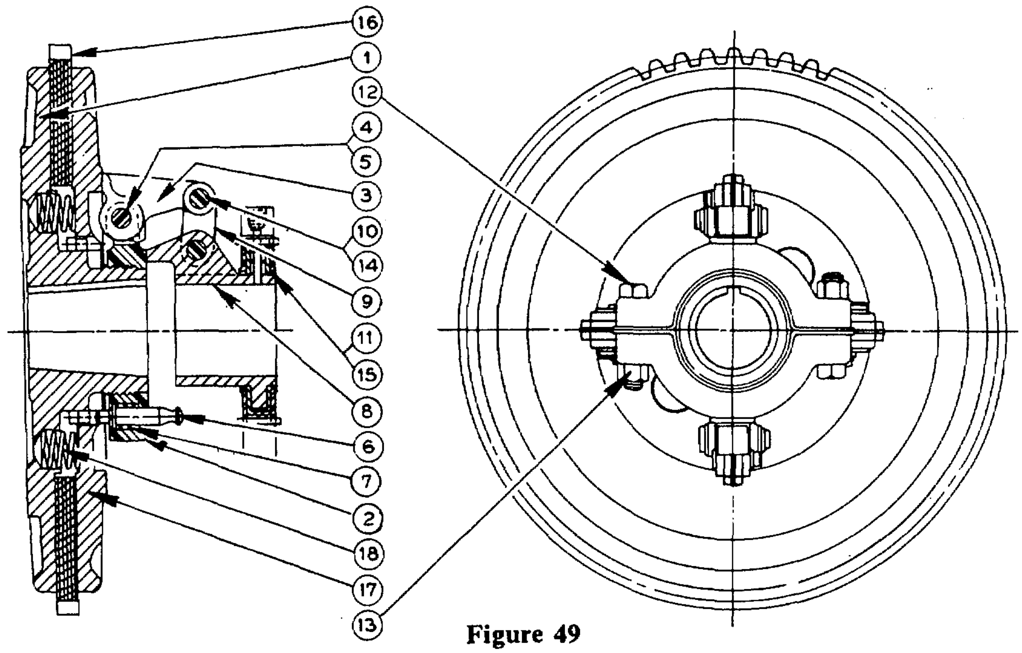


Figure 49

COMPOPNENT PARTS IDENTIFICATION - TWIN DISC C-110 CLUTCH

Ref. No.	Description	Qty.	Ref. No	Description	Qty
1	Hub & Back Plate	1	10	Lever Link Pin	8
2	Adjusting Yoke	1	11	Cone Collar	1
3	Finger Lever	4	12	Bolt	2
4	Lever Pin	4	13	Nut	2
5	Cotter Pin	4	14	Cotter Pin	8
6	Adjusting Lock Pin	1	15	Washer (Collar)	4
7	Adjusting Lock Pin Spring	1	16	Driving Plate (3 Segments Each)	1
8	Sliding Sleeve	1	17	Floating Plate	1
9	Lever Link	8	18	Release Spring	6

COMPONENT PART IDENTIFICATION - POWER TAKE-OFF ASSEMBLY (FIGURE 50)

Ref. No.	Description	Qty.	Ref. No	Description	Qty
1	Driving Ring	1	15	Shaft	1
2	Yoke, Throw Out	1	16	Seal, Oil	2
3	Key	1	17	Gasket	1
4	Grease Line	1	18	Instruction Plate,Clutch Adjustment	1
5	Lockwasher	1	19	Snap Ring	1
6	Locknut	1	20	Clutch, Twin Disc Model C-110 (See above parts identification list)	
7	Bearing	1			
8	Shaft, Clutch	1	21	Fitting, Grease	2
9	Handle	2	22	Fitting, Grease	2
10	Key	2	23	Lube Line - Shaft Bearing	1
11	Bell Housing	1	24	Lube Line - Yoke Throw Out Bearing	1
13	Bearing	1			
14	Cover	1	25	Capscrew (Nylock)	8

Clutch Adjustment (See Figure 49)

(a) Shift 24 Speed Transmission to Neutral. Stop engine and remove ignition key.

(b) Remove inspection door from Bell Housing (11). Dis-engage clutch.

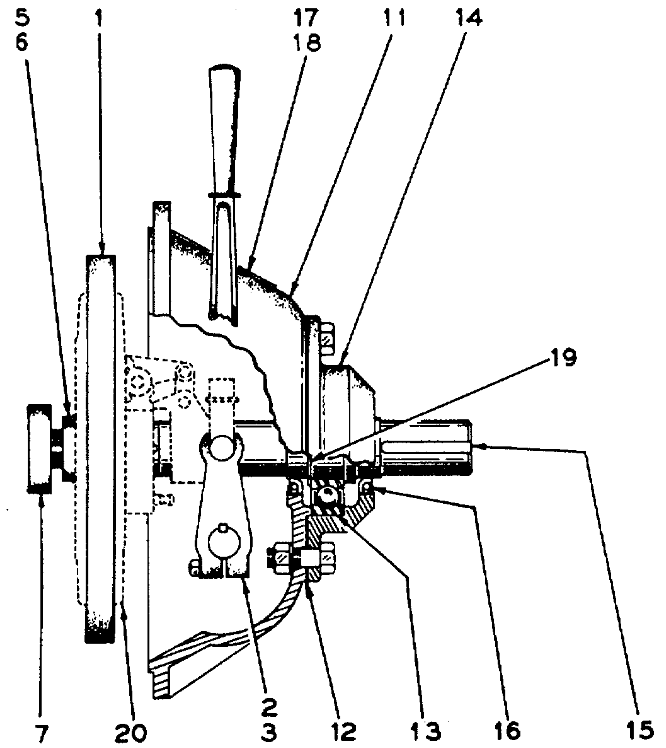
(c) Rotate clutch by means of generator V-belt until Lock Pin (6) is accessible.

(d) Pull out Lock Pin (6) and insert wire or nail to hold it disengaged.

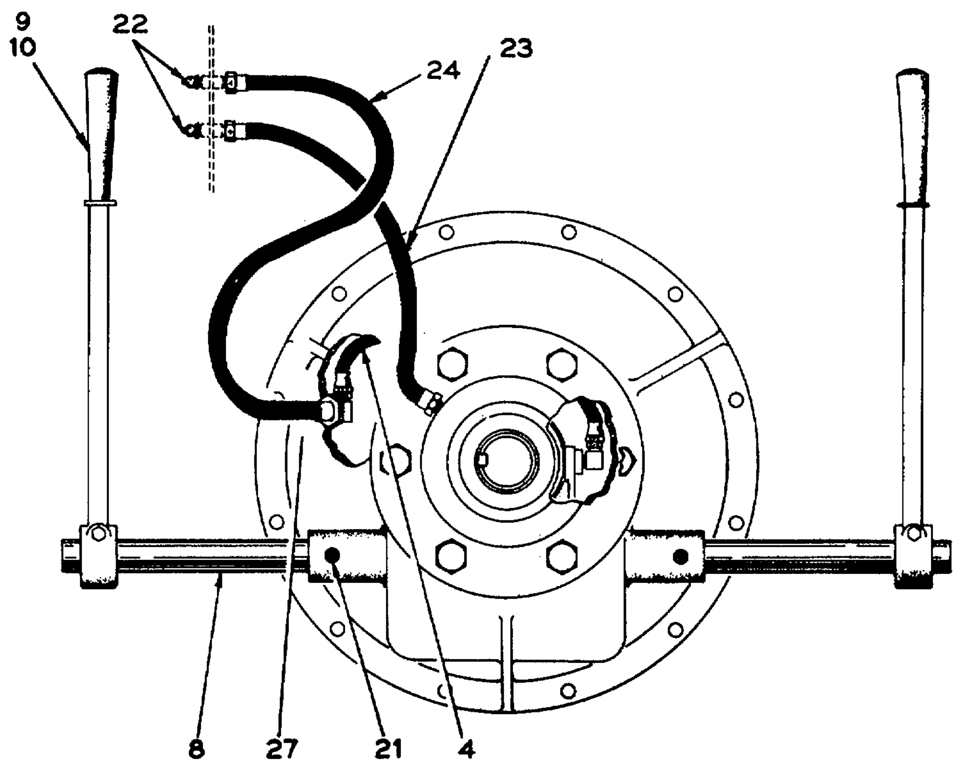
(e) Hold generator V-belt so that Shaft (15) cannot turn.

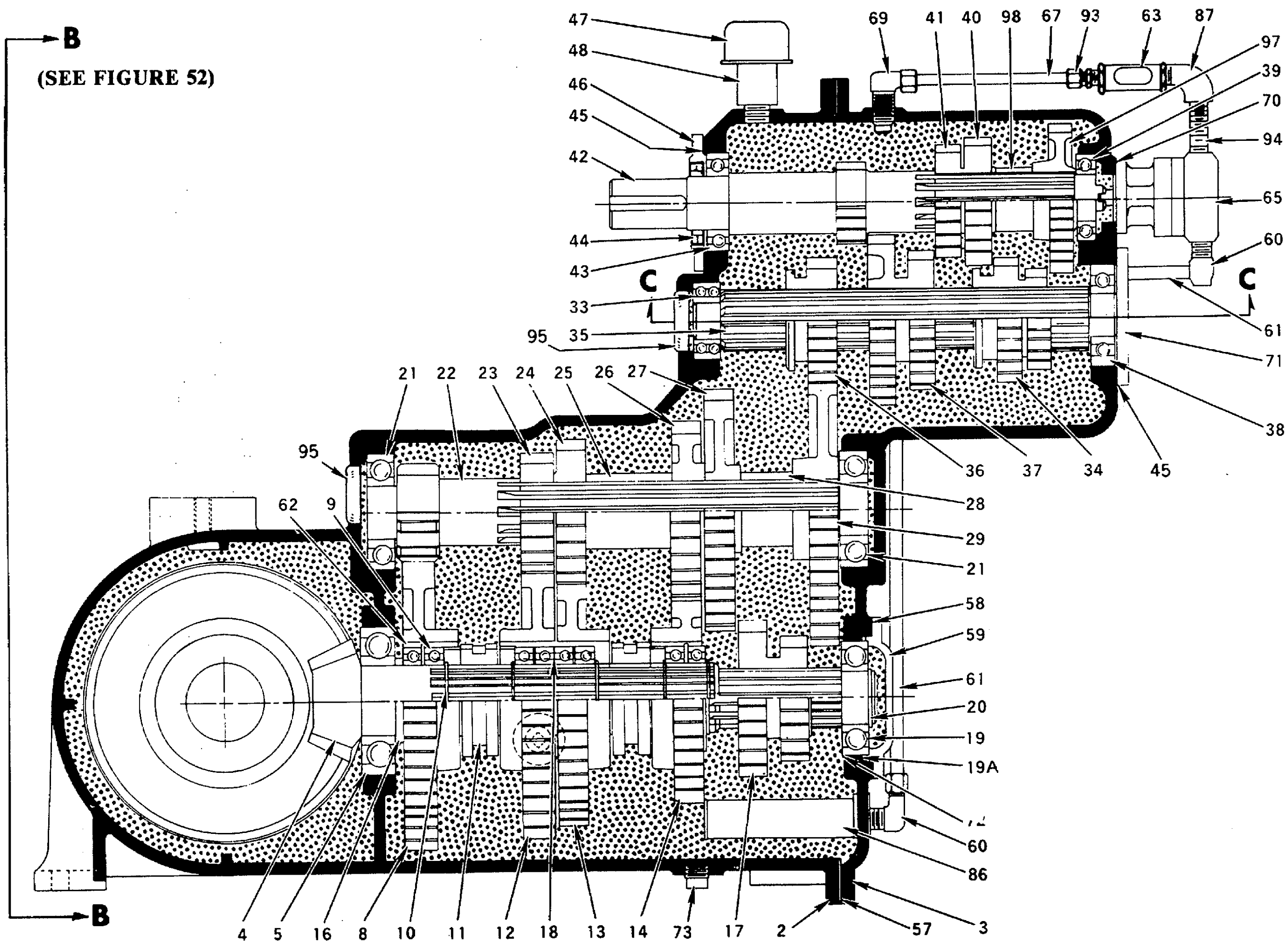
(f) Turn the Yoke and Sleeve Assemblies (2) & (8) clockwise to reduce slippage when clutch is engaged, or counterclockwise to increase clearance when clutch is dis-engaged.

(g) Release Lock Pin (6) to hold the setting, but **be sure the Pin enters one of the locking grooves.**



Power Take-off & Clutch Assembly for GM Diesel Engine
Figure 50





Cross-section View Of 24 Speed Manual Shift Transmission - (View A-A, Figure 52)
Figure 51

COMPONENT PART DESCRIPTIONS - 24 SPEED TRANSMISSION (FIGURE 51)

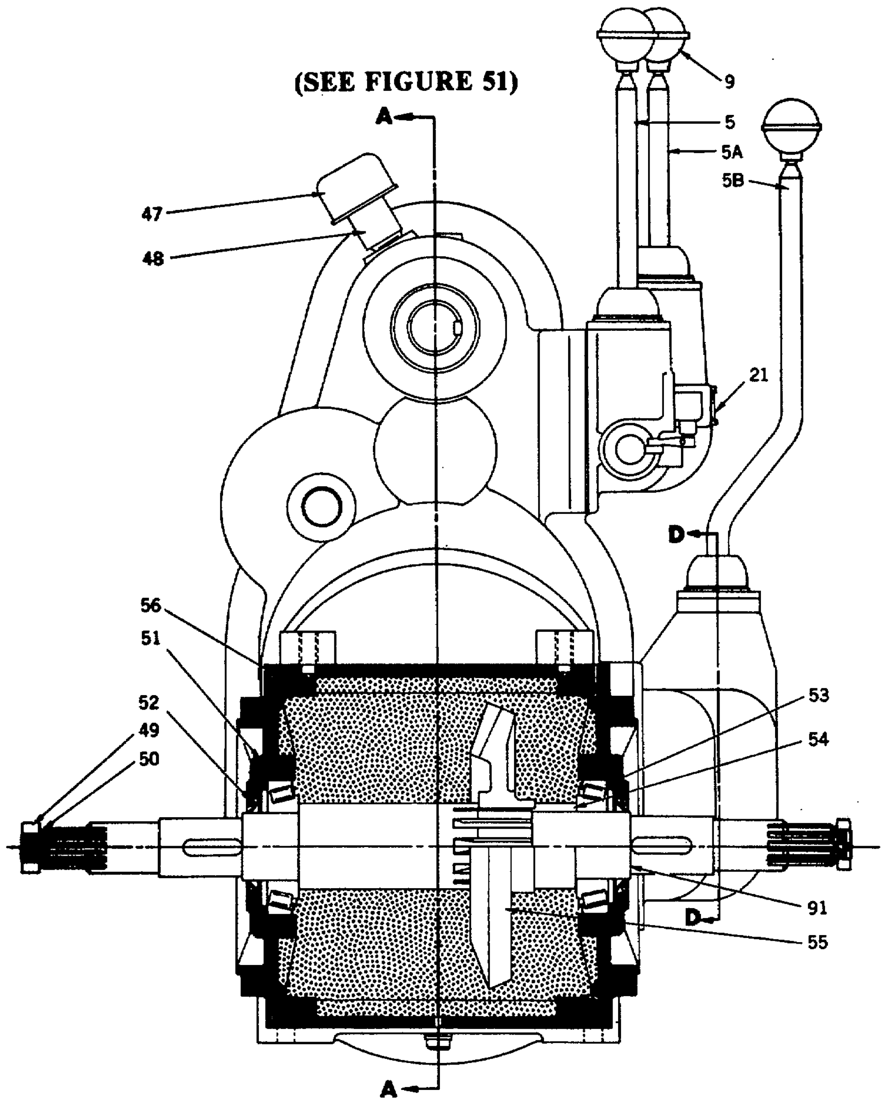
Item No.	Description	Qty.	Item No	Description	Qty.
2	Main Housing	1	38	Ball Bearing	1
3	Housing Cover	1	39	Ball Bearing	1
4	Bevel Pinion	1	40	Drive Gear, High	1
5	Ball Bearing	1	41	Drive Gear, Intermediate	1
7	Lockscrew, Idler Shaft	1	42	Input, Shaft	1
8	Driven Gear, Ist	1	43	Ball Bearing	1
9	Snap Ring	4	44	Oil Seal	1
10	Snap Ring	5	45	Gasket	2
11	Sliding Clutch	2	46	Bearing Retainer	1
12	Driven Gear, 2nd	1	47	Breather	1
13	Driven Gear, 3rd	1	48	Breather Extension	1
14	Driven Gear, 4th	1	57	Gasket, Main Housing	1
16	Washer	1	58	Gasket	1
17	Sliding Gear, 5th and 6th	1	59	Bearing Cover	1
*18	Bearing Shim Kit	1 Kit	60	Elbow, Male	2
19	Ball Bearing, Snap Ring Type	1	61	Tubing,1/2"	As Req.
*19A	Bearing Shim Kit	1 Kit	62	Ball Bearing	8
20	Snap Ring	1	63	Gauge, Sight	1
21	Ball Bearing	2	65	Oil Pump with Coupling	1
22	Pinion and Shaft	1	67	Lube Line, 3/8" OD	1
23	Drive Pinion, 2nd	1	69	Fitting, Lube Spray	1
24	Drive Pinion, 3rd	1	70	Gasket, Oil Pump	1
25	Spacer	1	71	Bearing Cover	1
26	Drive Gear, 4th	1	*72	Shim Kit	1 Kit
27	Drive Gear, 5th	1	73	Plug, 3/" Pipe Magnetic	1
28	Spacer	1	86	Filter, Cartridge	1
29	Drive Gear, 6th	1	87	Elbow	1
33	Ball Bearing	1	93	Connector, Male	1
34	Sliding Gear, High	1	94	Nipple	1
35	Countershaft	1	95	Plug, Expansion	1
36	Sliding Gear, Forward & Reverse	1	97	Gear	1
37	Sliding Gear, Low & Intermediate	1	98	Spacer	1

***Assembly Of Parts On Bevel Pinion Shaft (Item No.** 4)

(a) To prevent bearing "float", pre-assemble the double set of ball bearings (9) for gears (12) & (13) near the center of the shaft. Determine how many shims from Kit (18) are required between the bearing sets to keep them confined between the two snap rings you install on the pinion shaft. Remove all parts but keep the required shims with the bearings and snap rings for the assembly sequence.

(b) To prevent shaft "float", pre-assemble ball bearing (19) onto shaft (4) and install snap ring (20) to retain it. With the bearing pressed tight against the shoulder of the shaft, determine how many shims from Kit (72) must be slipped between the bearing and the snap ring to fill the gap. Lay aside the excess shims. Remove the bearing and install the shims between the shaft shoulder and the bearing to be sure there is no bearing float when the snap ring is again in place. Leave these parts on the shaft for the following Step (c) procedure.

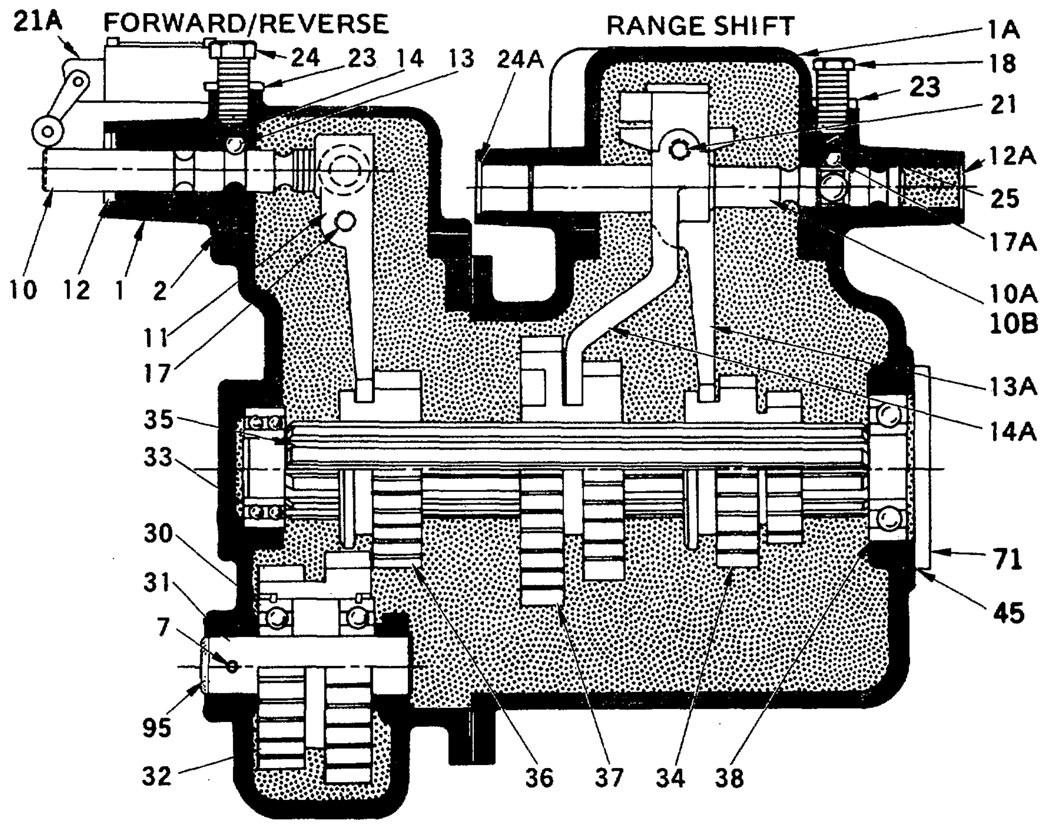
(c) To prevent shaft "float", hold the shaft (4) (with bearing, shims and snap ring installed as in Step b) in place inside the housing with the bearing snap ring tight against the housing counterbore. Install gasket (58) and bearing cover (59) and tighten at least three of its retaining screws. Attempt to move the shaft laterally back and forth to feel if "float" exists. If it does, add enough shims from Kit (19A) between the bearing snap ring and the housing shoulder to eliminate all float. Do not add too many shims so that gasket (58) is not properly compressed to prevent oil leakage when cover (59) is on tight. Remove all parts but keep the required number of shims with the bearing for the assembly sequence.



End View Cut-away of 24 Speed Manual Shift Transmission (View B-B, Figure 51)
Figure 52

COMPONENT PART DESCRIPTIONS - 24 SPEED TRANSMISSION (FIGURE 52)

Item No.	Description	Qty.	Item No	Description	Qty.
9	Plastic Ball	3	50	Lockwasher, Ball Bearing	2
5	Shift Lever, Fwd-Rev.	1	51	Cover, Bearing Mounting	2
5A	Shift Lever, Range	1	52	Oil Seal	2
5B	Shift Lever, 6-Speed	1	53	Ball Bearing	2
21	Micro Switch	1	54	Spacer	1
47	Breather	1	55	Bevel Gear	1
48	Extension . .	1	56	Gasket Kit	1
49	Locknut, Ball Bearing	2	91	Output Shaft	1



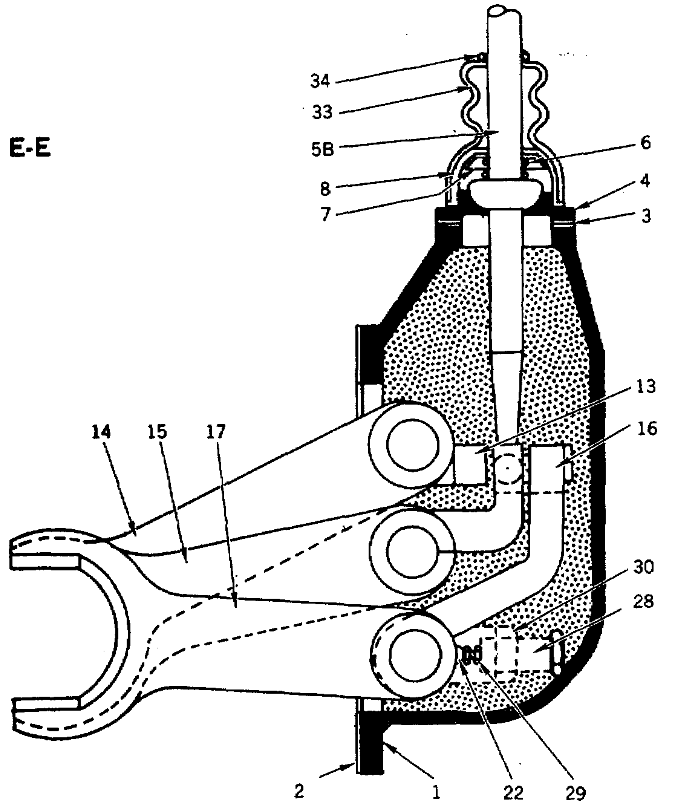
Cross-section View of 24 Speed Manual shift Transmission (View C-C, Figure 51)
Figure 53

COMPONENT PART DESCRIPTIONS - 24 SPEED TRANSMISSION (FIGURE 53)

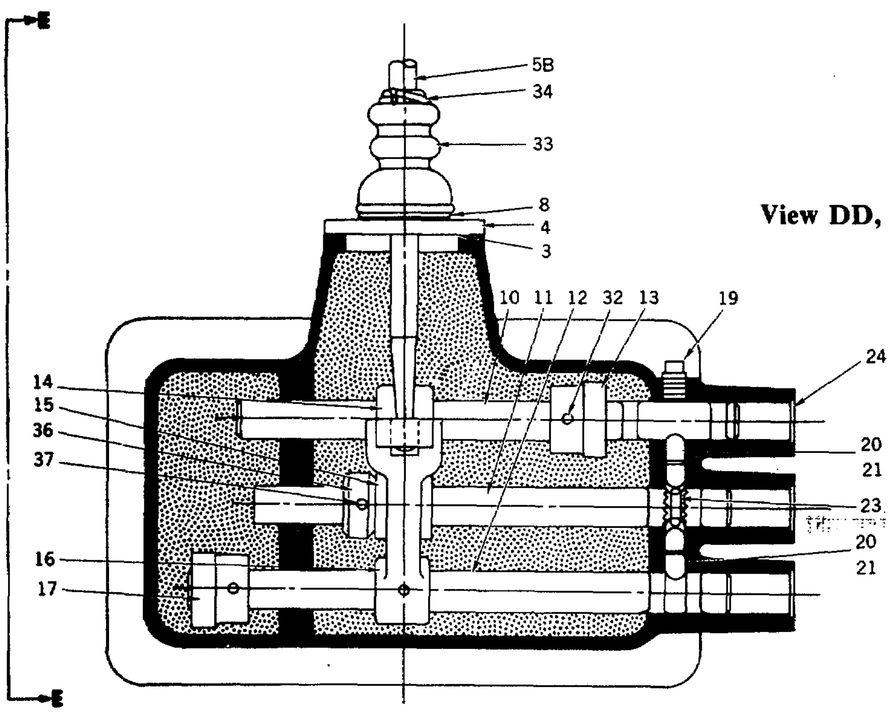
Item No.	Description	Qty.
1	Housing, Fwd-Rev. Shift	1
1A	Housing, Range Shift	1
2	Gasket	1
7	Lockscrew, Idler Shaft	1
10	Shaft, Fwd-Rev.	1
10A	Shaft, Range	1
10B	Shaft, Low & Intermediate	1
11	Shift Fork, Fwd-Rev.	1
12	Oil Seal	1
12A	Expansion Plug	2
13	Detent Ball	1
13A	Shift Fork, High	1
14	Detent Spring	1
14A	Shift Fork, Low & Intermediate	1
17	Capscrew	1
17A	Detent Ball	1
18	Retaining Screw	1
21	Capscrew	1

Item No	Description	Qty.
21A	Micro Switch	1
23	Jam Nut	2
24	Retaining Screw	1
24A	Expansion Plug	2
25	Detent Spring	I
30	Ball Bearing	2
31	Shaft, Idler Gear	1
32	Idler Gear, Reverse	1
33	Ball Bearing	1
34	Sliding Gear, High	1
35	Countershaft	1
36	Sliding Gear, Fwd-Rev.	1
37	Sliding Gear, Low & Intermediate	1
38	Ball Bearing	1
45	Gasket	I
71	Cover for Bearing	I
95	Expansion Plug	1

VIEW E-E



Side & End View Cross-sections Of 6 Speed Shift Lever Module
Figure 54



View DD, Figure 52

Side & End View Cross-sections Of 6 Speed Shift Lever Module
Figure 54

COMPONENT PART DESCRIPTIONS - 24 SPEED TRANSMISSION (FIGURE 54)

Item No.	Description	Qty.	Item No	Description	Qty.
1	Housing	1	19	Plug	1
2	Gasket	1	20	Plunger, Locking	4
3	Gasket, Shifter Cover	1	21	Spring	2
4	Cover, Shifter	1	22	Ball	3
5	Shift Lever, Six Speed	1	23	Pin	1
6	Spring, Shift Shaft	1	24	Expansion Plug	3
7	Washer, Shift Cap	1	28	Retainer, Spring	3
8	Cap, Shift Housing	1	29	Spring	3
9	Ball, Shift Lever	1	30	Nut	3
10	Shifter Shaft, 5th & 6th	1	32	Pin, Groove	3
11	Shifter *Shaft, 3rd* & 4th	1	33	Boot, Cover	1
12	Shifter Shaft, 1st & 2nd	1	34	Clamp, Boot	1
13	Shifter Dog, 5th & 6th	1	36	Collar, Shifter Stop	1
14	Fork, 5th & 6th	1	37	Pin, Roll	1
15	Fork, 3rd & 4th	1			
16	Shifter Dog, 1st & 2nd	1			
17	Fork, 1st & 2ND	1			

REPLACEMENT OF TRANSMISSION OIL PUMP

The paver is equipped with an oil pump on front end of transmission. (Item 65, Figure 51)This pump provides positive lubrication circulation to gears and bearing in the main transmission.

If it should be necessary to replace pump, it is important that it be **properly** mounted.

Failure to follow this assembly procedure can result in premature failure of the pump.

METHOD:

1. Check condition of upper shaft bearings in transmission. A slight lateral movement of shaft should be possible if bearings and shah are in acceptable operating condition.
2. Inspect pump coupling for wear and make sure it will slide freely on pump shaft. Also, inspect driving slot for coupling in transmission shaft. Replace parts if worn.
3. Assemble pump to transmission and only **finger tighten bolts.** Fill pump with the recommended transmission lubricant.
4. Attach lube lines to pump. Do not completely tighten lines so that the pump will be free to align itself to the transmission while rotating.
5. Start engine and engage clutch. **While pump is operating**, tighten mounting capscrews evenly and progressively.
6. Tighten lube lines securely.
7.

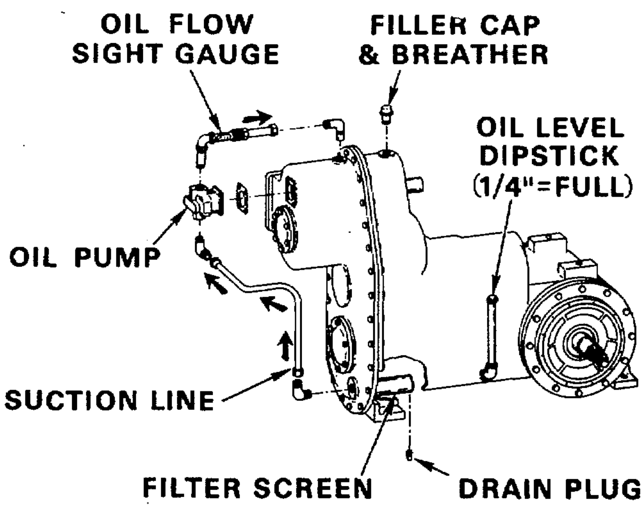
TRANSMISSION OIL LINE FILTER

A fine mesh filter screen is used ahead of the oil supply line of the transmission pump to keep the foreign particles from damaging the pump. This filter is a cartridge type unit which is screwed into the transmission housing. The oil pump suction line fitting is then screwed into the center of the filter cartridge. (Item 86, Figure 51)

If an oil pump in apparent good condition fails to maintain a good flow of oil through the sight glass, a plugged filter screen may be responsible. If this is suspected, back-flush the strainer and transmission case as follows:

1. Disconnect the suction line to the pump and attach a hose and funnel so that flushing solution can be poured into the line.
2. Drain the transmission oil, then re-install the drain plug.
3. Pour a quantity of Texaco Rando AA flushing solution into the gear case through the pump suction line to back-flush the filter screen. Fill the case to a point above the normal oil level (on dipstick) and allow several hours for the solution to dissolve the oil residue.

(Continued)



Transmission Oiling System - Exploded View

Transmission Oiling system - Exploded View
Figure 55

4. Drain the flushing solution.
5. With the drain plug removed, pour some additional fresh solution into the pump lines as a final flushing of the screen.
6. Re-attach line. Replace drain plug. Fill case to proper level with Texaco #EP90 Universal Gear Lubricant (about 17 quarts) and test pump for proper flow through sight glass.

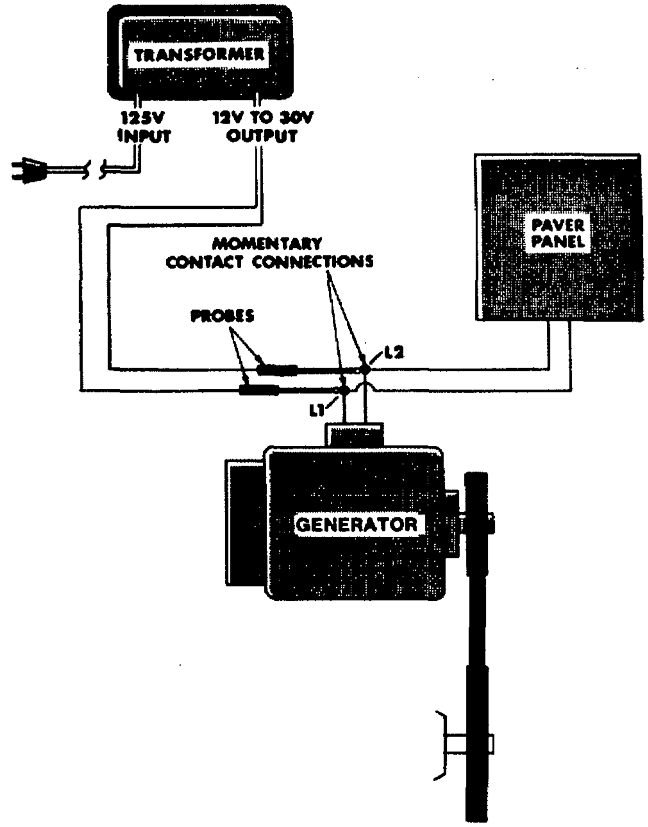
> **NOTE:** The filter screen flushing procedure is recommended as a seasonal lubrication requirement in keeping with good equipment maintenance programs. Where normally gear cases are drained, flushed, and re-filled with fresh lubricant for an upcoming season, this procedure varies only in that the flushing solution is poured into the case through the pump suction line so that the filter screen back-flush occurs automatically.

LOSS OF GENERATOR VOLTAGE (125 V.A.C.)

Occasionally, Winpower 3600 RPM generator will lose its residual magnetism and fail to produce AC power. This is very unusual, unless the generator has been dis-assembled, or has received a severe jolt. In such a case it will be necessary to "flash the field" in order for the generator to again produce power.

To 'flash the field" a step-down transformer with a nominal 125 V.A.C. **primary** winding and a 12 to 30 volt **secondary** winding can be used. A 12.6 volt filament transformer will also do the job. (See Figure 56).

The transformer primary should have a cord with a plug for a 125 V.A.C. wall receptical. The



Method Of Flashing 125 V AC Generator
Figure 56

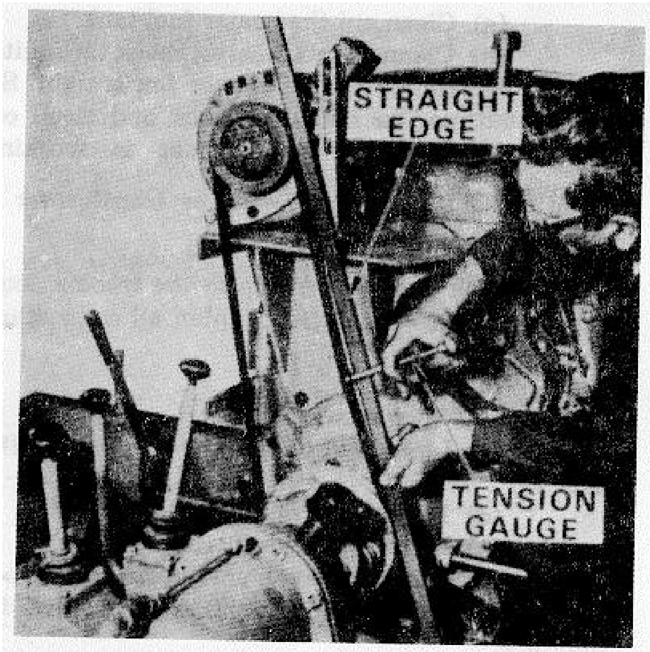
secondary should have extension leads with insulated probes.

> METHOD: With the generator rotating at proper speed, plug the transformer into any "Hot" 125 VAC outlet and touch the probes to L1 & L2 connections at the **junction box on the generator.** A momentary contact is all that is required.

GENERATOR MAINTENANCE

Little maintenance is required other than routine inspection and cleaning. The bearings are prelubricated and will be a long life item unless damaged by accident or excessive driving belt tension.

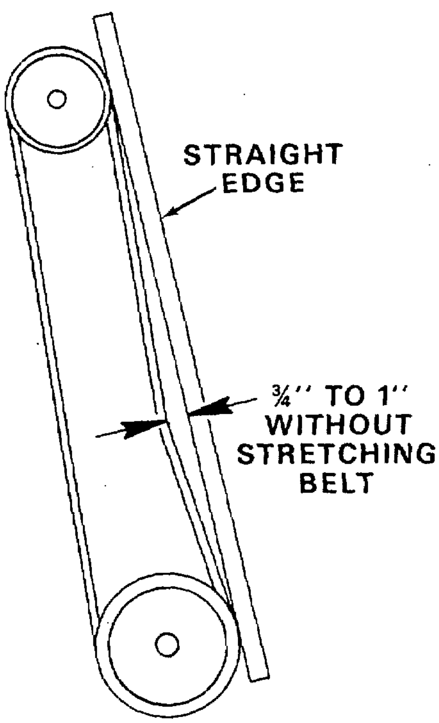
The interior of the generator should be clean and unobstructed. Slip rings and brushholders should be kept free from dirt, oil, and moisture. If compressed air is available it can be used effectively for cleaning.



Checking Belt Tension Using Pencil Type Gauge
Figure 57

GENERATOR V-BELT TENSION

It is important to keep the generator V-Belt at the proper tension. A loose belt will slip when the generator load is high and it will fail to produce the required current when most needed. An overly. tight belt will cause very rapid wearing of bearings in the generator and pre-mature



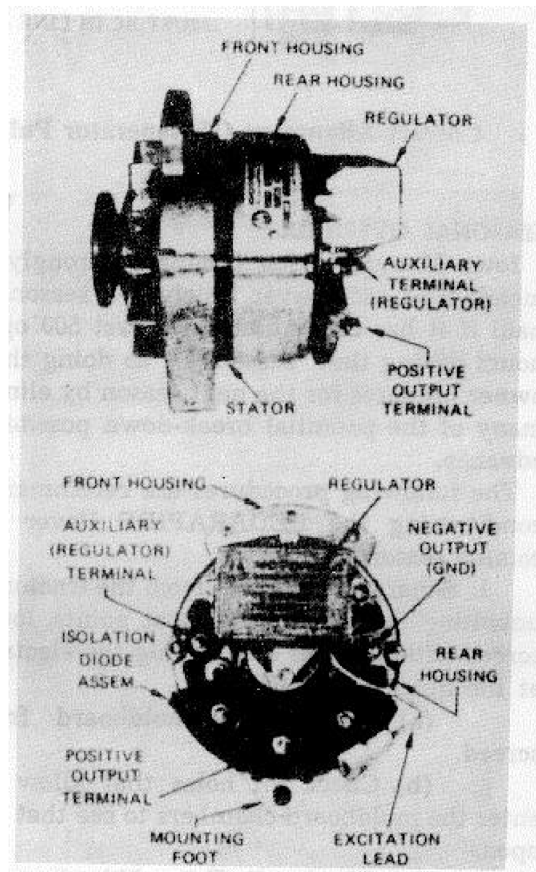
Checking Belt Tension With Straight Edge & Tape
Figure 58

failure of the unit.

When available use a pencil type belt tension gauge to accurately set the tightness. (See Figure 57). If no gauge is available, use a straight edge and a measuring tape (See Figure 58) and estimate a tightness that does not stretch the belt.

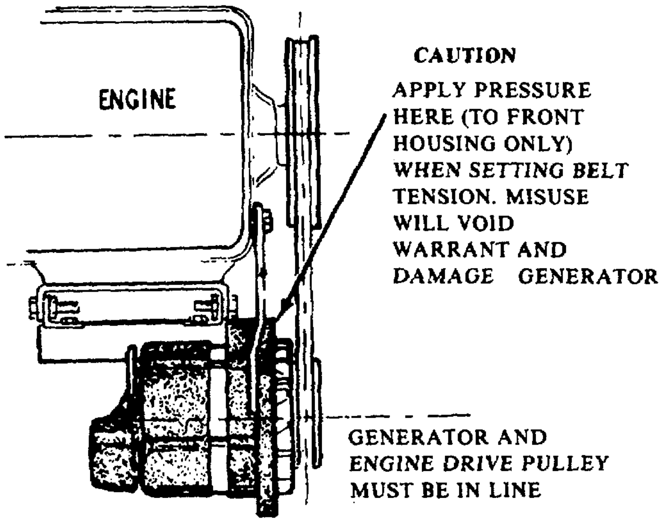
12 V DC GENERATOR MAINTENANCE

IMPORTANT! The voltage regulator used on the Motorola Model RA Generator must be Type 8RF201 1A with high voltage suppression feature. Do not substitute R3-1 or R.3-2 Regulators as neither type will last in this application.



Motorola 12 Volt DC Generator
Figure 59

V-BELT TENSION - When installing a generator be sure the pulley is in line with the motor drive pulley. Tighten the V-belt by putting pressure on the fan end of the housing. Do not apply pressure to the voltage regulator end! The belt should be just tight enough so that the driven pulley will not slip when an attempt is made to turn the fan by hand. (See Figure 60).



Correct Alignment of Generator Pulley
Figure 60

SEASONAL OVERHAUL

Iowa Manufacturing Company strongly recommends that each paver be given a seasonal overhaul if it has accumulated at least 500 operating hours during that season. By so doing the paver owner prepares for the next season by eliminating many of the potential break-down possibilities in advance.

The following procedures are recommended for conditioning the CEDARAPIDS Paver for the coming season.

1. Separate the screed from the tractor unit by unbolting the arm at the pivot points, loosen the screed lifting cables and unplug the electric cable at the quick-disconnect.

(a) Remove the moldboard from the screed.

(b) Check all holes that allow heat to enter the moldboard chambers to see that they are open.

(c) Check all Eriez Vibrators for the proper setting. Follow procedure as outlined in Section 7.

(d) Check all wiring and connections to make sure they are not broken or bare. Take care to check the heavy crossover cable.

(e) Check the screed plate thickness and look for cracks.

(f) Disassemble the depth control screws and socket. Clean out and check for wear and excessive looseness in these sockets, which could cause a wavy mat.

(g) Clean out the heater fuel tank.

(h) Clean out the heater; check the igniter tip and porcelain. Be sure blower fan is tight. Set tips as outlined in manual. Check and clean out pump. Be sure the transformer is working.

WARNING: Cover must be over transformer at all times.

2. Check over all wiring on the tractor, looking for loose or bare wire. Tighten all connections on:

(a) Relays

(b) Toggle switches

(c) Limit switch on the reverse shifter bar

(d) Depth control limit switches

(e) Manual override switch

(f) Check the 125 volt generator V-belt drive and mounting. Check pulley set screws for tightness.

(g) Check the 12 VDC Generator V-belt drive and mounting. Check pulley set screws for tightness.

3. Refer to the engine manufacturer's manual for all periodic maintenance instructions. Strict compliance with these instructions will help assure steady and efficient operation of the vital power plant.

4. Drain and flush the transmission and transfer cases and fill with the correct quantity and type of oil.

5. Check electric clutches - make sure each clutch is getting the proper amount of current. This should be a minimum of 11.4 volts when machine is in operation. Make sure all clutch settings are maintained as noted in Electric Clutch Paragraphs, this Section.

6. Remove the slat and screw conveyors.

(a) The liners for the slat conveyor may need replacing.

(b) If the chain of the slat conveyor is starting to show wear it may be reversed.

(c) Check the conveyor sprockets if they show excess wear, replace at this time.

(d) Check all the roller bearings and tighten all hold down bolts.

(e) The outboard bearing for the screw conveyor may need replacing.

(f) Hardface the screw conveyor. An extra hardfaced screw conveyor should be kept in stock. As the one on the machine starts to show wear, it should be replaced and built back up with hardface.

7. Remove track, upper lower, and oscillating rollers. Replace all track roller shafts that show wear. The rollers can be rebushed if the bore is not damaged. It the bore is damaged either a new roller is needed or a salvage operation can be performed by boring the roller oversize and pressing in a steel sleeve. For bore sizes, consult Iowa Manufacturing Company, Service Engineering Department.

(a) Check the sprockets and shoes.

(b) Clean out the guard around the track drive chain.

(c) Check the bolts which hold the flange drive sprocket to the rear track drive sprocket. Make sure they are S.A.E. bolts with a double jam nut and tightened properly.

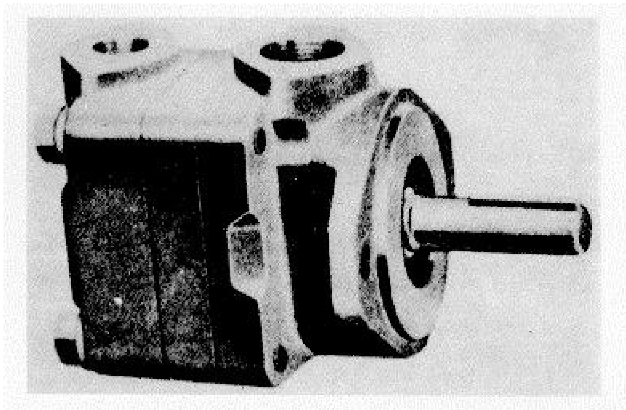
8. Drain hydraulic fluid reservoir. Clean tank and suction filter. Re-fill with fresh fluid. (See Section 5)

SECTION XII

Purchased Component Vendor Instructions

PART IV.

VANE PUMPS



V100, V200, V300, V400

V500, AND V2P SERIES

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Section I - INTRODUCTION

A. PURPOSE OF MANUAL

This manual has been prepared to assist the users of Vickers balanced vane type hydraulic single pumps in properly installing, maintaining and repairing their units. In the sections which follow, the single pumps are described in detail, their theory of operation is discussed and instructions are given for their proper installation, maintenance and overhaul.

The general series of models covered are V100, V200, V300, V400, V500 and V2P. The information given applies to the latest design configurations listed in Table I. Earlier designs are covered only insofar as they are similar to the present equipment.

B. GENERAL INFORMATION

1. Related Publications - Service parts information and installation dimensions are not contained in this manual. The parts catalogs and installation drawings listed in Table I are available from any Vickers Mobile Division Application Engineering office, or from:

Vickers
Mobile Hydraulics Division
Product Service Department
P.O. Box 302, Troy, Michigan

2. Model Codes - There are many variations within each basic model series, which are covered by variables in the model code. Table II is a complete breakdown of the code covering these units. Service inquiries should always include the complete unit model number, which is stamped on the pump cover.

TABLE I
PARTS CATALOGS AND INSTALLATION DRAWINGS

MODEL SERIES	DESIGN NO. (See Table II)	PARTS CATALOG	INSTALLATION DRAWING
V100	-10	M-2031-S	M-152060
V200	-12	M-1771-S	M-190082
V300	-11	M-2033-S	M-128797
V400			M-127065
V500	-10	M-1262-S	M-236696
V2P	-10	M-2002-S	M-289405

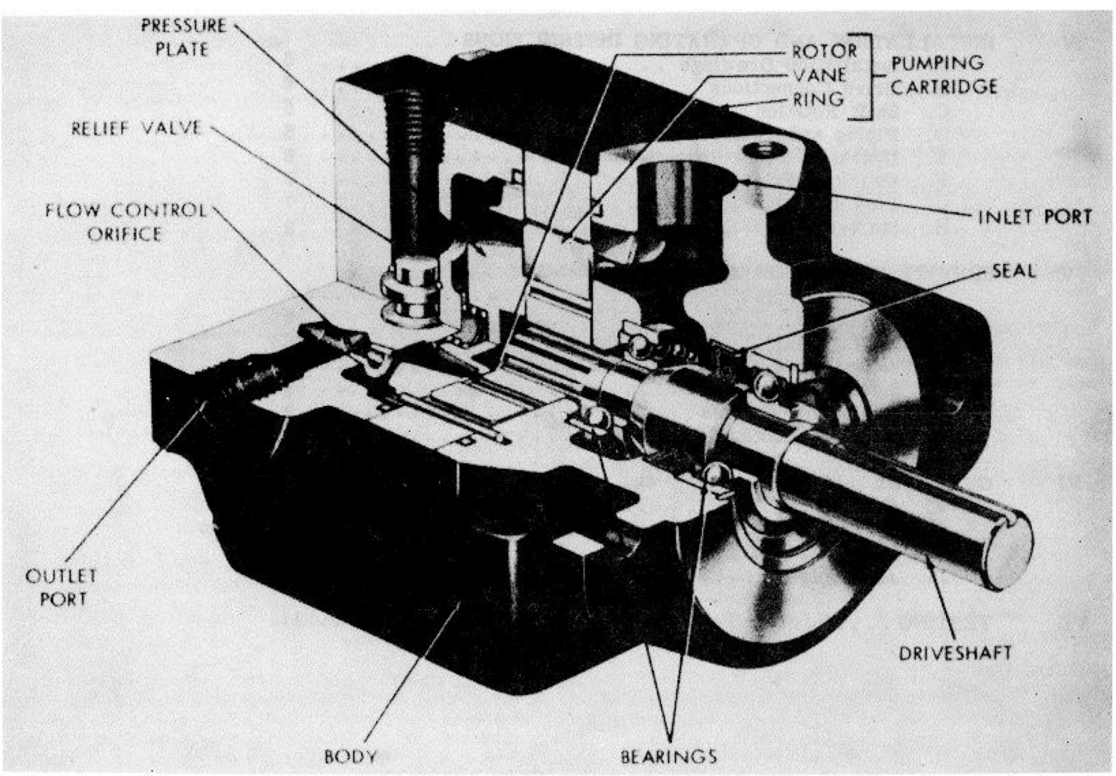


Figure 1

TABLE II - MODEL CODE BREAKDOWN

V 2 1 0 - 8 W - 1 F C - C 8 - 1 2 - L - *

- **V** — Vane Pump
- **2** — Series
- **1** — Body Type
  1. Standard Threaded
  2. Standard Flange
  3. Face Threaded
  4. Face Flange
  5. Tapped Foot Threaded
- **0** — Mounting
  - 0 - None
  - 4 - Foot
  - 5 - Flange
  - 7 - Power Take-off
- **8** — Capacity in GPM (At 1200 RPM)
- **W** — Wide Ring (V200 Only)
- **1** — Shaft Type
  - 1 - Straight with square key
  - 3 - Threaded
  - 6 - Straight stub with Woodruff key
  - 7 - Six-Tooth Spline
  - 11 - Splined
  - 24 - Tang Drive
  - 34 - Woodruff Key Threaded (Special)
  - 37 - Involute Spline (Special)
- **F** — Connection Flanges Supplied
- **C** — Port Positions (See Figure 6)
- **C** — Relief Valve Setting (V200 Only)
  - C - 750 PSI
  - D - 1000 PSI
  - E - 1250 PSI
  - F - 1500 PSI
  - G - 1750 PSI
  - H - 2000 PSI
- **8** — Controlled Flow Rate (GPM) (V200 Only)
- **12** — Design
- **L** — Optional Left Hand Rotation
- ***** — Special Features

Section II - DESCRIPTION

A. GENERAL

Pumps in this series are used to develop hydraulic fluid flow for the operation of Mobile equipment. The positive displacement pumping cartridges are the rotary vane type with shaft side loads hydraulically balanced. The flow rate depends on the pump size and the speed at which it is driven.

All units are designed so that the direction of rotation, pumping capacity and port positions can be readily changed to suit particular applications.

B. ASSEMBLY AND CONSTRUCTION

The V200 series pump illustrated in cutaway in Figure 1 is representative of all single pumps in this series. The unit consists principally of a ported body and cover, a drive shaft supported by two ball bearings, a pumping cartridge and a pressure plate. The components of the cartridge are an elliptical ring, a slotted rotor splined to the drive shaft and twelve vanes fitted to the rotor slots.

As the rotor is driven by the driveshaft, the vanes generate fluid flow by carrying fluid around the elliptical ring contour (see section m). Fluid enters the cartridge through the inlet port in the body and is discharged through the pressure plate to the outlet port in the cover.

C. FLOW CONTROL AND RELIEF VALVE

V200 pumps are available with an integr Flow Control and Relief Valve in the pump cover. This limits the fluid flow in the system to a maximum prescribed rate and prevents excessive pressure build-up. Fluid not required in the system is recirculated to tank.

D. APPLICATION

Pump ratings in GPM as shown in the model coding are at 1200 RPM. For ratings at other speeds, methods of installation and other application information, Vickers Mobile Division Application engineering personnel should be consulted.

Section III - PRINCIPLES OF OPERATION

A. PUMPING CARTRIDGE

As mentioned in Section II;, fluid flow is developed in the pumping cartridge. The action of the cartridge is illustrated in Figure 2. The rotor is driven within the ring by the driveshaft, which is coupled to a power source. As the rotor turns, centrifugal force on the vanes causes them to follow the elliptical inner surface of the ring.

Radial movement of the vanes and turning of the rotor cause the chamber between the vanes to increase as the vanes pass the inlet sections of the ring. This results in a low pressure condition which allows atmospheric pressure to force fluid into the chambers. (Fluid outside the inlet is at atmospheric pressure or higher.)

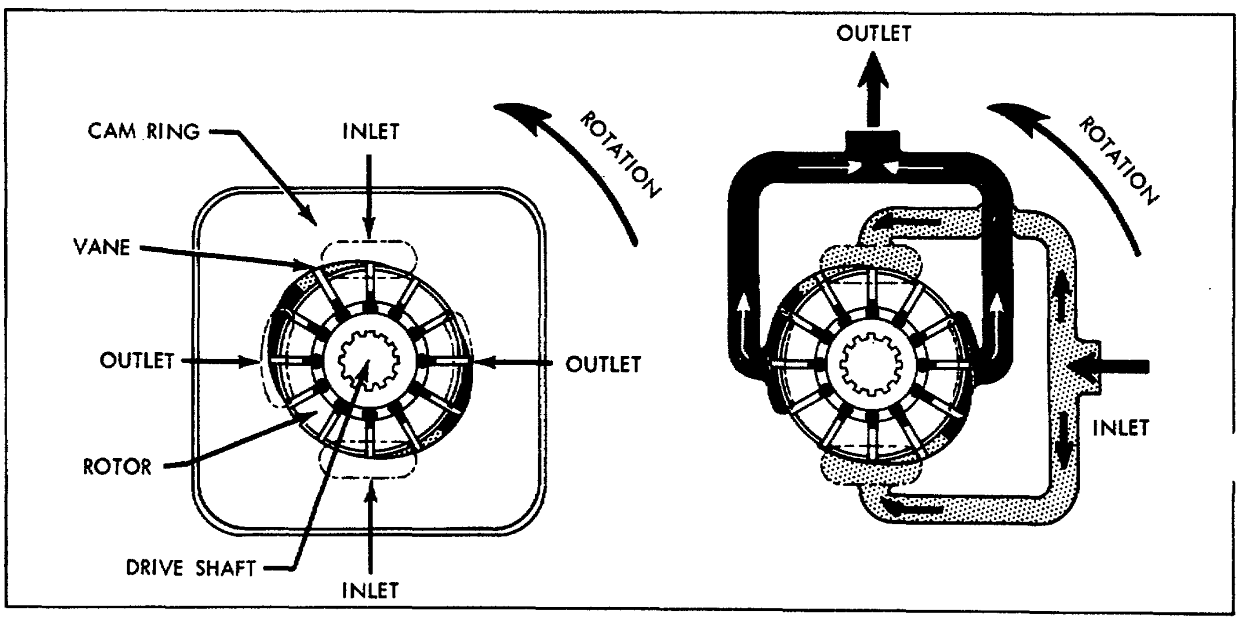


Figure 2

This fluid is trapped between the vanes and carried past the large diameter or dwell section of the ring. As the outlet section is approached, the ring diameter decreases and the fluid is forced out into the system. System pressure is fed under the vanes, assuring their sealing contact against the ring during normal operation.

B. HYDRAULIC BALANCE

The pump ring is shaped so that the two pumping chambers are formed diametrically opposed. Thus, hydraulic forces which would impose side loads on the shaft cancel each other out.

C. PRESSURE PLATE

The pressure plate seals the pumping chamber as shown in Figure 3. A light spring holds the plate against the cartridge until pressure builds up in the system. System pressure is effective against the area at the back of the plate, which is larger than the area exposed to the pumping cartridge. Thus, an unbalanced force holds the plate against the cartridge, sealing the cartridge and providing the proper running clearance for the rotor and vanes.

D. FLOW CONTROL AND RELIEF VALVE

1. Maximum pump delivery and maximum system pressure are determined by the integral flow control and 'relief valve in a special outlet cover used on some V200 pumps. This feature is illustrated schematically in Figure 4. An orifice in the cover limits maximum flow. A pilot-operated type relief valve shifts to divert excess fluid delivery to tank, thus limiting the system pressure to a prescribed maximum.

2. Figure 4A shows the condition when the total pump delivery can be passed through the orifice.

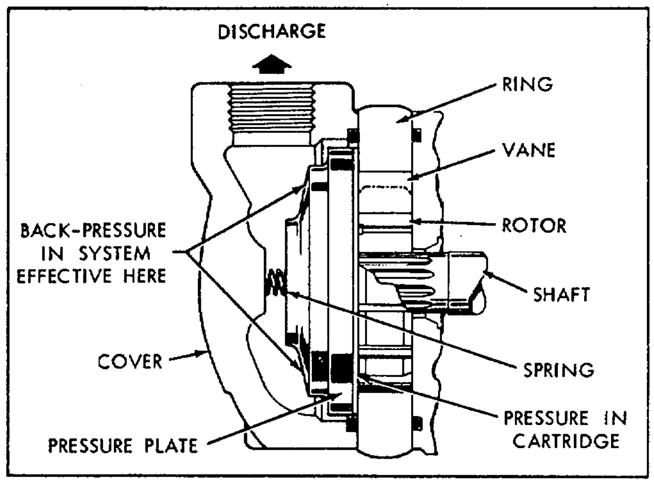


Figure 3

This condition usually occurs only at low drive speeds. The large spring chamber is connected to the pressure port through an orifice. Pressure in this chamber equalizes pressure at the other end of the relief valve spool and the light spring holds the spool closed. Pump delivery is blocked from the tank port by the spool land.

3. When pump delivery is more than the flow rate determined by the orifice plug, a pressure build-up forces the spool open against the light spring. Excess fluid is throttled past the spool to the tank port as shown in Figure 4B.

4. If pressure in the system builds up to the relief valve setting (Figure 4C), the pilot poppet is forced off its seat. Fluid in the large spring chamber flows through the spool and out to tank. This flow causes a pressure differential on the spool, shifting it against the light spring. All pump delivery is thus permitted to flow to tank.

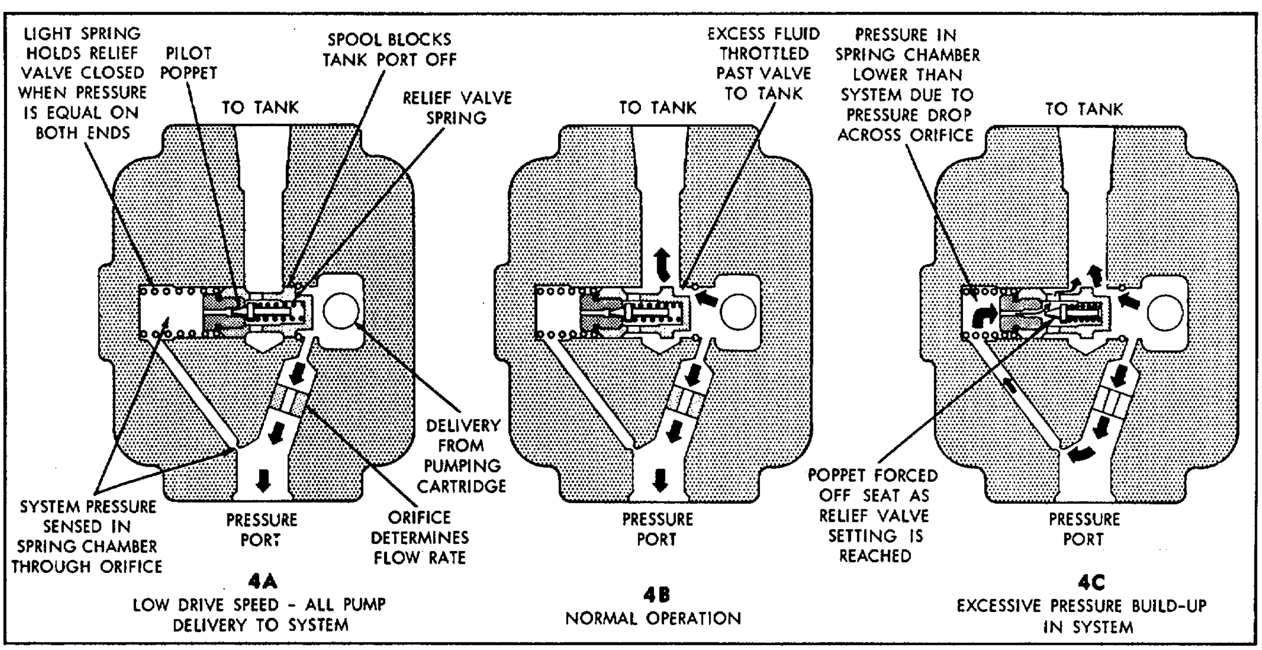


Figure 4

A. INSTALLATION DRAWINGS

B. DRIVE CONNECTIONS

CAUTION

Vickers pump shafts are designed to be installed in couplings, pulleys, etc., with a slip fit or very light tap. Pounding can injure the bearings. Shaft tolerances are shown on the pump installation drawings. (See Table I.)

1. Direct Mounting - A pilot on the pump mounting flange (Figure 5) assures correct mounting and shaft

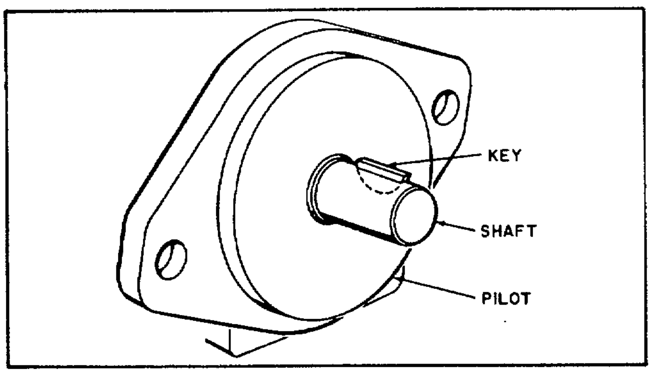


Figure 5

and shaft alignment, provided the pilot is firmly seated in the accessory pad of the power source. Care should be exercised in tightening all flange mounting screws to prevent misalignment.

If gaskets are used between flanges, they should be installed carefully so as to lay flat. Shaft keys and couplings must be properly seated to avoid slipping and possible shearing.

2. Indirect Drive - Chain, spur gear or vee belt pulley drives may also be used with these pumps. Flat belt drives are not recommended because of the possibility of slipping.

To prevent excessive side loads on the pump bearings, it is important to check for correct alignment and guard against excessive belt or chain tension.

C. SHAFT ROTATION

Vickers pumps are normally assembled for righthand (clockwise) rotation as viewed from the shaft ends. A pump made for lefthand rotation is identified by an "L" in the model code (See Table II).

NOTE

These pumps must be driven in the direction of the arrows cast on the pump ring. If it is desired to change the direction of drive rotation, it is necessary to reverse the ring. (See Section VI-B-D and Figure 9.)

CAUTION

Never drive a pump in the wrong direction of rotation. Seizure may result, necessitating expensive repairs.

D. PIPING AND TUBING

1. All pipes and tubing must be thoroughly cleaned before installation. Recommended methods of cleaning are sand blasting, wire brushing and pickling.

NOTE

For instructions on pickling refer to Vickers instruction sheet M-9600.

2. To minimize flow resistance and the possibility of leakage, only as many fittings and connections as are necessary for proper installation should be used.

3. The number of bends in tubing should be kept to a minimum to prevent excessive turbulence and friction of oil flow. Tubing must not be bent too sharply. The recommended radius for bends is three times the inside diameter of the tube.

E. HYDRAULIC FLUID RECOMMENDATIONS

The oil in a hydraulic system serves as the power transmission medium. It is also the system's lubricant and coolant. Selection of the proper oil is a requirement for satisfactory system performance and life. Oil must be selected with care and with the assistance of a reputable supplier.

TWO IMPORTANT FACTORS IN SELECTING AN OIL ARE:

1. Antiwear Additives - The oil selected must contain the necessary additives to insure high anti-wear characteristics.

2. Viscosity - The oil selected must have proper viscosity to maintain adequate lubricating film at system operating temperature.

SUITABLE TYPES OF OIL ARE:

1. Crankcase Oil meeting API service classification MS. The MS (most severe) classification is the key to proper selection of crankcase oils for Mobile hydraulic systems.

2. Antiwear Type Hydraulic Oil - There is no common designation for oils of this type. However, they are produced by all major oil suppliers and provide the antiwear qualities of MS crankcase oils.

3. Certain Other Types Of Petroleum Oils are suitable for Mobile hydraulic service if they meet the following provisions:

(a) Contain the type and content of antiwear impounding found in MS crankcase oils or have passed pump tests similar to those used in developing the antiwear type hydraulic oils.

(b) Meet the viscosity recommendations shown in the following table.

(c) Have sufficient chemical stability for Mobile hydraulic system service.

The following types of oil are suitable if they meet the above three provisions:

Series 3 Diesel Engine Oil
Automatic Transmission Fluid Types A, F and DEXRON
Hydraulic Transmission Fluid Types C-1 and C-2

The following table summarizes oil types recommended for use with Vickers equipment in Mobile hydraulic systems by viscosity and service classification.

Hydraulic System Operating Temperature Range (Min. * to Max.)	SAE Viscosity Designation	American Petroleum Institute (API) Service Classification
0°F to 180°F	10W	MS
0°F to 210°F	10W-30**	MS
50°F to 2100F	20-20W	MS

* Ambient Start Up Temperature
** See paragraph on Viscosity Index

OPERATING TEMPERATURE

The temperatures shown in table are cold start-up to maximum operating. Suitable start-up procedures must be followed to insure adequate lubrication during system warm-up.

ARCTIC CONDITIONS

Arctic conditions represent a specialized field where extensive use is made of heating equipment before starting. If necessary, this, and judicious use of SAE 5W or SAE 5W-20 oil in line with the viscosity guide lines shown in the table, may be used. Dilution of SAE 10W (SM) oil with maximum of 20% by volume of kerosene or low temperature diesel fuel is permissible. During cold start-up, avoid high speed operation of hydraulic system components until the system is warmed up to provide adequate lubrication. Operating temperature should be closely monitored to avoid exceeding a temperature of 130°F with any of these light weight or diluted oils.

OTHER FACTORS IN SELECTING AN OIL ARE:

1. Viscosity - Viscosity is the measure of fluidity. In addition to dynamic lubricating properties, oil must have sufficient body to provide adequate sealing effect between working parts of pumps, valves, cylinders and motors, but not enough to cause pump cavitation or sluggish valve action. Optimum operating viscosity of the oil should be between 80 SSU and 180 SSU. During sustained high temperature operation viscosity should not fall below 60 SSU.

2. Viscosity Index - Viscosity index reflects the way viscosity changes with temperature. The smaller the viscosity change the higher the viscosityindex. The viscosity index of hydraulic system oil should not be less than 90. Multiple viscosity oils, such as SAE 10W-30, incorporate additives to improve viscosity index (polymer thickened). Oils of this type generally exhibit both temporary and permanent decrease in viscosity due to the oil shear encountered in the operating hydraulic system. Accordingly, when such oils are selected, it is desirable to use those with high shear stability to insure that viscosity remains within recommended limits.

3. Additives - Research has developed a number of additive agents which materially improve various characteristics of oil for hydraulic systems. These additives are selected to reduce wear, increase chemical stability, inhibit corrosion and depress the pour point. The most desirable oils for hydraulic service contain higher amounts of antiwear compounding.

SPECIAL REQUIREMENTS

Where special considerations indicate a need to depart from the recommended oils or operating conditions, see your Vickers sales representative.

CLEANLINESS

Thorough precautions should always be observed to insure that the hydraulic system is clean:

1. Clean (flush) entire system to remove paint, metal chips, welding shot, etc.

2. Filter each change of oil to prevent introduction of contaminant into the system.

3. Provide continuous oil filtration to remove sludge and products of wear and corrosion generated during the life of the system.

4. Provide continuous protection of system from entry of airborne contamination.

5. During usage, proper oil filling and servicing of filters, breathers, reservoirs, etc., cannot be over-emphasized.

F. OVERLOAD PROTECTION

A relief valve must be installed in the system, unless it is an integral part of the pump. The relief valve limits pressure in the system to a prescribed maximum and protects the components from excessive pressure. The setting of the relief valve depends on the work requirements of the system and the maximum pressure ratings of the system components.

G. PORT POSITIONS

The pump cover can be assembled in four positions with respect to the body. A letter in the model code (Table II) identifies the cover position as shown in Figure 6. Disassembly and assembly procedures are in Section VI-B and D.

H. START-UP

With a minimum drive speed of 600 RPM, a pump should prime almost immediately if provision is made to

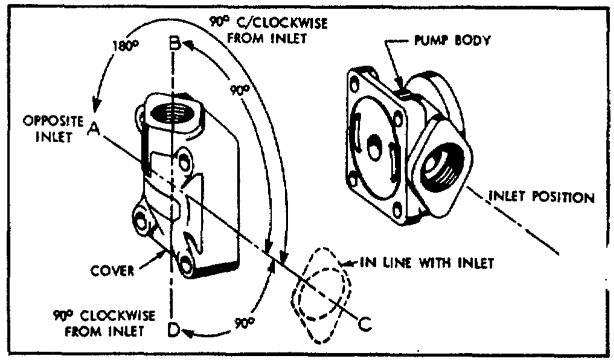


Figure 6

initially purge the air from the system. Failure to prime within a reasonable length of time may result in damage due to lack of lubrication. Inlet lines must be tight and free from air leaks. However, it may be necessary to crack a fitting on the outlet side of the pump to purge entrapped air.

Section V - SERVICE, INSPECTION AND MAINTENANCE

A. SERVICE TOOLS

No special tools are required to service these pumps.

B. INSPECTION

Periodic inspection of the fluid condition and tube or piping connections can save time-consuming breakdowns and unnecessary parts replacement. The following should be checked regularly.

1. All hydraulic connections must be kept tight. A loose connection in a pressure line will permit the fluid to leak out. If the fluid level becomes so low as to uncover the inlet pipe opening in the reservoir, extensive damage to the pump can result. In suction or return lines, loose connections permit air to be drawn into the systems, resulting in noisy and/or erratic operation.

2. Clean fluid is the best insurance for long service life. Therefore, the reservoir should be checked periodically for dirt or other contaminants.

If the fluid becomes contaminated the system should be thoroughly drained and the reservoir cleaned before new fluid is added.

3. Filter elements also should be checked and replaced periodically. A clogged filter element results in a higher pressure drop. This can force particles through the filter which would ordinarily be trapped, or can cause the by-pass to open, resulting in a partial or complete loss of filtration.

4. A pump which is running excessively hot or noisy is a potential failure. Should a pump become noisy or overheated, the machine should be shut down immediately and the cause of improper operation corrected.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to replenish the system, it should always be poured through a fine wire screen - 200 mesh or finer. It is important that the fluid be clean and free of any substance which could cause improper operation or wear of the pump or other hydraulic units. Therefore, the use of cloth to strain the fluid should be avoided to prevent lint getting into the system.

D. ADJUSTMENTS

No periodic adjustments are required, other than to maintain proper shaft alignment with the driving medium.

E. LUBRICATION

Internal lubrication is provided by the fluid in the system. Lubrication of the shaft couplings should be as specified by their manufacturers.

F. REPLACEMENT PARTS

Only genuine replacement parts manufactured or sold by Vickers should be used. These are identified in the parts catalogs listed in Table I.

G. TROUBLE-SHOOTING

Table IV lists the common difficulties experienced with vane pumps and hydraulic systems. It also indicates the probable causes and remedies for each of the troubles listed.

It should always be remembered that many apparent pump failures are actually the failures of other parts of the systems. The cause of improper operation is best diagnosed with adequate testing equipment and a thorough understanding of the complete hydraulic system.

TABLE IV - TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOT DELIVERING FLUID	DRIVEN IN THE WRONG DIRECTION OF ROTATION	The drive direction must be changed immediately to prevent seizure. Figure 9 shows the correct ring position for each direction of rotation.
	COUPLING OR SHAFT SHEARED OR DISENGAGED	Disassemble the pump and check the shaft and cartridge for damage. (See Section VI.) Replace the necessary parts.
	FLUID INTAKE PIPE IN RESERVOIR RESTRICTED	Check all strainers and filters for dirt and sludge. Clean if necessary.
	FLUID VISCOSITY TOO HEAVY TO PICK UP PRIME	Completely drain the system. Add new filtered fluid of the proper viscosity.
	AIR LEAKS AT THE INTAKE PUMP NOT PRIMING	Check the inlet connections to determine where air is being drawn in. Tighten any loose connections. See that the fluid in the reservoir is above the intake pipe opening. Check the minimum drive speed which may be too slow to prime the pump.
	RELIEF VALVE STUCK OPEN (MODELS WITH INTEGRAL RELIEF VALVE ONLY).	Disassemble the pump and wash the valve in clean solvent. Return the valve to its bore and check for any stickiness. A gritty feeling on the valve periphery can be polished with crocus cloth. Do not remove excess material, round off the edges of the lands or attempt to polish the bore. Wash all parts and reassemble the pump.
	VANE(S) STUCK IN THE ROTOR SLOT(S)	Disassemble the pump. Check for dirt or metal chips. Clean the parts thoroughly and replace any damaged pieces. If necessary flush the system and refill it with clean fluid.
INSUFFICIENT PRESSURE BUILD-UP	SYSTEM RELIEF VALVE SET TOO LOW	Use a pressure gauge to correctly adjust the relief valve.
	WORN PARTS CAUSING INTERNAL LEAKAGE OF PUMP DELIVERY -	Replace pump cartridge.
PUMP MAKING NOISE	PUMP INTAKE PARTIALLY BLOCKED	Service the intake strainers. Check the fluid condition and, if necessary, drain and flush the system. Refill with clean fluid.
	AIR LEAKS AT THE INTAKE OR SHAFT SEAL. (OIL IN RESERVOIR WOULD PROBABLY BE FOAMY)	Check the inlet connections and seal to determine where air is being drawn in. Tighten any loose connections and replace the seal if necessary. See that the fluid in the reservoir is above the intake pipe opening.
	PUMP DRIVE SPEED TOO SLOW OR TOO FAST	Operate the pump at the recommended speed.
	COUPLING MISALIGNMENT	Check if the shaft seal bearing or other parts have been damaged. Replace any damaged parts. Realign the coupled shafts.

NOTE

Complete cartridges are available in service kits for rebuilding these pumps. Refer to the catalogs listed in Table I for part numbers.

A. GENERAL

Plug all removed units and cap all lines to prevent the entry of dirt into the system. During disassembly, pay particular attention to identification of the parts, especially the cartridges, for correct assembly. Pump bearings are pressed in the bodies or on the shafts and should not be removed unless defective. Figure 7 is an exploded view which shows the proper relationship of the parts for disassembly and assembly. Figure 1 can be referred to for the correct assembled relationship of the parts.

B. DISASSEMBLY

1. Disassembly of basic pump - See Figure 7. If a mounting flange or foot bracket is used, remove it before dismantling the pump. Clamp the pump body in a vise (not too tightly), cover end up, and remove the four cover screws. Note the position of the cover port with respect to the body port before lifting off the cover and "O" ring. (See paragraph 2 for disassembly of flow control covers.)

Remove the pressure plate and spring and note the position of the ring for correct reassembly. Lift off the ring and remove the locating pin. Separate the vanes from the rotor and remove the rotor from the shaft.

Turn the pump body over and remove the shaft key and the snap ring which retains the outer bearing. Tap with a soft hammer on the splined end of the shaft to force the shaft out of the body. Support the bearing inner race and press the shaft out of the bearing. Pull the shaft seal out of the body with a suitable hooked tool and press out the inner bearing.

2. Disassembly of Flow Control and Relief Valve Covers - See Figure 7. If a screen is used in the cover, remove the plug and pull out the screen. Do not remove the orifice plug unless it is necessary. Check whether there is a plug at each end of the relief valve bore. If the bore is blind, remove the plug and the snap ring to release the valve and spring as shown in the inset view, Figure 7. If the bore is through the cover, remove only the one plug to release the spring and valve. Leave the snap ring and the other plug in the cover.

C. INSPECTION AND REPAIR

1. Discard the used shaft seal and all "O" rings. Wash the metal parts in mineral oil solvent, blow them dry with filtered compressed air and place them on a clean surface for inspection.

2. Check the wearing surfaces of the body, pressure plate, ring and rotor for scoring and excessive wear. Remove light score marks by lapping. Replace any heavily scored or badly worn parts.

3. Inspect the vanes for burrs, wear and excessive play in the rotor slots. Replace the rotor if the slots are worn.

4. Check the bearings for wear and looseness. Rotate the bearings while applying pressure to check for pitted or cracked races.

5. Inspect the oil seal mating surface on the shaft for scoring or wear. If marks on the shaft cannot be removed by light polishing, replace the shaft.

6. Check the relief valve sub-assembly for free movement in the cover bore. Remove burrs from the valve by polishing, but do not round off the corners of the lands. Do not attempt to rework the valve bore. If the bore is damaged, replace the cover.

D. ASSEMBLY

Coat all parts with hydraulic fluid to facilitate assembly and provide initial lubrication. Use small amounts of petroleum jelly to hold "O" rings in place during assembly.

IMPORTANT

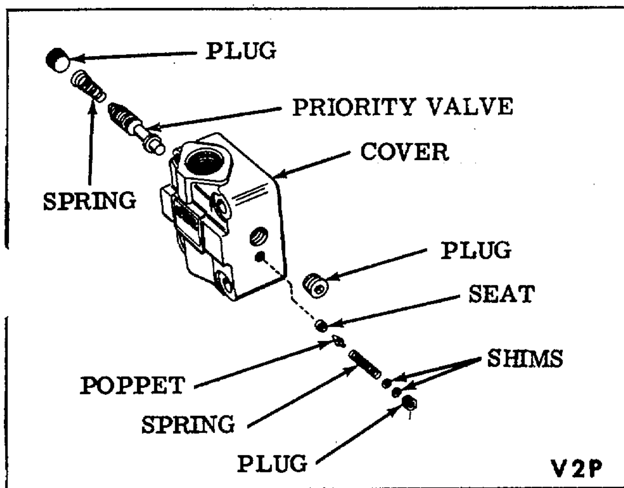
During handling and shipping of the precision machined cartridge parts, it is possible to raise burrs on the sharp edges. All sharp edges on the parts of a new cartridge kit should be stoned prior to installation.

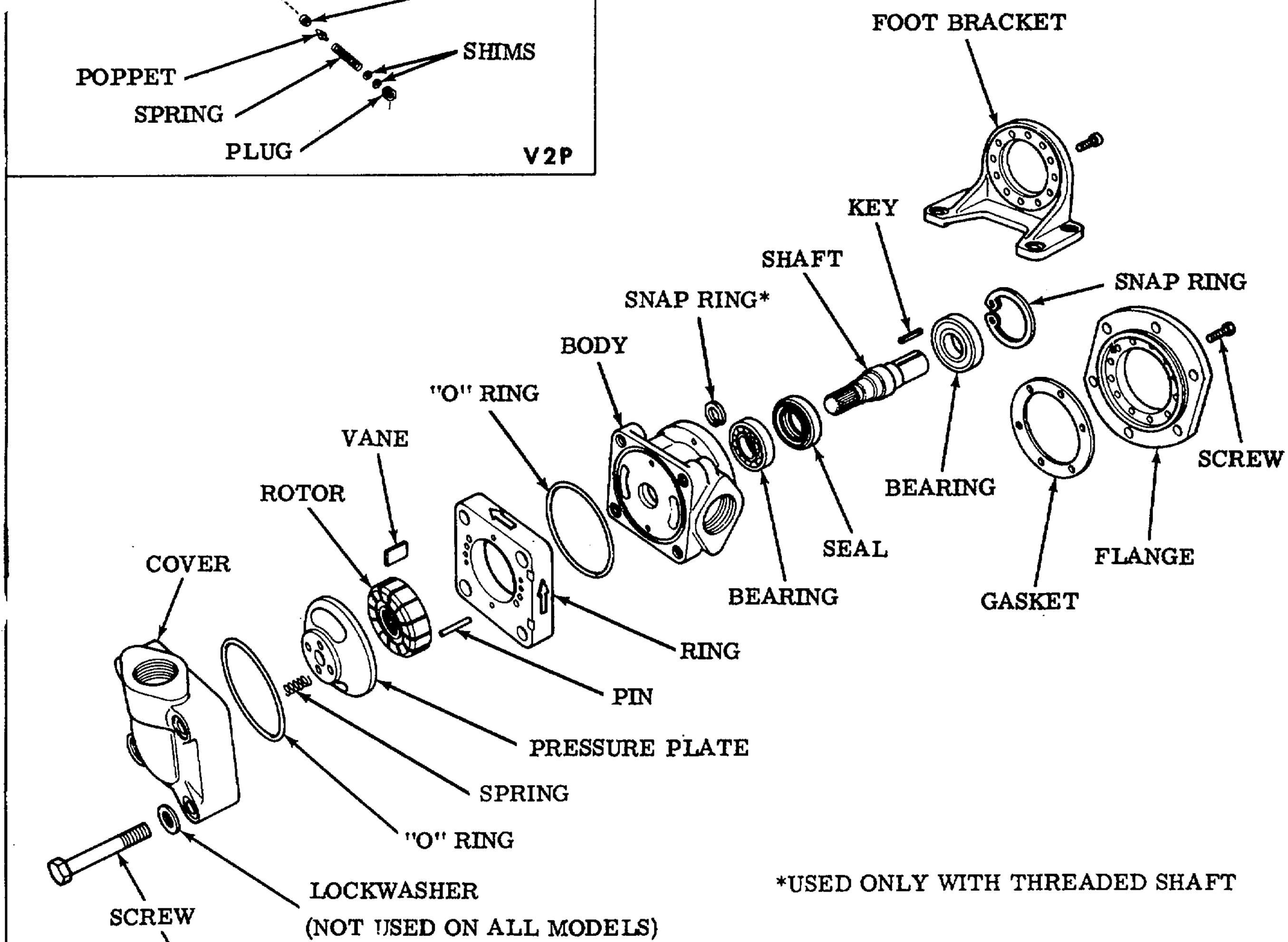
1. Assembly of Flow Control Cover - See Figure 7. If the cover has a through bore, insert the valve in the bore, small land first. Then install the spring and pipe plug. For models with the blind bore, first install the spring, then the valve, with the hexagon head end first. Follow this with the snap ring (being certain it is firmly seated in the groove) and the pipe plug. Install the screen and the plug which retains it.

2. Assembly of Pump - See Figure 7. Begin assembly by pressing the shaft into the front bearing while supporting the bearing inner race. Next, press the inner bearing into the body, using a driver which contacts the outer race only. Be certain both bearings are firmly seated.

NOTE

Before assembling the shaft seal, determine the correct position of the sealing lip. (See Figure 8.) Double lip seals are assembled with the spring toward the pumping cartridge. Single lip seals have two pressure holes, which are assembled toward the shaft end of the pump.





MODEL	TIGHTEN TO
V100	25± 3 ft. lbs.
V2, V200	70± 5 ft. lbs.
V300	100± 10 ft. lbs.
V400	150± 10 ft. lbs.
V500	250± 10 ft. lbs.

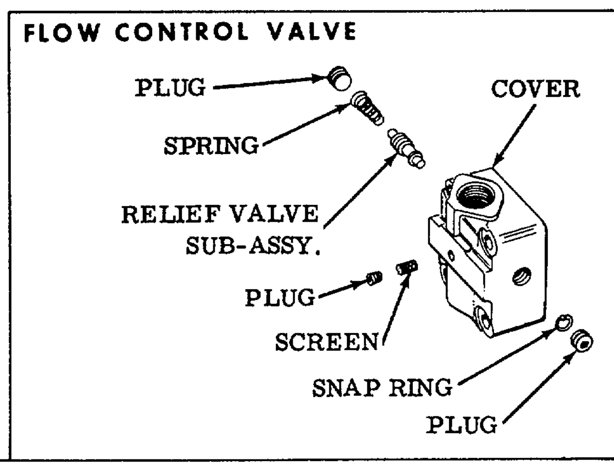


Figure 7

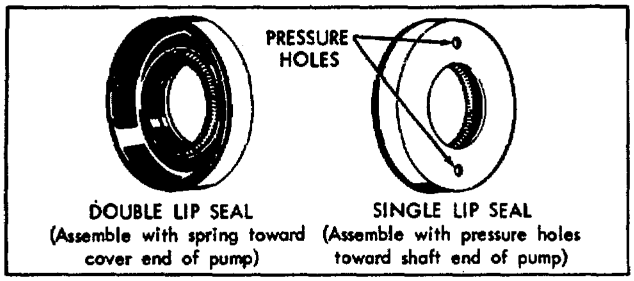


Figure 8

Press the seal firmly in place and lubricate the lip with petroleum jelly or other grease compatible with the system fluid. Slide the drive shaft into the body until the bearing is seated, Tap lightly on the end of the shaft if necessary. Install the snap ring.

Install the new "O" rings in the body and cover. Insert the ring locating pins in the body and assembly the ring so that the arrow on the perimeter points in the proper direction of rotation. Check the assembly against Figure 9. Install the rotor on the shaft and inset the vanes in the rotor slots. Be certain the radius edges of the vanes are toward the cam ring.

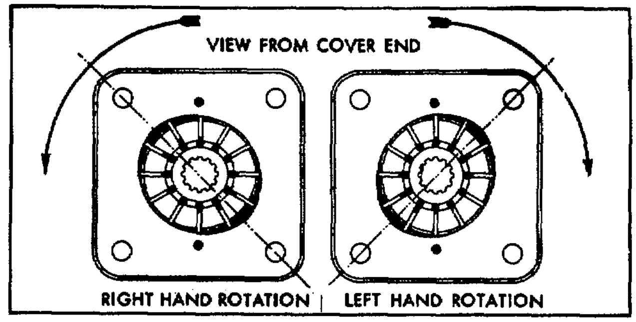


Figure 9

Place the pressure plate on the locating pins and flat against the ring. Use a small amount of petroleum jelly or grease to stick the spring in the recess In the pressure plate. Carefully install the cover with the outlet port in the correct position. Tighten the cover screws to the torque shown in Figure 8. Turn the shaft through by hand to insure that there is no internal binding. Install the shaft key.

Assemble the pump to its mounting flange or foot mounting. If a gasket is used, be certain it is flat to avoid misalignment of the shaft.

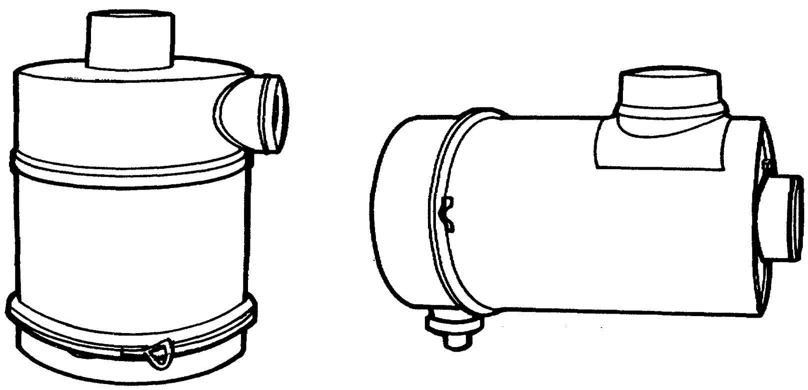
Section VII - TESTING

Vickers Mobile Division application engineering personnel should be consulted for test stand circuit requirements and construction. If test equipment is available, the pump should be tested at the recommended speeds and pressures shown on the installation drawings (see Table I).

PART V
Service Instructions for Cyclopac® Series Air Cleaners

FH Series
FW Series

Construction, Service Procedure, Element Cleaning, General *Service Tips*



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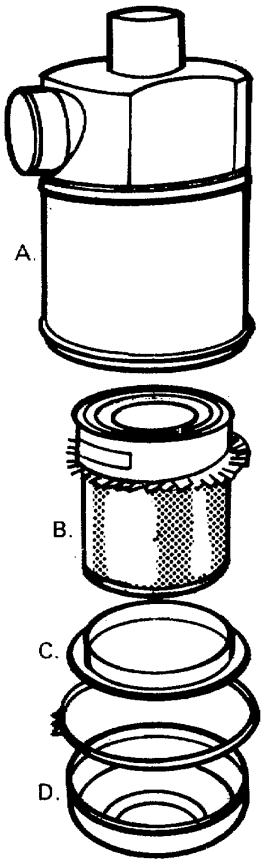


FW Series Cyclopac® Air Cleaners

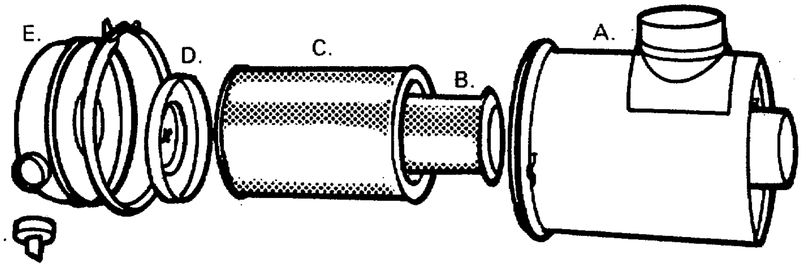
The Donaldson FW Series air cleaner has only a minimum number of parts. The heart of the air cleaner is the Duralife® II double-life element which can be cleaned and reused. The air cleaner is designed for fast, easy disassembly so that it may be serviced efficiently and quickly.

A. Body Assembly — This study shell contains the ducting and sealing surface of the air cleaner.

B. Duralife® II Filter Element — The heart of the air cleaner consists of the initial separator (fins), the final filter and the sealing gasket in one cleanable and reusable part. Rigid manufacturing specifications and controls are the key to the built-in quality of this part.

C. Baffle Assembly — Retains the dirt in the dust cup.

D. Dust Cup is reservoir for dust separated from air stream by the integral separator. The slotted baffle is an integral part of the separator which forms a barrier to hold dust in the cup. Dust cup can be equipped with a vacuator valve to dump collected dust automatically.



FH Series Cyclopac® Air Cleaners

The FH Series air cleaner is a low-maintenance cleaner featuring built-in pre-cleaner fins, Duralife® II primary element, and a "back-up" safety filter element for extra protection.

A. Body Assembly — Rugged construction for long operating life.

B. Safety Element — An added insurance policy which protects the engine in case of damage to the primary filter — also guards engine during servicing of primary element.

C. Duralife® II Primary Element — The double-life element — provides much more filter surface in the same size cleaner, holds more dust — lasts much longer.

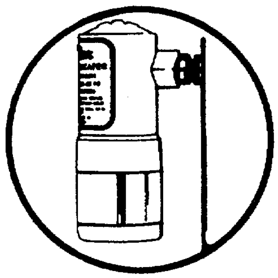
D. Baffle Assembly — Retains the dirt in the dust cup.

E. Dust Cup is reservoir for dust separated from air stream by the pre-cleaner.

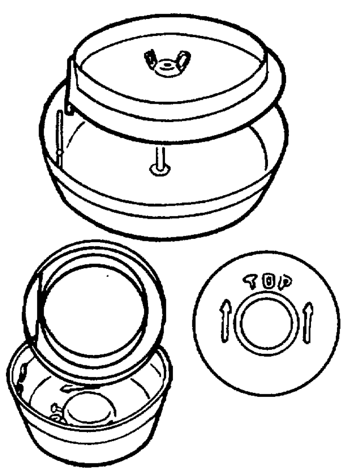
F. Vacuator Valve (optional) — Ejects dust and water continuously. Eliminates regular cup servicing, cuts service time.

Service Procedure

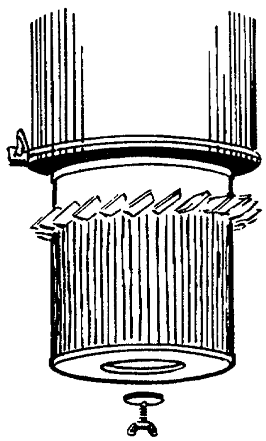
Maximum engine protection against the ravages of dust is possible ONLY if the air cleaner is serviced at regular intervals. Over-servicing does not utilize the air cleaner features to the fullest. The procedure is simple — just follow these easy steps as shown.



1 Measure the restriction of the air cleaner with a Donaldson restriction indicator, service gauge, or a water manometer at the restriction tap provided in the air cleaner, the transfer pipe, or the blower intake. Replace or clean the element only when the restriction has reached the maximum allowed by the engine or equipment manufacturer.



2 Empty the dust cup as required. Dust should not be allowed to build up closer than one inch from the baffle. On vacuator valve equipped models, dust cup service is cut to a minimum; a quick check to see that the vacuator valve is not inverted, damaged, or plugged is all that is necessary.



3 Element Servicing

When restriction indicates that element servicing is required, loosen wing nut and remove primary element. Before installing new element, inspect the element and gasket for shipping or storage damage. Carefully install element and wing nut. Reset the restriction indicater to green.

For minimum vehicle downtime, replace dirty filter with a new or properly cleaned Duralite filter element. If element is to be serviced for immediate re-use, reinstall outer cover to protect induction system while cleaning element.

4 Reinstall the dust cup, making sure it seals 360° around the air cleaner body. Reset the restriction indicator to green.

5 Check all connections between the air cleaner and the engine to be certain they are tight and leak-free.

Safety Element Service

The safety element is not intended to be cleaned. For maximum engine protection and air cleaner service life, replace the safety element with a new safety element every third primary element change.

Element Cleaning Methods

Clean Duralife element by one of the following methods:

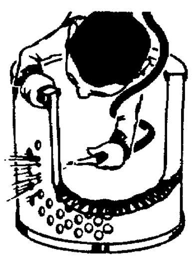
Compressed Air or Washing.

Compressed air is recommended when element will be re-used immediately because a washed element must be dried before re-use. However, washing does a better job and must be used when exhaust soot has lodged in fine pores of the filter media. Use Donaldson D-1400 detergent which contains a special additive for removing soot and carbon.

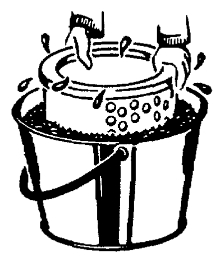
Replace element after 6 cleanings or annually, whichever occurs first.

Do not remove plastic fin assembly — back-flowing with compressed air or washing will remove dust from beneath the fin assembly.

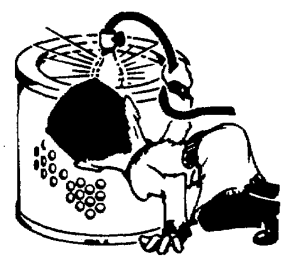
Request Form P45-7188 "How to Service Duralife® and Duralife® II Elements" for additional information.



Compressed Air
Direct air through element in the direction *opposite to normal air flow through the element.* Move nozzle up and down while rotating element. Keep nozzle at least one inch from pleated paper. Maximum air pressure to prevent damage of element is 100 P.S.I.



Washing
1. Soak element 15 minutes or more in Donaldson D-1400 and water solution. See carton for full instructions.
2. Rinse until water is clear (Maximum water pressure 40 P.S.I.)
3. Air-dry or use warm flowing air, max. 160°F. Do not use compressed air or light bulbs.



Inspection
Place bright light inside element and rotate element slowly. If any rupture, holes or damaged gaskets are discovered — replace.

General Service Tips

The air cleaner should be inspected periodically to maintain maximum engine protection and maximum service life. These inspections should include the following points:

1 — Inspect the air transfer duct between the air cleaner and the engine to be sure all clamps are tight, all flange joints are tight, and there are no cracks in the ducting.

2 — Air cleaner mounting bolts and clamps must be tight to hold the air cleaner securely.

3 — Check the dust cup to make sure it is sealing 360° around the air cleaner body.

4 — Vacuator valve must be in place, not inverted or damaged, and free from obstruction.

5 — Check for dents and damage to the air cleaner which could mean a leak.

6 — Make sure all inlet accessories are free from obstructions and securely mounted.

PART VI. PARTS LISTING
FOR

PAVING MACHINE, BITUMINOUS MATERIAL

CRAWLER MOUNTED

MODEL BSF-400

Serial Numbers 35627 thru 35633 inclusive

Contract No. DSA-700-77-C8481

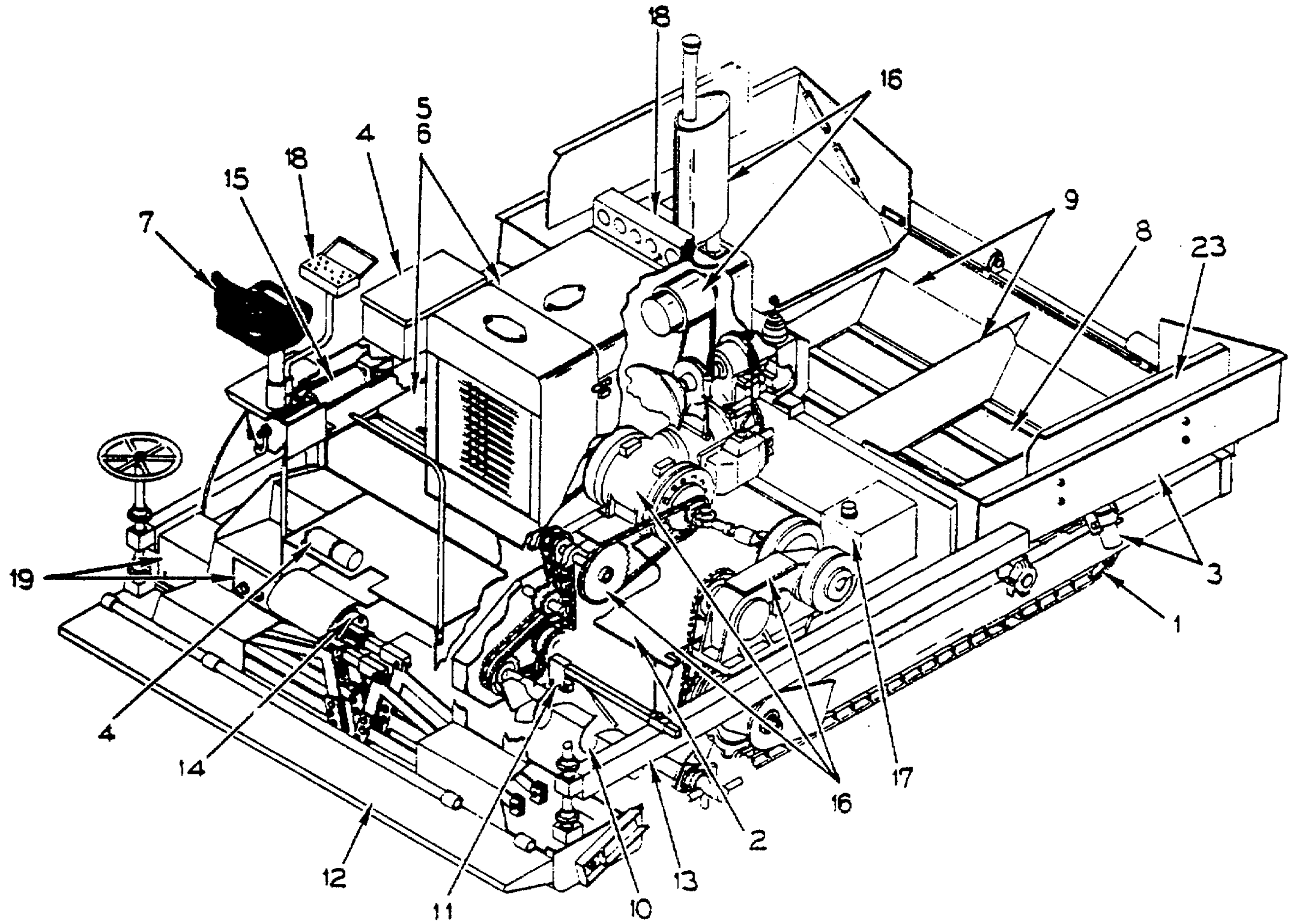
Serial Numbers 36955 thru 36964 inclusive

Contract No. DAAE07-79-C5795

SECTION INDEX

DESCRIPTION	SECTION
Components Index	1
Track	2
Main Frame Hopper Wings Tractor Accessories (Emblems and Attachments Hoods, Covers and Walkways Acoustic Details - Hood, Covers and Walkways Operators Seat Operator Remote Control - Main Clutch and Forward - Reverse Shifter	3
Conveyors, Slat and Screw	4
Screed	5
Power Mounting and Drives Power Mounting Parts Air Cleaner and Exhaust System Alternator and Drive Generator and Drive Automatic Throttle Control Power Take Off 24 Speed Transmission, Clutch and Drive Shaft Clutch, Transfer Case and Brakes Standard Conveyor Drive	6
Hydraulic	7
Electrical	8

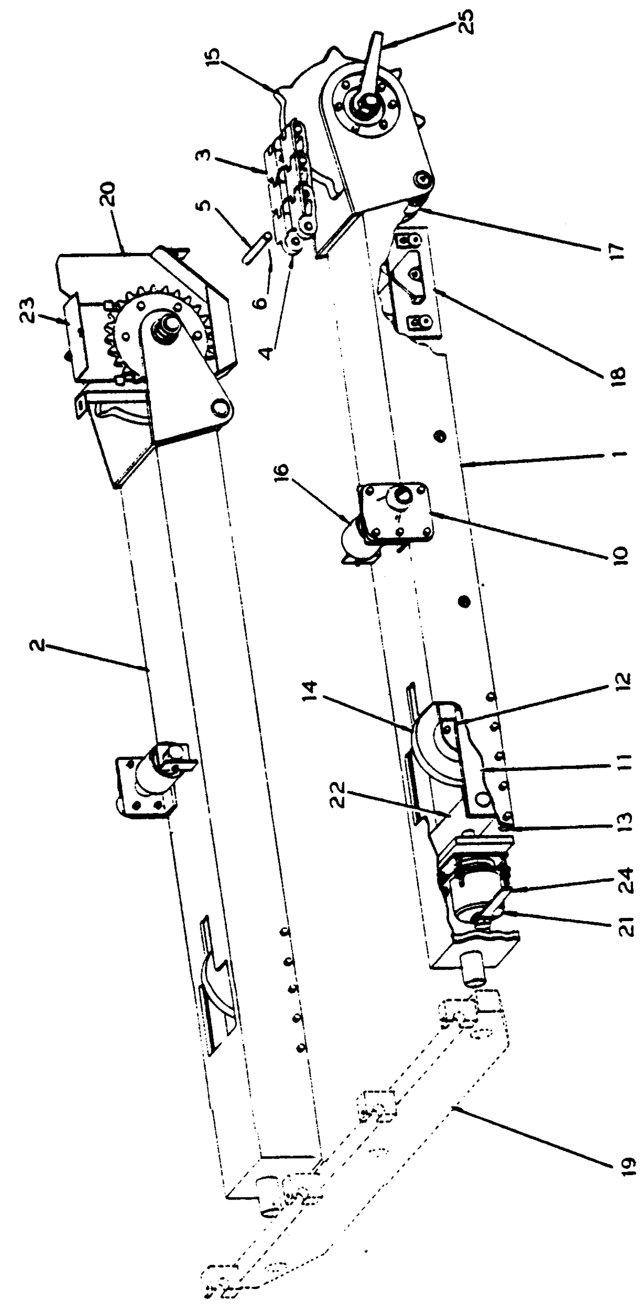
COMPONENTS



COMPONENTS

REF. NO.	DESCRIPTION	SECTION
1	Track	2
2	Main Frame	3
3	Hopper Wings	3
4	Tractor Accessories	3
5	Hoods, Covers, and Walkways	3
6	Acoustic Details	3
7	Operators Seat	3
8	Slat Conveyor	4
9	Skirtboards and Covers - Slat Conveyor	4
10	Screw Conveyor	4
11	Remote Adjustable Screw Control	4
12	Screed	5
13	Screed Pull Arms	5
14	Oil Burner	5
15	Screed Lift	5
16	Power Mounting and Drive	6
17	Hydraulic Components	7
18	Base Electrical Parts	8
19	Screed Electrical Parts	8

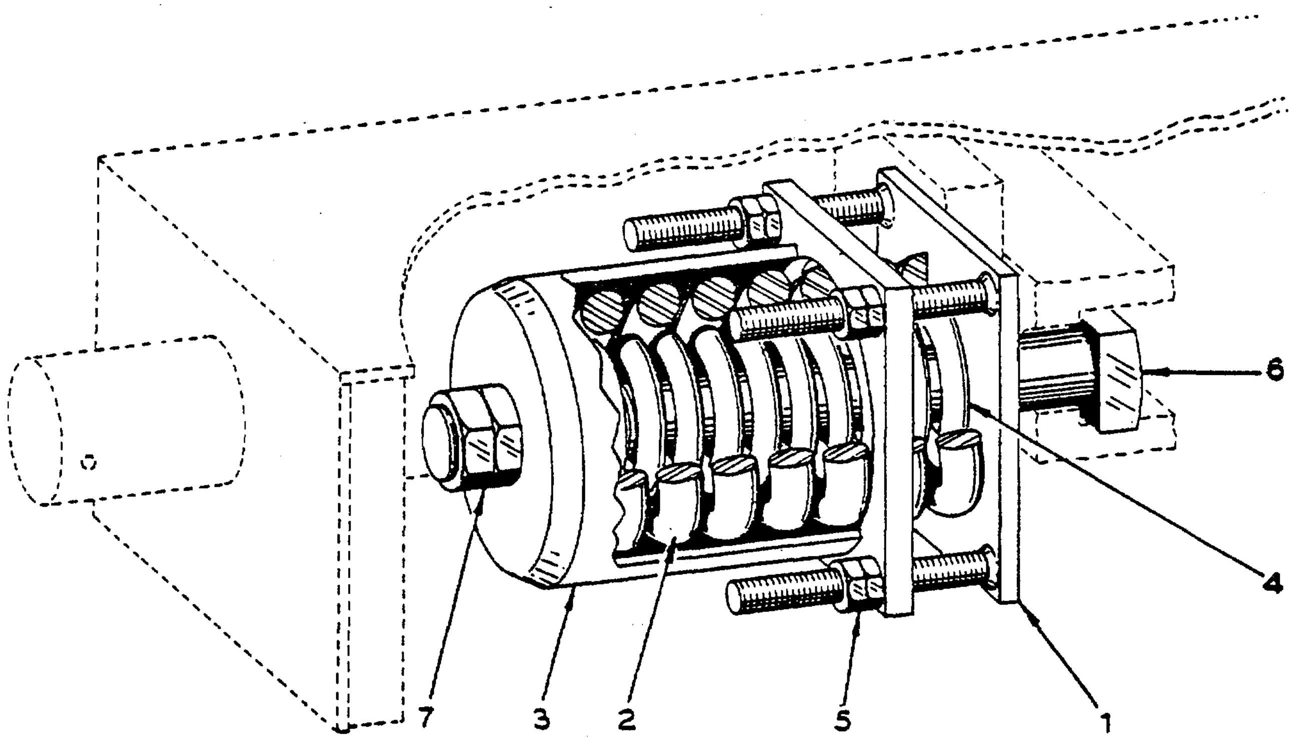
TRACK



REF. NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5036BV03	Frame, Track - Left Hand	1
2	50368V02	Frame, Track - Right Hand	1
3	5036BD56	Track Link Assembly (27 Links)	2
	5036BD56A	Track Link Assembly (26 Links)	2
4	5036A43C	Link, Track	106
5	5036BD27	Pin	106
6	7238-127	Pin, Roll 5/16" x 1-1/2"	212
10	5036BD29	Trunnion	2
	7010-045	Capscrew, 3/4" x 2-1/4" Hex Head NC	8
	7012-030	Nut, 3/4" Hex NC	8
	7014-009	Lockwasher, 3/4"	8
11	5036BP09	Bar, Side Yoke	4
12	7238-135	Pin, Roll 5/16" x 3-1/2"	4
13	5036BP10	Bar, Guide	4
	7010-022	Capscrew, 1/2" x 1-1/2" Hex Head NC	16
	7014-005	Lockwasher, 1/2"	16
14		See Take Up Idler - Section 2	2
15		See Rear Sprocket - Section 2	2
16		See Upper Roller - Section 2	2
17		See Lower Roller - Section 2	2
18		See Track Roller and Pivot Shaft - Section 2	6
19		Beam - See Main Frame - Section 1	
20	5036BD49	Guard - Left Hand (Not Shown)	1
	5036BD50	Guard - Right Hand (Shown)	1
	7010-025	Capscrew, 1/2" x 2-1/4" Hex Head NC	2
	7010-022	Capscrew, 1/2" x 1-1/2" Hex Head NC	4
	45890-102-19	Locknut, ½" NC	6
	7014-020	Lockwasher, 1/2"	6
21		See Track Spring - Section 2	2
22	5036BD13	Anchor	2
23	5036BD51	Cover, Guard	2
	7010-013	Capscrew, 3/8" x 1" Hex Head NC	2
	7014-003	Lockwarsher. 3/8"	2
	7014-018	Washer, 3/8" Flat	2
24	45500-750-05	Wrench, Track Adjusting	2
25	45500-750-02	Wrench, Track Frame (Not Shipped With Paver - Available From Factory)	2

NOTE: Quantities Shown are for Both Tracks.

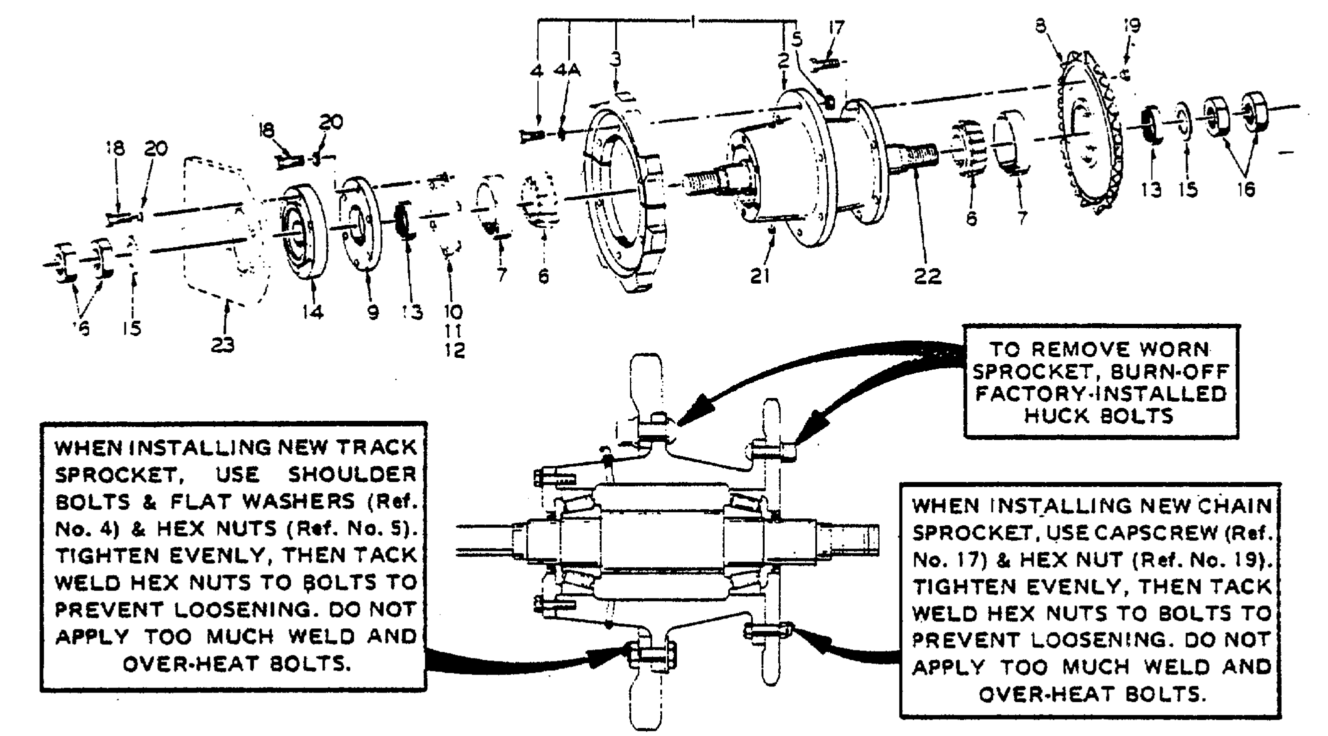
TRACK SPRING



REF. NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5036BP06	Base	1
2	5036BP07	Spring, Outer	1
3	5036BP05	Cap	1
4	5036BP08	Spring, Inner	1
5	7017-029	Nut, 5/8" Jam NC	8
6	7008-342	Bolt, 1½" x 17" NC	1
7	7017-036	Nut, 1½" Jam NC	2

NOTE: Quantities are shown for one assembly only.

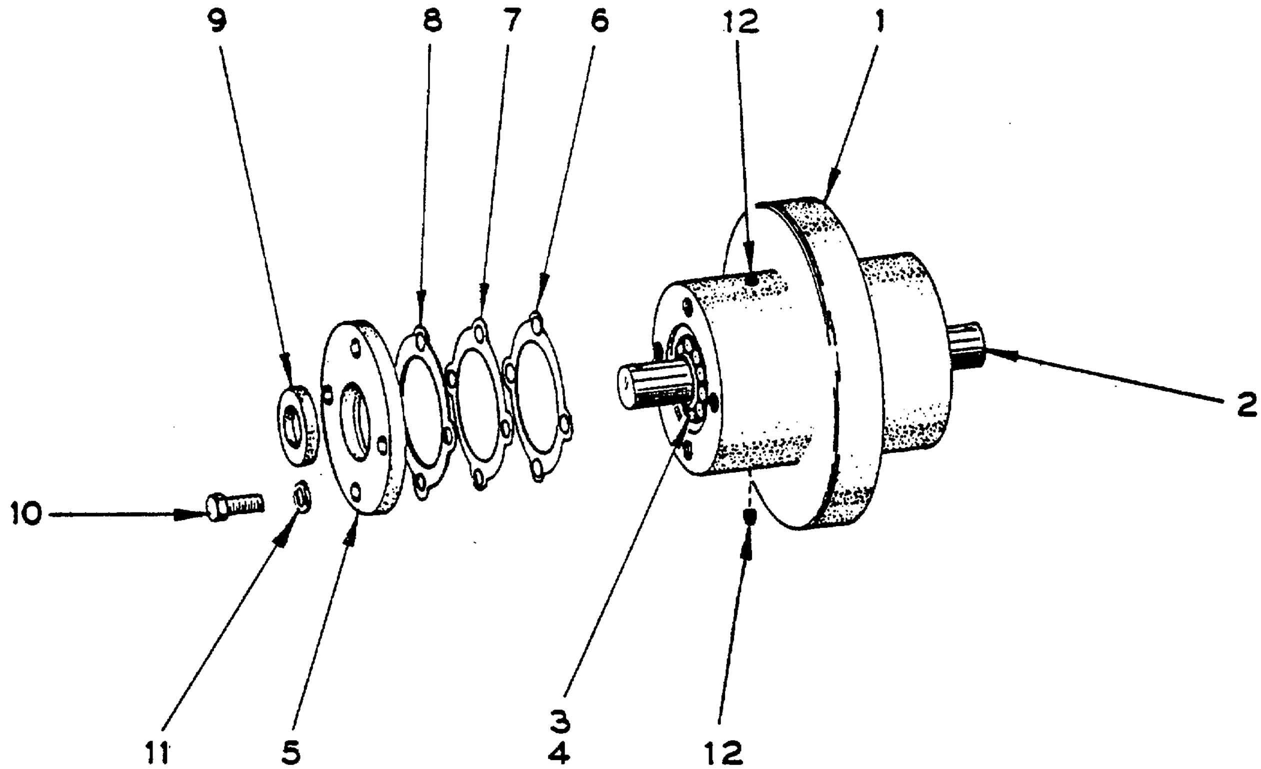
REAR SPROCKET



REF. NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	9704-050-01	Split Sprocket Assembly	1
2	5036BD53-02	Hub	1
3	5036BD54-01	Sprocket, Tooth Section	1
4	7455-013	Screw, Shoulder 3/4" x 1-1/2"	6
4A	7014-023	Washer, 3/4"	6
5	45890-102-17	Locknut, 5/8" NC	6
6	7258-013	Cone, Timken	2
7	7258-004	Cup, Timken	2
8	5036B059	Sprocket	1
9	5036BD06-02	Cap	1
10	7048-046	Shim, .020"	1
11	7048-047	Shim, .007"	1
12	7048-048	Shim, .005"	1
13	45200-040	Seal, Oil	2
14	50368D07	Plate	1
15	7049-003	Washer, Timken	2
16	7017-038	Nut, 1-3/4" Jam NC	4
17	7394-103	Capscrew, 5/8" x 2-1/4" Hex Head NF	6
18	7010-023	Capscrew, 1/2" x 1-3/4" Hex Head NC	12
19	7017-051	Nut, 5/8" Jam Hex NF	6
20	7014-005	Lockwasher, 1/2"	12
21	7024-001	Plug, '1/8" Pipe	2
22	5036B004	Shaft	1
23		See Track - Section 2	

NOTE: Quantities listed are for one assembly only.

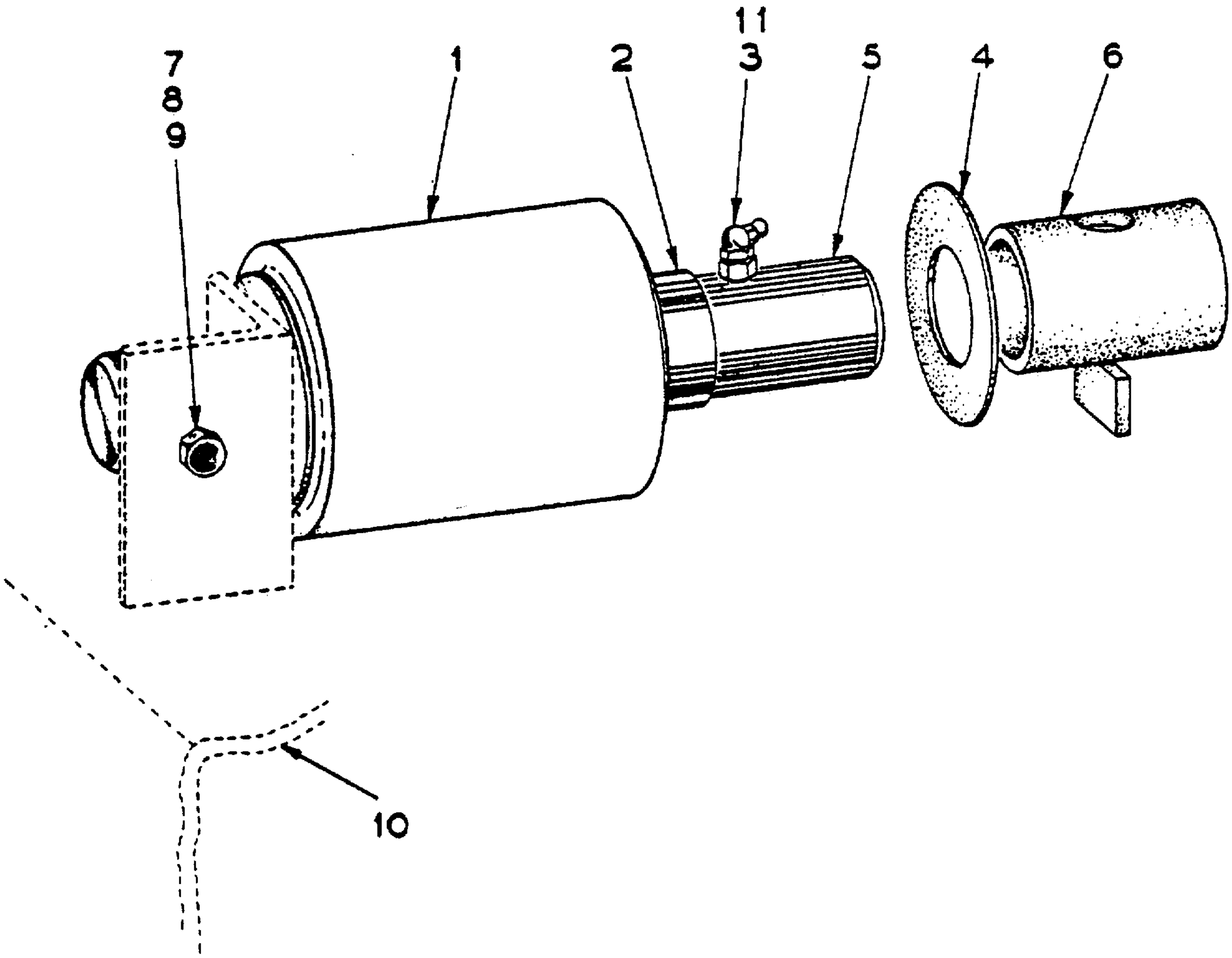
TAKE-UP IDLER



REF. NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5036BD26-02	Idler, Track	1
2	9701-020	Shaft	1
3	7376-005	Cone, Timken	2
4	7376-001	Cup, Timken	2
-5	50368D10-02	Cap	2
6	7048-014	Shim, .020"	As Req.
7	7048-015	Shim, .0071's	As Req.
8	7048-016	Shim, .005"	As Req.
9	45200-008	Seal, Oil	2
10	7010-021	Capscrew, 1/2" x 1-1/4" Hex Head NC	8
11	7014-005	Lockwasher, 1/2"	8
12	7024-001	Plug, 1/8" Pipe	2

NOTE: Quantities listed are for one assembly only.

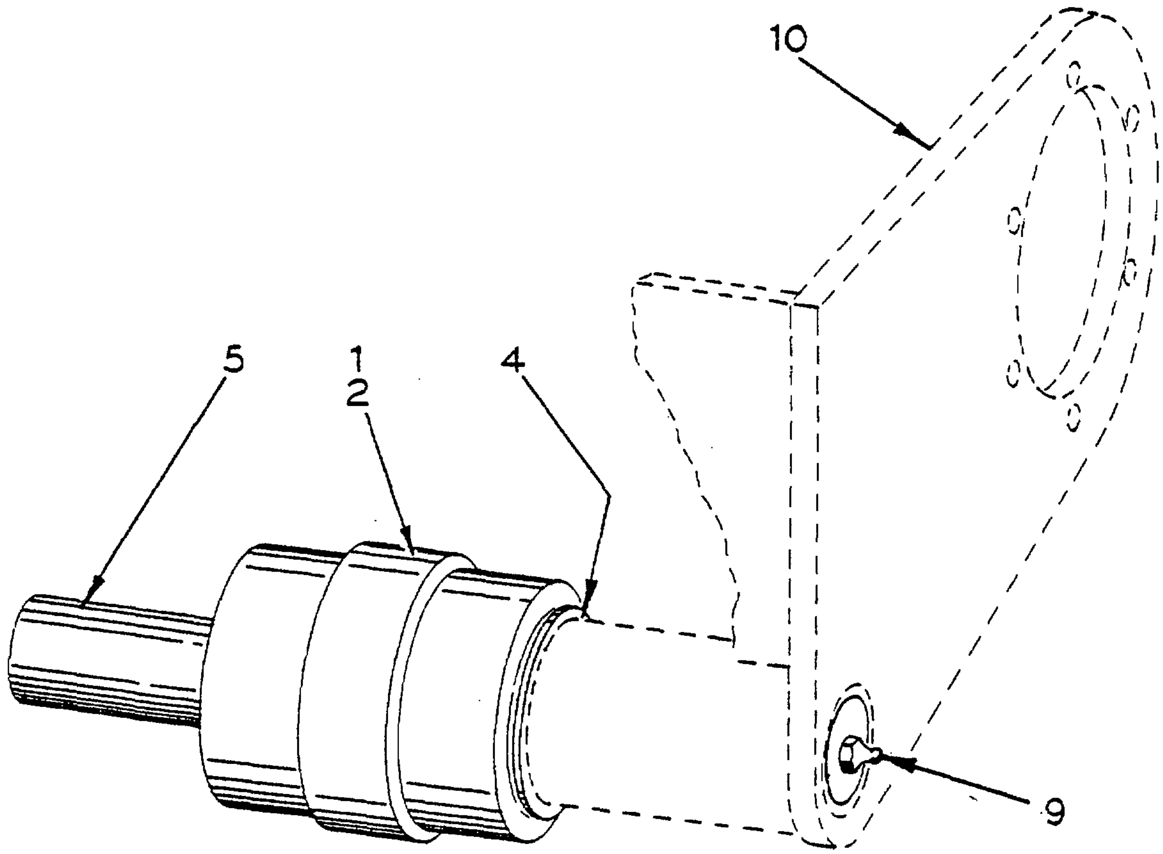
UPPER ROLLER



REF. NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5036BD38A	*Roller, With Bushing	1
2	45030-003-03	*Bushing	
3	7051-003	Alemite, Fitting 67 1/2°	1
4	5036BD041	Washer	2
5	50368016A	Shaft	1
6	50368D60	Spacer, Roller	1
7	7010-127	Capscrew, ½" x 3¼" Hex Head NC	1
8	7014-005	Lockwasher, "	1
9	7012-027	Nut, ½" Hex NC	1
10		Frame - See Track Frame - This Section	
11	7053-001	Nipple, Alemite Extension 3/4"	1

*NOTE: Items 1 and 2 are press fitted.
NOTE: Quantities listed are for one assembly only.

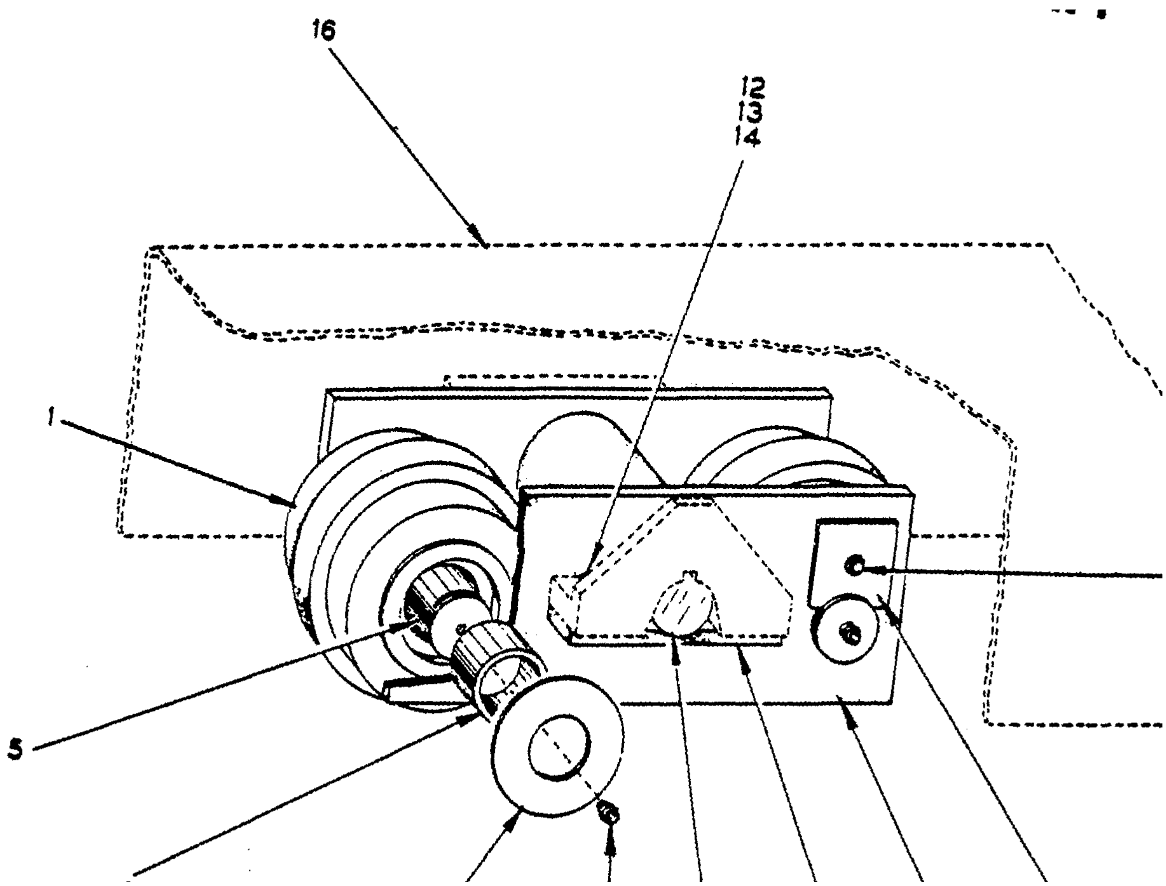
LOWER ROLLER



REF. NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5036BD37C	*Roller, With Bushing	1
2	45030-003-04	*Bushing (Only)	2
3	5036BD41	Washer	2
5	50368032	Shaft	1
6	7010-109	Capscrew, 3/8" x 4" Hex Head NC (Not Shown)	1
7	7012-025	Nut, 3/8" Hex (Not Shown)	1
8	7014-003	Lockwasher, 3/8" (Not Shown)	1
9	7051-001	Grease Fitting, 1/8"	1
10		Frame - See Track Frame - This Section	

NOTE: Quantities listed are for one assembly only.
*NOTE: Items #1 and 2 are press fitted to make Item #1.

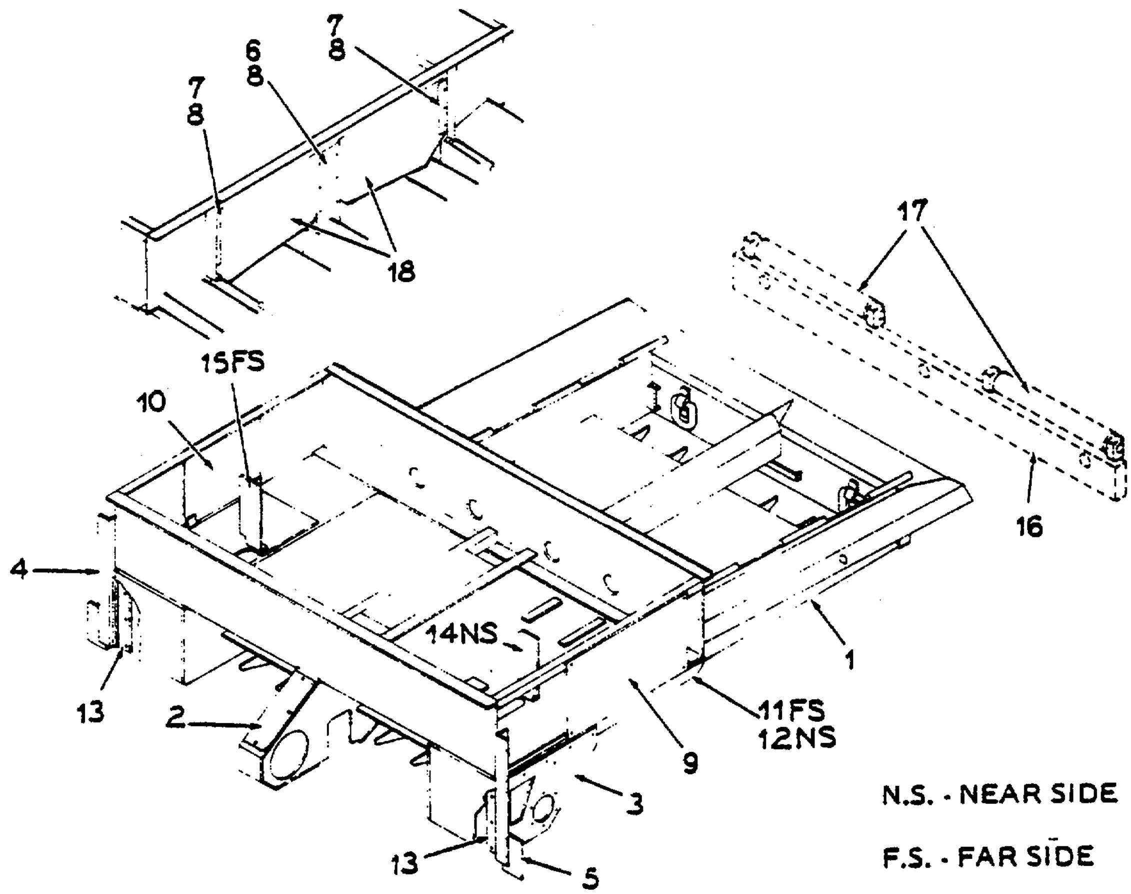
TRACK ROLLER PIVOT SHAFT



REF. NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5036BD39A	*Roller, With Bushing	2
2	45030-003-03	*Bushing (Only)	4
4	503BD41	Washer	4
5	5036BD23	Shaft	2
6	5036BD43	Lock	2
7	5036BD21	Bracket	1
8	5036BD20	Shaft	1
10	5036BD19	Flat	2
11	7010-034	Capscrew, 5/8" x 2" Hex Head NC	4
12	7010-034	Capscrew, 5/8"x 2" Hex Head NC	4
13	7012-029	Nut, 5/8 " Hex NC	4
14	7014-007	Lockwasher, 5/8"	4
15	7014-005	Lockwasher, 1/2"	2
16		Frame-See Track Frame- This Section	
17	7051-002	Fitting, Alemite 1/8" x 45°	2

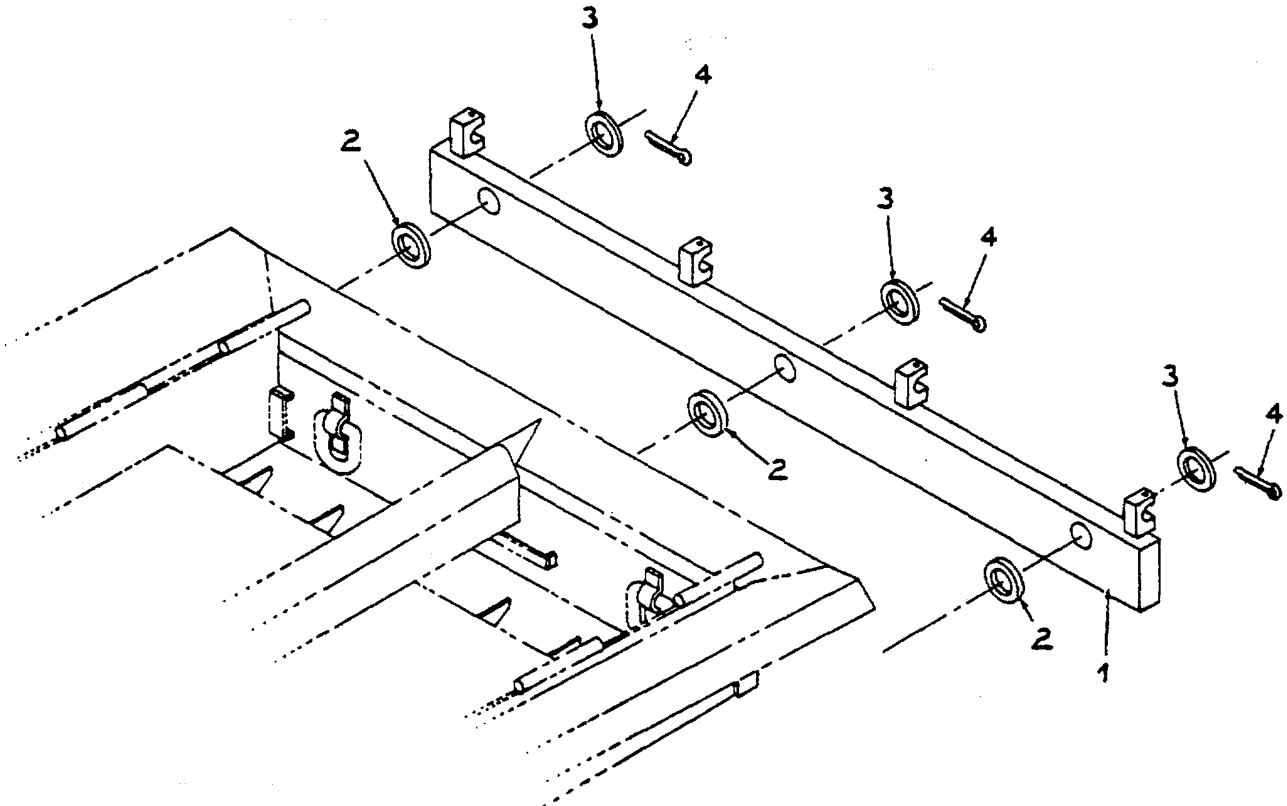
NOTE: Quantities listed are for one assembly only.
*NOTE: Item #1 and 2 are press fitted.

MAIN FRAME



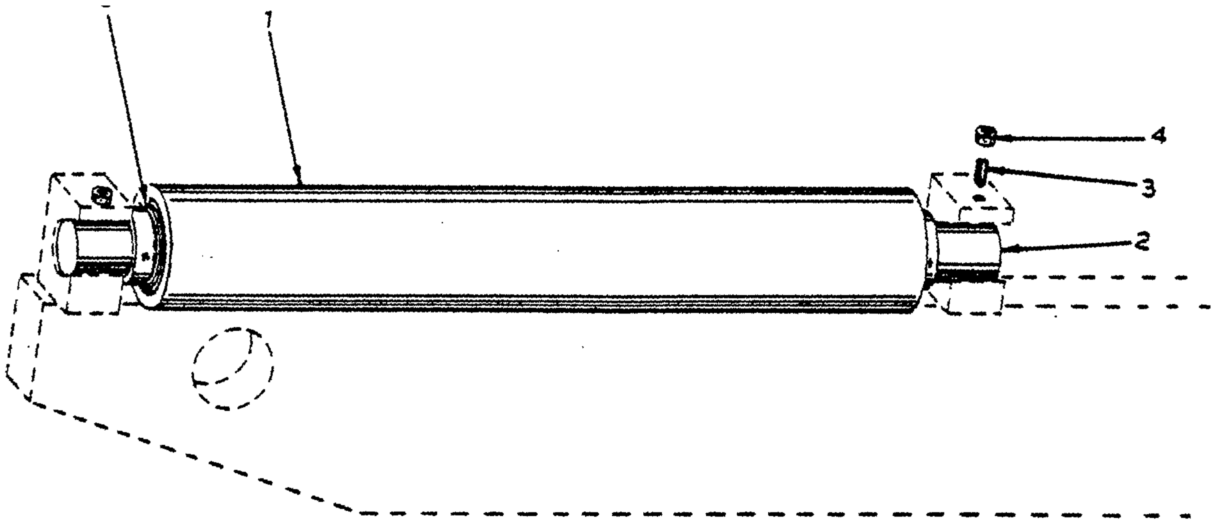
REF. NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	9704-000-01	Frame, Main	1
2	9701-568	Plate, Insp. Conveyor Chain	1
3	5036AK04	Plate, Side	2
4	5036KD09	Angle, Buffer Screed	1
5	5036K012	Angle, Buffer Screed	1
6	5036AD10	Clamp, Gate - Center	1
7	5036AD11	Clamp, Gate - Outside	2
8	40504-001-05	Pipe, 3/4" x 1-15/16"	12
9	5036KD10	Cover, Plate	1
10	5036KD11	Cover, Plate	1
11	5036AK05	Angle, Side - Far Side	1
12	5036AK06	Angle, Side - Near Side	1
	5036AK07	Angle, Corner	2
13	7072-149	Bolt, Carriage 5/8" x 2"	2
	7072-197	Bolt, Carriage 5/8" x 1-3/4"	4
14	5036AD33	Guard	1
15	5036AD35	Guard	1
16		See Walking Beam - This Section	
17		See Beam Roller - This Section	
18		See Gate - This Section	

WALKING BEAM



REF. NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5036AD17	Walking Beam	1
2	5036BD17	Washer	3
3	5036BD18	Washer	3
4	7011-139	Pin, Cotter ½" x 4"	3

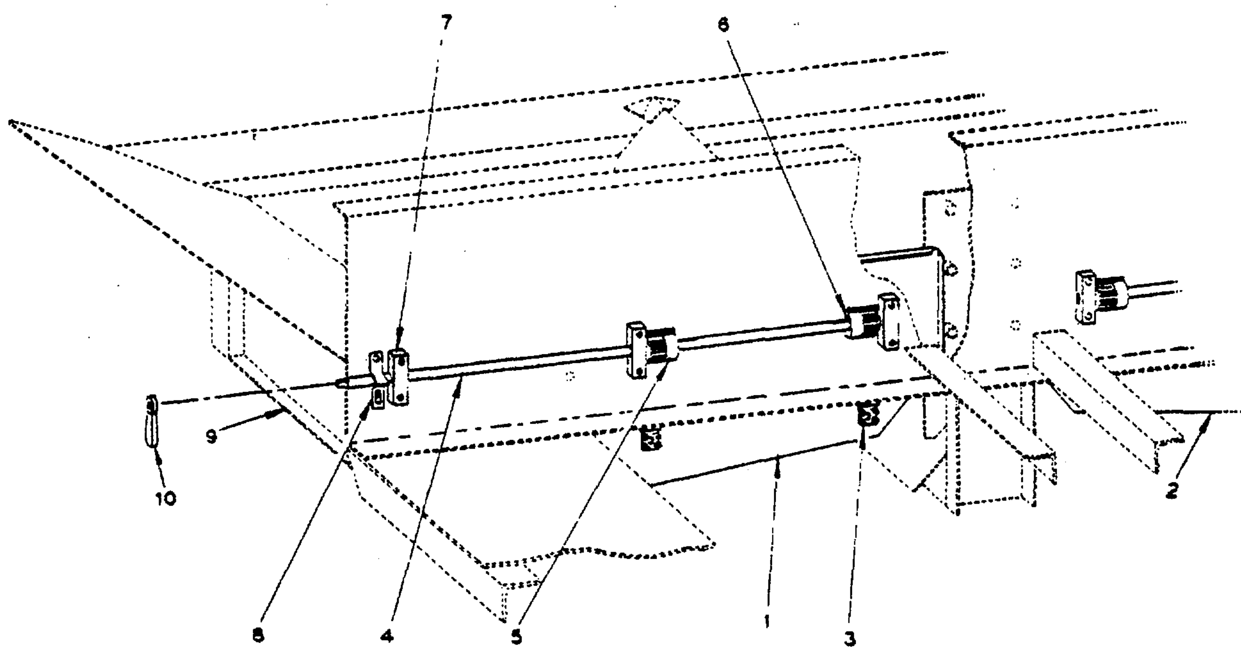
BEAM ROLLER ASSEMBLY



REF. NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5036AD32	Tube	1
2	41218-037-00	Shaft	1
3	7130-105	Setscrew, Socket Type 1/2" x 1-1/4 "- NC - Cone Point	4
4	7017-027	Nut, Jam 1/2" - NC	4
5	7302-013	Bearing	2

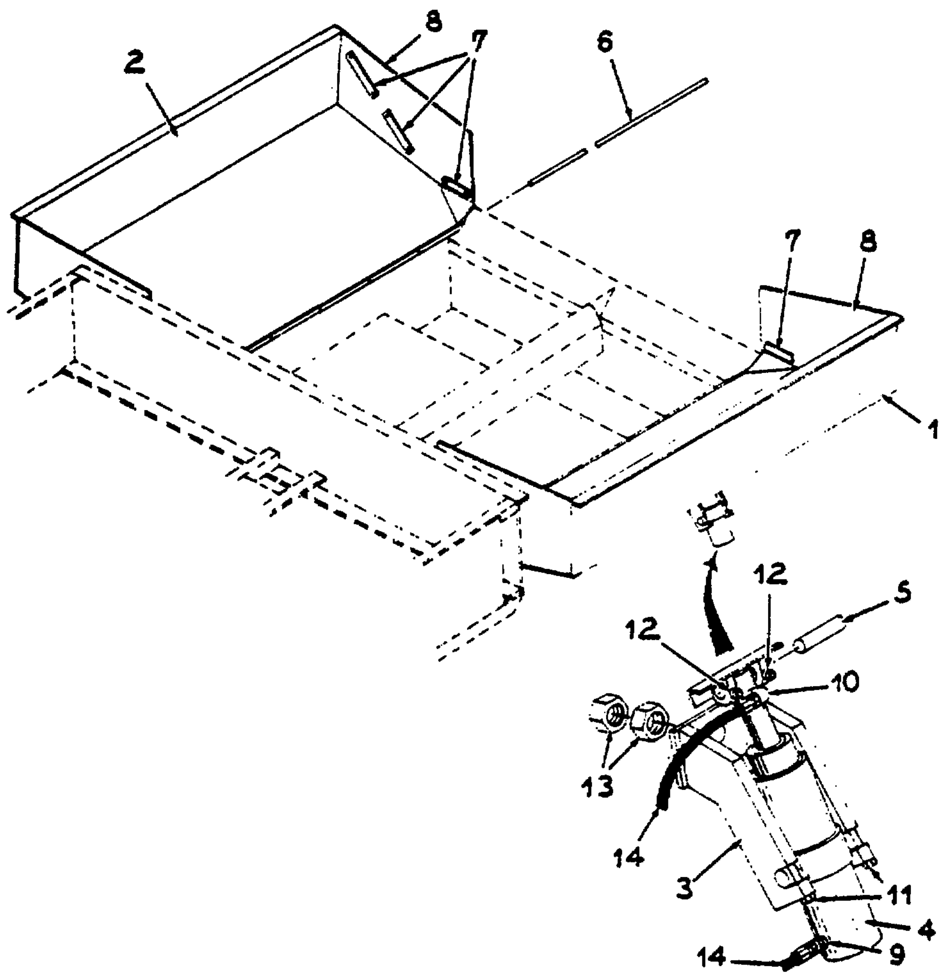
NOTE: Quantities shown are for one Assembly only.

GATE



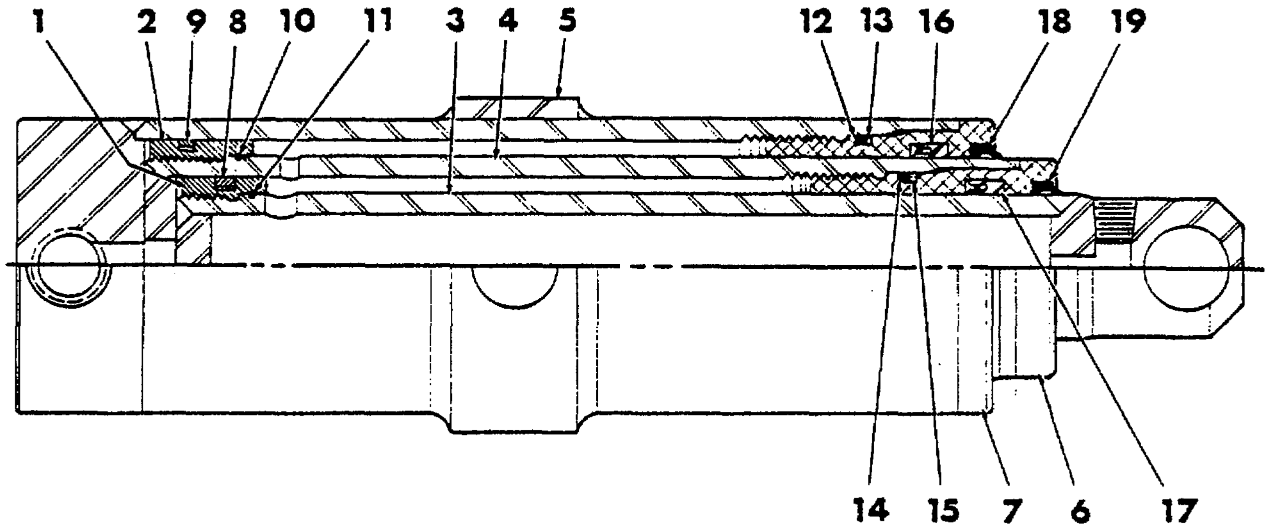
REF. NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5036AD12	Gate	1
2	5036AD25	Gate	1
3	1201B08BA	Rack	4
	5036AD36	Shim	As Req.
4	5036AD13	Shaft	2
5	5036AD14	Pinion	4
	7131-050	Setscrew, ¼" x ½a" Socket Head Cup Point NC	4
6	40812-002-04	Key, 3/16" x 3/16" x 2¼"	4
7	5036AD15	Block	6
8	5036AD16	Clamp	2
9		Frame - See Main Frame - Section 3	
	ACCESSORY TOOL NOT SHIPPED WITH PAVER. AVAILABLE FROM FACTORY.		
10	45500-024-01	Wrench, Gate Adjusting	1

HOPPER WINGS



REF. NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	9704-000-06	Wing, Hopper - Right Hand	1
2	9704-000-05	Wing, Hopper - Left Hand	1
3	5036VG12	Bracket, Cylinder Mount	2
4	45090-002-43	Cylinder, Hopper Wing - See Form # 14011 - This Section	2
5	5036VC09	Pin, Rod	2
6	41005-075	Rod, Hinge	2
	9700-907	Flat, Guard	6
7	7010-015	Capscrew, 3/8" x 1½" NC	12
	45890-102-16	Locknut, ½" Hex NC	12
8	9704-000-11	Guard, Front	2
9	7430-007	Fitting, Straight ½" MP x ½" 37°	2
10	7430-105	Fitting, 90° 1/2" NPT x 3/8" 37°	2
11	7010-104	Capscrew, 3/8" x 3-3/4" NC	4
	7014-003	Lockwasher, 3/8"	4
12	7131-080	Setscrew, 3/8" x 1" NC	4
	7017-025	Nut, 3/8" Jam NC	4
13	7017-034	Nut, 1¼" Jam NC	4
14		See Hopper Wing-Hydraulic Circuit - Section 7	

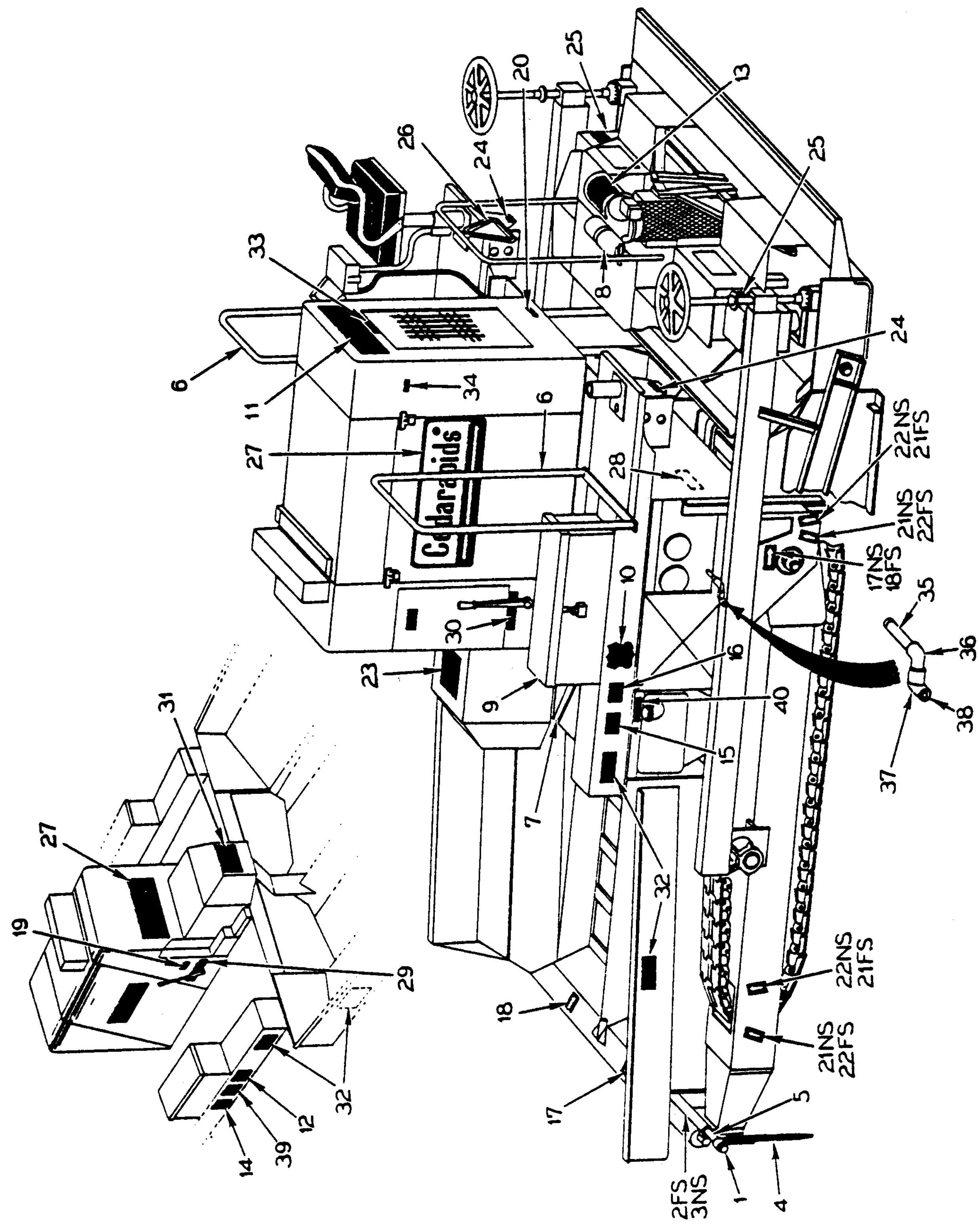
CYLINDER-HOPPER WINGS



REF. NO.	PART NUMBER	DESCRIPTION	QUANTITY
	45090-002-43	Cylinder - Complete	1
1	45090-524-24	Piston	
2	45090-524-23	Piston	1
3	45090-524-22	Tube, 2nd Stage	1
4	45090-524-21	Tube, 1st Stage	1
5	45090-536-07	Case	1
6	45090-539-03	Head	1
7	45090-539-02	Head	1
8	45090-524-08	*Piston Ring	1
9	45090-524-07	*Piston Ring	1
10	45090-512-58	*O-Ring	1
11	45090-512-59	*O-Ring	1
12	45090-512-53	*O-Ring	1
13	45090-511-31	*Back Up Washer	1
14	45090-512-54	*O-Ring	1
15	45090-511-32	*Back Up Washer	1
16	45090-526-38	*U-Cup and Load O-Ring	1
17	45090-526-39	*U-Cup and Load O-Ring	1
18	45090-526-36	*Seal, Wiper	1
19	45090-526-37	*Seal, Wiper	1

*NOTE: These parts may be purchased as a repair kit by ordering
Part Number 45090-526-35.

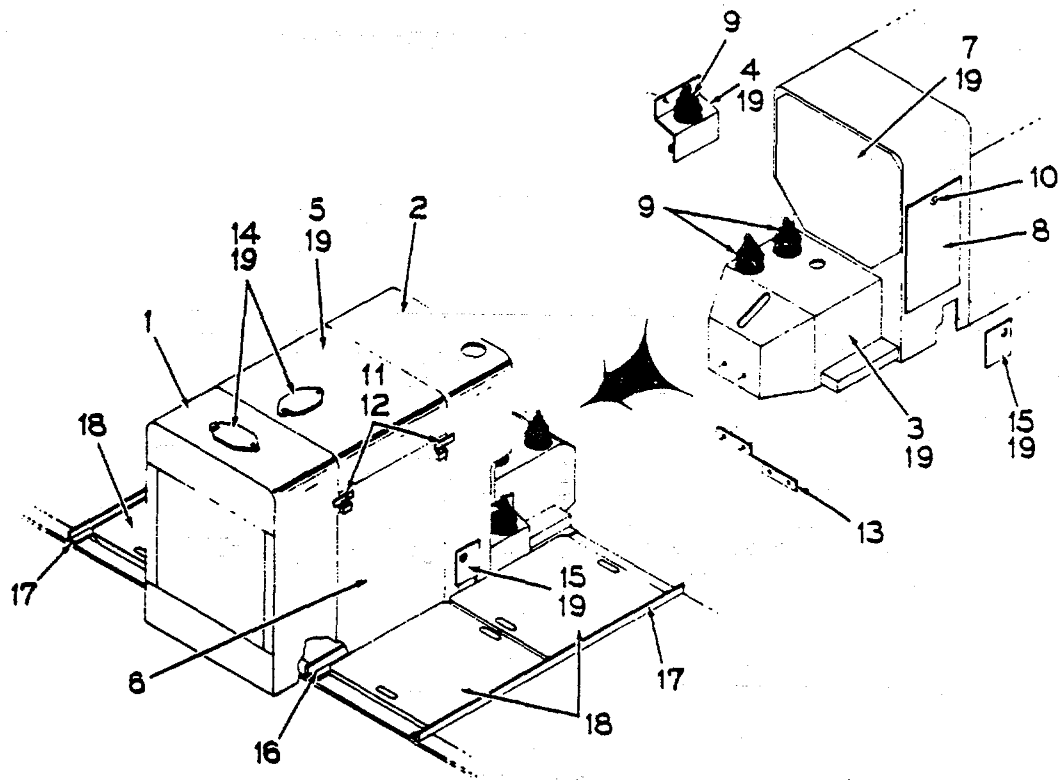
TRACTOR ACCESSORIES



TRACTOR ACCESSORIES

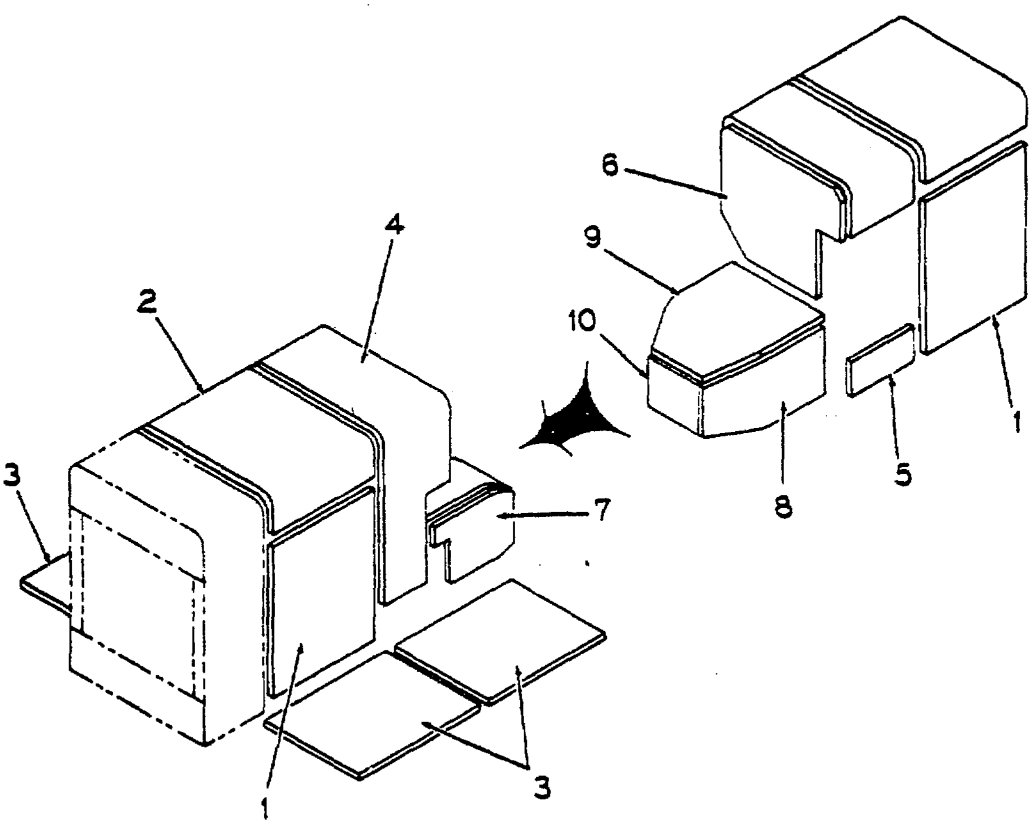
REF. NO.	PART NUMBER	DESCRIPTION	QTY.
	5036KD20	Bracket, Guide Marker	1
	7072-052	Bolt, Carriage 3/8" x 1" NC	1
1	7056-011	Nut, 3/8" Wing NC	1
	7014-003	Lockwasher, 3/8"	1
	7014-018	Washer, 3/8" Flat	1
2	5036KD18	Support, Guide Marker - Right Hand	1
3	5036KD19	Support, Guide Marker - Left Hand	1
4	5036KD14	Marker, Guide	1
5	40503-050	Pipe, 1/2" x 50"	1
6	9701-810	Rail, Hand	2
7	9704-450-09	Brace. Shipping (remove for operation)	2
	45515-004-01	Extinguisher, Fire	1
	45515-004-02	Bracket, Fire Extinguisher	1
8	7435-134	Screw, 1/4" x 5/8" Round Head Cadium	3
	45890-102-25	Locknut, 1/4"-20	3
	7014-016	Washer, 1/4" Flat	3
	9704-450-17	Box, Tool (Military)	1
9	46000-004-04	Padlock, with Two Keys	2
	7472-023	Screw, Tapping 3/8" -16 x 3/4"	8
10	4418-017	Plate, Serial	1
11	4418-087	Emblem, Cedarapids	1
12	4418-319	Plate, Tie Down Points	1
13	4418-129-09	Emblem Strike-off Adjustment	1
14	4418-320	Plate, Lifting Point	1
15	4418-135-01	Emblem, Patent	1
16	4418-135-02	Emblem, Lubrication	1
17	4418-305	Plate, Lift Here	2
18	4418-306	Plate, Lift Here	2
19	4418-304	Plate, Throw Out Collar	1
20	4418-135-18	Plate, Fill with Diesel Fuel Only	1
21	4418-307	Plate, Tie Down Here	4
22	4418-308	Plate, Tie Down Here	4
23	4418-135-28	Emblem, Paver Speed	1
24	4418-312	Plate, Safety Cable	2
25	4418-147	Emblem, Cedarapids	2
	4418-197	Emblem, Slow Moving Vehicle	1
26	7435-134	Screw, 1/4" x 5/8" Round Head Cadium	2
	45890-102-25	Locknut, 1/4"-20	2
	7014-016	Washer, 1/4" Flat	2
27	4418-010	Emblem, Cedarapids	3
28	4418-310	Plate, Battery Caution	1
29	4418-314	Plate, Clutch - Right Hand	1
30	4418-313	Plate, Clutch - Left Hand	1
31	4418-315	Plate, Do Not Stand in Hopper	1
32	4418-309	Plate, Stand Clear Hopper	4
33	4418-311	Plate, Ear Protection	1
34	4418-303	Plate, Stop	1
35	40503-004-00-02	Pipe. 1/2" x 4" TBE	2
36	7061-004	Elbow, 1/2" Pipe at 90 degrees Street	2
37	7085-004	Elbow. 1/2" Pipe at 90 degrees	2
38	7027-002	Plug, Magnetic	2
39	4418-335	Plate, Identification	1

HOODS, COVERS AND WALKWAYS



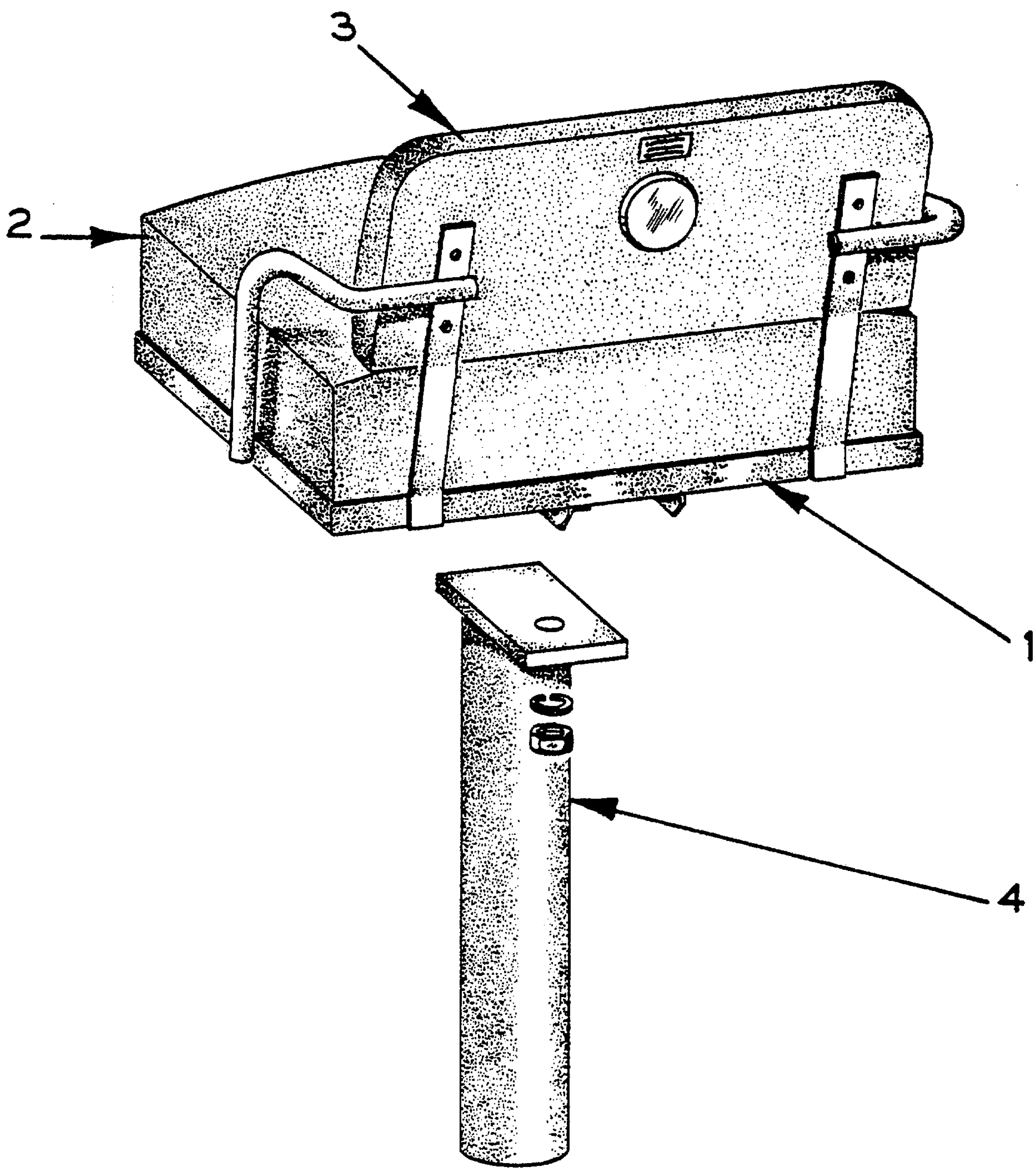
REF. NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	9704-300-29	Shell, Radiator	1
2	9704-300-30	Hood, Rear	1
3	9704-300-31	Cover, Transmission	1
4	9704-300-32	Cover, Six Speed	1
5	9704-300-33	Hood, Center	1
6	9704-300-34	Panel, Side	2
7	9704-300-35	Cover, End	1
8	9704-300-36	Panel, Electric Box	1
9	45775-282-03	Boot, Shifter	3
10	46000-004-05	Lock, With Keys	1
11	46000-004-07	Hasplock, With Padlock & Keys	4
12	41733-003-01	Tape, Sponge 1" x 2"	0.7
13	9704-300-37	Brace, Transmission Cover	1
14	9704-300-72	Cover, Vandal	2
15	9704-300-73	Cover, Clutch	2
16	9704-300-75	Angle, Hood Support	2
17	5036KN03	Angle, Walkway Support	2
18	9704-300-76	Walkway, Floor Plate	4
19	45890-252-07	Bolt, 5/16" Washer Head NF	29

ACOUSTIC MATERIAL
HOODS, COVERS, WALKWAYS



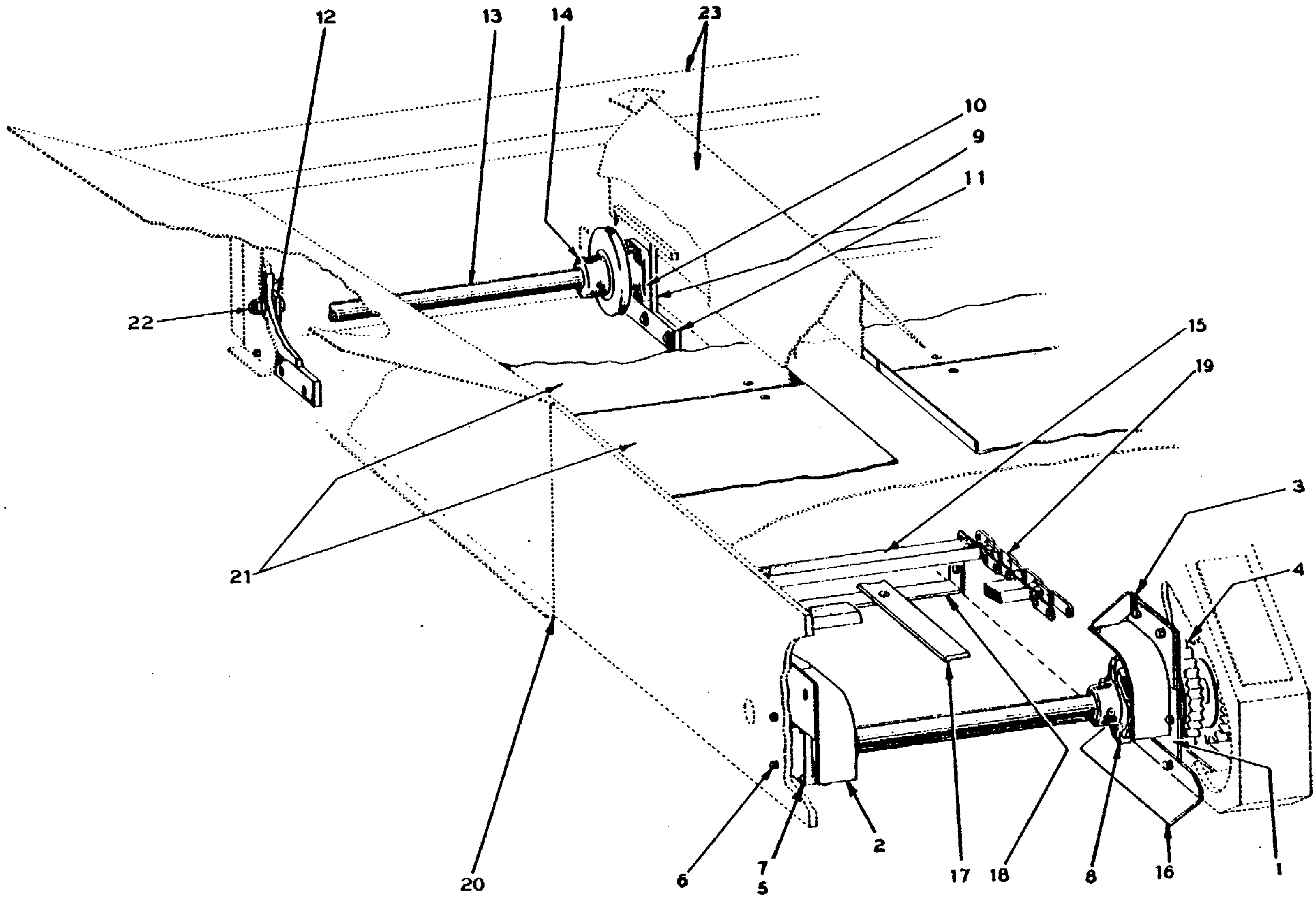
REF. NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	9704-300-66	Acoustic Material, Side Panel	2
2	9704-300-67	Acoustic Material, Center Hood	1
3	9704-300-84	Acoustic Material, Walkway	4
4	9704-300-88	Acoustic Material, Hood	1
5	9704-300-89	Acoustic Material, Hood	1
6	9704-300-90	Acoustic Material, Hood End Cover	1
7	9704-301-76	Acoustic Material, Transmission Cover	1
8	9704-301-77	Acoustic Material, Transmission Cover	1
9	9704-301-78	Acoustic Material, Transmission Cover	1
10	9704-301-79	Acoustic Material, Transmission Cover	1

OPERATORS SEAT STANDARD



REF.NO.	PART NO.	DESCRIPTION	QUANTITY
1	5036MD01	Seat Assembly	1
2	5036iNID01-01	Cushion, Seat	1
3	5036MD01-02	Cushion, Back Rest	1
4	5036MD02	Pedestal	1

SLAT CONVEYOR

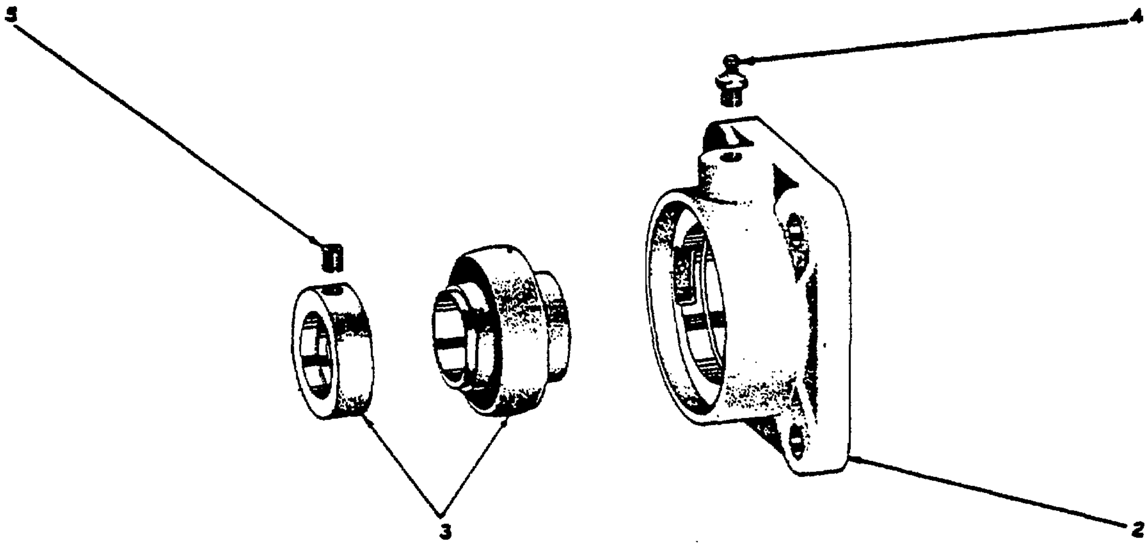


SLAT CONVEYOR

REF.NO	PART NUMBER	DESCRIPTION	QUANTITY
	9701-610	Plate - Right Hand (Not Shown)	1
1	9701-611	Plate - Left Hand (Shown)	1
2	5036EE02	Guard - Left Hand	2
3	5036EE03	Guard - Right Hand	2
4	5036ED05	Sprocket and Shaft	2
5	F0115FGA	Flange Bearing - 1-15/16" Bore - See Form # 1001	-
		This Section	4
6	7383-070	Capscrew, Grade 5, 1/2" x 1-1/2" Hex NC	8
	7383-071	Capscrew, Grade 5, 1/2" x 3/4" Hex NC	8
7	45890-102-19	Locknut, 1/2" NC	8
	7014-020	Washer, 1/2" Flat	8
8	4431-513-01	Sprocket	4
9	5036ED06	Plate	4
	F0107FGA	Flange Bearing - 1-7/16" Bore - See Form # 1001	-
		This Section	4
10	7445-011	Bolt, Plow 3/8" x 1-1/2"	16
	45890-102-17	Locknut, 3/8" NC	16
11	5036ED07	Flat	4
12	5036ED08	Bolt, Adjusting	4
13	41213-029-08	Shaft	2
14	4430-021-01	Idler, Front	4
15	4430-009	Bar, Flight	46
16	5036EE01-01	Plate, Baffle	2
	5036AG01-01	Track, Return	4
17	7445-010	Bolt, #3 Plow 1/2" x 1-1/4"	12
	45890-102-19	Locknut, 1/2"	20
18	5036AG01-02	Track, Hanger	6
19	5036ED24	See Slat Conveyor Chain - This Section	
20		See Main Frame - Section 3	
21		See Slat Conveyor Liner - This Section	
22	7072-172	Bolt, Carriage 3/4" x 2"	4
22	7017-030	Nut, 3/4" Hex Jam NC	16
23		Skirtboards and Covers - Slat Conveyors	
		For BSF-400 and BSF-420 - This Section	
		For BSF-2 - See Main Frame - Section 1	

ANTI-FRICTION BEARING

FLANGE TYPE

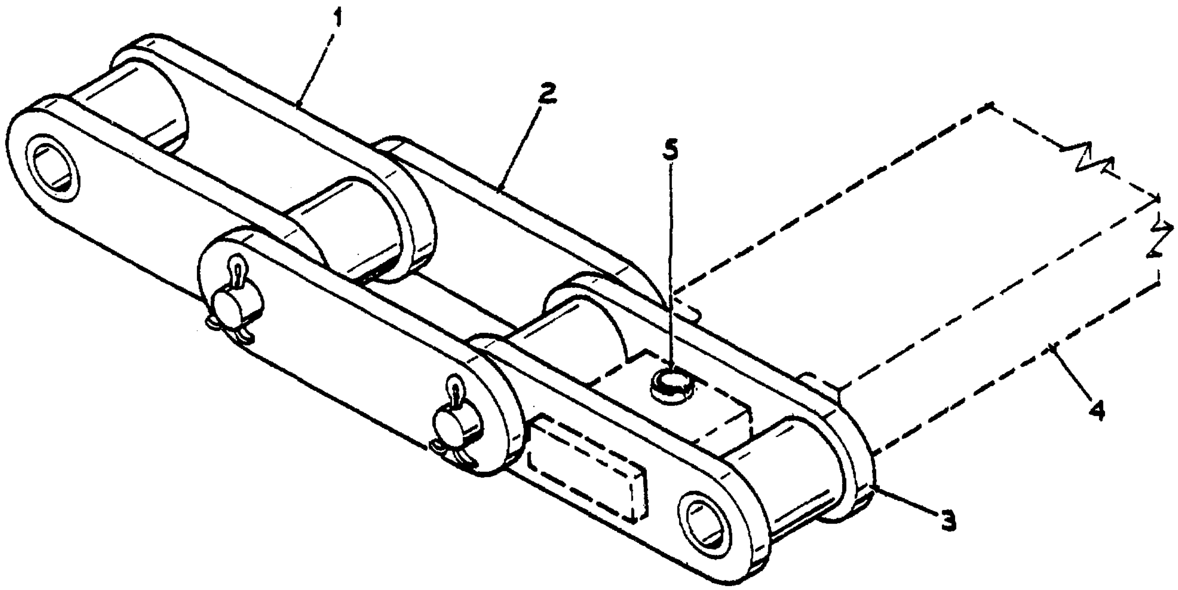


REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
		FLANGE TYPE - 1" BORE	
	F0100FGA	Bearing - Complete	1
2	F0100FG	Bearing Housing	1
3	7041-004	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-046	Setscrew, 1/4" x 1/4" Socket Head Cup Point	1
		FLANGE TYPE - 1-3/16" BORE	
	F0103FGA	Bearing - Complete	1
2	F0103FG	Bearing Housing	1
3	7041-007	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-046	Setscrew, 1/4" x 1/4" Socket Head Cup Point	1
		FLANGE TYPE - 1-3/8" BORE	
	FO1O6FGA	Bearing - Complete	1
2	F0107FG	Bearing Housing	1
3	7041-010	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-074	Setscrew, 3/8" x 3/8" Socket Head Cup Point	1
		FLANGE BEARING - 1-7/16" BORE	
	F0107FGA	Bearing - Complete	1
2	F0107FG	Bearing Housing	1
3	7041-011	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-074	Setscrew, 3/8" x 3/8" Socket Head Cup Point	1

-Continued-

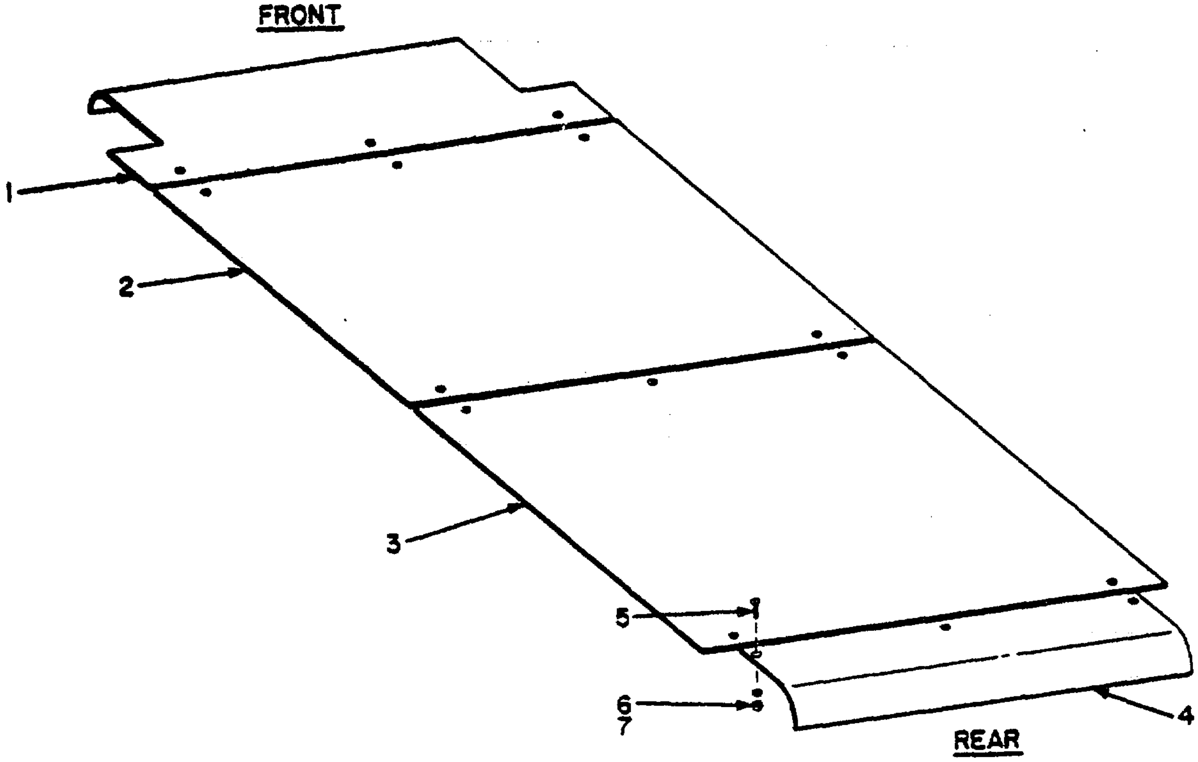
REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
		FLANGE TYPE - 1-5/8" BORE	
	F0110FGA	Bearing - Complete	1
2	F0111FG	Bearing Housing	1
3	7041-014	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-074	Setscrew, 3/8" x 3/8" Socket Head Cup Point	1
		FLANGE TYPE - 1-11/16" BORE	
	F0111FGA	Bearing - Complete	1
2	F0111FG	Bearing Housing	1
3	7041-015	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-074	Setscrew, 3/8" x 3/8" Socket Head Cup Point	1
		FLANGE TYPE - 1-3/4" BORE	
	F0112FGA	Bearing - Complete	1
2	F0111FG	Bearing Housing	1
3	7041-016	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-074	Setscrew, 3/8" x 3/8" Socket Head Cup Point	1
		FLANGE TYPE - 1-15/16" BORE	
	F011FGA	Bearing - Complete	1
2	F0115FG	Bearing Housing	1
3	7041-019	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-074	Setscrew, 3/8" x 3/8" Socket Head Cup Point	1
		FLANGE TYPE - 2-3/16" BORE	
	FO203FGA	Bearing - Complete	1
2	F0203FG	Bearing Housing	1
3	7041-023	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-087	Setscrew, 7/16" x 7/16" Socket Head Cup Point	1
		FLANGE TYPE - 2-7/16" BORE	
	F0207FGA	Bearing - Complete	1
2	F0207FG	Bearing Housing	1
3	7041-024	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-087	Setscrew, 7/16" x 7/16" Socket Head Cup Point	1
		FLANGE TYPE - 2-15/16" BORE	
	F0215FGA	Bearing - Complete	1
2	F0215FG	Bearing Housing	1
3	7041-025	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-100	Setscrew, 1/2" x 1/2" Socket Head Cup Point	1

SLAT CONVEYOR CHAIN



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
	5036ED24	Slat Conveyor Chain	4
1	50005-502-08	Link, Roller With Bushing and Roller - Plain	
2	50005-502-07	Link, Attaching Includes 2 Side Bars and Pins	
3	50005-502-09	Link, Roller With Bushing and Roller - Slotted	
4		Bar, Flight - See Slat Conveyor - This Section	
5	7238-168	Pin, Roll	92

SLAT CONVEYOR LINER ASSEMBLY

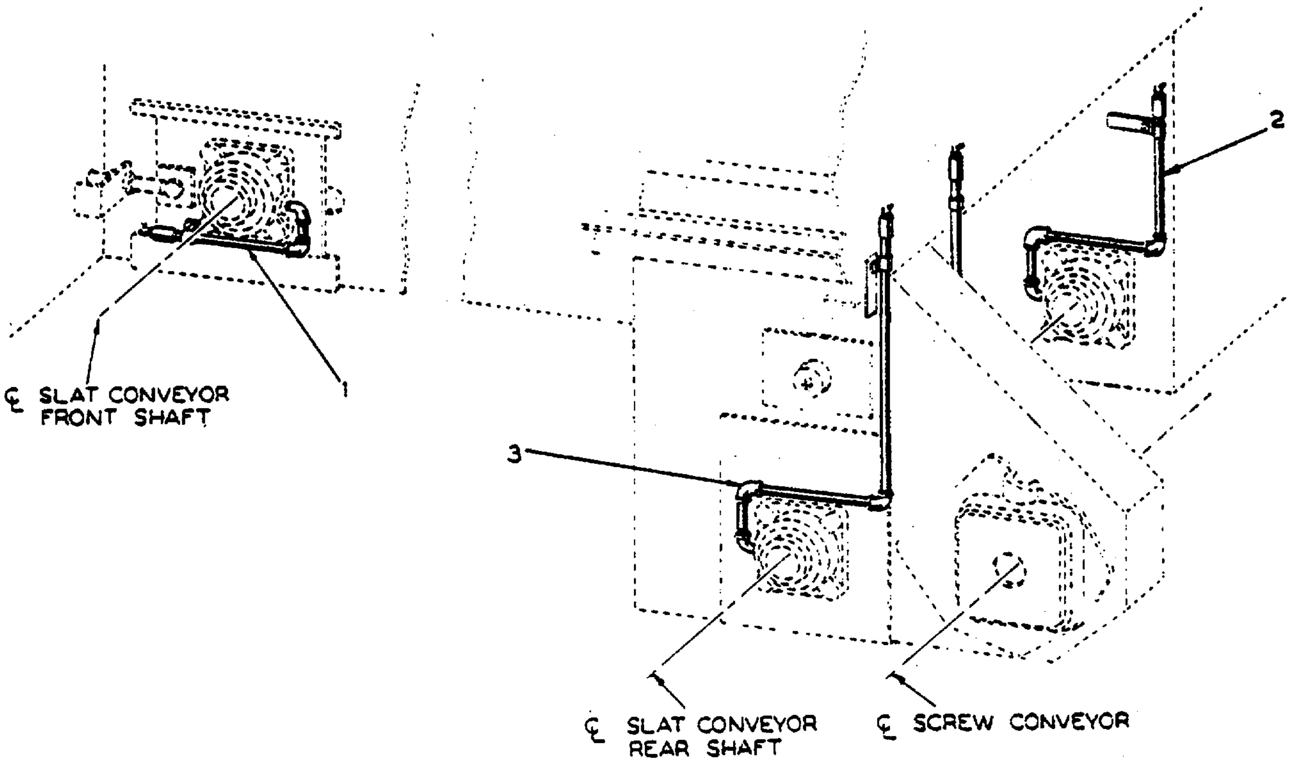


REF.NO.	PART NO.	DESCRIPTION	QUANTITY
I	5036ED18	Liner, Front Curved	2
2	5036ED19	Liner, Front Flat	2
3	5036ED20	Liner, Rear Flat	2
4	5036ED21	Liner, Rear Curved	2
5	7016-003	Capscrew, 3/8" x 1" Flat Head NC	40
6	7012-025	Nut, 3/8" Hex NC	40
7	7014-003	Lockwasher, 3/8" Spring	40

NOTE: 1 Set Shown

GREASE PIPING

SLAT CONVEYOR

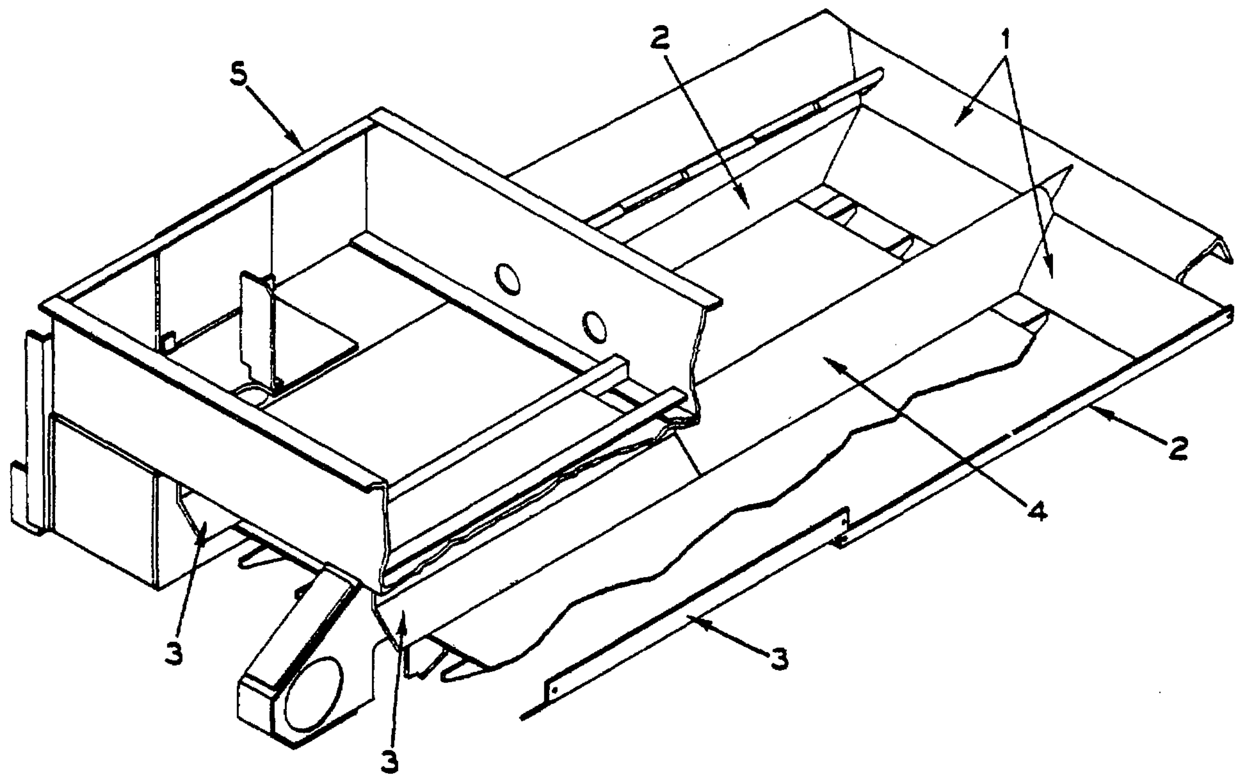


GREASE PIPING
SLAT CONVEYOR

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1		Run #1 - Slat Conveyor Front Shaft Bearing Grease Piping	
	7061-001	Elbow, Street 1/8" x 90°	4
	40500-001-08-01	Nipple, 1/8" x 1-1/2"	4
	7085-001	Elbow, Pipe 1/8" x 90°	4
	40500-007-0.8-01	Nipple, 1/8" x 7-1/2"	4
	7084-001	Coupling, Pipe 1/8"	4
	7051-002	Fitting, Grease 1/8" x 45°	4
	45000-251-01	Clamp, Tube	4
	7095-035	Bolt, Stove 1/4" x 1/2" NC	4
	7014-001	Lockwasher, 1/4"	4
2		Run #2 - Slat Conveyor Rear Shaft Outer Bearing Grease Piping	
	7061-001	Elbow, Street 1/8" x 90°	2
	40500-002-00-01	Nipple, 1/8" x 2"	2
	7085-001	Elbow, Pipe 1/8" x 90°	2
	40500-007-08-01	Nipple, 1/8" x 7-1/2"	2
	7085-001	Elbow, Pipe 1/8" x 90°	2
	40500-008-00-01	Nipple, 1/8" x 8"	2
	7084-001	Coupling, Pipe 1/8"	2
	7051-002	Fitting, Grease 1/8" x 45°	2
	7000E23B	Base, Tube Clamp	2
	7095-035	Bolt, Stove 1/4" x 1/2" NC	2
	7014-001	Lockwasher, 1/4"	2
	45000-251-01	Tube, Clamp	2
3	Run #3 - Slat Conveyor Rear Shaft	Inner Bearing Grease Piping	
	7061-001	Elbow, Street 1/8" x 90°	2
	40500-002-00-01	Nipple, 1/8" x 2"	2
	7085-001	Elbow, Pipe 1/8" x 90°	2
	40500-008-08-01	Nipple, 1/8" x 8-1/2"	2
	7085-001	Elbow, Pipe 1/8" x 90°	2
	40500-013-00-01	Nipple, 1/8" x 13"	2
	7084-001	Coupling, Pipe 1/8"	2
	7051-002	Fitting, Grease 1/8" x 45°	2
	45000-251-01	Clamp, Tube	2
	7000E23B	Base, Tube Clamp	2
	7095-035	Bolt, Stove 1/4" x 1/2" NC	2
	7014-001	Lockwasher, 1/4"	2

SKIRTBOARD AND COVERS

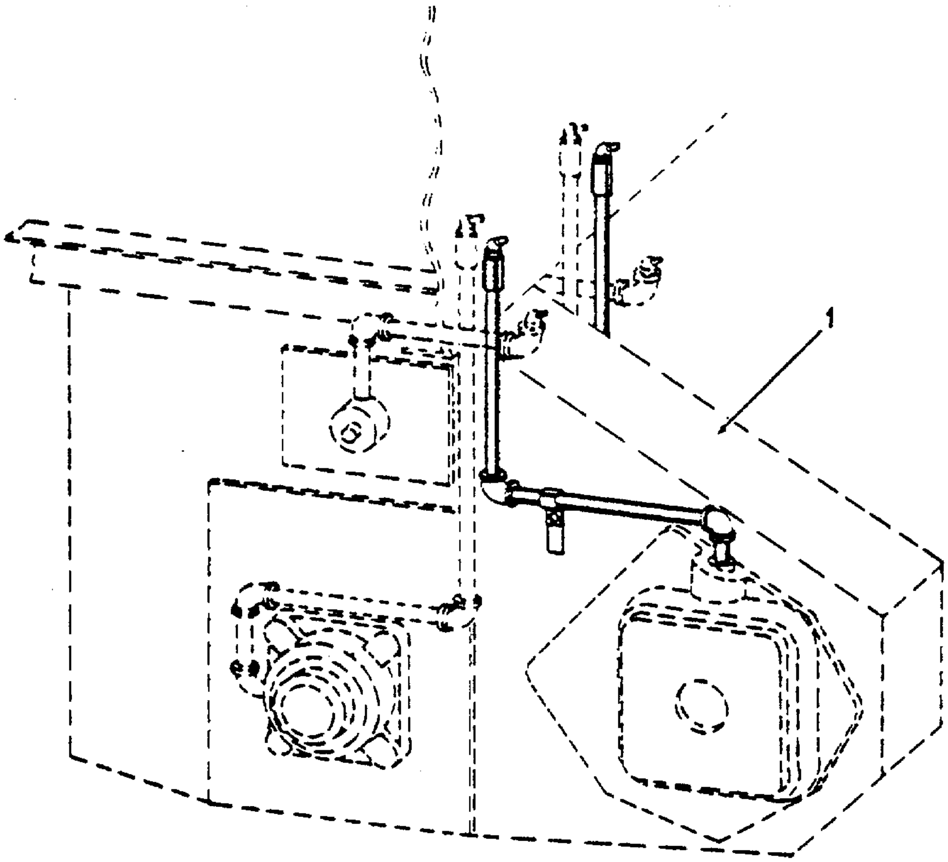
SLAT CONVEYOR



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5036AD09-01	Cover, Front	2
2	5036AK13	Skirtboard, Front	2
3	5036AD05	Skirtboard, Rear	4
4	5036AD07	Cover, Center	1
5		See Main Frame - Section 3	

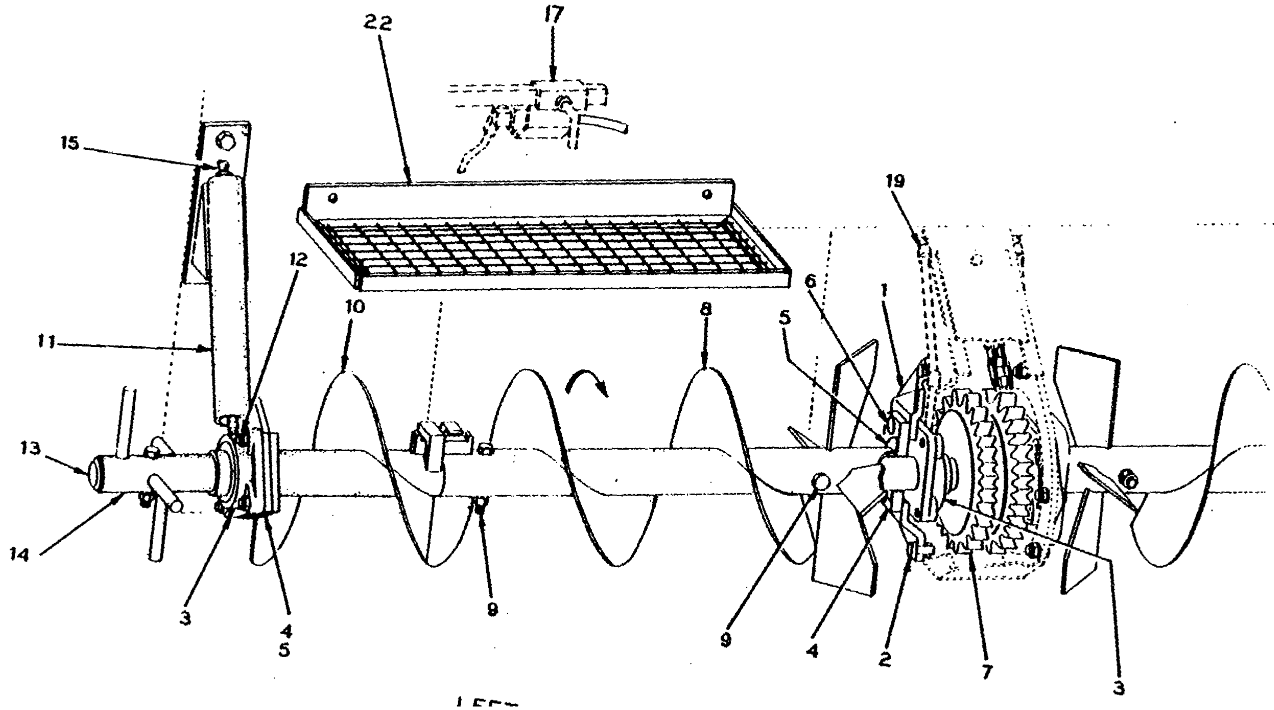
GREASE PIPING

SCREW CONVEYOR



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1			
		Grease Piping, Screw Conveyor Inner Bearing	
	40500-004-00-01	Nipple, 1/8" x 4"	2
	7061-001	Elbow, Pipe 1/8" x 90°	4
	40500-008-00-01	Nipple, 1/8" x 8"	4
	7084-001	Coupling, Pipe 1/8"	2
	7051-003	Fitting, Grease 1/8" x 67°	2
	45000-251-01	Clamp, Tube	2
	7000E23B	Base, Tube Clamp	2
	7095-035	Bolt, Stove 1/4" x 1/2" NC	2
	7014-001	Lockwasher, 1/4"	2

SCREW CONVEYOR
14" DIAMETER



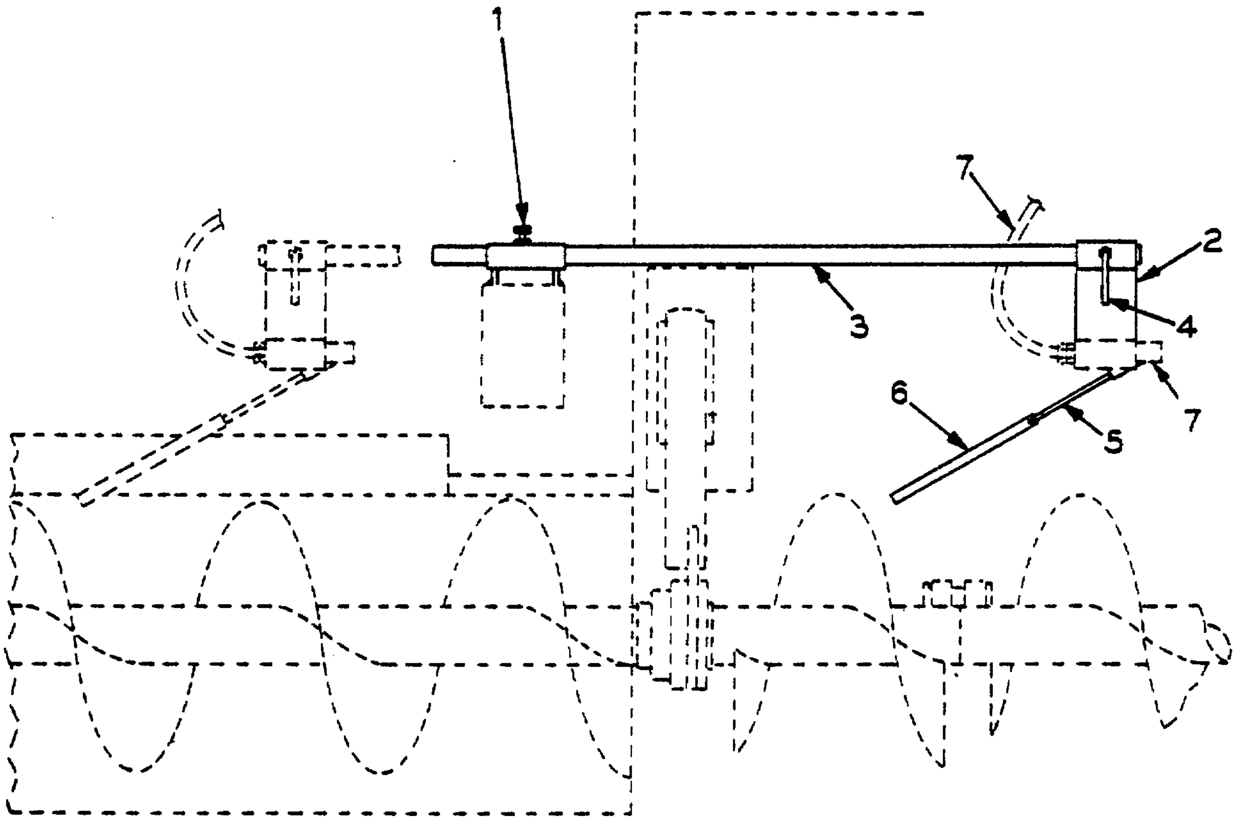
LEFT HAND SIDE SHOWN
-RIGHT SIDE TYPICAL-

SCREW CONVEYOR
14" DIAMETER - PARTS LIST NO ____.

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5036DD21-01	*Flange - Left Hand (Shown)	1
	5036DD22-01	*Flange - Right Hand (Opposite Side-Not Shown)	1
2	7010-020	Capscrew, 1/2" x 1" Hex Head NC	8
	7014-005	Lockwasher, 1/2"	8
3	F011SFGA	Flange Bearing - 1-15/16" Bore - See Form # 1001	4
		For BSF-2 Paver - See Section 12	
		For Any Other Paver - See This Section	
4	9700-608	Plate, Seal	4
5	5036BD41	Washer	4
6	7445-013	Bolt, Plow 1/2" x 1/2"	8
	45890-102-19	Locknut, 1/2"	8
7	5036FD03	Sprocket, With Shaft	2
8	5036FJO2	*Screw - Left Hand (Shown)	1
	5036FJ03	*Screw - Right Hand (Opposite Side-Not Shown)	1
	7383-109	Capscrew, Grade 5, 5/8" x 3-3/4" Hex NC	4
9	7014-007	Lockwasher, 5/8"	4
	7012-029	Nut, 5/8" Hex NC	4
10	5036FJ04	*Screw - Left Hand (Shown)	1
	5036FJ05	*Screw - Right Hand (Opposite Side-Not Shown)	1
		*Hanger, Bearing - Left Hand (Shown)	1
11		*Hanger, Bearing - Right Hand (Opposite Side-Not Shown)	1
12	47445-003	Bolt, Plow 1/2" x 2p."	8
	45890-102-19	Locknut, 1/2"	8
13	5036FD14	Shaft	2
14	5036FD22	Agitator	2
	40500-015-00-01	Pipe, 1/8" x 15"	2
15	7084-001	Coupling	2
	7051-002	Fitting, Grease 1/8" x 45°	2
17		See Remote Adjustable Screw Control - This Section	
19		See Grease Piping - This Section	
21	7051-001	Fitting, Grease 1/8"	2
22	9701-735	Cover, Screw	2

*NOTE: Right and Left Hand is determined by facing direction of paver travel.

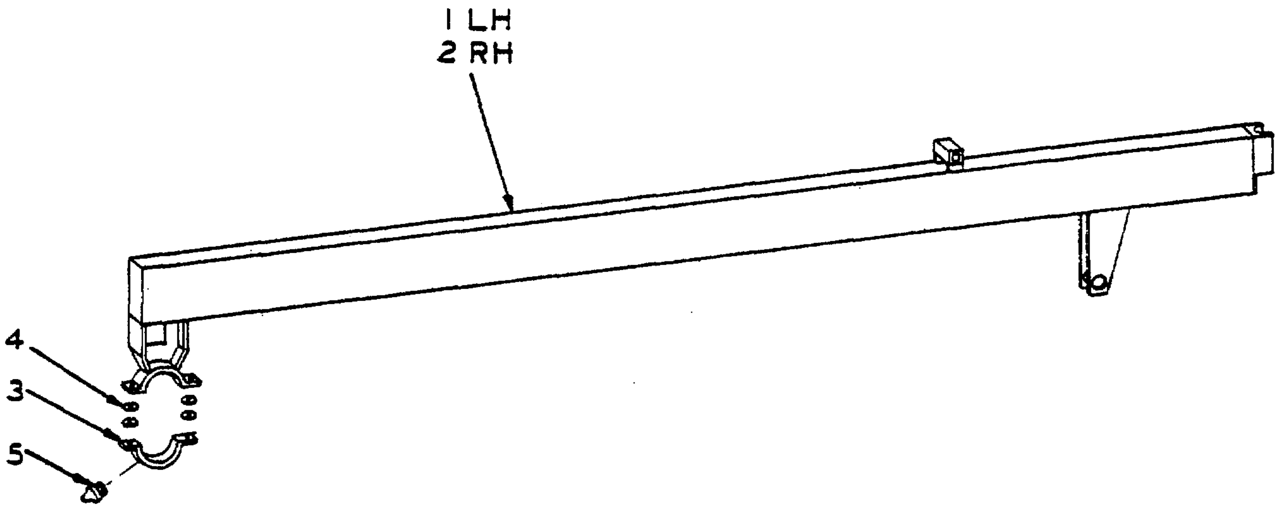
REMOTE ADJUSTABLE SCREW CONTROL



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	7383-038	Capscrew, Grade 5, 3/8" x 1" Hex Head NC - Heat Treated	1
2	5036PGB03	Support, Switch	1
3	{ 40721-032	Tubing (Used With Basic Screed	1
	9700-202	Tubing (Used With 5' Extensions	1
4	5036PGB04	Bolt, Tightening	1
5	5036PGB05	Control Arm	1
	7009-155	Capscrew, 1/4" x 5/8" Hex Head NF	2
6	5036LF09	Extension, Arm	1
	7018-001	Setscrew, 1/4" x 1/2" NC	1
7		Limit Switch and Cable - For BSF-2 Paver - See Terminal Box and Screw Control - Section 11; For BSF-2H or BSF-4 Paver - See Screed Electrical - Section 8; For BSF-3R Paver - See Electric Power and Control Tractor - Section 11; For BSF-400, BSF-420 and BSF-520 Paver - See Base Electric Parts - Section 8	

NOTE: Left Hand Assembly shown, quantities shown are for one assembly.

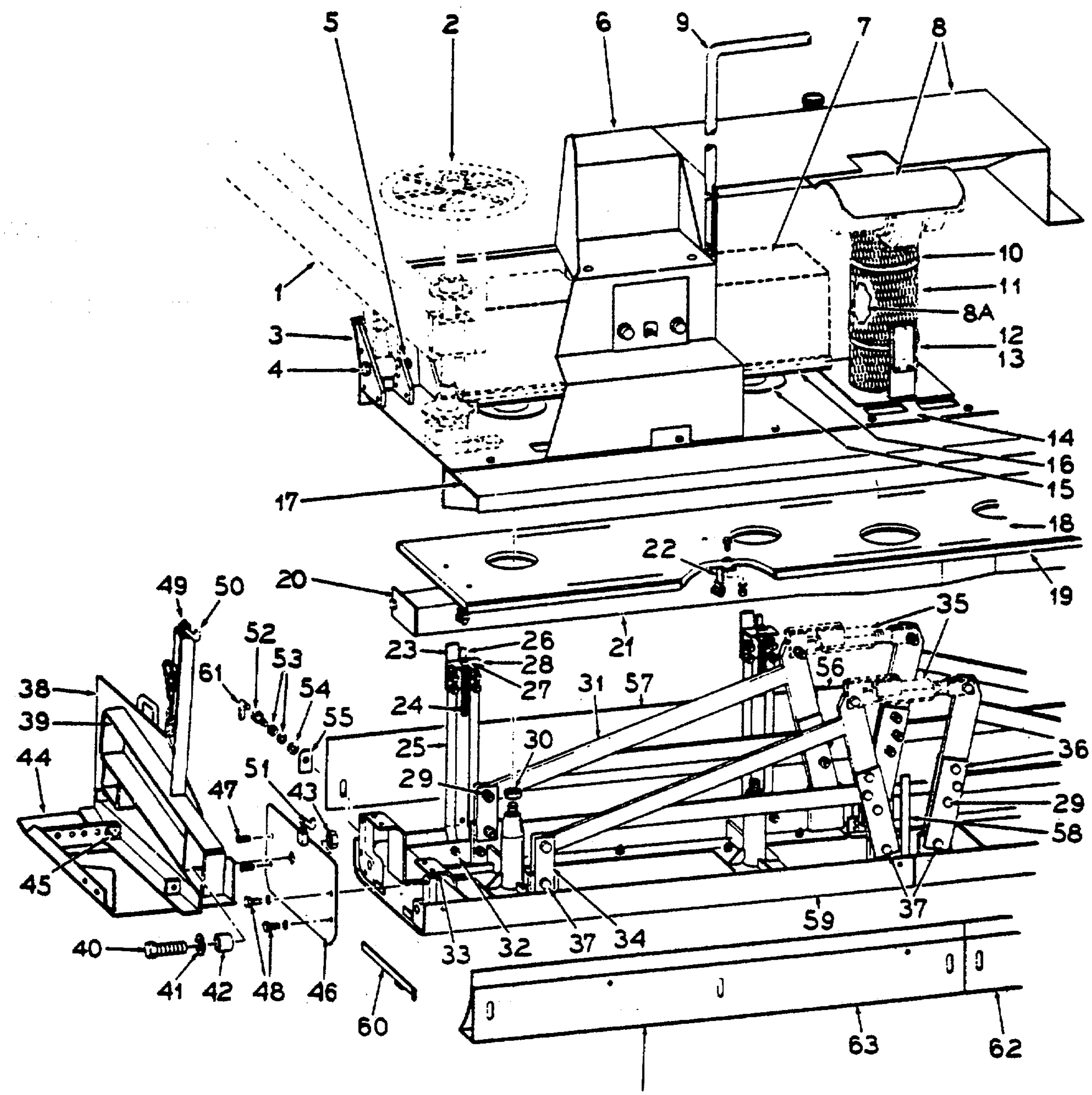
SCREED PULL ARMS
STANDARD



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	9701-130	*Arm, Screed - Left Hand	1
2	9701-130	*Arm, Screed - Right Hand	1
3	5036ND02-01	Cap	2
4	5036ND02-02	Shim, Trunnion zap	8
5	7051-002	Fitting, Alemite 1/8" - 45	1

*NOTE: Right and Left Hand is Determined by Facing Direction of Paver Travel.

SCREED



OPTIONAL CURVE STRIKE-OFF AVAILABLE

SCREED

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1		See Screed Pull Arms - This Section	
2		See Screed Adjusting Mechanism - This Section	
	9701-699	Moldboard, Models BSF-2, BSF-3R, BSF-400 and BSF-420	1
	9701-700	Moldboard, Models BSF-2H, BSF-4 and BSF-520	1
3	7012-027	Nut, 1/2" Hex NC	20
	5036NH21	Washer	20
	7472-026	Screw, 3/8" x 1¼" Swage Form	14
	7012-025	Nut, 3/8" NC	14
4	5036NH07	Bolt, 1½" x 6" Hex Head NC	2
5	7017-036	Nut, 1½"	4
6	9701-192	*Stair - Right Hand (Not Shown)	1
	9701-193	*Stair - Left Hand (Shown)	1
7		See Screed Vibrator BSF-2 and BSF-3R - Section 11 BSF-2H, BSF-4, BSF-520, BSF-420 and BSF-400 Section 8	-
8		See Burner Oil Lines - This Section	
8A	9700-559	Liner, Burner Stack With Insulation	1
9	9701-199	Hand Rail	1
10	45335-500-07	Clamp	2
11	5036NK02-01	Guard	1
12	5036NH12	Gauge, Crown	2
13	5036NH49	Back Plate, Gauge Crown	2
14	9701-249	Frame, Screed	1
15	5036NJ04	Seal	4
16	5036NH38	Plate, Mounting	4
17	5036N025	Walkway	1
	5021DE01	Key, Stud	4
18	41700-114-24	Insulation	1
19	5036NU03	Panel, Inner	1
20	5036ND22	Plate, End	2
21	5036ND21	Duct, Heat	1
22	5036ND23	Clip	8
23	5036RUB15	Gauge, Strike-Off Height	4
	5036RUF04	Bar and Bolt Adjusting	4
24	7383-070	Capscrew, Grade 5, ½" x 1½" Hex Head NC	4
	7014-005	Lockwasher, ½"	4
25	5036NU13	Support, Strike-Off Adjust	8
26	5036NU06	Pointer, Strike-Off Gauge	4
27	7012-029	Nut, 5/8" Hex NC	8
28	5036RUB06	Bracket, Adjusting	4
29	5036NH46	Bolt, 3/4" x 2¼" Hardened	16
2 4	45890-103-02	Locknut, 3/4" Hex NC	16
30	7012-034	Nut, 1¼" Hex NC	4
31	9701-509	Arm, Crown Adjusting	4
32	7010-023	Capscrew, Grade 5, ½" x 1" Hex Head NC	8
33	9700-404	*Frame, Screed - Right Hand (Not Shown)	1
	9704-405	*Frame, Screed - Left Hand (Shown)	1
34	5036NH04	Link, Outside	8
35		See Crown Adjusting Mechanism - This Section	

-Continued-

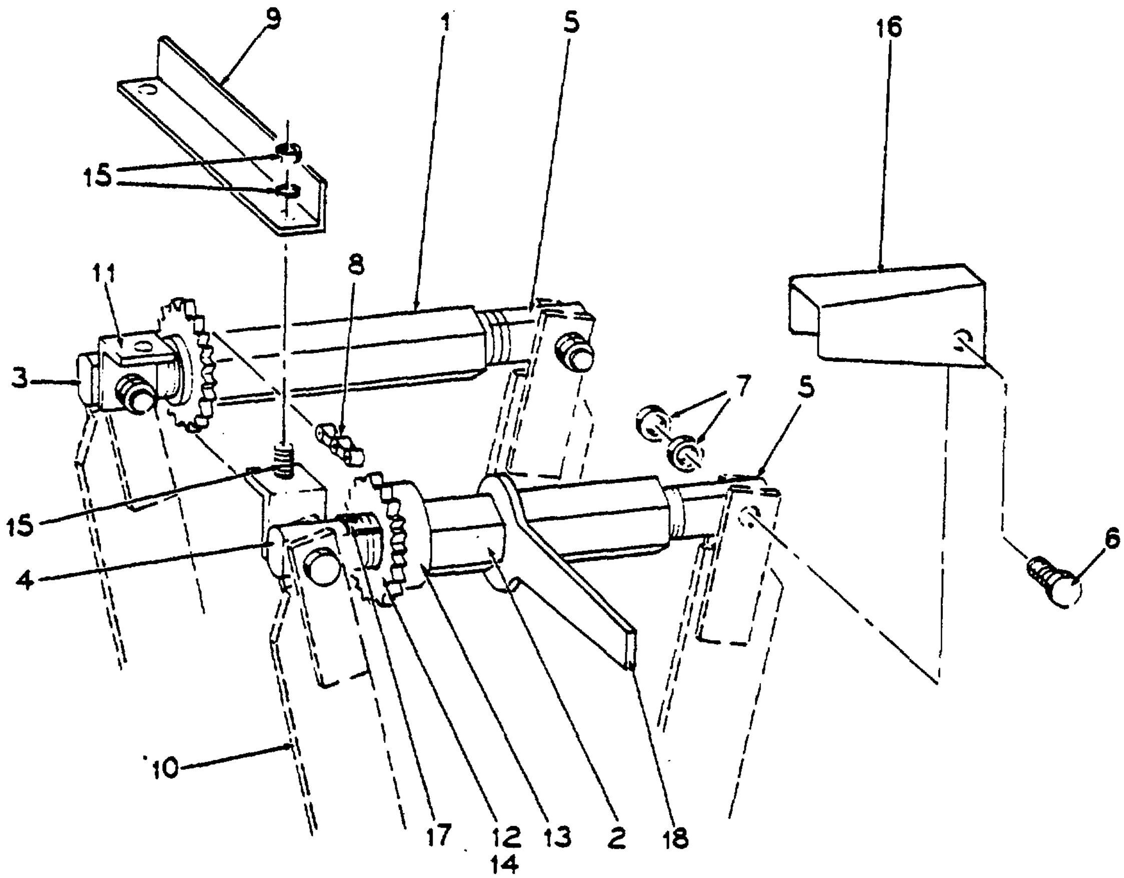
SCREED - Continued

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
36	5036NH05	Link, Center	8
37	5036NH06	Bolt, 3/4" x 2-3/4" Hex Head NC	8
	7017-030	Nut, 3/4" Jam	16
38	9701-042	*Plate, Side - Right Hand (Not Shown)	1
	9701-043	*Plate, Side - Left Hand (Shown)	1
39	9701-044	*Arm, Support - Right Hand (Not Shown)	1
	9701-045	*Arm, Support - Left Hand (Shown)	1
40	7010-157	**Capscrew, 1" x 3k" Hex Head NC	2
41	7014-025	**Washer, 1" Flat	2
42	9700-199	**Spacer	2
43	7012-032	**Nut, I" Hex NC	4
	5036RD06B	*Shoe, Cut-Off 12" (Not Shown)	1
44	5036RD07B	*Shoe, Cut-Off 24" (Shown)	1
	7010-021	Capscrew, ½" x 1i" Hex Head NC	2
45	7014-020	Washer, ½" Flat	2
	7014-005	Lockwasher, ½"	2
	7012-027	Nut, ½" Hex NC	2
46	9700-197	*Plate, End - Right Hand (Not Shown)	1
	9700-195	*Plate, End - Left Hand (Shown)	1
47	7389-056	Capscrew, Grade 5, 5/8" x 2" Flat Head	4
	7010-035	Capscrew, 5/8" x 2¼" Hex 'Head NC	4
48	7014-007	Lockwasher, 5/8"	4
49	5036NB03	Anchor, Chain Adjustment	2
	7014-023	Washer, 3/4" Flat	2
50	5036NB04	**Handle	2
51	9704-900-11	**Handle	2
52	7455-002	Screw, Shoulder	6
53	7453-601	Washer, 5/8" Compression Type	12
54	5036NU05	Washer	6
55	5036RUB07	Seal	6
56	5036RUF02	*Strike-Off Flat 60"	1
57	5036RUF03	*Strike-Off Flat 60"	1
58.	5036NH02-07	Indicator, Crown	2
59	9701-063	Screed, Bottom	1
60	45500-036-06	Gauge, Strike-Off	1
61	45500-020-06	Wrench, 5/16" Allen	1
		OPTIONAL'CURVED STRIKE-OFFS AVAILABLE	
62	5036RUG02	*Strike-Off, Curved - Right Hand	
63	5036RUG03	*Strike-Off, Curved - Left Hand	

*NOTE: Right and Left Hand is determined by direction of paver travel.

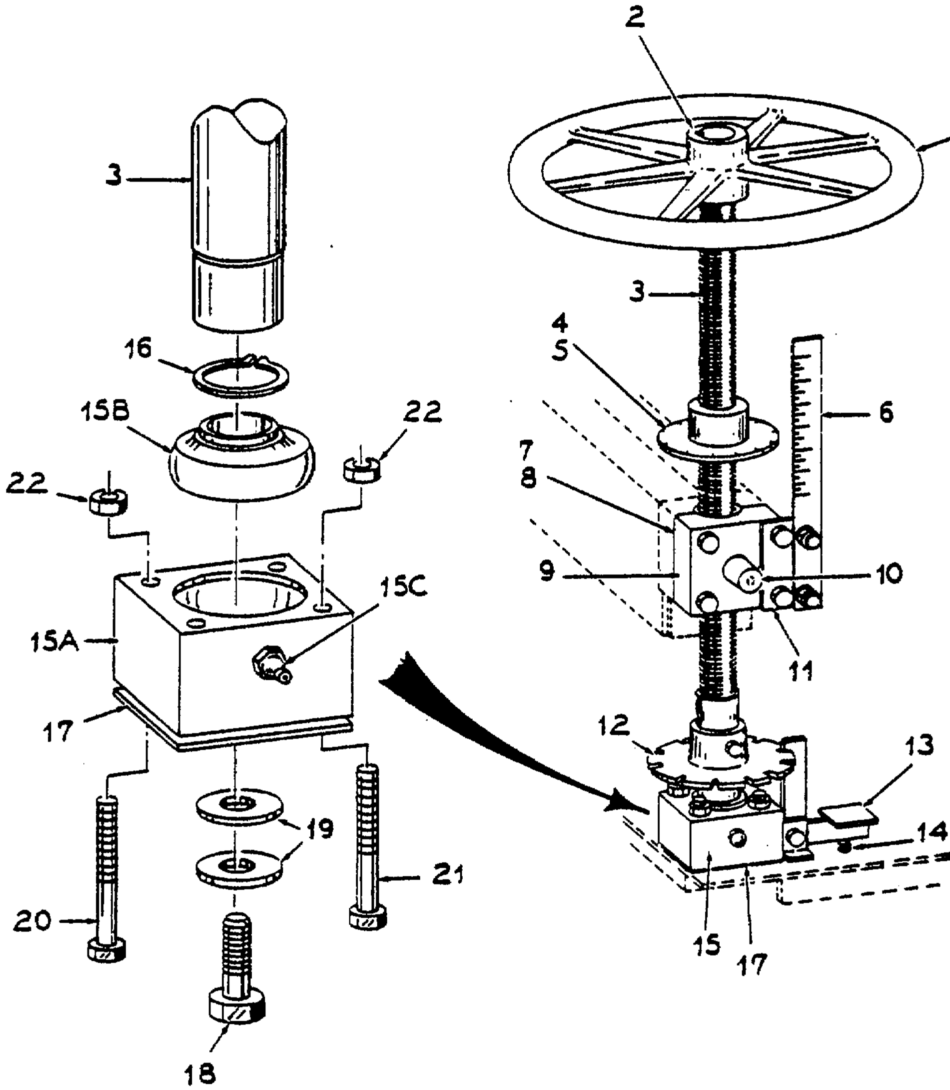
**NOTE: Items 40, 41, 42, 43, 50 and 51 are included by Ordering Hardware Package, Part Number 9701-369.

DUAL CROWN ADJUSTING MECHANISM



REF. NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5036QL02	Turnbuckle, Front	1
2	9700-179	Turnbuckle, Rear	1
3	5036QL04	Drawbolt - Right Hand Thread - Front	1
4	9700-429	Drawbolt - Right Hand Thread - Rear	1
5	5036QLO5	Drawbolt - Left Hand Thread'	2
6	5036NH06	Bolt, 3/4" x 2-3/4"	4
7	45890-103-02	Locknut, 3/4" Jam NC	8
8	9700-161	Chain Package	1
	50005-020	Chain, Roller	5.1'
	50005-020-01	Link, Offset Coupler	1
	50005-020-03	Link, Connecting	1
9	5036QL14	Spreader	1
10		See Screed - This Section	
11	5036QL13	Angle, Clip	2
12	9700-181	Sprocket	1
13	9700-180	Collar, Adjusting	1
14	7253-050	Ring, Retaining	1
15 {	7010-021	Capscrew, 1/2" x 1-1/4" Hex NC	2
	7014-005	Lockwasher, 1/2"	2
	7012-027	Nut, 1/2" Hex NC	2
16	9700-109	Lock	1
17	9700-183	Gauge	1
18	45500-750-06	Wrench	1

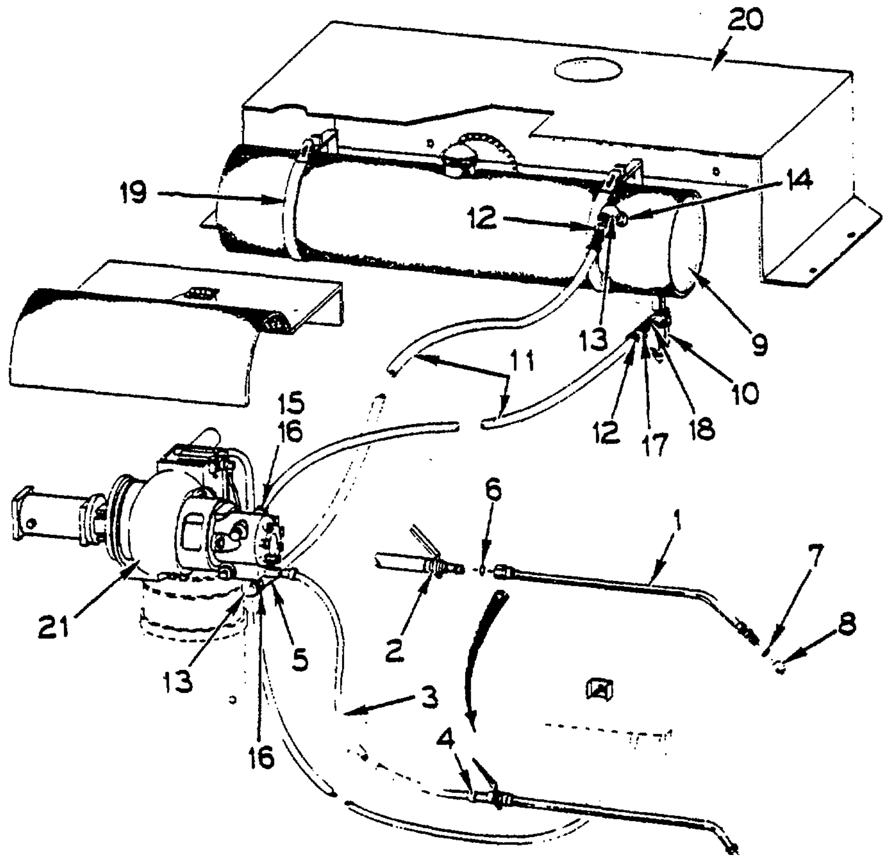
SCREED ADJUSTING MECHANISM



SCREED ADJUSTING MECHANISM

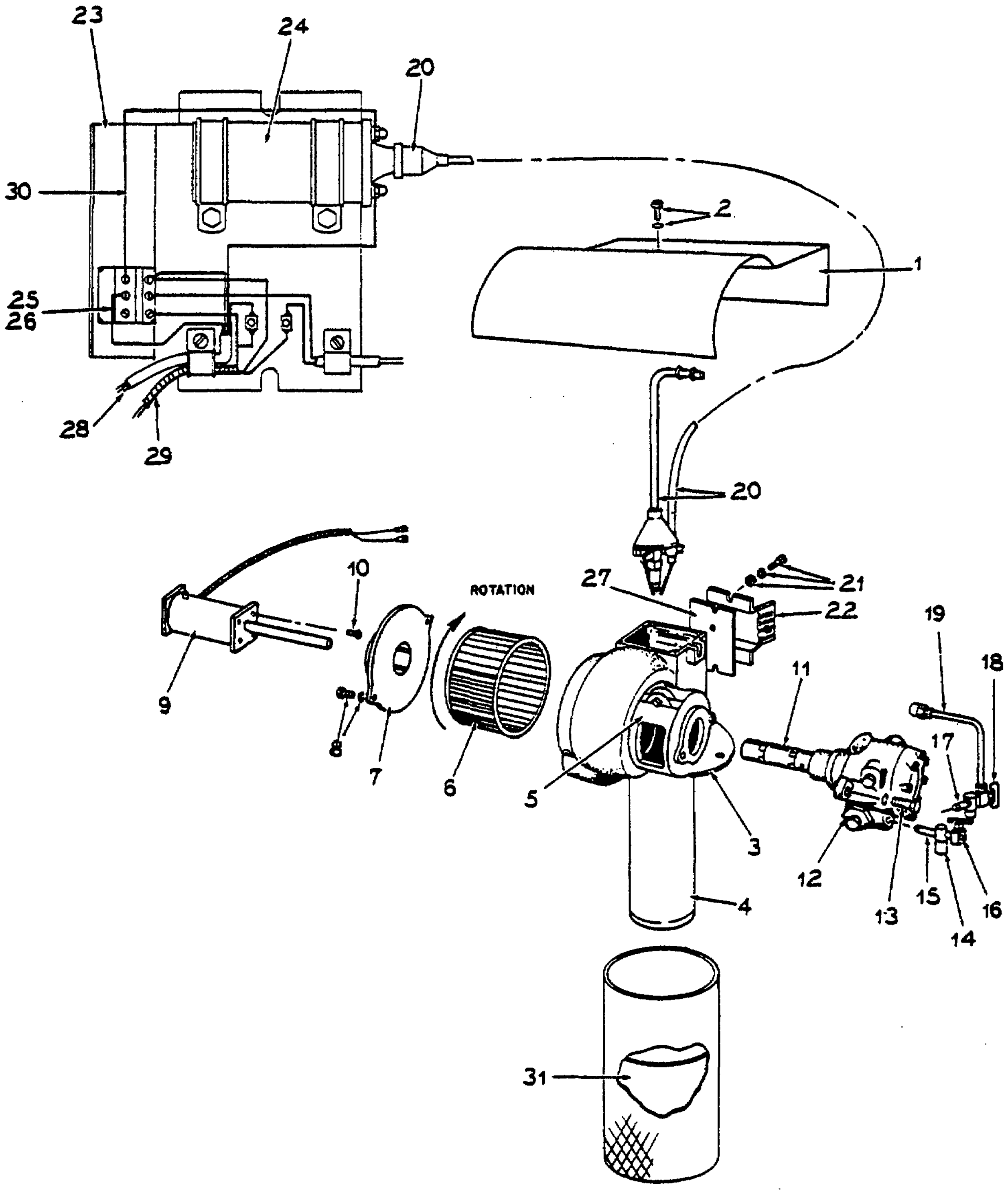
REF.NO	PART NUMBER	DESCRIPTION	QUANTITY
1	{ 5036ND31	Handwheel	2
	7131-052	Setscrew, ¼" x 3/4" Socket Head Cup Point	2
2	40800-002	Key, ¼" Square x 2"	2
3	9704-550-41	Screw, Screed Adjusting	2
4	5036ND54-01	Indicator	2
5	7018-022	Setscrew, 3/8" x 5/8" Square Head	2
6	9700-395	Scale	2
7	5036ND18	Shim, 1/16"	As Req.
8	5036ND51	Shim, 1/32"	As Req.
9	5036ND30	Cap	2
10	5036ND32-01	Nut	2
11	5036ND56	Bracket	2
12	5036ND33-01	Lock	2
13	5036ND19	Lever, Step Latch	2
14	5036NH13	Spring, Compression	2
15	4431-550-02	Bearing - Complete	2
15A	4431-550-01	Bearing	2
15B	7041-026	Ball Bearing	2
15C	7051-001	Grease Fitting, 1/8"	2
16	7253-040	Ring, Snap	2
17	5036NH26	Gasket, Bottom	2
18	7383-230	Lockscrew, Grade 5, 5/8" x 1;" NC	2
19	7014-022	Washer, 5/8" Flat	4
20	7383-080	Capscrew, Grade 5, ½" x 4" NC	4
21	7383-076	Capscrew, Grade 5, ½" x 3" NC	4
22	45890-102-19	Locknut, ½" NC	8

BURNER AND OIL LINE



REF. NO.	PART NUMBER	DESCRIPTION	QUANTITY
	9704-500-63	Spray Hose - Complete	1
1	45251-006-05	Extension	1
2	45251-001-76	Valve, Shut-Off	1
3	50030-001-21	Hose, 3/8" ID	As Req.
4	45191-004-05	Clamp, 3/8" Hose	2
5	40500-002-08-02	Nipple, Half 1/8" x 2 1/2"	1
6	45251-006-07	O-Ring	1
7	45251-006-06	O-Ring	1
8	45251-006-03	Nozzle, Cap	1
9	5036ND26A	Tank, Fuel	1
10	45186-002-03	Strainer, Fuel	1
11	50030-001-21	Hose, 3/8" ID x 22"	2
12	7431-003	Connector, 3/8" Hose x ¼" NPT	2
13	7061-002	Elbow, ¼," 900 St.	2
14	7107-002	Bushing, 3/8" x i" Pipe Reducer	1
15	7431-008	Connector, 3/8" Hose x 3/8" - 37^0	2
16	7430-004	Fitting, ¼" MP x 3/8" - 37^0 St.	2
17	7304-001	Reducer, 1/4" x 1/8" NPT	1
18	40500-000-12-01	Nipple, 1/8" NPT	1
	5036ND62	Bracket, Tank Mounting	2
19	7435-139	Screw, Machine ¼" x 1¼" NC	2
	7014-016	Washer, ½" Flat	2
	7012-023	Nut, ¼" Hex NC	2
20	9704-550-61	Walkway	1
21		See Screed Oil Burner - This Section	

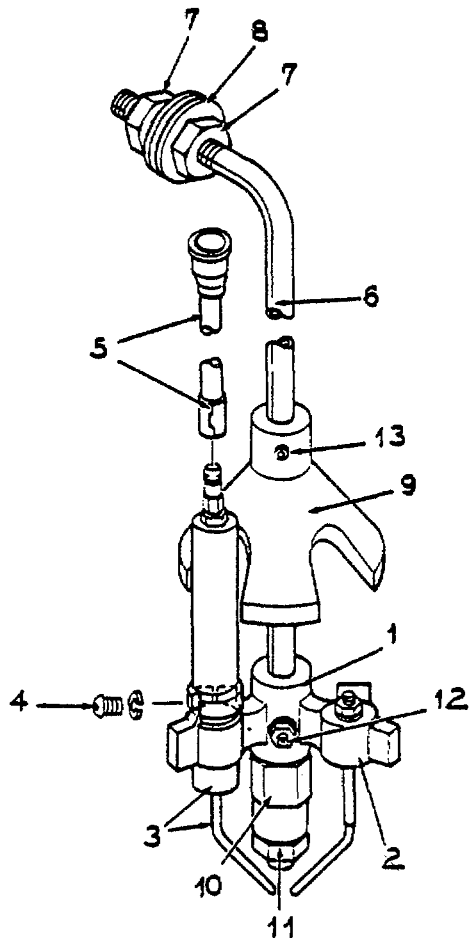
SCREED OIL BURNER



SCREED OIL BURNER

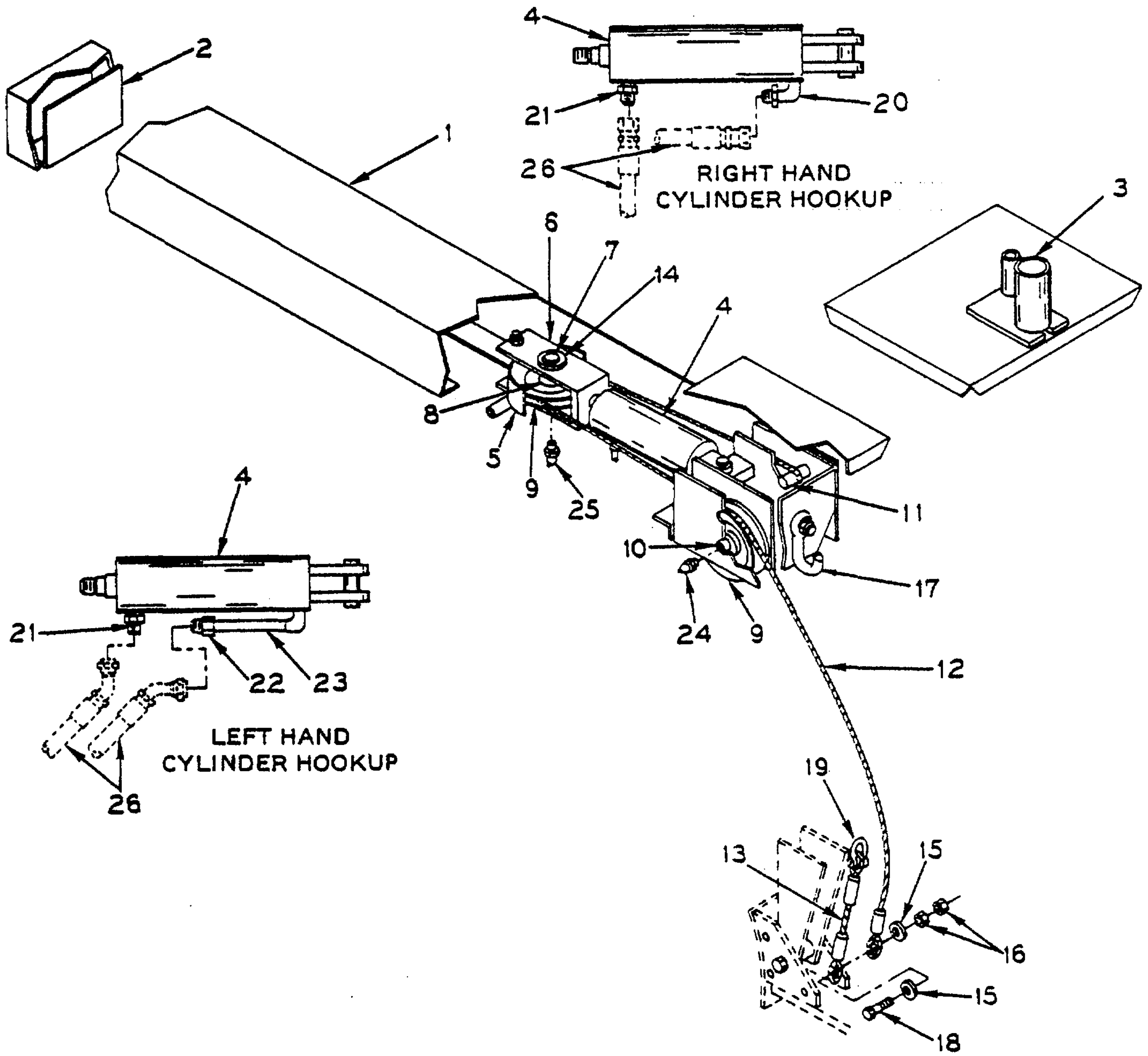
REF.NO	PART NUMBER	DESCRIPTION	QUANTITY
	9704-550-62	Screed Oil Burner - Complete	
1	9700-881	Cover	1
2	7010-077	Capscrew, ¼"-20 x ½"	4
	7007-064	Washer, ¼"	4
3	45652-507-02	Housing	1
4	9704-550-25	Manifold	1
	45652-508-02	Band, Shutter	1
5	7435-139	Screw, ¼" x ¼" Round Head	1
	7439-006	Lockwasher, ¼"	1
	7440-012	Nut, ¼"-20	1
6	45652-529-01	Wheel, Blower	1
7	4431-451-01	Standoff, Motor	1
8	7010-006	Capscrew, 5/16" x 3/4"	2
8	7014-002	Lockwasher, 5/16"	2
9	46098-400-09	Motor	1
10	47436-098	Screw, #10-32 x 3/4"	4
	7439-003	Lockwasher, #10	4
11	45652-511-06	Coupling	1
12	45652-528-01-01	Pump, Fuel Unit	1
13	7010-013	Capscrew,. 3/8" x 1"	2
	7014-003	Lockwasher, 3/8"	2
14	45252-003-02	Valve, Solenoid	2
15	40500-002-00-01	Nipple, 1/8" NPT x 2"	1
16	45652-518-02	Valve, Shut Off	1
17	40500-001-08-01	Nipple, 1/8" NPT x 1½"	1
18	45652-518-01	Valve, Shut Off 900	1
19	45652-516-03	Line, Fuel Oil	1
20	9704-550-48	Electrode Oil Pipe - See Form # 14390 - This Section	1
	7435-135	Screw, ¼" x 3/4" Round Head	2
21	7439-006	Lockwasher, ¼"	2
	7014-016	Washer, ¼" Flat	2
22	9704-600-60	Coil Switch - Complete	1
23	9704-550-28	Bracket	1
24	46176-006-01	Coil, Ignition	1
25	46200-009-03	Switch	1
26	9704-550-43	Name Tag	1
27	9704-500-29	Insulator	1
28	9704-600-58	Cable to Pulsator	1
29	45345-001-05	Spirap	1.3'
30	9704-600-59	Wire, Coil to Switch	1
31		Liner, With Insulations - See Screed - This Section	

ELECTRODE AND OIL PIPE



REF.NO	PART NUMBER	DESCRIPTION	QUANTITY
	9704-550-48	Electrode and Oil Pipe - Complete	
1	45652-533-12	Bracket	1
2	45652-505-27	Rod, Negative Electrode	1
3	45652-505-24	Electrode	1
4	7435-098	Screw, #10-24 x 3/4" Round Head NC - Cadium Plated	1
	7439-003	Lockwasher, #10 - Cadium Plated	1
5	9704-600-05	Wire, Ignition	1
6	9700-504	Pipe, Oil	1
7	9700-571	Nut, Fixture	2
8	7014-018	Washer, 3/8" Flat	2
9	45652-513-02	Cone, Air	1
10	45652-512-05	Adapter, Nozzle	1
11	45652-512-15	Nozzle, Tip 1.35 GPH @ 70°	1
12	7131-039	Setscrew, -10-24 x 1/2"	1
	7439-003	Lockwasher, #10 - Cadium Plated	1
	7440-009	Nut, #10-24 NC - Cadium Plated	1
13	7131-035	Setscrew, #10-24 x 1/4"	1

SCREED LIFT

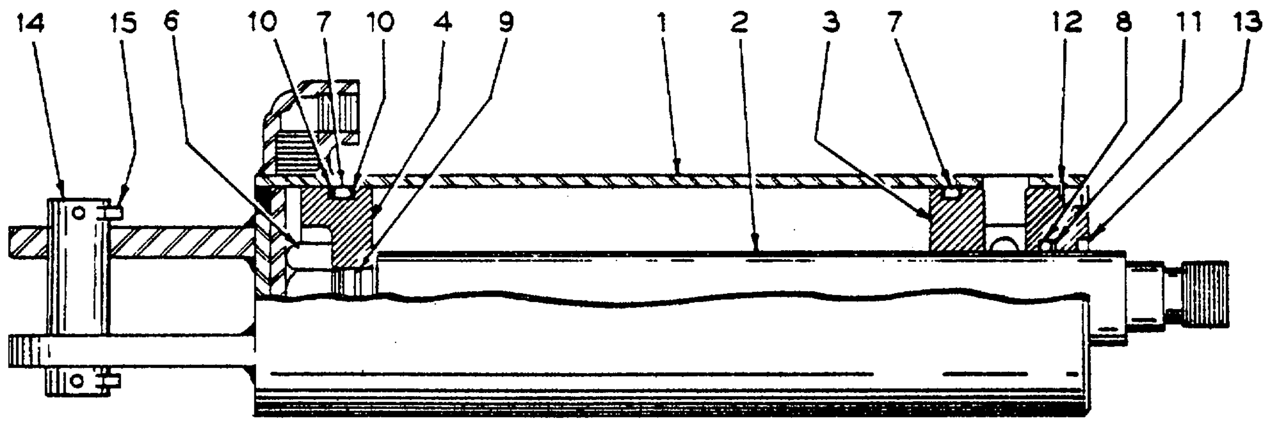


LEFT HAND SCREED LIFT SHOWN
RIGHT HAND TYPICAL

SCREED LIFT

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5036CL03	Housing, Screed Lift	2
2	9701-145	Baffle, Screed Lift Housing	2
3	9704-450-03	Support, Operator Seat	2
4	45090-002-32	Cylinder - See Form # 11023 - This Section	2
5	5032-176-03	Shroud	2
6	5032-176-04	Support, Sheave	2
7	5032-176-05	Pin	2
8	40510-000-12	Spacer, 12" XH Pipe x 3/4"	4
9	5036CD04-01	Sheave	4
10	5036CD12	Shaft, Sheave	2
11	5036CD21	Shaft, Cable Anchor	2
12	9704-100-03	Cable, Screed Lift	2
13	9704-100-04	Cable, Safety	2
14	7014-028	Washer, 1-3/8"' Flat	2
15	7014-023	Washer, 3/4" Flat	4
16	7017-030	Nut, 3/4" Jam NC	4
17	5036CF07	Screed, Hook	2
18	7010-047	Capscrew, 3/4" x 2-3/4" NC	2
19	7262-009	Shackle	2
20	7430-006	Fitting, Straight 3/8" MP x ½" 37°	1
21	7430-007	Fitting, Straight ½" MP x ½" 37°	2
22	7430-013	Fitting, Straight 3/8" FP x ½" 37°	1
23	40539-005-08-01	Nipple, 3/8" XH Pipe x 5½"	1
24	7051-001	Fitting, Grease	2
25	7051-003	Fitting, Grease	2
26		See Auxiliary Hydraulic Circuit - Section 7	
27		See Screed Lift Hydraulic Circuit - Section 7	

CYLINDER - SCREED LIFT

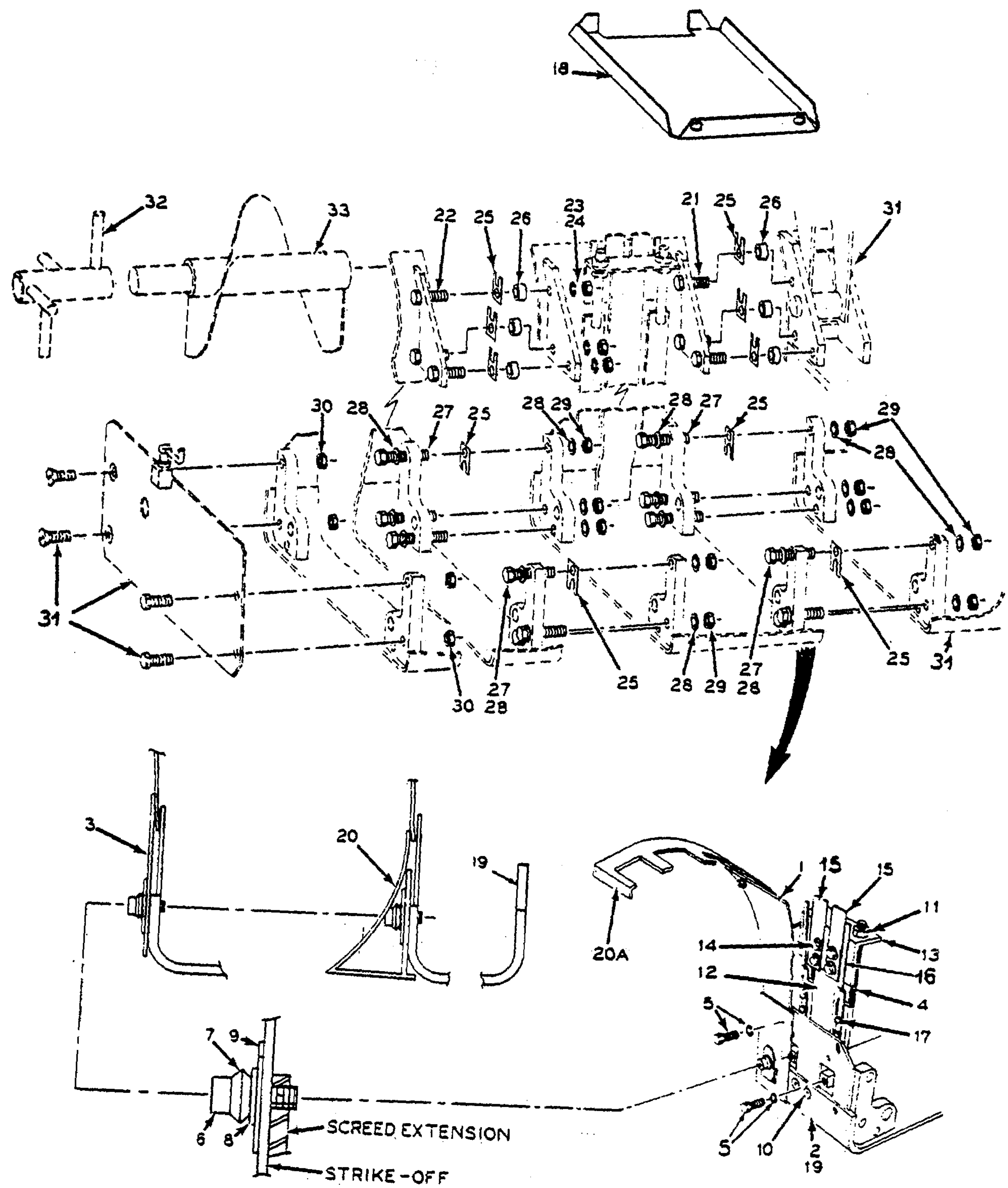


REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
	45090-002-32	Cylinder - Complete	
1	45090-500-07	Body, Cylinder	1
2	45090-527-11	Rod, Piston	1
3	45090-529-04	Guide, Piston Rod	1
4	45090-524-16	Piston	1
6		Nut, 7/8" Hex NF	1
7	45090-512-31	*O-Ring	2
8	45090-512-29	*O-Ring	1
9	45090-512-14	*O-Ring	1
10	45090-511-14	*Washer, Back-Up	2
11	45090-511-13	*Washer, Back-Up	1
12	45090-512-33	*Ring, Retaining	1
13	45090-513-05	*Wiper, Rod	1
14	45090-509-10	Pin, Clevis	1
15	45090-511-38	Hitch Pin Clip	1

*NOTE: These parts can be ordered as a complete packing kit, Part Number 45090-526-20.

NOTE: Quantities shown are for one (1) assembly.

12" SCREED EXTENSION
WITH ADJUSTABLE STRIKE - OFFS

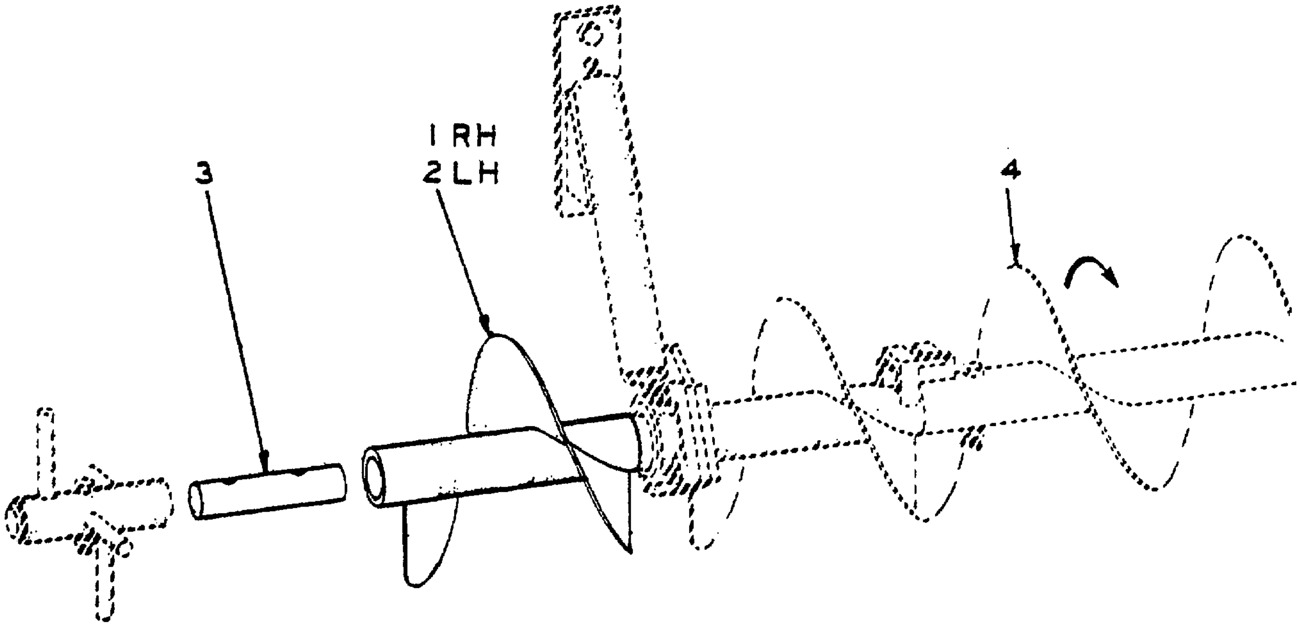


12'' SCREED EXTENSION
WITH ADJUSTABLE STRIKE - OFFS

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	9701-741	Extension, 12" Moldboard	1
2	5036-603-01	Extension, 12" Screed	1
3	5036RWF02	Strike-Off, 12" Flat	1
4	5036RWF04	Bolt, Adjusting	2
5	7383-070	Capscrew, Grade 5, 1/2" x 1-1/2" Hex NC	2
	7014-005	Lockwasher, 1/2"	2
6	7455-002	Screw, Shoulder	2
7	7453-601	Washer, Spring	4
8	5036NU05	Washer, Special Flat	2
9	5036RUB07	Seal	2
10	7389-044	Capscrew, Grade 5, 1/2" x 1" Flat Head Socket Type NC	2
11	7012-029	Nut, 5/8" Hex NC	4
12	5036RMF06	Support	1
13	5036RMF07	Bracket, Adjusting	1
	7010-016	Capscrew, 3/8" x 1-3/4" Hex NC	4
14	7014-003	Lockwasher, 3/8"	4
	7012-025	Nut, 3/8" Hex NC	4
	7014-018	Washer, 3/8" Flat	4
15	5036RUB15	Gauge, Strike-Off	2
16	5036NU06	Pointer, Strike-Off Gauge	2
17	7010-087	Capscrew, 1/4" x 5/8" Hex NC	4
	7014-001	Lockwasher, 1/4"	4
18	5036RMF04	Cover	1
19	5036RMFO9	Cover, Screed Extension	1
20	5036RWG02	*Strike-Off, 12" Curved	1
20A	9701-804	Guard	1
	HARDWARE FOR MOUNTING SCREED EXTENSIONS TOGETHER		
21	7010-025	Capscrew, 1/2" x 2-1/4" Hex NC	3
22	7383-078	Capscrew, Grade 5, 1/2" x 3-1/2" Hex NC	3
23	7014-005	Lockwasher, 1/2"	3
24	7012-027	Nut, 1/2" Hex NC	3
	9700-816	Shim, 1/4"	As Req.
25	9700-815	Shim, #10 Gauge	As Req.
	9700-814	Shim, #20 Gauge	As Req.
26	5036RF08	Spacer	3
27	7383-078	Capscrew, Grade 5, 1/2" x 3-1/2" Hex NC	6
28	7453-602	Washer, 1/2" Belleville	12
29	7012-027	Nut, 1/2" Hex NC	6
30	7012-029	Nut, 5/8" Hex NC	4
31		See Screed - Section 5	
32		See Screw Conveyor - Section 4	
33		See Screw Extensions - This Section	

NOTE: Quantities shown are for one complete assembly.
*NOTE: Curved Strike-Off, available from factory.
NOTE: Items 5, 6, 7, 8, 9, 10, 11, 14, 16, 17 and 21 thru 30 may be purchased by ordering Part Number 9701-763 Hardware Package.

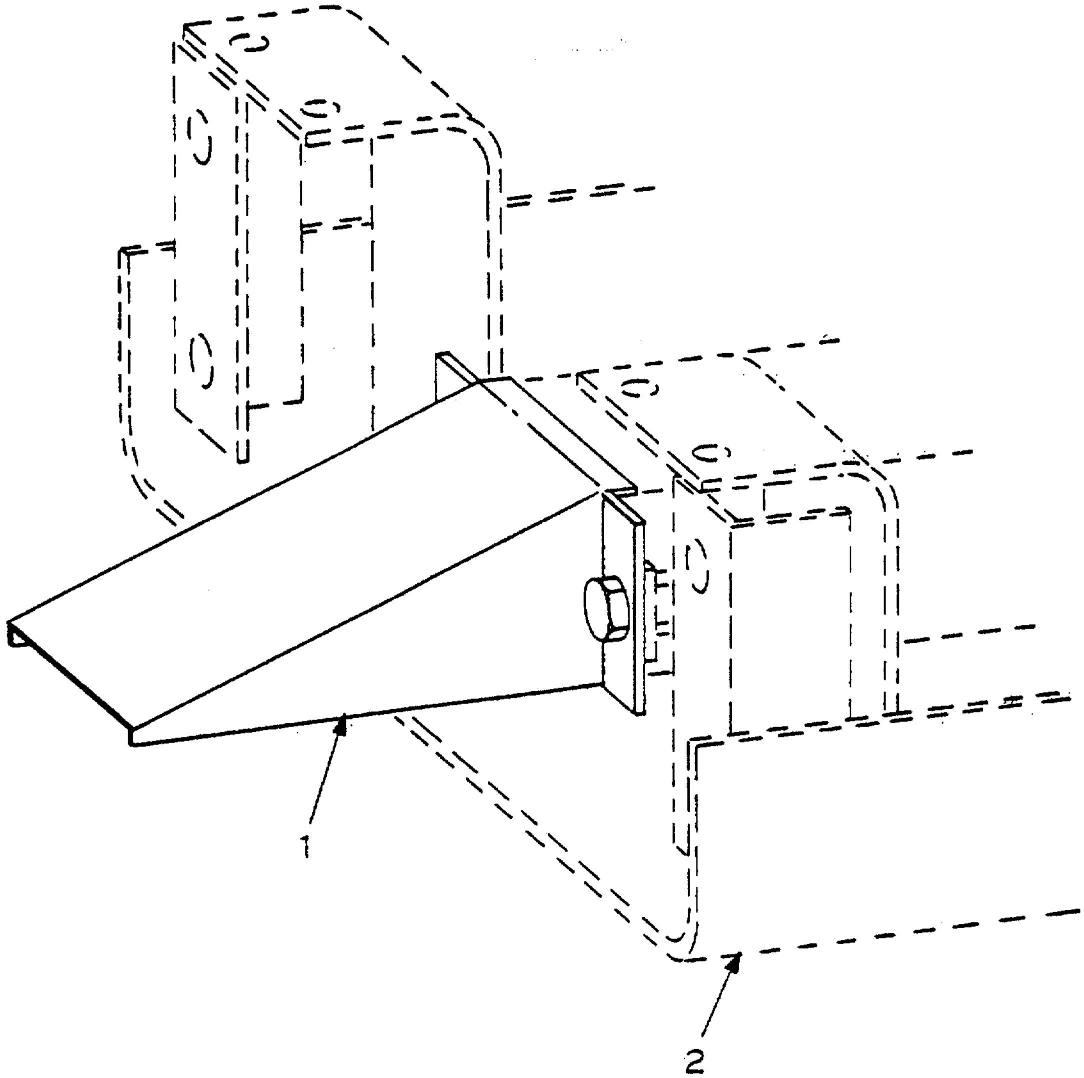
SCREW EXTENSIONS



LEFT HAND SIDE SHOWN
-RIGHT SIDE TYPICAL-

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5032-12!e-17	Screw, Section - Right Hand	1
2	5032-125-18	Screw, Section - Left Hand	1
3	5032-125-19	Shaft, Stub	2
4		See Screw Conveyor - Section 4	

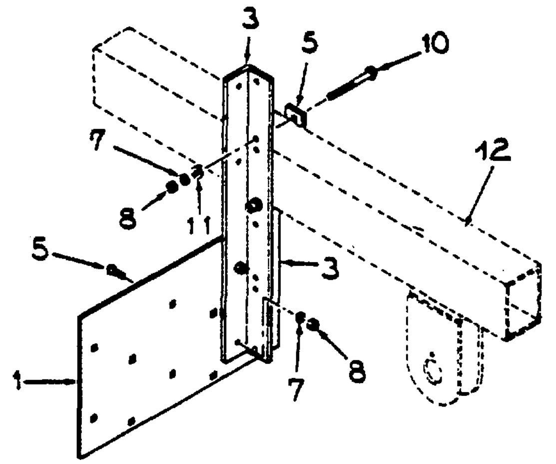
HEAT DUCT EXTENSION



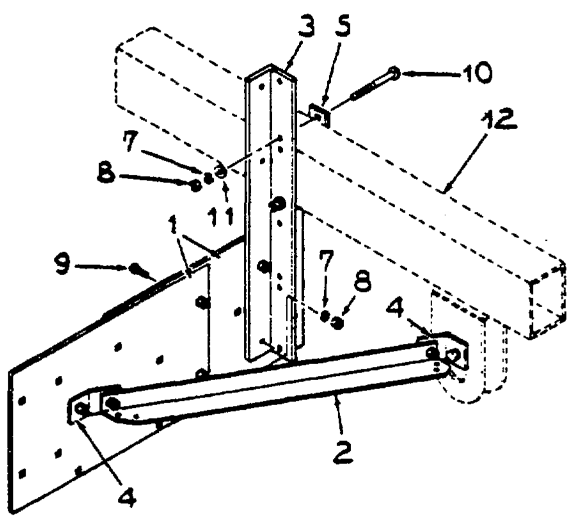
REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5036RF09	Extension, Heat Duct	1
2		See Screed - Section 5	

MATERIAL RETAINING PLATES

MODEL BSF-2 & BSF-3R

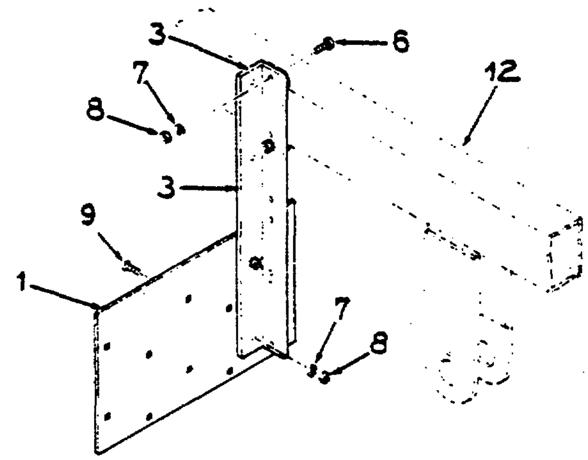


24" ARRANGEMENT

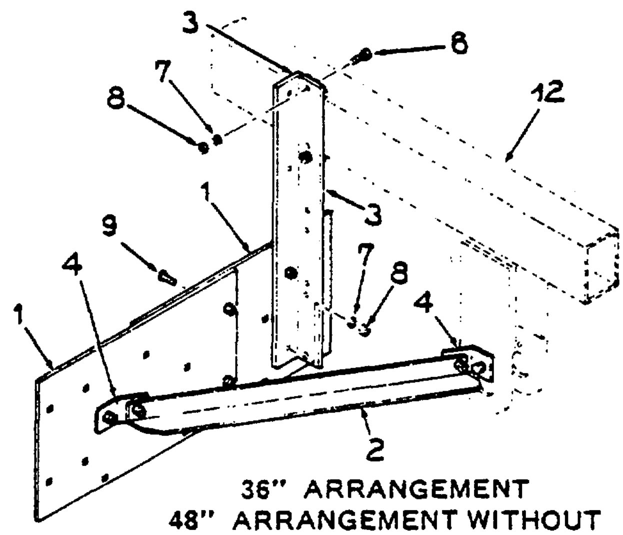


36" ARRANGEMENT
48" ARRANGEMENT

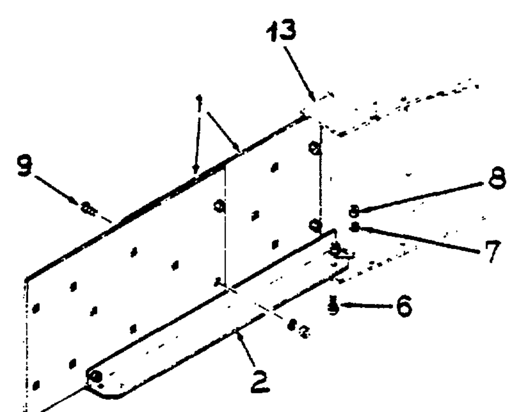
MODEL BSF-2H & BSF-4



24" ARRANGEMENT



36" ARRANGEMENT
48" ARRANGEMENT WITHOUT
5' SCREED EXTENSION

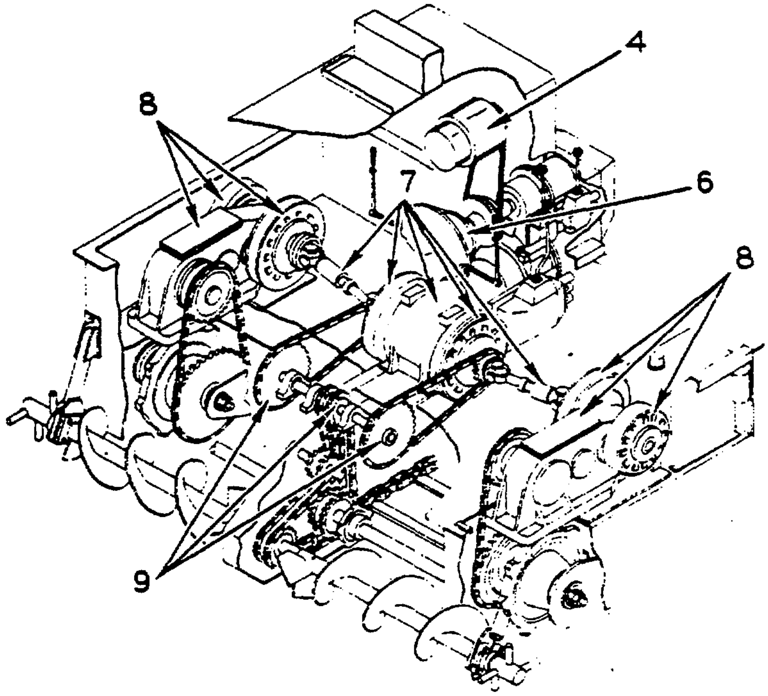


48" ARRANGEMENT WITH
5' SCREED EXTENSION

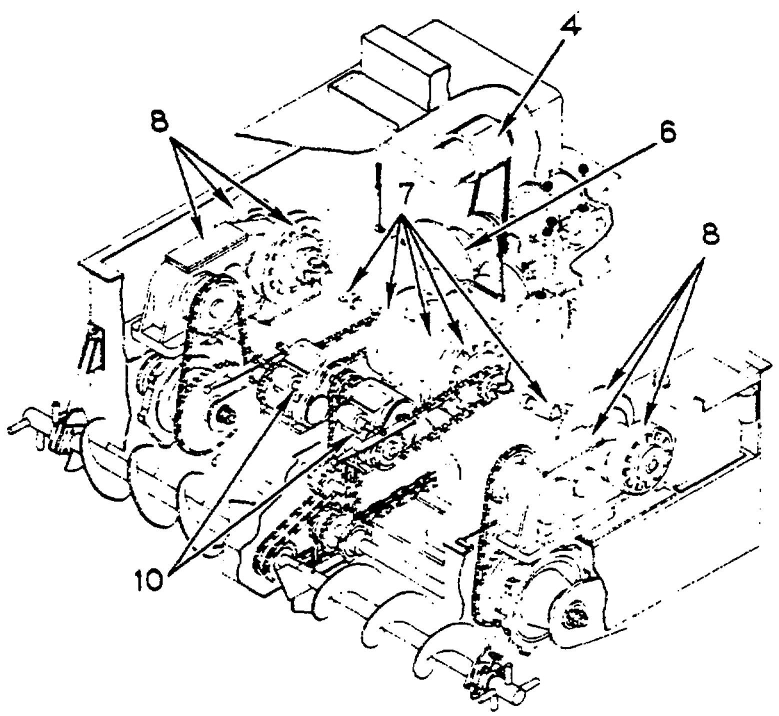
MATERIAL RETAINING PLATES

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	9700-514	Plate, Material	2
2	9700-225	Brace	1
3	9700-350	Angle, Retainer	1
4	9700-352	Support, Brace	2
5	5036RY04	Bar, Clamp	1
	9704-700-31	Hardware Package (Includes Items 5 thru 13)	
6	7010-022	Capscrew, 1/2" x 1-1/2" NC	4
7	7014-005	Lockwasher, 1/2"	11
8	7012-027	Nut, 1/2" Hex NC	11
9	7072-101	Bolt, Carriage 1/2" x 1-1/4" NC	5
10	0119A04	Bolt, Carriage 1/2" x 5-1/2"	2
11	7014-020	Washer, 1/2" Flat	2
12		See Screed Pull Arms - BSF-2H and BSF-4 - This Section See Screed Pull Arms - BSF-2 and BSF-3R - Section 5	
13		See 5' Screw Extension - BSF-2H and BSF-4 - Section 4	

POWER MOUNTING AND DRIVE COMPONENTS

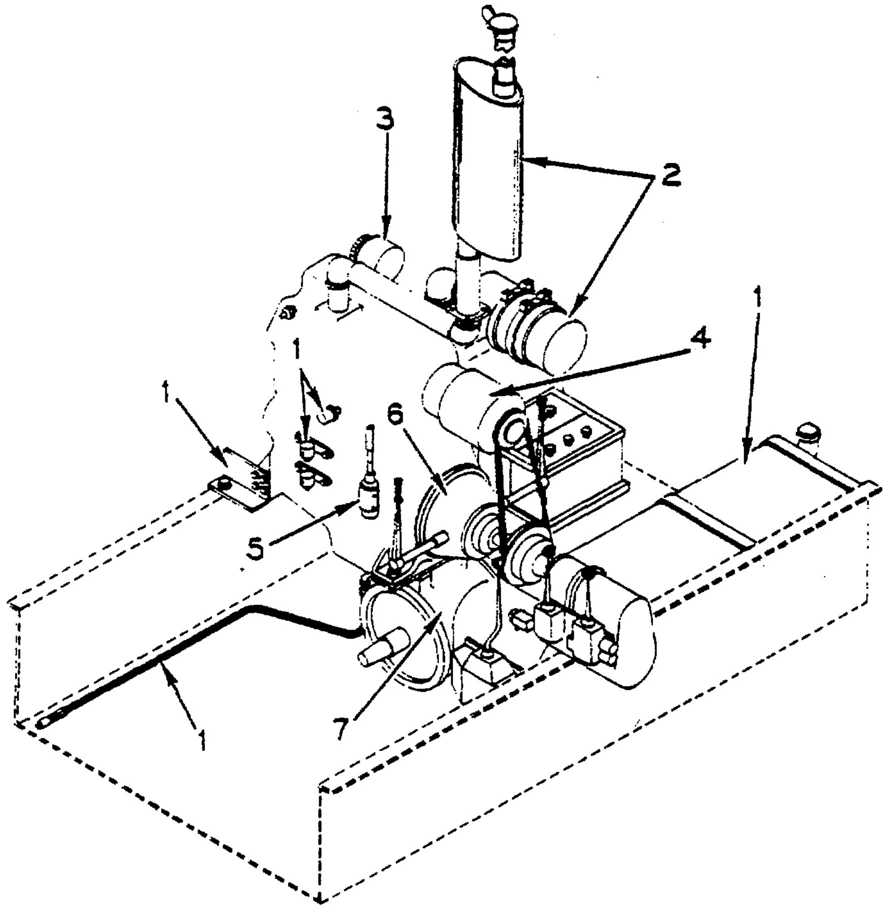


STANDARD CONVEYOR DRIVE



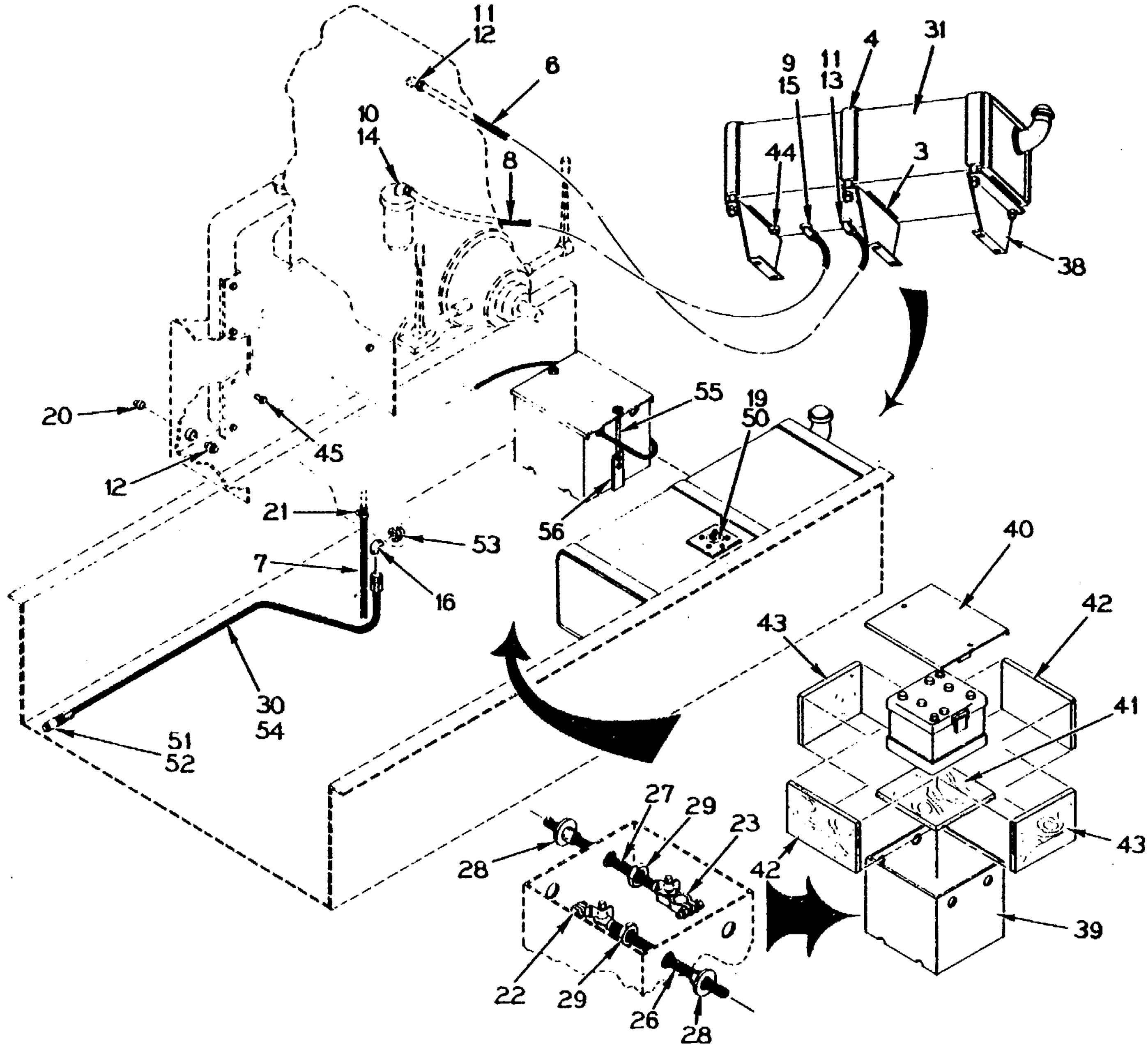
TWO SPEED CONVEYOR DRIVE

POWER MOUNTING AND DRIVE COMPONENTS

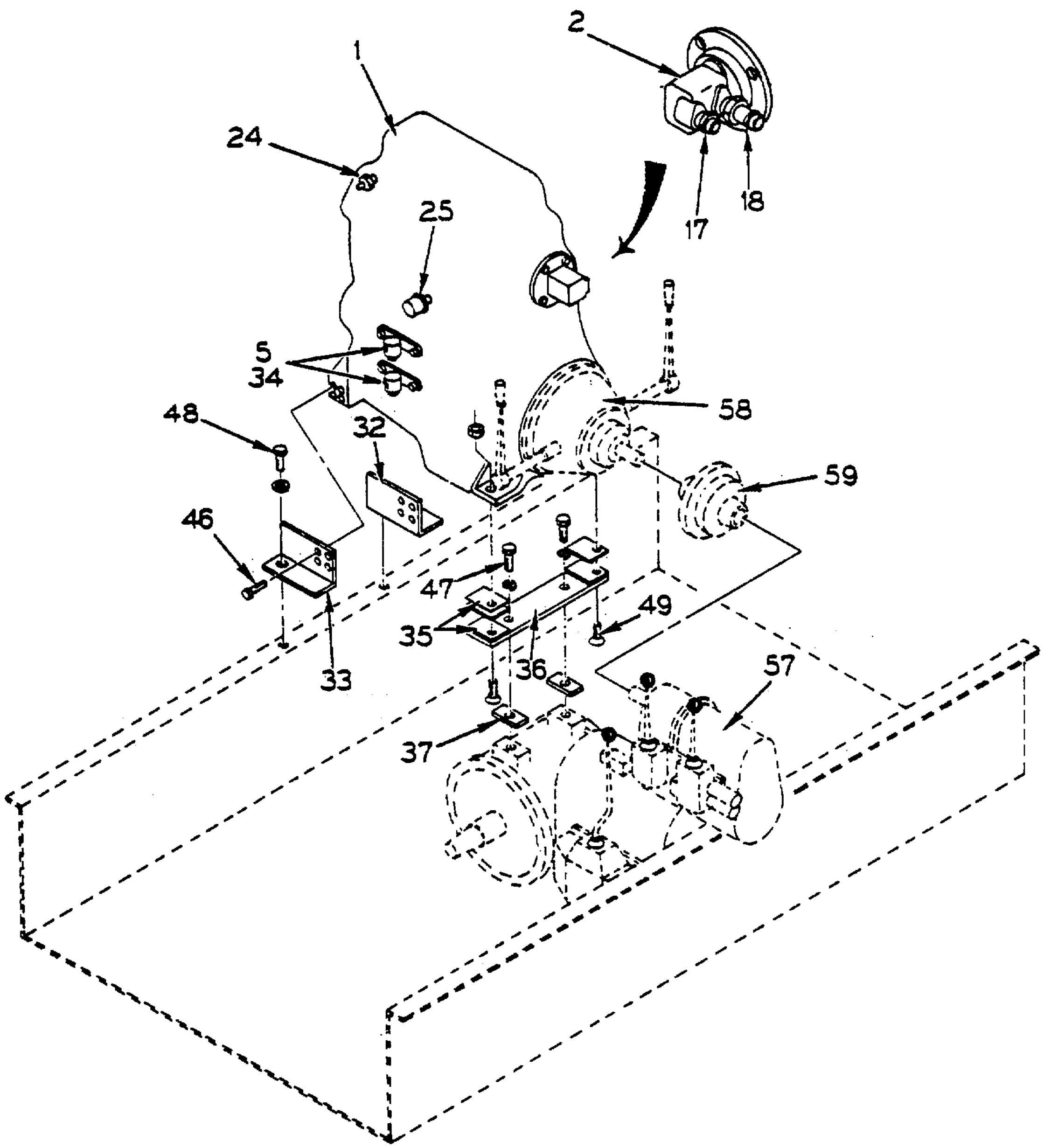


REF.NO.	DESCRIPTION
1	Power Mounting Parts
2	Air Cleaner and Exhaust System
3	Alternator and Drive
4	Generator and Drive
5	Automatic Throttle Control
6	Power Take Off
7	24 Speed Transmission, Clutch and Drive Shaft
8	Clutch, Transfer Case and Brakes
9	Standard Conveyor Drive
10	Two Speed Conveyor Drive (Optional)

POWER MOUNTING PARTS



POWER MOUNTING PARTS



POWER MOUNTING PARTS

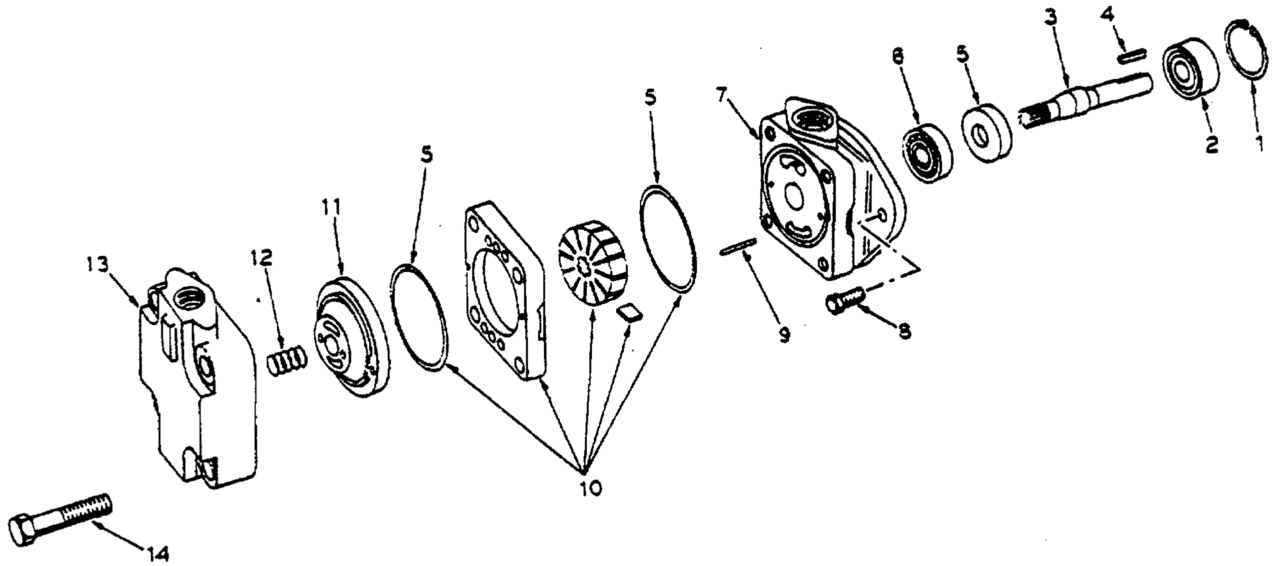
REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	45924-008-02	Power Mounting Make - GMC Diesel Model # 3-53	1
2	45080-001-07	Pump, Hydraulic - See Form # 12560 - This Section	1
3	41733-003-02	Tape, Anti Squeak 1/8" x 1½"	3.0'
4	5036GD21A	Strap, Tank	3
5	46325-002-09	Relay, Magnetic Continuous	2
6	50030-002-01	Hose, ¼" ID x 5'-6"	5.5'
7	50030-002-01	Hose, ¼" ID x 24"	2.0'
8	50030-002-02	Hose, 3/8" ID x 4'-6"	4.5'
9	7431-004	Hose End, 3/8" NPT Rigid Male	1
10	7431-008	Hose End, 3/8" NPT Sy. Female	1
11	7431-006	Hose End, ¼" Swivel Female	2
12	7430-002	Connector, ¼" Tube ¼" Pipe	2
13	7430-017	Elbow, 90° ¼" Tube x ¼" Pipe	1
14	7430-019	Elbow, 90° 3/8" Tube x 3/8" Pipe	1
15	45191-501-08	Elbow, 90° 3/8"	1
16	7430-022	Fitting, 90° ½" MP x ½" 37°	1
17	7430-007	Fitting, Straight ,½" MP x ½" 37°	1
18	45191-250-07	Fitting, Straight 1" MP x 1" Hose	1
19	9704-302-06	Sender, Fuel	1
20	7024-002	Plug, ¼" NPT	1
21	45191-004-28	Clamp, Hose	1
22	7296-006	Terminal, Stud Type - Negative	1
23	7296-005	Terminal, Stud Type - Positive	1
24	45865-003-03	Sensor, Temp Sending	1
25	45865-002-17	Sensor, Oil Pressure Sending	1
26	5008U20U	Cable, Battery	1
27	5008U20T	Cable, Battery - Starter	1
28	46026-004-03	Bushing, Male Fiber	2
29	46026-016-03	Locknut, Conduit	2
30	9701-416	Hose - Complete	1
	50036-070-00	Hose, ½" ID x 70"	1
	45191-503-13	Male Pipe End	1
	45191-503-15	Swivel Fitting JIC 37°	1
31	9704-302-05	Tank, Modified Fuel	1
32	9704-300-50	Bracket, Engine Mount	1
33	9704-300-51	Bracket, Engine Mount	1
34	9704-300-52	Bracket, Relay Mount	2
	5036GF10	Shim, 1/8"	As Req.
35	5036GF11	Shim, 1/16"	As Req.
	5036GF12	Shim, 1/32"	As Req.
36	5036GF31	Support, Engine - Rear	1

-Continued-

POWER MOUNTING PARTS - Continued

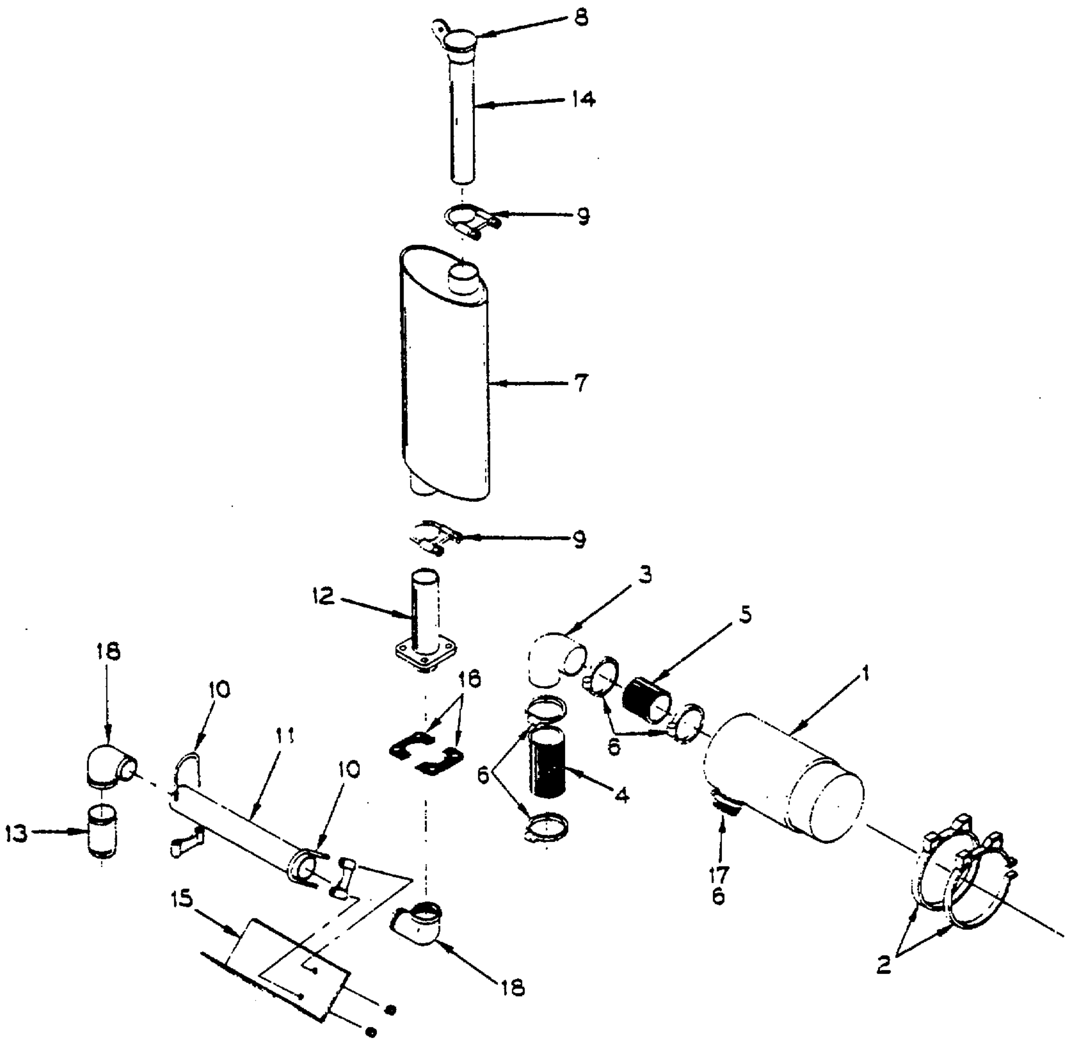
REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
37	5036GF31-01	Spacer, Rear Support	2
38	5036GD20A	Mount, Fuel Tank	3
39	5008U25J	Box, Battery	1
40	5008U26B	Lid, Battery Box	1
41	5008U27D-01	Liner, Bottom	1
42	5008U27D-02	Liner, Side	2
43	5008U27D-03	Liner, Side	2
44	7024-003	Plug, 3/8" NPT	1
45	45890-252-07	Bolt, Washer Head 5/16" NF	8
46	7838-038	Capscrew, Grade 5, 3/8" x 1" NC	12
47	7009-026	Capscrew, 5/8" x 1-3/4" NF	2
48	7010-035	Capscrew, 5/8" x 2¼" NC	2
49	7016-075	Capscrew, 3/4" x 2-3/4" Flat Head NC	2
50	7504-050	Capscrew, #8-32 x 3/8" NC	5
51	7084-004	Coupling, ½" NPT	1
52	7024-004	Plug, ½" NPT	1
53	7107-007	Bushing, 3/4" NPT x ½" NPT	1
54	7509-007	Clamp, Vinyl Cover 13/16"	1
55	45045-002-02	Hold Down	2
56	5036GFG01	Anchor, Hold Down	2
57		See 24 Speed Transmission - This Section	
58		See Power Take-Off - This Section	
59		See Coupling and Sheave - This Section	

HYDRAULIC PUMP



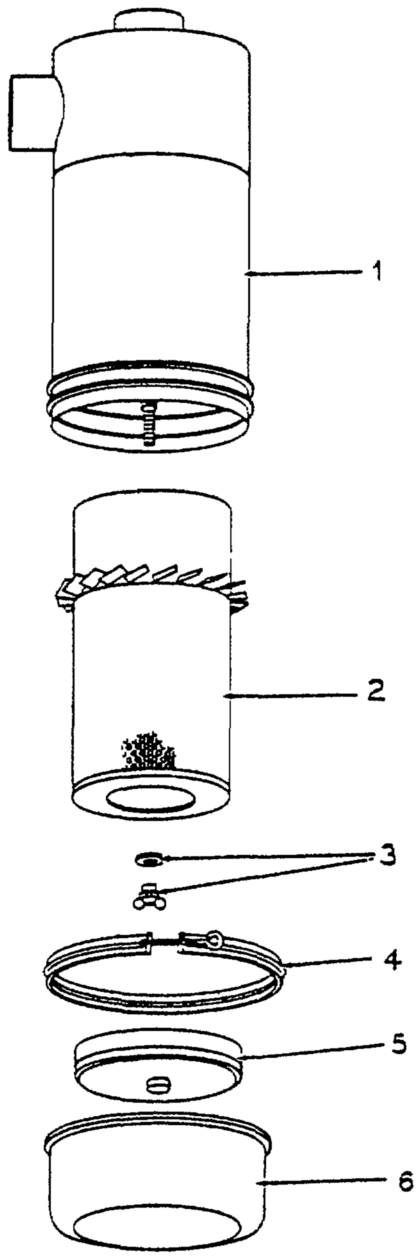
REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
	45080-001-07	Pump Assembly	
1	45080-500-17	Ring Snap	1
2	45080-504-01	Bearing	1
3	45080-507-05	Shaft	1
4	45080-506-05	Key	1
5	45080-502-07	Kit, Seal	1
6	45080-504-09	Bearing	1
7	45080-521-05	Body	1
8	45080-501-20	Bolt	2
9	45080-512-06	Pin	2
10	45080-511-02	Cartridge Kit	1
11	45080-513-10	Plate, Pressure	1
12	45080-517-08	Spring	1
13	45080-525-02	Cover	1
14	45080-525-03	Capscrew,-Cover	4

AIR CLEANER AND EXHAUST SYSTEM



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	45690-001-21	Air Cleaner - See Form v 14513 - This Section	1
2	45690-001-21-01	Sand, Air Cleaner Mounting	2
3	9704-301-23	Elbow, 90° Tubing	1
4	50030-004-10	Hose, Rubber 4" ID x 7"	0.6'
5	50030-004-10	Hose, Rubber 4" ID x 4"	0.3'
6	45191-004-62	Clamp, Hose 4"	5
7	45710-001-06	Muffler, Exhaust	1
8	45915-004-08	Cap, Rain	1
9	45710-002-02	Clamp, Muffler	2
10	46185-001-15	Clamp, Exhaust	2
11	50125-004-01	Tubing, Flexible Exhaust	1.6'
12	9704-301-28	Support, Exhaust	1
13	40516-005-12-0!	Nipple, 3" NPT x 5-3/4" TBE	1
14	40716-018	Tube, 16 Ga. 3½" OD x 18"	1
15	9704-301-27	Shield, Heat	1
16	9704-301-26	Gasket, Exhaust	2
17	9704-301-25	Screen, Air Cleaner Inlet	1
18	7061-011	Elbow, 90° Street 3" NPT	2

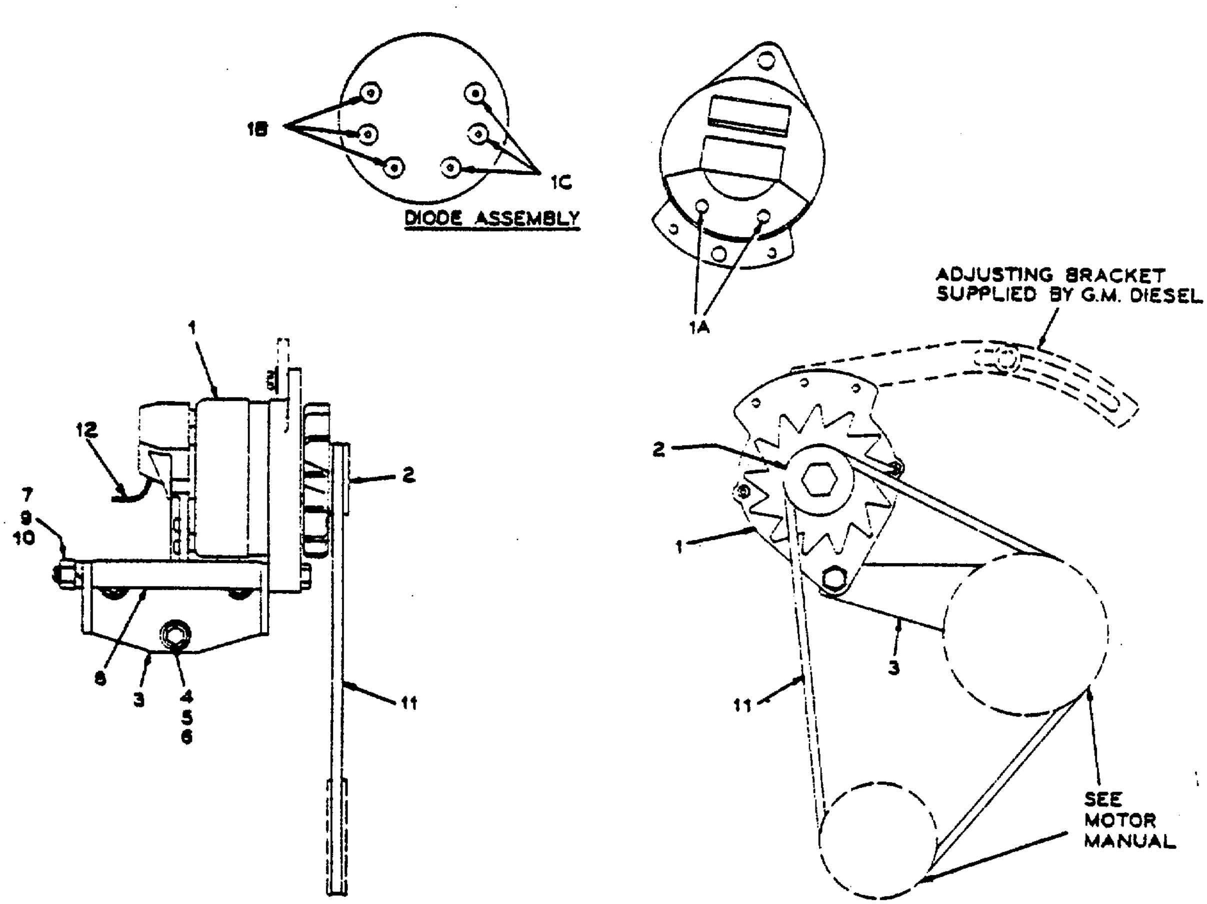
AIR CLEANER



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
	45690-001-21	Air Cleaner - Complete	1
1	*	Body	1
2	45690-001-21-03	Element	1
3	45690-001-21-04	Kit, Nut and Gasket	1
4	&5690-001-21-05	Clamp	1
5	45690-001-21-06	Baffle	1
6	45690-001-21-07	Cup, Dust	1

*NOTE: The Body is not a service item. The manufacturer recommends replacement of entire cleaner if body is damaged.

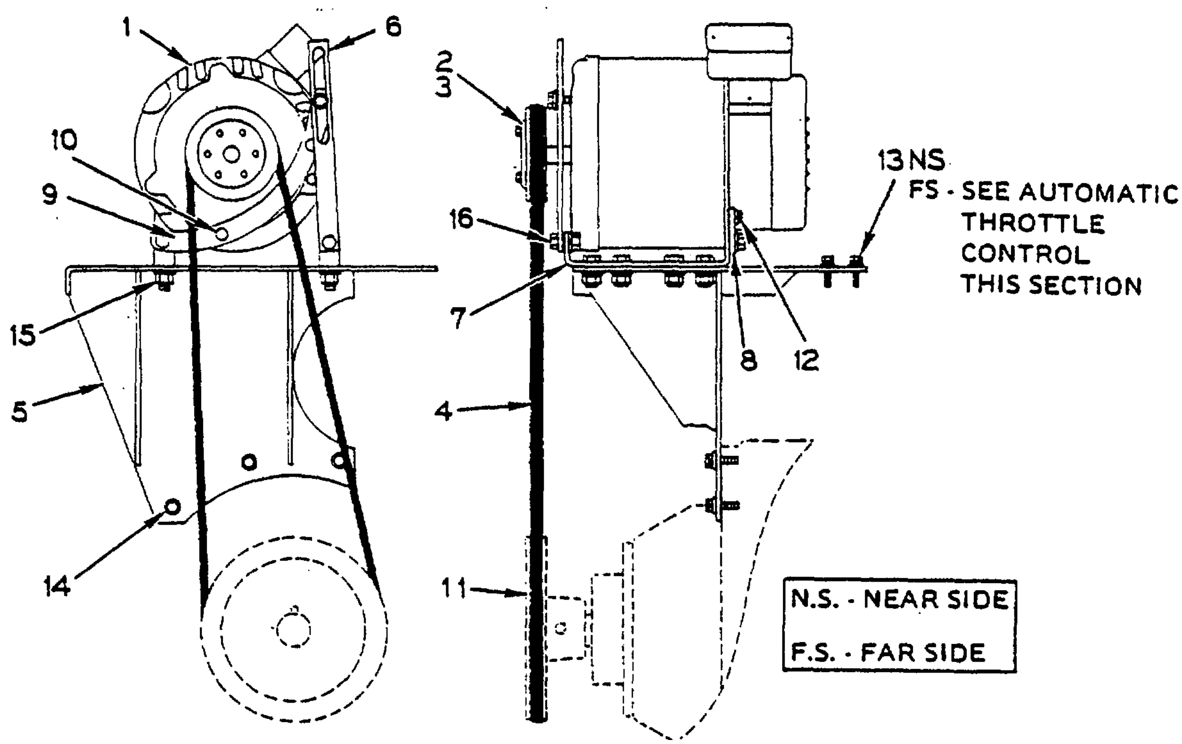
ALTERNATOR AND DRIVE



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5204-400-87	Alternator, Motorola	1
1A	46150-506-07	Diode, Isolation	2
1B	46150-506-08	**Diode, Positive	3
1C	46150-506-09	*Diode, Negative	3
2	46150-508-02	Sheave, Alternator	1
3	5032-308-02	Bracket, Mounting	1
4	7010-013	Capscrew, 3/8" x 1" NC	3
5	7014-018	Washer, 3/8" Flat	3
6	7014-003	Lockwasher, 3/8"	3
7	7010-264	Capscrew, ½" x 8" NC	1
8	40540-005-08	Pipe, ½" x 5½"	1
9	7014-005	Lockwasher, ½"	1
10	7012-027	Nut, ½" Hex	1
11	7441-041	V-Belt (Matched Set)	2
12	9704-402-56	Harness - See Base Electric Parts - Section 8	

*NOTE: Negative Diode (Black Stamped Part Number).
**NOTE: Positive Diode (Red Stamped Part Number).

GENERATOR AND DRIVE



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	46150-001-75	Generator - See Winpower Manual - This Section	1
2	01B04-002-03	Sheave	1
3	7401-018	Bushing	1
4	7118-031	Belt	1
5	9704-300-41	Support, Mounting	1
6	5036GE29	Bracket, Adjusting	1
7	5032-301-15	Clip, Generator Mounting	3
8	5032-301-21	Bracket, Rear	1
9	5032-301-22	Bracket, Front	1
10	7389-024	Capscrew, 3/8" x 1" Socket Flat Head NC	2
	7007-140	Washer, 3/8" Shakeproof	2
11		See Coupling and Sheave - This Section	
12	7010-087	Capscrew, 3/8" x 5/8" NC	4
	7014-001	Lockwasher, ¼"	4
	7010-013	Capscrew, 3/8" x 1" NC	2
13	7014-003	Lockwasher, 3/8"	2
	7014-018	Washer, 3/8" Flat	2
	7383-040	Capscrew, Grade 5, 3/8" x 1½" N C	3
14	7014-003	Lockwasher, 3/8"	3
	7014-018	Washer, 3/8" Flat	3
	7010-014	Capscrew, 3/8" x 1¼" NC	6
15	7012-025	Nut, 3/8" Hex NC	6
	7014-003	Lockwasher, 3/8"	6
	7014-018	Washer, 3/8" Flat	6
	7010-021	Capscrew, ½" x 1¼" NC	3
16	7012-027	Nut, ½" Hex NC	3
	7014-005	Lockwasher, ½"	3

OPERATING AND MAINTENANCE
INSTRUCTIONS

Model No.
FM3V2-B/3

INSTRUCTION MANUAL

INTRODUCTION

The information in this manual covers revolving field type alternators using static excitation. This type of excitation will be discussed in detail in later paragraphs of this manual. The information contained should be studied carefully and the instruction book kept at hand for ready reference. Read very carefully the paragraphs on proper use and maintenance.

The equipment described is the result of careful engineering design and manufacturing techniques. It has been thoroughly inspected and tested before shipment. Carefully inspect on delivery for evidence of shipping damage. If damage has occurred it should be noted on the freight bill in order that acclaim can be filed to recover the cost of the damage. If the damage appears to be of a major nature, the fault should be corrected before using.

If you wish to contact your dealer or the factory, make sure you mention the model and serial number as listed on the nameplate on the side of the alternator.

Winpower alternators are designed to deliver voltage and current identical to that of a normal power line. Equipment that can be operated on normal power can also be operated by the alternator, provided the capacity of the alternator is not exceeded. It should be remembered that the power line, for all practical purposes, is backed by an unlimited generator.

Promptly fill in and return the guarantee card enclosed in the front of the manual.

ALTERNATOR

The alternator is a revolving field type, using a static system for excitation and control of the voltage regulation. The section below describes the static excitation. The rotor in a two pole machine must revolve at 3600 RPM for 60 hertz current and at 3000 RPM for 50 hertz. Frequency varies in direct relation to the speed of rotation. The governor of the driving engine or tractor will therefore determine the variation in frequency. An unstable governor or
one that droops in speed excessively under load will result in excessive frequency variation. A droop at 5% in speed will result in a frequency variation of 3 hertz. This variation is of little consequence for most equipment to be powered. The driving engine should have sufficient power to maintain speed under load. The best of governors cannot control an overloaded engine.

WHAT IS STATIC EXCITATION?

The word "static" means without motion; thus, the term "static excited" means that the control system which provides the current for the electro-magnetic field is provided without the use of an out-moded revolving DC armature. Commutators and commutator brushes with the inherent problem of sparking and maintenance are eliminated. The use of a mechanical voltage regulator with vibrating or multiple moving contacts is also eliminated.

Direct current is required for the electro-magnetic field. A single coil is wound in the alternator stator (the stationary winding) to provide the current for the base field. This coil is entirely separate from the main winding and is at right angles in mechanical position. The AC voltage generated in this coil is fed to a full wave silicon diode bridge to provide rectified direct current for the base field. As the field is the rotating component, the current connection is accomplished by the use of slip rings and brushes. The base field is connected to ring #1 (nearest to the bearing) and ring #3. The base field is designed to provide magnetic lines of force required to generate rated voltage with no load on the alternator.

In order to maintain close voltage regulation as the load is varied, a control field is used. The control circuit consists of an additional full wave bridge, in series with one load line, and a control winding on the field poles. The control field is connected to ring #1 and ring #2. When a load is connected to the alternator, this current is rectified and fed through the control field winding. By this means, the total strength of the field is varied in relation to the load.

The description of static excitation opened with the statement that "static" is-defined as without motion. In later paragraphs the revolving field has been discussed. To avoid confusion, a word of explanation is in order. There must be some relative motion between the coils which generate voltage and the magnetic field which causes the voltage to be produced. In a revolving field generator, the winding that produces the voltage is stationary and the field poles revolve. The reverse is true in the case of a revolving armature generator; the field is stationary and the voltage producing winding rotates.

LOAD CONNECTION

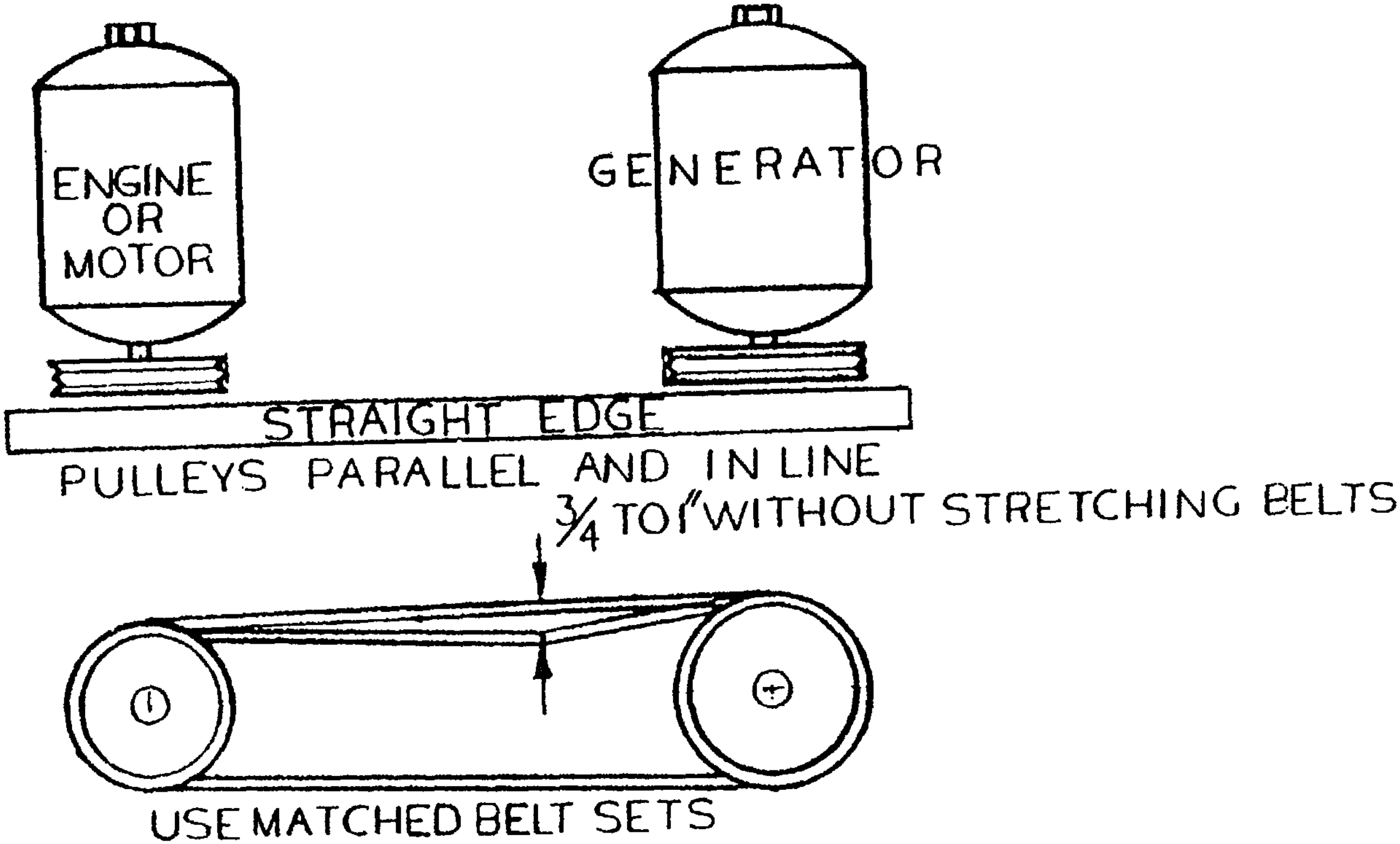
Standard connection for 2000 watt, single voltage alternators use duplex grounding type receptacles. Special applications, to be used as part of other equipment, may provide a plate to accept conduit fittings. Short leads are brought out for connection.

Larger capacity machines are provided with an outlet box enclosing a terminal strip for connection. Optional panels are available for capacities above 2000 watts. These are designed to be installed in the field. A voltage indicator, a circuit breaker, 15 ampere duplex receptacle and a 50 ampere receptacle are included in the special panels. The voltage indicator uses a color band of red and green in place of a numbered scale. Voltage and frequency are correct in the green portion of the color band.

MAINTENANCE

Little maintenance is required other than routine inspection and cleaning. The bearings are pre-lubricated and will be a long life item unless damage by accident or excessive driving belt tension.

The interior of the alternator should be clean and unobstructed. Slip rings and brushholders should be kept free from dirt, oil and moisture. If compressed air is available it can be used effectively for cleaning.



SHEAVE & BELT ALIGNMENT

LOW OUTPUT VOLTAGE	
POSSIBLE CAUSE	REMEDY
Low Speed	1. Check for overload on the engine. 2. Defective governor. Check governor spring ension, tight or defective throttle lever and joints. 3. Defective engine.
High line loss. Indicated by lower voltage at load than at generator terminals.	Increase size of line wiring. Might also be the result of loose connections which will be indicated by excessive heating at the loose connections.
Shorted or grounded field coil. In some cases one coil only, that is shorted or grounded, will reduce voltage to approximately one half of rating.	See information for testing field circuits.
Defective compound field circuit. Field connected to Rings #1 and *2. Defective control field bridge.	See information for testing field circuits. See information on-testing bridge assemblies.
HIGH OUTPUT VOLTAGE	
Excessive speed	Check governor linkage, spring tension, etc. Governor linkage must be free from dirt & gum.
EXCESSIVE HEATING	
Clogged ventilating inlet and/or outlet.	Clean. Make sure interior is unobstructed.-
Excessive heat from other equipment	Construct baffle or some means to direct heat in another direction.
Overload	Reduce load.
NO OUTPUT VOLTAGE	
Poor Brush Contact: Brushes tight in holder.	Clean Brushholder. Brush should move freely in holder.
Weak Brush Spring Tension	Brush spring tension should snap brush into contact with ring when lifted and released.
Film on Collector Rings caused by corrosive or dirty atmosphere.	Clean rings with fine sandpaper during rotation. Caution: Tape sandpaper to stiff cardboard for safety.
Defective Rectifier Bridge (See illustration for method of checking bridge.)	Replace defective bridge assembly. Find assembly number under DIODE ASSEMBLY in parts list.
Openifield circuit (See illustration for method for checking.)	Replace Rotor Assembly.
Grounded or shorted field coil(s) (See illustration for method.)	Replace Rotor Assembly.
Loss of residual magnetism. This is a condition brought about by some unusual condition. It will always occur after disassembly.	See note under field assembly for procedure to restore magnetism.
Defective Stator: Shorted winding. This can be identified by the use of a "growler" at a competent rewinding shop Grounded winding. Check by test lamp from stator winding to frame Open winding circuit. Check all circuits for continuity IE: S_2 to S_1, S_4 to L_1.	Replace the Stator. See illustration for testing method. (Include generator model and serial number on the order.)

Step by Step Check List

1. Check alternator shaft speed. Should be 3600 RPM, 60 hertz at full load.

2. Check voltage output at terminal ends of Lines L1 and L2. If volt-age is correct at this point, make a progressive check from this point through the wiring system.

3. Check brush contact to rings. Brushes and holders should be free from dirt. Brush should snap back when lifted and released. Using caution to prevent scratching the ring or chipping the brush, a thin knife edge can be inserted for lifting the brush.

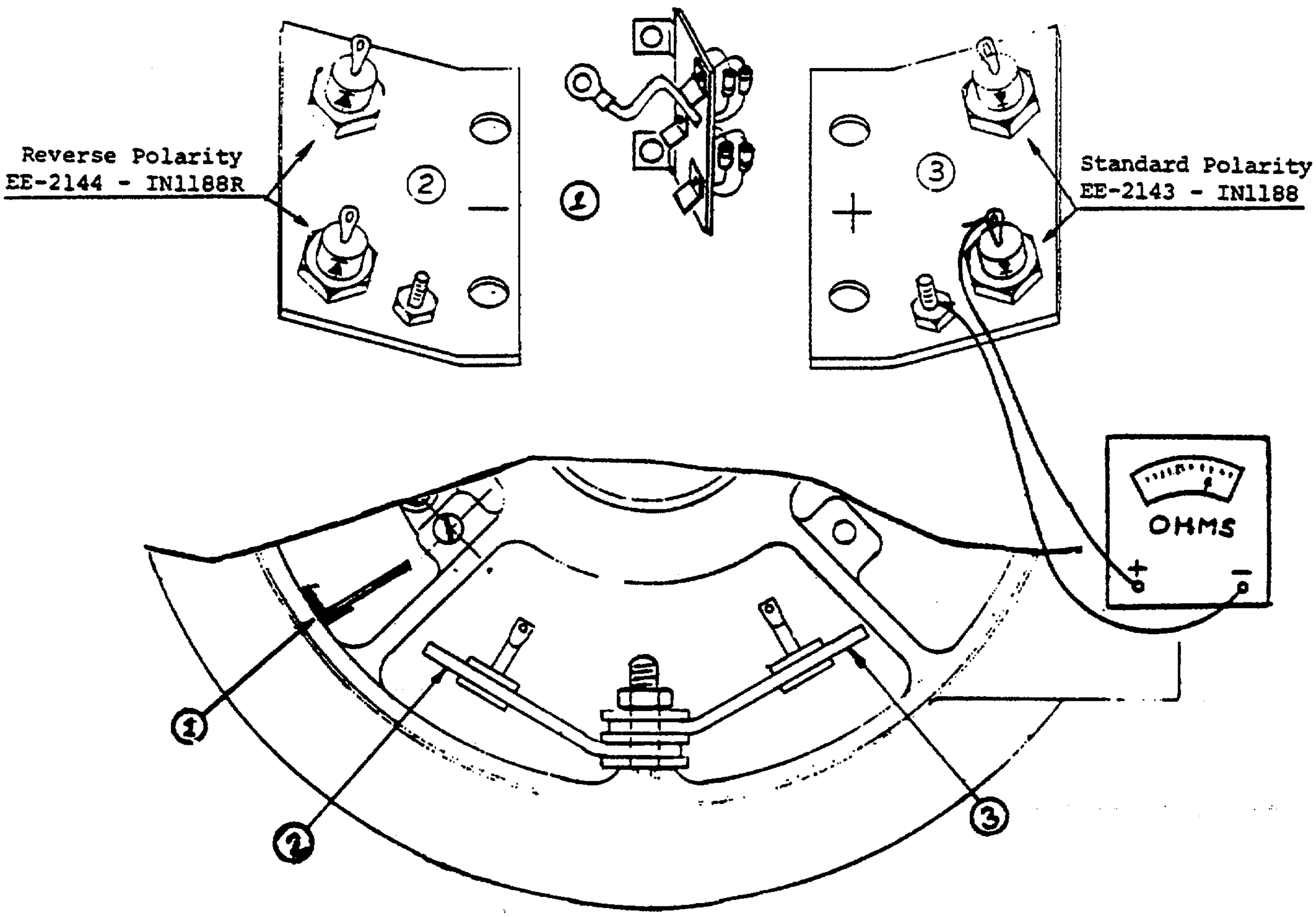
4. Inspect all wiring for loose or broken connection. Look for loose or broken solder joints. If a solder joint needs repairing on a diode, use a hot iron to accomplish repair quickly. Blow on the joint for quick cooling. Diodes can be destroyed by prolonged heat.

5. Check diodes. (See method outlined under Bridge Assemblies). Isolate all brushes from the rings by inserting heavy paper under the brush. Remove one quick disconnect clip from the base field bridge. This will isolate all parallel circuits.

6. Before removing the paper insulation from under brushes, check out the rotor as outlined under Field Assembly. If voltage is correct at no load but drops excessively on load, and correct speed is maintained, suspect the control field or the control field connections.

7. When the voltage at correct speed is very low at no load and approximately 50% of rating on load, the base stator winding may be open. Check for a circuit between the brown leads connected to the base field bridge. Disconnect one lead before making check.

BRIDGE ASSEMBLIES
(TYPICAL)

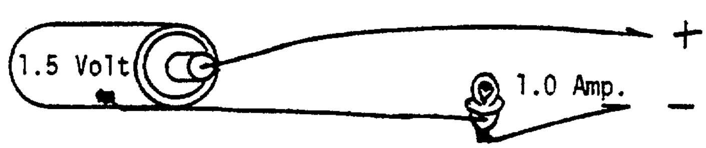


1. Base Field Rectifier Bridge Assembly
2. Negative Control Field Rectifier Bridge Assembly
3. Positive Control Field Rectifier Bridge Assembly

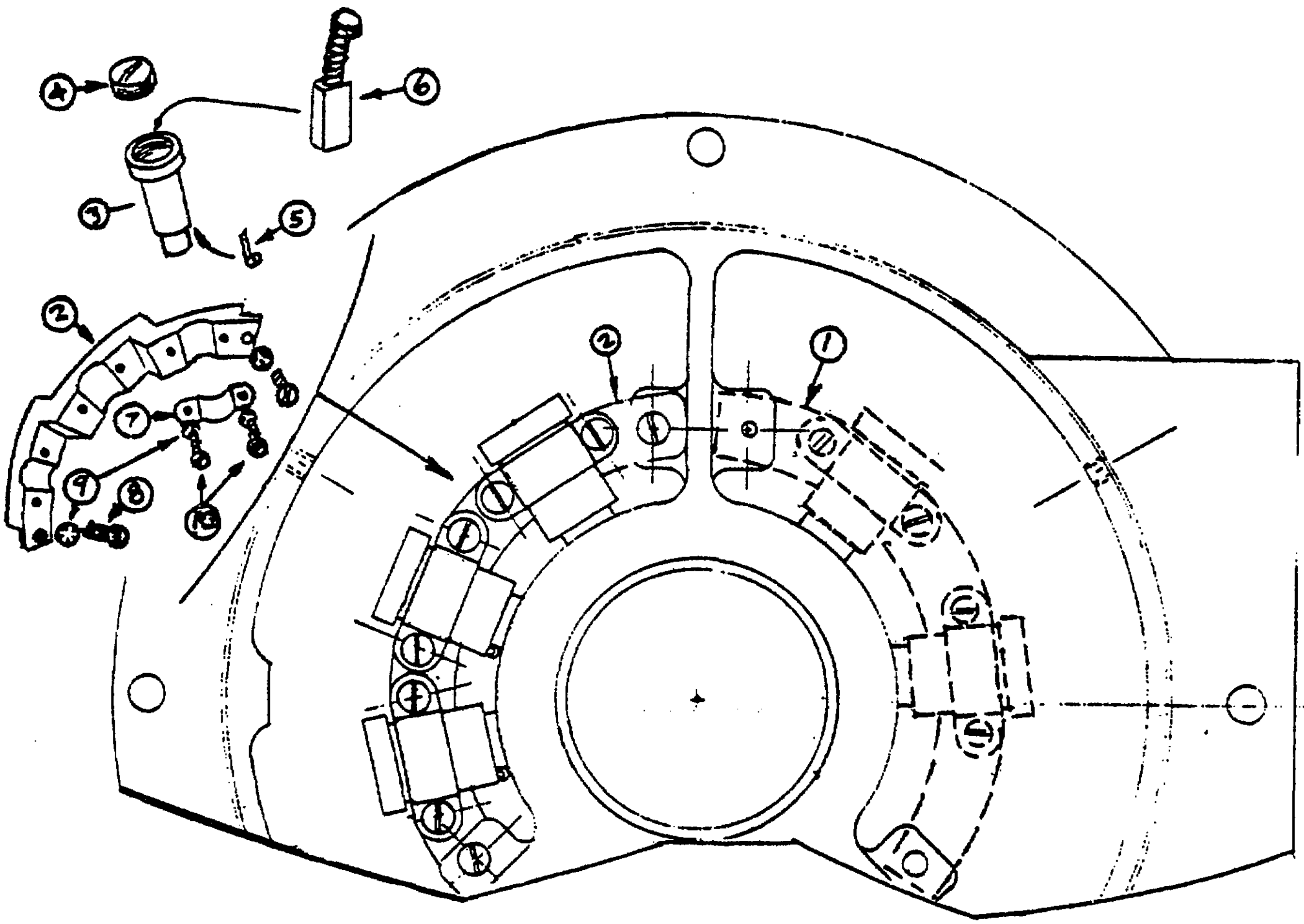
Caution: When replacing diodes a solider connection is required. It is very important that the solder joint is made quickly. Use a hot iron and remove immediately when the solder flows. The diode can be destroyed by prolonged heat. Check the diode with the ohmmeter before installing.

Check for Defective Diode

1. Disconnect all external wiring from both AC and DC circuit. (Carefully mark the point of connection of each wire to assure proper re-connection).
2. A diode that is in good order will conduct current in one direction and block in the opposite. The conducting direction is marked on the case by an arrow and by a color band on the smaller
3. Use an ohmmeter (or a 1.5 volt flash light battery and bulb as illustrated) to check the current direction. Connect positive at the base of the arrow and negative at the end to which the arrow points. (See illustration) A diode that conducts in both directions or neither direction is defective.



Alternate means for testing a diode if an ohmmeter is not available.



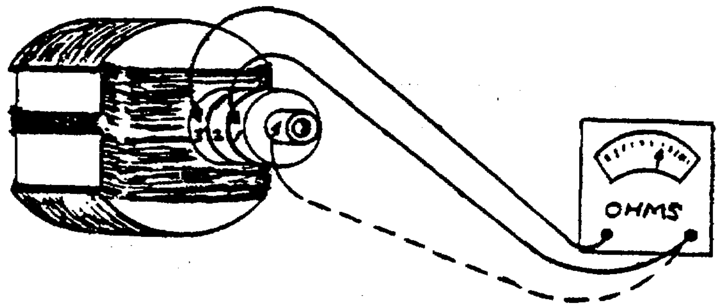
BRUSHHOLDER ASSEMBLY

Models rated at 2000 watts and under use one bracket assembly 2 as shown in solid lines. Models above that rating have two brushes on rings #1 and #2 (numbering from end of shaft) and use added bracket 1 as shown in dotted lines.

Note: When replacing brushes, the most simple method is to disconnect the entire bracket assembly by removing the screw at each end. The bracket can then be tilted forward for easy access to the brushholder caps.

1.	A-745	Brushholder bracket (right)	6.	Y-114	Brush
2.	A-746	Brushholder bracket (left)	7.	S-6096	Clamp
3.	B-701	Brushholder	8.	*2005	Screws
4.	B-791-A	Cap	9.	#1110	Lock Washer
5.	B-701-B	Clip	10.	#2652	Screw - Self tapping

FIELD ASSEMBLY



Resistance of Field Circuits at 25°C -(77°F)

Model	Base Field (Ring #1 to 3)	Control Field (Ring #1 to 2)
FM3V2-B/3	43 to 53 ohms	Less than 1 ohm
FM2V2-B	32 to 42 ohms	Less than 1 ohm
FM4V2-B	43 to 53 ohms	Less than 1 ohm
FM4V2-C	43 to 53 ohms	Less than 1 ohm
FM6V2-C	47 to 57 ohms	Less than 1 ohm

Note: When ordering replacement field assemblies, be sure to include model and serial number from nameplate on alternator frame.

TESTING A FIELD CIRCUIT

Make sure that all brushes are not in contact with the slip rings. If the alternator has not been disassembled, paper inserted between the brush and slip ring will serve as insulation. The complete brushholder bracket can be removed if this procedure is preferred, by removing the screws and nuts at each end of the bracket. The brush gear may use one bracket or two brackets, depending on the capacity of the alternator. When two are used, both must be insulated or disconnected.

To measure the resistance of the base field, touch the ohmmeter leads to ring #1 and #3 as shown in the illustration. Measure from rings #1 and #2 for the control field.

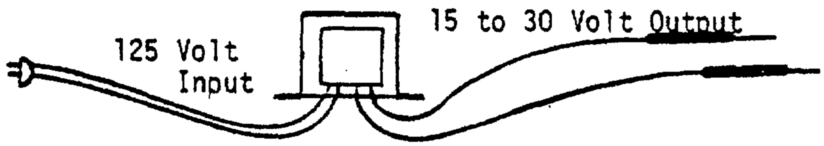
A resistance appreciably lower than shown on the table indicates shorted turns in one or both field coils. The resistance of less than one ohm on the control field is too low to measure accurately with the average ohmmeter. A complete circuit between rings should be indicated. A high resistance would indicate a broken connection.

A grounded field circuit can be identified by connecting the meter from the slip rings to the rotor shaft.

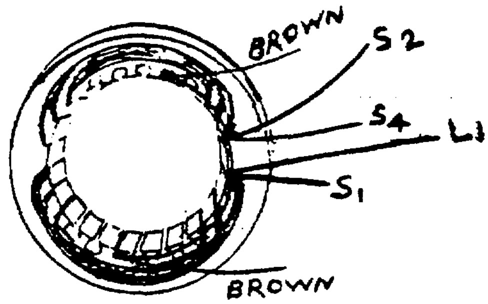
NOTE: Occasionally an alternator will lose residual magnetism. It is very unusual unless the alternator has been disassembled, in which case it will be necessary to "flash the field" on the first start.

(continued)

A step down transformer with a nominal 125 volt primary winding and from 15 to 30 volt secondary can be used for this purpose. The primary should have a cord with a plug for a wall receptacle. The secondary should have extension leads with insulated probes. With the alternator operating, plug into the wall outlet and insert the probes momentarily into the 125 volt convenience outlet. For equipment not furnished with the outlet, touch the probes to the connection of L1 and L2. A momentary contact is all that is required. The transformer assembly can be purchased from the factory at a nominal cost if not available locally.



STATOR ASSEMBLY



Note: When ordering replacement stator assemblies be sure to include the model and serial number from the nameplate on the side of the generator.

The stator assembly has a winding to develop voltage for the base field. The lead extensions from this winding are colored brown. Connection from this winding is to the base bridge.

A single, two pole winding is used for two wire, single voltage models. This winding connects to the control (Series) field bridge. The control bridge is divided into a positive and a negative side and is in series with the load. (See bridge assembly illustration)

Three wire, dual voltage models use two identical, two pole windings. Each winding generates 125 volts. The voltage from either line to neutral is, therefore, 125. From L1 to L: the winding is in series for 250 volt output.

When a fault in the stator is suspected each individual winding should be checked. The resistance of 'the separate windings will be low, less than one ohm, but a complete circuit should be indicated. IE: #S1 to #S2, #S4 to #L1.

The various windings should also be checked for ground. For this purpose connect an ohmmeter from a bare spot on the frame to one lead of each coil. A meter deflection indicates a grounded winding.

When all stator leads are disconnected, there should be no circuit from one winding to any other. If a circuit is indicated, the winding is shorted.

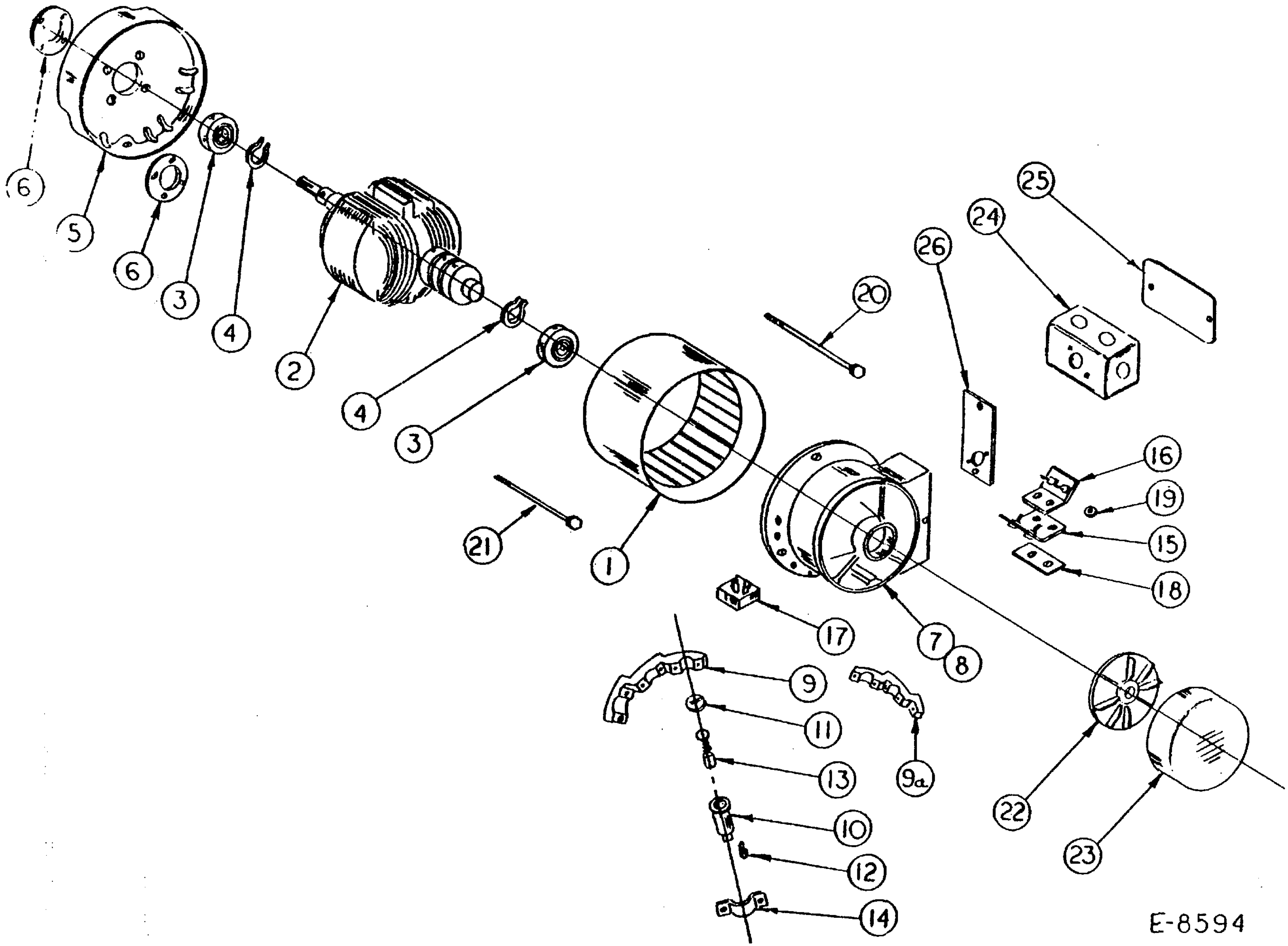
If any of the above conditions are indicated, the stator assembly must be replaced.

PARTS LIST
FM3V2-B/3
(IOWA MFG. CO.)
46150-001-75

FIND NO.	PART NO.	DESCRIPTION	REQ'D/UNIT
1	G-5208-9	Stator Frame Assembly	1
2	G-5285-2	Rotor Assembly	1
3	D-59	Bearing	2
4	11099	Retaining Ring	2
5	A-722-5	Drive End Bell	1
6	S-6242	Bearing Retainer	2
7	G-4799-3	Bearing End Bell Assembly	1
8	A-726-3	End Bell	1
9	A-746	Brushholder Bracket	1
9a	A-745	Brushholder Bracket	1
10	B-701	Brushholder	5
11	B-701-1	Brushholder Cap	5
12	B-701-2	Brushholder Clip	5
13	Y-114	Brush	5
14	S-6096	Clamp	5
15	G-5298-3	Rectifier Assembly (Neg.)	1
16	G-5297-3	Rectifier Assembly (Pos.)	1
17	EE-2171	Rectifier Assembly (Shunt)	1
18	J-545	Board, Insulating	1
19	J-546	Bushing	4
20	4074-2	Screw 1/4-20 x 7-1/2	1
21	4074-4	Screw 1/4-20 x 6-1/2	3
22	A-727	Fan	1
23	V-1059	End Hood	1
24	V-1085	Handy Box	1
25	EE-910	Cover	1
26	S-6982-1	Cover Plage	1

Wiring Diagram E-7374
PARTS DRAWING E-8594

E-8594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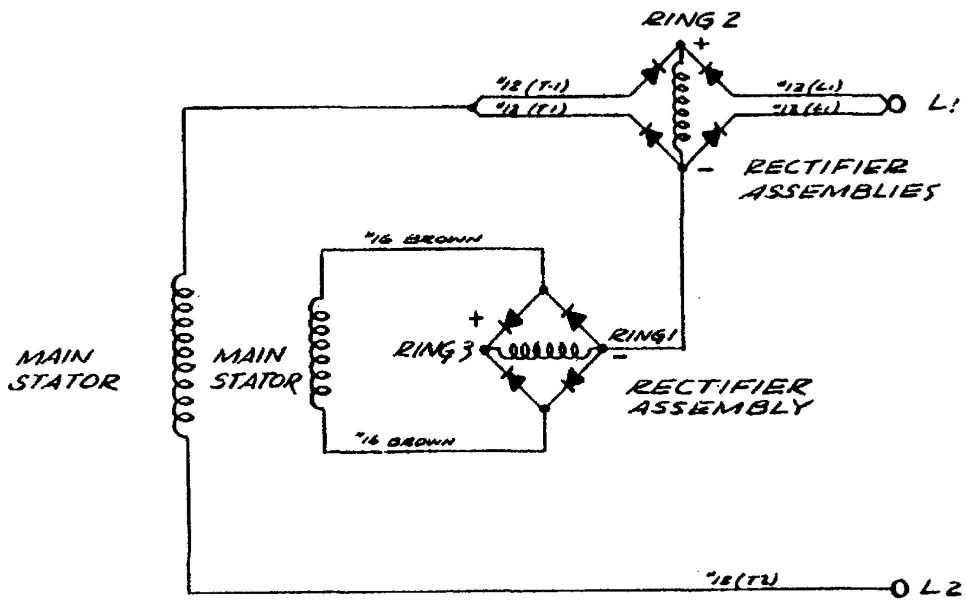


IOWA MANUFACTURING CO

CHANGE	WAS ORIGINALLY	DATE	CHK'D	CHG. REQUEST
E	DELETE CAPACITOR	10-5-71	T.G	
L	[illegible]	7-29-71	T.G.	

TOLERANCE ON DIMENSIONS NOT OTHERWISE SPECIFIED: DECIMAL ±, FRACTIONAL ±, ANGULAR ±

REMOVE ALL BURRS BREAK ALL SHARP MACHINED EDGES

NO. REQ'D.

MICROFILM DATA

MATERIAL

WIRING DIAGRAM

SCALE ~

DATE 7-29-71

DWN T.C.G.

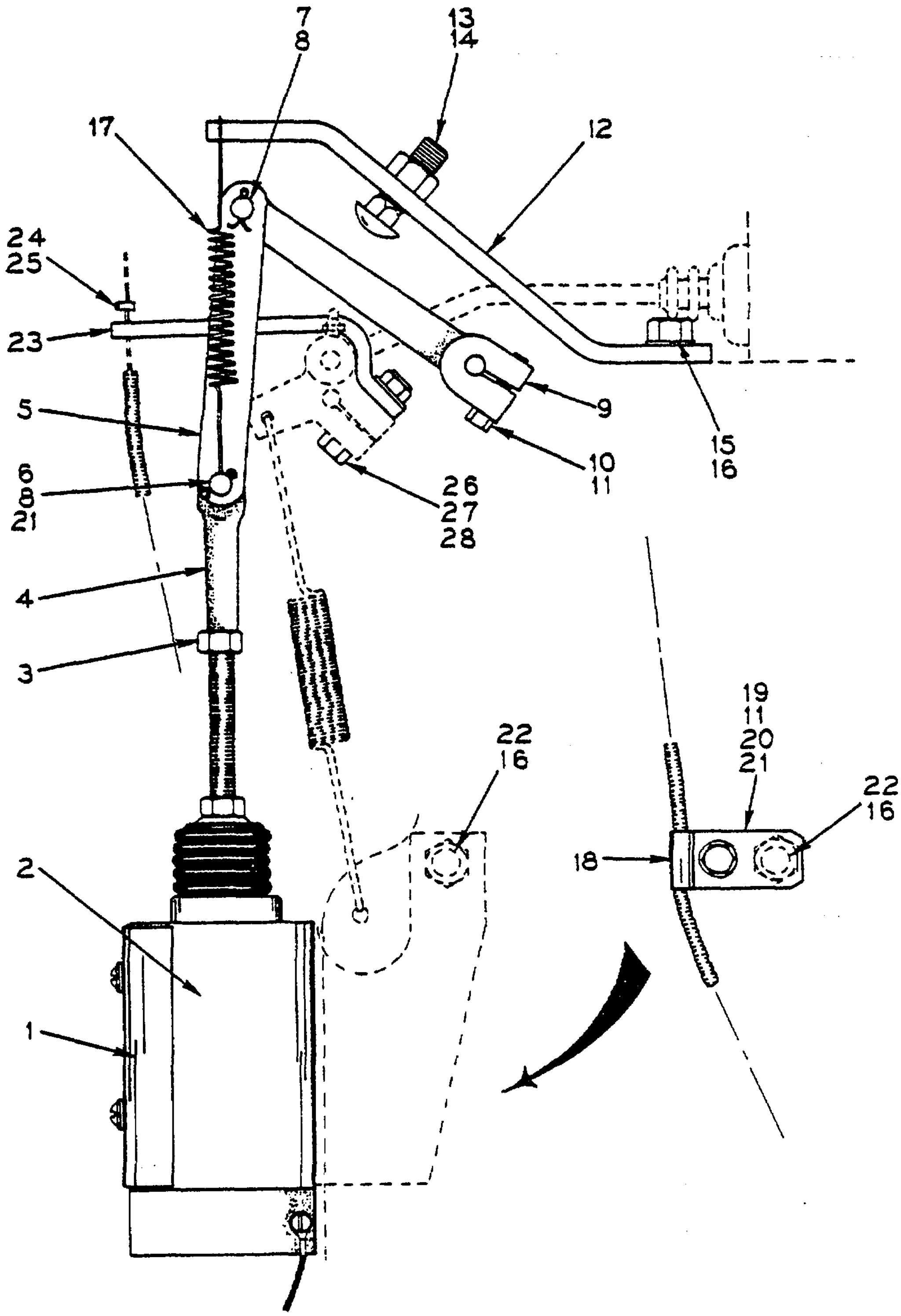
MODEL NO.

PART NO. 3-1355

CHK'D

WINPOWER MFG. CO.
NEWTON, IOWA

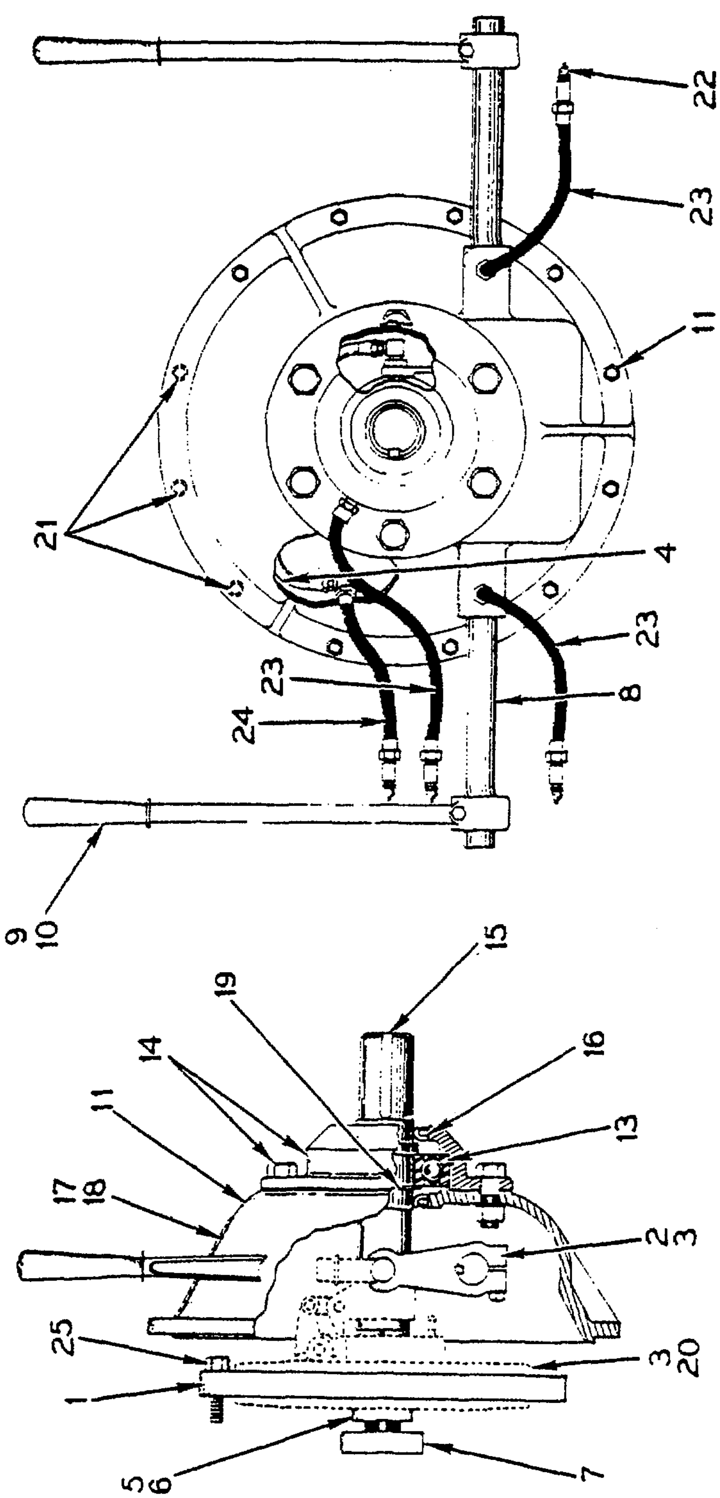
AUTOMATIC THROTTLE CONTROL



AUTOMATIC THROTTLE CONTROL

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5036XG21	Bracket, Solenoid	1
	7436-093	Screw, #10-32 x 3/8"	4
	7439-003	Lockwasher, #10	4
	7014-043	Washer, 3/16" Flat	1
2	46205-001-12	Solenoid	1
3	7012-046	Nut, 5/16" NF	1
4	9704-300-85	Coupler, Threaded	1
5	5036XG23	Link, Throttle	1
6	5036XG24	Pin, Lower Link	1
7	5036XG25	Pin, Upper Link	1
8	7011-001	Pin, Cotter 3/32" x 1"	2
9	5036XG26	Lever, Throttle	1
10	7025-001	Capscrew, ¼" x 3/4" Nylok Socket Head	1
11	7014-001	Lockwasher, ¼"	2
12	5036XG27	Bracket, Idler Stop	1
13	7072-054	Bolt, Carriage 3/8" x 1½" NC	1
14	7012-025	Nut, 3/8" Hex NC	1
15	7010-014	Capscrew, 3/8" x 1¼" NC	2
16	7014-003	Lockwasher, 3/8"	4
17	45870-001-19	Spring	1
18	5036XG01-08	Clamp, Bowden Wire	1
19	7010-087	Capscrew, ¼" x 5/8" NC	1
20	7012-023	Nut, ¼" NC	1
21	7014-017	Washer, 5/16" Flat	3
22	7010-015	Capscrew, 3/8" x 1½" NC	2
23	5036XG01-10	Lever, Fuel Stop	1
24	5036XD12	Collar Set	1
25	7435-071	Screw, #8-32 x ¼"	1
26	7026-003	Capscrew, 1/4" x 1¼" Socket Head NF	1
27	7012-045	Nut, ¼" NF	1
28	7438-007	Washer, ¼" Shakeproof	1

POWER TAKE-OFF
DIESEL ENGINE

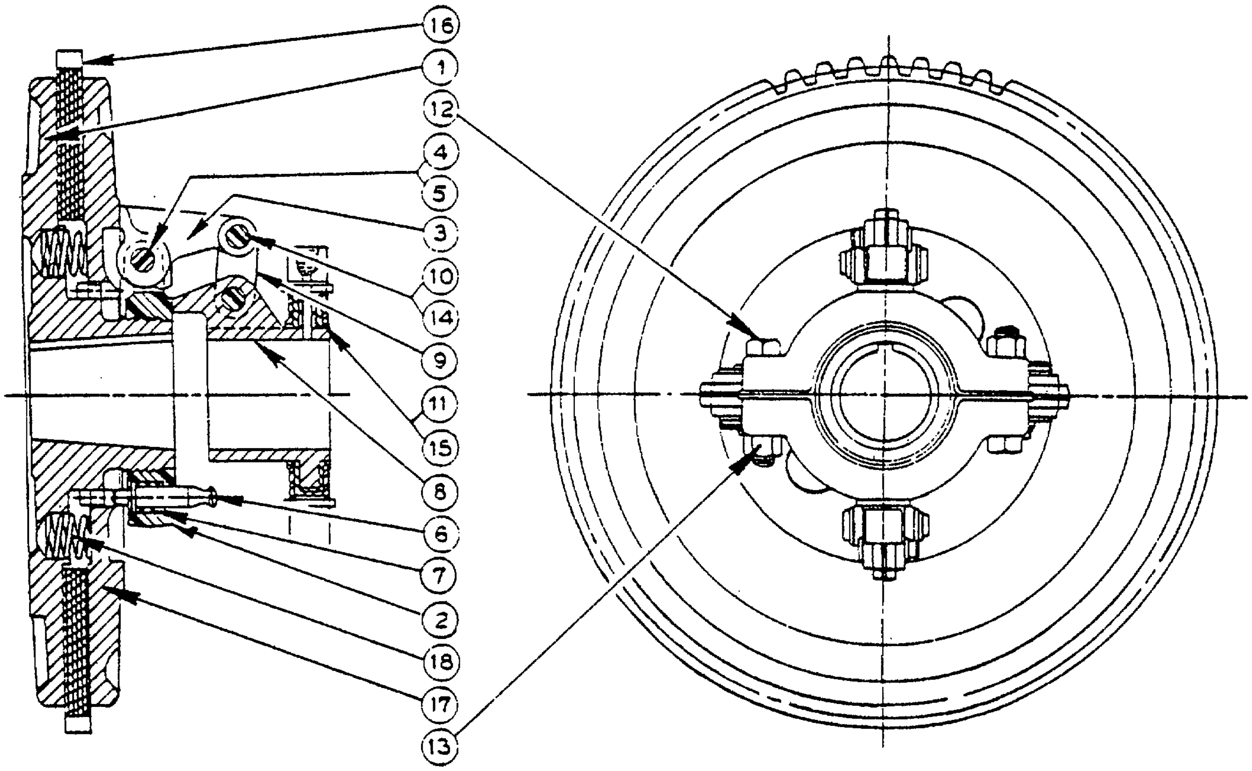


POWER TAKE-OFF
DIESEL ENGINE

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	45550-019-06	Ring, Driving	1
2	45550-002-17	Yoke, Throw-Out	1
3	40800-002	Key, ¼" Square x 2"	3
4	45550-024-01	Line, Lube	1
	7017-051	Nut, 5/8" Jam NF	1
5	7033-008	Lockwasher	1
6	7030-008	Locknut	1
7	7166-005	Bearing	1
8	5036GD23	Shaft, Clutch	1
9	5036GF61	Handle, Clutch	2
10	40800-001-04	Key, 1/4" Square x 1¼"	2
	5010W02A	Housing, Bell	1
11	7383-038	Capscrew, Grade 5, 3/8" x 1" NC	9
	7014-003	Lockwasher, 3/8"	9
13	45134-001-14	Bearing	1
	5010W05-01	Cover	1
14	7010-033	Capscrew, 5/8" x 1-3/4" NC	6
	7012-029	Nut, 5/8" Hex NC	6
	7014-007	Lockwasher, 5/8"	6
15	5010W07	Shaft	1
16	45200-021	Seal, Oil	2
17	5010W08	Gasket, Plate Adjusting	1
	4418-091	Plate, Clutch Adjusting	1
18	7010-077	Capscrew, ¼" x ½" NC	2
	7014-001	Lockwesher, ¼"	2
19	7253-048	Ring, Snap	1
20	45550-110-02	Clutch, Twin Disc - Model C-110 - See Form # 14963 - This Section	1
21		See Generator and Drive - This Section	
22	7051-001	Fitting, Grease 1/8" Straight	4
23	5036GMM02	Line, Lube 12"	3
24	5036BMM03	Line, Lube 10"	1
25	7383-263	Lockscrew, Grade 5, 3/8" x 1%" NC	8

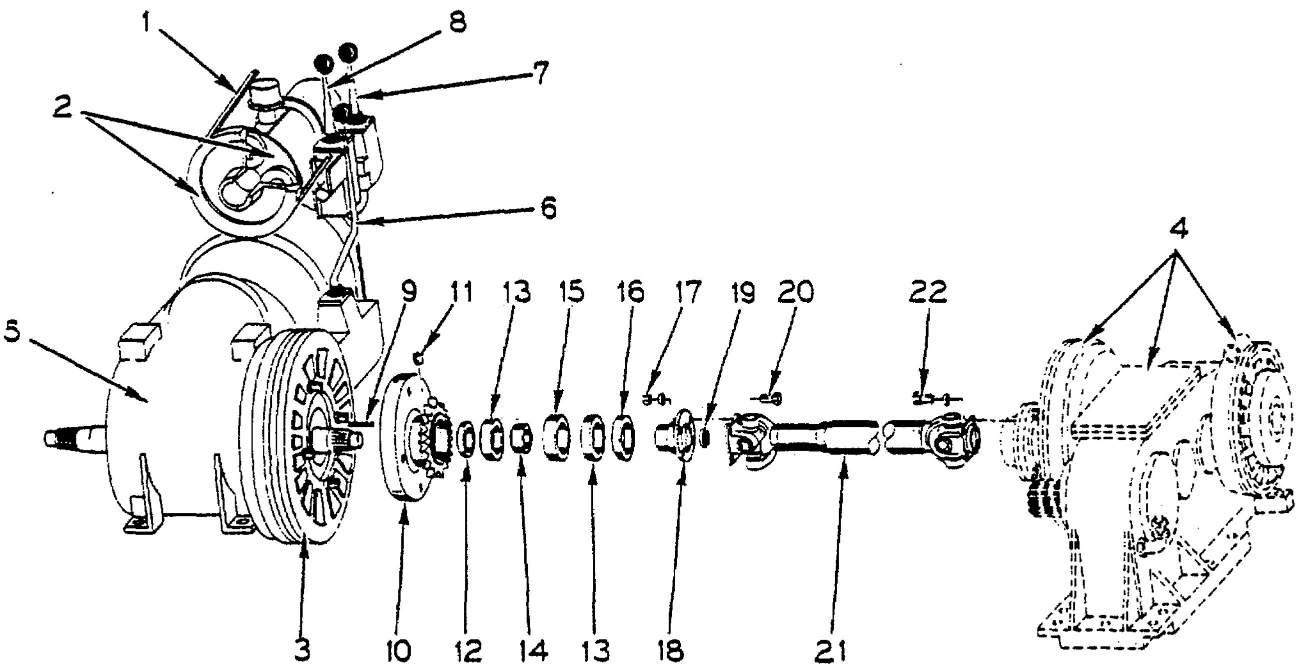
TWIN DISC CLUTCH

MODES C - 110



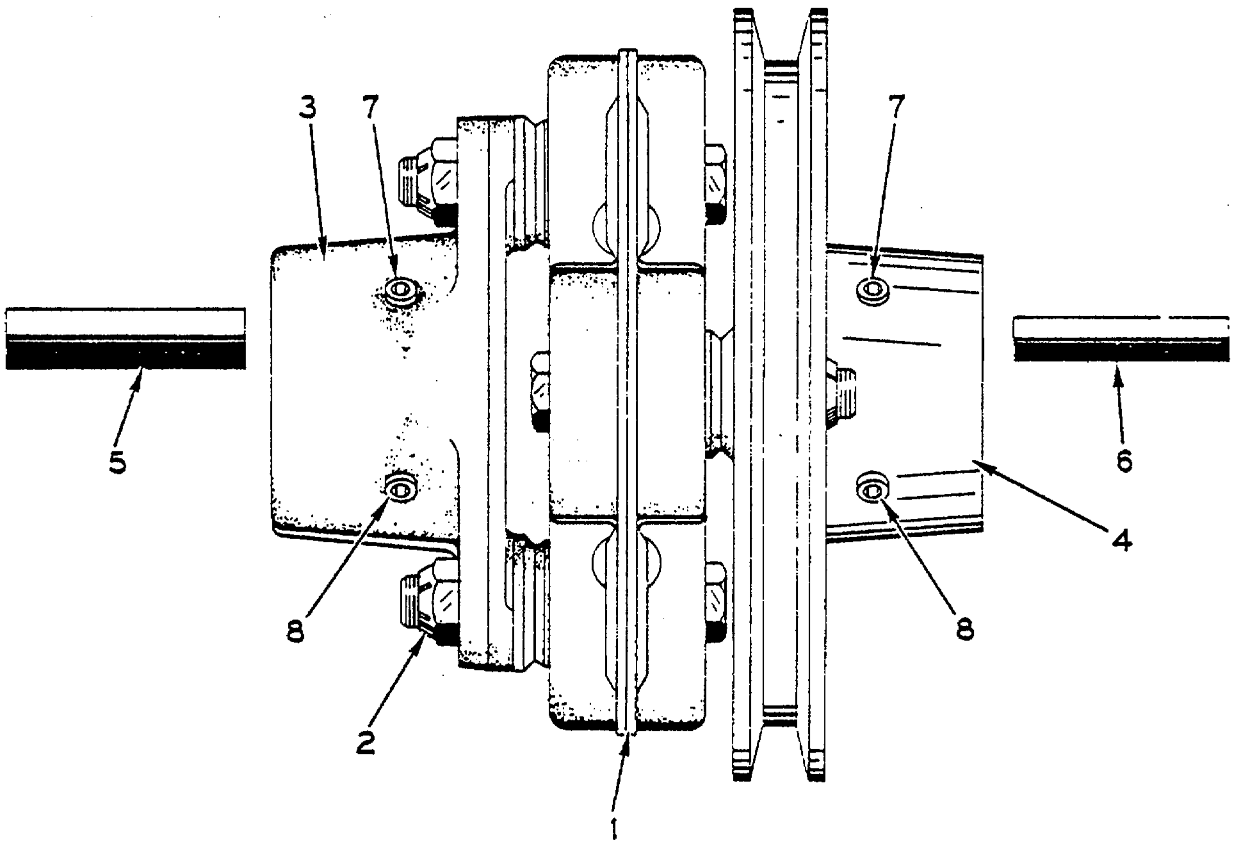
REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
	45550-110-02	Clutch Without Driving Ring - Complete	1
1	45550-004-13	Hub and Back Plate	1
	45550-002-08	Adjusting Yoke Assembly - Complete	1
2	45550-002-18	Adjusting Yoke	1
3	45550-005-02	Finger Lever	4
4	45550-014-37	Lever Pin	4
5	45550-014-36	Cotter Pin	4
6	45550-014-11	Adjusting Lock Pin	1
7	45550-010-16	Adjusting Lock Pin Spring	1
	45550-013-07	Sliding Sleeve Assembly - Complete	1
8	45550-013-15	Sliding Sleeve	1
9	45550-016-01	Lever Link	8
10	45550-014-42	Lever Link Pin	8
11	45550-013-31	Cone Collar	1
12	45550-007-08	Bolt	2
13	45550-020-03	Nut	2
14	45550-014-44	Cotter Pin	8
15	45550-018-02	Washer (Collar)	4
16	45550-022-10	Driving Plate (3 Segments Each)	1
17	45550-008-06	Floating Plate	1
18	45550-010-06	Release Spring	6

24 SPEED TRANSMISSION, CLUTCH & DRIVE SHAFT



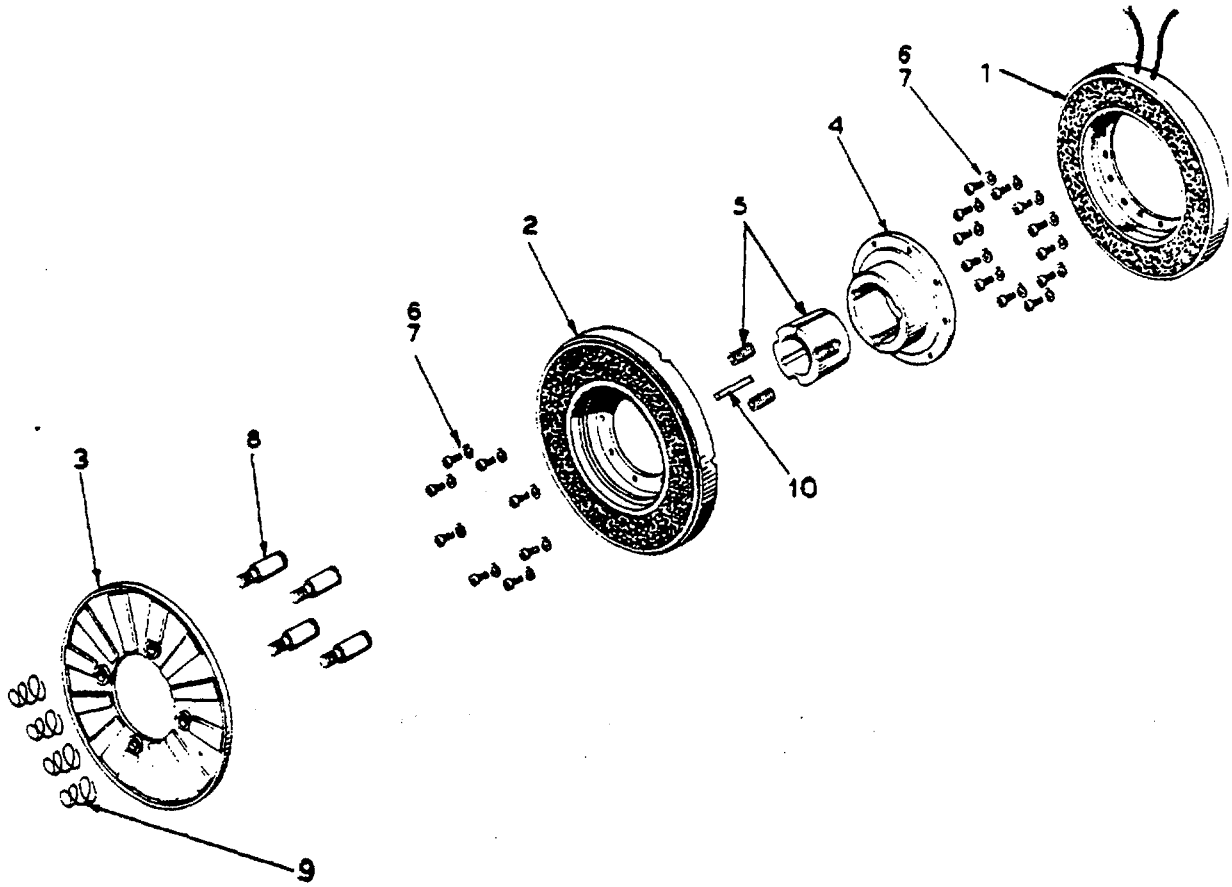
REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1		See Generator and Drive - This Section	
2		See Coupling and Sheave - This Section	
3		See Electric Clutch - This Section	
4		See Clutch Transfer Case and Brakes - This Section	
5		See 24 Speed Transmission - This Section	
6		See Six Speed Shifter - This Section	
7		See Range Shift - This Section.	
8		See Forward and Reverse Shift - This Section	
9	7264-037	Key	2
10	4430-006-01-01	Flange	2
11	7131-076	Setscrew, 3/8" x 1½" NC	4
12	45200-027	Seal, Oil	2
13	7166-011	Bearing	4
14	5036DD19	Spacer	2
15	5036DF06	Spacer	2
16	45200-033	Seal, Oil	2
17	{ 7012-047	Nut, 5/8" NF	8
	7014-003	Lockwasher, 3/8"	8
18	5036DF02	Coupling	2
19	5036DD32	Washer	2
20	7009-007	Capscrew, 3/8" x 11/4" NF	8
21	5036DF03	See Spicer Universal Joint - This Section	2
22	{ 7009-005	Capscrew, 3/8" x 3/4" NF	8
	7014-003	Lockwasher, 3/8"	8

COUPLING AND SHEAVE



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	45476-001-02	*Coupling - Complete With Bolts	1
2	45476-502-04	*Bolt Set (Only)	4
3	4431-038-01	Flange	1
4	4430-008-01	Sheave	1
5	40803-002-12	Key, 1/2" x 1/2" x 2-3/4"	1
6	40802-002-08	Key, 3/8" x 3/8" x 2 1/2)"'	1
7	7131-074	Setscrew, 3/8" x 3/8" NC	2
8	7131-077	Setscrew, 3/8" x 5/8" NC	2

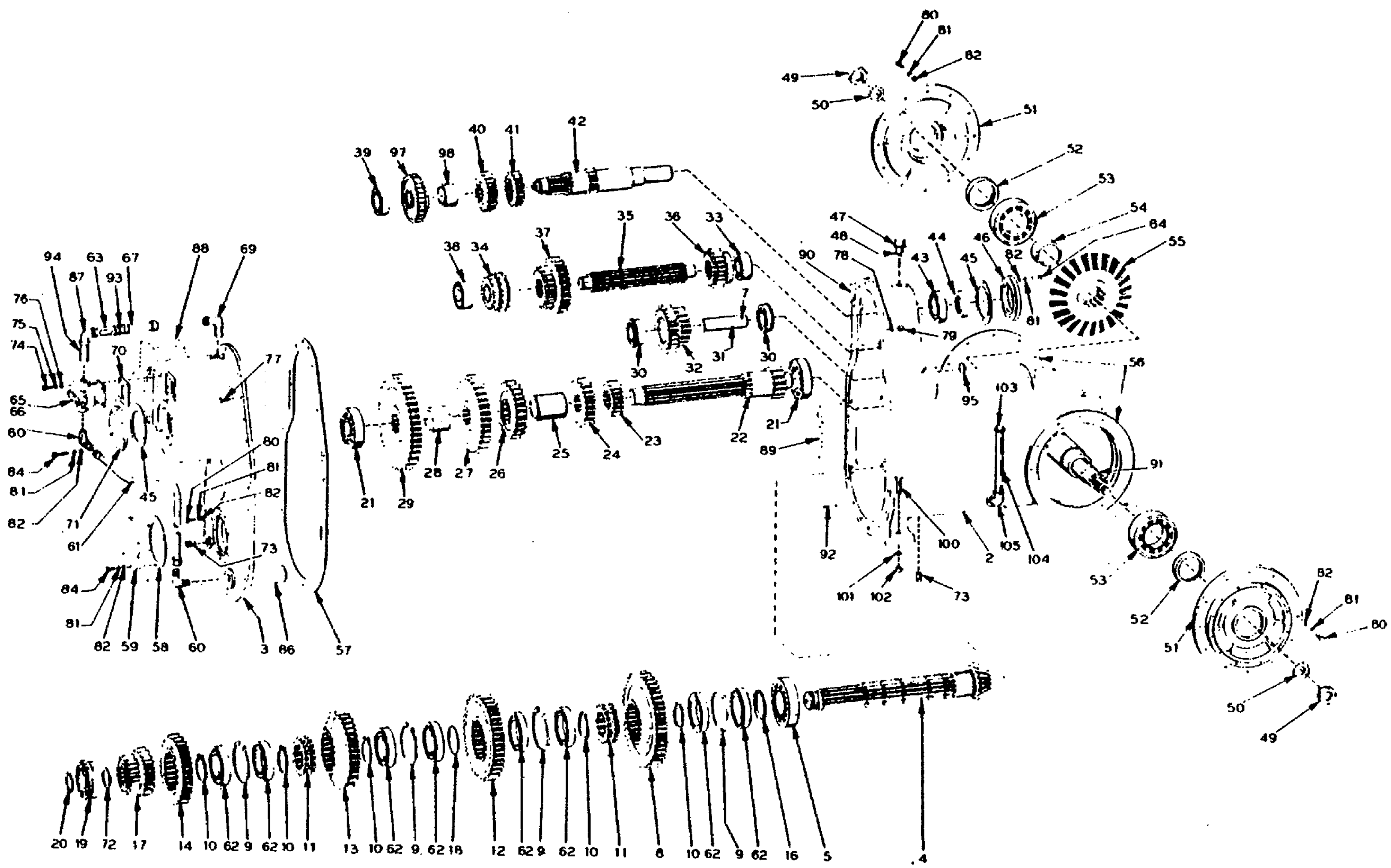
ELECTRIC CLUTCH - 12 VOLT



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	45003-504-02	Field Assembly, Inside Mounted 12 Volt	1
2	45551-263-01	Rotor	1
3	45552-258-01	Armature	1
4	45003-501-01	Hub, Rotor	1
5	7341-009	Bushing, Taperlock 2" Bore	1
6	7010-006	Capscrew, 5/16" x 3/4"	20
7	7014-002	Lockwasher, 5/16"	20
8	50360G02	Pin, Clutch Drive	4
9	45003-502-02	Spring, Follow Up	4
10	7264-037	Key, 1/2" x 1/2" x 2" Round End	1

NOTE: Quantities shown are for one clutch assembly only.

24 SPEED TRANSMISSION



24 SPEED TRANSMISSION

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	45775-009-03	Transmission - Complete	1
2	45775-255-03	Main Housing	1
3	45775-256-23	Housing Cover	1
4	45775-257-17	Bevel Pinion	1
5	45134-001-24	Ball Bearing	1
7	45775-262-46	Lockscrew, Idler Shaft	1
8	45775-251-22	Driven Gear, 1st	1
9	7252-068	Snap Ring	4
10	7253-059	Snap Ring	5
11	45775-266-02	Sliding Clutch	2
12	45775-251-23	Driven Gear, 2nd	1
13	45775-251-24	Driven Gear, 3rd	1
14	45775-251-25	Driven Gear, 4th	1
16	45775-262-04	Washer	1
17	45775-251-10	Sliding Gear, 5th and 6th	1
18	45775-267-01	Bearing Shim, #13 Standard	1
19	45134-001-26	Ball Bearing, Snap Ring Type	1
20	45775-261-02	Snap Ring, #10 Standard	1
21	45134-001-14	Ball Bearing	2
22	45775-257-06	Pinion and Shaft	1
23	45775-251-11	Drive Pinion, 2nd	1
24	45775-251-12	Drive Pinion, 3rd	1
25	45775-258-02	Spacer, 2-1/4" ID x 2-3/4" OD x 3-3/8"	1
26	45775-251-13	Drive Gear, 4th	1
27	45775-251-14	Drive Gear, 5th	1
28	45775-258-03	Spacer, 2-1/4" ID x 2-3/4" OD x 2-1/8"	1
29	45775-251-15	Drive Gear, 6th	1
30	45134-001-27	Ball Bearing, Snap Ring Type	2
31	45775-257-07	Idler Shaft	1
32	45775-268-01	Reverse Idler	1
33	45134-001-25	Ball Bearing	1
34	45775-251-47	Sliding Gear, High	1
35	45775-257-36	Countershaft	1
36	45775-251-17	Sliding Gear, Forward & Reverse	1
37	45775-251-18	Sliding Gear, Low & Intermediate	1
38	45134-001-21	Ball Bearing	1
39	7166-011	Ball Bearing	1
40	45775-251-19	Drive Gear, High	1
41	45775-251-20	Drive Gear, Intermediate	1
42	45775-257-35	Input, Shaft	1
43	45134-001-20	Ball Bearing	1
44	45200-021	Oil Seal, National	1
45	45775-259-04	Gasket	2
46	45775-260-02	Bearing, Retainer	1
47	45775-280-01	Breather	1
48	45775-281-01	Breather Extension	1
49	7030-006	Locknut, Ball Bearing	2
50	7033-006	Lockwasher, Ball Bearing	1
51	45775-256-10	Mounting Cover	2

- Continued -

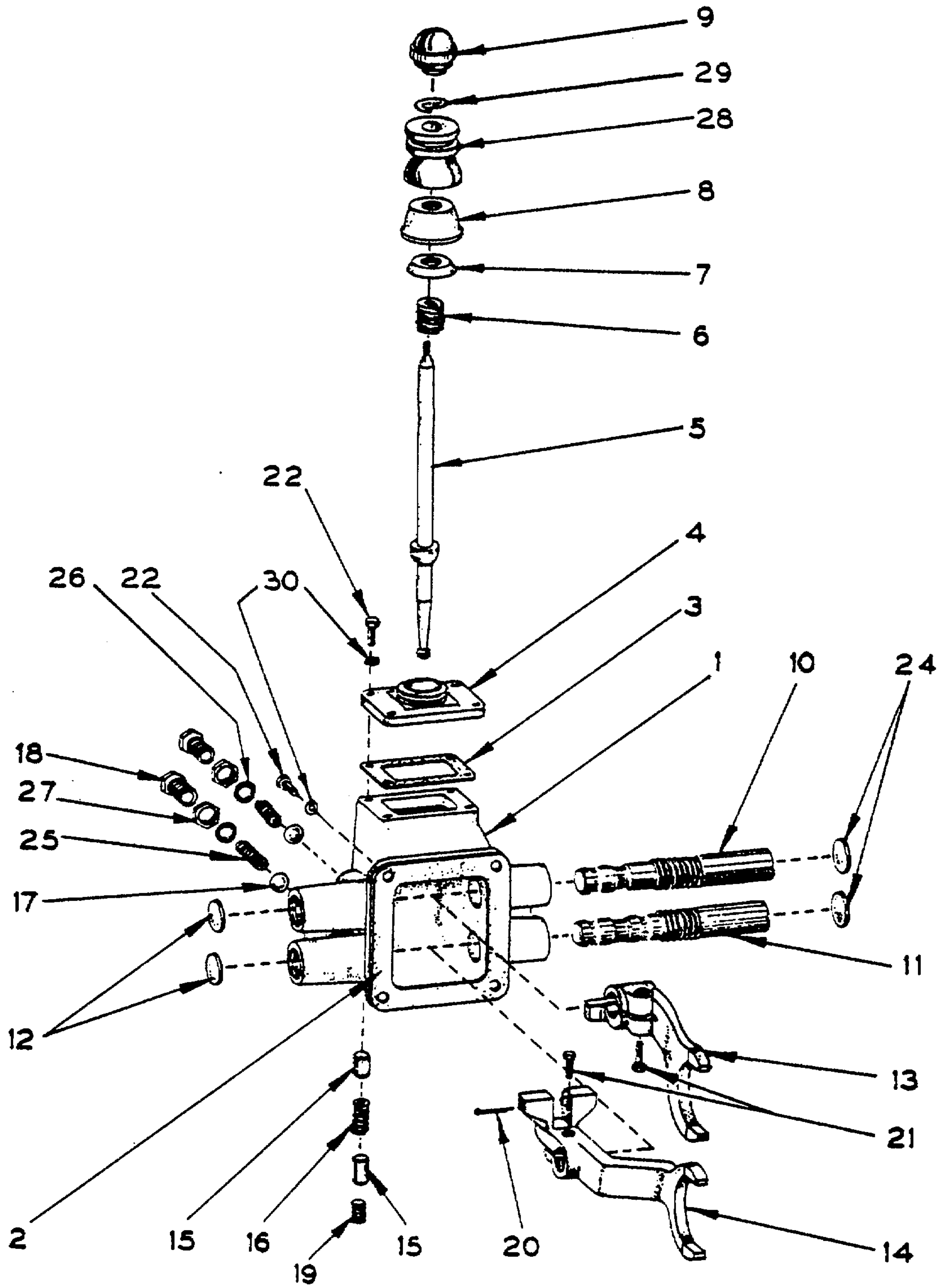
24 SPEED TRANSMISSION - Continued

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
52	45200-183	Oil Seal, National	2
	45130-002-06	Cup, Bearing	2
53	45130-001-09	Cone, Bearing	2
54	45775-258-04	Spacer, 2-3/8" ID x 3" OD x 1-5/8"	1
55	45775-251-21	Bevel Gear	1
56	45775-259-30	Gasket Kit	Kit
57	45775-259-07	Gasket, Main Housing	1
58	45775-259-08	Gasket	1
59	45775-256-07	Bearing Cover	1
60	45775-305-02	Elbow, Male	2
61	45775-295-02	Tubing, 1/2"	As Req.
62	7166-015	Ball Bearing	8
63	45775-302-01	Gauge, Sight	1
65	45775-253-03	Oil Pump With Coupling	1
66	45775-254-04	Coupling, Pump Only	1
67	45775-295-04	Lube Line, 3/8" OD	1
69	45775-264-04	Fitting, Lube Spray	1
70	45775-259-09	Gasket, Oil Pump	l
71	45775-256-11	Bearing Cover	1
72	45775-267-04	Shim Kit - Bevel Bearing	1 Kit
73	7027-003	Plug,'3/4" Pipe Magnetic	1
74	45775-262-48	Capscrew, '5/16" x 7/8" Hex Head NC	4
75	7007-024	Lockwasher, 5/16" Internal Teeth	4
76	7100-007	Washer, 5/16" Brass	4
77	7009-008	Capscrew, 3/8" x 1-1/2" Hex Head NF	6
78	7014-003	Lockwasher, 3/8"	16
79	7012-047	Nut, 3/8" Hex NF	14
80	7009-006	Capscrew, 3/8" x 1" Hex Head NF	11
81	7007-024	Lockwasher, 5/16" Internal Teeth	4
82	7100-008	Washer, 3/8" Brass	12
84	7009-007	Capscrew, 3/8" x 1-1/4" Hex Head NF	12
86	45775-296-02	Filter, Cartridge	1
87	7061-003	Elbow, 3/8" Street	1
88	45775-255-20	See Range Shift - This Section	
89	45775-255-19	See Six Speed Shifter - This Section	
90	5036DD02-03	See Forward and Reverse - This Section	
91	45775-257-10	Output Shaft	1
92	7028-061	Dowel	2
93	45720-003-18	Connector, Male	1
94	40502-002-08-01	Nipple, 3/8" x 2-1/2"	1
95	45775-276-12	Plug, Expansion	1
97	45775-251-48	Gear, 33T	1
98	45775-258-12	Spacer	1

THE FOLLOWING PARTS ARE NOT INCLUDED WITH COMPLETE 24 SPEED TRANSMISSION

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
100	7010-034	Capscrew, 5/8" x 2" Hex Head NC	4
101	7012-029	Nut, 5/8" Hex NC	4
102	7014-007	Lockwasher, 5/8"	4
103	5036DD53-01	Stick, Dip	1
104	40504-008-08-01	Nipple, 3/4" x 8-1/2" Pipe	1
105	7061-005	Elbow, 3/4" Street	1

RANGE SHIFT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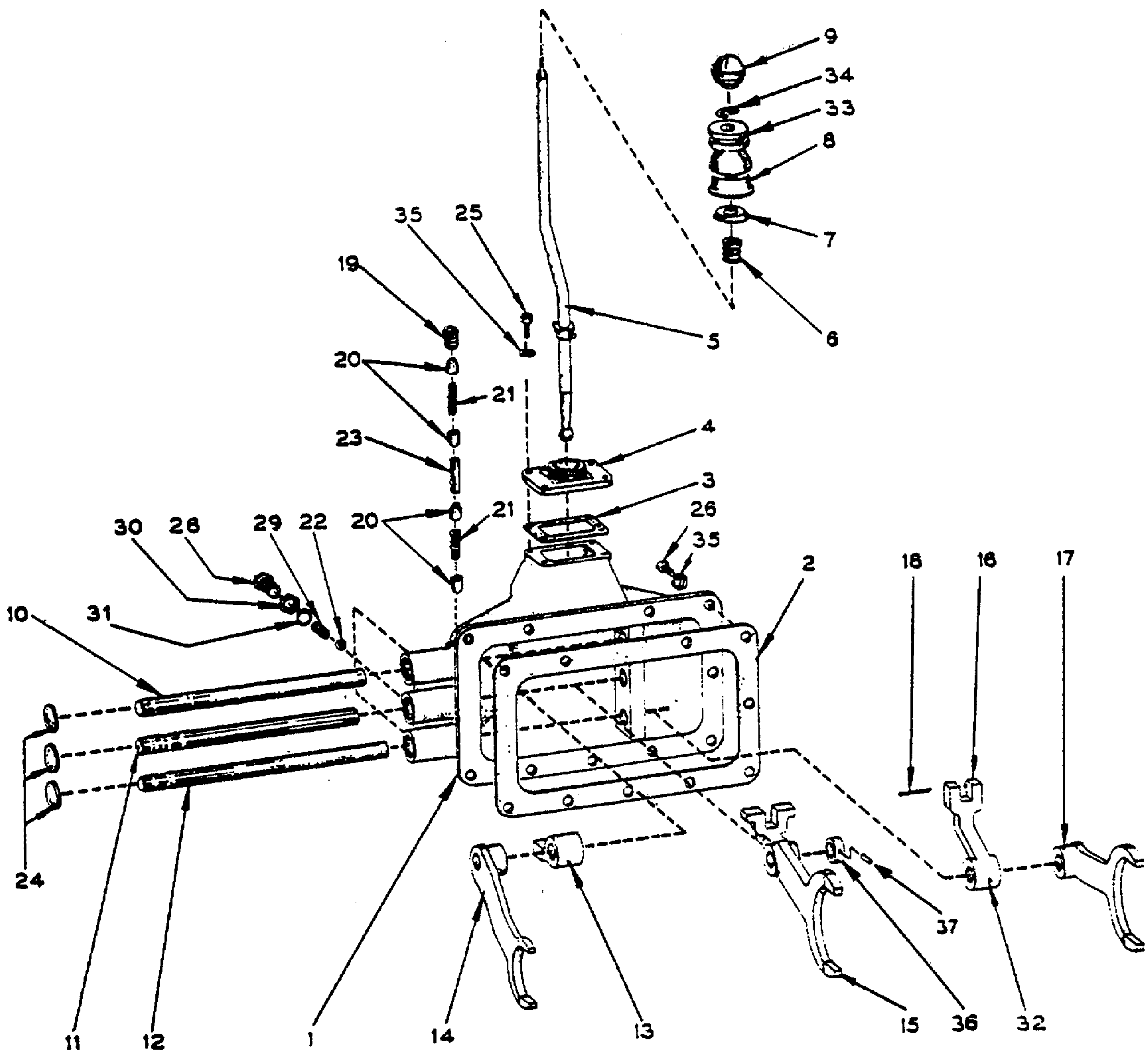
RANGE SHIFT

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
	45775-255-20	Range Shifter Assembly	1
1	45775-255-13	Housing, Range Shift	1
2	45775-259-46	Gasket, Range Shift Housing	1
3	45775-259-11	Gasket,-Shifter Cover	1
4	45775-256-30	Cover, Shifter	1
5	45775-269-02	Shift Lever, Range	1
6	45775-270-01	Spring, Shift Shaft	1
7	45775-262-03	Washer, Shift Cap	1
8	45775-273-01	Cap, Shift Housing	1
9	45775-252-01-	Ball, Shift Lever	1
10	45775-257-38	Shifter Shaft, High	1
11	45775-257-37	Shifter Shaft, Low and Intermediate	1
12	45775-276-01	Expansion Plug, 1-1/8"	2
13	45775-271-04	Fork, High	1
14	45775-271-14	Fork, Low and Intermediate	1
15	45775-274-02	Plunger, Interlock	2
16	45775-270-03	Spring	1
17	45775-277-01	Ball	2
18	45775-260-03	Retainer, Spring	2
19	45250-020-04	Plug, 1/2" Pipe	1
20	7011-064	Pin, Cotter 1/8" x 2"	1
21	7064-016	Capscrew, 1/2" x 1-3/4" Hex Head NF	2
22	7010-013	Capscrew, 3/8" x 1" Hex Head NC	8
24	45775-276-02	Expansion Plug, 1-1/4"	8
25	45775-270-04	Spring	2
26	7007-031	Lockwasher, Internal Teeth 1-1/4" OD	2
27	45775-278-03	Nut, 3/4" Hex Jam NF	2
28	45775-282-01	Boot, Cover	1
29	45775-261-04	Clamp, Boot	1
30	7014-003	Lockwasher, 3/8"	8

6 SPEED SHIFTER

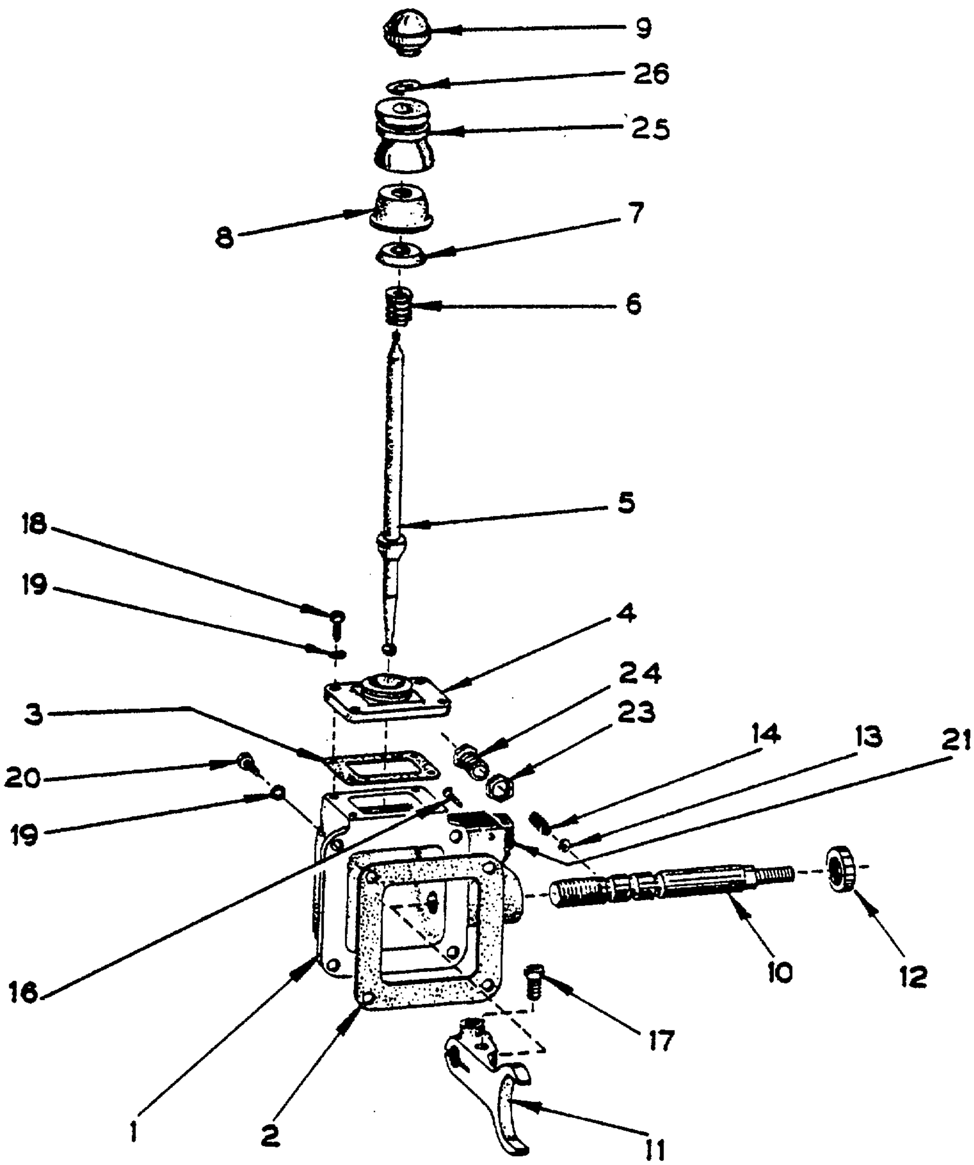


TRANSMISSIONS PRIOR TO SERIAL NO. 354
DID NOT HAVE ITEM NOS. 36 & 37

6 SPEED SHIFTER

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
	45775-255-19	Six Speed Shifter - Complete	1
1	45775-255-04	Housing	1
2	45775-259-10	Gasket	1
3	45775-259-11	Gasket, Shifter Cover	1
4	45775-256-09	Cover, Shifter	1
5	45775-269-01	Shift Lever, Six Speed	1
6	45775-270-01	Spring, Shift Shaft	1
7	45775-262-03	Washer, Shift Cap	1
8	45775-273-01	Cap, Shift Housing	1
9	45775-252-01	Ball, Shift Lever	1
10	45775-257-11	Shifter Shaft, 5th and 6th	1
11	45775-257-12	Shifter Shaft, 3rd and 4th	1
12	45775-257-13	Shifter Shaft, 1st and 2nd	1
13	45775-272-01	Shifter Dog, 5th and 6th	1
14	45775-271-01	Fork, 5th and 6th	1
15	45775-271-02	Fork, 3rd and 4th	1
16	45775-272-02	Shifter Dog, 1st and 2nd	1
17	45775-271-03	Fork, 1st and 2nd	1
18	7011-064	Pin, Cotter 1/8" x 2"	1
19	7024-003	Plug, 3/8" American Standard Pipe	1
20	45775-274-01	Plunger, Locking	4
21	45775-270-05	Spring	2
22	45775-277-01	Ball	3
23	45775-275-01	Pin, 1/4" x 1" Interlock	1
24	45775-276-01	Expansion Plug, 1-1/8"	3
25	7010-013	Capscrew, 3/8" x 1" Hex Head NC	4
26	7009-006	Capscrew, 3/8" x 1" Hex Head NF	10
28	45775-260-03	Retainer, Spring	3
29	45775-270-04	Spring	3
30	7017-052	Nut, 3/4" Jam NF	3
31	7007-031	Lockwasher, Internal Teeth 1-1/4" OD	3
32	45775-275-03	Pin, Groove	3
33	45775-282-01	Boot, Cover	1
34	45775-261-04	Clamp, Boot	1
35	7014-003	Lockwasher, 3/8"	14
36	45775-265-06	Collar, Shifter Stop	1
37	7238-116	Pin, Roll 1/4"	1

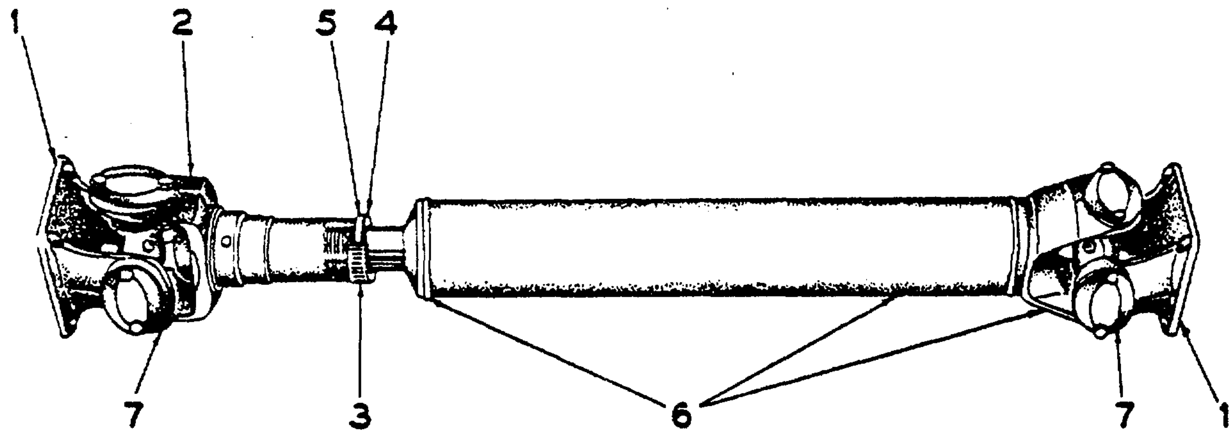
FORWARD AND REVERSE SHIFT



FORWARD AND REVERSE SHIFT

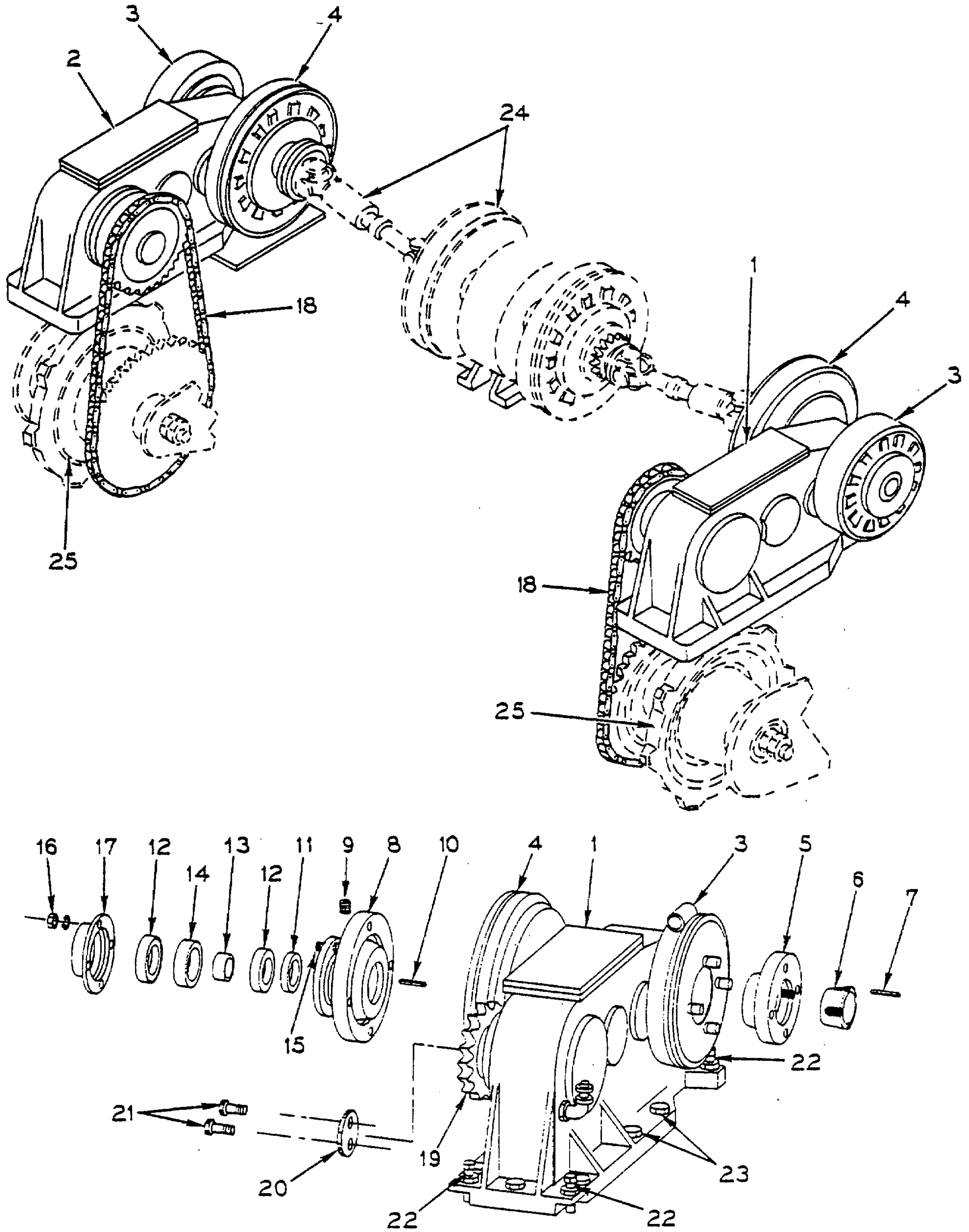
REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
	5036DD02-03	Forward and Reverse Shift - Complete	1
1	45775-255-06	Housing	1
2	45775-259-12	Gasket, Housing	1
3	45775-259-11	Gasket, Shifter Cover	1
4	45775-256-30	Cover, Shifter	1
5	45775-269-03	Shift Lever, Forward and Reverse	1
6	45775-270-01	Spring, Shift Shaft	1
7	45775-262-03	Washer, Shift Cap	1
8	45775-273-01	Cap, Shift Housing	1
9	45775-252-01	Ball, Shift Lever	1
10	45775-257-16	Shifter, Shaft	1
11	45775-271-06	Fork, Forward and Reverse	1
12	45200-184	Seal, Oil	1
13	45775-277-01	Ball	1
14	45775-270-04	Spring	1
16	45775-262-47	Capscrew, 1-1/2" Socket Head NC	4
17	7065-016	Capscrew, 1-1/2" x 1-3/4" Hex Head NF	1
18	7010-013	Capscrew, 3/8" x 1" Hex Head NC	4
19	7014-003	Lockwasher, 3/8"	8
20	7009-006	Capscrew, 3/8" x 1" Hex Head NF	4
21	46200-001-13	Micro-Switch	1
23	7017-052	Nut, 3/4" Jam NF	1
24	45775-260-03	Retainer, Spring	1
25	45775-282-01	Boot, Cover	1
26	45775-261-04	Clamp, Boot	1

SPICER UNIVERSAL JOINT



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
	5036DF03	Spicer Universal Joint Assembly, Complete	1
1	45377-500-01	Flange Yoke	2
2	45377-500-02	Sleeve Yoke Assembly	1
3	45377-501-01	Dust Cap	1
4	45377-502-01	Steel Washer	1
5	45377-502-02	Cork Washer	1
6	45377-503-01	Shaft Sub-Assembly	1
7	45377-504-01	Journal & Bearing Kit	2
	45377-505-01	Journal Cross Assembly	2
	45377-506-01	Bearing Assembly	8
	45377-507-01	Snap Ring	8
	45377-508-01	Zerk Nipple	2
	45377-509-01	Journal Gasket	8

Quantities shown are for One Assembly Only.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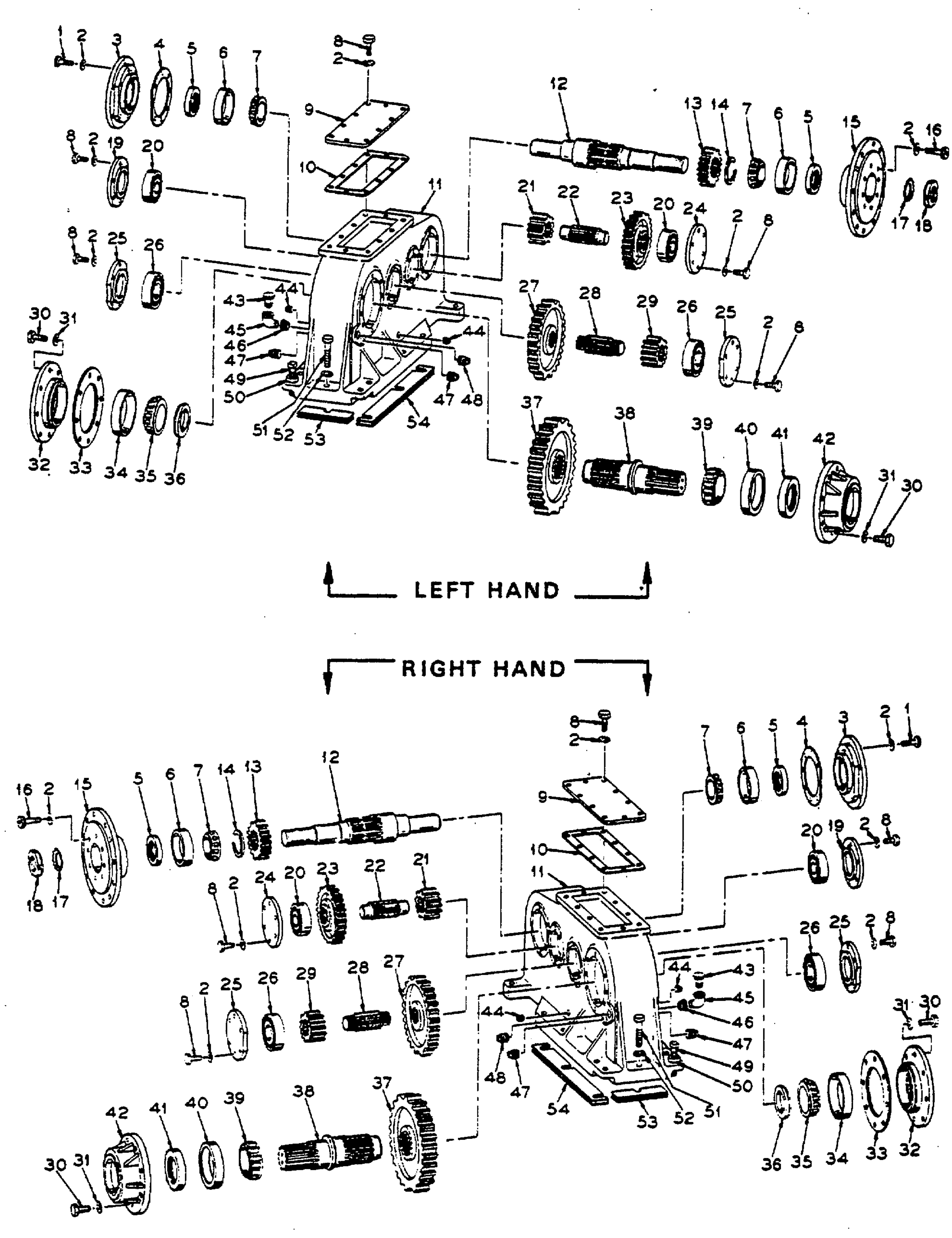
CLUTCH, TRANSFER CASE AND BRAKES

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	45775-009-04	See Transfer Case - Right Hand - This Section	1
2	45775-009-05	See Transfer Case - Left Hand - This Section	1
3		See Electrically Released Brake - This Section	2
4		See Electric Clutch - This Section	2
5	4430-007-01	Flange	2
6	7340-017	Bushing	2
7	5036DD51	Key	2
8	4430-006-01-02	Flange	2
9	7131-076	Setscrew, 3/81' x ½i NC	4
10		Key - See Electric Clutch - This Section	2
11	45200-027	Seal, Oil	2
12	7166-011	Bearing	4
13	5036DD19	Spacer	2
14	5036DF06	Spacer	2
15	7010-022	Capscrew, ½"x 1;½" NC	8
16	{ 7012-027	Nut, ½" Hex NC	8
	7014-005	Lockwasher, ½i"	8
17	4430-003-01	Flange	2
18	5036DD55	Chain	2
19	{ 9700-055	Sprocket, Transfer Case - Standard	1
	9700-054	Sprocket, Transfer Case - Slow Down	1
20	9700-056	Plate, Retaining	2
21	{ 7009-014	Capscrew, ½" x 1 ½" NF	4
	7014-005	Lockwasher, ½"	4
22	{ (7018-050	Setscrew	8
	7017-029	Nut, 5/8" Jam NC	8
23	{ (7010-048	Capscrew, 3/4" x 3" NC	16
	7012-009	Lockwasher, 3/4"	16
24		For BSF-420 Paver - See Two Speed Transmission, Hydraulic Motor, Clutch and Drive Shaft - This Section	
		For BSF-400 Paver - See 24 Speed Transmission, Clutch and Drive Shaft - This Section	
25		See Track Drive - Section 2	

TRANSFER CASE



TRANSFER CASE

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
	45775-009-04	Transfer Case, Complete - Right Hand	1
	45775-009-05	Transfer Case, Complete - Left Hand	1
1	7026-016	Capscrew, 3/8" x 1-3/4" Hex Socket Head NF	8
2	7014-003	Lockwasher, 3/8"	50
3	45775-256-35	Cover, Mounting	1
4	45775-267-16	Shim Kit	As Req.
5	45200-191	Seal, Oil	2
6	45130-002-04	Cup, Roller Bearing	2
7	45130-001-08	Cone, Roller Bearing	2
8	7009-007	Capscrew, 3/8" x 1-1/4" Hex Head NF	34
9	45775-256-31	Cover, Housing	1
10	45775-259-53	Gasket, Housing	1
11	1000-177	Housing, Main	1
12	45775-257-01	Shaft, Input	1
13	45775-251-03	Pinion, Input	1
14	45775-261-01	Snap Ring	1
15	45775-256-34	Cover, Mounting	1
16	7026-017	Capscrew, 3/8" x 2" Hex Socket Head NF	8
17	7033-0.10	Lockwasher	1
18	7030-010	Locknut	1
19	45775-256-33	Cover, Bearing	1
20	45134-001-21	Ball Bearing	2
21	45775-251-01	Gear, Drive	1
22	45775-257-02	Shaft, Stub	1
23	45775-251-04	Gear, Driven	1
24	45775-256-37	Cover, Bearing	1
25	45775-256-32	Cover, Bearing	2
26	45134-001-22	Ball, Bearing	2
27	45775-251-05	Gear, Intermediate	1
28	45775-257-03	Shaft, Stub	1
29	45775-251-31	Gear, Drive	1
30	7009-014	Capscrew, 1/2" x 1-1/2" Hex Head NF	16
31	7014-005	Lockwasher, 1/2"	16
32	45775-260-09	Retainer, Bearing	1
33	45775-267-15	Shim Kit	As Req.
34	7306-001	Cup, Roller Bearing	1
35	7306-016	Cone, Roller Bearing	1
36	45775-258-01	Spacer, Output Shaft	1
37	45775-251-02	Gear, Output	1
38	45775-257-45	Shaft, Output	1
39	45130-001-05	Cone, Roller Bearing	1
40	45130-002-03	Cup, Roller Bearing	1
41	45200-181	Seal, Oil	1
42	45775-256-36	Carrier, Bearing	1
43	7052-019	Breather, Alemite	1
44	7027-002	Plug, 1/2" Pipe - Magnetic Drain	2
45	7061-003	Elbow, 3/8" x 90°	1
46	7107-008	Reducer, Bushing 3/8" x 3/4"	1

- Continued -

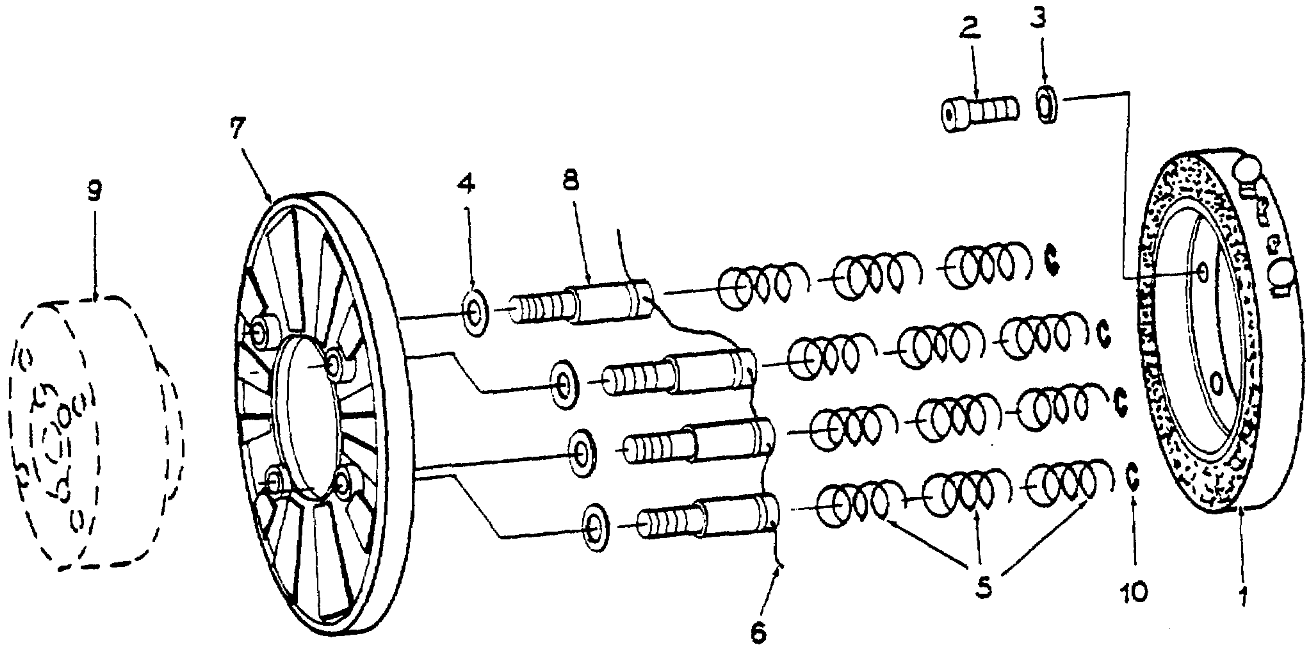
TRANSFER CASE - Continued

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
47	7024-004	Plug, 1/2" Pipe	2
48	7024-005	Plug, 3/4" Pipe	1

THE FOLLOWING PARTS ARE NOT INCLUDED WITH COMPLETE TRANSFER CASE.

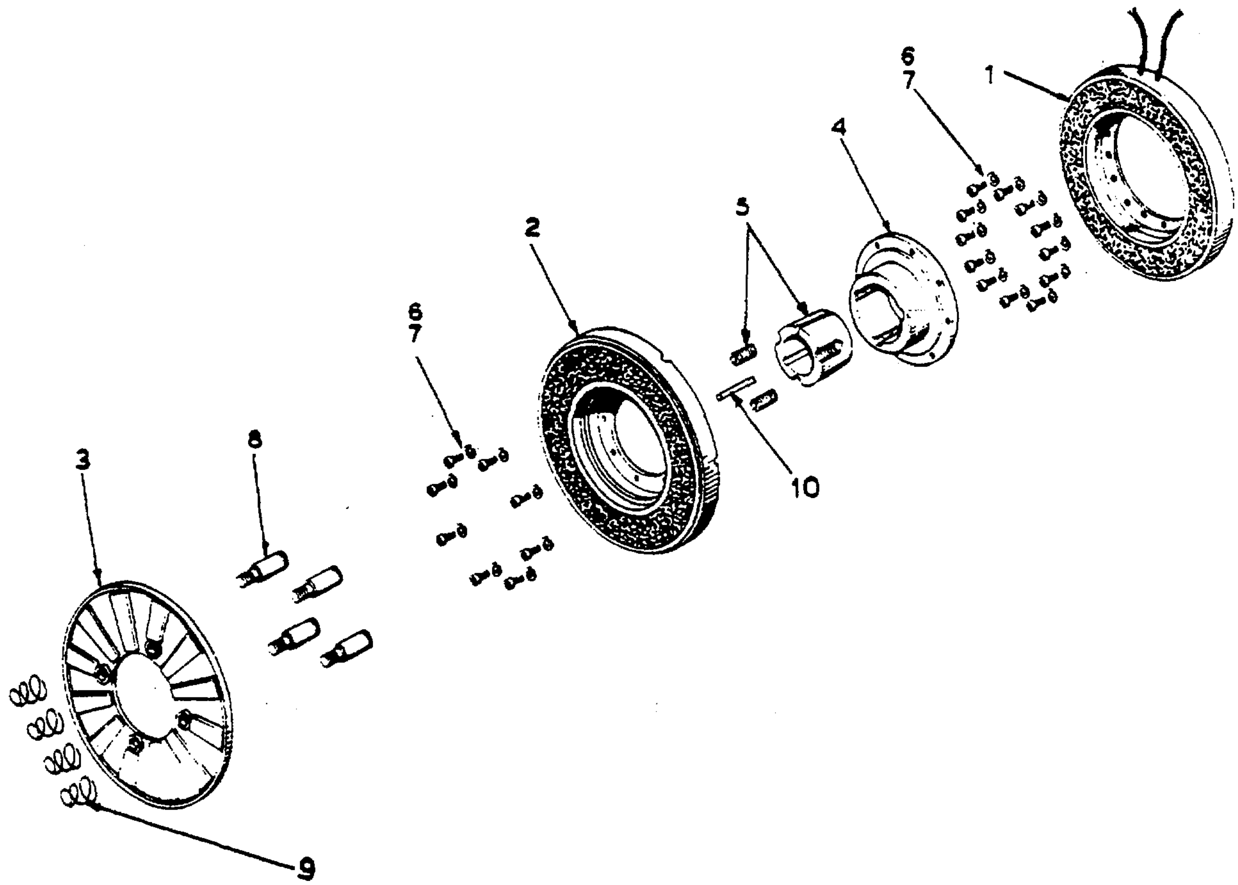
REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
49	7018-050	Setscrew, 5/8" x 3" Square Head	4
50	7017-029	Nut, 5/8" Jam Hex NC	4
51	7010-048	Capscrew, 3/4" x 3" Hex Head NC	8
52	7014-009	Lockwasher, 3/4"	8
	5036DD36	Shim, Short 20 Gauge	As Req.
	5036DD44	Shim, Short 16 Gauge	As Req.
53	5036DD43	Shim, Short 10 Gauge	As Req.
	5036DD47	Shim, Short 7 Gauge	As Req.
	5036DD37	Shim, Long 20 Gauge	As Req.
	5036DD41	Shim, Long 16 Gauge	As Req.
54	5036DD42	Shim, Long 10 Gauge	As Req.
	5036DD48	Shim, Long 7 Gauge	As Req.

ELECTRICALLY RELEASED BRAKE
12 VO LT



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	45003-506-13	Magnet, 12 Volt	1
2	7025-006	Capscrew, 5/16" x 3/4" Socket Head NC	6
3	7014-002	Lockwasher, 5/16"	6
4	45003-500-02	Washer, Retaining	4
5	45003-502-03	Spring	12
6	50020-001-02	Locking Wire	3.0'
7	45003-505-01	Armature	1
8	45003-503-01	Pin	4
9		Flange For BSF-2 - See Drives - This Section For BSF-520, BSF-2H, BSF-420 or BSF-400 - See Transfer Case, Clutch and Brake - This Section For BSF-620 or BSF-4 - See Drives - This Section	
10	45003-500-01	Ring, Retaining	1

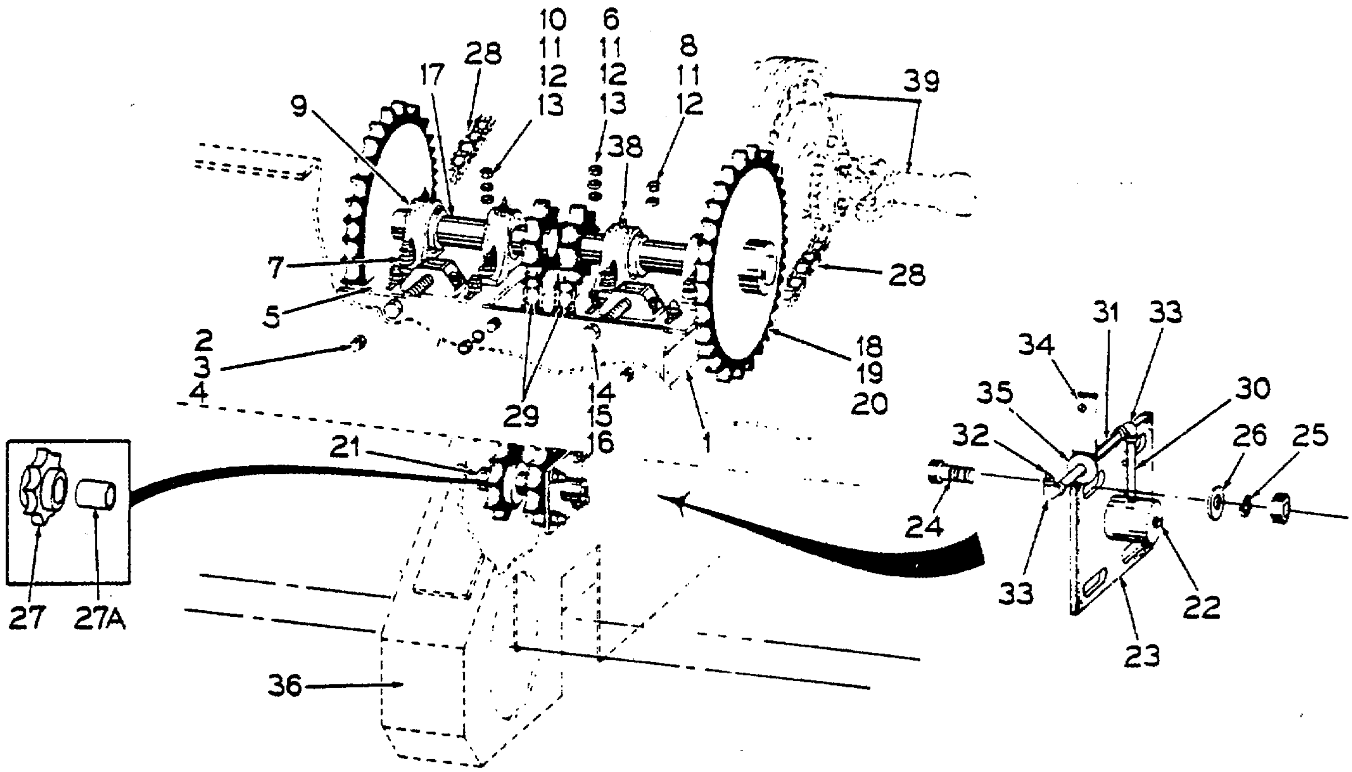
ELECTRIC CLUTCH - 12 VOLT



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	45003-504-02	Field Assembly, Inside Mounted 12 Volt	1
2	45551-263-01	Rotor	1
3	45552-258-01	Armature	1
4	45003-501-01	Hub, Rotor	1
5	7341-009	Bushing, Taperlock 2" Bore	1
6	7010-006	Capscrew, 5/16" x 3/4"	20
7	7014-002	Lockwasher, 5/16"	20
8	50360G02	Pin, Clutch Drive	4
9	45003-502-02	Spring, Follow Up	4
10	7264-037	Key, 1/2" x 1/2" x 2" Round End	1

NOTE: Quantities shown are for one clutch assembly only.

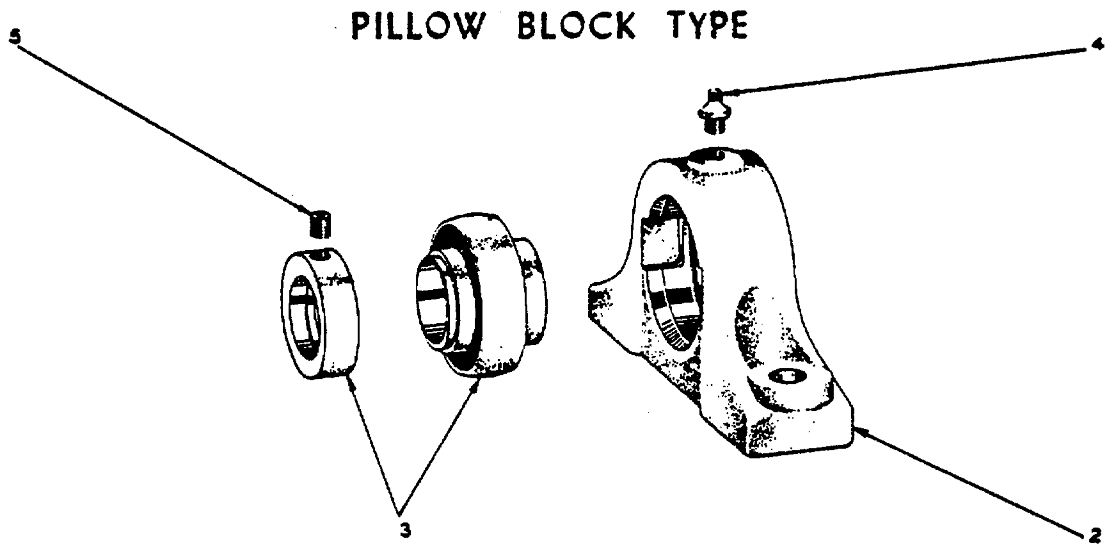
STANDARD CONVEYOR DRIVES



STANDARD CONVEYOR DRIVES

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5036DD06	Frame	1
2	7010-031	Capscrew, 5/8" x 1¼" NC	5
3	7012-029	Nut, 5/8" Hex NC	5
4	7014-007	Lockwasher, 5/8"	5
5	5036DD07	Plate, Take-Up	2
6	7072-102	Bolt, Carriage ½" x 1i½" NC	8
7	1206B10	Lug, Adjusting	2
8	7445-001	Bolt, Plow #3 I-" x 1-3/4" NC	4
9	F0115PGA	Pillow Block Bearing - 1-15/16" Bore - See Form # 1003 - This Section	4
10	7445-002	Bolt, Plow #3 2" x 2" NC	8
11	7012-027	Nut, ½" Hex NC	20
12	7014-005	Lockwasher, ½"	20
13	7014-020	Washer, ½" Flat	16
14	7153-027	Bolt, Adjusting 3/4" x 8½" NC	2
15	7012-008	Nut, 3/4" Square NC	2
16	7017-030	Nut, 3/4" Jam NC	4
17	5036DD08	Shaft and Sprocket	2
18	{ 1387A39E	Sprocket, Standard	1
	1387A30F	Sprocket, Speed Up	1
19	40803-b03	Key, ½" Square x 3"	2
20	7131-077	Setscrew, 3/8".x 5/8" NC	4
21	5036DD23	Shaft, Idler	1
22	7024-001	Plug, 1/8" Pipe	2
23	5036DD24	Plate	1
24	7010-020	Capscrew, ½" x 1" NC	8
25	7014-005	Lockwasher, I"	8
26	7014-020	Washer, ½'" Flat	8
27	5036DD16	Sprocket, With Bushing	2
27A	7254-033	Bushing (Only)	2
28	5036DD38	Chain, #100 Roller Counter Drive	2
29	9701-132	Chain, #120 Roller Conveyor Drives	2
30	40500-002-00-01	Nipple, Pipe 1/8" x 2"	2
31	40500-005-08-01	Nipple, Pipe 1/8" x 5½"	2
32	7051-002	Fitting, Alemite 1/8" @45°	2
33	7085-001	Elbow, 900 Pipe 1/8"	4
34	7000E23B	Base, Tube Clamp	2
35	7014-018	Washer, 3/8" Flat	2
36		Main Frame - See Main Frame - Section 3	
38	7051-001	Fitting, Hydraulic Straight 1/8"	4
39		See Transmission, Clutch and Drive Shaft - This Section	

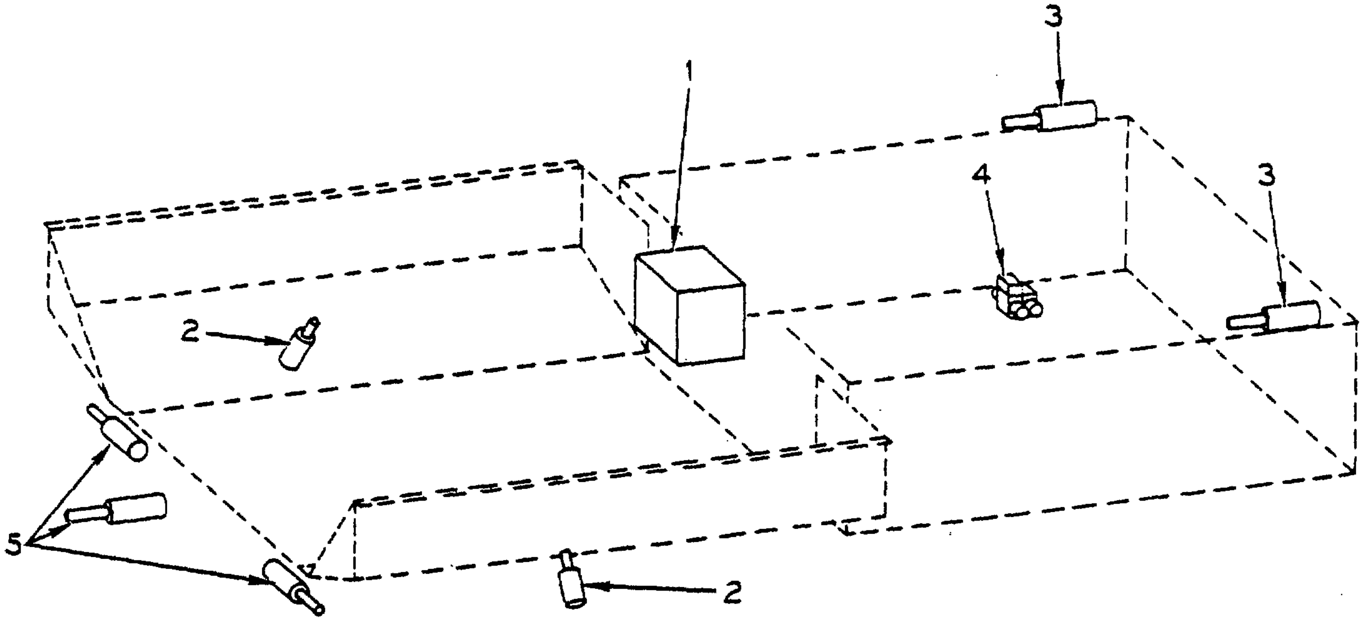
ANTI-FRICTION BEARING ASSEMBLIES



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
		PILLOW BLOCK TYPE - 1" BORE	
1	F0100PGA	Bearing Assembly - Complete	1
2	F0100PG	Bearing Housing	1
3	7041-004	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-046	Socket Head Set Screw - 1/" x 1/4" Cup Point	1
		PILLOW BLOCK TYPE - 1-3/16" BORE	
1	F0103PGA	Bearing Assembly - Complete	1
2	F0103PG	Bearing Housing	1
3	7041-007	Bearing and Collar	1
	Variable	Grease Fitting	1
5	7131-046	Set Screw, 1/4"x1/4" Socket Head, Cup Point	1
		PILLOW BLOCK TYPE - 1-3/8" BORE	
1	F0106PGA	Bearing Assembly - Complete	1
2	F107PG	Bearing Housing	1
	7041-010	Bearing and Collar	1
	Variable	Grease Fitting	1
5	7131-074	Socket Head Set Screw - 3/8" x 3/8" Cup Point	1
		PILLOW BLOCK TYPE - 1-7/16" BORE	
1	F0107PGA	Bearing Assembly - Complete	1
2	F0107PG	Bearing Housing	1
3	7041-011	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-074	Socket Head Set Screw - 3/8" x 3/8" Cup Point	1

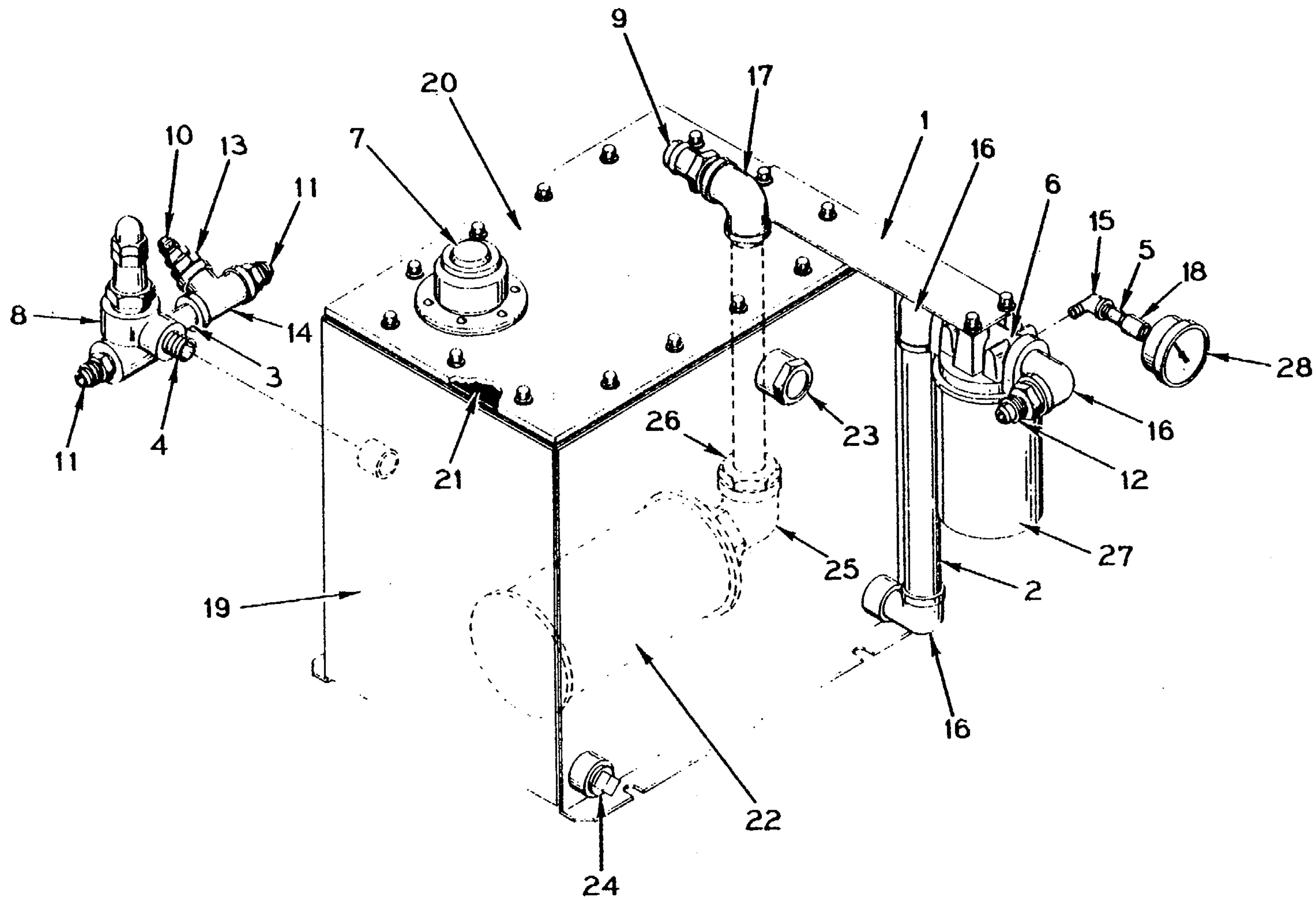
REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
		PILLOW BLOCK TYPE - 1-5/8" BORE	
1	FOIIOPGA	Bearing Assembly - Complete	1
2	FO11PG	Bearing Housing	1
3	7041-014	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-074	Socket Head Set Screw - 3/8" x 3/8" Cup Point	1
		PILLOW BLOCK TYPE - 1-11/16" BORE	
1	F0111PGA	Bearing Assembly - Complete	1
2	F0111PG	Bearing Housing	1
3	7041-015	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-074	Socket Head Set Screw - 3/8" x 3/8" Cup Point	1
		PILLOW BLOCK TYPE - 1-3/4" BORE	
1	F0112PGA	Bearing Assembly - Complete	1
2	F011lPG	Bearing Housing	1
3	7041-016	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-074	Socket Head Set Screw - 3/8" x 3/8" Cup Point	1
		PILLOW BLOCK TYPE - 1-15/16" BORE	
1	F011SPGA	Bearing Assembly - Complete	1
2	F011SPG	Bearing Housing	1
3	7041-019	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-074	Socket Head Set Screw - 3/8" x 3/8" Cup Point	1
		PILLOW BLOCK TYPE - 2-3/16" BORE	
1	F0203PGA	Bearing Assembly - Complete	1
2	F0203PG	Bearing Housing	1
3	7041-023	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-087	Socket Head Set Screw - 7/16" x 7/16" Cup Point	1
		PILLOW BLOCK TYPE - 2-7/16" BORE	
1	F0207PGA	Bearing Assembly - Complete	1
2	F0207PG	Bearing Housing	1
3	7041-024	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-087	Socket Head Set Screw - 7/16" x 7/16" Cup Point	1
		PILLOW BLOCK TYPE - 2-15/16" BORE	
1	F0215PGA	Bearing Assembly - Complete	1
2	F0215PG	Bearing Housing	1
3	7041-025	Bearing and Collar	1
4	Variable	Grease Fitting	1
5	7131-100	Socket Head Set Screw 1/2" x 1/2" Cup Point	1

HYDRAULIC COMPONENTS



REF.NO.	PART NUMBER	DESCRIPTION	SECTION
1		Hydraulic Reservoir, Filter and Relief Valve	7
2		Hydraulic Lines-Hopper Wings	7
3		Hydraulic Lines-Screed Wings	7
4		Hydraulic Valve Bank	7
		OPTIONAL EXTRA EQUIPMENT	
		If this Section is Missing from Your Parts Manual this mean the Truck Hook was Not Purchased:	
5		Truck Hook Hydraulic Circuit	10

HYDRAULIC RESERVOIR, FILTER & RELIEF VALVE

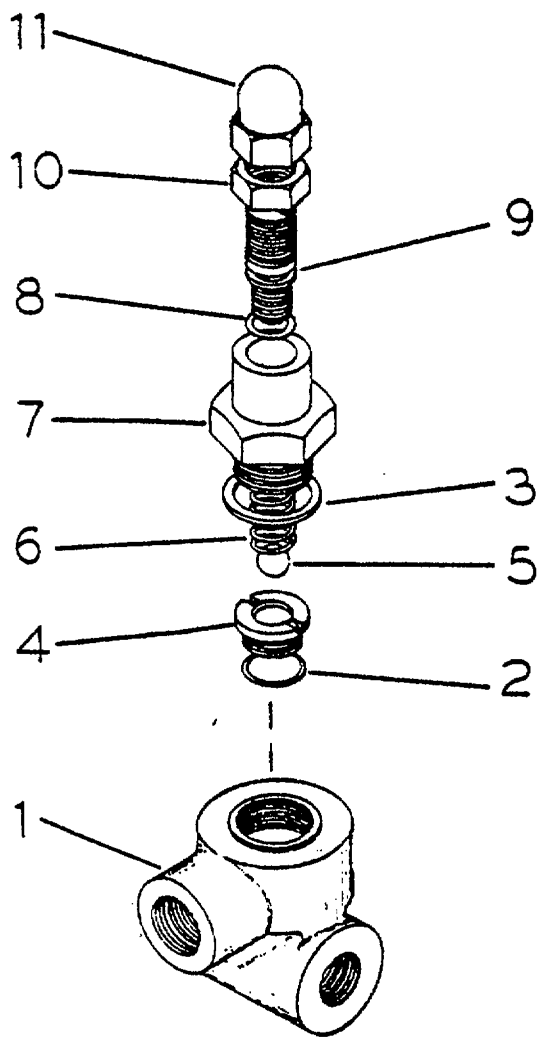


HYDRAULIC RESERVOIR, FILTER & RELIEF VALVE

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	5036QT05	Brace, Filter	1
2	40504-011-02-01	Nipple, 3/4" Pipe x 11-1/8"	1
3	40540-001-02-01	Nipple, 2" Pipe x 1-1/8"	1
4	40540-002-00-01	Nipple, ½" Pipe x 2"	1
5	40500-001-08-01	Nipple, 1/8" Pipe x 1½"	1
6	45080-510-21	Filter, Oil	1
7	45080-510-05	Filter, Oil Fill and Air Cap	1
8	45259-006-35	Valve, Relief - See Form - 11159 - This Section	1
9	45191-250-15	Fitting, 3/4" MP x 1" Hose	1
10	7430-002	Fitting, Str. ¼" MP x ¼ " 370	1
11	7430-007	Fitting, Str. ½" MP x ½ " 370	2
12	7430-046	Fitting, Str. ¾ " MP x ½ " 370	1
13	45720-769-05	Reducer, Pipe ½ " x ¼"	1
14	7390-050	Tee, Pipe ½"	1
15	7061-001	Elbow, 90º Street 1/8" Pipe	1
16	7061-005	Elbow, 90º Street 3/4" Pipe	3
17	7085-005	Elbow, 90º 3/4" Pipe	1
18	7084-001	Coupling, Pipe 1/8"	1
19	9704-650-60	Reservoir	1
20	5036QT03	Cover, Reservoir	1
21	5036QT04	Gasket, Reservoir	1
22	45080-510-20	Strainer, Oil	1
23	7060-004	Gauge, Oil Window	1
24	7027-003	Plug, Pipe Magnetic	1
25	7061-007	Elbow, 90º Street 1I" Pipe	1
26	7107-015	Bushing, Pipe 1¼" x 3/4"	1
27	45080-510-22	**Element, Filter	1
28	45080-001-21	**Gauge	1

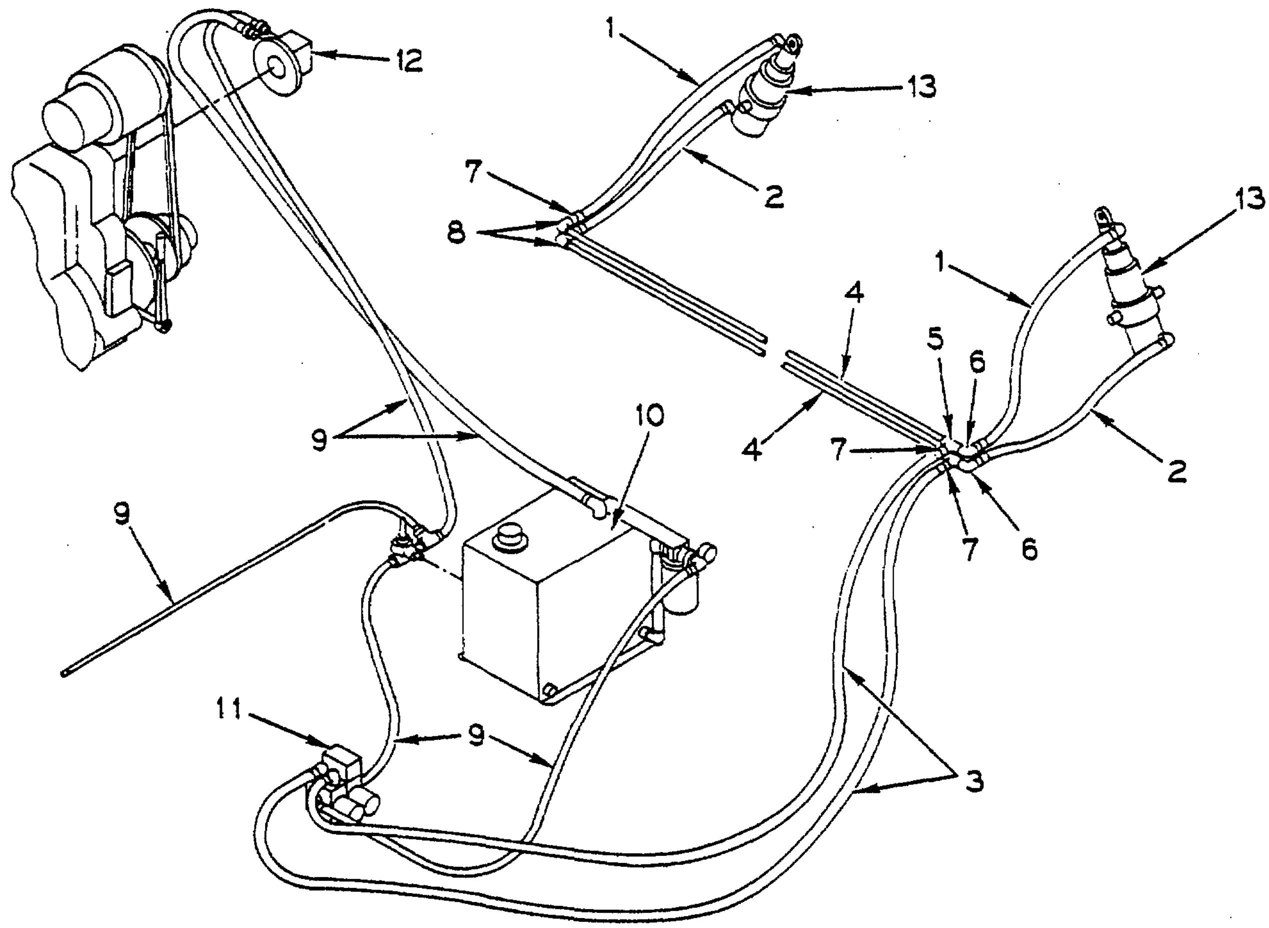
**NOTE: Items 27 and 28 are furnished with Item # 6.

HYDRAULIC RELIEF VALVE ASSEMBLY



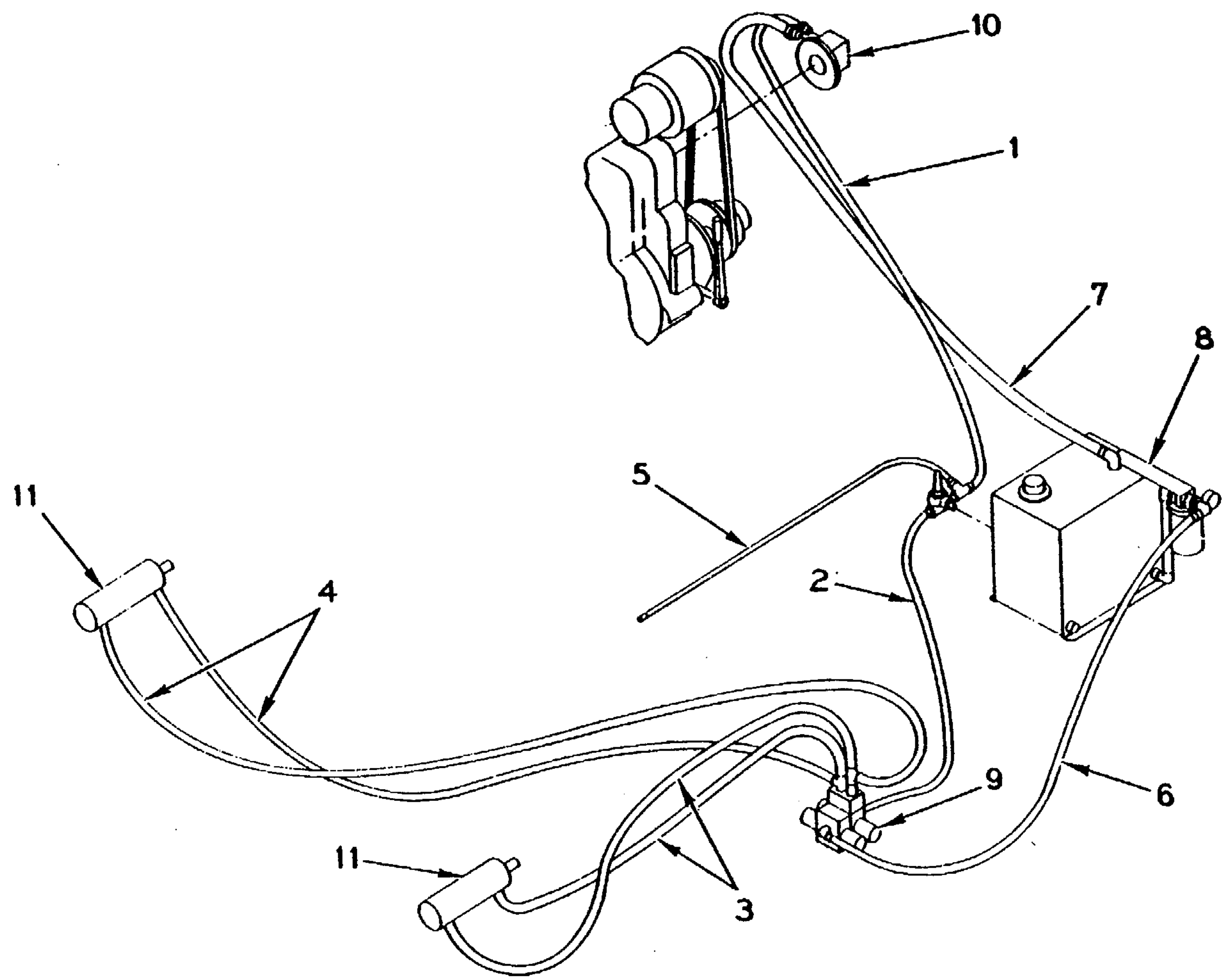
REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
	45259-006-35	Relief Valve - Complete Assembly	1
1	45259-506-11	Housing	1
2	45259-508-14	"O"-Ring	1
3	45259-502-16	Gasket, Body	1
4	45259-513-04	Relief Seat	1
5	45259-533-01	Ball	1
6	45259-509-06	Spring	1
7	45259-506-10	Body	1
8	45259-508-40	"O"-Ring	1
9	45259-516-13	Adjusting Screw	1
10	45259-517-05	Jam nut	1
11	45259-517-06	Acorn Cap	1

HYDRAULIC LINES
HOPPER WINGS



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	7551-043-33-01	Hose - Complete	2
	50035-043-00	Hose, 3/8" ID x 43"	2
	45191-503-86	Swivel Fitting JIC 37º	2
	45191-503-81	Swivel Fitting JIC 37º	2
2	7552-037-33	Hose - Complete	2
	50036-037-00	Hose, '" ID 37"	2
	45191-503-15	Swivel Fitting JIC 37º	4
3	7552-088-35	Hose - Complete	2
	50036-088-00	Hose, ½ " ID x 88"	2
	45191-503-15	Swivel Fitting JIC 37º	2
	45191-503-47	90º Elbow With SAE 37º Nut	2
4	40540-102-00-01	Pipe, ½" x 8'-6"	2
5	45720-770-10	Tee, ½" Pipe	2
6	7430-022	Fitting, 90º 1/2" MP x ½" 37º	2
7	7430-007	Fitting, ½ " MP x ½ " 37º	4
8	7390-003	Elbow, 90º ½" Pipe	2
9		See Hydraulic Line-Screed Lift - This Section	
10		See Reservoir - This Section	
11		See Valve Bank - This Section	
12		Pump - See Power Mounting - Section 6	
13		Cylinder - See Hopper Wings - Section 3	

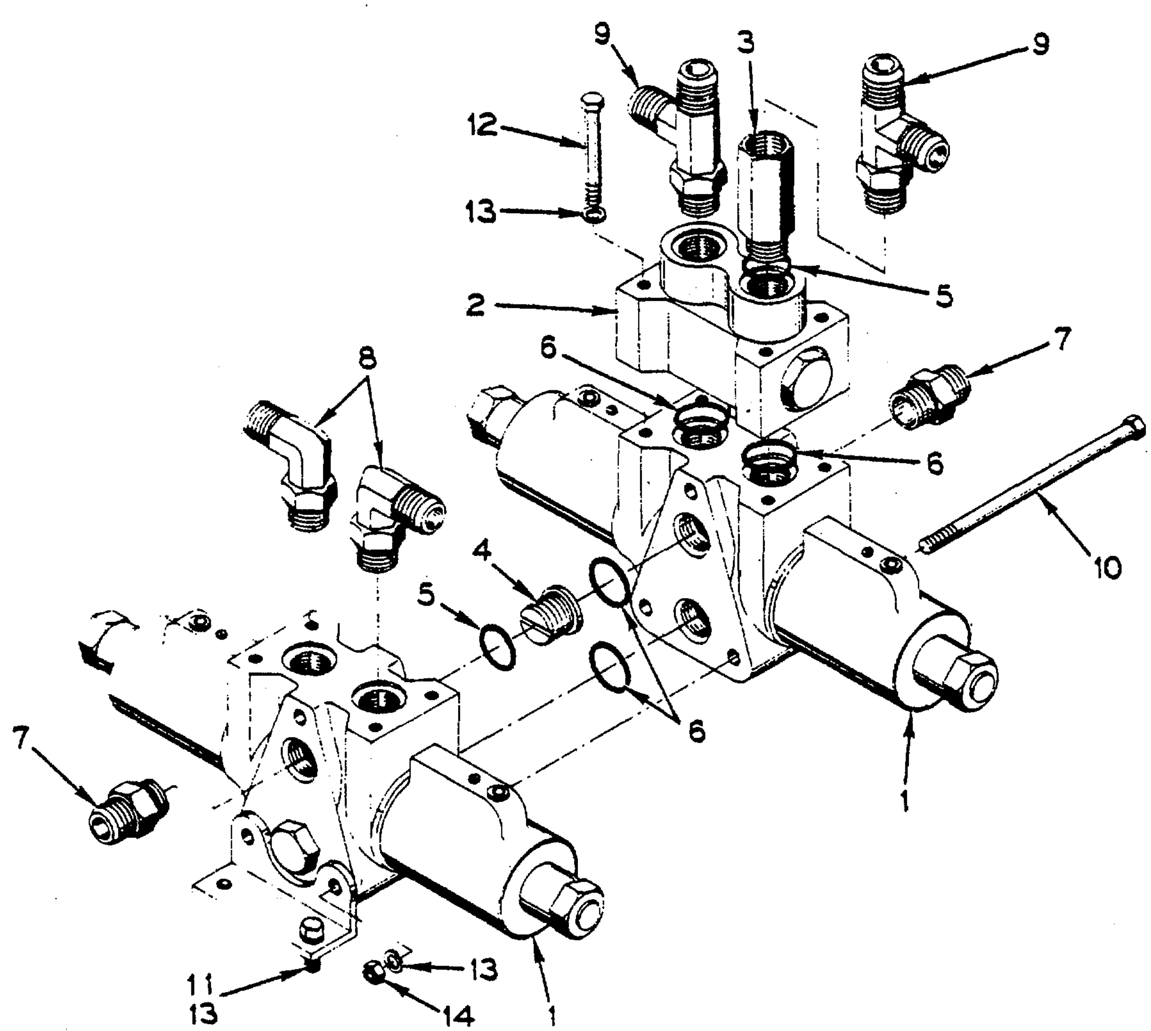
HYDRAULIC LINES
SCREED LIFT



HYDRAULIC LINES
SCREED LIFT

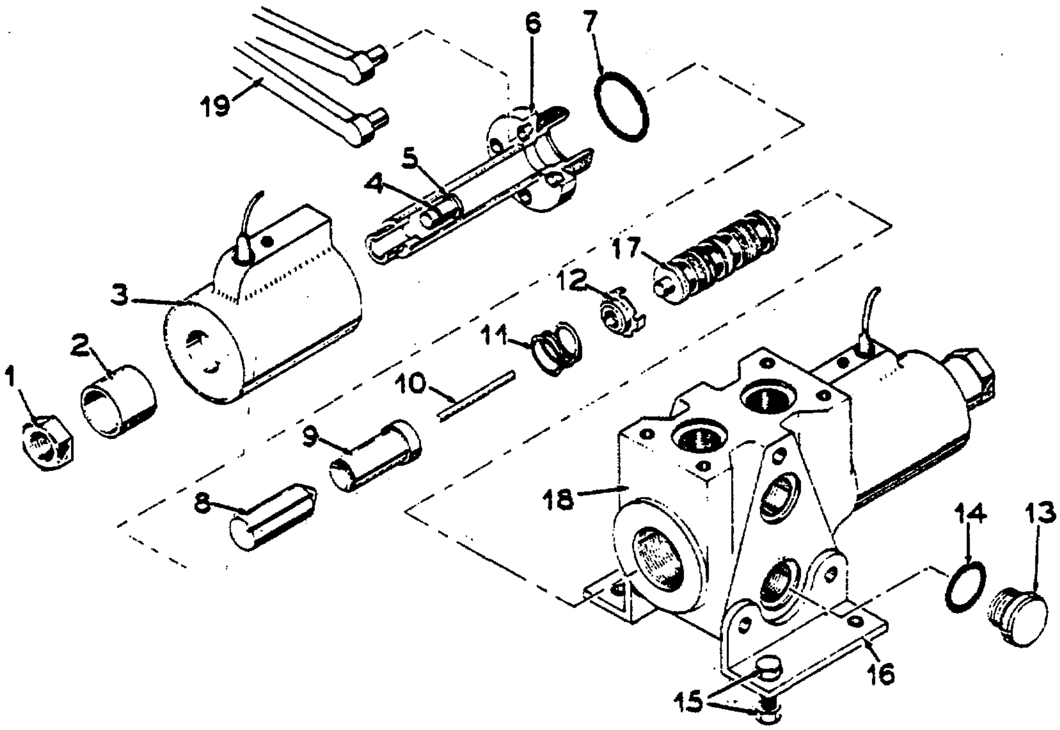
REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	7552-065-35	Hose - Complete	1
	50036-065	Hose, ½" ID x 65"	1
	45191-503-15	Fitting, ½" Hose x ½" 37º	1
	45191-503-47	Fitting, 90º ½ " Hose x ½ " 37º	1
2	7552-028-33	Hose - Complete	1
	50036-028	Hose, ½" ID x 28"	1
	45191-503-15	Swivel Fitting ½" H x ½" 37º	2
3	7552-041-35	Hose - Complete	2
	50036-041	Hose, ½" ID x 41"	2
	45191-503-15	Swivel Fitting JIC 37º	2
	45191-503-47	90º Elbow With SAE 37º Nut	2
4	7552-080-34	Hose - Complete	2
	50036-080-00	Hose, ½ " ID x 80"	2
	45191-503-15	Swivel Fitting JIC 37º	2
	45276-002-04	Hose End 370 JIC Swivel 45º Ell.	2
5	7550-068-33	Hose - Complete	1
	50039-068	Hose, ¼ " ID x 68"	1
	45191-503-85	Fitting, ¼" Hose x i" 37º JIC	2
6	7552-080-35	Hose - Complete	1
	50036-080	Hose, ½" ID x 80"	1
	45191-503-15	Swivel Fitting JIC 37º	1
	45191-503-47	90º Elbow With SAE 37º Nut	1
7	50030-007-02	Hose, 881 1" x 62"	5.2"
8		See Reservoir - This Section	
9		See Valve Bank - This Section	
10		Pump - See Power Mounting - Section 6	
11		Cylinder - See Screed Lift - Section 5	

HYDRAULIC VALVE BANK



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	45252-005-01	Valve, 4-Way Solenoid - See Form # 13575 - This Section	2
2	45090-001-36	Valve, Holding - See Form # 12617 - This Section	1
3	45090-001-42	Valve, Throttle	1
4	45090-503-11	Valve, Banking	1
5	45259-508-14	O-Ring	2
6	45259-508-47	O-Ring	4
7	7430-255	Fitting, Str. ½" '0' x ½" 37º	2
8	7430-278	Fitting, 90º 2½" '0' x 2" 37º	2
9	7430-292	Fitting, Tee ½ " 'P' x 2" 37º x ½" 37º	2
10	7383-227	Capscrew, Grade 5, 5/16" x 5-1/2" Hex Head NC	3
11	7010-084	Capscrew, 5/16" x 5/8" NC	4
12	7010-095	Capscrew, 5/16" x 21/4 " NC	4
13	7014-002	Lockwasher, 5/16"	11
14	7012-024-	Nut, 5/16" Hex NC	3

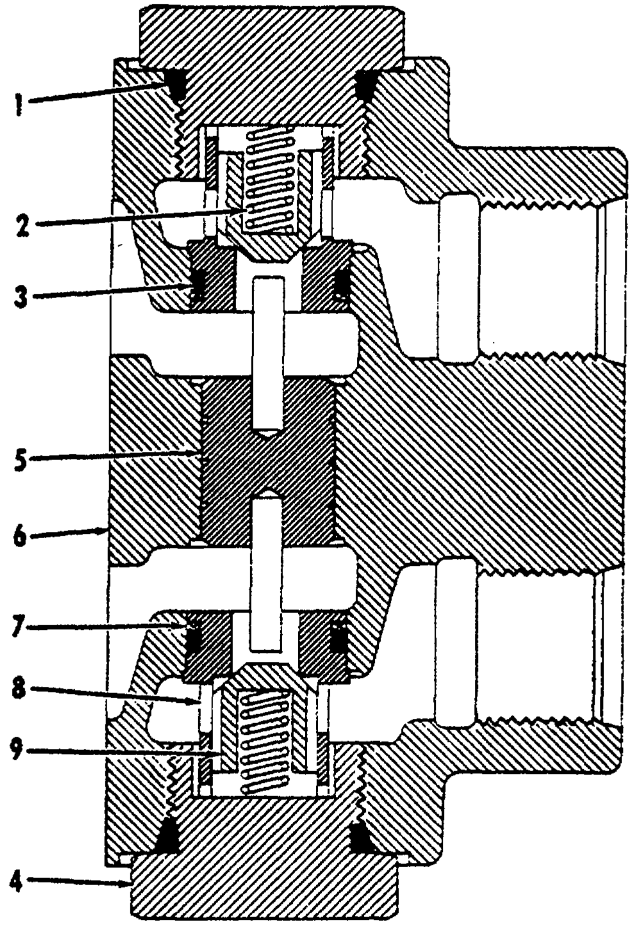
4-WAY SOLENOID VALVE



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
	45252-005-01	4-Way Solenoid Valve - Complete	1
1	45090-511-36	Nut	2
2	45090-510-07	Sleeve	1
3	46176-004-03	Coil	2
4	45259-508-30	O-Ring	2
5	45090-509-13	Pin	2
6	45090-531-08	Tube	2
7	45259-508-17	O-Ring	2
8	45090-535-05	Plunger	2
9	45090-503-09	Plug	2
10	45090-509-14	Pin	2
11	45090-506-15	Spring	2
12	45090-540-02	Retainer	2
13	45720-779-39	Plug, Banking	2
14	45259-508-14	O-Ring	As Req.
15	{ 7010-097	Capscrew, 5/16" x 2-3/4" Hex Head NC	2
	7012-024	Nut, 5/16" Hex NC	2
16	45090-250-11	Bracket, Mounting	2
17		*Spool	1
18		*Body	1
19	45500-015-03	Wrench, Spanner	1

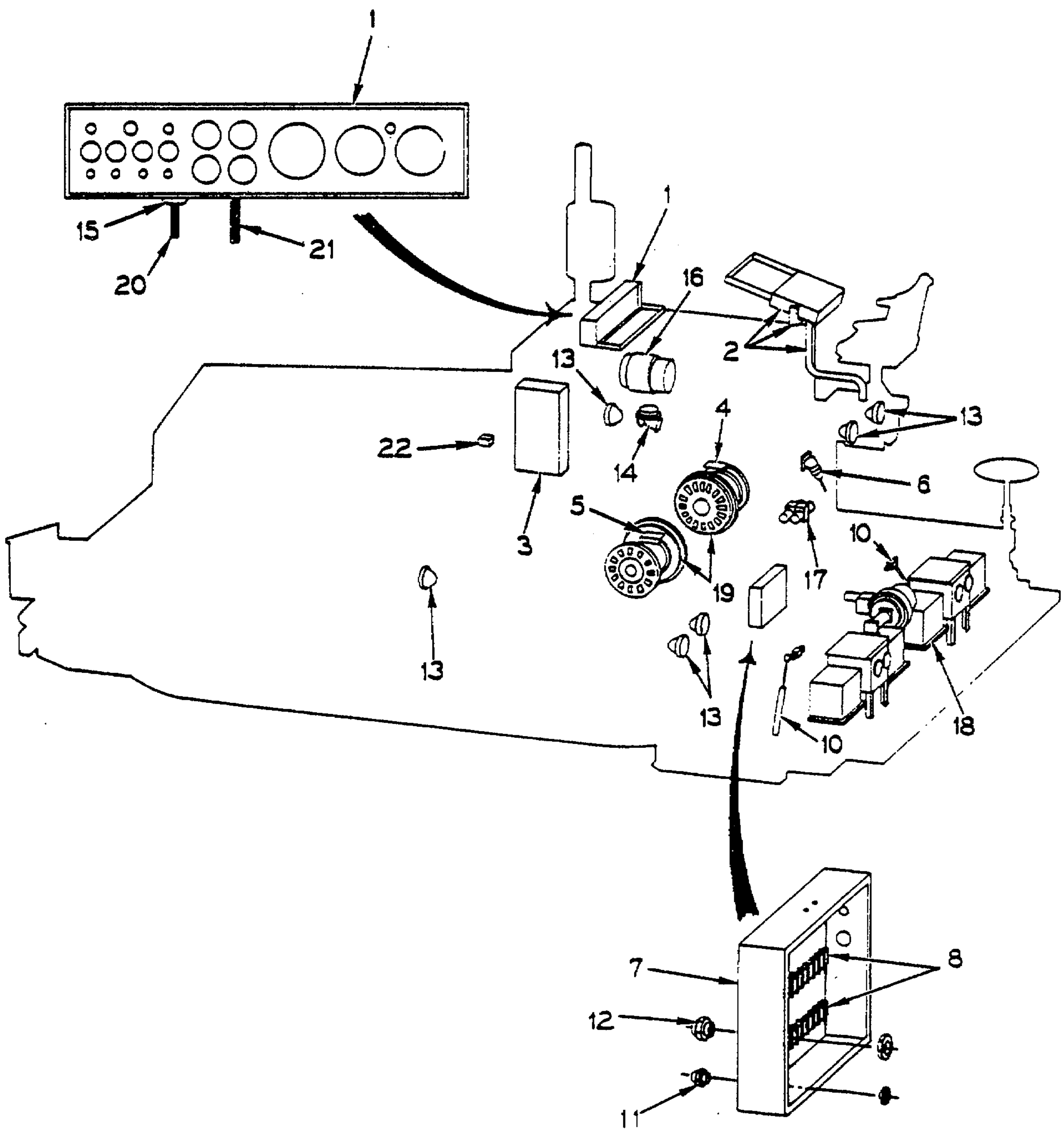
NOTE: Quantities shown are for one assembly.
*NOTE: Body and Spool are not available as separate items-purchase complete assembly.

HOLDING VALVE
SCREED LIFT



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
	45090-001-36	Holding Valve Attachment - Complete	1
1	45259-508-44	O-Ring	2
2	45090-506-17	Spring	2
3	45259-508-34	O-Ring	2
4	45090-503-10	Plug	2
5	45090-524-27	Piston	1
6	45090-500-19	Body	1
7	45090-512-55	Back-Up Ring	2
8	45090-536-10	Cage	2
9	45090-544-02	Check	2

BASE ELECTRIC PARTS

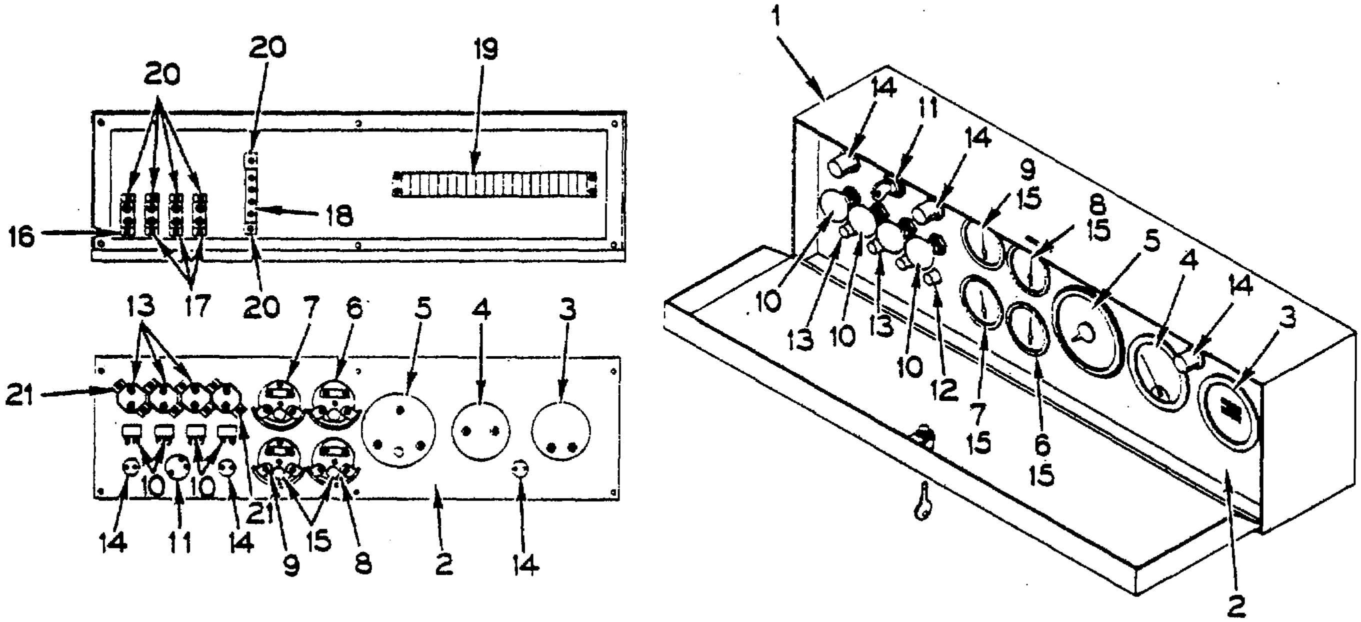


BASE ELECTRIC PARTS

REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	9704-402-33	See Meter Box - This Section	1
2	9704-402-52	See Control Console - This Section	1
3		See Control Box Parts - This Section	1
4	9704-402-40	See Pad, Brake - Right Hand - This Section	1
5	9704-402-41	See Pad, Brake - Left Hand - This Section	1
	46300-003-10	Receptacle, 30A	1
6	7435-132	Screw	4
	7438-025	Washer, Shakeproof	4
	9704-401-16	Terminal Box	1
7	7435-102	Screw, #10-32 x 1¼41	4
	7439-003	Lockwasher, #10	4
	7440-023	Nut, 410-32 Hex	4
8	46260-001-10	Terminal Block	2
10	46200-001-17	Switch, Limit	2
11	46026-023-01	Hub, ½"	1
12	46026-023-03	Hub, 1"	1
13	46270-252-06	Lights	6
14	46010-001-12	Horn	1
15	46026-004-03	Bushing, Fibre 1"	1
	46026-016-03	Locknut, 1"	1
16		See Generator and Drive - Section 6	
17		See Hydraulic Assemblies - Section 7	
18		See Screed. Electrical - This Section	
19		See Electric Clutch and Brake - Section 6	
20		Engine Harness - See Power Mounting Parts - Section 6	
21		See Electrical Cables - This Section	
22		Forward-Reverse Limit Switch - See	

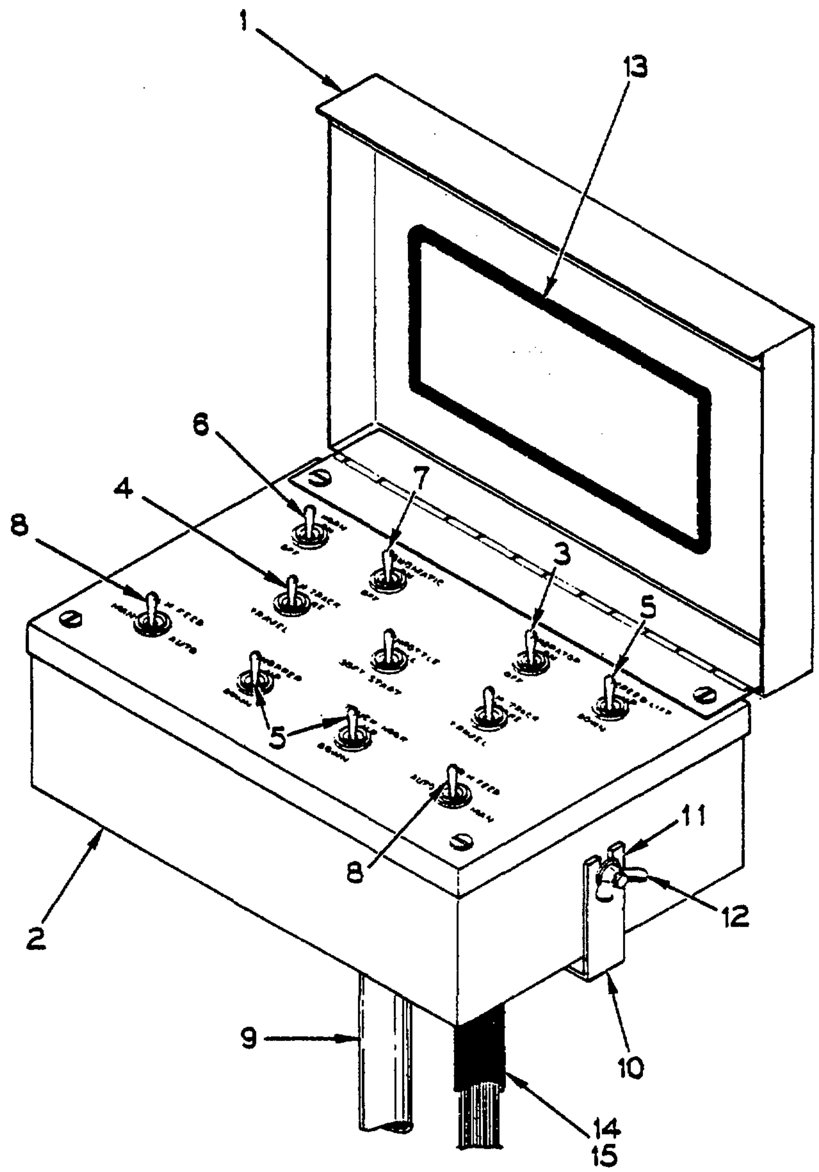
METER BOX
MILITARY PAVER-VSF-400

METER BOX
MILITARY PAVER — BSF-400



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
	9704-402-33	Meter Box - Complete	1
1	9704-402-34	Box	1
	9704-402-32	Meter Panel	1
3	46225-003-02	Frequency Meter	1
4	46225-001-07	AC Voltmeter	1
5	45865-001-23	Hour Tachometer	1
6	46225-002-07	Ammeter	1
7	45865-002-16	Oil Pressure Meter	1
8	45865-003-04	Water Temperature Meter	1
9	45915-012-04	Fuel Level Meter	1
10	46200-010-05	Push-Pull Switch	4
11	46200-003-75	Ignition Switch	1
12	46165-002-72	Circuit Breaker 30A	1
13	46165-001-41	Circuit Breaker 30A	3
14	46270-004-04	Socket, Panel Light	3
	46270-002-37	Bulb, Panel Light	3
15	46270-005-03	Socket, Gauge Light	4
	46270-001-36	Bulb, Gauge Light	4
16	46165-001-40	Circuit Breaker 10A	1
17	46165-004-79	Circuit Breaker 15A	3
18	46260-001-78	Bus Bar	1
	46260-001-10	Terminal Block	1
19	435-060	Screw, #6-32 x 9/16" Round Head NC	4
19	440-007	Nut, #6-32	4
	7438-021	Shakeproof, -6	4
	7435-076	Screw, -8-32 x 9/16" Round Head NC	10
20	7440-008	Nut, -8-32	10
	7438-022	Shakeproof, -8	10
21	7504-055	Screw, #8-32 x 3/4" Binding Head	8

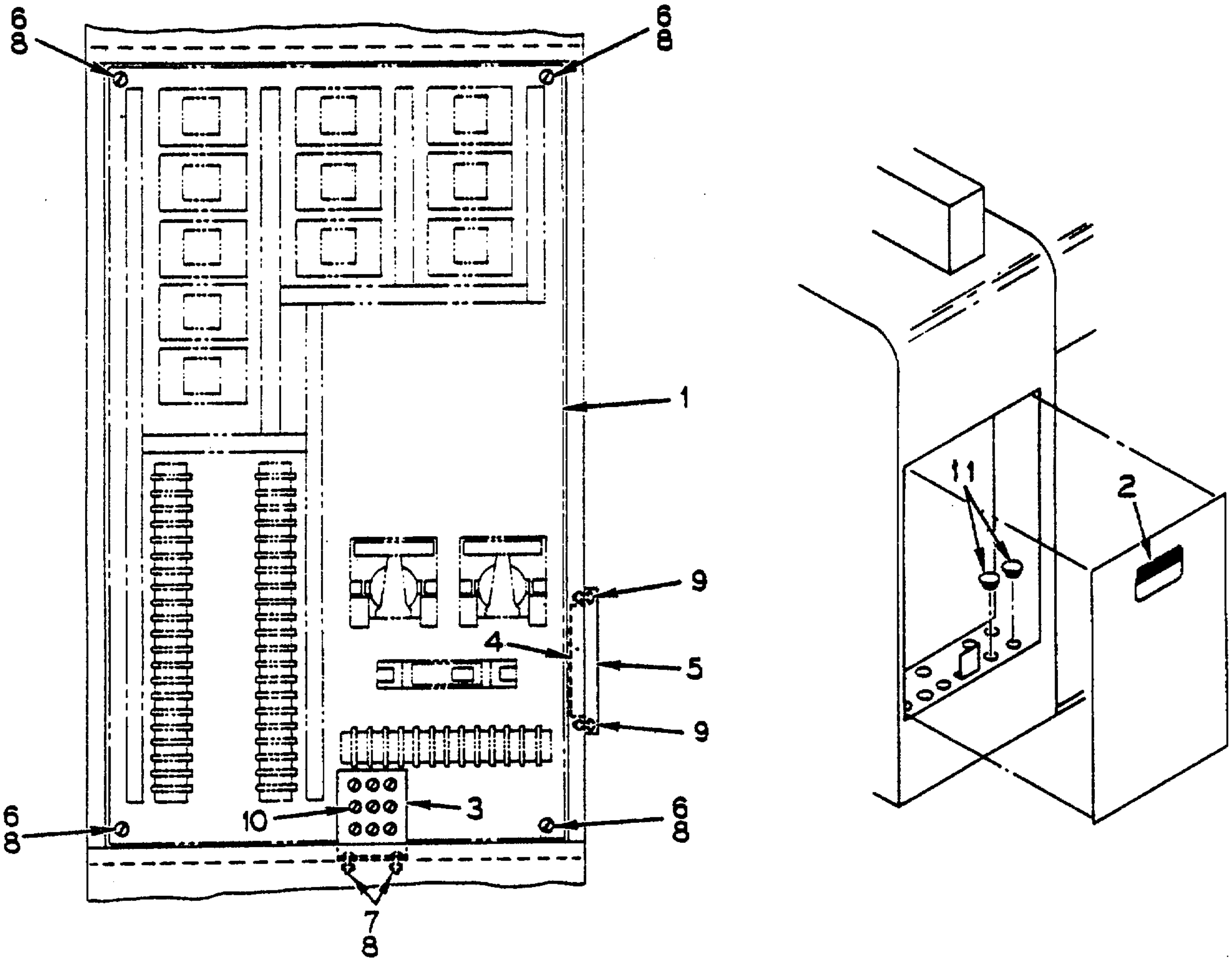
CONTROL CONSOLE



CONTROL CONSOLE

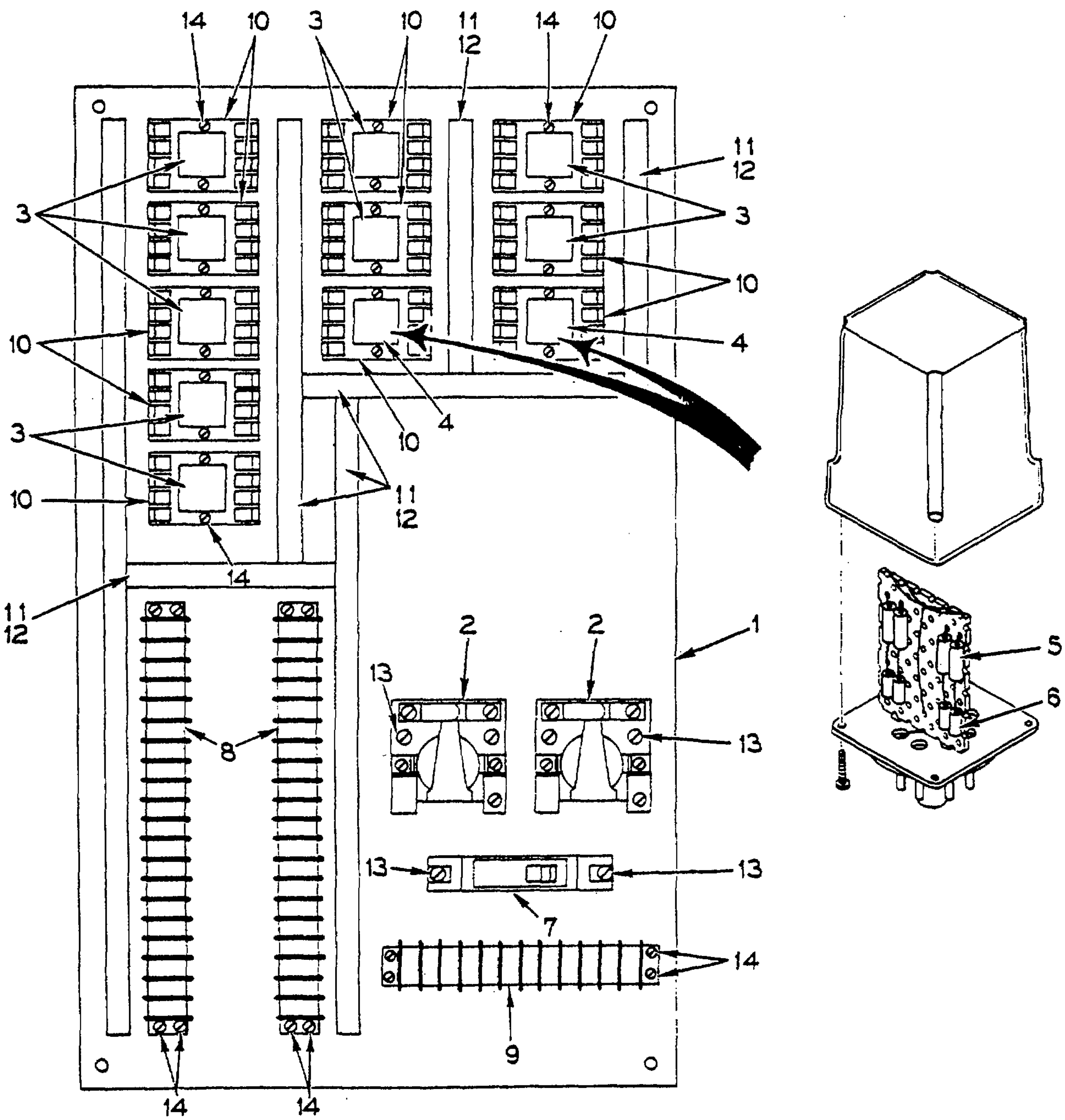
REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
	9704-402-52	Control Console - Complete With Cover	1
1	5036JJC12	Cover	1
2	9704-401-63	Box, Console	1
3	46200-009-06	Switch	1
4	46200-009-08	Switch	3
5	46200-009-21	Switch	3
6	46200-009-11	Switch	1
7	46200-009-18	Switch	1
	{ 46200-009-08	Switch	2
8	46955-001-35	Diode	
9	5036JG09-01	Support, Console	1
10	5036JJC04	Yoke, Console Mount	1
11	7014-017	Washer, 5/16" Flat	4
12	7056-026	Nut, 5/16" Wing	2
13	4418-296	Instruction Decal	1
14	9704-402-51	Cable, Control Console to Rear Junction Box	1
15	46026-016-03	Locknut	1

CONTROL BOX PARTS



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	9704-402-53	See Control Box Panel - This Section	1
2	4418-220	Decal	1
3	5036JG02-04	Ground Plate	1
4	46313-001-01	Duplex, Outlet	1
5	46313-002-19	Cover, Outlet	1
6	7435-134	Screw, ¼"-20 x 5/8"	4
7	7435-132	Screw, ¼"-20 x -½"	2
8	7438-025	Lockwasher, ¼"	6
	7504-037	Screw, #6-32 x ½"	2
9	7438-021	Lockwasher, #6	2
	7440-007	Nut, #6-32	2
	7504-069	Screw, #10-32 x 3/4"	9
10	7438-023	Lockwasher, #10	9
	7440-023	Nut, #10-32	9
11	46295-001-01	Hole Covers, a" CDT	2

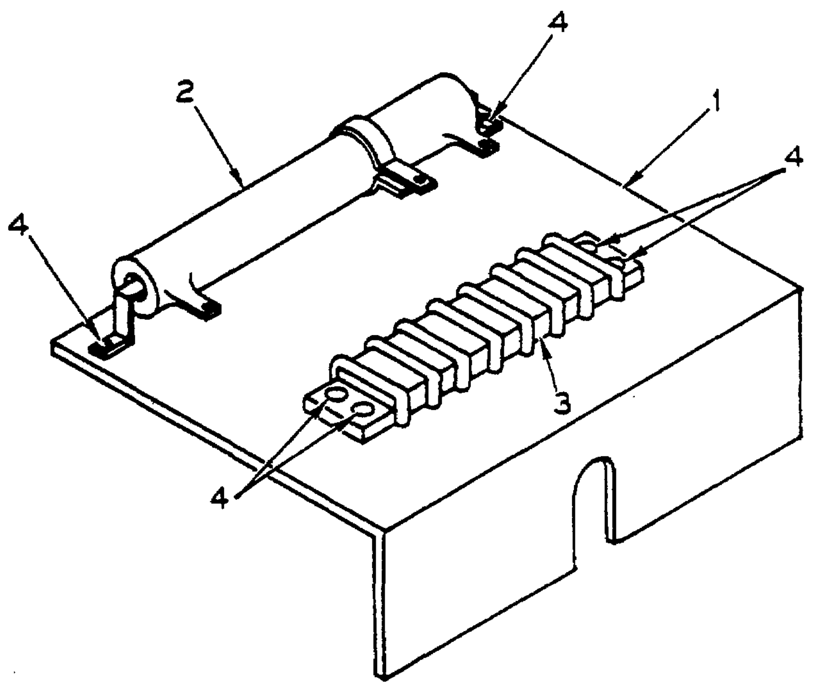
CONTROL BOX PANEL



CONTROL BOX PANEL

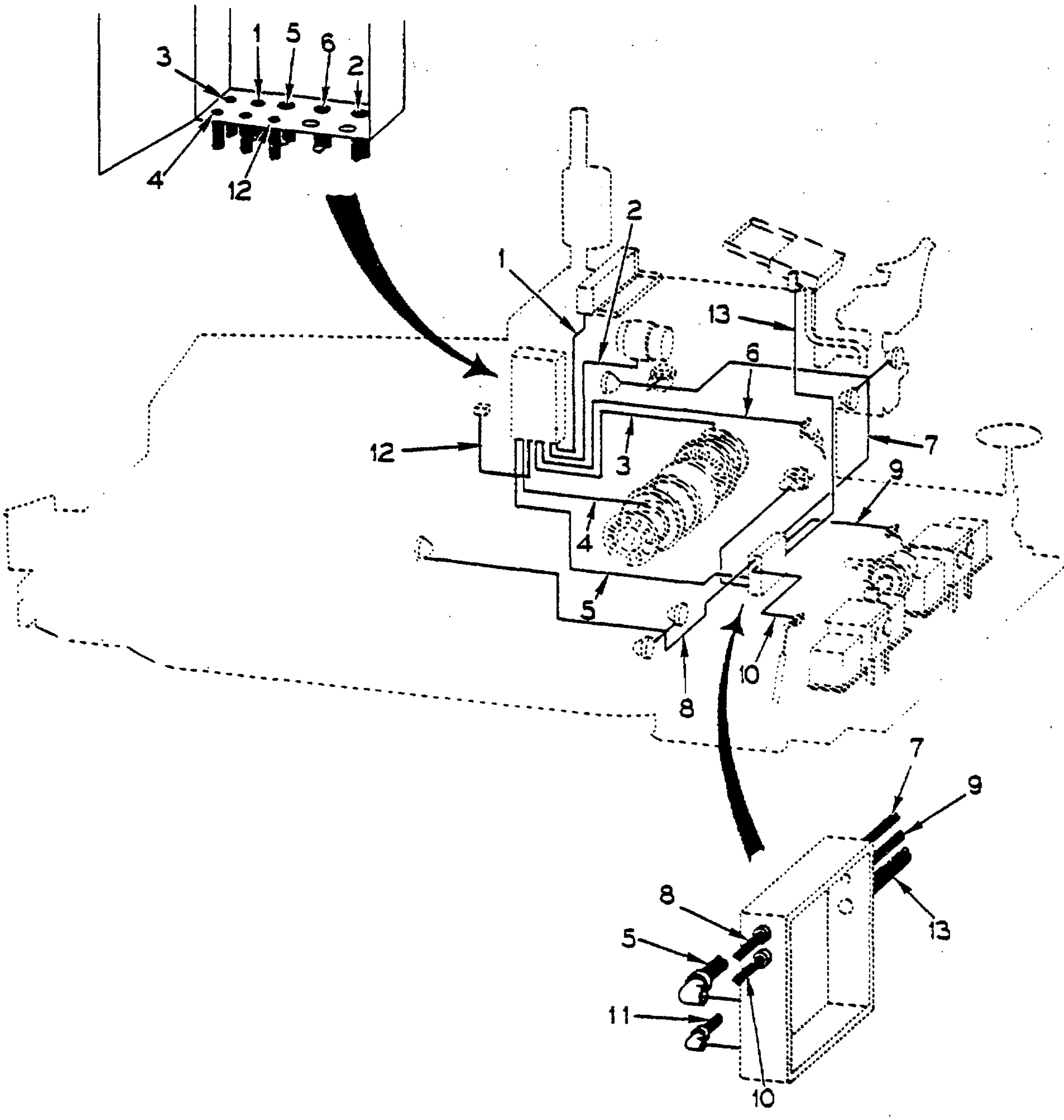
REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
	9704-402-53	Panel - Complete	1
1	9704-401-05	Panel, Mounting	1
2	46325-002-16	Relay	2
3	46325-001-52	Relay	9
4	9800-019	Module, Bleeder	2
5	46960-002-54	Resistor	8
6	46955-001-35	Diodes	8
7	46165-002-93	Break, 30A	1
8	46260-001-10	Terminal Block	2
9	46260-001-04	Terminal Block	1
10	46015-001-13	Socket, Octal	11
11	56000-003-01	Panduit, 1/2" x 1-1/4"	6.0’
12	45345-001-02	Tape, Double-Sided	6.0’
13	7504-052	Screw, #8-32 x 1/2"	6
	438-022	Lockwasher, #8	6
	7504-037	Screw, #6-32 x 1/2"	34
14	438-021	Lockwasher, #6	34
		Not Shown	
15	9704-402-55	Control Box Wire Harness - Complete	1

PAD, BRAKE



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
	9704-402-40	Pad, Brake - Right Hand - Complete	1
	9704-402-41	Pad, Brake - Left Hand - Complete	1
1	9704-400-72	Pad, Mounting	1
2	46960-002-70	Resistor	1
3	46260-001-14	Terminal Block	1
4	7435-061	Screw, #6-32	6
	7438-021	Lockwasher, -#6	6
	7440-007	Nut, #6-32	6

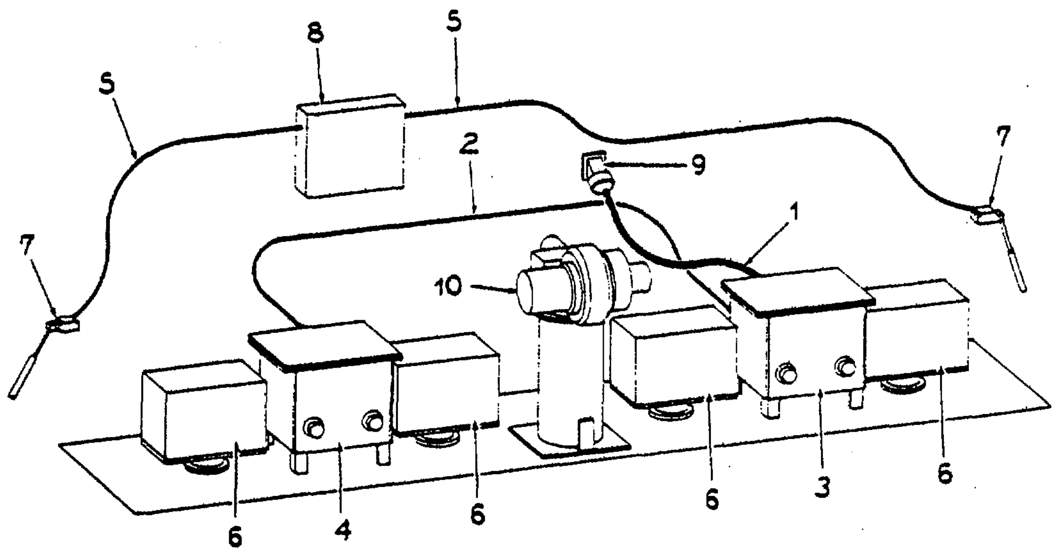
ELECTRICAL CABLES



ELECTRICAL CABLES

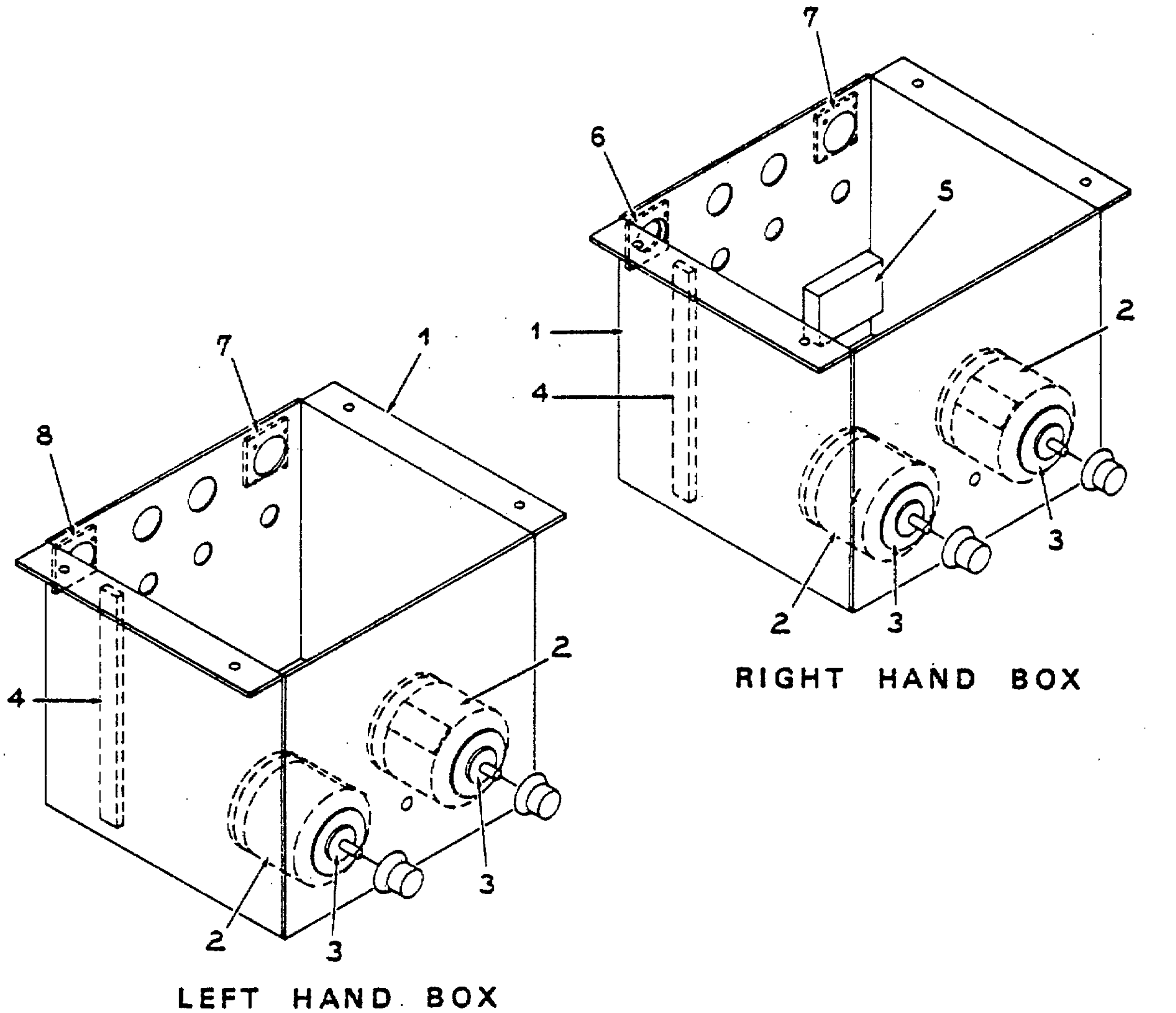
REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	9704-402-54	Conduit, Meter Box to Control Box	1
2	9704-400-84	Conduit, A.C. Generator to Control Box	1
3	9704-402-42	Cable, Control Box to Right Hand Brake	1
4	9704-402-43	Cable, Control Box to Left Hand Brake	1
5	9704-402-49	Cable, Control Box to Rear Junction Box	1
6	9704-400-78	Cable, Control Box to Screed Receptacle	1
7	9704-402-46	Cable, Right Hand Lights to Junction Box	1
8	9704-402-47	Cable, Left Hand Lights to Junction Box	1
9	9704-402-44	Cable, Limit Switch to Junction Box - Right Hand	1
10	9704-402-45	Cable, Limit Switch to Junction Box - Left Hand	1
11	9704-402-48	Cable, Junction Box to Solenoid Bank	1
12	9704-402-50	Cable, Control Box to Forward-Reverse Limit Switch	1
13		See Control Console - Cable-Console to Junction Box - This Section	1

ELECTRICAL PARTS - SCREED



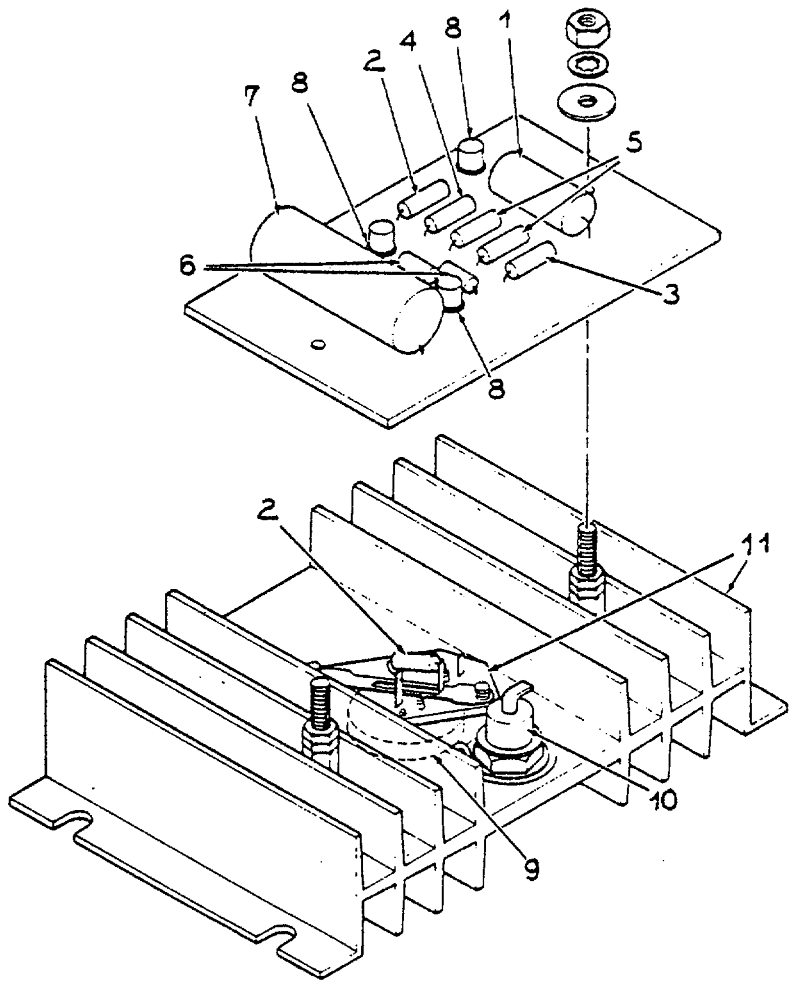
REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	9704-600-57	Cable, 10/4 to Paver	1
2	9704-600-56	Cable, Left Hand to Right Hand Box	1
3	9704-600-52	See Screed Electrical Box - Right Hand - This Section	1
4	9704-600-53	See Screed Electrical Box - Left Hand - This Section	1
5		See Electrical Cables - This Section	
6	46950-001-11	See Vibrator - Form # 7513 - This Section	4
7		Limit Switch - See Base Electrical Parts - This Section	
8		Junction Box - See Base Electrical Parts - This Section	
9		Receptacle - See Base Electrical Parts - This Section	
10		See Screed Oil Burner - Section 5	

SCREED ELECTRICAL BOX

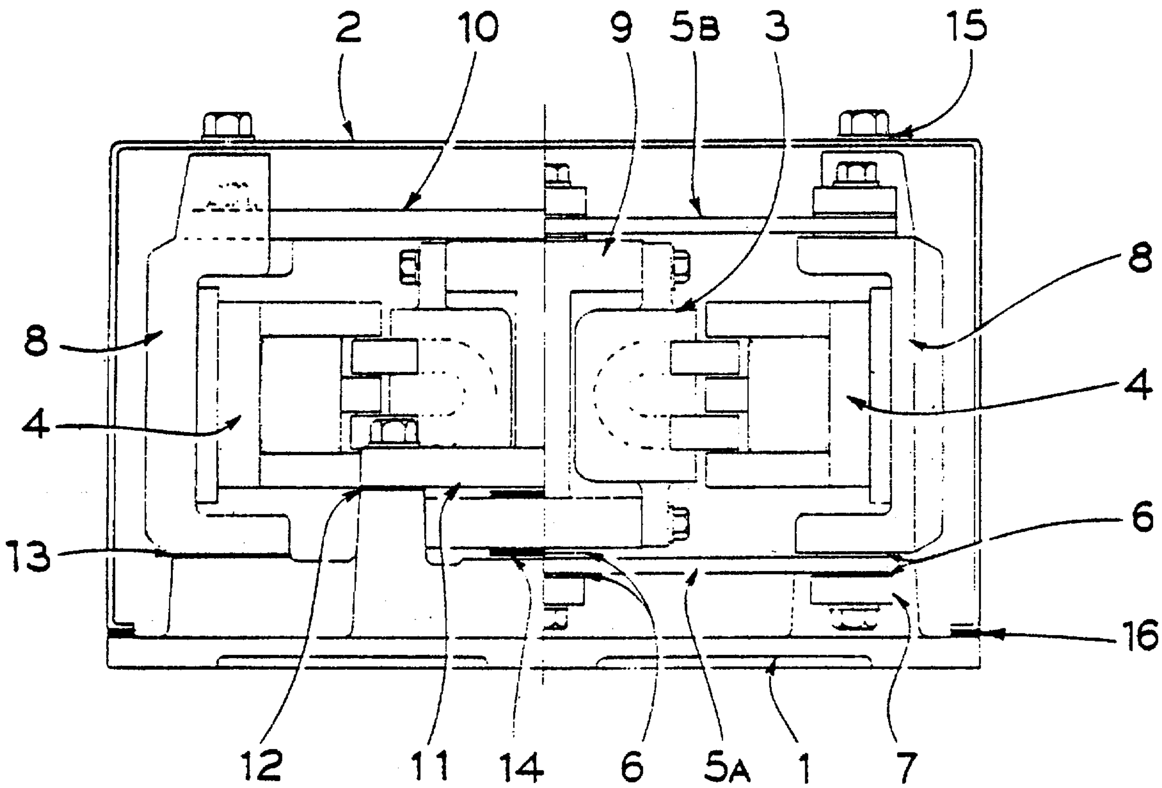


REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	9704-600-51	Box	2
2	46245-251-11	Auto-Transformer	2
3	5036PDG02	Washer, Rubber	2
4	46260-001-05	Terminal Block	1
S	9704-600-06	Pulsator - See Form # 14356 - This Section	1
6	9800-643	Plate	1
7	9800-738	Plate	2
8	9800-626	Cover	1

PULSATOR



REF.NO.	PART NUMBER	DESCRIPTION	QUANTITY
	9704-600-06	Pulsator - Complete	1
1	46960-002-65	Resistor	1
2	46960-002-30	Resistor	2
3	46960-002-63	Resistor	
4	46960-002-47	Resistor	1
5	46960-002-64	Resistor	2
6	46180-001-18	Capacitor	2
7	46180-001-22	Capacitor	
8	46955-002-01	Transistor	3
9	46955-002-07	Transistor	1
10	46955-001-37	Diode	
11	46955-003-02	Heat Sink	


2
10
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5B
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6
16
12
11
14
6
5A
1
7

SCREED VIBRATOR

REF.NO.	PART NUMBER	DESCRIPTION	*QUANTITY
	46950-001-11	Vibrator - Complete	
1	46950-520-01	Base Casting	1
2	46950-505-03	Cover	1
3	46950-510-02	Armature Assembly	2
4	46950-521-01	E-Frame Assembly	2
5		Spring	
	46950-501-05	(a) Bottom	1
	46950-501-06	(b) Top	1
6	46950-504-02	Spacer, Spring	14
7	46950-506-02	Clamp, Spring	6
8	46950-522-01	Support, End	2
9	46950-523-01	Hammer Assembly	1
10	46950-524-01	Rod, Tie	2
11	46950-525-01	Bar, Strike	2
12	46950-518-02	Shim, Strike Bar	As Req.
13	46950-518-03	Shim, End Support	As Req.
14	46950-526-01	Pads, Impact	Set of 4
15	46950-513-10	Grommet, Capscrew - Cover	4
16	41733-003-03	Seal, Neoprene	4.6'

*NOTE: Quantities Shown are for One vibrator Only. When Ordering always give Eriez Model Number and Serial Number.

PART VII

SUPPLEIMNTAL OPERATING, MAINTENANCE, AND REPAIR PAIRTS INSTRUCTIONS

FOR

PAVING MACHINE, BITUMINOUS MATERIAL, CRAWLER-MOUNTED DIESEL-ENGINE-DRIVEN

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SECTION I

GENERAL

1-1. Purpose. To provide User and Support personnel supplemental maintenance and repair parts instructions that have special application for the Paving Machine - Model BSF-400.

1-2. Scope. This publication applies to Department of the Army Units, Organizations and Activities that use and/or support the Paving Machine, Bituminous Material, Crawler - Mounted.

1-3. Description. The Paving Machine, Bituminous Material, Crawler Mounted is designed to lay a uniform high density mat of asphalt material, on highways, roadways, airport runways, parking lots, and driveways. It is capable of performing jobs having strict control specifications and high production requirements.

The paver will level and compact asphalt material up to 10 inches in depth with mat widths varying from 6 to 20 feet. Mat depth and width are accomplished by adjustment of feed controls and by arrangement and adjustment of the finishing and compacting device called the "screed."

1-4. Operational Concept. The uniformly mixed hot asphalt material is dumped by truck onto the hopper of the paver at a rate suitable for spreading. The paver contacts the rear wheels of the truck and pushes the vehicle ahead as the paving progresses. The hot material is metered by two separate slat conveyors to the two spreading screws at the rear of the tractor and ahead of the screed where the feed of material may be manually or automatically regulated for proper distribution. The screed rides up on the asphalt to the degree set on the adjustable controls and varies the thickness and contour of the mat deposited beneath it. The screed unit is equipped with electric vibrators which assist in the initial compaction and smoothing of the high density mat. Final compaction is accomplished by separate rolling equipment.

Numerous cut-off and leveling attachments meet the need for varying width and contour requirements.

The screed is equipped with an oil fired heater which is operated prior to paving, in order to bring the screed temperature up to the temperature of the asphalt so that no sticking or dragging will occur.

Raising and lowering of the full floating screed for paving or travel is done hydraulically by toggle switch control.

1-5. Procurement Status. The procurement contract number is IDA 700-77- C-8481 and was awarded on 15 August 1977. Additional Pavers were procured under Contract Number DAAE07-79-C-5795, dtd 29 Jun 79.

1-6. Equipment Publications.

a. Initially two sets of the manufacturer's commercial publications will be overpacked and shipped with each paver (reference Appendix a).

b. Additional commercial manuals may be obtained by requisitioning from Defense Construction Supply Center (DCSC). Requisitions to DCSC should be prepared in the same manner as for part numbered repair parts, using the Federal Supply Code for manufacturer's FSCM and manual numbers listed in Appendix A. If DD Form 1348-6 is used, mail it direct to Commander, DCSC, ATTN: DCSC-OSR, Columbus, OH 43215.

c. If additional assistance is required, contact the address in paragraph 1-10 of this publication.

1-7. Personnel and Training.

a. MOS Requirements:

(1) Operator: 62H20, Concrete/Asphalt Equipment Operator.
(2) Organizational Maintenance: 62B20, Construction Equipment Repairman.
(3) Direct and General Support Maintenance: 62B30, Construction Equipment Repairman; 63G20, Fuel and Electrical Systems Repairman, 44B20 Metal Body Repairman.

b. New Equipment Training: New Equipment Training Teams (NETTs) are available to major field commands. Requests for NETTs should be forwarded to Commander, US Army Tank-Automotive Materiel Readiness Command (TARCOM), ATTN: DRSTA-MLT, Warren, MI 48090. Training teams should be requested only when trained personnel are not available in the command to operator and/or maintain the paving machine.

1-8. Logistics Assistance.

a. Tank-Automotive Command Field Maintenance Technicians (FMTs) stationed at CONUS and OCONUS installations will be fully qualified and available to furnish on-site training and or assistance concurrent with receipt of the paving machine.

b. Assistance can be obtained by contacting the Logistics Assistance Office listed in Appendix B of AR 700-4.

1-9. Warranty. The paving machine contractor warrants the products furnished under this contract according to the terms and conditions described in the equipment publications and Appendix B of this publication. All warranties furnished to the paving machine contractor by subcontractors of assemblies or components utilized in the manufacture of the end item will be extended to the Government. See Appendix B for warranty guidelines.

1-10. Reporting. You can improve this publication by recommending improvements, using DA Form 2028 (Recommend Changes to Publications and Blank Forms) and mail direct to Commander, US Army Tank-Automotive Materiel Readiness Command, ATTN: DRSTA-MBA(S), Warren, MI 48090.

SECTION II

MAINTENANCE

2-1. Maintenance Concept. The paving machine will not require any new or special maintenance considerations. All maintenance functions can be accomplished within the current maintenance concepts established for construction equipment.

a. Operator/Crew Maintenance: Operator and crew maintenance is limited to daily preventive maintenance checks and services.

b Organizational Maintenance: Organizational maintenance consists of scheduled preventive maintenance services, minor repairs and adjustments.

c. Direct Support Maintenance: Direct support maintenance consists of repairs on-site or in a direct support unit's shops. Repairs are accomplished with a minimum of tools and test equipment; the assemblies and end items thus repaired are returned to their users.

d. General Support Maintenance: General support maintenance overhauls selected assemblies and repairs items designated by the area support command for return to stock.

e. Depot Maintenance: Depot maintenance overhauls end items and selected major assemblies when they are required to satisfy overall Army requirements. Overhaul of the end item may also be performed by contract with the manufacturer.

2-2. Maintenance Allocation Chart. Maintenance will be performed as necessary by the category indicated in the Maintenance Allocation Chart (MAC) (Appendix C) to retain or restore serviceability. All authorized maintenance within the capability of a using organization will be accomplished before referring the item to support maintenance. Higher categories will perform the maintenance functions of lower categories when required or directed by the appropriate Commanders. Using and support units may exceed their authorized scope and functions in the MAC when approval is granted by the next higher support maintenance Commander.

2-3. Modifications. Modifications will be accomplished by the end item manufacturer after TARCOM approves the field campaign or modification plan. See Appendix D.

2-4. Equipment Improvement Recommendations (EIR). Equipment Improvement Recommendations will be submitted in accordance with TM 38-750.

2-5. Equipment Readiness Reporting. Readiness Reporting will be accomplished as required by the current TM 38-750.

2-6. Maintenance Expenditure Limits. The average life expectancy for the paver is 12 years.

PECENT OF REPAIR	YEAR
50%	1981
45%	1983
40%	1985
35%	1987
30%	1989
20%	1991
10%	1993

2-7. Shipment and Storage.

a. Shipment and Storage. Refer to TB 740-94-2 for procedures covering preservation of equipment for shipment and storage.

b. Administrative Storage. Refer to TM 740-90-1 for instructions covering administrative storage of equipment.

2-8. Destruction to Prevent Enemy Use. Refer to TM 7593-244-3 for procedures covering destruction of equipment to prevent enemy use.

2-9. Fire Protection.

a. A hand operated fire extinguisher may be installed at the discretion of the using unit.

b. Approved hand-portable fire extinguishers are listed in TB 5-4200-200-10.

2-10. Basic Issue Items List (BILL). See Appendixes E and F for a list of items which accompany the end item or are required for operation and/or operator's maintenance.

2-11. Maintenance and Operating Supply List. See Appendix M for a list of maintenance and operating supplies required for initial operation.

2-12. Special Tools and Equipment. No special tools or equipment are required for operation and maintenance of the paving machine.

2-13. Maintenance Forms and Records. Operational, maintenance, and historical records will be maintained as required by the current TM38-750.

SECTION III

REPAIR PARTS SUPPLY

3-1. General.

a. The basic policies and procedures in AR 710-2, AR 725-50 and DA CIR70)-27 are applicable to repair parts management for construction equipment.

b. Manufacturer's parts manuals are furnished with paver instead of Department of the Army Repair Parts and Special Tool List (RPSTL).

c. National Stock Number (NSNs) are initially assigned only to PLL/ASL parts and major assemblies, i.e., engines, transmissions, etc. Additional NSNs are assigned by the supply support activities as demands warrant.

d. Automated Processing (AUTODIN) of Federal Supply Code Manufacturer (FSCM) part number requisitions, without edit fair matching NSNs and exception data, is authorized.

e. Proper use of project codes and weapon systems designator codes on parts requisitions is essential.

f. Repair parts are available from commercial sources and may be purchased locally in accordance with AR 711-2 and AR 734-110.

g. Initial Prescribed Load List (PLL) and Authorized Stock List (ASL) will be distributed by US Army Tank-Automotive Materiel Readiness Command (TARCOM), ATTN: DRSTA-FH.

3-2. Prescribed Load List (PLL). The PLL distributed by TARCOM is an estimated 15 days supply recommended for initial Blockage at organizational maintenance. Management of PLL items will be governed by the provisions of AR 710-2 and local command procedures. Selection of PLL parts for shipment to CONUS/OCOOIUS units is based upon the receiving Command's recommendation after their review of the TARCOM prepared list. Organizations and activities in CONUS/OCONUS will establish PLL stocks through normal requisitioning process.

3-3. Authorized Stockage List (ASL). The ASL distributed by TARCOM is an estimated 45 days supply of repair parts for support units and activities. The ASL parts will be shipped according to the recommendations of the receiving commands, after they have reviewed the initial list distributed by TARCOM. Support units and activities in CONUS/OCONUS will establish ASL stocks through normal requisitioning process.

3-4. Requisitioning Repair Parts.

a. Using Units/Organizations: Requisitions (DA Form 2765 Series) will be prepare(d according to AR 710-2 and local command directives. Units in CONUS will use Project Code "BGW" In block 19. Units OCONUS will enter in block 19 Project Code "JZC", see Appendix H.

b. Support Units and Activities:

(1) General: All MILSTRIP requisitions (DD Form 1348 Series) prepared for repair parts support will include distribution and Project Codes, see Appendixes I, J, and K.

(2) Distribution Code: Supply customers in CONUS will use code "F" in card column 54. Customers OCONUS will use the appropriate code from Appendix P, Paragraph P-31(1) AR 725.50.

(3) Project Codes: The applicable Project Code will be entered in card columns 57-59 of requisitions for NSN parts, whether CONUS or OCONUS customers. Project Code "BGW1" will be used by CONUS customers when requisitioning part numbered parts. Supply customers OCONUS will use Project Code "JZC" for part numbered parts.

3-5. Submitting Requisitions.

a. Using Units and Organizations will submit DA Form 2765 Series requisitions to designated support units or activities in accordance with local procedures.

b. Support units and activities will forward MILSTRIP requisitions for NSN parts through the Defense Automated Addressing System (DAAS) to the managing Supply Support Activity. Requisitions for part numbered part will lie forwarded through DAAS to the Defense Construction Supply Center (DCSC).

NOTE: When the manufacturer's part number and Federal Supply Code for Manufacturer (FSCM) exceed the space in card columns 8 through 22 of A02/AOB requisitions, prepare an A05/AOE requisition (DD Form 1348-6) and mail it to Commander, Defense Construction Supply Center, ATTN: DCSC-OSR, Columbus, Ohio 43215.

APPENDIX A
REFERENCES

A-1. Publications

Logistic Assistance Program ....AR 700-4
Material Management for Using Units,
Support Units and Installations..AR 710-2
Requisitioning Receipt, and Issue System ....AR 725-50
Indexes should be consulted frequently for latest changes of revisions of references and for new publications relating to material covered in this publication.
Index of Administrative Publications...DA PAM 310-1
Index of Blank Forms ....DA PAM 310-2
Index of Doctrinal Training and Organization Publications...DA PAM 310-3
Index of Technical Manuals, Technical Bulletins, Supply Manuals
(Types 7, 8, and 9), Supply Bulletins and Lubrication Orders ....DA PAM 310-4

A-2. Forms.

Refer to TM 38-750, The Army Maintenance Management System (TAMMS), for instructions on the use of maintenance forms pertaining to the materiel.

A-3. Other Publications.

The following publications contain information pertinent to the major item and associated equipment.

a. Camouflage.
Camouflage ....FM 5-20

b. Decontamination.
Chemical, Biological, and Radiological (CBR) Decontamination......................................TM 3-220
Nuclear, Biological and Chemical Defense...FM 21-40

c. General.
Utilization of Engineer Construction Equipment..TM 5-331b
Basic Cold Weather Manual..FM 31-70
Northern Operations..FM 31-71
Operation and Maintenance of Ordnance Materiel in Cold Weather (0°to -65° F)..........FM 9-207
Procedures for Destruction of Equipment to Prevent Enemy Use ....TM 750-244-3

d. Maintenance and Repair

Inspection, Care and Maintenance of Antifriction Bearings....................TM 9-214
Welding Theory and Application....................TM 9-237
Hand Portable Fire Extinguishers Approved for Army Users....................TB 5-4200-200-10

e. Administrative Storage.

Administrative Storage of Equipment....................TM 740-90-1
Preservation of USAMECOM Mechanical Equipment for
Shipment and Storage....................TB 740-97-2

APPENDIX B
WARRANTY GUIDELINES

1. A warranty period of 12 months applies to the Paving Machine, Model BSF-400, manufactured by IOWA Mfg. Co. after delivery to the Government. This warranty applies to the end item, components and all supplies furnished under the contract.

2. Using units may not contact their local dealer. You must mail DA Form 2407 to the Maintenance Directorate, TARCOM, at the following address: US Army Tank-Automotive Material Readiness Command, ATTN: DRSTA-MVB, Warren Michigan 48090. To expedite actions you may call the information to AUTOVON 273-3349, 3439, or 3387 with the information from your DA 2477, section 1, block 1 through 11, blocks 16, 17, 18 and 20.

3. General information:

a. DA Form 24)7 (prepared in accordance with warranty claim actions in TM 38-750) will be used to submit warranty claims actions for end items when components, parts or assemblies are defective and are covered by a manufacturer's warranty. End items under warranty are identified by a decal plate and/or warranty statement included in the operator's and maintenance manual for the end item. <u>All warranty actions</u> settled or unsettled <u>will be reported to the National Maintenance Point (NMP)</u> on DL Form 2407. For warranties settled locally the DA Form 2407 will contain a statement "For Information Only" in block 35.

b. Maintenance activities in support of organizational maintenance are the responsible points of contact between the originator of warranty claims and the National Maintenance Point (US Army Tank-Automotive Material Readiness Command, DRSTA-MVB, AUTOVON 273-3349, 273-3439, 273-3.387, Warren, Michigan 48090, which serves as the DL Representative with the contractor. in warranty matters. NOTE: In certain instances, the originating organization and the support activity are one and the same.

c. Before you take your equipment to a dealer for repair, whether or not it was necessary for you to go through the NMP (TARCOM), check with your local procurement office to see if a funds commitment document is needed. Sometimes, even though the majority of the repairs are covered by the warranty, there may be a small charge for normal maintenance costs, i.e., oil filters, oil, etc. Further, the cause of damage could be determined by the dealer to be directly related to "operator abuse." In that case, the Government may be obligated to pay for teardown services even if the repairs are no longer desired, or for the complete cost if repairs are to be completed by the dealer.

d. When the equipment is given to the dealer for repairs, find out how long the work will take, the extent of the problem, if possible, and the charges, if any, which may be involved. Leave the name and telephone number of the person to be contacted for pickup of the equipment and specifically state that he should be called as soon as the repairs are finished. In addition, state he should be telephoned if unexpected problems, costs and/or delays are encountered. Get the name and telephone number of the Service Manager, for any required follow-up purpose".

e. When you arrive to pick up your equipment after completion of services, make certain that you know exactly what repairs were performed and/or parts replaced. This is required for overall problem trend evaluation by the IMP and must be identified upon completion of warranty services.

f. Telephone the NMP at TARCOM, AUTOVON 273-3349, 273-3439, and/or 273-3383 if:

(1) Your equipment requires repairs and you cannot obtain these services using the procedures listed above.

(2) The length of time required for repairs may seriously hamper your mission, or if the dealer's overall response to your requirements are not satisfactory.

(3) You have any questions regarding warranty procedures - either in general or about a specific job. Do not wait until your problems become critical.

g. <u>Do not attempt to conduct negotiations regarding a breach of warranty.</u> This is a function of the Contracting Officer, through the NMP at TARCOM.

APPENDIX C

MAINTENANCE ALIOCATICN CHART
FOR
Paving Machine, Bituminous Material, Crawler Mtd.

Section I. INTRODUCTION

1. General: This Maintenance Allocation Chart designates responsibility for performance of Maintenance functions to specific Maintenance categories.

2. Maintenance functions:

a. Inspect: To determine the serviceability of an item by comparing its physical, mechanical and/or electrical characteristics with established standards through examination.

b. Test: To verify serviceability and detect incipient failures by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service: Operations required periodically to keep an item in proper operating condition, i.e., to clean (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

d. Adjust: To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

e. Align: To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate: To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipment used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install: The act of emplacing, seating, or fixing into position an item, part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

h. Replace: The act of substituting a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i. Repair: The application of maintenance services or other maintenance actions to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. Overhaul: That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. Rebuild: Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours/miles, etc) considered in classifying Army equipments/components.

3. Column entries: Columns used in the Maintenance allocation chart are explained below:

a. Column 1, Group Number: Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column 2, Component/Assembly: Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Functions: Column 3 lists the functions to be performed on the item listed in Column 2.

d. Column 4. Maintenance Category: Column 4 specifies, by the listing of a "work time" figure in the appropriate subcolumn(s), the lowest level of maintenance authorized to perform the function listed in Column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate "work time" figures will be shown for each category. The number of manhours specified by the "work time" figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the Maintenance Allocation Chart.

e. Column 5, Tools and Equipment: Column 5 specifies by code those common tool sets (not individual tools) and special tools, test, and support equipment required to perform the designated function.

f. Column 6, Remarks: Column 6 contains an alphabetic code which leads to the remark in Section IV, Remarks, which is pertinent to the item opposite the particular code.

APPEDIX C

Section II. MAINTENANCE: ALLOCATION CHART
Paving Machine, Bituminous Material, Crawler, Mtd.

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQUIP	(6) REMARKS
01	Engine							1,2,3,4	
0100	Engine Assembly	Test		2.0					
		Service	0.1						
		Replace			16.0				
		Repair			21.0				
		Overhaul				48.0			
	Engine Mounts	Replace			3.0				
0101	Cylinder Block	Test				5.0		1,2,3,4	
		Replace				4.0			
		Repair				20.0			
	Cylinder Sleeve	Replace				3.0			
	Cylinder Head	Replace			4.0				
		Repair				4.0			
		Overhaul				8.0			
0102	Crankshaft	Replace				5.0		1,2,3,4	
	Main Bearings	Replace				4.0			
	Drive Pulley	Replace		2.0					
0103	Flywheel	Replace			3.0			1,2	
0104	Pistons & Connecting Rods	Replace				3.0		1,2	
		Repair				2.0			
	Rings & Bearings	Replace				.5			
0105	Rocker Arms	Replace			.5			1,2	
	Valve Springs	Test				.8			
		Replace				.3			
	Valve Exhaust	Adjust			2.0				
		Replace				1.0			
		Repair				2.0			
	Camshaft, Bearings & Gears	Replace				4.0			
0106	Oil Cooler	Service		.2				1,2	
		Replace			1.0				
	Oil Pan	Replace			1.5				
		Repair			1.0				

*The subcolumns are as follows:
C--operator/crew
O--organizational
F--direct support
H--general support
D--depot
**Work times are included in DMWR

Section II. MAINTENANCE ALLOCATION CHART
Paving Machine, Bituminous Material, Crawler, Mtd.

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQUIP	(6) REMARKS
	Oil Pump	Replace			.8				
		Repair			2.0				
	Oil Pressure Regulator	Adjust			.2				
		Replace			.5				
	Oil Filter Assembly	Service		.5					
		Replace			1.0				
	Oil Filter Element	Replace		.5					
0108	Exhaust Manifold	Replace			1.0			1,2,3,4	
		Replace			1.0				
02	Clutch							1,2	
0200	Clutch Assembly	Replace			8.0				
		Repair			4.0				
	Drive Ring	Replace			8.0				
	Clutch Housing	Replace			6.0				
		Repair			2.0				
0200	Throwout Fork Bearings	Service			.5				
		Replace			6.0				
	Clutch Lever Shaft / Linkage	Service		1.0					
		Adjust		1.0					
		Replace		4.0					
		Repair		2.0					
03	Fuel System								
0301	Fuel Injector	Test			1.0			1,2	
		Replace			1.5				
0302	Fuel Pump	Replace		1.0				1,2	
		Repair			1.0				

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APPENDIX C

Section II. MAINTENANCE ALLOCATION CHART
Paving Machine, Bituminous Material, Crawler, Mtd.

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQUIP	(6) REMARKS
0304	Air Cleaner	Service	0.4					1	
		Replace		1.0					
		Repair		.5					
	Air Cleaner Element	Replace	0.5						
0305	Blower Air Intake	Service		0.3				1,2	
		Replace			1.0				
		Repair			2.0				
	Air-Shut Down	Adjust			0.5				
		Replace			1.5				
		Repair			2.0				

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Section II. MAINTENANCE ALLOCATION CHART
Paving Machine, Bituminous Material, Crawler, Mtd.

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQUIP	(6) REMARKS
0306	Tank Fuel	Service		.2				1,2	
		Replace			1.5				
		Repair				1.0			
	Lines & Fittings	Replace		1.0					
0308	Governor Engine Speed	Test			0.5			1,2	
		Adjust			0.5				
		Replace			1.0				
		Repair				2.0			
	Controls & Linkage	Adjust			.1				
		Replace			.4				
0309	Fuel Filters	Service	.2					1	
	Fuel Filter Element	Replace		.5					
04	Exhaust System								
0401	Muffler							1	
	Exhaust Pipes	Replace		1.0					
		Repair		1.0					
05	Cooling System								
0501	Radiator	Service	.2					1,2	
		Replace			2.0				
		Repair				2.0			
	Thermostat	Replace		1.0					
	Hoses & Clamps	Replace		0.5					
0504	Water Pump	Replace		2.0				1,2	
		Repair			1.0				
0505	Fan Assembly	Replace		1.0				1	
		Repair			1.0				
	Fan Guard	Replace		1.0					
		Repair		1.0					
	Fan Belts	Inspect		0.1					
		Adjust		0.5					
		Replace		1.0					

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Section II. MAINTENANCE ALLOCATION CHART
Paving Machine, Bituminous Material, Crawler, Mtd.

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQUIP	(6) REMARKS
06	Electrical System							1,2,5	
0601	Alternator	Test		.1					
		Replace		.5					
		Repair			1.5				
	Generator	Test		.1					
		Replace		.5					
		Repair			1.0				
	Generator & Alternator	Inspect	.1						
	Drive Pully	Repair		.1					
	Alternator & Generator	Inspect	.1						
	Drive Belts	Adjust		.2					
		Replace		.2					
0603	Starting Motor	Test		.1				1,2,5	
		Replace		.5					
		Repair			1.5				
0607	Instrument Panel								
	Accessories	Replace		.5				1,5	
		Replace		.7					
0608	Circuit Breakers	Test		.1				1,5	
		Replace		.3					
0609	Head, Tail, & Conveyor								
	Lights	Replace		.2				1,5	
		Repair		.4					
0610	Flasher	Replace		.2				1,5	
	Limit Switches	Replace		.2					
	Screed Lift Switch	Replace		.2					
0611	Horn Assembly	Replace		.3				1,5	
0612	Batteries Storage	Inspect	0.1					1,5	
		Test		.3					
		Replace		0.5					
		Service	0.2						

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APPENDIX C

Section II. MAINTENANCE ALLOCATION CHART
Paving Machine, Bituminous Material, Crawler, Mtd.

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQUIP	(6) REMARKS
	Battery Cables	Replace		0.4					
		Repair		0.5					
0613	Screed Wiring	Replace		.5				1,5	
		Repair		.5					
	Cross Over Cable	Replace		.2					
		Repair		.5					
	Chassis Wiring	Replace		.5					
		Repair		.5					
07	Transmission							1,2	
0700	Transmission Assembly	Test			1.0				
		Service		0.5					
		Replace			10.0				
		Repair			20.0				
		Overhaul				30.0			
0705	Shifters	Replace			2.0			1,2	
		Repair			5.0				
0719	Transfer Case	Replace			3.0				
		Repair			7.0				
		Overhaul				15.0			
0725	Electrical Brake	Replace			3.0				
15	Frame & Towing Attachments								
1501	Platforms	Replace			2.0			1,2	
		Repair			1.0				
	Drivers Seat	Replace		1.0					
		Repair		1.5					
42	Electrical Equipment (Not in other groups)							1,2,5	
4202	Electrical Controls								
	Screed Vibrators	Replace			2.0				
	Vibrator Transformer	Replace		.2					
	Screed Vibration Adjusting Controls	Replace		1.0					
		Repair			2.0				

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APPENDIX C

Section II. MAINTENANCE ALLOCATION CHART
Paving Machine, Bituminous Material, Crawler, Mtd.

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQUIP	(6) REMARKS
43	Hydraulic System							1,2	
4301	Oil Filter & Air Cap	Replace		.7					
	Oil Filter Element	Replace		.4					
	Oil Strainer, Reservoir	Replace		.5					
	Lines & Fittings	Replace		.5					
		Repair			1.0				
4302	Hydraulic Pump	Replace		1.5				1,2	
		Repair			3.0				
4305	Solenoid Valve	Replace		.5				1,2	
		Repair			1.5				
	Relief Valve	Replace		.3					
		Repair			.5				
	Holding Valve, Screed Lift	Replace		.5					
		Repair			1.5				
	Cylinder, Hopper Lifts	Replace		.6					
		Repair			1.5				
	Cylinder, Screed Lift	Replace		.7					
		Repair			1.5				
60	Heating Unit & Burner							1,2	
6004	Pump Fuel	Replace		.6					
		Repair			1.0				
	Fuel Lines	Replace		.5					
	Fuel Strainer			.3					
6005	Burner Assembly	Replace		.5				1	
		Repair		1.5					
	Nozzle Adapter	Replace		.4					
	Electrodes	Adjust		.2					
		Replace		.3					
	Blower Wheel	Replace		.4					
	Hose & Fittings	Replace		.4					
		Repair		.5					

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APPENDIX C

Section II. MAINTENANCE ALLOCATION CHART
Paving Machine, Bituminous Material, Crawler, Mtd.

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQUIP	(6) REMARKS
6006	Motor Assembly	Replace		.3				1	
6007	Fuel Tank	Replace			1.5			1,2	
		Repair			1.0				
73	Asphalt Equipment Components							1,2	
7303	Screed & Controls								
	Dual Crown Adjusting Mech	Adjust		.5					
		Service	.2						
		Replace			2.0				
		Repair			2.0				
	Chain, Offset Coupler	Adjust		.2					
		Service		.1					
		Replace		.5					
		Repair		1.0					
	Screed	Service		.3					
		Adjust		.5					
		Replace			1.0				
		Repair			3.0				
		Overhaul				8.0			
	Screed Adjusting Mech	Service		.2					
		Replace		.5					
		Repair			1.0				
7304	Hopper Wings	Service	.1					1	
		Replace		.5					
		Repair		1.5					
	Screed Pull Arms	Replace		.4					
7305	Main Drive							1,2,3,4	
	Track	Inspect	.1						
		Service		.2					
		Adjust		.3					
		Replace			2.0				
		Repair			3.0				
	Sprocket, Shaft & Bearings	Replace		1.0					
		Repair			2.0				

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Section II. MAINTENANCE ALLOCATION CHART
Paving Machine, Bituminous Material, Crawler, Mtd.

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQUIP	(6) REMARKS
			C	O	F	H	D		
	Chain	Adjust		.1					
		Replace		1.0					
		Repair			2.0				
	Front Idler	Replace		1.0					
		Repair			1.5				
	Track Spring	Replace		.5					
7305	Take Up Idler & Bearings	Service		.1				1,2	
		Replace			1.0				
		Repair				1.0			
	Upper & Lower Rollers	Service		.1					
		Replace			.5				
	Beam Roller Assembly	Replace		.3					
		Repair			.4				
	Guards: Housing & Covers	Replace		.2					
		Repair			.8				
7307	Feeding & Conveyor Frames							1,2	
	Slat Conveyor	Service	.2						
		Adjust		.2					
		Replace		1.0					
		Repair			1.0				
	Slat Conveyor Liner Assembly	Replace		1.0					
		Repair			1.0				
	Slat Conveyor Chain	Service		.1					
		Replace		1.0					
		Repair			1.0				
7309	Screw Feeder or Conveyor							1	
	Screw Conveyor Bearings & Seals	Service	.2						
		Replace		1.0					
		Repair		1.0					
	Guards & Covers	Replace		.2					
		Repair		.5					

*The subcolumns are as follows:
C--operator/crew
O--organizational
F--direct support
H--general support
D--depot
**Work times are included in DMWR

APPENDIX C

Section II. MAINTENANCE ALLOCATION CHART
Paving Machine, Bituminous Material, Crawler, Mtd.

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQUIP	(6) REMARKS
7309	Grease Fittings & Piping	Service	.1					1,2	
		Replace		.2					
	Chain: Sprocket Bearings & Idler	Service	.1						
		Adjust		.1					
		Replace			2.0				
		Repair			1.0				
	Shaft: Bearings Drive Sprocket: & Chain	Service	.1						
		Replace		.4					
		Repair			.8				
	Screw Extension	Service	.1						
		Replace		.2					
		Repair			.2				
	Remote Screw Control	Adjust	.1						
		Repair		.1					
	Material Retaining Plates	Service	.1						
		Replace		.2					
		Repair		.4					
7313	Screed Vibrator Agitator	Adjust		.2				1,2	
		Replace		.4					
		Repair			.6				
	Screed Extender	Adjust		.1					
		Replace		.6					
		Repair		.8					
	Screed Shim Pack	Adjust		.1					
	Screed Strik Off	Adjust		.2					
		Replace		.4					
		Repair			.6				
	Screed Adjusting Cables	Replace			.5				
76	Fire Fighting Equipment							1	
7638	Portable Fire Extinguisher	Replace		.2					

*The subcolumns are as follows:
C--operator/crew
O--organizational
F--direct support
H--general support
D--depot
**Work times are included in DMWR

MAINTENANCE ALLOCATION CHART FOR PAVING MACHINE, BITUMINOUS MATERIAL

CRAWLER MTD., DED

APPENDIX C

SECTION III - TOOL AND TEST EQUIPMENT REQUIREMENTS

TOOL OR TEST EQUIPMENT REFERENCE CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL / NATO STOCK NUMBER	TOOL NUMBER
		Unless otherwise noted all maintenance functions can be accomplished with the tools contained in the following common two sets.		
1	O, F, H	Shop Equip Contact Maint. TRD MTD (SC 4940-97-CL-E-05)	4940-00-294-9518	T10138
1	O, F, H	Shop Equip Org Repair, Light TRK MTD (SC 4940-97-CL-E04	4940-00-294-9516	T13152
1	O, F, H	Tool Kit Automotive Maint, Org Maint Common #1 (SC 4910-95-CL-A72)	410-00-754-0654	W32593
1	O, F, H	Tool Kit Automotive Maint, Org Maint Common #2 (SC 4910-95-CL-W26)	5180-00-177-7033	W33004
1	O, F, H	Shop Equip Auto Maint and Repair Org Maint Supp #1 (SC 4910-95-CL-A73)	4910-00-754-0653	W32867
1	O, F, H	Shop Equip Welding Field Maint (SC 3470-95-CL-A08)	3470-00-357-7268	T16714
1	O, F, H	Tool Set, Veh Full Tracked Sugg #2 SC 4940-95-CL-A08	4940-00-7541-0743	W65747
2	F, H	Shop Equip Gen Purp Repair Semitrir MTD (SC 4940-97-CL-E03)	4940-00-287-4894	T10549
2	F, H	Tool Kit Automotive, Fuel and Elec Sys Repair (SC 4910-95-CL-A50)	4910-00-754-0655	W32456
2	F, H	Tool Kit, Master Mechanic and Equip Maint and Repair (SC 5180-90-CL-E05)	5180-00-699-5273	W45060

MAINTENANCE ALLOCATION CHART FOR
PAVING MACHINE, BITUMINOUS MATERIAL

CRAWLER MTD., DED

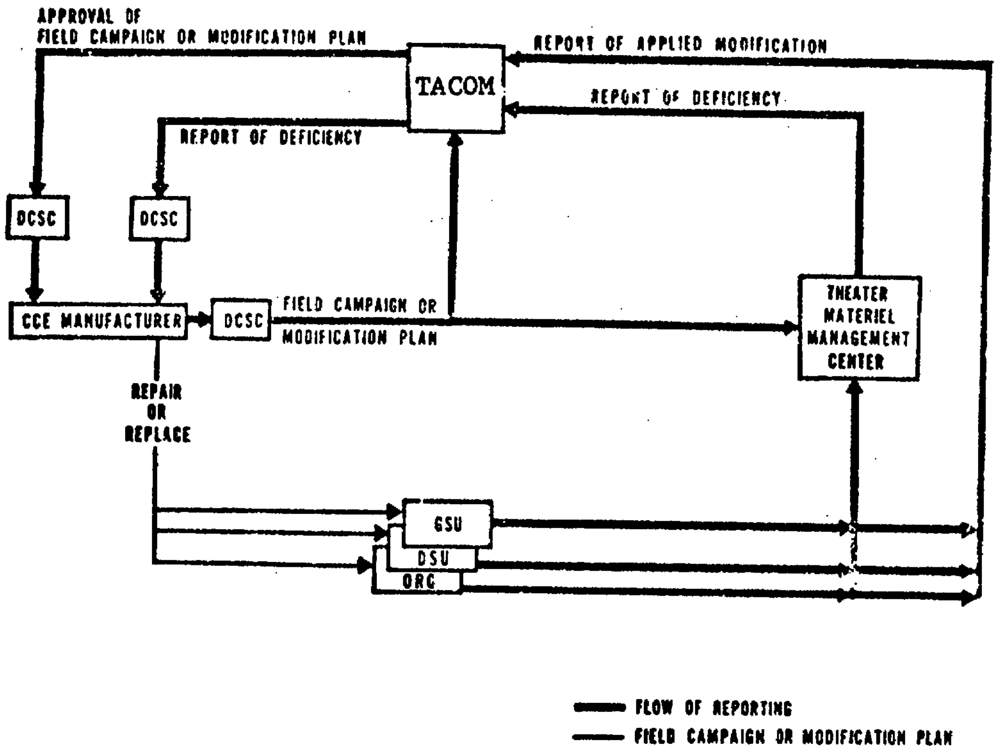
APPENDIX C

SECTION III - TOOL AND TEST EQUIPMENT REQUIREMENTS

TOOL OR TEST EQUIPMENT REFERENCE CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL / NATO STOCK NUMBER	TOOL NUMBER
2	F, H	Shop Set, Fuel and Elec Sys Field Maint Basic (SC 4910-95-CL-A01)	4910-00-754-0714	T30414
2	F, H	Shop Set, Fuel and Elec Sys Field Maint Basic Sup #2 (SC 4910-95-CL-A65)	4910-00-390-7775	T30688
2		Shop Equip Machine Shop, Field Maint Basic (SC 3470-95-CL-A02)	3470-00-754-0708	T15644
2		Measuring Lay Out Tool Set, Mach (SC-5280-95-CL-A02)	5280-00-511-1950	W44512
2		Tool Kit Body And Fender Repair	5180-00-754-0643	W33689
3		Wrench Set Socket, ¾" Drive Hex Type	5310-00-754-0743	W65747
4	O, F, H	Wrench Torque, ¾" Drive 500 lb Cap	5120-00-542-5577	Y84966
5	O, F, H	Multimeter	6625-00-999-7465	M80242

APPENDIX D

CCE MANUFACTURER FIELD CAMPAIGNS AND MODIFICATION PROCEDURES



APPENDIX E

BASIC ISSUE ITEMS LIST				
(1) MFR PART NO.	(2) MFR FED CODE	(3) DESCRIPTION	(4) UNIT OF ISSUE	(5) QUANTITY FURNISHED W/EQUIP
45500-020-06	31245	Wrench, Allen 5/16”	EA	1
45500-036-06	31245	Gage, Strike Off	EA	1
45500-750-06	31245	Wrench, Crown Adj	EA	1

APPENDIX F

ITEMS TROOP INSTALLED OR AUTHORIZED LIST					
(1) SMR CODE	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION REF No & MFR CODE	 USABLE ON CODE	(4) UNIT OF MEAS	(5) QTY AUTH
		NOTE: The following items are overpacked with the paver.			
	7520-00-559-9618	Case, Cotton Duck: MIL-B-11743 (81349)		EA	1
	7510-00-889-3494	Log Book Binders MIL-B-43064		EA	1
		NOTE: The following items are authorized but not issued with the paver.			
	4210-00-889-2221	Extinguisher, Fire Dry Chemical		EA	1
	4930-00-277-9525	Grease Gun, Hand		EA	1
	4930-00-204-2550	Adapter, Grease Gun Coupling, Rigid		EA	1
	4930-00-288-1511	Adapter, Grease Gun Coupling, Flex		EA	1

APPENDIX G

INITIAL RECOMMENDATION
PRESCRIBED LOAD LIST (PLL)
AUTHORIZED STOCKAGE LIST (ASL)

END ITEM: Paving Machine, Bituminous	MAKE: IOWA Mfg Co	MODEL: BSF-400	
MFR PART NO: N/A	NSN: 3895-01-063-7891	SERIAL NUMBER RANGE 5627 TO 35633	DATE Mar 80

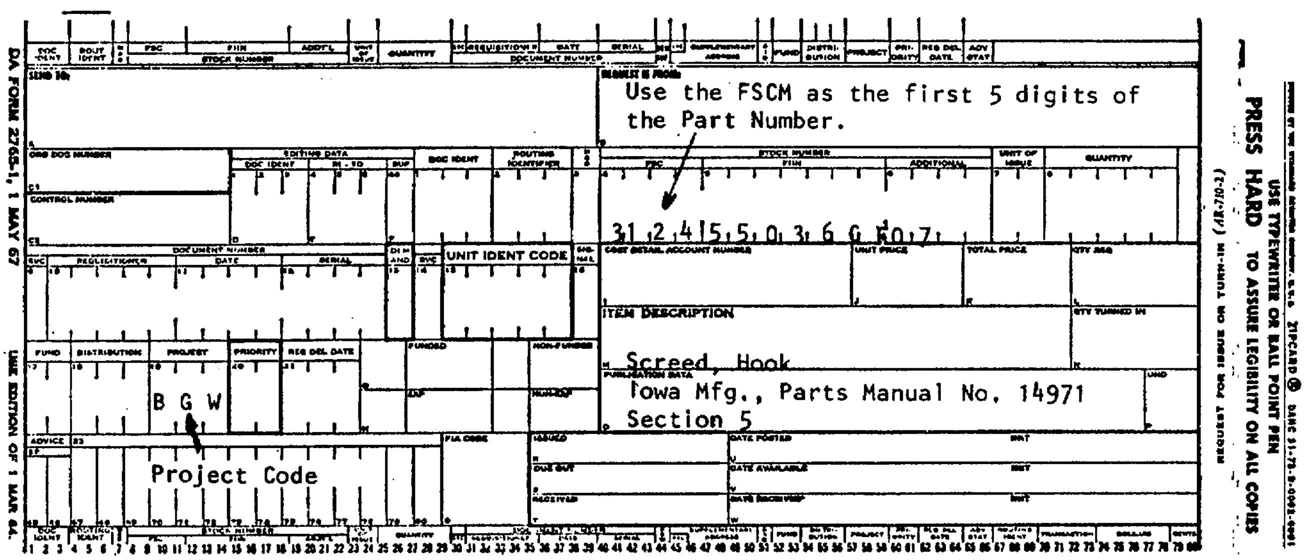
SMR CODE	NATIONAL STOCK NUMBER	PART NUMBER	FSCM	PART DESCRIPTION		U/M	QTY OF PARTS REQ'D FOR NO. OF END ITEMS			
							PLL		ASL	
							1-5	1-5	6-20	21-50
PAOZZ	2940-00-019-8087	5574978	72582	Element, Oil Filter	$1.32	EA	1	1	1	2
PAOZZ	2910-00-890-2436	5573261	70040	Element, Fuel Filter Secondary	.51	EA	1	1	2	2
PAOZZ	2910-00-792-8985	5574961	72582	Element, Fuel Filter Primary	1.59	EA	1	1	2	2
PAOZZ	4930-01-038-9307	45652-512-15	31245	Nozzle, Screed Burner	1.50	EA	2	2	2	2
PAOZZ	3030-00-865-2470	5131395	72582	Belt Set, Crankshaft Pulley	3.55	EA		1	1	1
PAOZZ	3030-00-421-1553	5139228	72582	Belt Set, Water Pump	2.11	EA		1	1	1
PAOZZ	3030-00-529-0466	B66	24161	Belt, Generator Drive	5.66	EA		1	1	1
PAOZZ	3030-00-668-7201	MS39277-040	96906	Belt Set, Alternator Drive	4.00	EA		1	1	1
PAOZZ	5977-01-089-6783	45652-505-24	31245	Electrode, Screed Burner	1.70	EA	2	2	2	2
PAOZZ	4330-00-073-0371	1551	02249	Element, Hyd System Oil Filter	4.11	EA	1	1	2	2
PAOZZ	2940-00-129-9757	P11-8159	18265	Element, Air Cleaner	7.81	EA	1	1	1	1

APPENDIX H

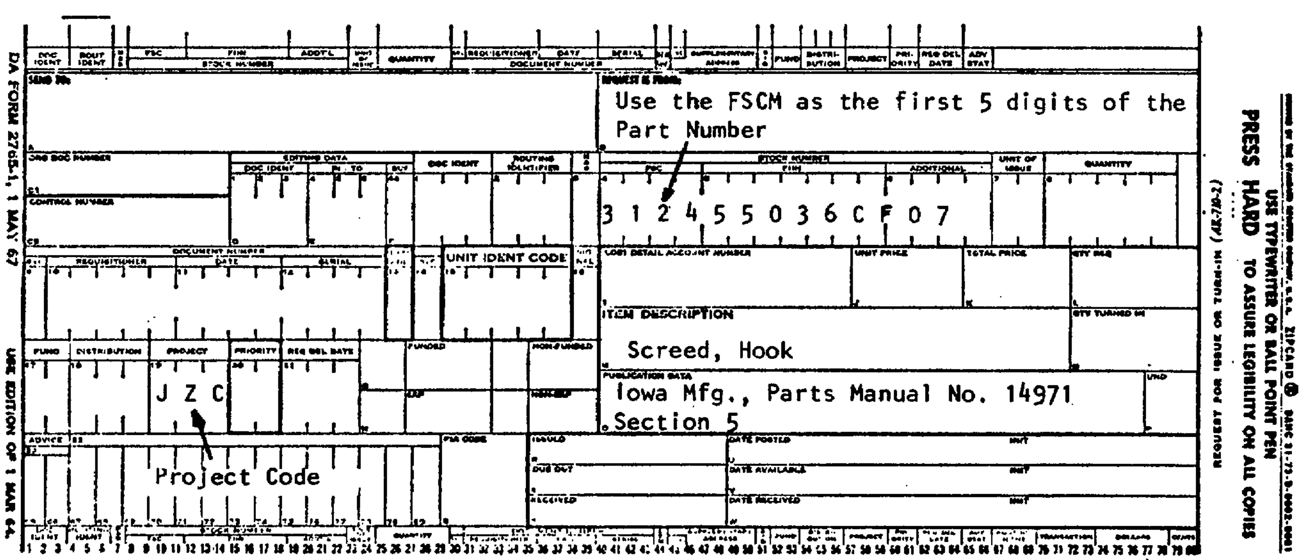
APPENDIX

SAMPLE FORMAT - DA FORM 2765 PART NUMBER REQUEST

(CONUS Requester)

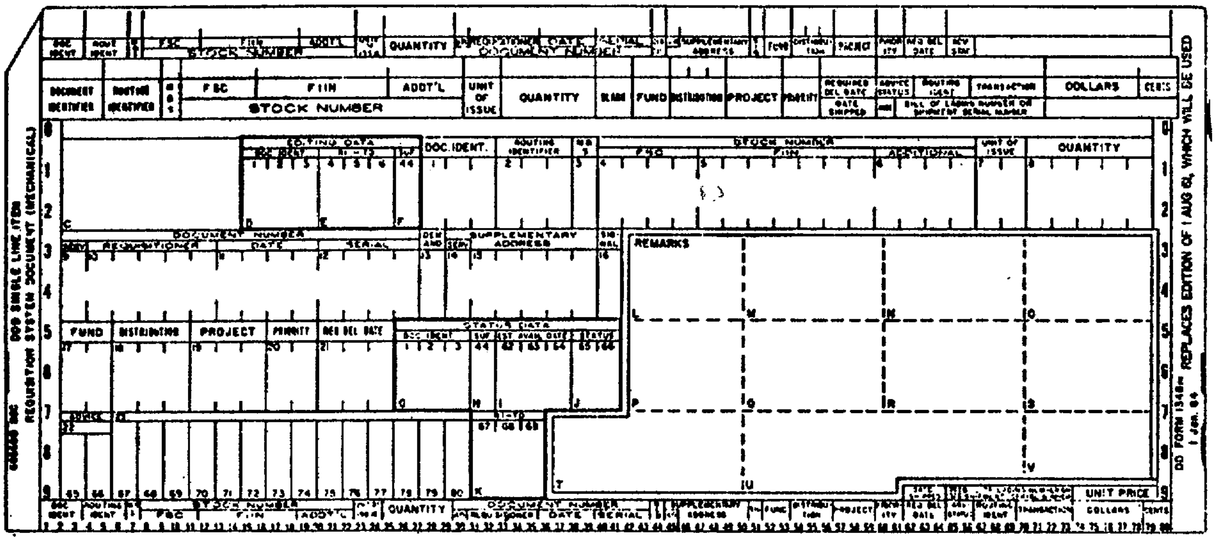


(OCONUS) Requester)



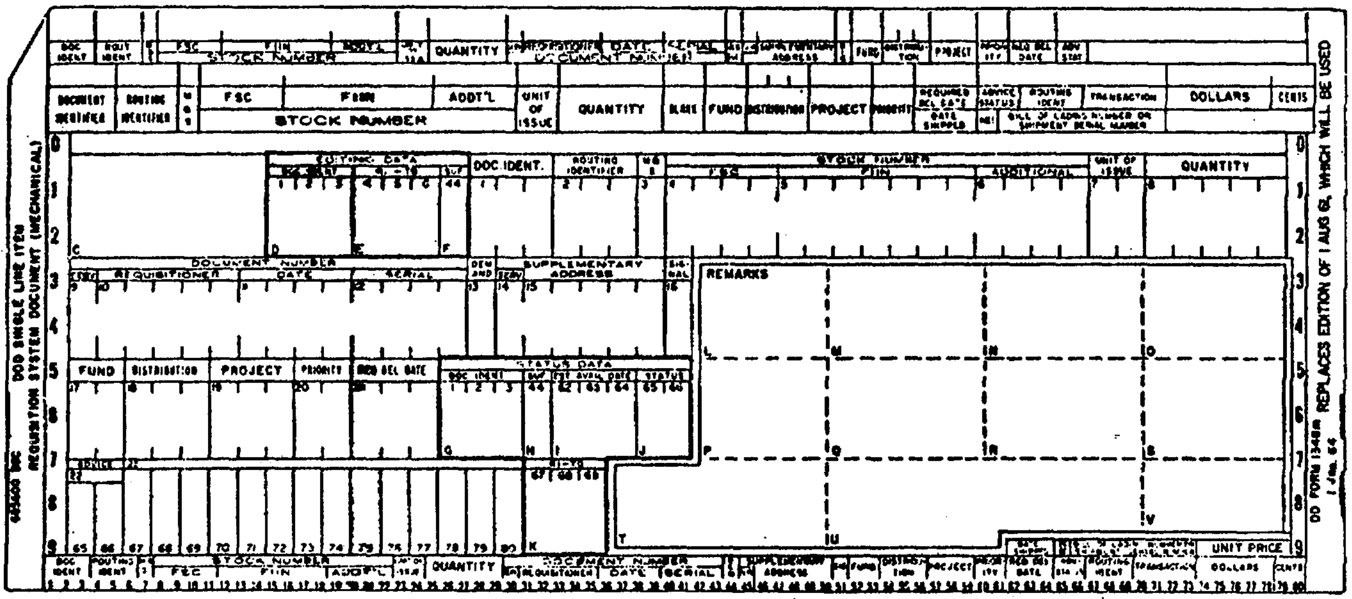
APPENDIX I

SAMPLE FORMAT - MILSTRIP REQUISITION FOR (NSN)



Card Column	Description of Data	Mandatory Entry for CCE
1-3	Document Identifier Code	A∅A - CONUS A∅1 - Overseas
4-6	Routing Identifier Code	
7	Media/Status Code	
8-22	NSN	
23-24	Unit of Issue	
25-29	Quantity	
30-43	Document Number	
44	Demand Code	
45-50	Supplementary Address	
51	Signal Code	
52-53	Fund Code	
54-56	Distribution Code CC-54	"F" for CONUS; see AR 725-50 for OCONUS
	CC-55-56	Weapon System Code
57-59	Project Code	
60-61	Priority Code	
62-64	Required Delivery Date	
65-66	Advice Code	

SAMPLE FORMAT - MILSTRIP REQUISITION FOR (NON-NSN)



Card Column	Description of Data	Mandatory Entry for CCE
1-3	Document Identifier Code	A∅B - CONUS A∅2 - Overseas
4-6	Routing Identifier Code	Always S9C
7	Media/Status Code	
8-22	FSCM and Part Number	
23-24	Unit of Issue	
25-29	Quantity	
30-43	Document Number	
44	Demand Code	
45-50	Supplementary Address	
51	Signal Code	
52-53	Fund Code	
54-56	Distribution Code CC-54	"F" for CONUS; see AR 725-50 for OCONUS
	CC-55-56	Weapon System Code
57-59	Project Code	
60-61	Priority Code	
62-64	Required Delivery Date	
65-66	Advice Code	

Card Column	Description of Data	Mandatory Entry for CCE
67-69	Blank	
70	Identification code applicable to entry in cc 71-80. A - Technical order or Technical Manual. B - End Item Identification C - Noun Description D- Drawing or Specification No.	
71-80	Reference Identification	Identification of reference specified in cc 70

SAMPLE FORMAT - MILSTRIP REQUISITION FOR (NON-NSN)(MANUAL)

DOCUMENT IDENTIFIER			ROUTING IDENTIFIER			M & S	MANUFACTURER'S CODE AND PART NUMBER *															UNIT OF ISSUE		QUANTITY					DOCUMENT NUMBER													
							FSCM					PART NUMBER																	SERV	REQUISITIONER					DATE				SERIAL			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43

DEMAND	SUPPLEMENTARY ADDRESS						SIGNAL	FUND CODE		DISTRIBUTION CODE			PROJECT CODE			PRIORITY		REQUIRED DELIVERY DATE			ADVICE CODE		BLANK														REJECT CODE (FOR USE BY SUPPLY SOURCE ONLY)	
	SERV																																					
44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	65	66

IDENTIFICATION DATA

* 1. MANUFACTURER'S CODE & PART NO. *(When they exceed Card Columns 8 thru 22)*	2. MANUFACTURER'S NAME
3. MANUFACTURER'S CATALOG IDENTIFICATION AND DATE	4. TECHNICAL ORDER NUMBER
5. TECHNICAL MANUAL NUMBER	6. NAME OF ITEM REQUESTED
7. DESCRIPTION OF ITEM REQUESTED	7a. COLOR 7b. SIZE

FOLD LINE

FOLD LINE

8. END ITEM APPLICATION AND SOURCE OF SUPPLY

8a. MAKE	8b. MODEL NUMBER	8c. SERIES	8d. SERIAL NUMBER

9. REMARKS

FORM
DD 1 JAN 71 1348-6 NON-NSN REQUISITION *(MANUAL)*

APPENDIX K

INSTRUCTIONS

This form will only be used in those cases where the manufacturer's code and part number exceed the spaces allocated in card columns 8 - 22 of the requisition.

Card Column	Description of Data	Mandatory Entry for CCE
1 - 3	Document Identifier Code	A∅E - CONUS A∅5 - OCONUS
4 - 6	Routing Identifier Code	Always S9C
7	Media Status Code	
8 - 22	FSCM and Part Number	Leave Blank Enter In Block 1 under Identification Data
23-24	Unit of Issue	
25-29	Quantity	
30-43	Document Number	
44	Demand Code	
45-50	Supplementary Address	
51	Signal Code	
52-53	Fund Code	
54-56	Distribution Code CC 54	"F for CONUS. (See AR 725-50 for OCONUS)
	CC 55-56	Weapon System Code
57-59	Project Code	
60-61	Priority Code	
62-64	Required Delivery Date	
65-66	Advice Code	
67-80		Blank

IDENTIFICATION DATA - Lower half of DD Form 13418-6, complete Blocks 1 thru 9.

APPENDIX L

CROSS REFERENCE PART NUMBER LIST

Iowa P/N	Iowa FSCM	Prime P/N	Prime FSCM
45003-500-02	31245	748-0329	63810
45033-501-01	“	540-0004	“
45003-502-02	“	830-0008	“
45003-502-03	“	800-3042	“
45093-503-01	“	5301-101-01	“
45033-504-02	”	5204-451-14	“
45003-505-31	“	5303-111-001	“
45003-505-13	“	DX11576A	“
45080-001-07	“	V230-8-1C549	62983
45090-001-36	“	3011A	07983
45090-002-32	“	XB265	17913
45090-002-43	“	C1301656D	16294
45090-503-11	“	4022030	07488
45090-526-20	“	XA605	17913
45090-526-35	“	990-90003448	16294
45130-091-95	“	42687	60038
45130-001-08	“	385	“
45130-001-09	“	476	“
45130-002-03	“	42620	“
45130-002-04	“	382A	“
45130-002-06	“	472A	“
45134-001-14	“	3310	43334
45134-001-20	“	3210	“
45134-001-21	“	3308	“
45134-001-22	“	3309	“
45134-001-24	“	3313 (433343309)	“
45134-001-25	“	5207	“
45134-001-26	“	3310G	“
45134-001-27	“	3307G	“
45200-008	“	450286	81596
45200-021	“	50145S	“
45200-040	“	55147S	“
45200-181	“	55088S	“
45200-183	“	50350S	“
45200-184	“	50230S	“
45200-191	“	63X1345	73680
45252-005-01	“	7107-256	07988
45259-508-14	“	3-8	02697
45259-508-47	“	2-118	“
45377-504-01	“	5-153X	72447
45476-001-02	“	DB7493	76474
45550-003-31	“	X117C8	61208
45550-019-06	“	6187A	“
45550-022-10	“	6314G	“
45551-263-01	“	5204-751-02	63810
45552-258-01	“	315380	18967
45652-505-24	“	SC5813	34181

APPENDIX L

CROSS REFERENCE PART NUMBER LIST

Iowa P/N	Iowa FSCM	Prime P/N	Prime FSCM
45652-512-02	31245	1-3/8LX1/SFNPT	71895
45652-512-15	“	1-35GPH	“
45652-528-01	“	J2BC100-3	99166
45652-529-01	“	AA524-316-1	60399
45865 002-16	“	6464910	70040
45865-003-04	“	6402618	“
46098-400-09	“	B122-1061	94506
46150-oo0-75	“	FM3V2B3	66127
46165-001-40	“	30055-10	13445
46165-001-41	“	CDM15-1	82647
46165-002-72	“	CDM35-1	“
46165-004-79	“	30055-15	13445
46200-001-13	“	1LS 1	91929
46200-003-75	“	95582	13445
46200-009-06	“	1TL1-2	91929
46200-009-08	“	2TL1-1	91929
46200-009-11	“	1TL1-6	91929
46200-009-18	“	2TL1-3	91929
46205-001-12	“	SA2263-12	78388
46225-001-07	“	AEA33353	94916
46225-002-07	“	6474386	70040
46225-003-02	“	6717-134	16127
46260-001-10	“	20-141	71785
46955-001-35	“	1N2071A	04713
50005-020-01	“	ANS1-40CONN	84233
50005-080-01	“	ANS1-80CONN	“
7033-006	“	W05	52676
7048-014		K21820	“
7048-015	“	K21807	“
7048-016	“	K21805	“
7048-046	“	K22420	“
7048-047	“	K22407	“
7048-048	“	K22405	“
7118-031	“	B66	24161
7166-005	“	7506	43334
7166-11	“	3209	“
7166-015	“	3L13	“
7238-127	“	59-062-312-1500	22599
7258-004	“	6420	60038
7258-013	“	6454	“
7306-001	“	3920	“
7306-016	“	3982	“
7376-001	“	59425	“
7376-005	“	59175	“
7441-041	“	3V400 (MS 39277-40)	24161
45)8)-510-22	“	1551	02249
“	“	DP-752-10	50590
45690-001-21-03	“	P11-8159	18265

APPENDIX M

APPENDIX __________

MAINTENANCE AND OPERATING SUPPLY LIST

NOMENCLATURE: Paving Machine, Bituminous	MAKE: IOWA Mfg Co	MODEL: BSF-400	
MFR PART NO: N/A	NSN: 3895-01-063-7891	SERIAL NUMBER RANGE 5627 TO 5633	DATE Mar 80

(1) COMPONENT APPLICATION	(2) MFR PART NO. OR NAT'L STOCK NO.	(3) DESCRIPTION	(4) QTY REQ F/INITIAL OPN	(5) QTY REQ F/8 HRS OPN	(6) NOTES
Engine Crankcase	9150-00-188-9858	Oil, Lubricating OE/HDO 30 MIL-L-2104	14 qt.	*	5 gal.
	9150-00-186-6668	Oil, Lubricating OE/HDO10 MIL-L-2104			5 gal.
Fuel Tank, Engine	9150-00-286-5296	Diesel Fuel, DF2	33 gal.	*	55 gal. Drum
Cooling System	6850-00-181-7933	Anti-Freeze, Permanent MIL-A-46153	13 qt.	*	50-50-solution
Hydraulic System	9150-00-843-1636	Automotive Trans Fluid (Dexron Type F)	10 gal.	*	
Fuel Tank Screed Heater	9140-00-247-4365	Fuel Oil	12.5 gal.	*	* As Required

APPENDIX __________

MAINTENANCE AND OPERATING SUPPLY LIST

NOMENCLATURE: Paving Machine, Bituminous		MAKE: IOWA Mfg Co	MODEL: BSF-400
MFR PART NO: N/A	NSN: 3895-01-063-7891	SERIAL NUMBER RANGE 5627 TO 5633	DATE Mar 80

(1) COMPONENT APPLICATION	(2) MFR PART NO. OR NAT'L STOCK NO.	(3) DESCRIPTION	(4) QTY REQ F/INITIAL OPN	(5) QTY REQ F/8 HRS OPN	(6) NOTES
Transmission	9150-01-035-5392	Oil, Lubricating G080W/90 MIL-L-2105C	17 qt.	*	1 qt.
	9150-01-035-5393				5 gal.
	9150-01-035-5394				55 gal.
Transfer Case Left & Right	9150-01-035-5392	Oil, Lubricating G080W/90 MIL-L-2105C	19 qt.	*	1 qt.
Conveyor Drive Chains	9150-01-035-5392	Oil, Lubricating G080W/90 MIL-L-2105C	*	*	1 qt.
Bearings, Pivots Fittings, General Application	9150-00-190-0905	GAA Grease, MIL-G-10924	*	*	* As Required

APPENDIX N

PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Maintenance Forms and Records

Every mission begins and ends with the paperwork. There isn't much of it, but you have to keep it up. The forms and records you fill out have several uses. They are a permanent record of the services, repairs, and modifications made on your vehicle. They are reports to organizational maintenance and to your commander. And they are a checklist for you when you want to know what is wrong with the vehicle after its last use, and whether those faults have been fixed. For the information you need on forms and records, see TM 38-750.

Preventive Maintenance Checks and Services

1. Do your before (B) PREVENTIVE MAINTENANCE just before you operate the vehicle. Pay attention to the CAUTIONS and WARNINGS.

2. DURING checks and services (D) of PREVENTIVE MAINTENANCE will be performed while the equipment and/or its component systems are in operation.

3. Do your after (A) PREVENTIVE MAINTENANCE right after operating the vehicle. Pay attention to the CAUTIONS and WARNINGS.

4. Do your weekly (W) PREVENTIVE MAINTENANCE weekly.

5. Do your monthly (M) PREVENTIVE MAINTENANCE once a month.

6. If something doesn't work, troubleshoot it with the instructions in this manual or notify your supervisor.

7. Always do your PREVENTIVE MAINTENANCE in the same order so it gets to be a habit. Once you've had some practice, you'll spot anything wrong in a hurry.

8. If anything looks wrong and you can't fix it, write it on your DA Form 2404. If you find something seriously wrong, report it to organizational maintenance RIGHT NOW.

9. When you do your PREVENTIVE MAINTENANCE, take along the tools you need to make all the checks. You always need a rag or two.

A - Keep it clean: Dirt, grease, oil, and debris only get in the way and may cover up a serious problem. Clean as you work and as needed. Use dry cleaning solvent (SD-2) on all metal surfaces. Use soap and water when you clean rubber or plastic material.

WARNING

> Dry cleaning solvent, used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100°F - 138°F.

B - Bolts, nuts, and screws: Check them all for obvious looseness, missing, bent or broken condition. You can't try them all with a tool, of course, but look for chipped paint, bare metal, or rust around bolt heads. If you find one you think is loose, tighten it, or report it to organizational maintenance if you can't tighten it.

C - Welds: Look for loose or chipped paint, rust, or gaps where parts are welded together. If you find a bad weld, report it to organizational maintenance.

D - Electric wires and connectors: Look for cracked or broken insulation, bare wires, and loose or broken connectors. Tighten loose connectors and make sure the wires are in good shape.

E - Hoses and fluid lines: Look for wear, damage, and leaks, and make sure clamps and fittings are tight. Wet spots show leaks, of course. But a stain around a fitting or connector can mean a leak. If a leak comes from a loose fitting or connector, tighten it. If something is broken or worn out, report it to organizational maintenance.

10. It is necessary for you to know how fluid leakage affects the status of your vehicle. The following are definitions of the types/classes of leakage an operator or crew member needs to know to be able to determine the status of his/her vehicle. Learn, then be familiar with them and REMEMBER - WHEN IN DOUBT, NOTIFY YOUR SUPERVISOR!

Leakage Definitions for Crew/Operator PMCS

Class I	Seepage of fluid (as indicated by wetness or discoloration) not great enough to form drops.
Class II	Leakage of fluid great enough to form drops but not enough to cause drops to drip from item being checked/inspected.
Class III	Leakage of fluid great enough to form drops that fall from the item being checked/inspected.

<u>CAUTION</u>

EQUIPMENT OPERATION IS ALLOWABLE WITH MINOR LEAKAGES (CLASS I OR II). OR COURSE, CONSIDERATION MUST BE GIVEN TO THE FLUID CAPACITY IN THE ITEM/SYSTEM BEING CHECKED/INSPECTED. WHEN IN DOUBT, NOTIFY YOUR SUPERVISOR.

OPERATOR/CREW PREVENTIVE MAINTENANCE CHECKS AND SERVICES

B-Before D-During A-After W-Weekly M-Monthly

APPENDIX N

ITEM NO	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: Check for and have repaired, filled or adjusted as needed	Equipment is not ready/ AVAILABLE IF:
						NOTE PERFORM WEEKLY AS WELL AS BEFORE PMCS'S IF: a. You are the assigned operator but have not operated equipment since the last weekly. b. You are operating the equipment for the first time.	
1						GENERAL	
	●					a. Visually check for loose wiring, damaged piping or hoses	
	●	●				b. Look for evidence of fluid leakage (Oil, Fuel, Coolant)	Class III leaks or any fuel leakages are found.
2	●					ENGINE CRANKCASE Check dipstick for proper level. Add oil as necessary to FULL mark.	
3	●					RADIATOR Check coolant level. Add coolant as required. (Level should be approximately 1 inch from bottom of iller neck.)	
4	●					FUEL STRAINER Drain approximately $\frac{1}{4}$ pint to remove sediment and water.	

OPERATOR/CREW PREVENTIVE MAINTENANCE CHECKS AND SERVICES

B-Before D-During A-After W-Weekly M-Monthly

APPENDIX N

ITEM NO	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: Check for and have repaired, filled or adjusted as needed	Equipment is not ready/ AVAILABLE IF:
5				●		<u>TRANSFER CASE</u> Check fluid level. Add as required to level plug.	
6	●					<u>GREASE FITTINGS</u> One pump of gun each day (Refer to LO Appendix Q).	
7						<u>TRANSMISSION</u>	
	●					a. Check dipstick for proper level. Level should be approximately $\frac{1}{4}$" on dipstick.	
		●				b. With engine running, sight glass must show oil flow.	Oil not visible in sight gage.
8						<u>HYDRAULIC SYSTEM</u>	
	●					a. Reservoir: Check fluid level at sight gage. Add as required.	
		●				b. With engine running, check oil filter gage.	Gage reads 15 or above.
9						<u>CONTROLS AND INSTRUMENTS</u> (Check for proper indication and operation)	Engine oil pressure or coolant gages indicate abnormal operation.
		●				a. Engine Coolant Temperature Gage 160° - 185°F normal operations	
		●				b. Ammeter Slight (+) Charge	

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OPERATOR/CREW PREVENTIVE MAINTENANCE AND SERVICES

APPENDIX N

OPERATOR/CREW PREVENTIVE MAINTENANCE CHECKS AND SERVICES

B-Before D-During A-After W-Weekly M-Monthly

APPENDIX N

ITEM NO	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: Check for and have repaired, filled or adjusted as needed	Equipment is not ready/ AVAILABLE IF:
		●				c. A.C. Voltmeter 120V to 135V	
		●				d. Frequency Meter (Cycles per second) Engine at full throttle, 59CPS - 61CPS	
		●				e. Hour - Tachometer 2100 RPM - Full Load 2200 RPM - Max High Idle 500 RPM - Lo Idle	
		●				f. Engine Oil Pressure 40 - 60 PSI Normal Operation	
		●				g. Fuel level	
		●				h. Controls (ie steering, shifting, etc.) check for proper operation	
10			●			<u>CLEANING PAVER</u> Refer to Appendix O.	
11						<u>AIR FILTER</u>	
		●				a. Check air cleaner indicator, if red clean and service element.	
				●		b. Inspect air cleaner element.	Element missing
12					●	<u>V-BELTS</u> Check for frayed, cracked or broken belts	

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OPERATOR/CREW PREVENTIVE MAINTENANCE CHECKS AND SERVICES

B-Before D-During A-After W-Weekly M-Monthly

APPENDIX N

ITEM NO	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: Check for and have repaired, filled or adjusted as needed	Equipment is not ready/ AVAILABLE IF:
13					•	BATTERIES Check fluid level. Fill as required to split ring. Inspect for obvious defects, such as cracked case, burnt, broken or loose terminals and cables	One or more missing or will not crank engine.
14			•			TRACK PINS, SLAT CONVEYOR CHAIN & TRACK DRIVE CHAINS Spray all track pins, all conveyor chains, track drive chains (complete loops) with fuel oil (use oil spray accessories from screed heater system). Refer to Appendix O. CAUTION Keep oil spray away from all electrical boxes, motors, generators, starters, etc. Do not spray paver when it is parked on an asphalt mat! Move it to the side of the road where drainage of oil and dissolved asphalt will not damage anything. When spraying chain and sprockets, use care not to spray the electric clutch on transfer case.	

APPENDIX N
ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Q-Quarterly S-Semiannually A-Annually B-Biennially H-Hours M-Miles

ITEM NO	INTERVAL Q	S	A	B	H	MI	ITEM TO BE INSPECTED PROCEDURE: Check for and have repaired, filled, or adjusted as needed
1	●						ENGINE
							Check for leaks, loose mounts and proper operation.
2					100		OIL FILTER
							Change oil and filter
3					300		FUEL FILTER AND STRAINER
							Change filter and strainer elements.
4					200		V-BELTS (All Belts)
							Check tension.
5							RADIATOR
		●					a. Check for leaks and clean exterior as required.
			●				b. Check antifreeze protection.
					1000		c. Drain and flush radiator and engine.
6							AIR FILTER
	●						a. Check filter element and clean as required.
					500		b. Change filter element

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OPERATOR/CREW PREVENTIVE MAINTENANCE AND SERVICES

APPENDIX N

Q-Quarterly S-Semiannually A-Annually B-Biennially H-Hours M-Miles

ITEM NO	INTERVAL Q	S	A	B	H	MI	ITEM TO BE INSPECTED PROCEDURE: Check for and have repaired, filled, or adjusted as needed
7			●				BATTERY Check specific gravity of electrolyte in each cell and clean exterior if required.
8			●				GAGES Check for operation.
9			●				GENERAL Check for loose wiring, damaged piping or hoses.
10			●		1000		TRANSMISSION Check for leaks and flow of oil through sight gage Drain, back-flush filter screen and case and refill with fresh lubricant.
11			●		1000		TRANSFER CASE Drain, flush and refill with fresh lubricant.
12					250		HYDRAULIC SYSTEM Replace filter element or when filter gage reads 15 or above.
			●		1000		Drain, flush, wash strainer and refill with fresh lubricant.
13			●				SEASONAL OVERHAUL Refer to Operation and Maintenance Manual for complete details, instructions and wear limits.

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APPENDIX N

APPENDIX N

ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Q-Quarterly S-Semiannually A-Annually B-Biennially H-Hours M-Miles

ITEM NO	INTERVAL Q	S	A	B	H	MI	ITEM TO BE INSPECTED PROCEDURE: Check for and have repaired, filled, or adjusted as needed
14							AC GENERATOR
					200		Check AC output.
15	●						HEAT DUCT
							Check and clean heat vent holes of the moldboard.
16	●						SCREED HEATER
							Clean and adjust fuel nozzle and electrodes.
17	●						TRACK AND DRIVE CHAINS
							Adjust tension and lubricate.
18	●						SLAT CONVEYOR AND SPREADER SCREW DRIVE CHAINS
							Adjust tension and lubricate.
19			●				ELECTRIC CLUTCH
							Check wear and adjust.

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APPENDIX O

Cleaning and Lubricating Paver

CLEANING PAVER

It is extremely important that the paver be thoroughly cleaned at the end of each day's operation! A spray nozzle with 15 foot hose is attached to the pressure side of the screed heater fuel system. This permits the operator to reach all areas of the paver which require cleaning and lubricating.

Method:

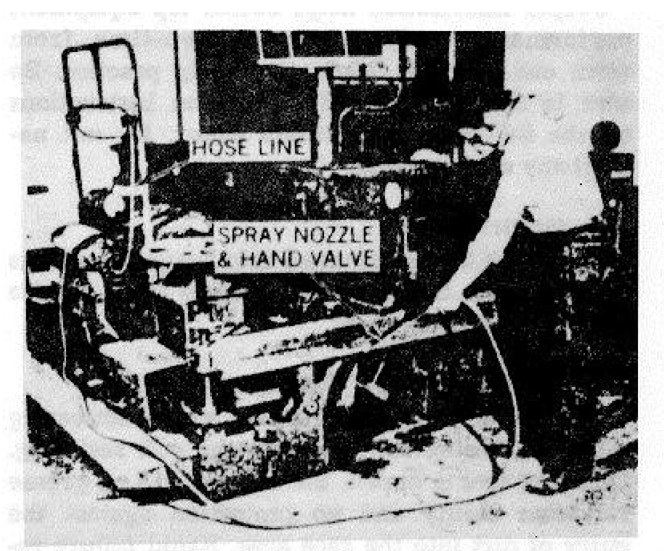
(1) Run engine at IDLE speed.
(2) Set valve selector switch to SPRAY-DOWN
(3) Push panel circuit breaker to ON
(4) Turn junction box burner switch to ON
(5) Depress hose line valve lever

Clean all parts of the paver which come in contact with asphalt. The track and track rollers, hopper, slat conveyors, spreader screws, screed, drive chains, etc. all require cleaning at the end of each day. This holds true even if the paver was actually used only a short time. **Many paver troubles can be traced to improper cleaning!** Fuel oil on the slat conveyors and tracks provides the needed lubrication which prevents rapid wear. The spray should reach all track link pins so that there is no squeaking as the paver moves. The slat conveyors should be operated during the spraying to be sure that all of the slats and chain are reached.

> **IMPORTANT!** Keep oil spray away from all electrical boxes, motors, generators, starters, etc. Do not spray paver when it is parked on an asphalt mat! Move it to the side of the road where drainage of oil and dissolved asphalt will not damage anything.

In addition to spray cleaning of the paver the following clean up practices should be routine.

1. Check for accumulation of asphalt in the heat vent holes along the top of the moldboard. This check can best be made by feeling the exhaust of hot air when the heater is being operated (the upper vents become plugged when asphalt spills over the moldboard when a material level too high above the screw is allowed to build up. Use a stiff wire to clean out accumulated asphalt.
2. Periodically remove the screed plate as described in Screed Section 7 and clean the interior of all asphalt, sand, and fine material. Failure to keep the inside of the screed plate clean will cause uneven distribution of heat to the screed bottom and possible tearing of the mat surface.



Cleaning Paver with Screed Heater Fuel Spray Accessory
Figure 1

TRUCK ROLLERS

Two rollers located on the front of the hopper are lubricated before assembly and require no further lubrication. However, these rollers should be cleaned often during operation to eliminate material build-up.

LUBRICATION - GENERAL SUGGESTIONS

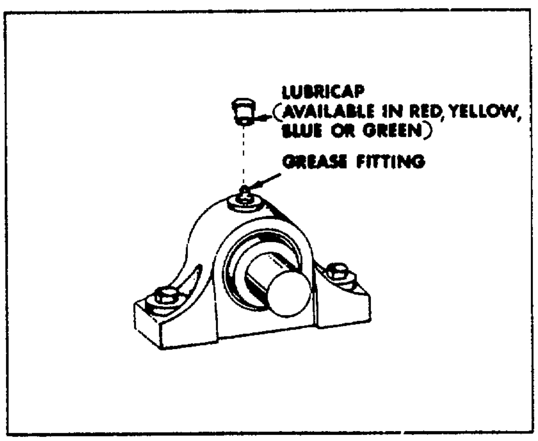
PROPER LUBRICATION:
Proper Lubrication helps obtain top equipment performance and minimum down-time from worn out bearings. Make it a daily practice. Be sure to comply with all lubrication instructions on the following Lubrication Chart. Do not neglect any area or details.

TOO MUCH GREASE:
Too Much Grease pumped into bearing housings can overheat bearings and reduce their service life. Use good judgment.

TOO MUCH LUBRICANT PRESSURE
The use of too much pressure when lubricating a sealed bearing can blow-out the soft seal ring. Once the seal is blown, the bearing has no grease retention ability and no protection against the entry of dirt into the race area. Rapid failure results!
When using a hand operated grease gun, stop pumping as soon as the easy stroking begins to change to a hard pumping requirement. When using a pressurized grease system, develop a "feel" for the correct pressure of gun against fitting for automatic pressure relief in case the bearing becomes filled.

SELECTION OF LUWRICANTS:
Texaco Lubricants are recommended on the lubrication chart following. Use only recommended lubricants.

GOOD HABITS:
Cleanness when lubricating is vital! The grit which is always present around grease fittings and oil reserves can destroy a good bearing surface rapidly if it is forced inside with the lubricant.
When using a grease gun, wipe the nozzle clean before use.
Wipe grease fittings absolutely clean before each application or keep them covered with the special plastic Lubricaps which are on each paver fitting when it leaves the factory. Keep lubricaps clean while they are off the fittings.
Leave an excess of grease on each fitting. Don't wipe it off until the next greasing. It protects the fitting.
Use grease gun with cartridge type supply unit for positive elimination of dirt and abrasive particles in the new grease.



Plastic Lubricap for Bearing Grease Fittings
Figure 2

COLOR CODED Lubricaps
Lubricaps can be installed on all fittings to keep the area around the grease fittings free from dirt and dust. This Neoprene cap is easily removed and replaced. These inexpensive Lubricaps are available in quantities and can be ordered for placement on equipment in the field. Lubricaps are available in colors, to the customer can establish a coding system fir different types and time intervals of lubrication. Grease guns and lubricant containers with matching color coding make correct lubricating routines easier.
Correct lubrication practices and continued use of the Lubricaps will insure the customer a longer bearing life, as well as eliminate many hours of unnecessary down time. It is important that the lubrication requirements be thoroughly understood and followed. **SCHOOL YOUR LUBRICATION MAN** .

APPENDIX P

Lubrication Detail

(a) **Bearing Inspection**

Anti-friction bearing assemblies should be checked immediately after stopping the paver, whenever possible, as their failure is most easily detected by a high operating temperature. If a bearing is too hot to be touched, it is either running without any lubricant; with too much, or has failed.

(b) **Transmission**

The main transmission for the "CEDARARAPIDS" Bituminous Paver has a capacity of 17 quarts an should be lubricated with Texaco Multigear of Universal Gear Lubricant EP 90. It is important that the operator check for a flow of oil through the sight gauge each day and check the level of the transmission when making general lubrication inspections. The transmission should be flushed with Rando AA oil every 1,000 hours or seasonally. (See lubrication chart.)

(c) **Transfer Gear Cases**

There are two transfer gear cases, one located on each side of the paver. Bother have a capacity of 9-1/2 quarts. Use Texaco Multigear or Universal Gear Lubricant EP 90. The same instructions for flushing and checking should be followed as for the main transmission. (See lubrication chart.)

(d) **Hydraulic System**

The system has a capacity of 10 gallons. Use Texaco Rando HD-C Oil. When filling the reservoir tank it is important that the fluid is allowed time to floe and fill the system. Every 1,000 hours this system must be drained, the strainer washed, and refilled with recommended lubricant. (See Section 5 for complete details.)

(e) **Slat Conveyor Bearings**

Each of the slat conveyors have four bearings. Two are mounted at the front of the paver and two at the back. The lubrication of these bearings is important. They should be lubricated every 8 hours of operation with Texaco Marfak O lubricant.

(1) To lubricate front slat conveyor bearings, remove front hopper cover plate. (See lubrication chart.)

(2) To lubricate rear slat conveyor bearings, see lubrication chart.

(f) **Conveyor Drive Chains**

The four conveyor drive chains should be lubricated once each week to minimize wear. To reach the chains connecting each conveyor drive shaft to the countershafts, remove the rear deck plate on each side of the engine. The two chains connecting the countershafts to the conveyor shafts are located directly beneath the rear end of the engine and are readily accessible. Lightly coat all chain links with Texaco EP90 Universal Gear Lubricant. (Also used in the paver gear cases).

(g) **Track Assembly**

(1) Crawler Track Link Pins - Spray fuel oil over crawler tracks when cleaning paver at the end of each day's operation to lubricate link pins and keep them from squeaking.

(2) Paver tracks are driven from the transfer cases with heavy duty chains and sprockets, that require cleaning and lubricating at the end of the day's operation. Remove the two rear deck plates and spray fuel oil over the chain and sprocket using the wash-off hose from the heater fuel tank. This will normally keep the asphaltic material soft so that it falls off during the following day's operation.

Failure to spray the chain can result in the asphaltic material building up in the chain and on the sprockets until the chain becomes so tight it will cause the chain to break.

> **CAUTION:** When spraying chain and sprockets, use care not to spray the electric clutch on transfer case.

(3) Lower roller and track roller and pivot shaft assemblies are equipped with grease fittings to lubricate the pivot pins and each roller with Texaco Marfak O lubricant every 8 hours of operation. (See lubrication chart).

(4) Track rear sprocket or front idler - Once each year remove the fill plugs and install grease fitting. Add Texaco Marfak O lubricant until new lubricant appears at opposite pipe plug hole. Remove fitting and replace both pipe lugs. (See illustrations in Maintenance Section II)

(h) **Spreader Screw Bearings**

All bearings for the spreader screws have grease fittings which are easily accessible and should be lubricated every 8 hours of operation. It is important these fittings be cleaned before lubricant is applied. Use Texaco Marfak O lubricant. (See lubrication chart).

(i) **Travel and Feed Clutches** - All travel and feed clutch bearing assemblies must be disassembled and repacked with Texaco Marfak O lubricant every season.

(j) **Screed Adjusting Mechanism and Pull Arms**

Ball joint housings on screed adjusting mechanisms and pull arms are equipped with grease fittings to lubricate the ball joints with Texaco Marfak O lubricant every 8 hours of operation. (See lubrication chart).

(k) **Pulleys For Screed Lift Cables**

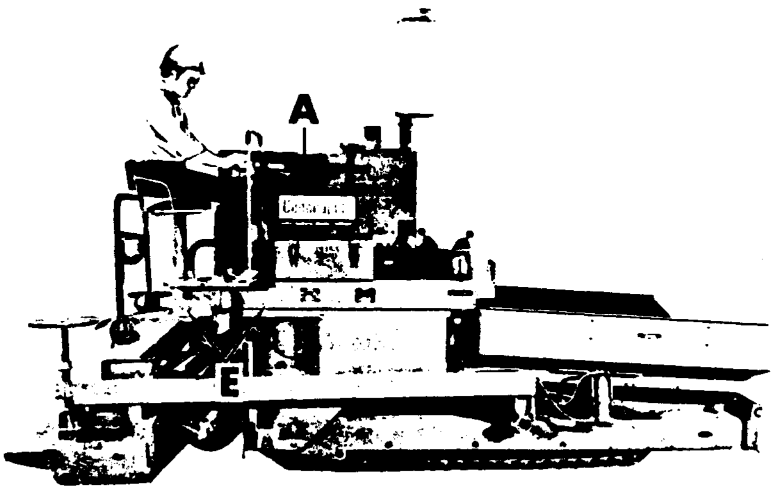
There are two pulleys for each screed lift cable and each has a grease fitting. The fitting of the enclosed pulley is not in plain sight. All four fittings should be greased once each month.

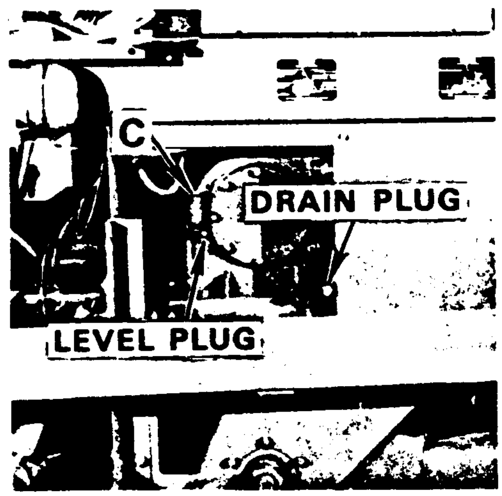
(1) **Power Unit**

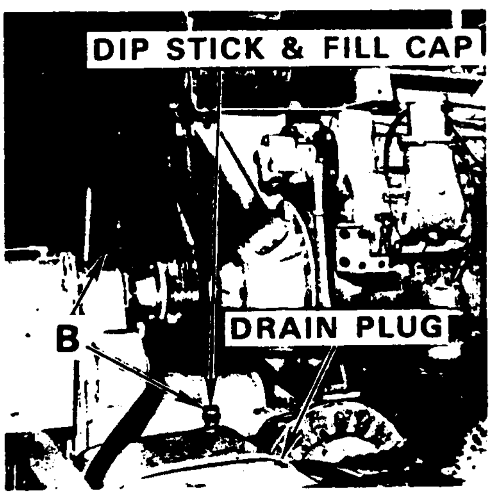
The diesel engine that powers the paver must be properly lubricated and maintained to insure the dependable and smooth performance needed in a paving operation.

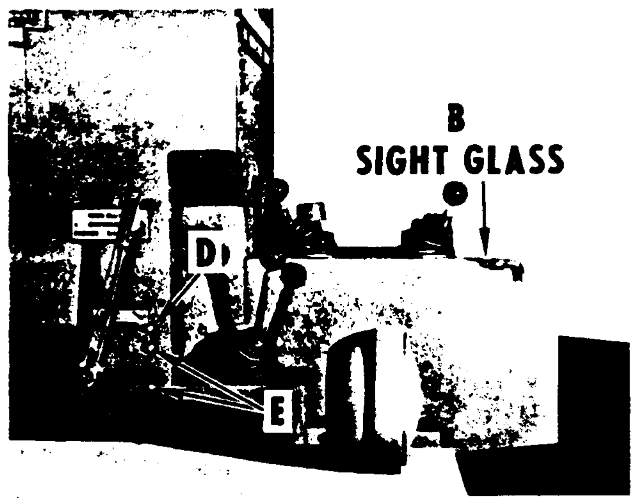
An individual instruction manual is provided, carefully outlining intervals of time to lubricate, clean air filter, and change oil along with other points of preventative maintenance. More frequent replacement or cleaning of air filter will be required in dusty conditions.

APPENDIX Q
ASPHALT PAVER LUBRICATION CHART





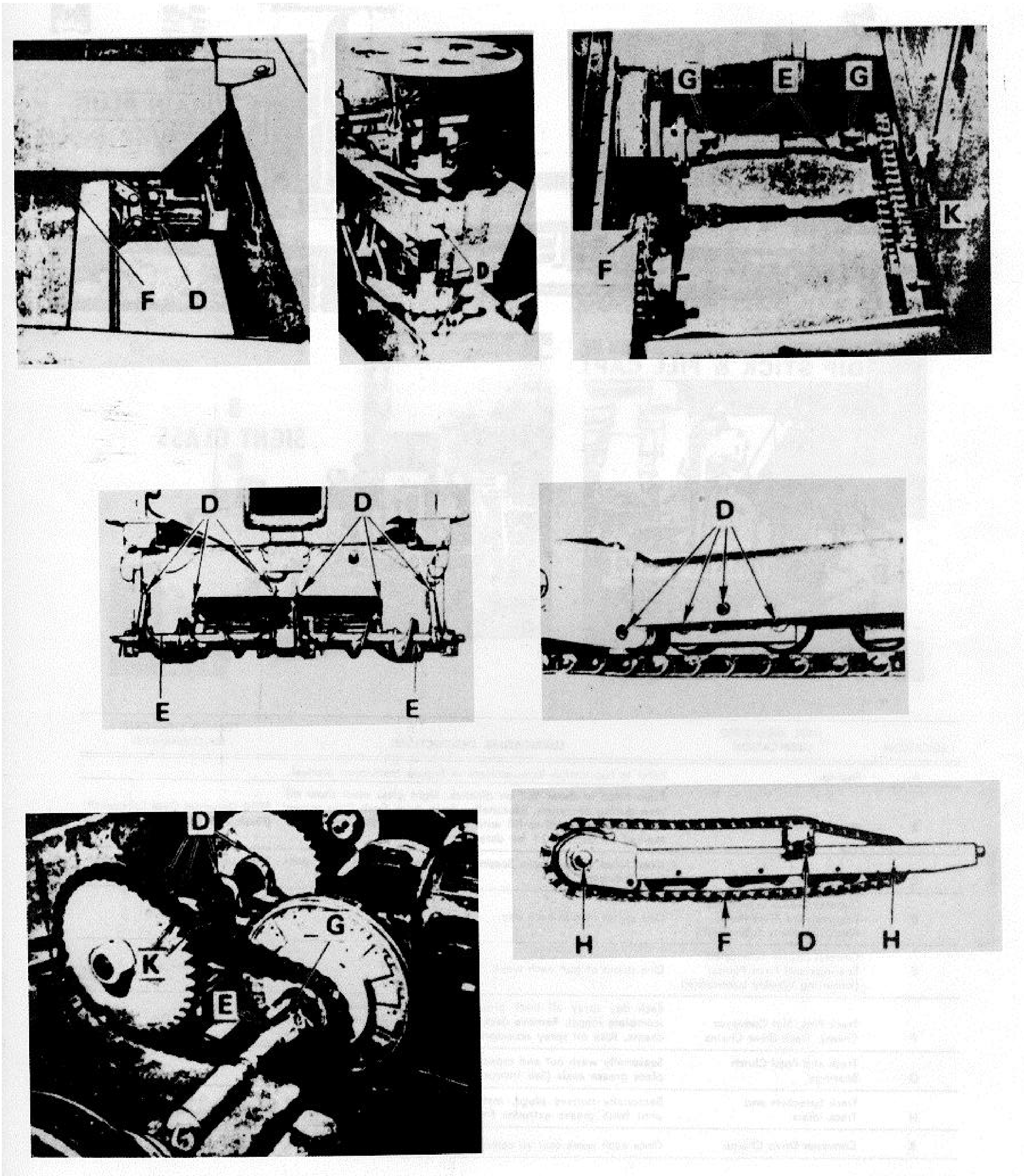




LOCATION	ITEM REQUIRING LUBRICATION	LUBRICATING INSTRUCTIONS	TEXACO LUBRICANT RECOMMENDED
A	Engine:	Refer to Lubrication Requirement In Engine Instruction Manual.	
B	Main Transmission:	Keep filled to show I/4" on dipstick. Sight glass must show oil flow during operation. Seasonally, drain, back-flush filter screen and case. Drain and re-fill with fresh lubricant (See instruction Manual - Section 11 for details).	
C	Power Transfer Cases:	Keep filled to level hole. Seasonally, drain, flush and re-fill with fresh lubricant.	
D	Bearings and Pivot Points	One pump of gun each day.	
E	Bearings and Pivot Points:	one pump of gun each week.	
F	Chains. Track Drive Chains	Each day spray all track pins. Spray all slat conveyor chains (complete loops). Remove deck plates and spray both track drive chains. (Use oil spray accessories from screed heater system).	
G	Bearings	Seasonally wash out and repack bearings and lube chamber. Replace grease seals (See Instruction Manual - Section 11).	
H	Track Idlers:	Seasonally remove plugs, install temporary fitting, add grease until fresh grease extrudes from opposite hole. Remove plugs.	
K	Conveyor Drive Chains:	Once each week coat all conveyor drive chains lightly.	

***IMPORTANT NOTE:**
Never mix brands of lubricant in paver gear cases. Chemical inter-action can occur to produce harmful, non-lubricating compounds. If uncertain of lubricant in a gear case, drain, flush and re-fill. DON'T JUST ADO MORE LUBRICANTI

ASPHALT PAVER LUBRICATION CHART



Index For Engine Repair Parts
DETROIT DIESEL ENGINE MODEL 5033-7001

ENGINE STANDARD AND OPTION EQUIPMENT

GROUP NAME	GROUP NO.	PARTS BOOK TYPE NO.
Cylinder Block	1.1000	29
Air Box Drains	1.1000A	63
Cylinder Head	1.2000	23
Engine Lifter Bracket	1.2000A	1.90
Crankshaft	1.3000	20
Crankshaft Front Cover	1.3000A	119
Crankshaft Pulley	1.3000C	111
Crankshaft Pulley Belt	1.3000D	176
Flywheel	1.4000A	327
Flywheel Housing (SAE #3)	1.5000A	349
Connecting Rod and Piston	1.6000	61
Camshaft and Gear Train	1.7000	31
Accessory Drive (Hydraulic Pump)	1.7000B	203
Valve Operating Mechanism	1.8000	30
Rocker Cover	1.8000A	38
Fuel Injector (N-45)	2.1000A	76
Fuel Pump	2.2000	127
Fuel Filter	2.3000A	157
Fuel Manifold Connections	2.4000	48
Fuel Lines	2.5000A	360
Governor Hydraulic	2.8000A	1002
Injector Controls	2.9000	121
Air Cleaner Adaptor	3.1000A	211
Air Inlet Housing	3.3000A	140
Blower	3.4000	114
Oil Pump	4.1000A	49
Oil Distribution System	4.1000B	235
Oil Pressure Regulator	4.1000C	9
Oil Filter	4.2000A	226
Oil Cooler	4.4000A	230
Dipstick	4.6000A	253
Oil Pan	4.7000A	584
Fresh Water Pump	5.1000	145
Water Outlet Elbow	5.2000A	67
Thermostat	5.2000B	72
Water By-Pass Tube	5.2000C	318
Radiator	5.3000A	64
Water Connections	5.3000B	135
Fan	5.4000A	290
Exhaust Manifold	6.100A	217
Exhaust Muffler Flange	6.2000A	234
Starting Motor	7.3000A	174
Engine Mount	11.1000A	510

QUICK REFERENCE ON REPLACEMENT ELEMENTS

TYPE	MFG.	PACKAGE PART NO.
Fuel Strainer	AC	T-553 (DDAD #5574961)
Fuel Filter	AC	TP-509 (DDAD #5573261)
Lube Oil Filter	AC	PF-147 (DDAD #5574978)
Air Cleaner	Donaldson	P114159

By Order of the Secretary of the Army:

E. C. MEYER
General, United States Army
Chief of Staff

Official:

J. C. PENNINGTON
Major General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-25B, Operator and Organizational Maintenance requirements for Paver Bituminous.

* U.S. GOVERNMENT PRINTING OFFICE : 1993 O - 342-421/63427

THE METRIC SYSTEM AND EQUIVALENTS

LINEAR MEASURE

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

WEIGHTS

1 Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 Lb.
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq Centimeter = 100 Sq Millimeters = 0.155 Sq Inches
1 Sq Meter = 10,000 Sq Centimeters = 10.76 Sq Feet
1 Sq Kilometer = 1,000,000 Sq Meters = 0.386 Sq Miles

CUBIC MEASURE

1 Cu Centimeter = 1000 Cu Millimeters = 0.06 Cu Inches
1 Cu Meter = 1,000,000 Cu Centimeters = 35.31 Cu Feet

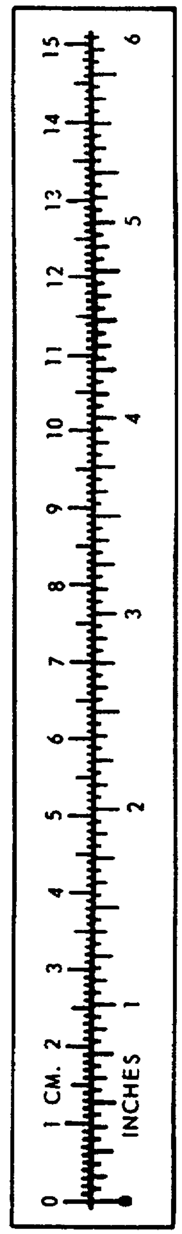
TEMPERATURE

$\frac{5}{9}(°F - 32) = °C$
212° Fahrenheit is equivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
$\frac{9}{5}°C + 32 = °F$

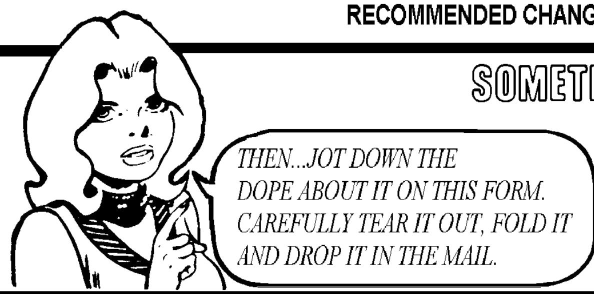
APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
Pints	Liters	0.473
Quarts	Liters	0.946
Gallons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
Liters	Gallons	0.264
Grams	Ounces	0.035
Kilograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pound-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
Kilometers per Liter	Miles per Gallon	2.354
Kilometers per Hour	Miles per Hour	0.621



RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS



SOMETHING WRONG WITH PUBLICATION

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE

BE EXACT PIN-POINT WHERE IT IS

PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.	IN THIS SPACE, TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT.

PRINTED NAME, GRADE OR TITLE AND TELEPHONE NUMBER	SIGN HERE

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PREVIOUS EDITIONS ARE OBSOLETE.

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