MAINTENANCE INSTRUCTION

SERVICE DEPARTMENT · ELECTRO-MOTIVE DIVISION · GENERAL MOTORS · LAGRANGE, ILLINOIS

RECONDITIONING NEEDLE VALVE INJECTORS

DESCRIPTION

The most important part of the fuel system is the unit injector, which is a high pressure fuel metering pump and spray valve combined in one housing.

It is located and seated in a tapered hole in the center of the cylinder head, with the spray tip protruding slightly below the bottom of the head. It is positioned in the head by a dowel and held in place by an injector hold-down crab and nut. A cross-section of the unit injector and names of the various parts is shown in Fig. 1.

The external working parts of the injector are lubricated by oil from the end of the injector rocker arm adjusting screw. The internal working parts are lubricated and cooled by the flow of fuel oil through the injector.

The main working parts of the injector are: rack, gear, plunger, follower, spring, and needle valve.

The plunger is given a constant stroke reciprocating motion by the injector cam acting through the rocker arm and plunger follower. The timing of the injection period during the plunger stroke is set by an adjusting screw at the end of rocker arm. Fig. 2 shows flow of fuel during one downward stroke.

Rotation of the plunger by means of the rack and gear, controls the quantity of fuel injected into the cylinder during each stroke. Rack position is controlled by the governor through the injector layshaft and linkage. The gear is keyed with a sliding fit to the plunger to allow plunger vertical movement.

The helices near the bottom of the plunger control the opening and closing of both fuel ports of the plunger bushing. Rotation of the plunger regulates the time that both

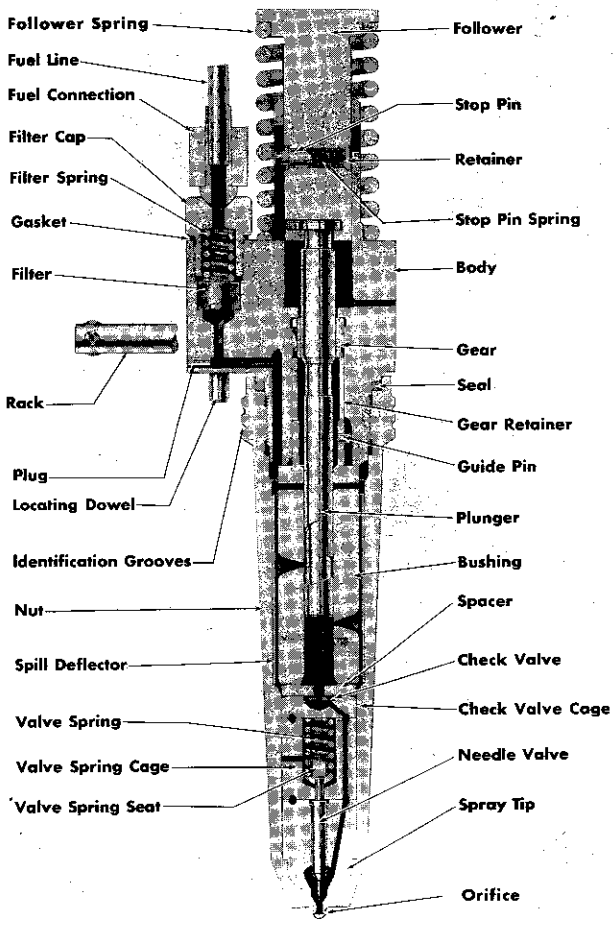

Fig. 1 — Unit Injector, Cross-Section

ports are closed during the downward stroke, thus controlling the quantity of fuel injected into the cylinder as shown in Fig. 3. As the plunger is rotated from idling position to full load position, the pumping part of the stroke is lengthened, injection is started earlier, and more fuel is injected.

Proper atomization of the fuel is accomplished by the high pressure created by the downward stroke of the plunger, which forces fuel past the needle valve and out through the spray holes in the tip of the injector.

Filters at the fuel inlet and outlet connections protect the working parts of the injector.

MAINTENANCE

Special equipment, tools, fixtures, and gauges called out in the maintenance procedures are listed at the end of the M.I. with their part number.

When servicing the injectors, clean conditions must be maintained. Foreign material in any form is the most common cause of injector failure. When an injector

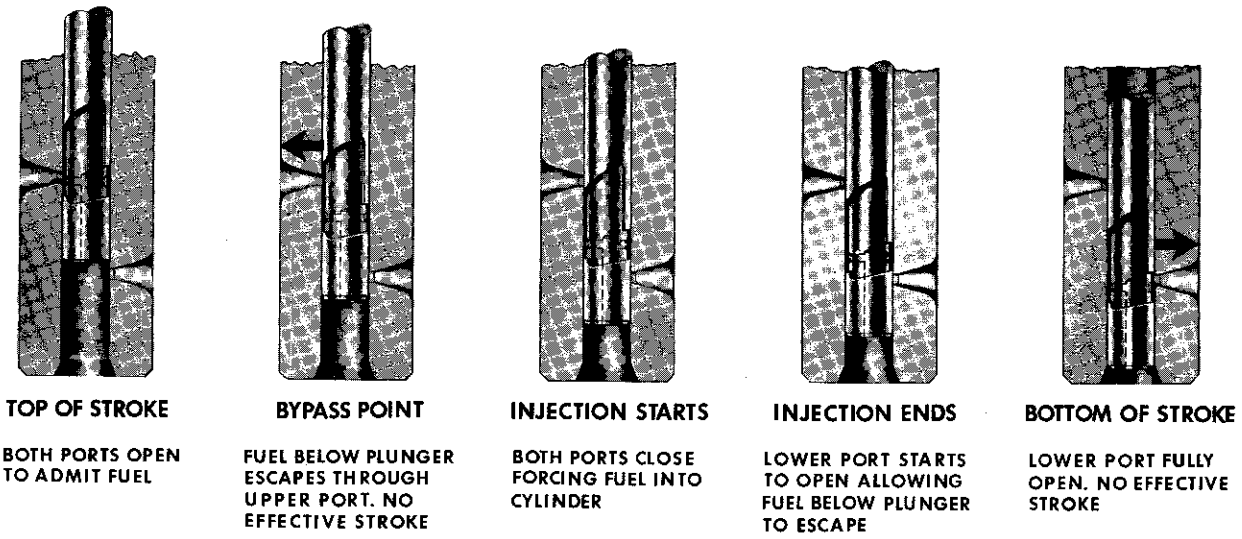

Fig. 2 — Pumping Action Of Injector Plunger

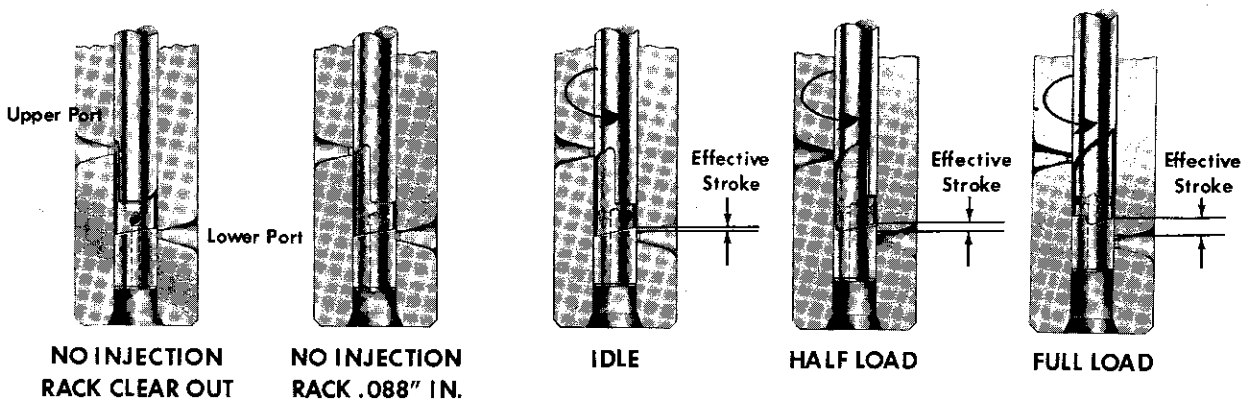

Fig. 3 — Fuel Control Plunger Rotation

is in an engine it is protected against dirt, dust and other foreign materials by the various filters employed. When an injector is in storage it is protected by the filters which seal the body openings, which in turn are protected by a shipping block or plastic caps.

However, an entirely different set of conditions is encountered when it becomes necessary to disassemble an injector for repair or overhaul. Under these conditions, care should be exercised for proper handling of the parts and to provide the cleanest possible working facilities.

The mechanics working on the injectors must protect the parts by careful handling, as some parts are so finely finished that the slightest burr or scratch can make them unfit for use. It is important also, that the hands and the apparel of the mechanic be clean.

DISASSEMBLY

When disassembling an injector, care must be taken not to damage any of the parts. As parts are removed, place them in a parts pan and keep them separate from other injector parts. Many of the components are matched and are not usable with other injectors.

1. Clamp injector in vise in upright position, Fig. 4, and remove the shipping block or plastic caps, if installed.

2. Remove the fuel filter caps using a 3/4" socket. Remove and discard gasket and filter elements.

3. While manually compressing the follower spring, insert a small rod between coils of spring and push "stop pin" in to release the follower. The spring can now be unloaded by gradually allowing the follower to move upward.

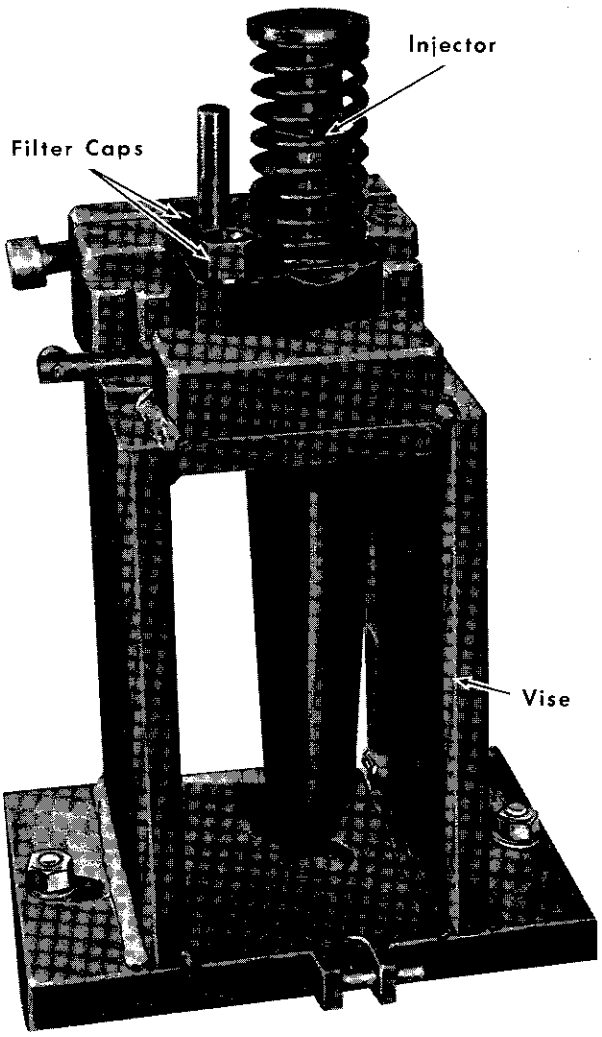

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Fig. 4 — Preparation For Disassembly

4. Carefully lift the follower and plunger from the injector, Fig. 5. Disengage the plunger from the follower and remove the follower spring.

5. Invert the injector in the vise. Using wrench, loosen the injector nut, Fig. 6. Unscrew the nut by hand and lift it straight up so as not to disturb the parts underneath.

6. After the nut is removed, Fig. 7, the exposed stacked parts can be removed.

NOTE: Occasionally the spray tip sticks in the nut and is removed with the nut. If the spray tip cannot be pressed out with the fingers, it can be removed by setting the nut on a block of wood and using a short

length of brass tubing to drive out the spray tip. The inside diameter of the brass tubing must be large enough so that only the outer edge of the spray tip is contacted by the tubing.

7. Remove the spill deflector and plunger bushing by lifting them straight up. Insert the previously removed plunger into its mating bushing, but in a reversed position so that plunger enters bushing at the end of bushing opposite end with guide pin.

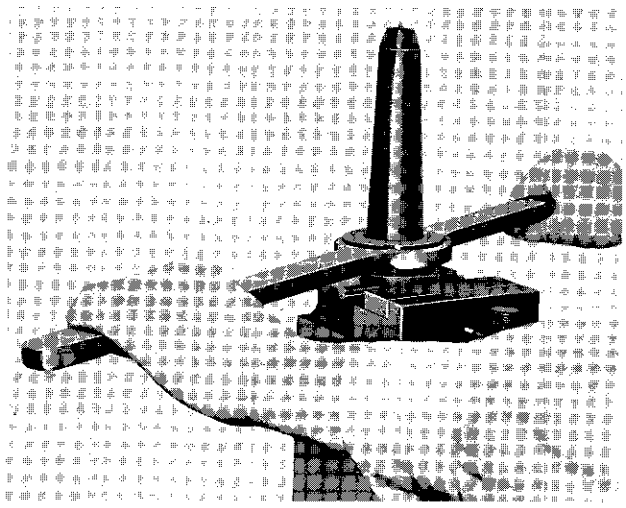

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Fig. 6 — Loosening Injector Nut

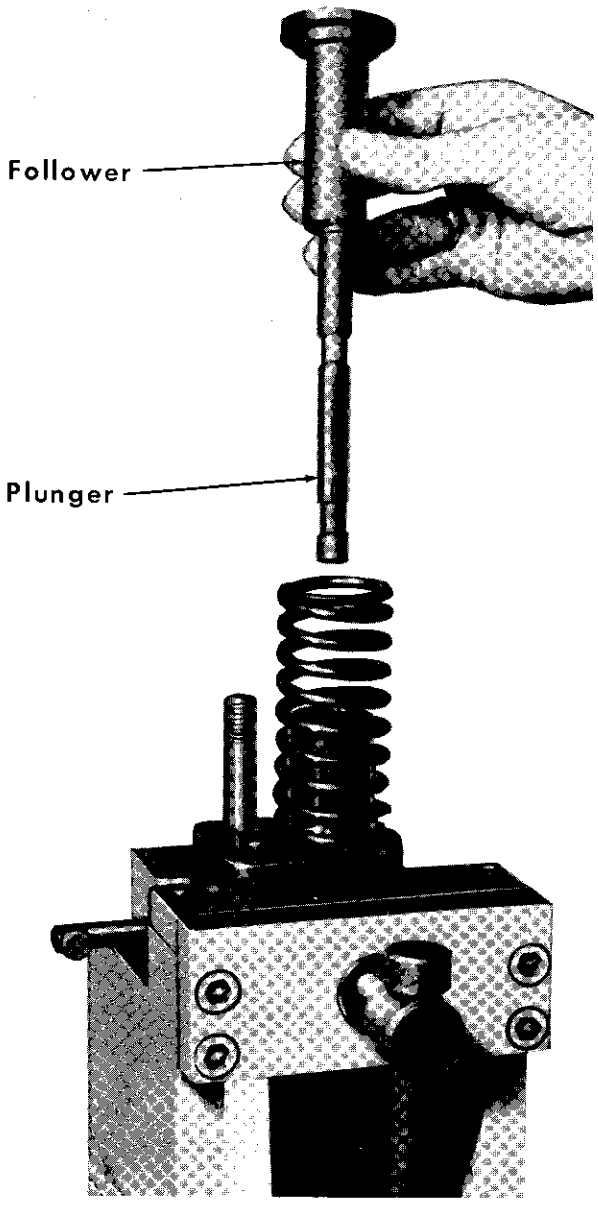

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Fig. 5 — Removing Follower And Plunger

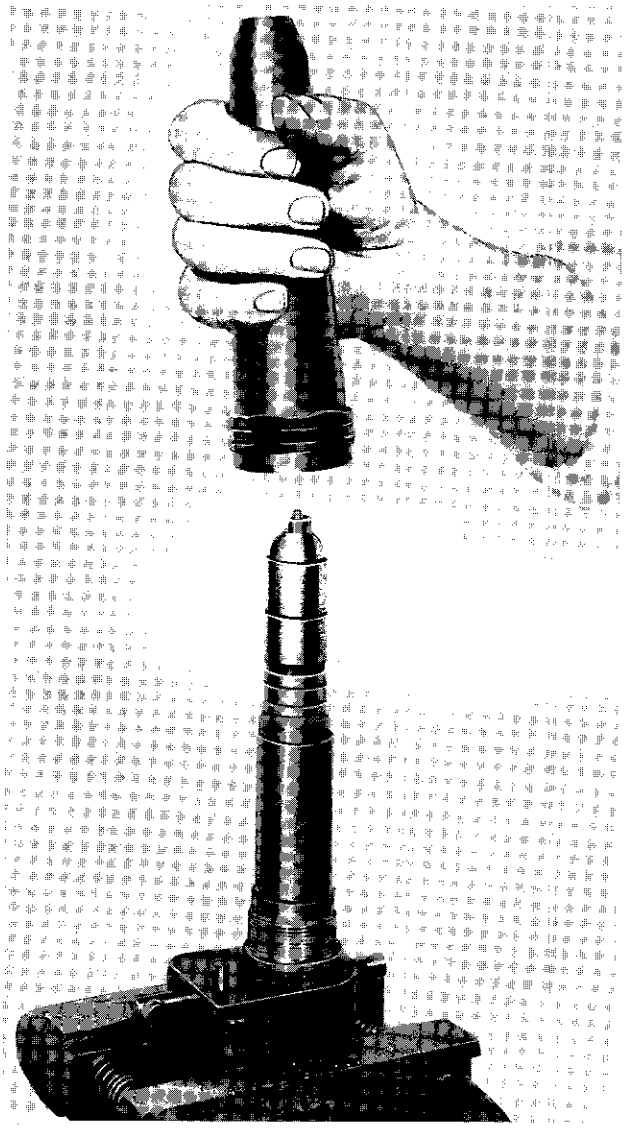

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Fig. 7 — Removing Injector Nut

8. Remove and discard the body to nut seal ring.

9. Release the injector body from the vise and holding free hand at bottom, invert the body to remove the gear retainer and gear. After the gear is removed, the injector rack can be withdrawn from the body, Fig. 8.

CLEANING

In preparation for cleaning the parts of the disassembled injector, a perforated carrying basket should be provided for each injector. The cleaning containers may be conventional baking pans made of rust proof material of such size to accommodate all parts of one injector, or a large cleaning tank is available which is divided into four large cleaning compartments.

The physical dimensions of the cleaning tank are approximately 5' long by 2' wide and each compartment is 12" deep and equally spaced the length of the tank. The hood of the tank has provisions for an air filter and exhaust fan.

The parts of each injector can remain in the perforated carrying basket and be placed into either the cleaning tank or pan. This will allow the cleaning solution to drain when the basket is removed. The cleaning containers should also have a removable screened or perforated frame at the bottom to keep injector parts above the contaminants which settle in the cleaning containers.

The four cleaning containers should contain the following solutions:

Container No. 1

This container holds a non-phenolic, non-chlorinated, oil-soluble, water-miscible, liquid-type soap solution which when diluted with four parts of a petroleum distillate-type solvent forms a solvent-emulsion cleaner.

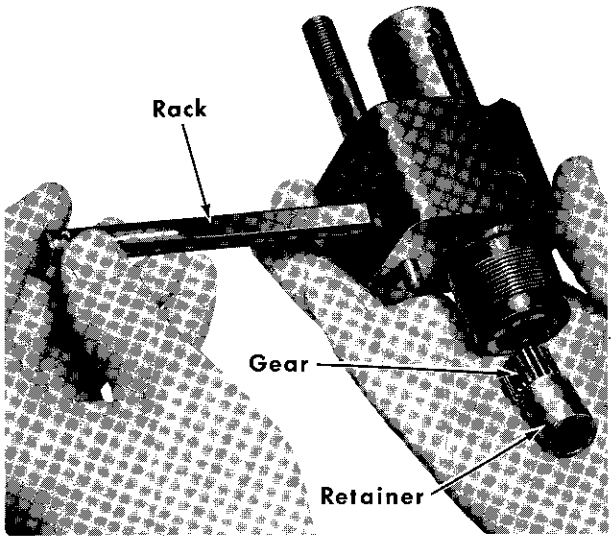

Fig. 8 — Removing Injector Rack, Gear And Retainer

Sufficient liquid should be added to cover all parts. Leave disassembled parts in this container about fifteen minutes. Carbon and lacquer must be completely removed from all parts.

Container No. 2

The second container is filled with clean solvent or mineral spirits. This is used for rinsing parts after removal from the first container and after secondary cleaning.

Container No. 3

The third container is used for storing parts after they have been cleaned and inspected, until they are ready for reassembly. Fill container with enough fuel oil or injector testing-rust proofing oil to completely cover all the injector parts.

Container No. 4

The fourth container is filled with the same kind of oil as used in No. 3. The solution in this container is not used until reassembly of the injector parts is about to begin. Just prior to assembly, the part is removed from container No. 3 and blown off with filtered compressed air. Immediately after

blowing off, the part is dipped into container No. 4 solution and assembled in the injector without further drying. The oil that adheres to the part after dipping provides rust proofing and/or initial lubrication.

After the parts have soaked in container No. 1 and rinsed in container No. 2, they should be dried with compressed air, and cleaned further as outlined in the following procedure.

NOTE: Care must be taken while wire brushing the following parts, not to wire brush their lapped surfaces.

BODIES

1. Apply abrasive disc (11/16" diameter - 60 grit emery disc) to seating tool. Mount the seating tool in a motor driven chuck and remove any carbon from inside diameter flat on gear side of the body.

2. Apply abrasive disc (13/16" diameter - 60 grit emery disc) to seating tool and apply seating tool in motor driven chuck. Remove any carbon from the inside diameter flat on follower side of body, Fig. 9.

3. Using magnetized reamer, Fig. 10, clean out oil passages in the body. A pin vise may be used to hold the reamer. There are two other passages besides the two fuel passages at the bottom of the body namely: the vent passage at the back, and the passage whose entrance is opposite the shallow timing gauge hole.

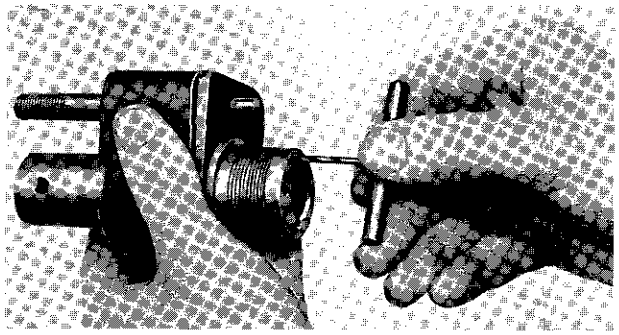

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Fig. 10 — Reaming Body Fuel Passages

4. Buff external surfaces (except bottom) on a soft wire buffing wheel.

5. Wash off entire body being sure that all carbon particles are removed. Use brush (1" diameter china bristle) to clean the body. Using compressed air, blow out fuel passages and dry the body.

6. Place body on a clean surface or pan for inspection.

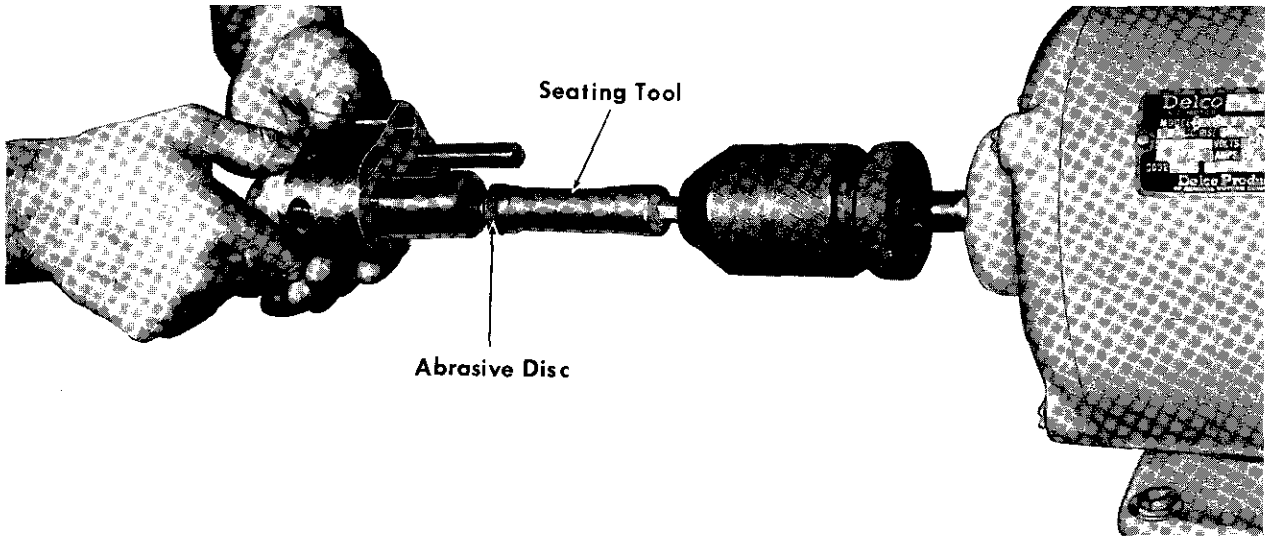

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Fig. 9 — Cleaning Flat, Gear Side Of Body

INJECTOR NUT

1. Clean external surface of the nut by buffing on the soft wire buffing wheel.

2. Using nut reamer, Fig. 11, clean carbon from inside diameter of the nut and spray tip seating surface.

3. Wash nut inside and out using brush and solvent. Dry nut with compressed air and place with body for inspection.

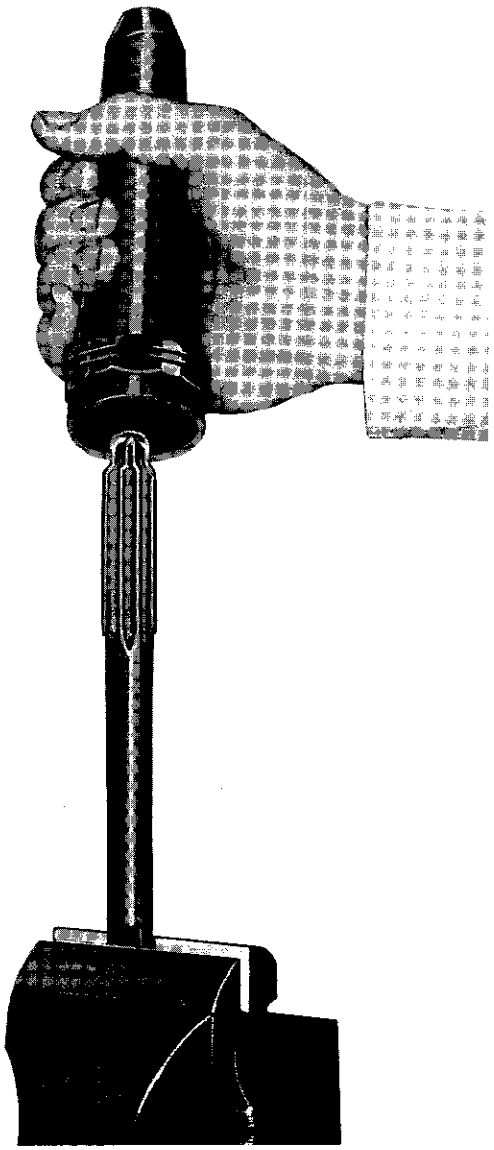

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Fig. 11 — Reaming Injector Nut

INJECTOR RACK

Buff the rack on soft wire wheel, being careful to clean thoroughly between rack teeth. Wash the rack in solvent and blow dry.

INJECTOR GEAR

1. Clean gear teeth and outside surface by buffing. Clean inside using 7/16" diameter wire brush mounted in a motor driven chuck.

2. Wash gear in solvent, then dry and place with other items.

PLUNGER BUSHING

1. If required, lightly buff the external surface of the bushing, taking care to avoid the lapped end.

2. Using soft bristle brush and solvent, wash bushing bore and external surface. Dry with compressed air.

PLUNGER

1. If required, lightly buff only the upper half of the plunger. Do not buff on the lapped lower portion of the plunger.

2. Wash the plunger using solvent and brush, paying careful attention to the helical grooves. Dry with compressed air and clean tissue.

NOTE: After plunger and bushing are cleaned, insert plunger in its mating bushing with the plunger placed into the end of bushing opposite the end containing the guide pin.

SPILL DEFLECTOR

Lightly buff the spill deflector to remove carbon, if required. Using brush and solvent, wash entire part. Dry with compressed air.

SPRAY TIP

1. Buff external surface of spray tip on the soft wire buffing wheel, taking care to avoid the lapped surface.

2. Clean spray tip bore, valve seat, and the guide O.D. on the valve with solvent to remove lacquer and carbon.

3. Clean out spray holes in tip, Fig. 12.

   a. Apply short length of 011" wire to pin vise. About 1/4" of wire should extend beyond vise jaws.

   b. Hone wire end to a point to remove any burrs, using abrasive stone.

   c. After cleaning holes with wire, wash spray tip in solvent and blow dry.

GEAR RETAINER

1. Buff external surface of gear retainer on soft wire buffing wheel. Remove any carbon from the inside diameter, using 1/2" diameter wire brush mounted in motor driven chuck.

2. Using solvent, wash the retainer and blow dry with compressed air.

SPRING CAGE

1. Buff outside surface, except lapped surface, using soft wire wheel.

2. Remove any carbon from the inside diameter, using 7/16" diameter wire brush mounted in a motor driven chuck.

3. Wash in solvent and blow dry with compressed air.

SPACER

1. Using magnetized reamer, ream out fuel passage in the spacer.

2. Buff spacer surface, except lapped surfaces, on soft wire buffing wheel.

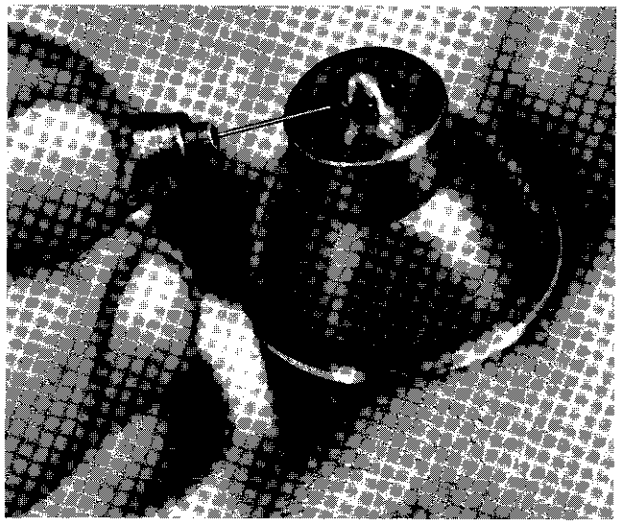

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Fig. 12 — Checking Spray Tip Orifice

3. Wash in solvent and dry with compressed air.

REMAINING PARTS

1. Clean the parts listed below by buffing on soft wire wheel:

Follower	Filter Caps
Follower Spring	Filter Springs
Valve Spring	

2. Wash each in solvent and dry with compressed air.

EMERGENCY MEASURES

1. Filters - The old filters should be discarded when reconditioning injectors. However, if it is necessary due to parts shortage to reuse old filters, they should only be cleaned by gentle sloshing in the cleaning solvent.

CAUTION: Do not use a brush or compressed air on these filters.

2. Copper Gaskets - Copper gaskets often become hard and lose their sealing ability, so they should be discarded after use. However, if it is necessary to reuse them, they should be cleaned and annealed.

To anneal copper gaskets, heat them to a dull cherry color, 1200° F. (649° C.) to 1500° F. (816° C.) and quench them quickly in water.

INSPECTION

BODIES

The injector bodies should be carefully inspected for any burrs, metal slivers or bad threads. The body and all drilled passages should be clean. On injectors equipped with calibrating slides, remove slide from body before inspecting. Check slide for same conditions as body.

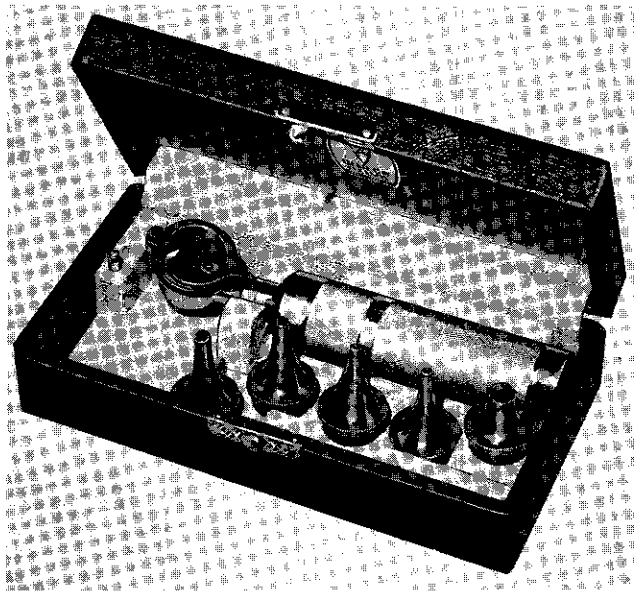
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Fig. 13 — Otoscope

PLUNGER AND BUSHING

Plunger should be closely examined for scores and scratches on the lapped surface. The helices should be inspected for chipping or eroding. Scored surface on the plunger is easily seen, but the bushing requires a good light such as provided by an otoscope, Fig. 13, to see evidence of scoring. For any of these defects, reject the plunger and bushing. Refer to Fig. 14 for examples of plunger defects which are cause for rejection. It may be necessary to remove light lacquer buildup or oil stains from the plunger and bushing by polishing. Procedure for polishing these parts is given under "Lapping of Injector Parts."

In addition to being free from burrs, scratches, scores, or other imperfections, the plunger and bushing must be absolutely clean. To test for cleanliness, insert the plunger in its bushing and spin the bushing. If both the plunger and bushing have been properly cleaned, the bushing will spin freely.

NOTE: The plunger and bushing must be absolutely dry while making this test. If the bushing does not spin freely, the cleaning operations should be repeated, or the parts replaced.

Plunger and bushing should always be kept together as they are manufactured only in matched sets. If these parts should become mixed, due to error in handling, lightly etched identification numbers will be found in the undercut below the head of the plunger and on the outside surface of the bushings. The same number will be etched on each mating piece. This number will be different on each assembly and has no meaning except to identify the parts as being matched sets.

NUT

Inspect the outside of the nut for deep scratches or gouges on the seating surfaces, or pits around the spray tip end. Any of the above defects, that appear on the flat surface adjacent to the spray tip, may be removed by refinishing to 6.870" overall length. The inside spray tip seating surface must be free of scratches or burrs and be clean. Discard nut if imperfections are present on inside of nut.

CONTROL RACK AND GEAR

These parts should be free from burrs and rough spots so that the rack will move

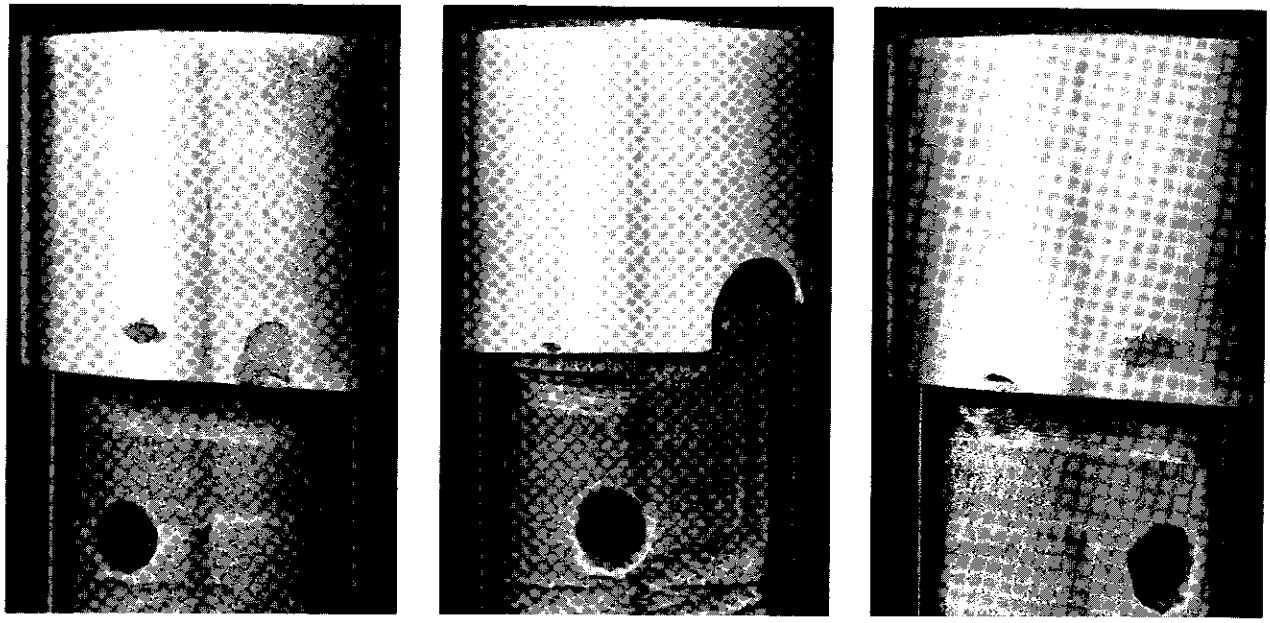

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Fig. 14 — Examples Of Chipped And Scored Plungers

freely when the injector is assembled. Make sure that the rack is straight by checking against a straight edge. The rack must be straight so as not to bind in the injector during operation.

SPRAY TIP ASSEMBLY

1. Replace needle valve in spray tip, if removed, and check valve action. If movement of valve is sticky, remove valve from spray tip and check guide O.D. on valve and spray tip bore for scoring and pitting. Reject assembly if either condition is observed.

2. Check valve and valve seat for spalling, nicks, and scratches. Reject badly spalled valves. Refer to Fig. 15 for an example of spalling on needle valve. If the spray tip condition is satisfactory, but the valve is not, the spray tip can be reworked and a new valve installed.

3. Inspect center hole and spray orifices for cleanliness and burrs.

4. Inspect the three fuel supply holes for obstructions and burrs. Inspect the lapped surface for a high mirror finish, and for scratches or cracks.

5. Check each spray tip orifice with a .014" wire. Reject any spray tip which will accept the wire in any orifice.

6. Place spray tip in air flow gauge, Fig. 16, set air pressure to 30 psi as indicated at bottom right side of gauge, and check air flow through orifices in tip. Air flow should register within

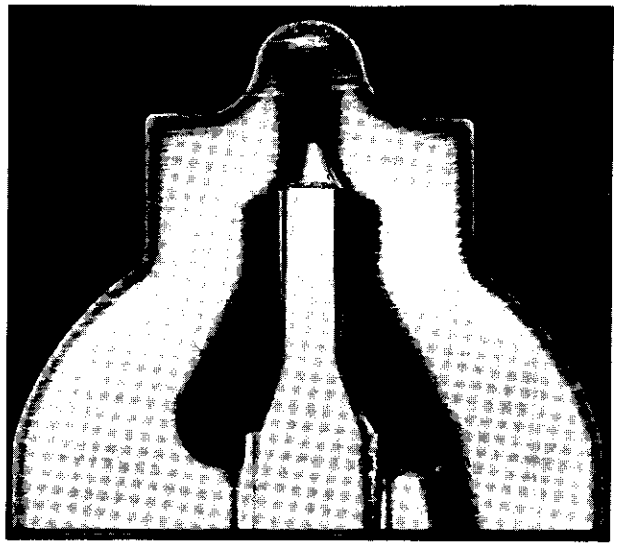

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Fig. 15 — Example Of Spalling On Needle Valve

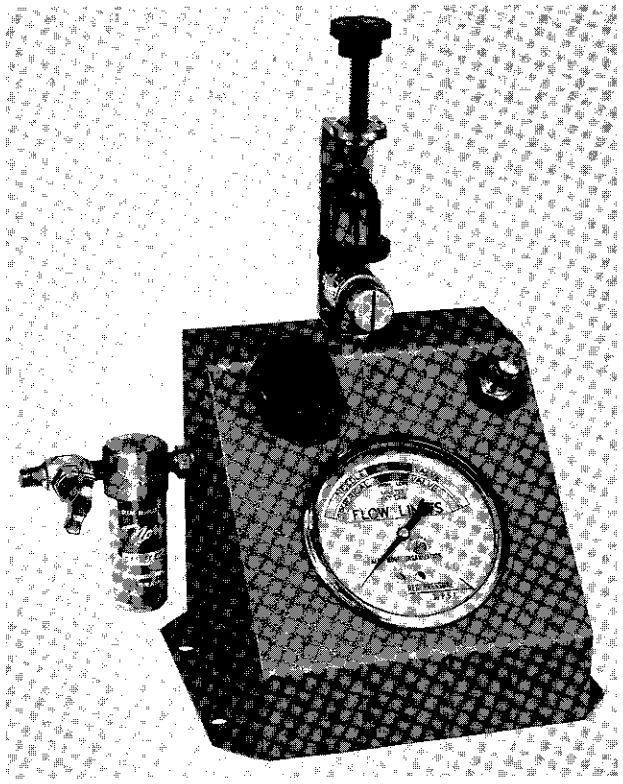

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Fig. 16 — Injector Tip Air Flow Gauge

the green area on gauge to indicate acceptable tip. Instructions for gauge operation are provided with the gauge.

7. Assemble needle valve to spray tip making sure that the needle is seated in the tip.

8. Place the spray tip assembly in the dial indicator gauge, Fig. 17, and measure the valve lift. The lift being the difference in height between the upper lapped surface of the spray tip and the shoulder of the needle valve. If the lift exceeds .020", replace the spray tip assembly.

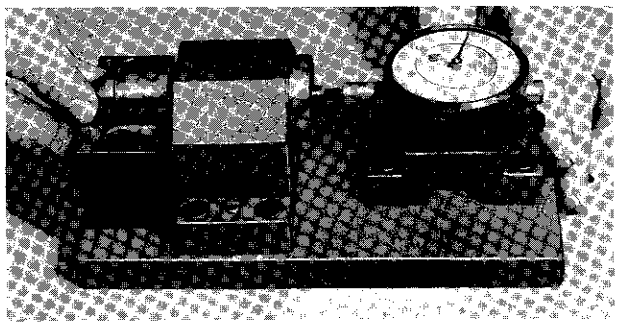

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Fig. 17 — Dial Indicator Gauge

SPRING CAGE

Check that the wear on the bottom of the spring cage, where the needle valve shoulder makes contact, does not exceed .002". A new spring cage is required if wear exceeds limit.

VALVE SPRING

New valve springs should be used when the injectors are rebuilt. However, if due to parts shortage it is necessary to reuse springs, they should be inspected as follows:

1. Determine if the spring has taken a set or shortened. This is done by comparing spring length with an unused spring of the same part number. If there is a noticeable difference in length, do not use the old spring.

2. The outside of the spring should be examined for bright marks which would indicate that the coils have rubbed hard against the wall of the spring cage. Also check spring for pitting or erosion. A valve spring in either condition should not be used except in extreme emergency.

RECONDITIONING PROCEDURES

LAPPING OF INJECTOR PARTS

As previously stated, the injector valve assemblies and their related parts are subjected to full injector fuel pressure. Each of these parts has at least one surface making contact (sealing) with an adjacent part. These sealing surfaces must be clean, brightly polished and absolutely flat, so that when the injector is assembled and operated, each joint will withstand full injection pressure without leaking.

The required high polish and flatness is attained by hand lapping the parts on suitably prepared "lapping plates". This is an operation that requires some degree of skill. Since this skill can only be attained by actually lapping parts, it is recommended that some time be spent in practicing the lapping operations, using scrap parts before lapping parts intended for use in injectors.

To ensure the best quality of finished lapping work requires use of correct lapping plates that are kept in proper condition. The lapping plate set consists of three lapping plates, 8" x 8" x 1", in a covered wooden box. The lapping surface of each plate is grooved into 1/8" squares separated by 1/64" grooves. The plates should be kept covered in the box when not in use.

Continued use of the lapping plates tends to cause worn or low spots to develop, and sometimes the plates become scratched. Imperfections of this kind are evident when a plate is held under a strong light. When such defects are present, the lapping surfaces of the plates must be refinished.

Refinishing Lapping Plates

To refinish the lapping plates, sprinkle some lapping powder (600X), or equivalent, on one of the plates and add sufficient light machine oil to make a lapping paste. Place another plate on top of this plate face to face, and work them together. Alternate the plates from time to time. For example, assuming the plates are numbered 1, 2, and 3, work No. 1 and No. 2 together, then No. 1 and No. 3, and finally No. 2 and No. 3 together. Continue this procedure until all plates are perfectly flat and free of imperfections. After the surfaces have been refinished, clean all lapping paste from the plates by rinsing in fuel oil and washing, using a soft bristle brush.

It is good practice where considerable lapping work is done to devote some time each day to refinishing the plates. This procedure ensures the plates being in first class condition at all times.

Lapping Procedure

Avoid unnecessary lapping of injector parts. It frequently happens that when an injector is disassembled for repairs, many of the lapped surfaces still retain their mirror finish. When parts are found to be in good condition, set them aside and lap only the parts which require cleaning or removal of mirror defects. New replacement parts also should be polished by lapping.

1. Lap following parts on the lapping plates:

Body assembly seat	Spring cage
Plunger bushing	Spacer
Flat check valve	Spray tip

2. Clean off lapping plate using compressed air. Do not use a cloth or other material for this purpose.

3. Sprinkle some lapping powder on one of the lapping plates. (A common salt shaker is good for this purpose.)

4. Place the part to be lapped flat on the plate, as shown in Fig. 18, moving it back and forth across the plate using a figure "8" motion. Do not exert too much pressure on the part, but sufficient to keep the part flat. Rotate the part in hand 10 to 30 degrees every few seconds to produce an even smooth surface. When the part is flat and clean, wash it in solvent and dry with compressed air.

5. To provide a mirror finish on the lapped surface, lap the part on the second plate dry. Do not use any lapping powder. Make several figure "8" passes with part.

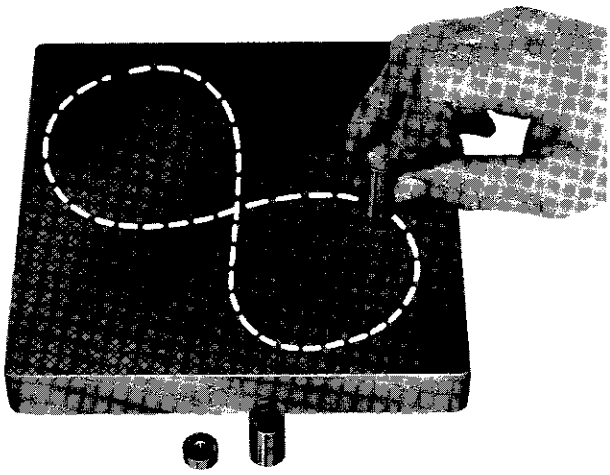

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Fig. 18 — Lapping Injector Parts

NOTE: If the body assembly seat has a nick or low spot which cannot be removed through normal lapping, place No. 320 grit aluminum oxide cloth on lapping plate and make as many figure "8" passes with the body assembly as required to remove defect. Then lap to required finish.

Polishing Bushing And Plunger

The bushing and plunger are polished using jewelers rouge paste and toilet tissue. The paste is made by mixing a small amount of jewelers rouge and mineral spirits.

1. Polishing Bushing

   To polish the injector bushing, wrap a sufficient amount of toilet tissue around a small diameter rod so that it may be inserted into the bushing bore. Apply a small amount of the jewelers rouge paste to the toilet tissue and insert into the bushing bore, Fig. 19. Work bushing back and forth over tissue, using a rotary motion.

2. Polishing Plunger

   The plunger is polished using some of the jewelers rouge paste on toilet tissue held in the hand, Fig. 20. The plunger is then worked back and forth through the tissue using a rotary motion. When the plunger and mating bushing have been thoroughly cleaned and polished, the bushing should be able to be spun around the inserted plunger. It is important in making this check that both the plunger and bushing are absolutely dry and clean.

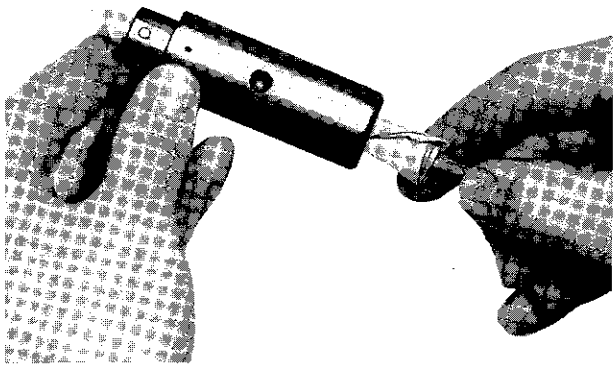

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Fig. 19 — Polishing Injector Bushing Bore

After the injector parts have been lapped and polished, they should be washed in solvent to remove all compound. They then should be blown dry with clean compressed air. Place them in cleaning container No. 3 in preparation for assembly of the injector.

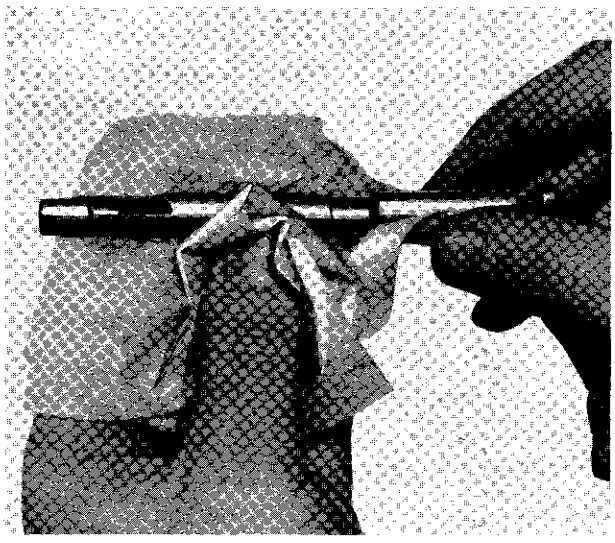

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Fig. 20 — Polishing Injector Plunger

Lapping Spray Tip

Lap needle valve spray tip, if required. Improper seating is indicated by drip or poor spray pattern at the "pop" test or when under pressure, and lack of chatter during the "pop" test.

1. Flush spray tip clean and dry with air hose.
2. Select the proper lapping tool from set.

NOTE: The 21 lapping tools are graduated in increments of .0001" from .2170" through .2190" diameters. Select the tool which has a light wring fit with the spray tip in order to maintain seat-to-bore concentricity of .0001".

3. Place a small amount of 800 grit lapping compound on the 60° lap seat of the lapping tool. Place tool into spray tip. Use extreme caution to prevent the tool with compound from touching the side walls of the .2170" - .2190" diameter since this will destroy the selective fit of the plunger and spray tip and will be cause for rejection.
4. With the lapping tool properly positioned in the spray tip, revolve the lapping tool between the thumb and index finger, applying a light pressure while revolving. Lift the tool slightly each turn to permit the compound to be drawn under the lap. Three or four complete revolutions should reseat the tip.
5. Carefully remove the lapping tool from the tip making sure to wash all of the compound from the tool. Wipe dry and replace in box. Flush all compound from the internal passages of the spray tip, and dry with air hose.
6. Visually inspect seat, using otoscope.

NOTE: The spray tip has a 60° seat angle while the needle plunger is 62°. Therefore, the assembly will show only a hairline bearing area. When reworking, consider the lift dimension of .012" - .018".

7. If bright rubbing marks are on the shank, lap the pilot diameter of the needle valve as follows. Insert upper stem of needle valve into chuck and spin at 350 RPM maximum. Do not chuck needle on lapped pilot diameter. Apply a very small quantity of lapping compound to the spinning valve with the tip of the finger. Rub back and forth across the lapped diameter with the tip of the finger just long enough to remove any bright rubbing marks on the needle valve shank. If needle valve seat has soft deposits or lacquer, touch with finger and clean the same as described for the pilot diameter.

CHECKING VALVE OPENING PRESSURE

1. Assemble needle valve to test fixture, Fig. 21, and connect test pump fuel line.

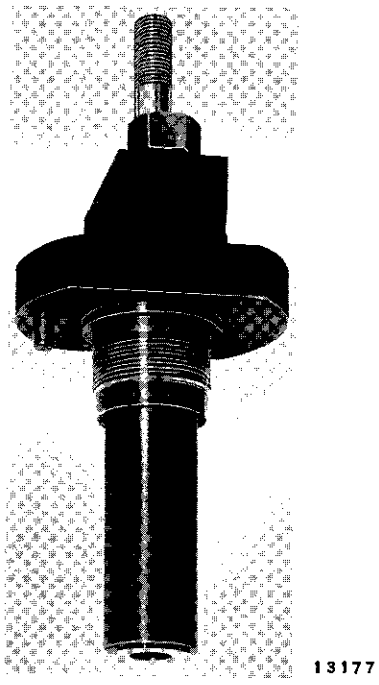

Fig. 21 — Injector Valve Test Fixture

2. Actuate pump handle at approximately 40 smooth even strokes per minute, observing pressure gauge until opening pressure is obtained. The opening pressure should be between 2200 - 3400 psi.

   A finely atomized spray at the tip will result. Rapid closing of the needle valve will produce a sharp "chatter".

3. If the valve opens without producing a finely atomized spray or the valve seats without producing the sharp "chatter", make several rapid strokes with the pump to dislodge any foreign material from the needle valve seat. If the needle valve fails to function properly, dirt on the seat or a defective seat may be the cause. Misalignment can also cause sluggish valve action. To correct misalignment, loosen injector nut and rotate the tip 180° with finger tips. Repeat Step 2.

ASSEMBLY

In preparation for the assembly of the injector, remove the parts which have been previously cleaned, inspected, and reconditioned, from cleaning container No. 3. Blow the individual parts off with compressed air, and place them in a clean dry parts pan or on clean paper.

As each injector part is selected for assembly as subsequently outlined, dip the part in container No. 4, containing the injector test and rust proofing oil or fuel oil. After dipping the part in container No. 4, do not blow off, but leave it wet. The liquid retained on the part will provide rust protection and/or lubrication during assembly.

The assembly sequence is as follows:

1. Insert the injector rack into the body. Position the rack so the two marked teeth are centrally located in the body bore as viewed from the thread end (bottom) of the body.

   On injectors equipped with calibrating slides, assemble the slide so that the end of the slide is flush with the face of the injector body.

2. Apply rack gear to mesh with the rack so timing mark on the one gear tooth is between the marked teeth of the rack. Timing markings should be facing the assembler when looking down at the parts from the thread end of the body, as shown in Fig. 22. The use of a flashlight or illuminated magnifying glass greatly facilitates the timing of rack and gear, as otherwise it is difficult to see the markings.

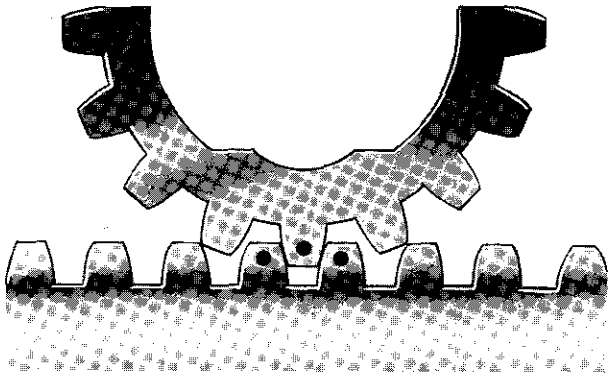

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Fig. 22 — Location Of Timing Marks On Rack And Gear

   After gear is correctly applied to the rack, clamp the body, thread end up, in the injector vise.

   Apply gear retainer on top of the gear.

3. Position the bushing on the body so locating pin enters the slot in the body.

   Place spill deflector over the bushing.

   Apply new body seal as shown in Fig. 23.

4. After dipping each part into container No. 4, assemble the spacer, check valve, check valve cage, valve spring, valve spring seat, and valve spring cage, see Fig. 24. Carefully position this assembly with spacer end on bushing.

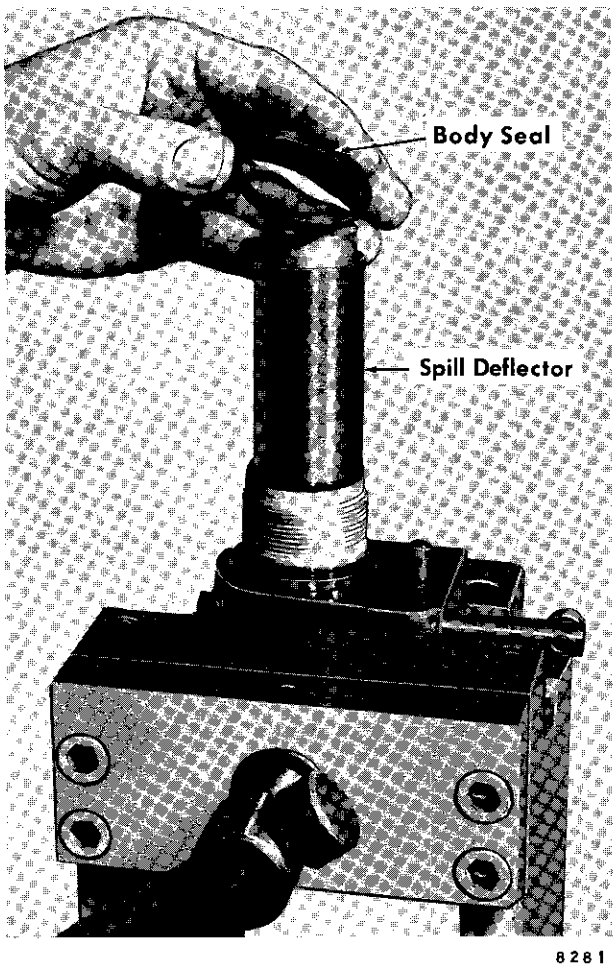

Fig. 23 — Applying New Body Seal

5. After dipping the spray tip assembly, Fig. 25, place it in position so that needle valve enters valve spring cage and rests on valve spring seat.

6. Place the injector nut carefully over the stacked parts, Fig. 26. Screw nut down by hand, then finally tighten to 120 ft-lbs using special injector nut socket and torque wrench.

7. Invert the injector in the vise, nut end down and reclamp in the vise.

8. Apply two new fuel filters in place in the body. Then apply filter springs and filter caps, using new filter cap gaskets. Torque filter caps to 40 ft-lbs with torque wrench.

9. Apply follower spring in place on injector body.

10. Install stop pin, spring, and their retainer in the follower. Slide the plunger into the cutout at the bottom of the follower.

11. With the roller end of the rack to the left side of the injector, position the rack so that the circumscribed groove on the rack (1" from end) is approximately flush with the face of the injector body.

12. Position the flat side of the plunger to the right side and align the stop pin with the stop pin slot in the body.

13. Place the follower and plunger assembly into the body, Fig. 27.

14. Depress the stop pin and press down on top of the follower. If necessary,

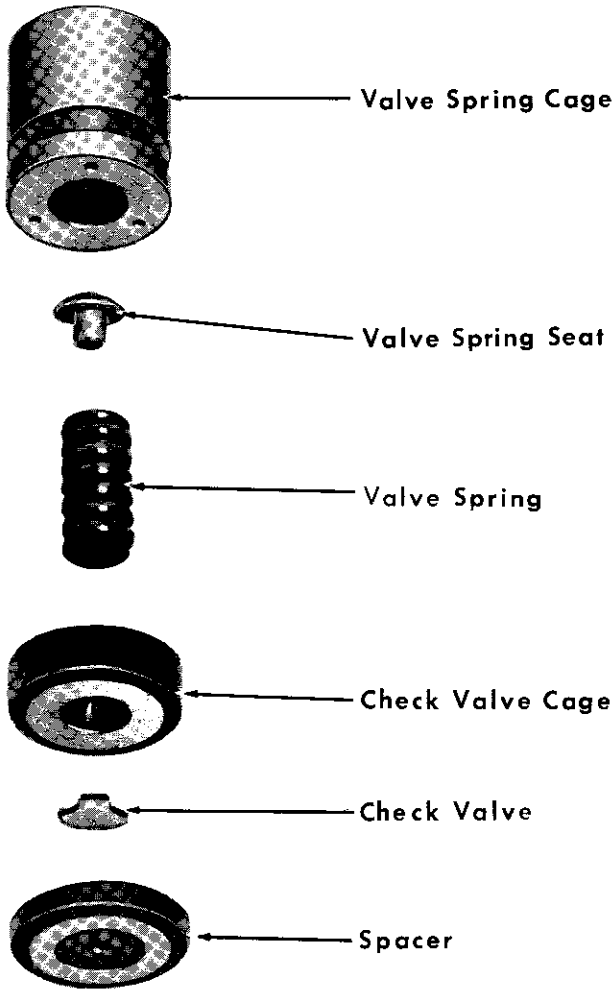

Fig. 24 — Injector Sub-Assembly

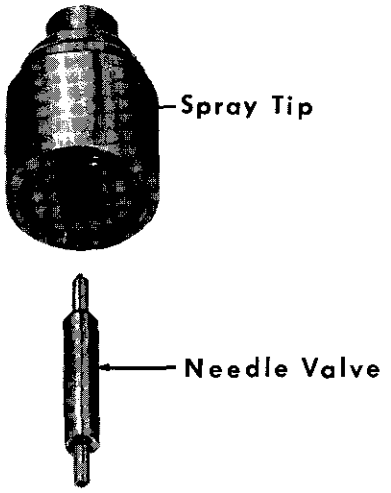

Fig. 25 — Spray Tip Assembly

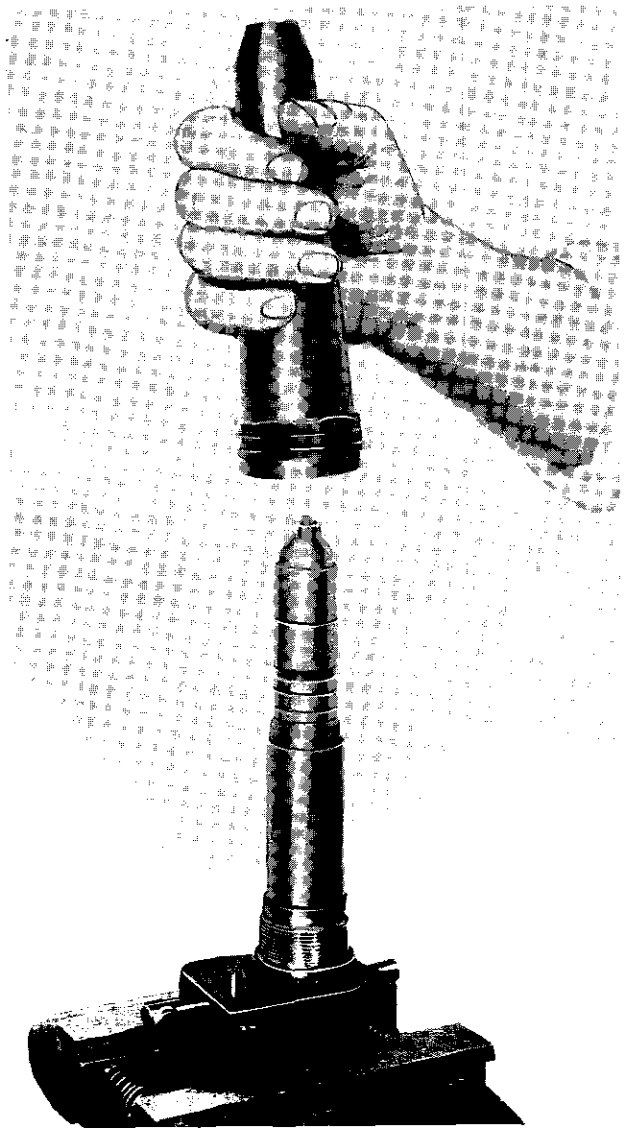

Fig. 26 — Installing Injector Nut

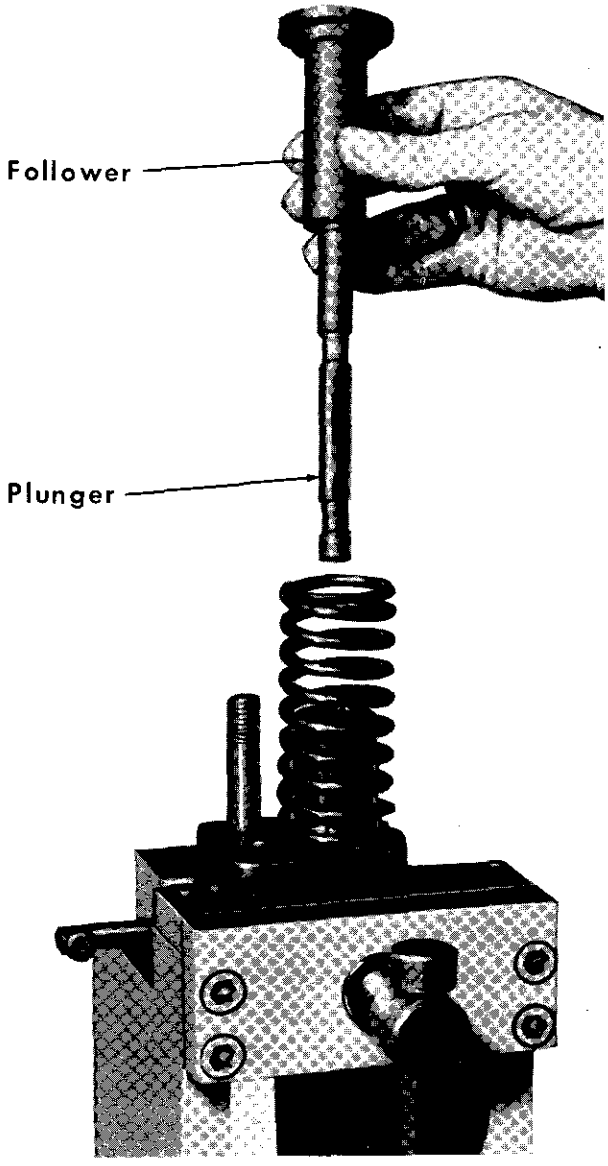

Fig. 27 — Plunger And Follower Installation

move rack slightly in or out until plunger engages with rack gear.

15. Continue pressing on follower until stop pin enters slot.

16. Apply the shipping block or plastic caps over the body stud to protect the open filter caps.

17. Place injectors in holding rack, Fig. 28, in preparation for testing.

TESTING

In order to ensure efficient engine performance, injectors should be tested whenever removed from an engine, regardless

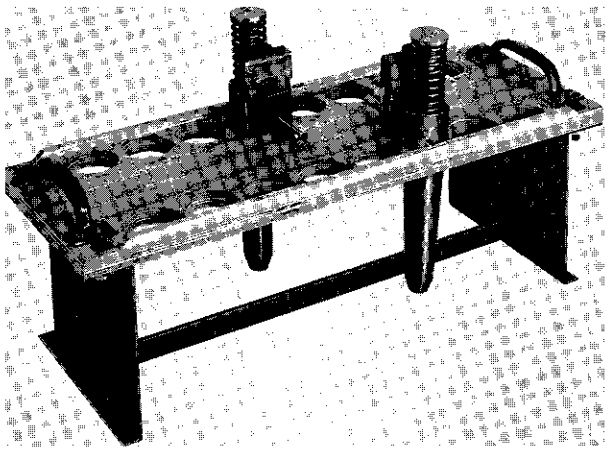

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Fig. 28 — Injector Holding Rack

of the reason for removal. In addition, it is advisable to test all injectors in an engine during each annual inspection. It is recommended that injectors be tested with the same oil used for protection against rust as given under "Storing Injectors."

It is important that the individual doing the testing understands the basic principles of injector operation and testing procedures in order to prevent acceptance of defective injectors and rejection of good ones. Instructions in the use of the injector test stand and an outline of each separate test procedure along with a basic explanation of operation follows.

These instructions cover the testing of all needle valve injectors using the test stand shown in Fig. 29. The procedures are not applicable to other types of testing equipment, since injector leakoff rates vary greatly in proportion to the volume of fuel contained in the high pressure portion of the test stand.

SETTING UP TEST STAND

Basically, the stand consists of a fuel reservoir, filter, high pressure pump, pressure gauge, and necessary connecting lines and fittings to supply fuel to the injector under test. The test stand should be set up as instructed by the manufacturer. Inspect carefully for dirt or foreign material in the tank and lines. Fill the tank with clean fuel and operate the pump to purge all free air from the system. Investigation has shown that the viscosity of the fuel oil used in the test stand has a marked effect on the test results obtained. Regular fuel oil may be used provided the viscosity is not less than 32 S.S.U. at 100° F. Do not reuse fuel oil which has been pumped through the injectors into the plastic bowl.

CHECKING TEST STAND

Install the test block in place of an injector in the stand and pump up pressure to 2000 psi, as indicated by the gauge. After five minutes, the pressure should not have dropped below 1975 lbs. Release the block and recheck at 500 and 1000 psi. These pressures should hold one minute with no apparent gauge drop. Make these tests with the pressure shutoff valve, Fig. 29, open all the way. If the tests are satisfactory, all injector tests may be made without using the shutoff valve. If the preceding tests indicate leakage in the stand, repeat the tests, closing the shutoff valve before timing the leakoff rates. If the tests are satisfactory with the shutoff valve closed, it will be necessary to use the shutoff valve when making the injector holding pressure test.

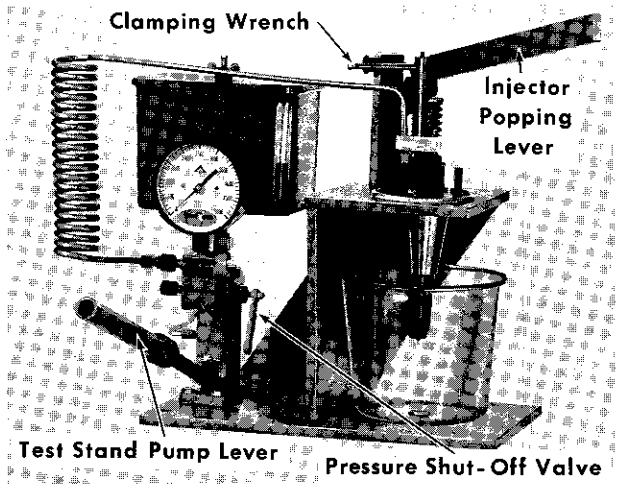

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Fig. 29 — Injector Test Stand

When placing a new test stand in operation, or after removing and replacing the gauge, fuel tank, filter, or pump, for any reason, the test block should be installed and pressure raised to 2500 psi and vented at least six times before making an operational check.

TEST STAND OPERATION

The operator must consider the test stand as an instrument, rather than a tool. Every effort should be made to make the manual operation of repeated tests the same. The following general information is provided to help in obtaining uniform operation:

General Information

1. When operating the pump, use a rate of approximately 40 smooth strokes per minute. This provides a fuel rate to operate the check valve smoothly and to circulate fuel within the injector.
2. When using the popping lever, do not use such force as to damage either the injector or the lever. Do not permit the lever to fly up freely.
3. In making holding tests, do not pump the stand above 2500 psi.
4. Test stands regularly in use should be checked daily for leaks, using the test blocks.
5. Fuel oil used for testing should not be reused.

INJECTOR TESTS

Preparation

1. Install the injector in the test stand.
2. Fill the injector with fuel oil, but do not connect the fuel line from pump to injector at this time.
3. Set the injector rack at maximum fuel output position (minimum rack length).
4. "Pop" the injector with the popping lever, Fig. 29, using spproximately 40 smooth even strokes per minute. A finely atomized spray should show at each of the six holes in the tip. Rapid closing of the needle valve should produce a sharp "chatter".

   If the valve opens without producing a finely atomized spray, or the valve seats without producing the sharp "chatter", make several rapid strokes with the lever to dislodge any foreign material on the valve seat. If the needle valve still fails to function properly, a stuck needle, dirt on the valve seat, or a defective valve seat may be the cause.

Holding Pressure and Leak Test

1. All injectors lose pressure due to leakage at any of several points, but this leakage must be controlled during injector manufacture to prevent engine lube oil dilution. The holding pressure test will qualify injectors having specified leakoff rates, providing this leakage is at the proper point and is satisfactorily controlled.
2. Manually hold the test stand fuel line block on the injector. Pump until fuel is discharged from filter cap on opposite side, to remove air. Tighten block securely to injector. Apply 1800 to 2000 psi pressure to the injector. No leakage is permitted at the nut to body seal, filter cap gasket, body plugs, or between spray tip and injector nut.
3. Used injectors should be qualified on the pressure holding test by timing the interval for a drop in pressure from 2000 psi to 1500 psi. If this interval is less than 20 seconds, repeat the test, but close the pressure shutoff valve on the test stand immediately after establishing the 2000 psi pressure. This is to ensure that the leak-down time is not being affected by possible leakage

in the test stand itself. If the timed interval for the pressure drop from 2000 psi to 1500 psi is still less than 20 seconds, the injector should be rejected. Do not attempt to "pop" the injector, except with the popping lever.

Rack Freeness Test

1. The rack engages with a small pinion on the injector plunger and serves to rotate the plunger with respect to two ports in the injector bushing, which regulates the amount of fuel injected with each stroke of the plunger. Binding of the rack is generally caused by damaged gear teeth, scored plunger and bushing, or galling of rack itself. A binding rack may cause sluggish or erratic speed changes and overspeed trip action.

2. To be considered satisfactory, the rack must fall in and out through full travel, by its own weight, when injector is held horizontally and rotated about its axis.

Binding Plunger Test

1. Failure of the injector plunger to move up and down freely indicates scoring of the plunger and bushing, or weak or broken spring. A binding plunger will cause erratic cylinder firing and, in extreme cases, overspeed trip action.

2. Place injector in test stand but do not attach the fuel line. Place rack in the full fuel position and pump all the fuel out of the injector with injector popping lever, Fig. 29. When all of the fuel has been removed, depress the injector plunger to full extent of its travel and release popping lever. Plunger should return to the top of its stroke with a definite snap action. Repeat this test with the rack in the half fuel and no fuel positions. Care should be used in the test to prevent the plunger from snapping back so violently that the plunger stop pin is broken.

CALIBRATING INJECTOR OUTPUT

If it is desired to calibrate the output of the injectors after reconditioning, it will be necessary to use a calibration stand such as shown in Fig. 30.

The calibration stand will enable the user to:

1. Check all injectors for output.

2. Obtain specified output by interchanging components of injectors not equipped with calibrating slides.

The data for checking output on the referenced stand is listed on the following page. Procedures for setting up and operating the calibration stand are included with the stand.

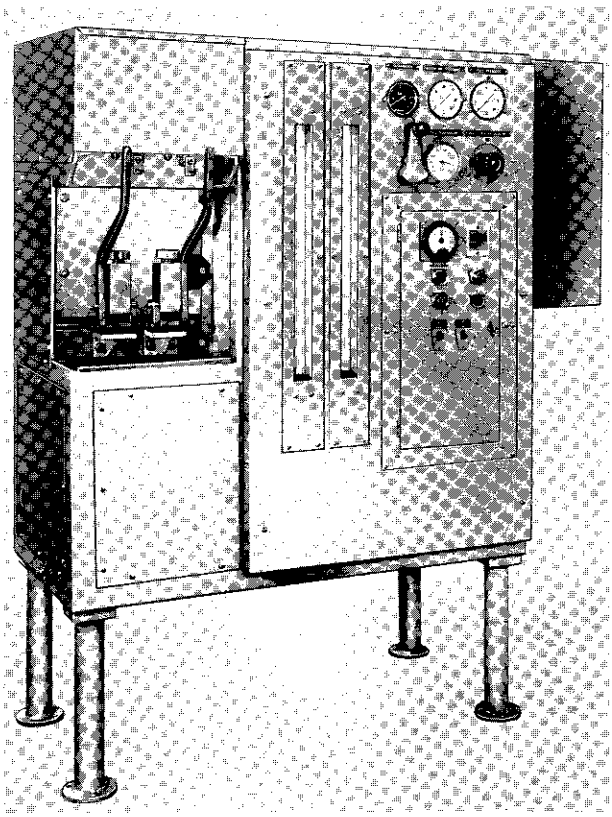

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Fig. 30 — Injector Calibration Stand

INJECTOR OUTPUT CALIBRATION DATA

Calibration	Part No. 8332467
Test Oil	EMD Test and Storage Oil Part No. 8203258 - 50 gallons Part No. 8219007 - 5 gallons or Fuel Oil with viscosity of 32-34 sec. Saybolt at 100° F.
Test Oil Temperature	95° F. - 105° F.
Test Oil Pressure	35 psi
Test Stand Speed	835 RPM
Injector Output	
Low Output Injectors	183-197 CC/400 strokes at .875" rack length
5228565 Needle Valve 5228810 Needle Valve with Calibrating Slide	
Medium Output Injectors	219-230 CC/400 strokes at .875" rack length
5228540 Needle Valve 5228800 Needle Valve with Calibrating Slide	
High Output Injectors	184-195 CC/300 strokes at 1.00" rack length
5228605 Needle Valve 5228750 Needle Valve with Calibrating Slide	

REPLACING INJECTOR FILTERS

Injector filters should not be disturbed or removed except during injector reconditioning (when all parts are completely washed), or in the event of fuel stoppage to the injector.

STORING INJECTORS

When injectors are not to be used for a considerable length of time, they should be protected against rust by using a stable, noncorrosive straight-run petroleum distillate in the kerosene volatility range. It is also recommended that injectors be tested using this oil. If this is done, treatment will be taken care of at time of injector test. After treatment, the injectors should be stored in the protective holding rack, Fig. 28, until needed.

EQUIPMENT LIST

	Part No.
Wrench, Nut	8032655
Brush, Body	8069986
Brush, Plunger bushing	8069987
Vise, Pin	8069988
Vise, Spray tip cleaning wire	8069989
Stone, Spray tip wire abrasive	8070961

	Part No.
Wire, Spray tip cleaning	8122519
Wrench, Torque (100 ft-lbs)	8157120
Rack, Injector holding	8159228
Wrench, Torque (200 ft-lbs)	8173332
Plate Set, Lapping	8191188
Reamer, Body fuel oil passage	8194040
Tool, Body seating	8201443
Disc, Abrasive (use with 8201443)	8201444
Socket, Nut	8201445
Tool, Body burring	8201446
Disc, Abrasive (use with 8201446)	8201447
Vise, Injector	8201448
Rouge, Jewelers (1 lb. can)	8201456
Powder, Lapping (600X)	8201459
Cleaner, Liquid (55 gal. bbl.)	8201460
Solvent, Liquid (55 gal. bbl.)	8201461
Stand, Test	8202944
Tank, Cleaning (drawing available on request)	8204639
Oil, Test (5 gal. can) (50 gal. drum - 8203258)	8219007
Brush, Spring cage and gear	8236901
Fixture, Valve test	8276319
Reamer, Nut	8291642
Bulb, Light (use in 8330339)	8330338
Otoscope	8330339
Stand, Injector calibration	8332467
Gauge, Spray tip air flow	8360398
Gauge, Dial indicator	8360447
Injector reconditioning room construction drawing	File #470
Injector storage box construction drawing	File #207
Set, Lapping tool	File #687

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