FIATALLIS

HD-5

crawler tractor

service manual

(COMPLETE)

Form 70626144 English

Reprinted

AVOID ACCIDENTS

Most accidents, whether they occur in industry, on the farm, at home or on the highway, are caused by the failure of some individual to follow simple and fundamental safety rules or precautions. For this reason MOST ACCIDENTS CAN BE PREVENTED by recognizing the real cause and doing something about it before the accident occurs.

Regardless of the care used in the design and construction of any type of equipment there are many conditions that cannot be completely safeguarded against without interfering with reasonable accessibility and efficient operation.

A careful operator is the best insurance against an accident. The complete observance of one simple rule would prevent many thousand serious injuries each year.
That rule is:

Never attempt to clean, oil or adjust a machine while it is in motion.

NATIONAL SAFETY COUNCIL

WARNING

On machines having hydraulically, mechanically, and/or cable controlled equipment (such as shovels, loaders, dozers, scrapers, etc.) be certain the equipment is lowered to the ground before servicing, adjusting and/or repairing. If it is necessary to have the hydraulically, mechanically, and/or cable controlled equipment partially or fully raised to gain access to certain items, be sure the equipment is suitably supported by means other than the hydraulic lift cylinders, cable and/or mechanical devices used for controlling the equipment.

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INCLUDES ALL SERIAL NOS.

Form 70626144 English

⚠ WARNING

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

⚠ The Operation and Maintenance Instruction Manual provides the instructions and procedures for starting, operating, maintaining, fueling, shutdown and servicing that are necessary for properly conducting the procedures for overhaul of the related components outlined in this Service Manual.

⚠ This symbol is your safety alert sign. It means ATTENTION! BECOME ALERT! YOUR SAFETY IS INVOLVED.

⚠ Read and heed all safety instruction carrying the signal words WARNING and DANGER.

⚠ Machine mounted safety signs have been color coded yellow with black borders and lettering for warning and red with white borders and lettering for danger points.

N O T I C E

Allis-Chalmers Corporation and FIAT S p A entered into a joint venture agreement to combine their manufacture, sale and service of construction machinery products throughout the world after January 1, 1974.

In view of the new enterprise, wherever in this publication reference is made to Allis-Chalmers or your Allis-Chalmers dealer, such reference is intended to identify FIAT-ALLIS Construction Machinery Inc or your FIAT-ALLIS dealer.

SAFETY RULES

GENERAL

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

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

Machine-mounted safety signs have been color coded yellow with black borders and lettering for warning and red with white borders and lettering for danger points.

No unauthorized personnel should be allowed to service or maintain this machine. Do not perform any work on equipment that is not authorized. Follow the Maintenance and Service procedures. Study the Operation and Maintenance Instruction Manual before starting, operating, maintaining, fueling or servicing this machine.

Always wear safety glasses with side shields.

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

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

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

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

Keep operator's compartment, stepping points, grab-rails and handles clean of foreign objects, oil, grease, mud or snow accumulation to minimize the danger of slipping or stumbling.

Never attempt to operate the machine or its tools from any other position than seated in the operator's seat.

Keep operator's compartment clear of loose objects.

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

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

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

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

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

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

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

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

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

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

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

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

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

Remove sharp edges and burrs from reworked parts.

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

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

Never place gasoline or diesel fuel in an open pan.

Safety Rules

GENERAL (Continued)

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

When using compressed air for cleaning parts use safety glasses with side shields or goggles. Limit the pressure to 30 psi according to OSHA requirements.

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

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

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

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

When making equipment checks that require running of the engine, have an operator in the operator seat at all times with the mechanic in sight. Place the transmission in neutral and set the brakes and lock. Keep hands and clothing away from moving parts. Shut off engine and disengage the Power Take-Off lever before attempting adjustments or service.

Never use the bucket as a man lift.

The articulation point between frames will not clear a person. Stay clear when engine is running. Support, using device provided when servicing. Return support to carry position and secure before moving machine after servicing. See Operation and Maintenance Instruction Manual.

Use linkage safety support provided to secure linkage in the raised position. Secure supports immediately after use and transporting. Do not substitute any other device in the places provided. See the Operation and Maintenance Instruction Manual.

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

Guard against kinking chains or cables. Do not lift or pull through a kinked chain or cable. Always wear heavy gloves when handling chain or cable.

Be sure cables are anchored and the anchor point is strong enough to handle the expected load. Keep exposed personnel clear of anchor point and cable or chain. DO NOT PULL OR TOW UNLESS OPERATOR'S COMPARTMENTS OF MACHINES INVOLVED ARE PROPERLY GUARDED against accidental cable or chain backlash.

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

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

Before starting machine or moving attachment check and adjust and lock operator's seat. Be sure all personnel in the area are clear before starting or moving machine and any of its attachments. Sound horn.

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

Do not carry loose objects in pockets that might fall unnoticed into open compartments.

Keep clutches and brakes of machine and attachments such as Power Control Units, winches and master clutches adjusted according to Operation and Maintenance Instruction Manuals of the manufacturer at all times. DO NOT adjust machine with engine running except as specified.

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

Wear welder's protective equipment such as dark safety glasses, helmets, protective clothing, gloves and safety shoes when welding. Wear dark safety glasses near welding — DO NOT LOOK AT ARC WITHOUT PROPER EYE PROTECTION.

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

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

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

START UP

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

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

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

ENGINE

Turn radiator cap slowly to relieve pressure before removing. Add coolant only with engine stopped or idling and if hot. See Operation and Maintenance Instruction Manual.

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

ENGINE (Continued)

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

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

Never lubricate a machine with the engine running.

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

ELECTRICAL

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

Always turn the master switch (key switch if so equipped) to the off position when maintaining or servicing machine.

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

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

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

Disconnect batteries before working on electrical system.

HYDRAULIC

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

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

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

ATTACHMENTS

Keep head, body, limbs, feet, hands and fingers away from blade, bucket or ripper when in raised position. Use authorized blocking as a safety measure before proceeding with service or maintenance per OSHA requirements.

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

Do not use machine to carry loose objects by means other than attachments for carrying such objects.

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

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

TIRES (APPLICABLE MACHINES)

Be sure tires are properly inflated to the manufacturer's specified pressure. Inspect for damage periodically.

Stand to one side when changing inflation of tires.

Check tires only when the machine is empty and tires are cool to avoid overinflation. Do not use reworked wheel parts. Improper welding, heating or brazing weakens them and can cause failure.

Never cut or weld on the rim of an inflated tire. Inflate a spare tire only enough to keep rim parts in place — a fully inflated tire might fly apart when it is not installed on a machine.

Use care if you must transport (haul) a fully inflated tire.

When servicing tires block the machine in front and back of all wheels. After jacking up, place blocking under machine to protect from falling per OSHA requirements.

Deflate tires before removing objects from the tread.

Never inflate tires with flammable gases. Explosion and personal injury could result.

FOREWORD

This manual is prepared to provide the customer and the organization personnel with complete information and instructions on the maintenance of the Model HD-5 Tractor. Extreme care has been exercised in the designing, selection of materials and the assembly of the tractor. By proper maintenance and skillful operation of the tractor, the utmost satisfaction in performance and service can be obtained.

In order to become familiar with the various parts of the tractor, it is urged that the mechanic study the instructions in the manual and use it as a reference when performing repair or maintenance operations.

All information and illustrations shown throughout this manual are of the "Standard" Model HD-5B Tractor, unless otherwise stated.

Where special tools are required, their application and use are illustrated.

Sections I through XIX contain a detailed description of the various assemblies of the tractor and instructions for the proper adjustment and repair or rebuilding of these assemblies.

Section XX describes the Special Equipment available for the tractor and outlines the service on these parts.

General Maintenance Instructions are given in Section XXI, and Fits and Tolerances in Section XXII.

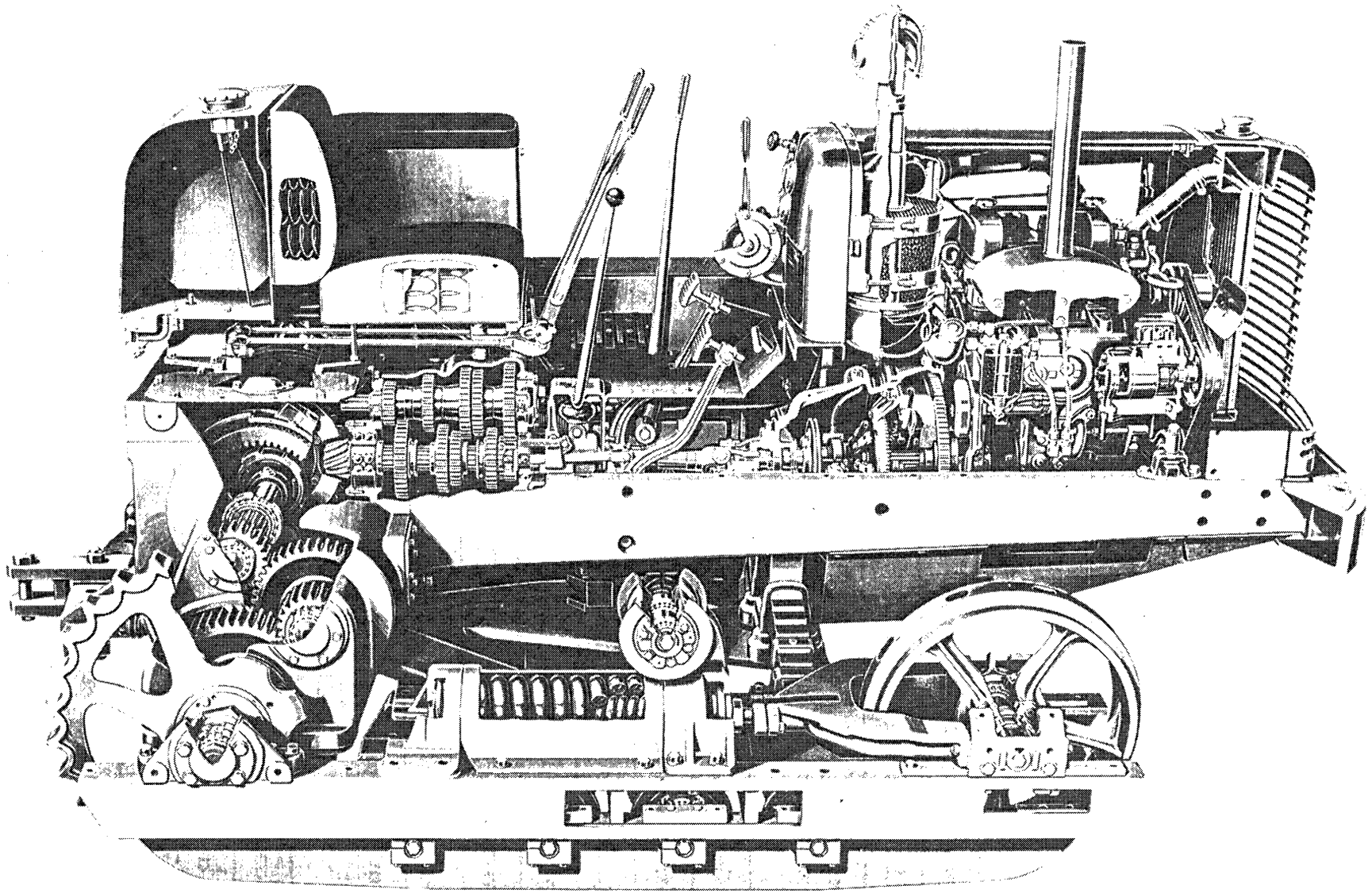
Trouble Shooting Information given in Section XXIII will aid in determining the cause of operating irregularities that may occur and indicates what may be done to correct them.

To obtain the best results and to maintain the original quality built into the tractor, it is important that genuine Allis-Chalmers Parts be used when new parts are required.

IMPORTANT: Always furnish the dealer with both the Tractor and Engine Serial Numbers when ordering parts.

Many Allis-Chalmers owners employ the Dealer's Service Department for all work other than routine care and adjustment. This practice is encouraged as our dealers are kept well informed by the factory regarding advanced methods of servicing Allis-Chalmers products and are equipped to render satisfactory service.

SUBJECT INDEX



Cutaway — Model HD-5 Tractor

SECTION 1 — DESCRIPTION AND SPECIFICATIONS

1. GENERAL DESCRIPTION

The description given herein and the information contained in this manual pertains only to the Model HD-5B Tractor (Standard Model) unless otherwise stated.

The model HD-5B Tractor is a 11,250 pound track-type tractor powered with a 54.6 horsepower, 2 cylinder, 2 cycle Diesel Engine. Power from the engine is transmitted through a single plate over-center type clutch and a universal joint drive shaft assembly to the transmission. The final drive gears and track drive sprockets are driven by two multiple-disc steering clutches, one on each end of the steering clutch cross shaft.

At full governed engine speed (under load) of 1800 R.P.M. the transmission provides 5 forward speeds, ranging from 1.46 M.P.H. to 5.47 M.P.H., and a reverse speed of 1.99 M.P.H. Mechanical self-energizing brakes insure easy and positive control of the tractor at all times.

The tractor is equipped with electric starter, head lights, full width crankcase guard, hinged radiator grille, front bumper, and positive seal truck wheels, track idlers and track support rollers.

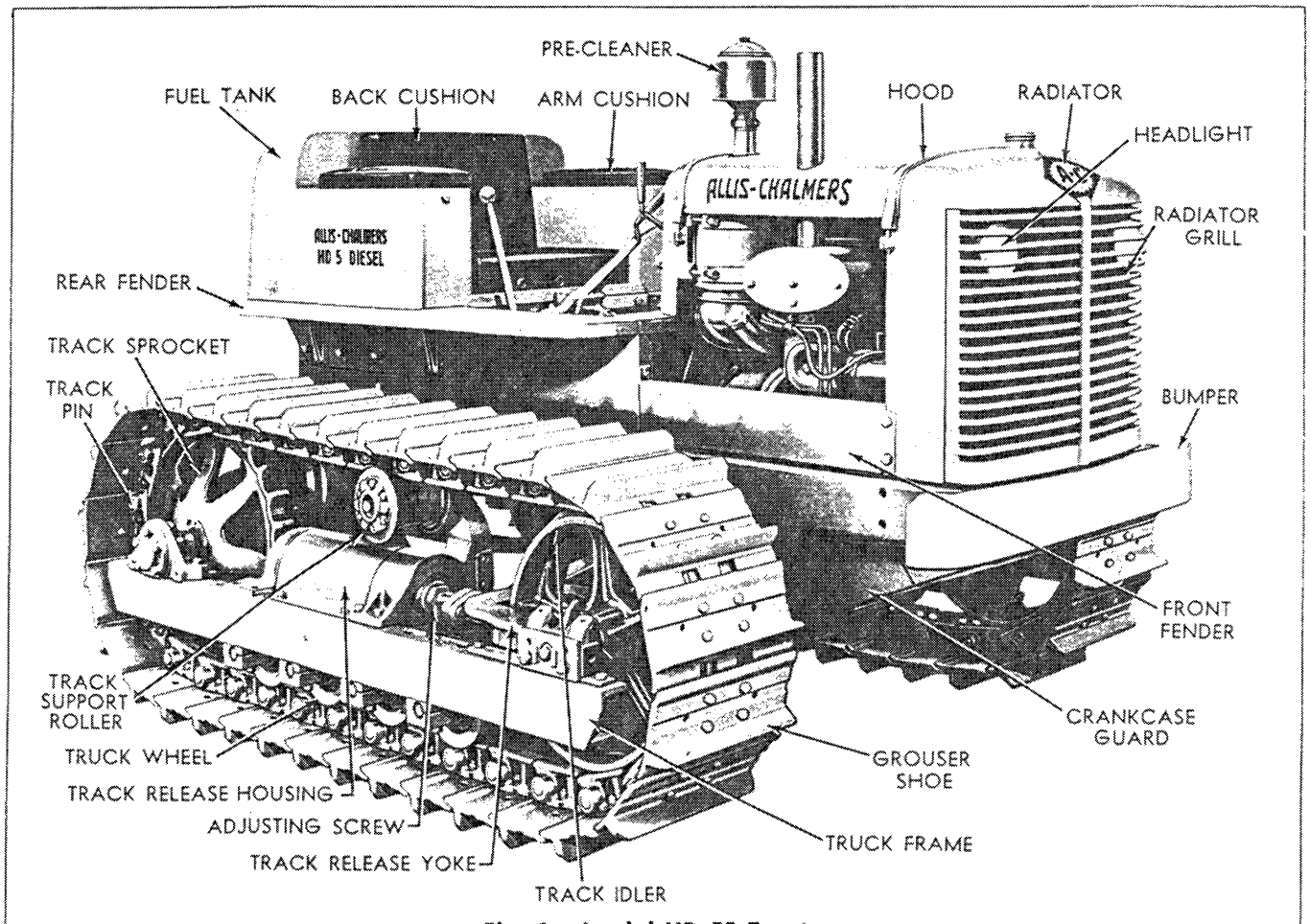


Fig. 1 — Model HD-5B Tractor

2. GENERAL SPECIFICATIONS (STANDARD TRACTOR)

GENERAL:

Weight (60" tread)	11,250 lbs.
Overall Length	10 ft. 4⅞ in.
Overall Width (60" tread)	6 ft. 6½ in.
Overall Height (including air pre-cleaner and exhaust pipe)	6 ft. 1⅛ in.
(Air pre-cleaner and exhaust pipe removed)	5 ft. ⅜ in.
Tread Width — Wide Tread	60 in.
Turning Radius (60" tread)	6 ft. 10⅞ in.
Length of Track on Ground	5 ft. 4¼ in.
Track Shoe Width (Standard)	13 in.
Ground Contact Area (Standard Shoe)	1670½ sq. in.
Ground Pressure (60" tread)	6.73 lbs. per sq. in.
Ground Clearance	11¼ in.
Drawbar Height	13-15/16 in.
Lateral Movement of Drawbar	21 in.

MAXIMUM SPEEDS:

1st Gear	1.46 M.P.H.
2nd Gear	2.44 M.P.H.
3rd Gear	3.30 M.P.H.
4th Gear	3.96 M.P.H.
5th Gear	5.47 M.P.H.
Reverse	1.99 M.P.H.

ENGINE:

Make	General Motors Diesel
Type	2-Cycle
Number of Cylinders	2
Bore and Stroke	4¼ x 5 in.
Piston Displacement	142 cu. in.
Full Governed Speed (under load)	1800 R.P.M.
Maximum Net Torque	179.1 ft. lb. @ 1270 R.P.M.
Drawbar Horsepower (at rated speed of 2.44 M.P.H.)	43.8
Belt Horsepower	51.9
Fuel Used	No. 1 and 2 Diesel
Fuel Injection System	Unit Injectors
Lubrication	Forced Feed

CAPACITIES (Fuel, Oil and Coolant—U. S. Standard Measure):

	Approximate Capacity
Fuel Tank	37 Gallons
Cooling System	3¾ Gallons
Engine Crankcase	2 Gallons
Transmission	5 Gallons
Final Drives (each)	3 Gallons
Air Cleaner	2¼ Quarts

The Allis-Chalmers Manufacturing Company reserves the right to make changes in the above specifications or to add improvements at any time without notice or obligation.

3. SPECIFICATIONS OF LUBRICANTS

A. Engine Crankcase Lubricant.

USE NON-CORROSIVE DIESEL ENGINE LUBRICATING OIL CONTAINING ADDITIVES WHICH WILL PREVENT SLUDGE OR GUM DEPOSITS. UNDER NO CIRCUMSTANCES SHOULD A CORROSIVE DIESEL ENGINE LUBRICATING OIL EVER BE USED.

Atmospheric Temperature	Viscosity
Above 32° F.	Use SAE 30
0° F. to 32° F.	Use SAE 20
0° F. and below	Use SAE 10

Manufacturers of lubricants recognize the importance of the qualities required for use in our equipment and they are co-operating fully to insure the use of only those oils which fulfill these requirements. The oil distributor and oil manufacturer are to be held responsible for the results obtained from their products.

The outstanding lubricating requirements for efficient operation of this engine are: The maintaining of piston rings in a clean, free condition; absence of hard carbon and "varnish" deposits on or within engine parts; the prevention of bearing corrosion and the promotion of general cleanliness within the engine.

Proper operation and maintenance of the engine is necessary to obtain the desired results from the lubricating oil. Operating and maintenance factors can be effectively controlled by the engine user.

B. Transmission and Final Drive Lubricant.

Lubricate these assemblies with engine oil. A list of the various brands of engine oils which have been tested and found satisfactory for use in these assemblies is shipped with each tractor and is also available from Allis-Chalmers dealers. Use only an oil shown on this list, as the use of untested oils may result in deterioration of the Neoprene boots and rings in these assemblies.

Use oils with the following viscosity:

Atmospheric Temperature	Viscosity
Above 32° F.	Use SAE 50
32° F. and below	Use SAE 30

C. Truck Wheel, Track Idler and Track Support Roller Lubricant.

Lubricate these assemblies with a grease that has been tested and found satisfactory by Allis-Chalmers Manufacturing Company.

The type of grease used for lubricating these assemblies was selected because of its good pumpability and cold temperature characteristics and because of its having a minimum effect on the synthetic rubber seal boots. It is also an extremely stable grease and will not deteriorate excessively with long use.

A revised list of approved oils and greases is issued every six months and new oils and greases which have been tested and approved during each period are added to the list. Ask your nearest Allis-Chalmers factory branch or authorized dealer for the latest list.

D. Pressure Gun Lubricant.

Use a pressure gun lubricant with a minimum melting point of 300° F. This lubricant should be in a viscosity range so as to insure easy handling in the pressure gun at prevailing air temperatures.

4. SPECIFICATIONS OF FUEL OIL

Use No. 1 Diesel Fuel Oil purchased from a reputable oil company. In warm weather, No. 2 Diesel Fuel Oil may be used. This fuel must be within the classification limits as established by the American Society for Testing Material. Tentative Diesel Fuel Oil Specifications (ASTM — D975).

For commercially satisfactory engine life and performance, fuel oil requirements must comply with four basic qualifications:

1. Physical cleanliness.
2. Absence of Chemical contamination.
3. Proper burning characteristics.
4. Cold starting ability.

Physical cleanliness means freedom from water, dirt and other incombustible ingredients. Since all present day high speed engine fuels are completely distilled, they leave the refinery in clean condition. Transport and subsequent storage account for the addition of most foreign matter found in the fuel.

Proper burning characteristics are dependent upon ignition quality and volatility.

The fuel should have a cetane number of at least 40, and should be free from alkali, acids, gum, and water. The sulphur content should not exceed 0.5% for summer operation and 0.3% for winter operation. Fuel oils having these specifications are available from most oil companies. *The use of fuels having more than the specified sulphur content are conducive to harmful engine deposits, rapid wear, and sticking rings and valves.*

Volatility is determined by the boiling temperature range. Fuels having a low final boiling point will vaporize and burn more completely than fuels with a high final boiling point.

The preferred high speed diesel fuels range in color from white to light amber.

5. FUEL STORAGE

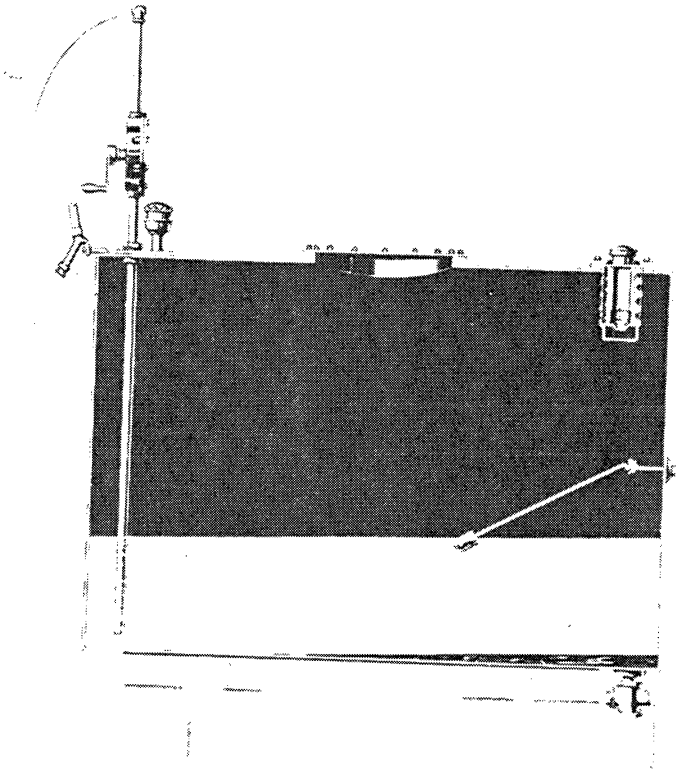


Fig. 2 — Fuel Storage Tank

The importance of proper storage of fuel cannot be too strongly stressed. Storage tanks, drums or service tanks must be free from rust, scale, sediment or any other foreign matter which will con-

taminate the fuel, clog the filters and eventually damage the fuel pump and injectors.

A portable storage tank provides the best method for storing fuel on the job. In a tank, the sediment and water can easily be drained and the fuel can be pumped into the tractor fuel tank with a minimum of handling. Consult your local Allis-Chalmers dealer for details about this type of storage tank. Since condensation will occur in the tank, it is very important that a sediment sump be provided in the bottom of the storage tank where the water and settlings can be drained daily.

Fuel should be allowed to settle at least 48 hours in the storage container before it is put in the fuel tank of the tractor. It is advisable to use a pump and draw the fuel from the tank or barrel rather than from the bottom of the container by means of a faucet or through the bung hole.

Where conditions are such that drums must be used to supply fuel, it is advisable to have enough drums to allow sufficient time for the fuel to settle. The fuel should be used only to within about three inches from the bottom. The fuel thus left in a number of drums can be collected into one drum and used after the usual time allowed for settling. In this manner, the sediment and foreign matter will be disposed of and no fuel will be wasted. Whenever drums are used for storage, they should be covered or placed under shelter to avoid the fuel becoming contaminated by water which will enter through the filler plugs when it rains, even though the plugs are tight.

The fuel tank of the tractor should be filled at the end of the day's run rather than in the morning. This will reduce the water content, as a full tank is less subject to condensation. The fuel tank is provided with a drain elbow and drain cock. Sediment will settle into this elbow and can be drained.

6. TRACTOR AND ENGINE SERIAL NUMBERS

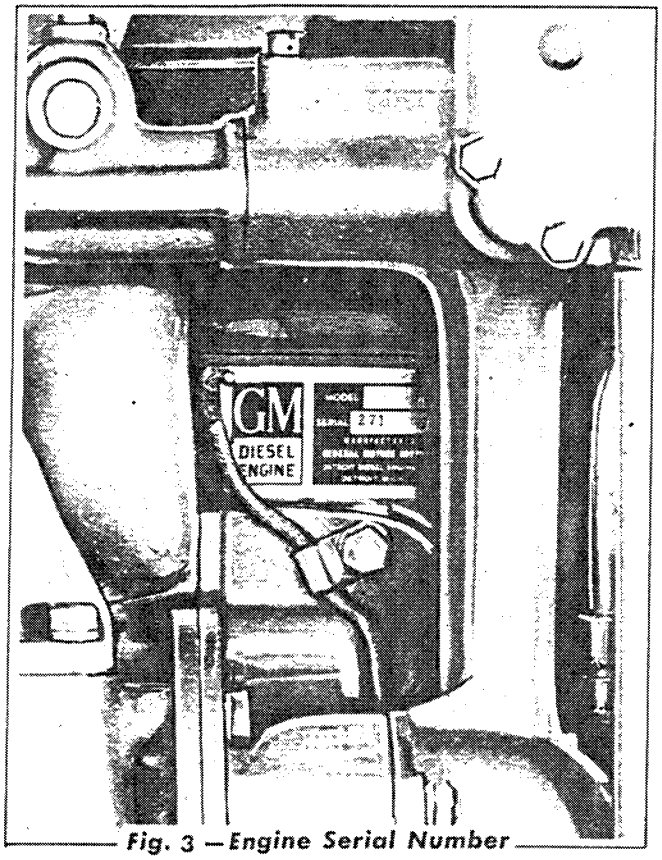


Fig. 3 —Engine Serial Number

On all parts orders and in all correspondence relative to the tractor, it is necessary that both tractor and engine serial numbers be given. This will properly identify the particular tractor and will insure obtaining the correct replacement parts for it.

Prior to engine Serial Number 2-71-11180, the engine serial number is stamped on a plate attached to the left side of the cylinder block below the governor control housing. On engines Serial Number 2-71-11180 to 2-71-15635 the number is stamped directly in the cylinder block in the same relative location. Effective on engines after 2-71-15635 the engine serial numbering system was changed. In the new system of numbering, the prefix numbers 2-71 were changed to read 2A-1, 2A-2, etc., and are stamped in the cylinder block.

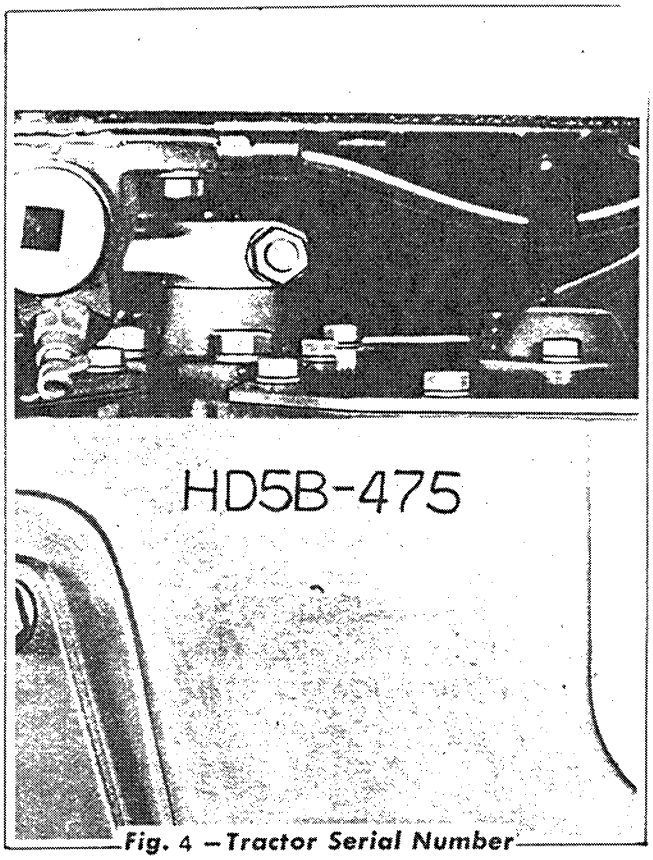


Fig. 4 —Tractor Serial Number

The tractor serial number is stamped in the rear face of the steering clutch housing near the upper right corner.

SECTION II — ENGINE FUEL SYSTEM

1. DESCRIPTION OF SYSTEM

The engine fuel system consists of the fuel tank, first stage fuel filter, fuel pump, second stage fuel filter, injectors and fuel lines. The fuel is drawn from the bottom of the tank and through the first stage filter by the fuel pump. The pump circulates the fuel under pressure through the second stage fuel filter and inlet fuel manifold in the cylinder head, and through the injectors. As the fuel enters each injector, it passes through a small porous metal filter in the injector body. The amount of fuel required by the engine is injected into the cylinders by the injectors. Surplus fuel not required for combustion, leaves each injector through a second porous metal filter, enters the return fuel manifold in the cylinder head and returns to the fuel tank. A pressure of 25 to 45 pounds is maintained within the system by a restricted fitting located at the cylinder head return manifold opening. The continuous circulation of the fuel through the injectors helps to cool them and eliminates the possibility of air pockets in the fuel supply system.

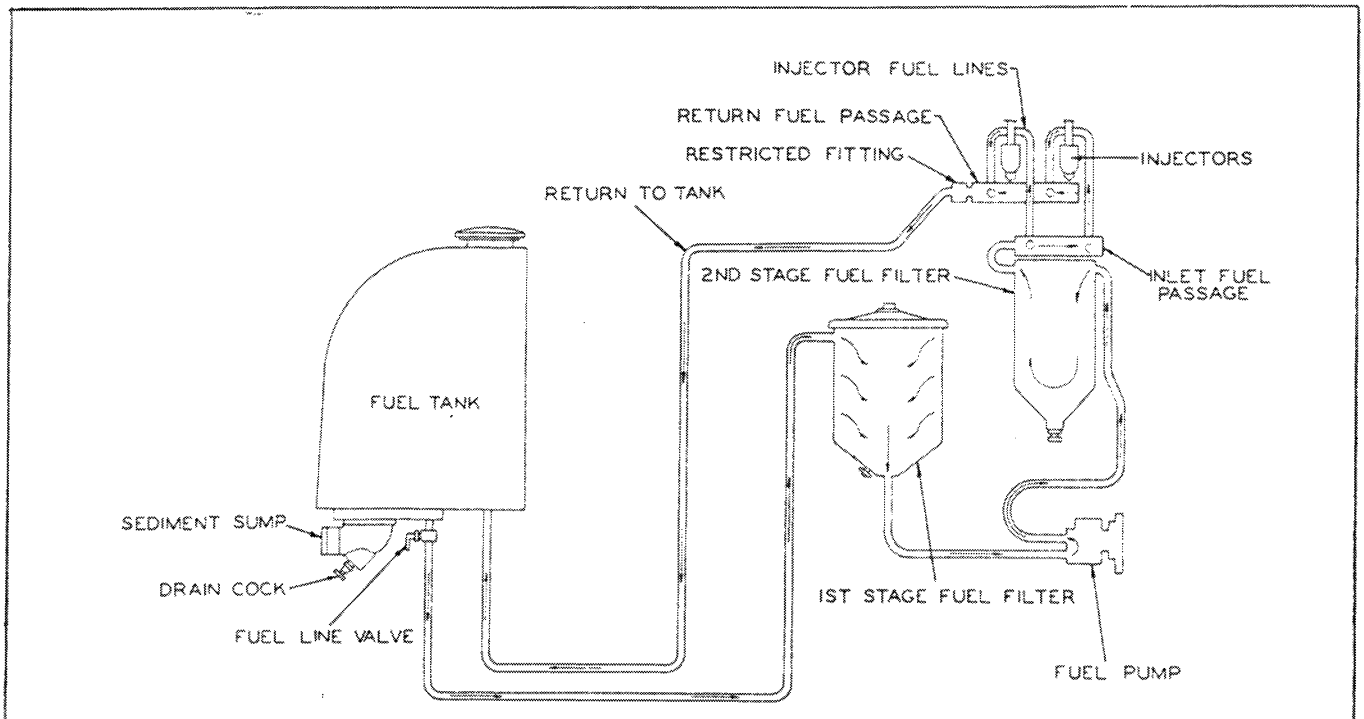


Fig. 1 — Schematic Fuel Flow Diagram

2. CHECKING FUEL SUPPLY SYSTEM

A. General.

Under normal conditions with the engine operating at full throttle, 25 to 45 pounds pressure will be indicated on the fuel pressure gauge, if the tractor is equipped with a gauge. If the tractor is not equipped with a fuel pressure gauge, and conditions occur which indicate incorrect fuel pressure, the pressure can be checked by installing a gauge in the delivery line of the fuel pump at any point between the pump and the inlet manifold opening.

Fuel pressure below normal, uneven running of the engine, excessive vibration, stalling when idling, and a loss of power are indications of insufficient fuel supply to the injectors.

To determine the cause for the above conditions check for the following:

Air being drawn into system
Clogged fuel filter elements and fuel lines
Clogged injector fuel filters
Inoperative fuel pump

To check the flow of fuel through the system, disconnect the fuel return line at any point between the fuel return manifold and the fuel tank. With the engine operating at full throttle, the system will be functioning properly when a full stream of fuel with considerable force can be observed returning to the fuel tank through the fuel return line. If only a small stream is observed returning to the tank, all the causes listed above must be checked and eliminated in turn.

B. Check for Admission of Air Into System and for Clogged Filter Elements and Fuel Lines.

To check for air being admitted into the system, remove the valve rocker arm cover and loosen or disconnect one of the injector fuel lines, then start the engine. If air is entering the fuel system, foam or bubbles will be observed in the fuel that emerges from the loosened connection. Correct this condition by tightening any loose fuel lines and filter connections between the fuel pump and the fuel tank. Test for smooth operation and full flow of fuel.

If the fuel lines or filters are clogged remove the fuel lines, clean both filter shells and install new elements. Blow out the lines while they are disconnected. This should eliminate the difficulty. Check for full flow of fuel after engine is again started.

C. Check for Clogged Injector Filters.

If the engine still runs "ragged" with suitable fuel return, the injector filters for one or both cylinders may be partially clogged. Locate the faulty injector as follows:

1. Run the engine at idling speed and cut out each injector in turn by holding the injector follower down with a screwdriver or small block of wood while the engine is running, as illustrated in Figure No. 2.

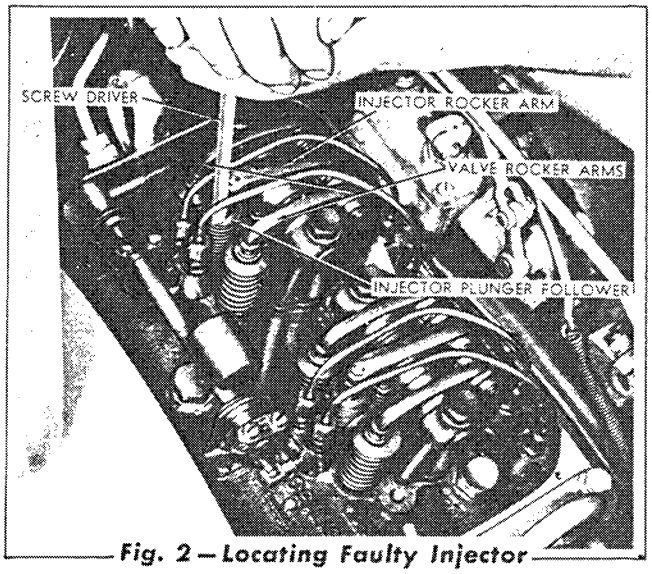


Fig. 2 — Locating Faulty Injector

CAUTION: Do not allow the screwdriver to slip off the follower as damage to the valve assemblies can easily result. If the engine speed decreases when the follower is held down it will indicate that the injector for that cylinder is functioning properly. If the engine continues to run with no decrease in speed, the injector is inoperative and should be removed for further inspection.

2. Stop the engine and remove the fuel feed line that connects the injector to the return fuel manifold. Hold a finger over the injector fuel outlet and crank the engine with the starter. If the fuel gushes from the injector while the starter is cranking the engine, an ample fuel supply is indicated. Remove the injector and

check for clogged injector filters. Refer to "INJECTOR REMOVAL" in this section.

D. Check for Inoperative Pump.

Assuming that there is a sufficient supply of fuel in the fuel tank, and that the fuel is reaching the fuel pump, remove the pipe plug from the top of the second stage fuel filter. With the engine running the fuel will gush from the opening in the filter. If it does not, the fuel pump will be considered inoperative and must be removed and repaired or replaced.

E. Excessively High Pressure.

A relief valve is installed in the fuel pump to prevent high fuel pressure. When the relief valve sticks, high pressure will develop and will be indicated on the fuel pressure gauge, if the tractor is equipped with a fuel pressure gauge.

When high pressure occurs, the valve in the fuel pump should be inspected and the cause determined for its sticking. The second stage fuel filter, the restricted fitting in the fuel return line at the return manifold and all fuel lines should be inspected for clogged passages.

Continued operation with excessively high pressure (over 60 pounds) may result in damage to the fuel system.

3. FUEL TANK AND DRAIN ELBOW

A. Description.

The fuel tank, located at the rear of the tractor has a capacity of approximately 37 gallons.

The drain elbow on the bottom of the fuel tank provides a means of flushing the tank and also acts as a sediment sump. Open the drain cock on this elbow before the engine is started at the beginning of the day's operation in warm weather or shortly after the end of the day's operation in freezing weather. Close the cock when clean fuel runs out. Drain the tank, when an accumulation of rust and scale is evident, by removing the plug in the end of the drain elbow, then flush the tank thoroughly.

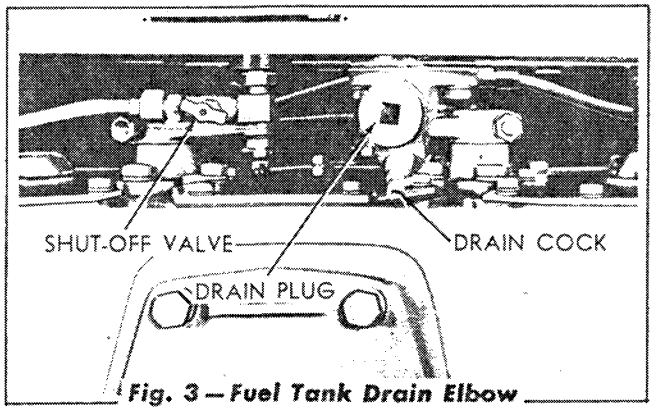


Fig. 3 — Fuel Tank Drain Elbow

B. Maintenance.

If a large accumulation of rust or scale in the tank becomes apparent, remove the drain elbow and the fuel lines from the bottom of the tank and flush the tank with clean fuel or clean the tank with live steam. This will prevent frequent clogging of the fuel filters and will eliminate possible trouble in the fuel system.

C. Removal.

When it becomes necessary to remove the fuel tank, proceed as follows:

1. Remove the arm cushions from the top of each battery box and remove the capscrews used in fastening each battery box to the fuel tank.
2. Remove the bolts attaching the tank to the rear fenders.
3. Close the fuel shut-off valve at the bottom of the tank and disconnect the fuel supply line and the fuel return line from the fuel tank.
4. Place a suitable chain or rope around the fuel tank and remove the tank from the tractor. Protect all openings of the fuel tank and disconnected lines against the entrance of foreign material.

4. FUEL FILTERS

A. Description of First Stage Fuel Filter.

This filter, mounted at the left side of the engine, contains a replaceable element. Dirt and sediment in the fuel is collected by this filter and prevented from passing on to the fuel pump. A drain cock in the bottom of the filter shell allows drainage of the sediment collected.

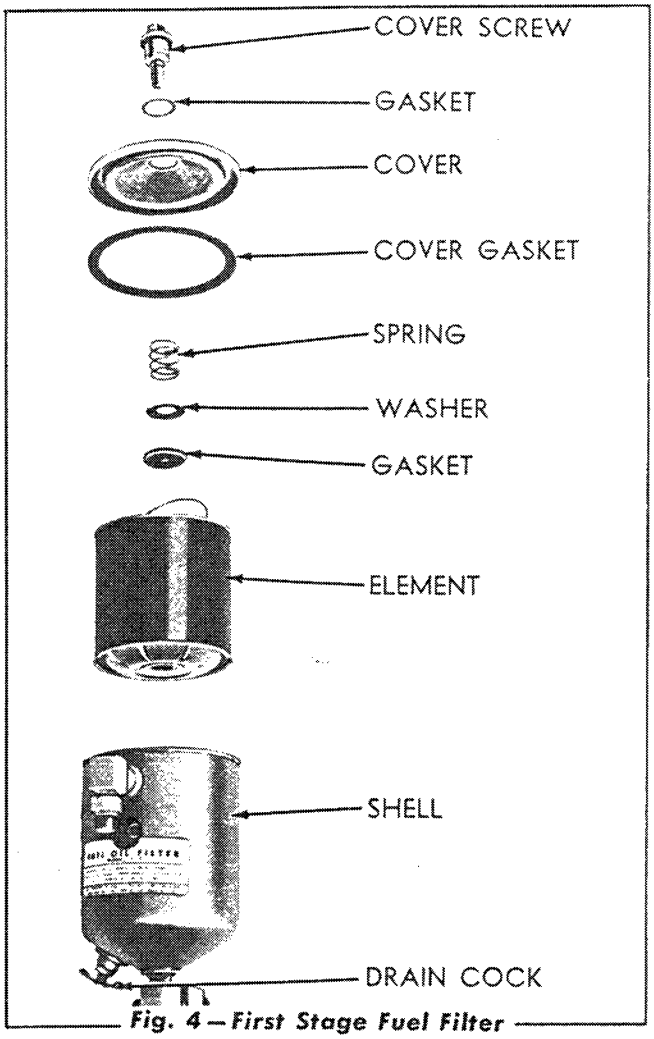


Fig. 4—First Stage Fuel Filter

B. Service of First Stage Fuel Filter.

Open the filter drain cock daily, before the engine is started at the beginning of the day's operation in warm weather or shortly after the end of the day's operation in freezing weather, and allow the water or sediment to drain. Close the drain cock when clean fuel runs out. Remove and discard the old element and install a new one after every 300 to 500 hours of operation (more often if conditions warrant) or when the filter becomes clogged. A clogged filter is usually indicated by irregular engine performance.

To change the element, remove the filter cover, drain the filter, lift out the spring and element and wash the inside of the filter shell. Place a new element and the spring in position and re-install the cover, using the new cover gasket furnished with the new element. Start the engine and check to be sure that the filter does not leak.

C. Description of Second Stage Fuel Filter.

This filter, mounted on the right side of the engine, contains a replaceable element. Any small particles of dirt, which may have passed through the first stage filter are collected by this filter and prevented from reaching the injectors. A drain cock, in the bottom of the filter shell, allows for drainage of the sediment collected.

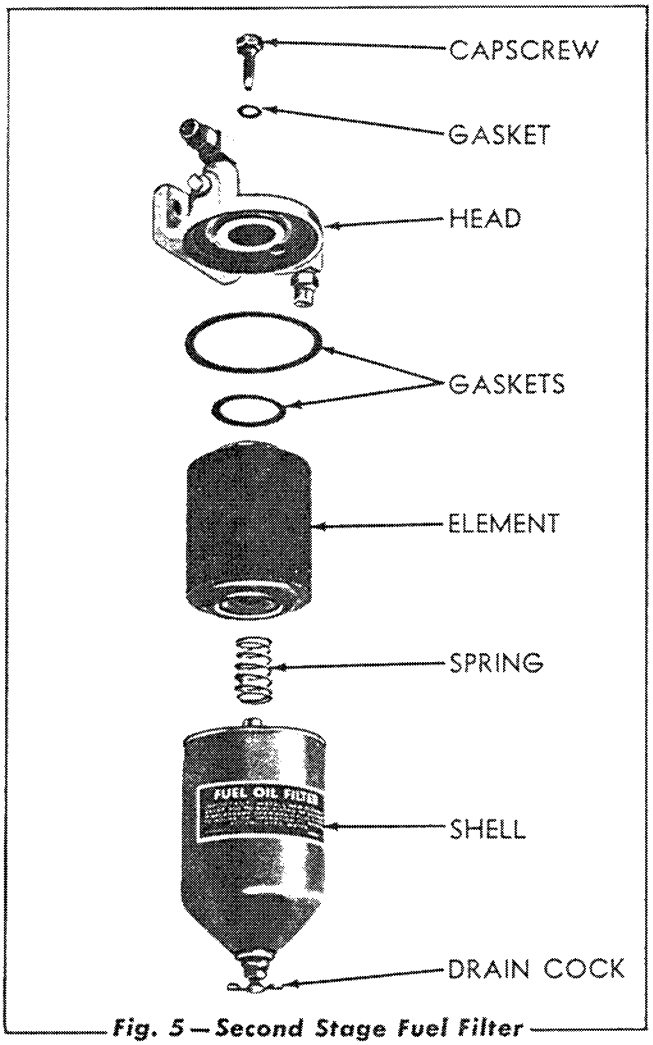


Fig. 5—Second Stage Fuel Filter

D. Service of Second Stage Fuel Filter.

Open the filter drain cock daily, before the engine is started at the beginning of the day's operation in warm weather or shortly after the end of the day's operation in freezing weather, and allow the water or sediment to drain. Close the drain cock when clean fuel runs out. Remove and discard the old element and install a new one after every 300 to 500 hours of operation (more often if conditions warrant) or when the filter becomes clogged. A clogged filter is usually indicated by irregular engine performance.

To change the element, drain the filter and remove the shell from the filter head. Remove and discard the old element. Wash the shell thoroughly. Install a new element. *NOTE: The spring is installed below the element in this filter and above the element in the first stage filter.* Reinstall the shell, using the new gasket furnished with the new element. Start the engine and check to be sure that the filter does not leak.

5. FUEL PUMP

A. Description.

The tractor may be equipped with either an "Eaton" or a "Barnes" Fuel Pump, mounted to the engine as shown in Figure No. 6.

The "Eaton" Fuel Pump is a rotor type pump having a delivery capacity of approximately 35 gallons per hour at 1000 R.P.M. The pump is bolted to an adapter, and is driven by an adapter shaft through a hollow sleeve which acts as a universal joint. The adapter shaft is driven by a helical gear on the balancer shaft of the engine.

The pump rotates in a counter-clockwise direction, viewed from the cover end. The four lobe inner rotor rotates the outer rotor eccentrically when the pump is in operation to open and close the passages in the pump housing. The four lobe inner rotor is attached to the pump shaft by a ball lock and rotates the outer rotor which is free to turn in the pump housing cover. As the rotors revolve in the housing, fuel is displaced from the inlet passage to the outlet passage.

Two pump shaft oil seals are used inside the body at the inner end. The sealing edge of one seal faces the pump cover and retains the fuel within the pump, the other faces the opposite direction and prevents engine lubricating oil from entering the pump. The seals are located approximately 1/16" apart. A drain hole, located between the two seals, vents to the atmosphere. A neoprene gasket fitted into the machined recess in the cover is compressed between the housing and the body when the attaching bolts are drawn tight. This seal prevents fuel oil from leaking out as well as preventing air leaking into the pump between the cover and the housing.

A spring loaded relief valve, located on the inlet side of the pump (right side of pump viewed from cover end) is provided to by-pass fuel back to the inlet side when the outlet pressure exceeds 37 to 47 P.S.I. This valve normally does not open since its purpose is to relieve excessive pump pressure in case of clogging in any of the fuel lines or filters.

The "Barnes" Fuel Pump is a constant flow gear type pump, having a delivery capacity of approximately 35 gallons per hour at 40 pounds pressure and 1000 R.P.M. The Barnes Pump is bolted to an adapter and is driven in the same manner as the Eaton Pump. Two steel gears revolve inside the pump housing to create a vacuum in the intake chamber, thus drawing fuel from the fuel tank. The fuel is carried around the gears in the spaces between the teeth, and is forced out of the pump under pressure.

The driving gear is mounted on a free-floating type drive shaft and is keyed to the shaft by a shear pin. The driven gear is supported in the bore of the pump housing by its supporting journals which are an integral part of the driven gear.

Two pump shaft oil seals are used inside the stator at the inner end. The sealing edge of one seal faces the pump housing and retains the fuel within the pump, the other faces the mounting flange end of the stator, and prevents engine lubricating oil from entering the pump. The seals are located approximately 1/16" apart. A drain hole, located between the two seals, vents to the atmosphere.

A spring loaded relief valve, located on the inlet

side of the pump (right side of pump viewed from cover end) is provided to by-pass fuel back to the inlet side when the outlet pressure exceeds 47 to 60 P.S.I. This valve normally does not open since its purpose is to relieve excessive pump pressure in case clogging occurs in any of the fuel lines or filters.

B. Service.

If the fuel pump is removed for reconditioning, the pump drive assembly should also be removed for inspection.

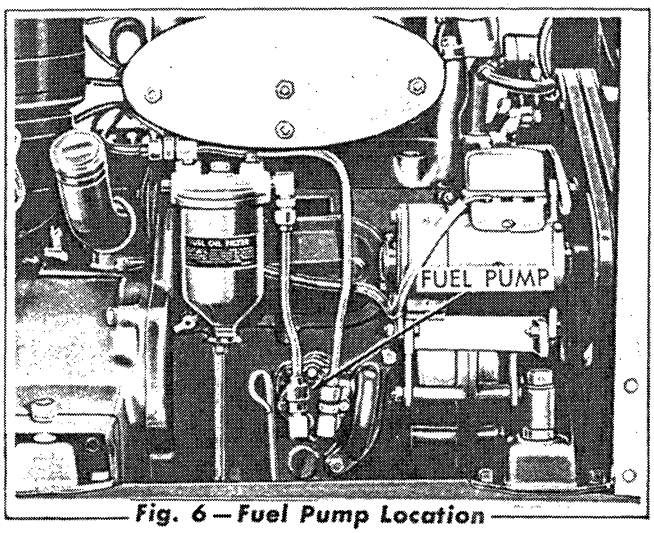


Fig. 6—Fuel Pump Location

C. Removal of Fuel Pump and Pump Drive Shaft Assembly.

1. Disconnect the fuel lines from the pump.
2. Remove the nuts attaching the fuel pump and drive adapter to the engine block.
3. Pull the pump off the attaching studs and remove the square, tubular fuel pump coupling.
4. Remove the flat head capscrew attaching the drive adapter to the engine block if capscrew is used for attaching. *NOTE:* A flat head capscrew is used to hold the adapter assembly in place on the early model engines, and a dowel is used on the later model engines.
5. Tap the drive adapter flange lightly to loosen and withdraw it from the engine block.

D. Disassembly of "Eaton" Fuel Pump.

The relief valve assembly may be removed from the pump body without disassembly of the other parts of the pump, by removing the fuel pump plug and jarring the valve parts from the body.

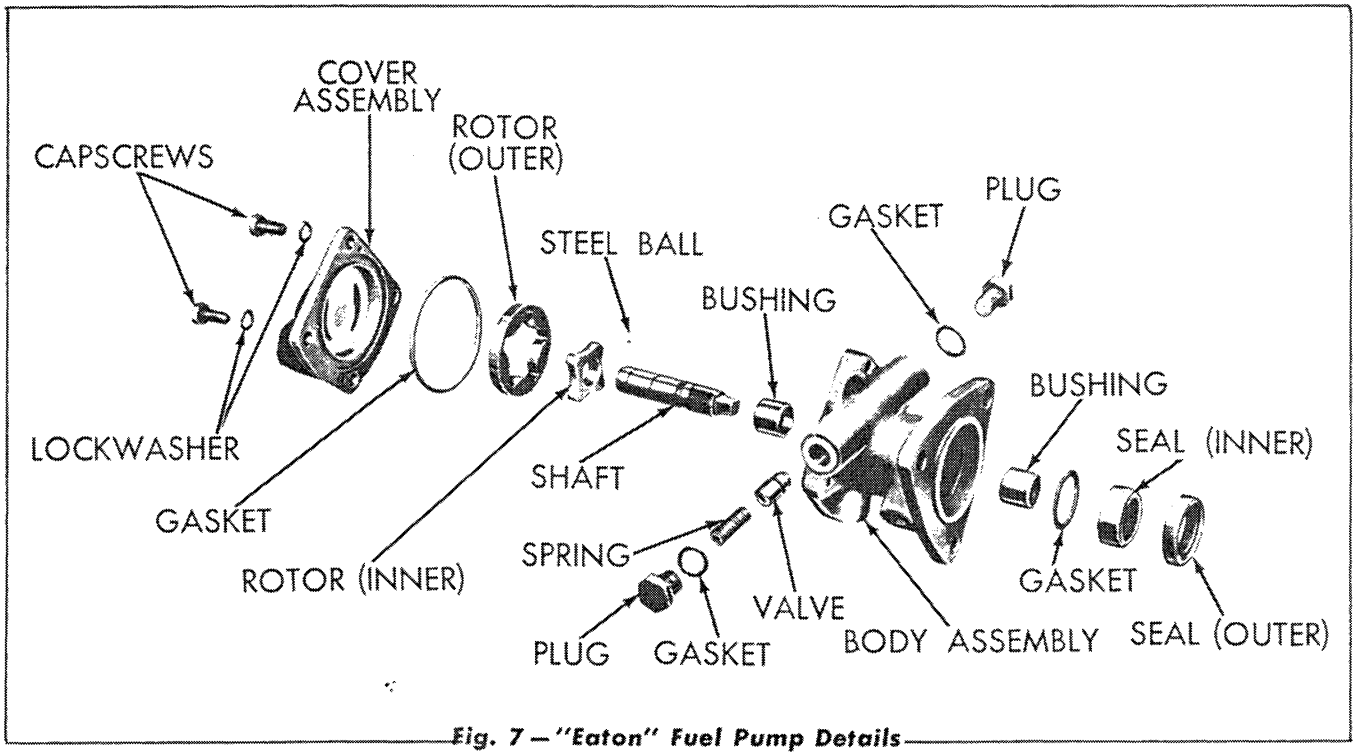


Fig. 7—"Eaton" Fuel Pump Details

When removing the relief valve assembly, note the position of each part so that the parts may be reassembled in their same relative position.

If the relief valve only is to be inspected, no further disassembly is necessary. If the entire pump is to be dismantled proceed as follows:

1. Remove the cover to body attaching bolts and install capscrews 1/4" x 20 x 3" long, so that the heads of the capscrews extend out 3/4" from the pump cover.
2. Holding the pump assembly in hand, tap on the heads of the capscrews with a soft hammer, separating the body and cover. DO NOT PRY BODY AND COVER APART.
3. Remove the outer rotor, and move the shaft out toward the cover end of the pump, slide the inner rotor forward on the shaft and remove the locking ball, then remove the inner rotor from the rotor shaft.
4. Remove the rotor shaft from the pump body carefully, so as not to damage the oil seals.
5. Drive the dowels from the pump body if necessary by means of a small punch and hammer.
6. If it is necessary to remove the seals, a tool of the proper design may be used to remove them so they will not be damaged.

E. Inspection of "Eaton" Fuel Pump Parts.

1. Wash all the parts in clean fuel oil or solvent and inspect them carefully. The oil seals, once removed from the pump, should be replaced. If the sealing edges of the seals are damaged in any way, so that they do not form a perfect seal around the shaft, either a fuel oil leak or lubricating oil leak will result.
2. Inspect the rotors and the wearing surfaces of the pump cover and body for wear and scoring. If the rotors show excessive wear or are scored they should be replaced. If the wearing surfaces in the pump cover are worn or scored, causing excessive looseness of the rotors in the cover and body, the pump should be replaced.
3. Install the inner rotor on the pump shaft with the locking ball in place. If excessive wear between these parts is found, new parts must be installed.
4. Check the fit of the pump shaft in the pump body bushings. If the shaft and bushings show excessive wear they must be replaced. The specified diameter of the shaft is .4992" and the specified inside diameter of the bushings as installed is .5015" making a clearance of .0023" between the shaft and bushings.
5. Check the pump relief valve. If the valve does not form a tight seal on its seat, lap the valve using fine valve lapping compound. A piece of wood about the size of a pencil makes a good holder for hand lapping. *CAUTION:* Use only a small amount of compound so that only the seat on the valve and in the body will be affected. The ideal seat is a ring about 1/64" to 1/32" wide in the pump body. Thoroughly wash all the lapping compound and foreign material off the valve and out of pump body.
6. Inspect the pump cover sealing gasket and the pump shaft seal gasket and replace if necessary.

F. Assembly of "Eaton" Fuel Pump.

1. Install the bushings for the pump shaft in the pump body if they were removed for replacement, then, ream the inside diameter of the bushings to .5015".
2. Install the pump shaft seal gasket in place in the pump body, then install pump shaft inner seal with the sealing edge towards the cover end of the pump. Make certain the seal is installed tight against the seal gasket.
3. Install the pump shaft outer seal with the sealing edge towards the mounting flange end of the pump.
4. Lubricate the pump shaft end seals and install the shaft in the pump body. Install the shaft from the cover end pushing it through the bushings and then through the seals being

exceptionally careful not to damage the seals. Use an oil seal pilot tool on the drive end of the shaft if tool is available. Before inserting the shaft completely into position in the pump body, install the inner rotor and locking ball on the shaft.

5. Install the outer rotor in place on the inner rotor.
6. Install the pump cover sealing gasket in the recess of the pump cover, then place the pump cover in position on the dowels and pump body. Install the cover attaching bolts and tighten securely.
7. Turn the pump shaft and test it for bind. The shaft should turn smoothly, with a slight drag, but should not bind or have tight spots.
8. Install the relief valve parts, make certain that the parts are installed properly in their respective places on the inlet side of the pump (right side when viewed from pump cover end).
9. Install the pump body plug and gasket in the side opposite the relief valve.
10. Install the fuel pump on the engine by direct reversal of the removal procedure.

G. Disassembly of "Barnes" Fuel Pump.

The relief valve assembly may be removed from the pump stator without disassembly of the other parts of the pump, by removing the pressure relief spring plug and jarring the valve parts from the body.

When removing the relief valve assembly, note the position of each part so that the parts may be reassembled in their same relative position.

If the relief valve only is to be inspected, no further disassembly is necessary. If the pump is to be dismantled proceed as follows:

1. Remove the screws attaching the pump housing to the stator and install capscrews 1/4"

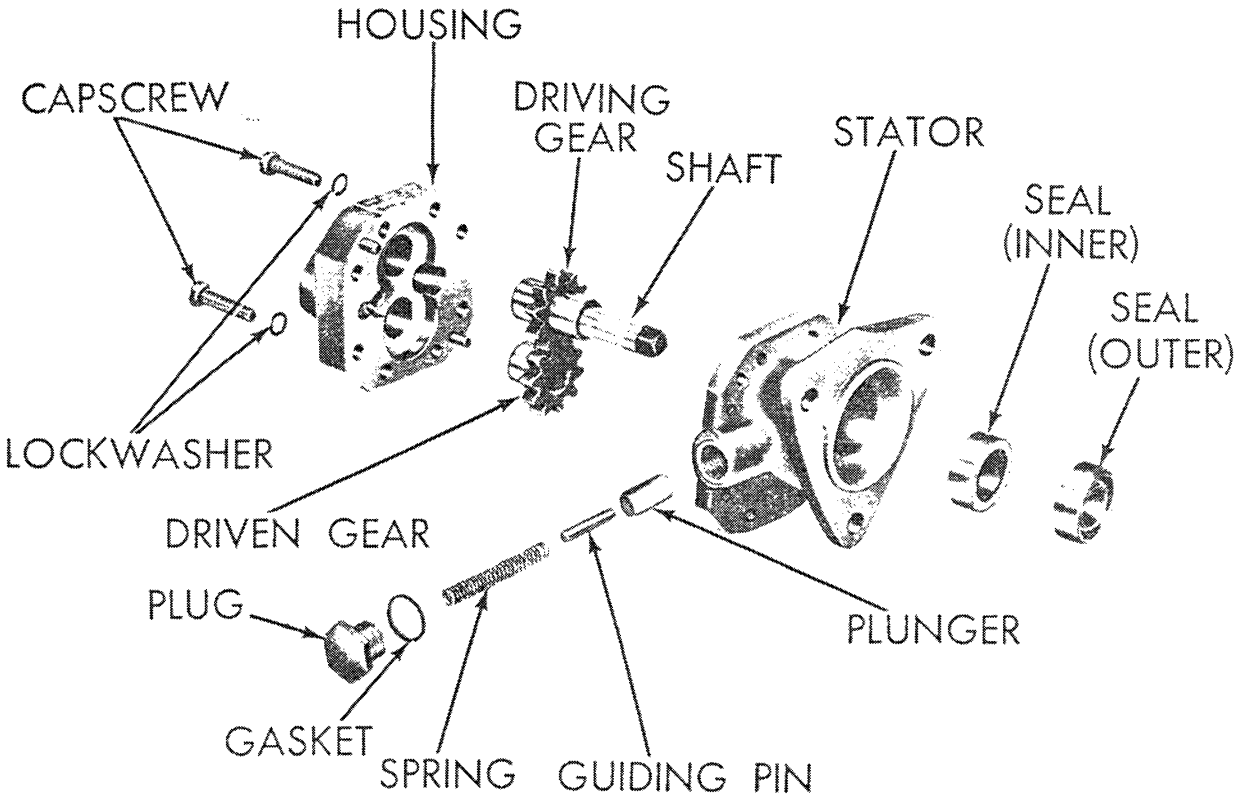


Fig. 8—"Barnes" Fuel Pump Details

x 20 x 3" long, so that the heads of the capscrews extend out about 3/4" from the pump housing.

2. Holding the pump assembly in the hand, tap the heads of the capscrews with a soft hammer, separating the stator and housing. DO NOT PRY STATOR AND HOUSING APART.
3. Remove the pump driven gear.
4. Remove the pump shaft and driving gear from the stator carefully, so as not to damage the pump shaft seals.
5. Remove the dowels if necessary.
6. If it is necessary to remove the shaft seals, a tool of the proper design may be used to remove them so they will not be damaged.

H. Inspection of "Barnes" Pump Parts.

1. Wash all the parts in clean fuel oil or solvent and inspect them carefully. The shaft seals, once removed from the pump, should be replaced. If the sealing edges of the seals are damaged in any way, so that they do not form a perfect seal around the shaft, either a fuel oil leak or lubricating oil leak will result.
2. Inspect the gears. If the gears are slightly worn on the involute surfaces, they should be replaced. If the pump is operated until an appreciable amount of wear is noticeable, the delivery capacity of the pump will be affected.
3. Inspect the driving gear on the pump shaft. The shear pin holding the gear to the shaft must be tight. Replace parts if necessary.
4. Check the fit of the gears in the bores of the stator and housing. If the stator and housing are worn or scored, causing looseness, the entire pump must be replaced.
5. Inspect the surfaces inside the stator and housing contacted by the gear faces. If the surfaces show excessive wear or are scored, the entire pump must be replaced.
6. When the pump is overhauled, it is recommended that the relief valve and spring be replaced. Replacement of these parts may prevent difficulties in pump operation in the future.

I. Assembly of "Barnes" Fuel Pump.

1. Install the pump shaft inner seal in the stator. Install the seal so that the sealing edge is toward the pump housing.
2. Install the pump shaft outer seal in the stator. Install the seal so that the sealing edge is toward the mounting flange end of pump.
3. Lubricate the pump shaft and seals and install the pump shaft (with driving gear in place) in the stator. Push the shaft through the seals being exceptionally careful not to damage the seals. Use an oil seal pilot tool on the drive end of the shaft if a tool is available.
4. Install the driven gear in place in the housing. Lubricate the gears with light engine oil.
5. Coat the machined attaching surfaces of the stator and the pump housing with a commercial non-hardening sealing compound. *CAUTION:* Do not get any sealing compound inside the pump. Place the pump housing in position on the stator, turn the pump shaft to mesh the gear teeth, and push the parts together. Install the attaching screws and tighten securely.
6. Turn the pump shaft and test it for bind. The shaft should turn smoothly, with a slight drag, but should not bind or have tight spots.
7. Install the relief valve parts, make certain that the parts are installed properly in their respective places.
8. Install the fuel pump on the engine by direct reversal of the removal procedure.

6. FUEL PUMP DRIVE

A. Description.

The fuel pump drive consists of a shaft mounted on bronze bearings which are retained inside the cast housing. A collar at one end of the shaft and a helical gear pressed on, and keyed to, the shaft at the other end positions the shaft endwise and also serves as a drive.

The non-gear end of the adapter shaft is squared to the same dimensions as the drive end of the fuel pump shaft. A coupling of suitable dimensions slips over the adjoining ends of the two shafts to provide a connection between the drive and the pump.

B. Disassembly of Fuel Pump Drive Shaft Assembly.

The fuel pump drive shaft may be removed from the adapter as follows:

1. Pull the pinion gear off the drive shaft and remove the Woodruff Key from the shaft.
2. Slide the shaft out of the adapter.

C. Inspection and Repair.

1. Inspect the pump drive pinion. If the pinion is worn excessively or damaged, it is advisable to also inspect the drive gear on the balancer shaft. If the drive gear on the balancer shaft shows excessive wear or the teeth are damaged, it will be necessary to replace both the drive pinion and the balancer shaft.
2. Check the fit of the adapter shaft in the adapter shaft bushings. If the shaft and bushings show excessive wear they must be replaced. The specified diameter of the adapter shaft is .4965" and the specified inside diameter of the bushings is .498" making a clearance of .0015" between the shaft and bushings.
3. Inspect the fuel pump coupling. If the coupling is worn and is an extremely loose fit on the adapter shaft and on the fuel pump shaft, replacement is necessary.

D. Assembly of Fuel Pump Drive Shaft.

1. Install the bushings for the pump shaft in the adapter if they were removed for replacement, then, ream the inside diameter of the bushings to .498".

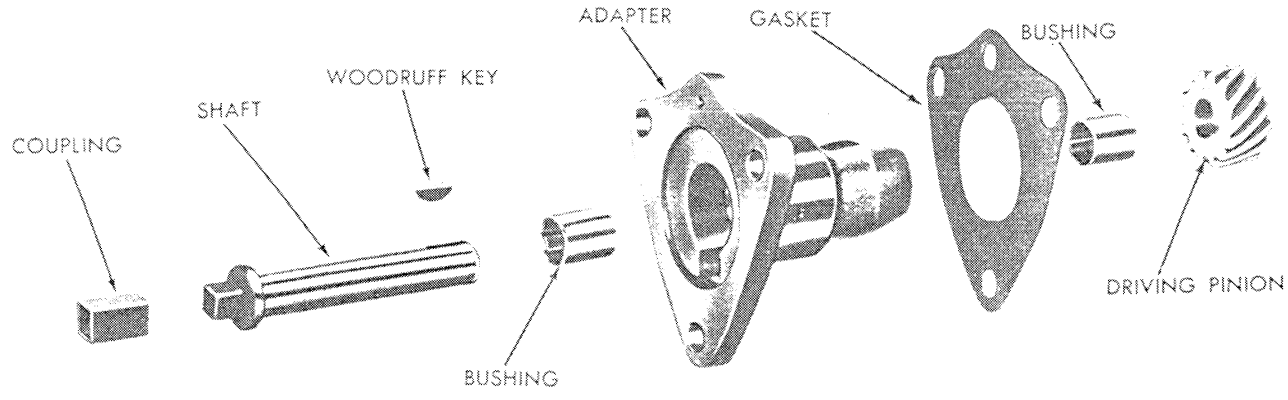


Fig. 9 — Fuel Pump Drive Shaft Details

2. Lubricate the shaft and bushings and insert the shaft in place in the adapter. Install the Woodruff Key in the shaft.

3. Press the pinion on the adapter shaft only far enough to provide .004" to .006" end play of the shaft when assembled.

4. Install the fuel pump drive on the engine by direct reversal of the removal procedure (refer to "REMOVAL OF FUEL PUMP AND PUMP DRIVE SHAFT ASSEMBLY" in this section).

7. FUEL INJECTORS

A. Description.

The unit fuel injector combines in a single unit all of the parts necessary to meter, atomize and inject the required amount of fuel into the combustion chamber of the cylinder. The fuel is injected under high pressure at the end of each compression stroke and mixes with the charge of air that has been delivered to the cylinder by the blower. Since there is an injector for each cylinder, a complete and independent injection system for each cylinder is thus provided.

The injectors are mounted in the cylinder head, with their spray tips projecting slightly through the cylinder head into the combustion chambers. A clamp holds each injector in place in a water-cooled copper tube which passes through the cyl-

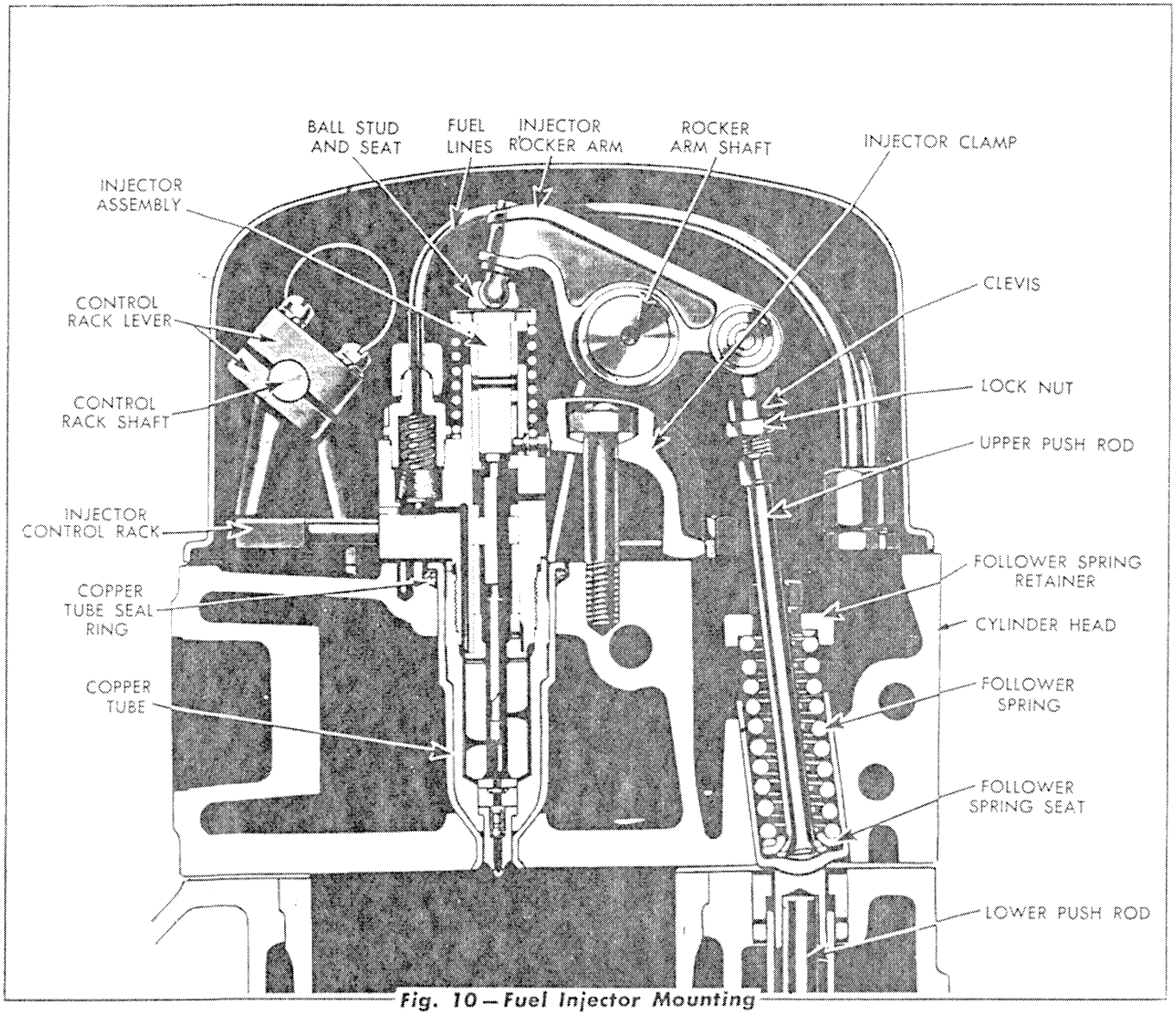


Fig. 10—Fuel Injector Mounting

inder head. The tapered lower end of the injector seats in the copper tube forming a tight seal to withstand the high pressure inside the combustion chamber.

B. Operation.

The cross section of the Model 71 Injector, illustrated in Figure No. 11, shows the various fuel injector parts. Fuel is supplied to the injector under pressure and enters the drop-forged steel body of the injector at the top through the filter cap. After passing through the porous metal filter in the inlet passage, the fuel fills the annular supply chamber between the bushing and the spill deflector. The plunger for metering purposes. The relation of this helix and cut-off to the two ports changes with the rotation of the plunger.

As the plunger moves downward, the fuel in the high-pressure cylinder or bushing is first displaced through the ports back into the supply chamber until the lower edge of the plunger closes the lower port. The remaining fuel is then forced upward through the center passage in the plunger into the recess between the upper helix and the lower cut-off from which it can still flow back into the supply chamber until the helix closes the upper port. The rotation of the plunger, by changing the position of

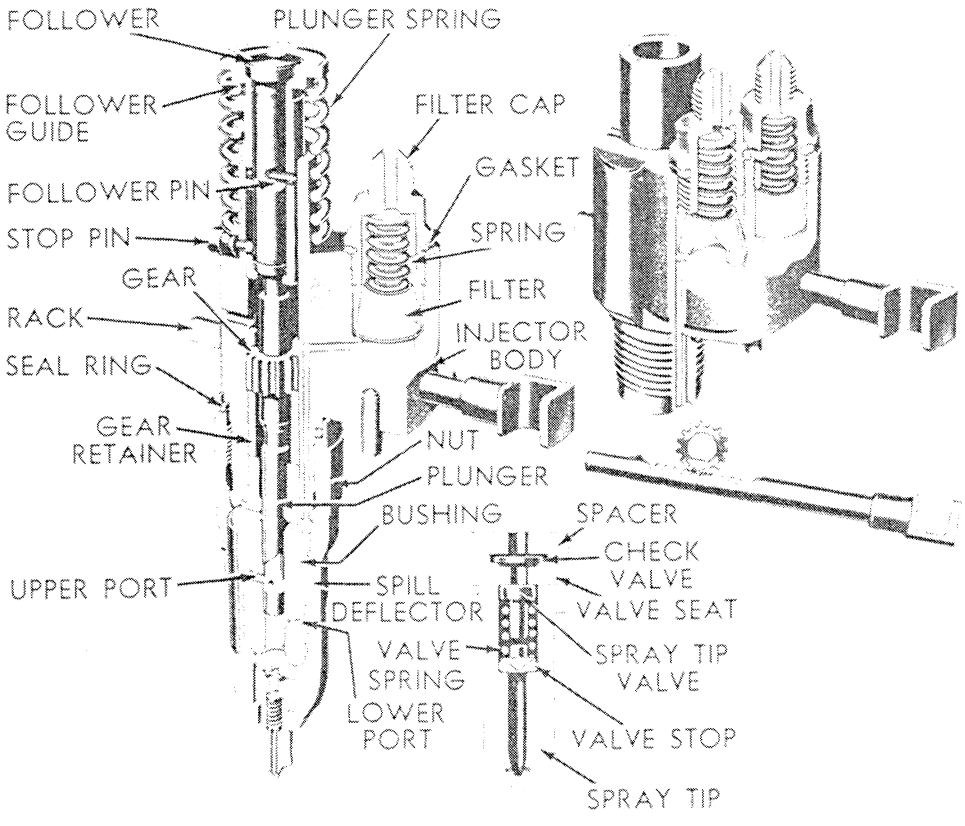


Fig. 11 — Fuel Injector Details

plunger operates up and down in this bushing, the bore of which is connected to the fuel supply in the annular chamber by two funnel-shaped ports.

The motion of the injector rocker arm is transmitted to the plunger by the follower which bears against the return spring. In addition to this reciprocating motion, the plunger can be rotated in operation, around its axis, by the gear which is in mesh with the control rack. An upper helix and lower helix, or cut-off, are machined into the lower end of the the helix, retards or advances the closing of the ports and the beginning and end of the injection period, at the same time increasing or decreasing the amount of fuel which remains under the plunger for injection into the cylinder.

The upper part of Figure No. 12 shows four plunger positions from NO INJECTION to FULL INJECTION. With the control rack pulled OUT (no injection), the upper port is not closed by the helix until after the lower port is uncovered. Consequently, with

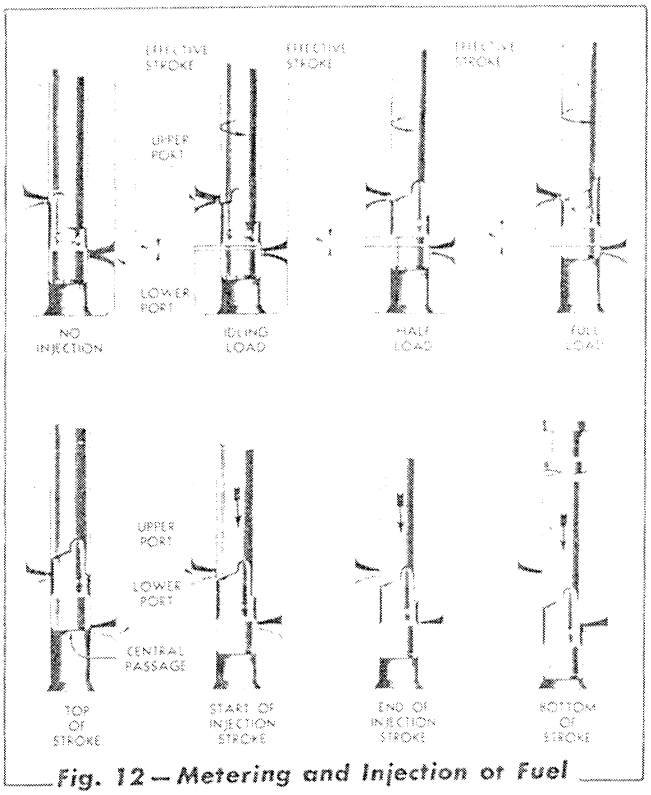


Fig. 12 — Metering and Injection of Fuel

the control rack in this position, all of the fuel charge is forced back into the supply chamber, and no injection of fuel takes place. With the control rack pushed IN (full injection), the upper port is closed shortly after the lower port has been covered, thus producing a full effective stroke and maximum injection.

From the NO INJECTION position to FULL INJECTION position (full rack movement) the contour of the helix advances the closing of the upper port and the beginning of injection.

The lower part of Figure No. 12 shows four positions for downward travel of the plunger. On the downward travel of the plunger, the metered amount of fuel is forced through the center passage of the valve assembly, through the check valve shown in Figure No. 11, and against the spray tip valve. When sufficient fuel pressure is built up, the valve is lifted from its seat and fuel is forced through six small orifices of .006" diameter in the spray tip and atomized in the combustion chamber.

The spray tip check valve prevents air leakage from the combustion chamber into the fuel system in case the spray tip valve is accidentally held open by a small particle of dirt, thus allowing the injector to continue to operate until the particle works through the valve.

On the upward movement of the plunger, the high-pressure cylinder in the injector is again filled with fuel through the ports. The constant circulation of fuel through the injectors renews the fuel supply in the chamber, helps to maintain even operating temperatures of the injectors, and effectively removes all traces of air which might otherwise accumulate in the system and interfere with the accurate metering of the fuel. The fuel injector outlet opening, which returns the excess fuel supplied by the fuel pump, is adjacent to the inlet opening, and is protected against dirt or other foreign matter by a porous metal filter, exactly like the one on the inlet side.

C. Injector Service.

Because of the important part the injector plays in the operation of the engine, the necessity for proper care and cleanliness of these units cannot be over-emphasized. The instructions below must be carefully followed in connection with injector service:

1. Whenever the fuel lines are removed from an injector which is installed in the engine, protect the fuel fittings with shipping caps to prevent dirt from entering the injector and fuel system.
2. After the injectors have operated in an engine, the injector filter caps or filters should not be removed from the injector when the injector is in the engine. If the filter caps or filters are to be removed, the injector must be completely disassembled and cleaned.
3. Whenever an injector has been removed and reinstalled, or a new injector has been installed in the engine, the injectors must be timed and equalized. Refer to "INJECTOR TIMING" AND "INJECTOR EQUALIZING" in this section.
4. Any used or rebuilt injector should be tested before it is installed in an engine. Refer to "TESTING INJECTOR" in this section.

D. Injector Removal.

1. Remove the engine hood, clean off the rocker arm cover, and remove the cover from the cylinder head.

2. Disconnect and remove the two fuel lines from the injector. Install shipping caps on the fuel line fittings to prevent dirt from entering the fuel system while the injector is removed.

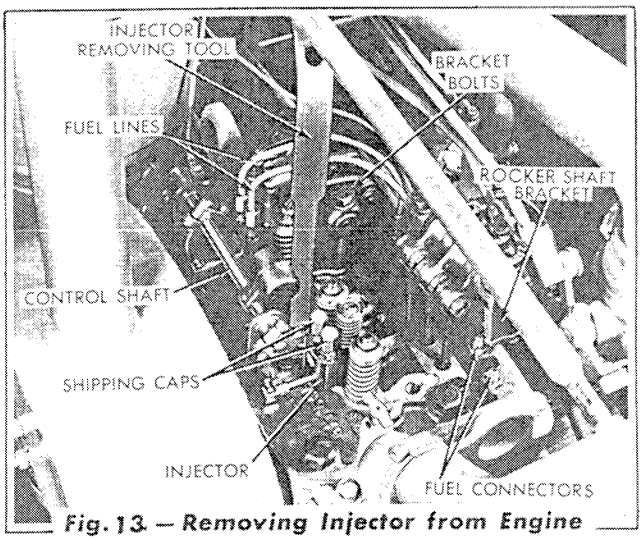


Fig. 13 — Removing Injector from Engine

3. If necessary, turn the engine with the starter until the rocker arm clevis pins (at push rod end of arms) are in line, then turn the rocker arm bracket bolts out of the cylinder head and fold the rocker arm assembly back out of the way. *CAUTION: Push rods may be bent if the rocker arms are not aligned when removing this assembly.*

4. Remove the nut from the injector hold-down stud and remove the special washer, and the injector clamp.

5. Insert the end of the injector removing tool under the shoulder at the side of the injector body and pry the injector from its seat. Disengage the control rack from the control lever as the injector is lifted up and out.

E. Injector Disassembly.

Before starting to dismantle an injector, it is necessary to have an extremely clean work bench on which to work and to store the parts. Cleanliness for the injector and its parts is emphasized because practically all injector service troubles are directly due to dirt, or other foreign material entering the injectors. Use clean paper on the work bench, and, after the injector has been disassembled, place the loose parts in a pan of clean fuel oil as protection against dirt and corrosion. Leave the parts in the clean fuel oil until needed for reassembly.

When more than one injector is dismantled, it is necessary to keep the parts of each injector separate. The plungers must always be fitted with the same bushings from which they were removed. It is advisable to keep the parts of the spray tip assembly — the spring, stop, spray tip valve and seat, as a unit, as this insures that the "pop" pressure and calibration built into the injector will remain essentially the same as when it was first tested and assembled.

NOTE: The spray tip, valves and valve seats may be removed, cleaned and replaced without disassembling the entire injector by performing steps 4 through 6 in the following disassembly procedure:

Before removing the spray tip, test the injector for free movement of the plunger by pressing down on the plunger follower with the thumb and forefinger. Also turn the injector from side to side to see if the control rack moves back and forth by its own weight. If binding of the plunger or control rack is evident by these tests, complete disassembly and inspection of parts will be required. The repair of an injector should not be attempted unless special injector tools described in the following procedure are available.

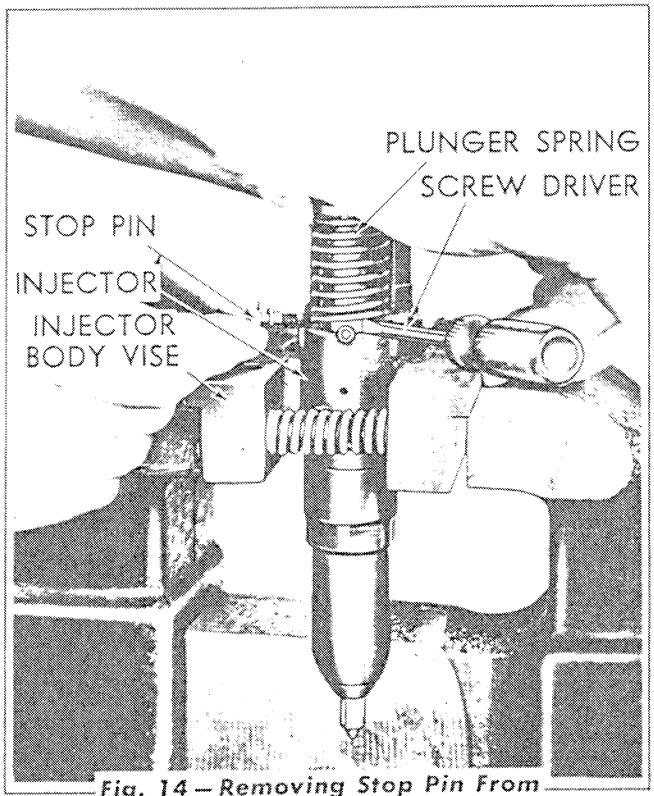


Fig. 14 — Removing Stop Pin From Injector Follower