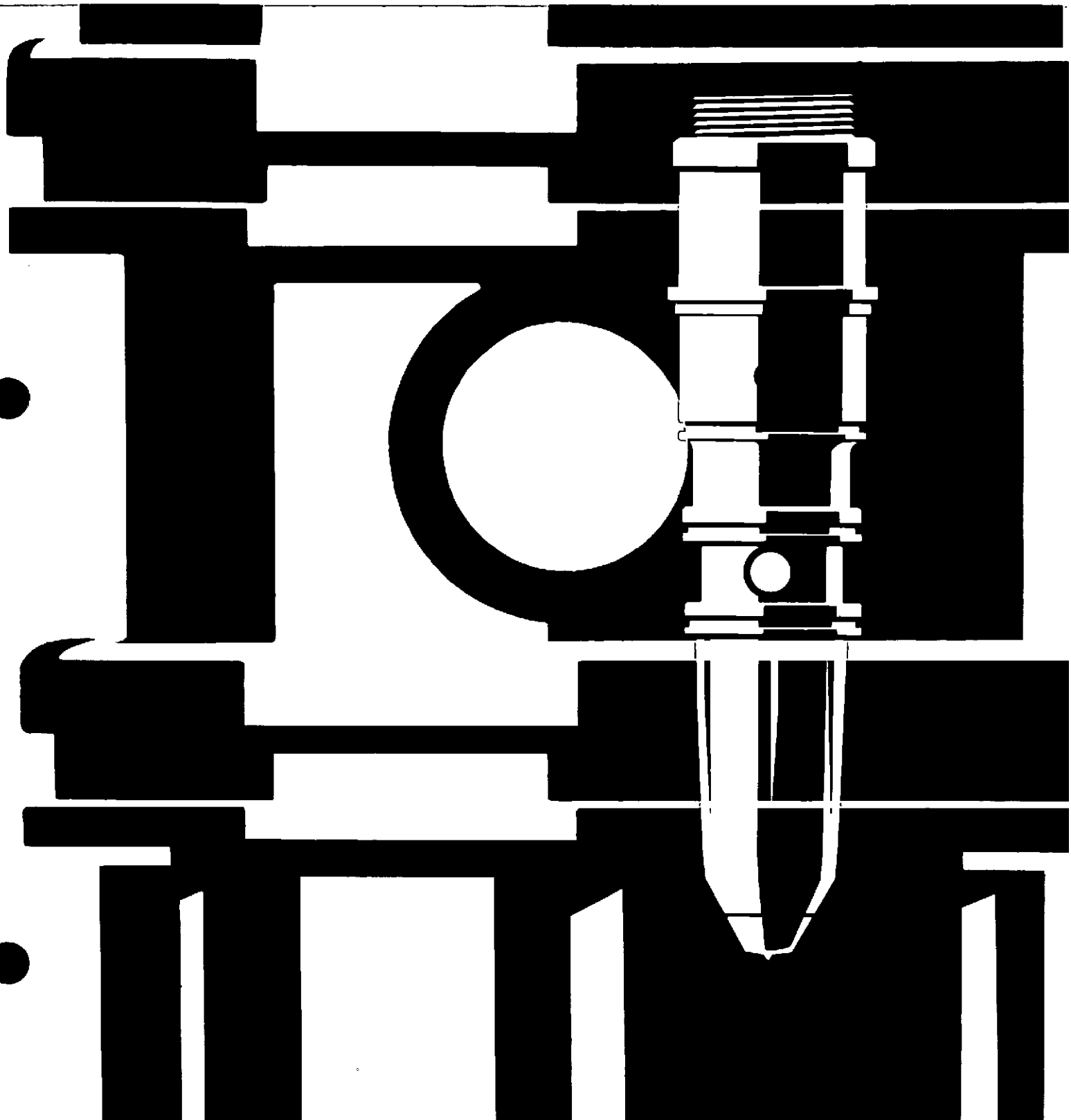
Injectors
PT (all types)



Cummins Engine Company, Inc.
Service Publications Comment Form

Suggested improvements? Errors? Please let us know.

Name	(AC) Tel No. ( )
Company	Bulletin No.
Address	Printing Date
City State Zip	Page No.

Comment/Correction

Signed Date

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 15 • COLUMBUS, INDIANA 47202

Postage Will be Paid By

Service Operations Dept. 80203
Cummins Engine Company, Inc.
Box 3005
Columbus, Indiana 47202-3005

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 15 • COLUMBUS, INDIANA 47202

Postage Will be Paid By

Service Operations Dept. 80203
Cummins Engine Company, Inc.
Box 3005
Columbus, Indiana 47202-3005

Cummins Engine Company, Inc.
Service Publications Comment Form

Suggested improvements? Errors? Please let us know.

Name	(AC) Tel No. ( )
Company	Bulletin No.
Address	*Printing Date*
City State Zip	Page No.

Comment/Correction

Signed Date

Component Shop Manual

Cummins PT Injectors

Bulletin No. 3379071-06, Printed 12-82

Foreword

This manual covers the operating principles, disassembly, cleaning, inspection, repair, assembly and testing of Cummins PT injectors. Also covered are the inlet and drain connections and the fuel lines and fittings.

The injector flow values, rebuild parts information and cross reference are now in Bulletin No. 3379664.

Cummins Engine Company, Inc.
Columbus, Indiana, U.S.A. 47202-3005

Table of Contents

PT Injectors

It is the policy of Cummins Engine Company, Inc. to constantly improve their product; therefore, design changes may affect procedures outlined in this manual. If variances are observed, verify the information through a local Cummins Distributor or Dealer.

This manual includes Service Topic information pertaining to injectors through September 1982.

Service Topic Information In This Manual

Topic Number	Description
81T 22-14	New Injector Cup Spray Tester
81T 22-16	Top Stop Setting Fixture Changes
82T 6-1	Injector Adapter Pins and Gasket For The Small Vee Engine Series
82T 6-5	Injector Check Ball Depth
82T 6-11	PT (type D) Injector Barrel Fuel Groove

The topics not included in this list do not pertain to this manual.

This manual supersedes Bulletin No. 3379071-05.

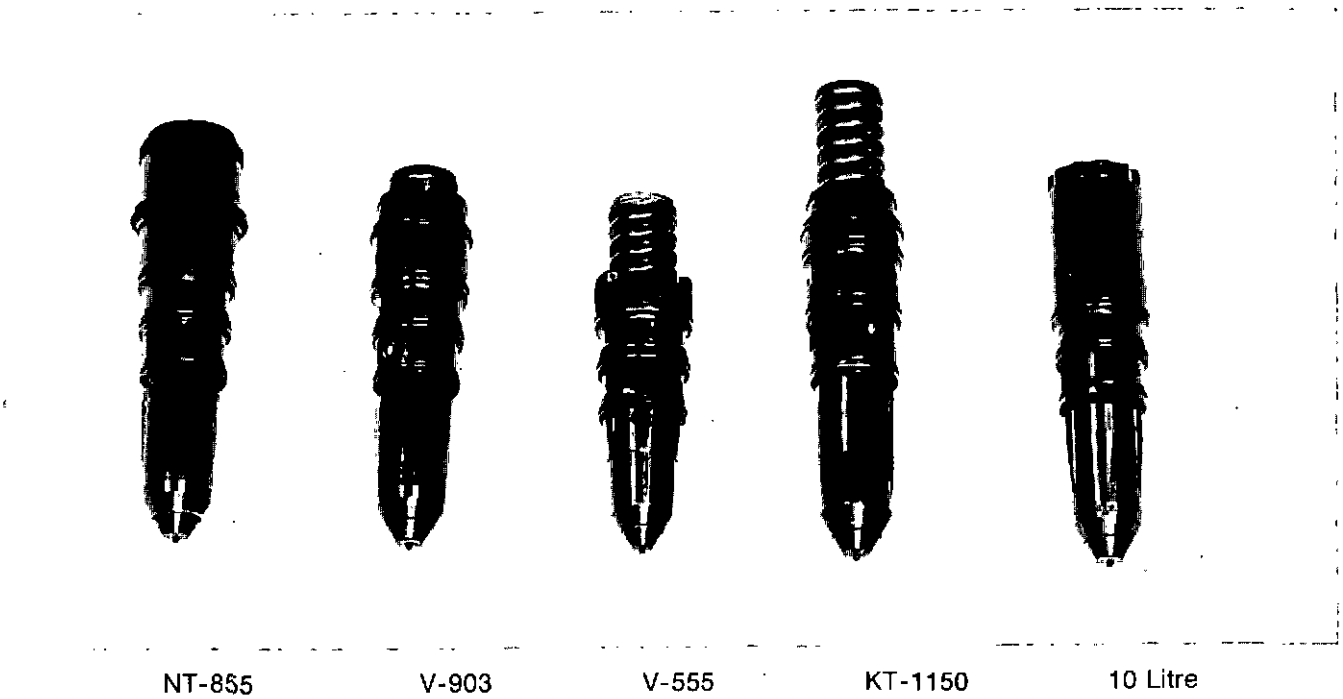


Fig. 1, (F60313). The five types of PT (type D) injectors

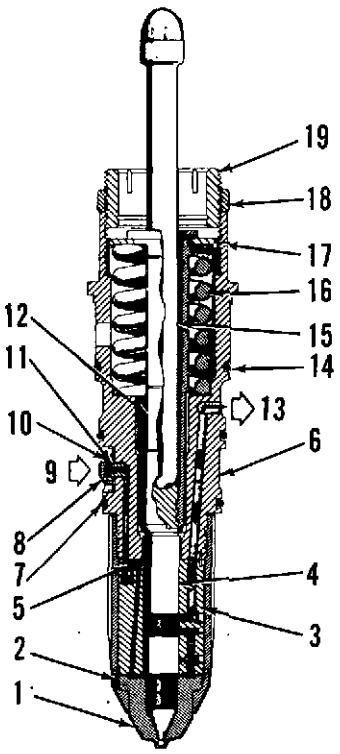


Fig. 1-1. (FWC27). PT (type D) Top Stop Injector cross-section

1. Cup
2. Cup Retainer
3. Barrel
4. Plunger
5. Check Ball
6. Adapter
7. Screen Clip
8. Fuel Screen
9. Fuel In
10. Orifice Plug
11. Orifice Gasket
12. Coupling
13. Fuel Out
14. O-ring
15. Link
16. Spring
17. Retainer
18. Locknut
19. Top Stop Screw

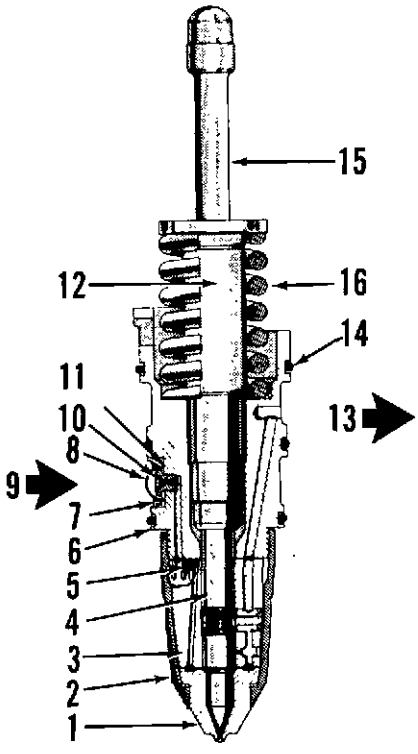


Fig. 1-2. PT (type D) Injector cross-section

PT (type D) and PT (type D) Top Stop Injectors

The PT fuel system is used exclusively on Cummins Diesels. The identifying letters, "PT", are an abbreviation for "pressure time". Detailed description of the different injector models are given below.

Operating Principle and Parts Description

Injector Description

The PT Injector is a simple mechanical unit which receives fuel from the fuel pump under pressure. The injector meters and injects fuel through the small injector cup spray holes into the combustion chamber.

The general description "PT Injectors" is used only to indicate that the injector is used with the PT fuel system and not with the former Cummins Disc fuel system.

The PT Injectors are separated into two basic groups; those which are cylindrical in shape without a flange for mounting and those which are flange mounted in the cylinder head. This section contains the PT (type D) and the PT (type D) top stop injector information.

Injector Parts

Adjustable Orifice Plug

An orifice plug is used in the inlet drilling of the injectors to adjust the fuel delivery. Fuel delivery is adjusted by changing the orifice plug or by burnishing the plug in its operating position. The orifice plugs now in use have a flange and require a gasket beneath the flange.

Drain Orifice Hole

The drilled orifice hole in the cup end of the injector barrel is the drain drilling. This orifice hole is fixed in size and must not be altered.

Metering Orifice Hole

This orifice hole is also in the cup end of the injector barrel. It allows fuel to enter the injector plunger bore and cup. This orifice hole is fixed in size and must not be altered.

Adapter — PT (type D)

In Fig. 1-1, the parts in adapter (14) are the plunger return spring (12), adjustable orifice plug (6), orifice plug gasket (7), fuel screen (5) and screen retainer (4). The adapter has O-ring seals (15) on the outside, which seal against the head to form the fuel inlet and drain passages. Fuel enters through the adjustable orifice plug (6) and flows to the barrel (18), past the check ball (3) to the cup-to-barrel passage, then up to the metering orifice hole where it is metered into the cup (1). In the direct fuel feed barrels, the fuel goes directly from the check ball to the metering orifice hole. Fuel not used circulates past the metering orifice hole, around the plunger and out the drain orifice passage while the plunger is seated in the cup. The cup, adapter and barrel are held in the assembled position by the cup retainer (2).

Top Stop Parts

The top stop injector parts are the same as the standard PT (type D) except the adapter (14, Fig. 1-1) is longer to accommodate the stop. The plunger coupling top is smaller, allowing it to pass through the stop screw. The injector spring retainer (11), adjustable stop screw (9) and stop screw locknut (10) are parts required only for top stop injectors.

Service Tools and Service Literature

Required Tools and Literature

The Cummins service locations that rebuild and calibrate injectors must have the service tools and service literature in Table 1-1.

Table 1-1: Service Tools (or Equivalent) Required

Tool No.	Description
ST-726	Adapter Pot
ST-838	Test Stand Adapter Kit
ST-995	Cup Retainer Wrench
ST-1072	Crowsfoot Wrench
ST-1089	Injector Plunger Extension
ST-1210	Master Injector — 132cc
ST-1254	K Injector Adapter Pot
ST-1261	K Injector Cam Conversion Kit
ST-1262	Master Injector — 184Acc
ST-1303	Cup Retainer Wrench
ST-1306	Master Injector — 178Acc
3375048	Cup Retainer Wrench
3375084 or ST-1298	Injector Assembly Stand
3375086	PT (type D) Injector Adapter Pot
3375160	Top Stop Setting Fixture
3375317	Injector Test Stand
3375364 or 3375365	Calibration Fluid
3375366	Injector Test Stand Audit Kit
3376010 or 3375375 or ST-990	Injector Leakage Tester
3376135 or ST-708	Burnishing Tool
3376169	Cam (No. 169) Use With 3375317 Test Stand
3376170	Cam (No. 230) Use With 3375317 Test Stand
3376177	Injector Orifice Torque Wrench
3376350	Injector Cup Spray Tester
3376665 or 3375000	Ultrasonic Cleaner
3379144	Fuel System Rack and Literature
3379208	Fuel System Literature Monthly Update

Recommended Service Tools

The Cummins service tools listed in Table 1-2 are recommended but not a requirement.

Table 1-2: Service Tools (or Equivalent) Recommended

Tool No.	Description
ST-426	Injector O-Ring Assembly Tool
ST-427	Injector O-Ring Assembly Tool
ST-1129	Flowmeter Kit (For ST-790 Test Stand)
ST-1332	Orifice Plug Gauge
3375182	Spring Tester
3375209	Plunger Sticking Checking Tool
3376297	Injector Barrel Tester

A complete parts list and pictures of the Cummins service tools are in the Service Tools Catalog, Bulletin No. 3377971.

PT (type D) and PT (type D) Top Stop Injectors

Disassembly

The disassembly and cleaning procedures, described on the following pages, are operations which must be performed in a clean, well equipped shop.

PT (type D) and PT (type D) Top Stop Injectors

1. To disassemble an injector that does not have a top stop, lift out the injector plunger and spring. Remove the spring from the plunger.
2. To disassemble a top stop injector, the locknut and adjusting screw must be removed before the spring and the spring retainer can be removed.
   a. Install the injector body wrench, Part No. 3375102, in a vise.
   b. Slide the flat machined areas in the fuel supply groove of the injector into the body wrench.
   c. Use the crowsfoot wrench, Part No. 3375166, to loosen the top stop locknut, Fig. 2-1.
   d. Use the top stop adjusting wrench, Part No. 3375165, to loosen the top stop adjusting screw, Fig. 2-2.
   e. Remove the locknut and adjusting screw.

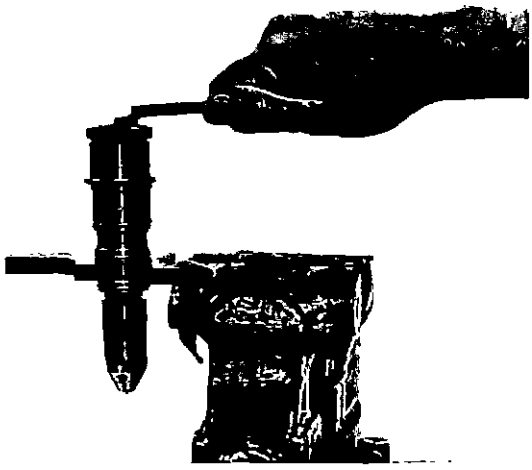


Fig. 2-2, (F60304). Loosen the top stop adjusting screw

   Remove the spring retainer or washer and the plunger spring.
   f. Use the cup retainer wrench, Part No. ST-995, to **LOOSEN** the cup retainer, Fig. 2-3.

DO NOT REMOVE THE CUP RETAINER WHEN THE INJECTOR IS IN A HORIZONTAL POSITION. THE CUP AND BARREL WILL FALL OFF AND THE CHECK BALL WILL FALL OUT. DO NOT LOSE THE CHECK BALL.

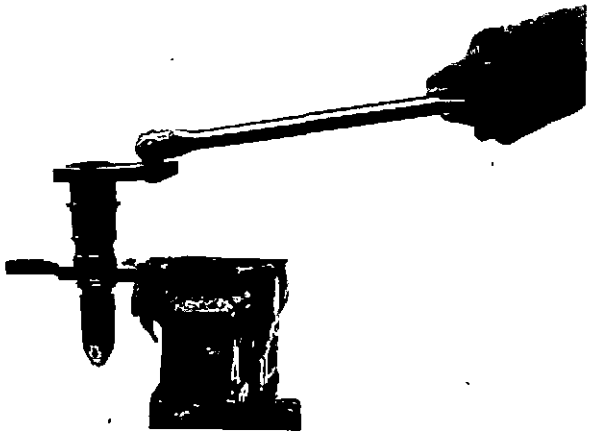


Fig. 2-1, (F60303). Loosen the top stop locknut

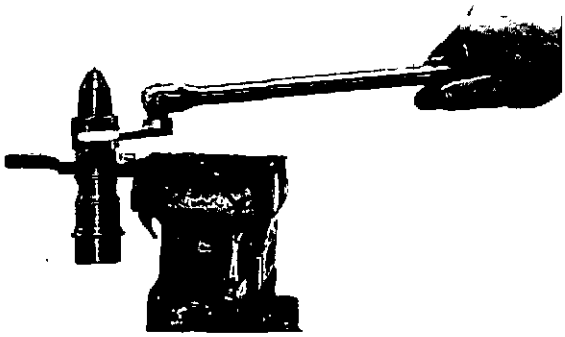


Fig. 2-3, (F60305). Loosen the cup retainer

3. Remove the injector from the body wrench.

Note: To disassemble six injectors at the same time, make a fixture to hold six injectors. Make the body wrench 3/16 inch (4.7 mm) thick, not 3/8 inch (9.5 mm) thick. The flats in some new design injectors are not as wide as the PT (type D) injectors now in production.

4. Hold the injector with the cup up and screw the cup retainer off of the adapter, Fig. 2-4.
5. Remove the cup, Fig. 2-5.
6. Hold the barrel against the adapter and turn the injector so the barrel is down. Remove the barrel, Fig. 2-6. **DO NOT LOSE THE CHECK BALL.**
7. Remove the check ball from the barrel, Fig. 2-7.

Fig. 2-4, (F60306). Remove the cup retainer

Fig. 2-5, (F60194). Remove the cup

Fig. 2-6, (F60307). Remove the injector barrel

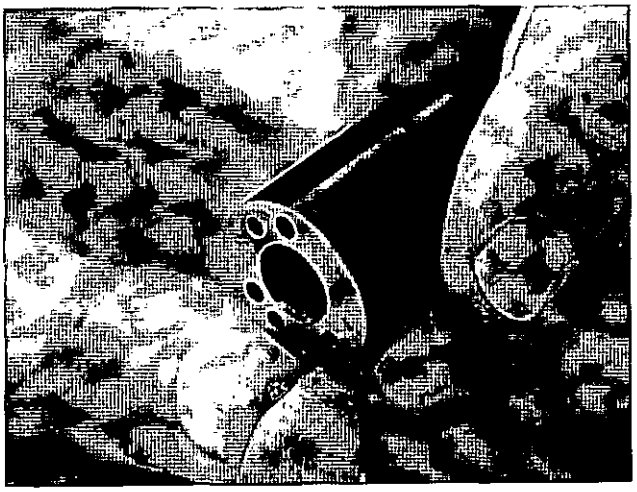


Fig. 2-7. (F60190). Remove the check ball

8. Discard the gasket that is between the barrel and adapter, if used.
9. Store the plunger by standing it on the coupling end.

Note: The injector barrels and plungers are class fit. Do not interchange these parts.

10. Remove the O-rings from the injector adapter and discard.
11. Remove the screen retainer ring and remove the screen.

Note: Do not remove the adjustable orifice plug from the fuel inlet counterbore.

Cleaning

1. Clean the injector parts thoroughly of any carbon varnish. Soak the parts in a solvent. Ultra-sonic cleaning in Service Tool 3376665 or 3375000 is recommended for the barrel, plunger and cup.
2. Neutralize the solvent after cleaning by dipping the parts in mineral spirits.
3. Dry with compressed air.
4. Use lint free towels during the disassembly and assembly of the injectors.
5. A clean shop, clean tools, and good cleaning practices are essential to good injector repair. Most injector failures occur because of dirt.

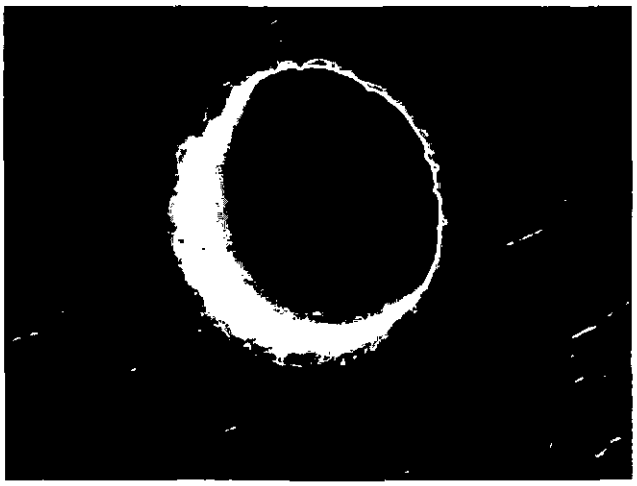


Fig. 2-10 (F60295) Injector cup hole before wire brushing

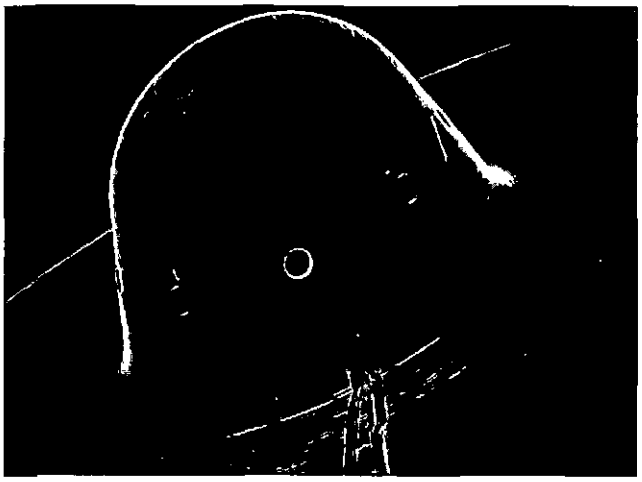


Fig. 2-8, (F60293). Injector cup tip before wire brushing

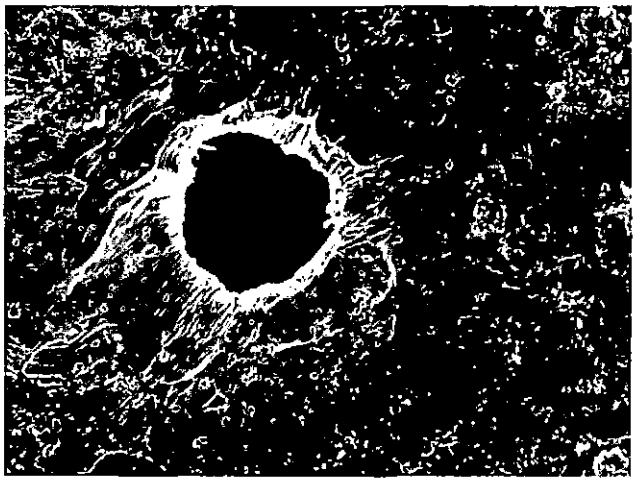


Fig. 2-11 (F60296) Injector cup hole after wire brushing

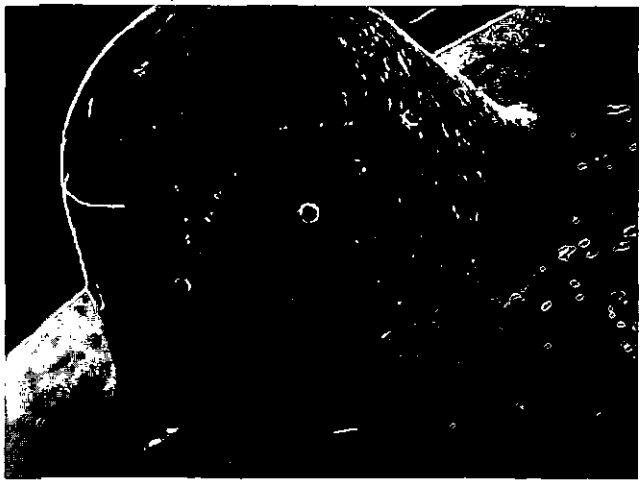


Fig. 2-9, (F60294) Injector cup tip after wire brushing

6. The effect of using a rotary wire brush is shown in Fig. 2-8 thru 2-11.
   a. The hard injector cups now used in production had a restriction flow in the cup holes of 10 to 50 percent after wire brushing for two-seconds.
   b. The soft injector cups had more restriction after wire brushing.

Caution: Do not use drills or other instruments to clean the cup holes. This will alter the size of the holes. Wires may be used if a smaller size wire is used than the spray hole. Do not use a wire brush or crocus cloth to clean the cup tip area.

Inspection

Injector Plunger and Coupling PT (type D) and PT (type D) Top Stop

1. Check closely for metal seizure. As a rule this is the only true indication of scuffing or scoring.
2. Bright spots or surface disruption at the top of the plunger machined area, on the opposite side at the bottom of the plunger or at the mid-point, usually are normal results of rocker lever thrust action. Unless metal is displaced or wear is measurable at these points, the plunger can be reused. If the barrel and plunger do not pass the leakage test, return the parts to a Cummins Rebuild Location for fitting of a new plunger.
3. Narrow streaks running the length of the plunger usually are the result of the varying thickness of the penetrant treatment used to prevent rusting. The plunger is satisfactory for reuse unless a surface disruption is evident.
4. Check the area where the plunger is swaged to the coupling for cracks and looseness. If the plunger can be rotated, replace the barrel and plunger.
5. Excessive wear or fretting may be found on the spring or spring retainer contact area of the coupling flange.
   a. Replace the plunger and barrel assembly if the plunger coupling flange is less than 0.144 inch [3.66 mm] thick, Fig. 2-12.
   b. Replace the spring retainer if it is worn more than 0.003 inch [0.076 mm] deep, Fig. 2-13.

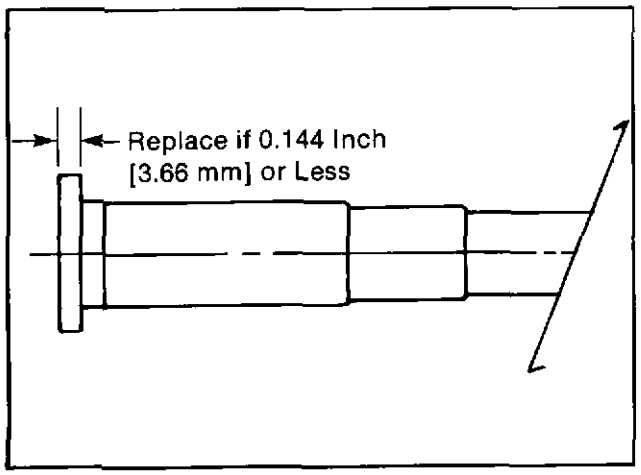


Fig. 2-12. Injector plunger flange thickness

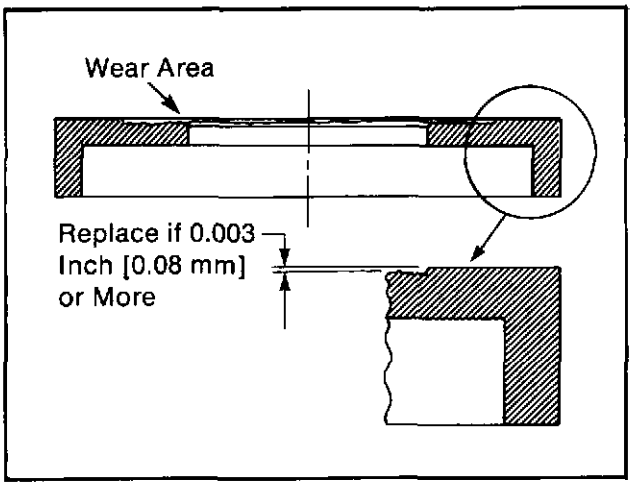


Fig. 2-13. Injector spring retainer thickness

6. Check the socket for wear or cracking.

Caution: Handle the injector plunger with care to prevent damage which could render it useless.

7. Check for carbon on the small diameter, near the tip of the plunger.

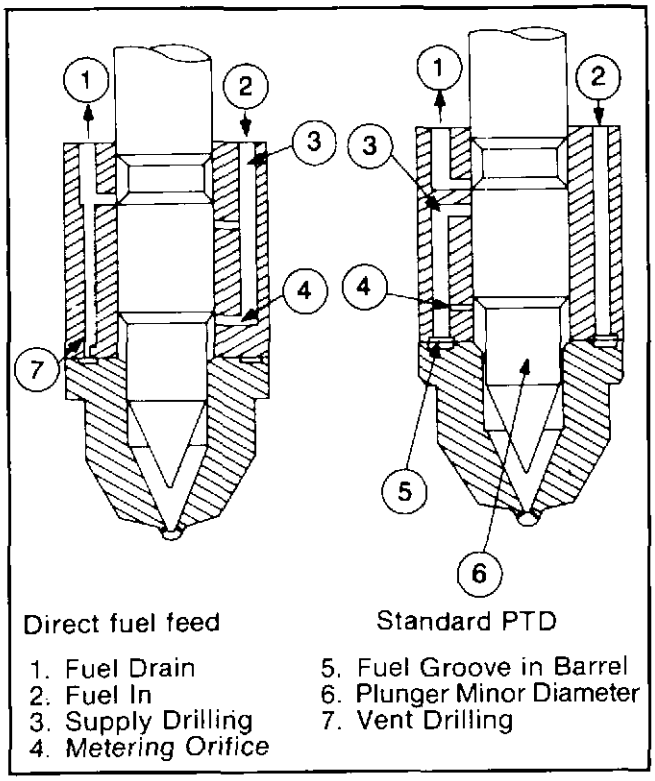


Fig. 2-14, (F60282). Direct fuel feed and standard PT (type D) injector barrel comparison

a. Some engines that have Jacobs engine brakes have had plunger tip carboning.

b. Check the engine control Parts List for a direct fuel feed injector, Fig. 2-14.

c. Change the complete set of injectors. Do not mix the direct fuel feed injectors with the standard PT (type D) injectors.

d. Some engines that are timed slow, have had plunger tip carboning.

e. Check the engine injection timing.

8. Injector plunger sticking of the top stop injectors can usually be corrected by changing to chrome plated plunger injectors.

9. The high capacity plunger assembly can be identified by a wider fuel drain groove in the plunger. The old style groove was 0.215 inch [5.46 mm] wide. The high capacity plunger groove now in use is 0.265 inch [6.73 mm] wide, Fig. 2-15.

Note: The high capacity plungers can be used in either the standard or high capacity barrels.

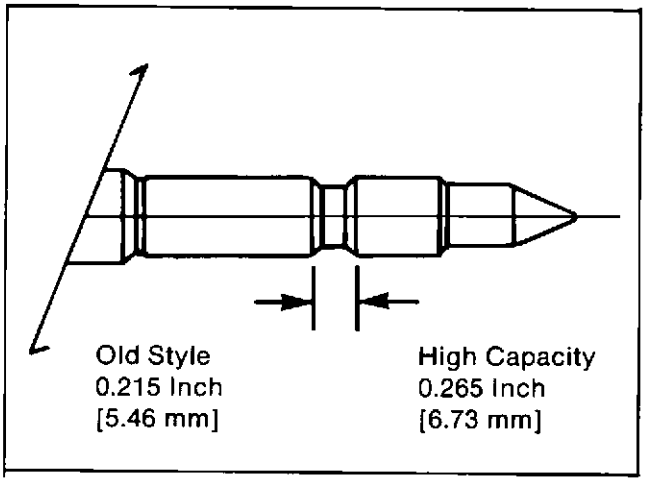


Fig. 2-15, (F60297). Injector plunger fuel drain groove width

Injector Barrel
PT (type D) and PT (type D) Top Stop

1. Inspect the injector barrel plunger bore for scoring or corrosion. If the injector will pass the ST-990 or 3375375 leakage test, the barrel is usable. If the leakage is too high, the barrel and plunger must be replaced.

2. Use a strong magnifying glass to check for burrs, carbon and distorted radii in the orifice. When the metering orifice is damaged, the injector will not function properly. Do not attempt cleaning with wires, plug gauges, etc. Use solvent cleaners.

3. Check the fuel passage plugs for looseness and the barrel for cracks.

4. Check the injector barrel surfaces for mutilation and flatness in the black area as shown in Fig. 2-16. The groove has been removed from the cup end of the barrels manufactured in England and the direct fuel feed injectors.

   a. Thoroughly clean and dry the barrel of all oil film before bluing.

   b. Use a surface plate (preferably a lapping plate) and "bluing" to check for surface flatness.

   c. If mutilation or unevenness are found, lap to repair. Use Grade A 280 grit lapping compound.

   d. Do not use crocus cloth or a wire brush on the barrel and cup contact area.

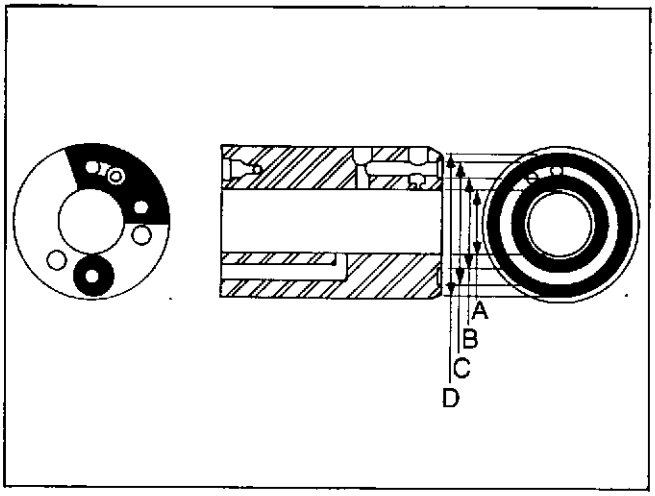


Fig. 2-16, (F60191). Barrel surface at cup contact area

Table 2-2: Cup Contact Area of Barrel — Fig. 2-16

Engine Series	"A" Dia. Inch [mm]	"B" Dia.	"C" Dia.	"D" Dia.
V6-200, V8-265, V-903, NH, NT,V12	0.400 [10.16]	0.540 [13.72]	0.710 [18.03]	0.820 [20.83]
V6-140, V8-185, V-504, V-555	0.337 [8.56]	0.480 [12.19]	0.650 [16.51]	0.706 [17.93]

5. If the 5/16 inch type injector has been overheated, the barrel to adapter gasket, if used, can melt. Loss of the injector cup retainer torque will occur; therefore, the following items should be suspected:
   a. Lubricating oil dilution or blocked injector spray holes.
   b. Damaged injector sleeves or damaged injector plungers.
6. The high capacity barrel feed and drain holes are about 0.050 to 0.065 inch [1.27 to 1.65 mm] higher in the barrel, Fig. 2-17. Do not mix standard and high capacity injector barrels in the same engine.

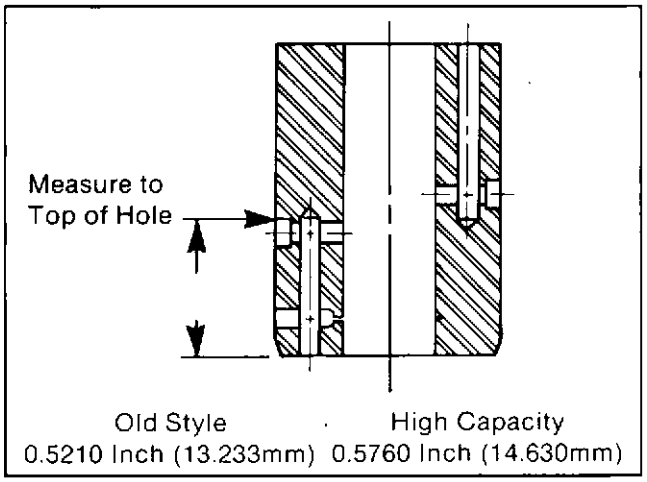


Fig. 2-17, (F60298). Injector barrel fuel holes

7. In 1982 the fuel groove in the top of the barrel was made deeper, Fig. 2-18. The deeper groove will allow more fuel to flow around the check ball. The barrel part number was not changed when this improvement was made.
8. The metering orifice hole is the smallest hole in the plunger bore of the barrel. This orifice hole is near the cup end of the barrel, Fig. 2-14.
   a. There are eleven different barrels that have five different sizes of metering orifice holes.
      1) The K, KT, and KTA engine series all use the same size high flow metering orifice hole.
      2) The small vee (V-555, etc.) engines use two different sizes of metering orifice holes — one size for low flow injectors, and a larger size for high flow injectors.

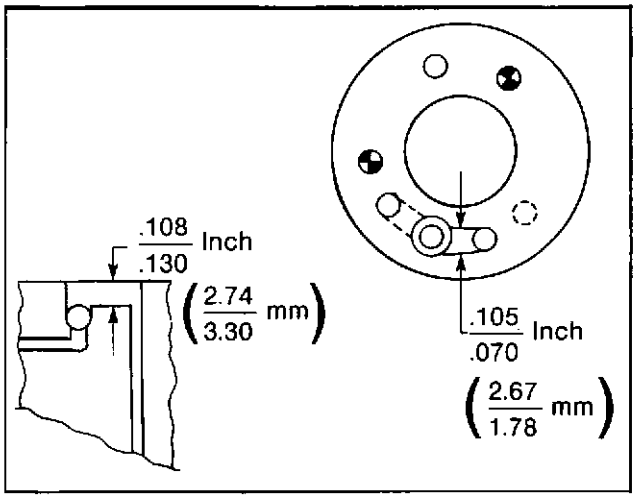


Fig. 2-18. Dimensions of the fuel groove in the injector barrel

      3) All of the other engines use two different sizes of metering orifice holes — one for low flow, and the other for high flow injectors.

Note: The size of the orifice holes is from about 0.024 inch (0.61 mm) to 0.047 inch (1.19 mm).

   b. Do not mix high flow and low flow barrels in the same engine.
   c. The part number, on the outside of the barrel, can be used for barrel indentification.
   d. The injector barrel and plunger assembly identification table is in Bulletin No. 3379664. One barrel can be used on many assemblies.
   e. Check the Control Parts List, Bulletin No. 3379133, for the standard and optional injectors that can be used in the engine.

Check Ball and Barrel Check Ball Seat.

1. Replace the check ball if it is worn or damaged.
2. Inspect the check ball seat for damage.
   a. If damage is found, the check ball seat can be improved by lapping a ball to the seat.
      1) Weld a check ball to the end of a small rod.
      2) Use a 600 grade paste lapping compound to lap the seat.
      3) Clean the lapping compound out of the barrel.
3. Inspect the depth of the check ball seat.
   a. Install a check ball in the barrel.

b. The depth of the check ball must not be more than 0.055 inch (1.40 mm), Fig. 2-19.

4. Use service tool, Part No. 3376297, to measure the check ball leakage.

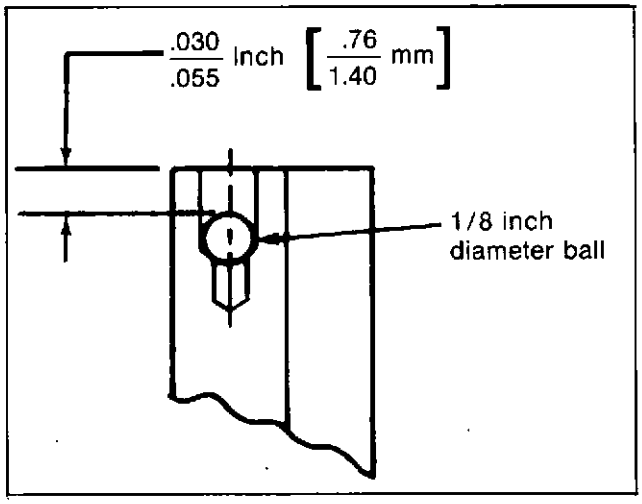


Fig. 2-19. Measure the check ball depth

Injector Barrel/Check Ball Tester, Part No. 3376297

The injector barrel check ball tester allows tests to be performed prior to the assembly of the barrel to the injector adapter. This makes it quicker and easier to make sure that the check ball or check ball seat in the injector barrel is within the acceptable limits, Fig. 2-20.

1. The injector barrel check ball tester is used with service tool, Part No. 3375375 or ST-990. It uses only the regulated air supply, the two air lines, and the "air-flow" flowmeter.
2. The check ball and seat must be wet with calibration fluid.
3. Install the barrel in the testing fixture.

Installation and Operation

1. Attach one air supply hose to the lower connection and one hose to the upper connection, Fig. 2-21.

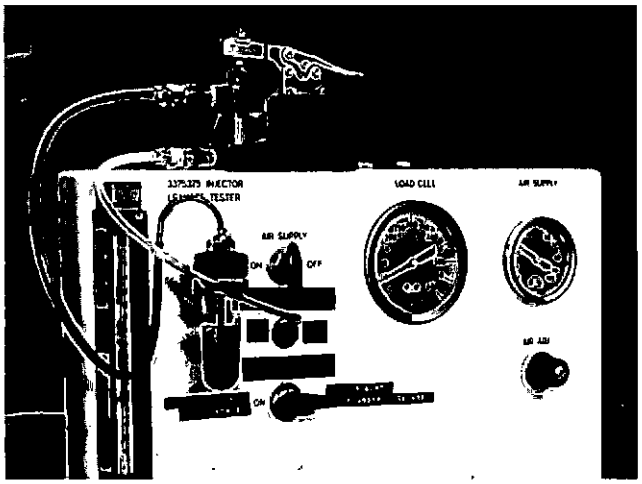


Fig. 2-21, (F60290). Service tool attached to, Part No. 3375375 tester.

2. Position knobs on service tool, Part No. 3375375 or ST-990 to their normal location.
3. Use normal pressure, 80 psi [552 kPa] for check ball test. The leakage must be less than 12 units at 80 psi.
   a. An optional procedure is to test the leakage at 60 psi. The leakage must be less than 8.5 units at 60 psi [414 kPa].
4. Observe test results on the air flow flowmeter.
5. Switch air supply on and off several times to make sure the check ball is in the seat.

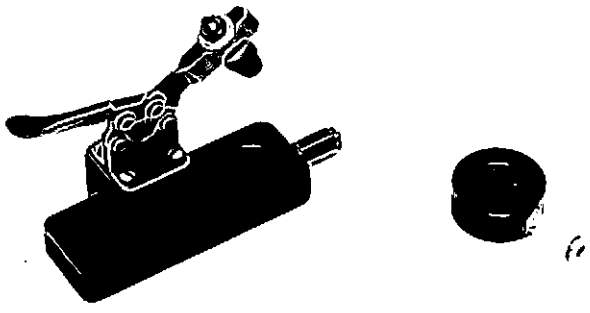


Fig. 2-20, (F60289). Check ball/seat test (3376297)

Injector Cup
PT (type D) and PT (type D) Top Stop

1. Inspect the injector spray holes and tip with a magnifying glass. Compare them with a new cup. Discard the cup if any of the following conditions exist.

a. Abrasive wear: This wear can begin internally; therefore, inspect both the interior and exterior.

b. Corrosion and erosion damage and the effect of excessive heat: This condition usually results from high water, acid or sulphur content in the fuel or from overloaded operating conditions, Figs. 2-22 and 2-23.

c. Enlarged or distorted spray holes: This is caused by wire brushing, cleaning with drills or other instruments and high mileage.

d. See Figs. 2-8 thru 2-11 for the effect of wire brushing an injector cup.

Caution: Never alter the size of the injector cup spray holes.

2. Many injector cups will show some erosion. The holes can be worn away on the outside surface but the hole size has not changed. The cup tip wall thickness has very little erosion. Reuse these cups, Figs. 2-24 and 2-25.

3. Inspect the cup for plunger seat pattern. Select a new plunger and coat with Prussian Blue. Insert the plunger in a cup and rotate 90 degrees. If plunger seat covers a 40 percent continuous area around the cup cone or plunger bore, it is possi-

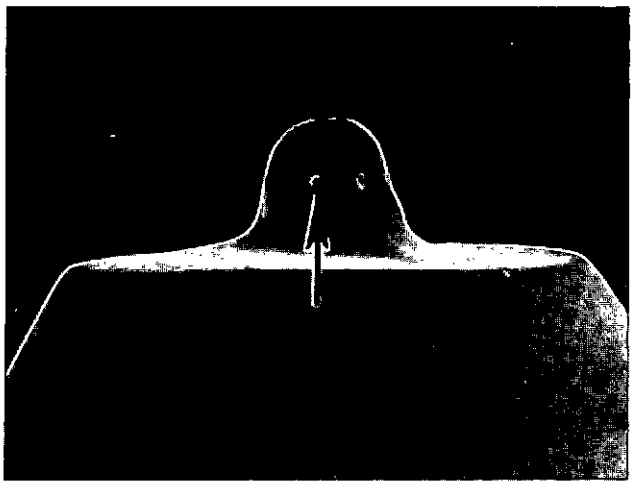


Fig. 2-22, (F60284). Eroded injector cup tip and holes

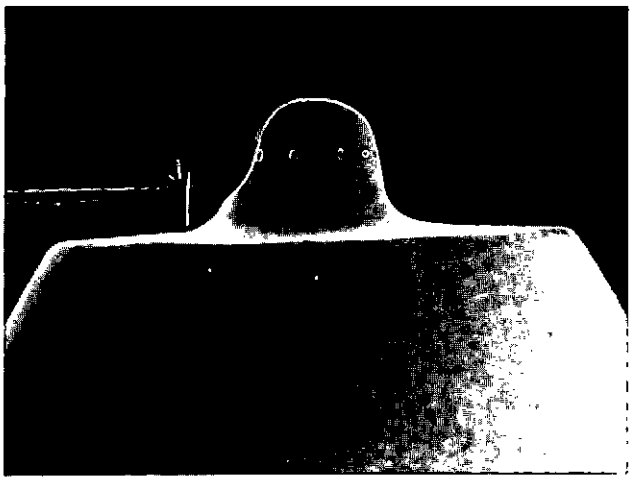


Fig. 2-23, (F60285). Exhaust side of injector cup eroded away

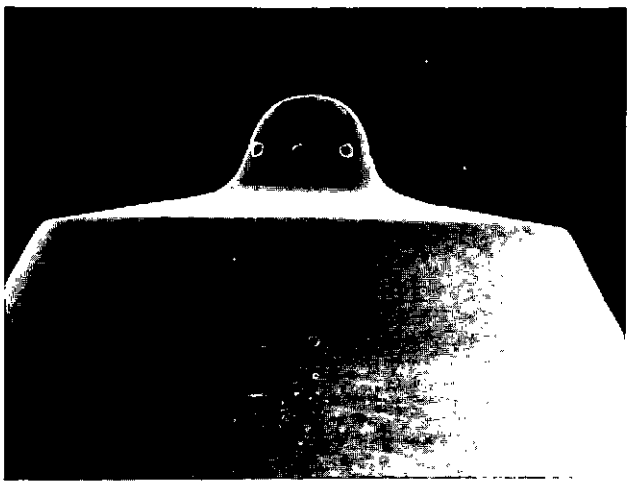


Fig. 2-24, (F60286). Injector cup hole outside surface worn away

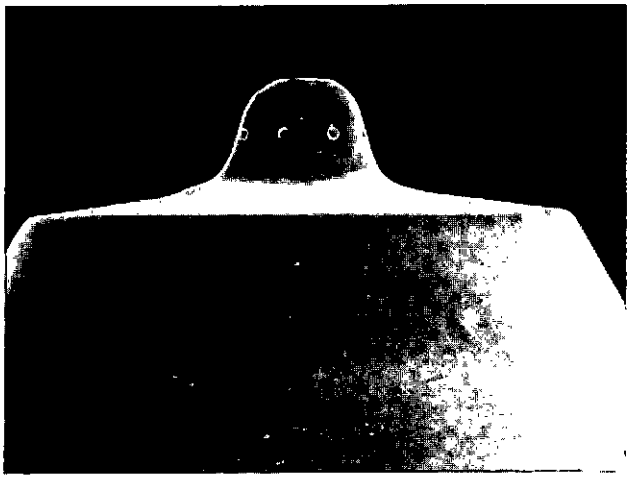


Fig. 2-25, (F60287). Injector cup with a little erosion

ble the cup may be reused. The cup must pass the ST-990 or 3375375 cup-to-plunger leak test. Fig. 2-26.

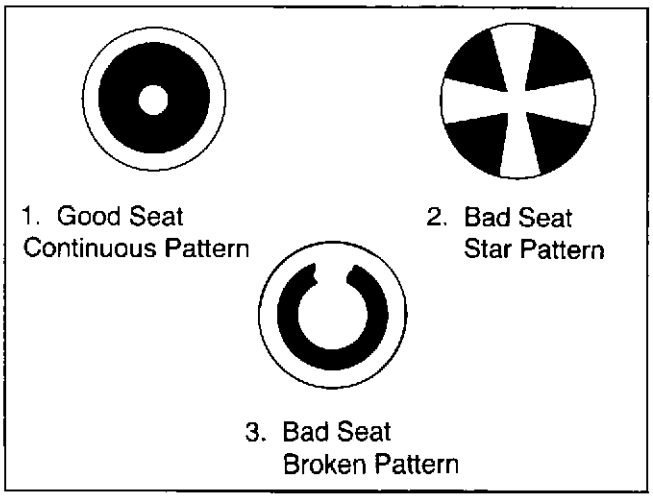


Fig. 2-26. (F60108). Seat pattern of plunger in cup

Caution: The plunger must seat in the cup from 1/4 of the upper cone area to the full cone area. Reject a cup that seats in lower 1/4 cup tip area. If a cup seats in the tip area, it must seat more than 1/2 of cone area to be accepted.

4. Check the injector cup barrel surface for mutilation and flatness.
   a. For mutilation, check in the area (black area) as shown in Fig. 2-27.
   b. Use a flat steel plate (preferably a lapping plate) and "bluing" to check for surface flatness.
   c. If mutilation or unevenness are found, mark for repair.

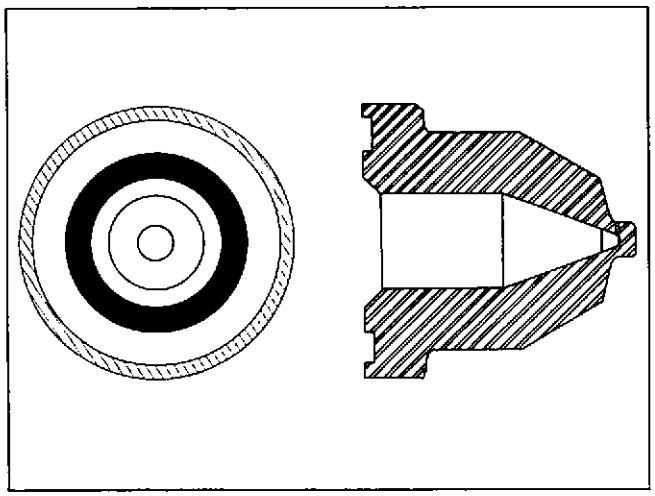


Fig. 2-27. (F60161). Cup surface at barrel contact surface

Check the Spray Pattern of the Injector Cup

See section four for the complete installation and operation instructions for this service tool. This tester can check the cup spray holes before the cup is assembled on the injector.

1. Use the injector cup spray tester, Tool No. 3376350, to check the cup spray holes, Fig. 2-28.
2. Install the correct adapter for the type of cup to be tested.
3. Install the injector cup into the adapter.
4. Start the injector test stand. Adjust the pressure on the cup spray tester to 8-10 psi [55-69] kPa, Fig. 2-29.
5. If the spray holes are plugged or spraying a fuzzy pattern, reverse flow air through the holes or clean the cup again in the sonic cleaner.
6. If the cup holes are defective, discard the cup.
7. If the cup is acceptable, it can be installed on an injector.

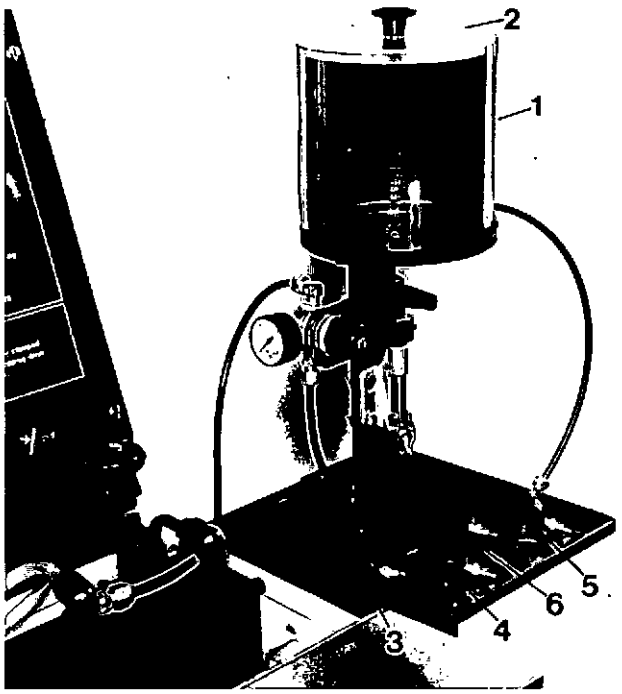


Fig. 2-28. 3376350 Injector Cup Spray Tester

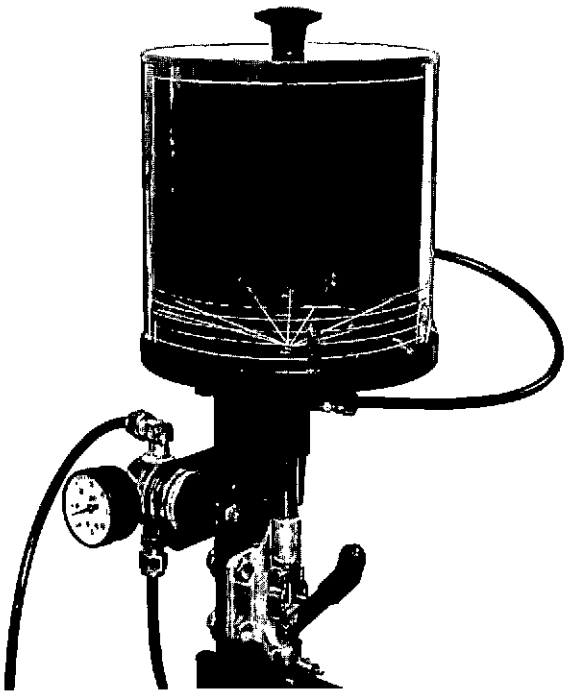


Fig. 2-29. Spray Tester in operation

Adapter
PT (type D) and PT (type D) Top Stop

1. Check the balance orifice for burrs or other obstructions.
2. Inspect both fuel passages to be certain they are open.
3. Inspect the cup retainer threads for damage.
4. Check the O-ring areas for nicks or burrs which will damage the O-rings during installation.
5. Inspect the barrel mating surface for nicks or burrs. If damage is found, lap to repair.
6. Check the inside diameter behind the adjustable orifice plug. If a burnishing needle that is too long is used, there will be a hole through the adapter. This will cause lubricating oil dilution.

Cup Retainer
PT (type D) and PT (type D) Top Stop

1. Inspect the threads for damage.
2. Check the outside cone area for nicks for burrs which could prevent proper seating with the sleeve in the head.
3. Inspect the inside of the cone area on the cup seating ledge for nicks or burrs which could prevent the cup from seating.

Injector Spring
PT (type D) and PT (type D) Top Stop

1. Check the spring for excessive wear or mutilation.
2. Test the spring tension on the spring tester, 3375182, Fig. 2-30. This spring tester is capable of very accurate measurements of spring lengths and applied load by means of standards and the dial indicator gauge, Table 2-3.
3. If the injector springs compress to the dimen-

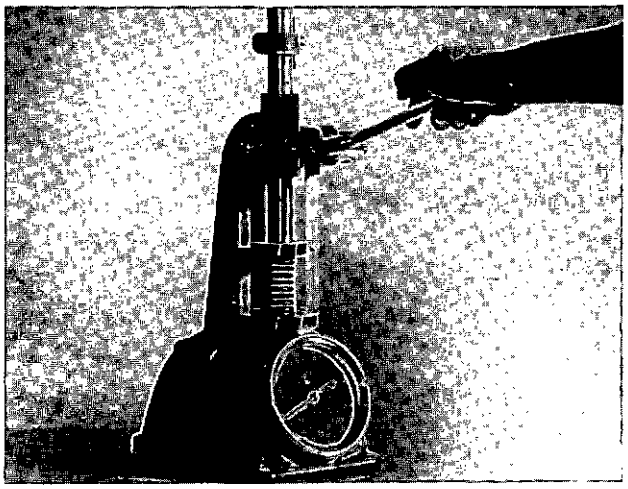


Fig. 2-30, (F60163). Test the injector spring on 3375182

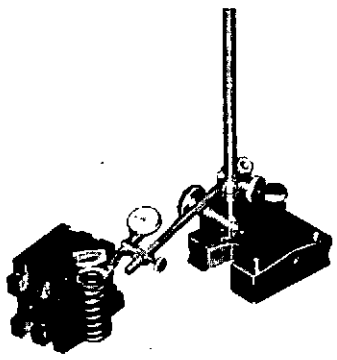


Fig. 2-31, (F60281). Check the spring squareness

sions shown at less than the load indicated under the "worn limits", the spring must be discarded.

4. Check the squareness of the spring used in the top stop injector.

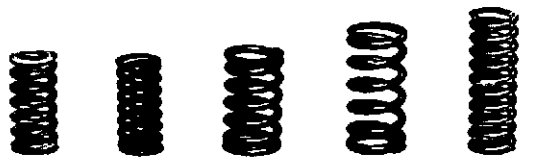
   a. Place the spring in a V-block and stand the assembly up on a flat surface. Fig. 2-31.

   b. Maintain contact between the coils of the spring and the V-block and the baseplate while rotating the spring. Measure the flatness of the ground ends (approximately 270 degrees) with a dial indicator.

   c. Turn the spring over in the V-block and check the opposite end using the procedure as outlined in Steb b.

Note: The amount must not exceed 0.016 inch [0.41 mm] on each end.

   d. Springs which do not meet this standard must be used in non-top stop applications or discarded.



166009 9337 62123 128040 205464

Fig. 2-32, (F60109). Injector Spring Comparison

5. Inspect the top stop spring retainer. Replace the retainer if it is worn more than 0.003 inch [0.076 mm] deep.

Table 2-3: Injector Spring Data

Part No.	Approximate Free Length Inches [mm]	No. Coils	Wire Dia. Inches [mm]	Load Required to Compress Springs to Length Length Inch [mm]	New Min. Lb. [kg]	New Max. Lb. [kg]	Worn Limit Lb. [kg]
9337 Flanged C, J	1-7/8 [47.6]	8-1/2	0.177 [4.50]	1-9/16 [39.7]	135 [61]	149 [68]	130 [59]
62123 Flanged H, NH, NT, V12 5-1/8"	2-1/32 [51.6]	7	0.1875 [4.77]	1-9/16 [39.7]	135 [61]	149 [68]	130 [59]
8091-1 Flanged L, LR, LRT	2-7/16 [61.9]	7	0.2625 [6.65]	1-7/8 [47.6]	228 [163]	252 [114]	218 [99]
128040 Cylindrical Injector PT-B, C V-903, V8-265, V12 5-1/2"	2-1/2 [63.5]	*7	0.1875 [4.77]	1.975 [50.2]	133 [60]	147 [67]	128 [58]
166009 PT-D, NH, NT, N14, L10, V12 5-1/2", V6-378, V8-504, V-555 PT-D Flanged — Color Code White	1.95 [49.7]	8	0.187 [4.75]	1.663 [42.2]	143.25 [65]	158.75 [72]	138 [63]
205464 PT-D, KT-6, KTA-2300, KTA-3067 — Color Yellow	2.82 [7.16]	11	0.187 [4.75]	2.40 [61]	134.25 [60.9]	149.75 [67.9]	129 [58.5]

*Earlier model springs have 9.5 coils with two closely spaced as shown in Fig. 2-32. These may be used interchangeably.

Injector Plunger Link
PT (type D) and PT (type D) Top Stop

1. Replace the plunger link if worn excessively. See Fig. 2-33.
2. If the wear can be seen or felt, it is excessive.

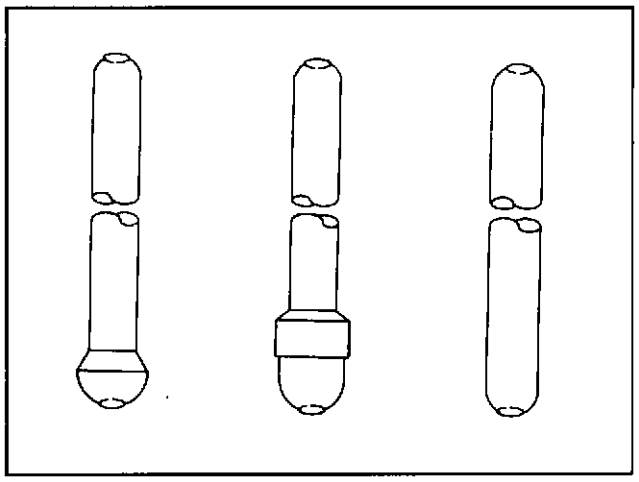


Fig. 2-33, (F60188). Plunger links with excessive wear.

Injector screen
PT (type D) and PT (type D) Top Stop

1. Three types of screens have been used on the PT (type D) injectors, Fig. 2-34.
2. The screens used before July 1977 had a single layer of fine mesh wire.
3. The screens used between July 1977 and December 1979 had an outer layer of coarse wire and an inner layer of fine wire.
4. The screens now in use have an outer layer of fine wire mesh and an inner layer of coarse wire.
5. Replace the screen if it is not the design now in use.

Single Layer Fine Before July 1977	Outer Layer Coarse Inner Layer Fine From July 1977 to Dec. 1979	Inner Layer Coarse Outer Layer Fine From Dec. 1979 to now

Fig. 2-34, (F60299). The old and new style injector screens.

Assembly

PT (type D) and PT (type D) Top Stop

The ST-1298, 3375084 and 3375536 are three types of loading fixture tools.

The ST-1298 has been redesigned so the cup to plunger alignment pressure is maintained by an air cylinder. The air cylinder reduces the injector assembly time.

If you have ST-1057 or 3375084 and wish to add the air cylinder attachment, it is available as St-1298-5111.

1. If the barrel location pins were removed, install new spiral pins into the barrel.

Note: Roll pins are no longer used. The 5/16 inch (V-555) type injector only requires one spiral pin.

2. Drop the check ball into the top of the barrel, Fig. 2-35.

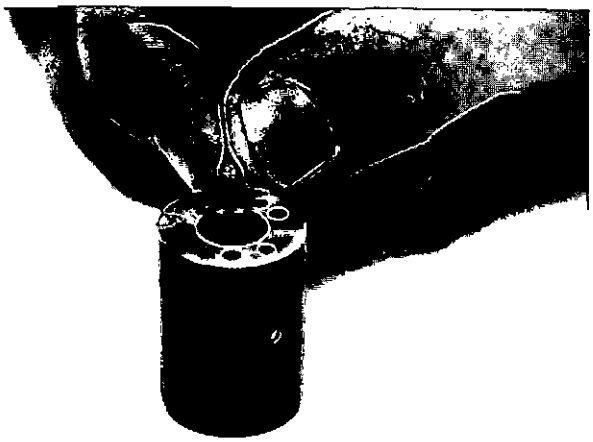


Fig. 2-35, (F60190). Install the check ball in the barrel

Caution: Be certain all mating surface parts are clean and free of burrs or other imperfections which will result in incorrect flow or torque. Lap to repair.

3. The gasket between the barrel and adapter is required for the (V555) 5/16 inch type only that was made before 1982.
4. Hold the barrel with the check ball up and install the adapter on the barrel, Fig. 2-36.
5. Immerse the injector plunger in clean injector test oil and install it in the adapter without the spring.
6. Turn the adapter and barrel with the barrel up and place the cup on the barrel, Fig. 2-37.

Fig. 2-36, (F60308). Install adapter on the barrel

Fig. 2-37, (F60194). Install the cup on the barrel

7. Lubricate the cup flange contact area of the cup retainer with engine lubricating oil and assemble to the adapter. Screw the retainer down finger tight and loosen 1/4 turn.
8. Raise the 3375103 Special Stud in the 3375084 Holding Fixture. Insert the injector into the loading fixture.
9. Slide the 3375102 Body Wrench over the flats on the injector adapter.
10. Place the ST-995 Retainer Wrench on the injector retainer, Fig. 2-38.
11. Lubricate the threads of 3375103 Stud and screw in the 3375084 Loading Fixture far enough to hold the injector.
12. Tighten the stud in 3375084 to 75 in-lb [8.5

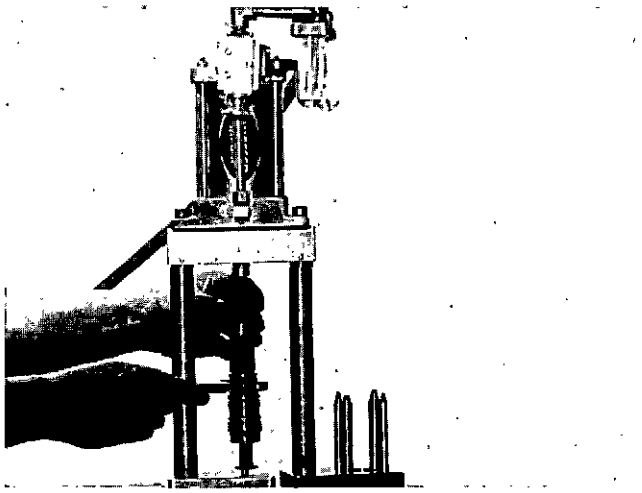


Fig. 2-38, (F60195). Install the retainer wrench on injector

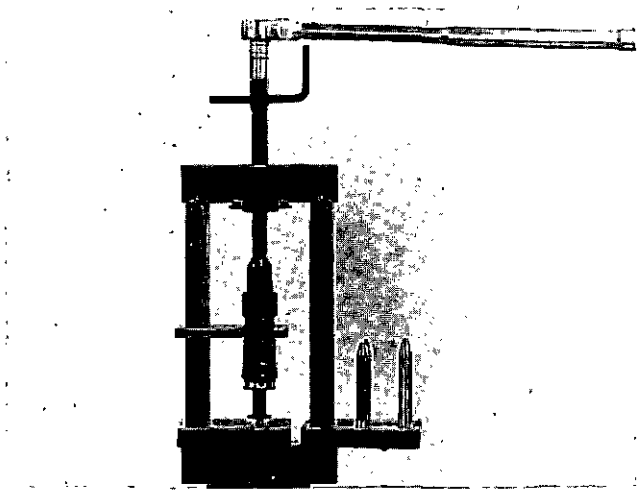


Fig. 2-39, (F60196). Torque the loading fixture stud of 3375084

N•m] (Fig. 2-39) or activate the air cylinder on ST-1298 to 70 psi [483 kPa] to align the cup and plunger, Fig. 2-40.

13. Tighten the cup retainer with the ST-1072 Crowsfoot Wrench and ST-995 Retainer Wrench to the torque value listed in Table 2-4, Fig. 2-41.

14. Remove the injector from the loading fixture being careful not to hit the cup on the stud.

15. To check the cup to plunger alignment by hand, remove the plunger and coat it with either clean fuel oil or test oil. Install the ST-1089 on the plunger.

16. Hold the injector in a vertical position (cup down) and allow the plunger to drip a few drops of oil into the cup.

Table 2-4: Injector Cup Retainer Torques — with Crowsfoot Wrench ST-1072

Engine Series	Retainer Torque
V6-140, V8-185, V-555	43/47 ft-lb [58/64 N•m]
KT	65/70 ft-lb [88/95 N•m]
NH, V6-200, V8-265, NT, V12, V-903	53/57 ft-lb [72/77 N•m]

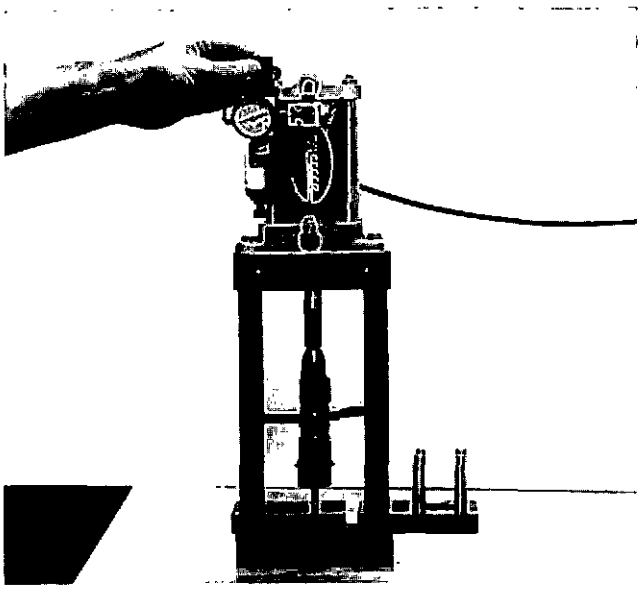


Fig. 2-40, (F60235). Adjust the air pressure on ST-1298

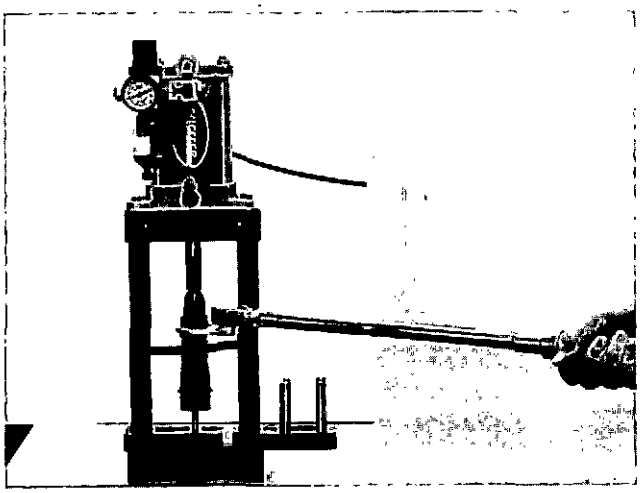


Fig. 2-41, (F60197). Torque the cup retainer-injector in ST-1298

17. Insert the plunger about 1/2 inch [12.7 mm] into the barrel to be certain the plunger is started straight.

18. Push the coupling with the palm of your hand to seat the plunger in the cup and rotate 90 degrees while holding the plunger firmly against the cup seat, Fig. 2-42.
19. Hold the injector with the cup up and the plunger will slide out when the injector is lifted quickly.
20. If the plunger does not slide out, remove the plunger, coat the tip and repeat the test.

Fig. 2-42, (F60198). Check the plunger to cup binding

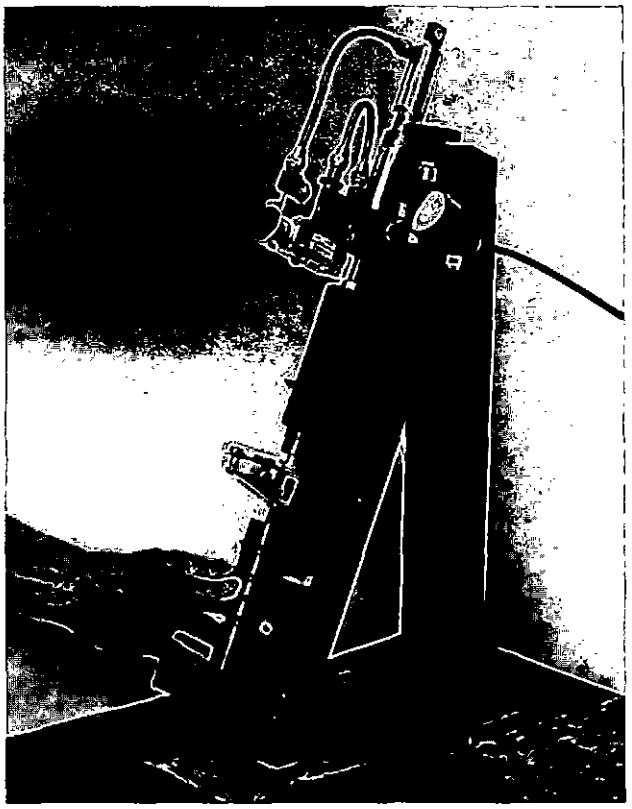


Fig. 2-43, (F60302). Injector in the plunger sticking tool

21. To check the injector plunger sticking in the PT (type D) and flanged injectors, use 3375209 Injector Plunger Sticking Checking Tool, Fig. 2-43. See section four for the operating instructions.
22. Remove the plunger from the adapter and lubricate the plunger with test oil, Fig. 2-44. Install the spring retainer on the spring if the injector is the top stop design. Install the spring on the plunger and insert into the adapter.

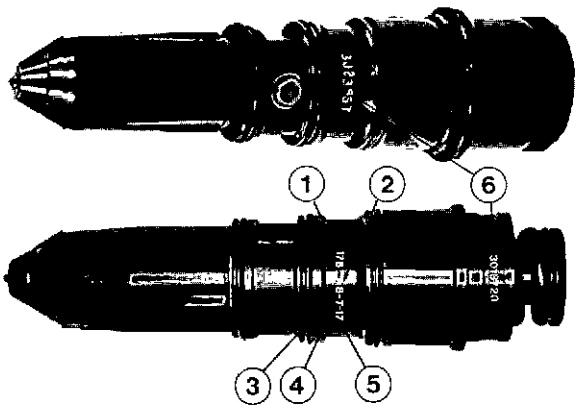
Note: If the injector is to be checked for leakage or the cup is to be spray tested, do not install the spring.

23. Check the plunger leakage on 3375375 as described in section four.
24. Check the cup spray pattern on ST-668 as described in section four.
25. Another method of checking for open cup spray holes is as follows:
    a. Remove the plunger and spring.
    b. Fill the barrel and cup full of fuel oil.
    c. Insert the plunger with an ST-1089, less spring, into the injector and force fuel out of the spray holes, Fig. 2-42.

Fig. 2-44, (F60199). Marking location on the plunger

Warning: At any time fuel is forced from the cup spray holes, be sure to keep hands or body out of the spray steam to prevent injury.

    d. Remove the plunger and install the spring and spring retainer, if required.



1. 178 Injector Flow
2. A 80% Flow
3. 8 Number of Holes
4. 7 Size of Holes (.007)
5. 17 Degree of Holes
6. Assembly Number

Fig. 2-45, (F60200). Assembly number of the PT (type D) injector

26. Lubricate and install new O-rings into the proper grooves in the adapter.

Note: In 1982 the injector flow and cup size was omitted from the injector, Fig. 2-45 and Fig. 2-46.

Note: K Engine type of injectors require three different O-rings. See your injector parts list.

27. Install a new style fuel inlet screen and retainer, Fig. 2-47.

28. After assembly, store in a clean place.

Top Stop Injector Calibration and Adjustment

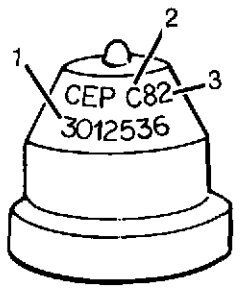
1. If the top stop injector is to be calibrated on the 3375317 test stand, adjust the top stop before calibrating the injector. If the top stop injector is to be calibrated on ST-790 test stand, adjust the top stop after the injector is calibrated.

Note: Make sure the operating lever weight is 10-3/16 inch [258.7 mm] from the dowel to the weight centerline.

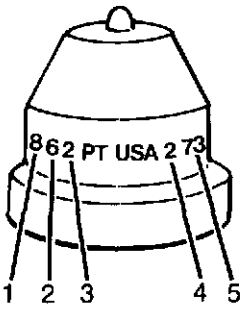
2. See section four for the top stop adjustment procedure.

Note: When rechecking the travel of new injectors or from one assembly stand to another, the tolerance is ±0.001 inch [0.025 mm].

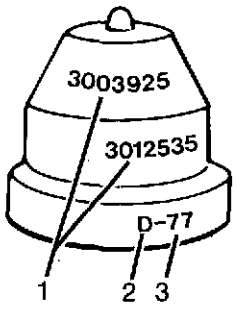
Caution: Do not lift up the lever. The weight on the lever simulates "Zero Lash" when the injector is in the engine.



NEW — Laser Marked
1. Cup Part Number
2. Year Quarter Made
   A.—First Quarter
   B.—Second Quarter
   C.—Third Quarter
   D.—Fourth Quarter
3. Year



OLD — Stamped
1. Number of Holes
2. Size of Holes
3. Degree of Holes
4. Month
5. Year



Old — Acid Etched
1. Cup Part Number
2. Year Quarter Made
   A.—First Quarter
   B.—Second Quarter
   C.—Third Quarter
   D.—Fourth Quarter
3. Year

Fig. 2-46, (F60201). Size Marking on the PT (type D) injector cups

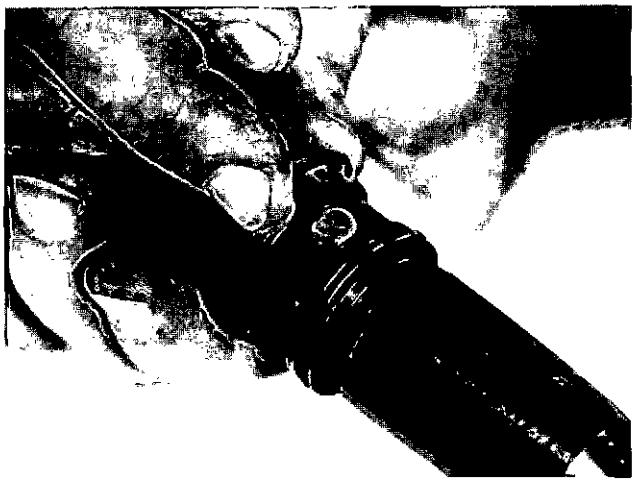


Fig. 2-47, (F60202). Install the fuel inlet screen and retainer

Leakage Checks

The injector leakage tester, Service Tool No. 3375375, will measure the injector plunger to barrel leakage, plunger to cup leakage and injector check ball leakage. These checks will determine if the injector is to be exchanged or can be calibrated and reused in an engine.

See section four for the leakage check procedure.

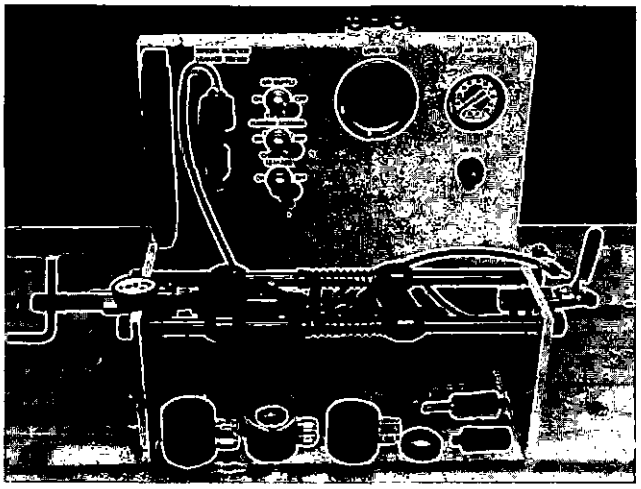


Fig. 2-47A. Injector leakage tester, Tool No. 3375375

Leakage Specifications

Cup to Plunger Tip Leakage

If no bubbles appear within 10 seconds, or if the time between bubbles is more than 5 seconds, the cup to plunger seating is acceptable. If unacceptable, retorque the cup.

Barrel to Plunger Leakage

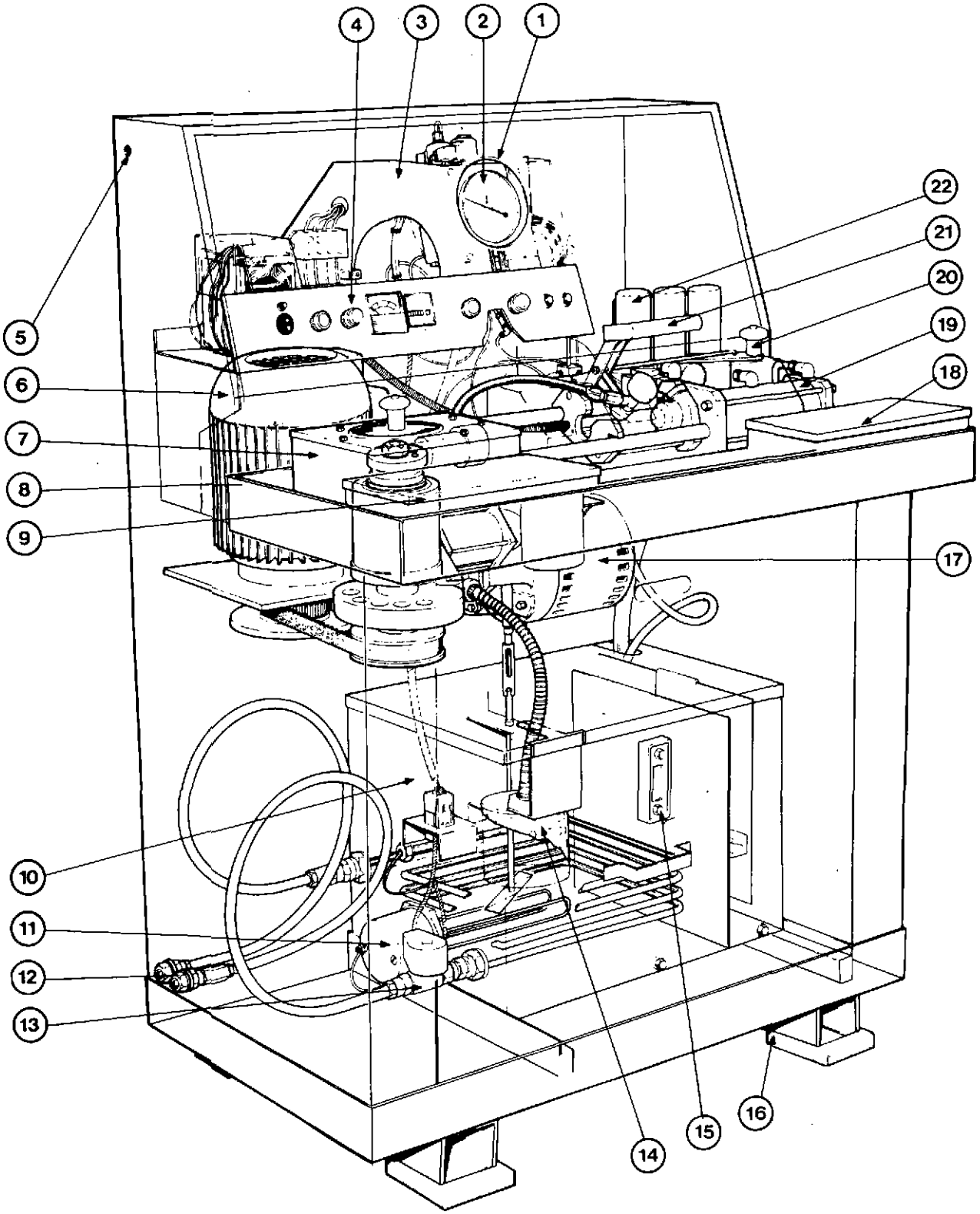
The maximum leakage on a rebuilt injector is 4.5 units.

If the leakage exceeds the specifications, mark the injector for plunger replacement.

Check Ball Leakage

If the leakage is over 12 units at 80 psi [552 kPa] rework the check ball seat.

An optional method is to check the leakage at 60 psi [414 kPa]. The leakage must be less than 8.5 units.



1. Front Panel
2. Dial Indicator
3. Electrical Chassis
4. Control Panel (Part of 3)
5. Main Electrical Supply
6. Camshaft Drive Motor
7. Cambox
8. Top Tray
9. Storage Box (cams etc.)
10. Test Oil Tank
11. Test Oil Tank Heater
12. Cooler Connections
13. Cooler Solenoid
14. Main Test Oil Filter
15. Test Oil Sight Gauge
16. Anti-vibration rubber pads
17. Test Oil Pump Motor
18. Storage Box (Adapters & links)
19. Injector Clamping Cylinder
20. Control Handle (clamping)
21. Handle Lever
22. Deadweight Valves

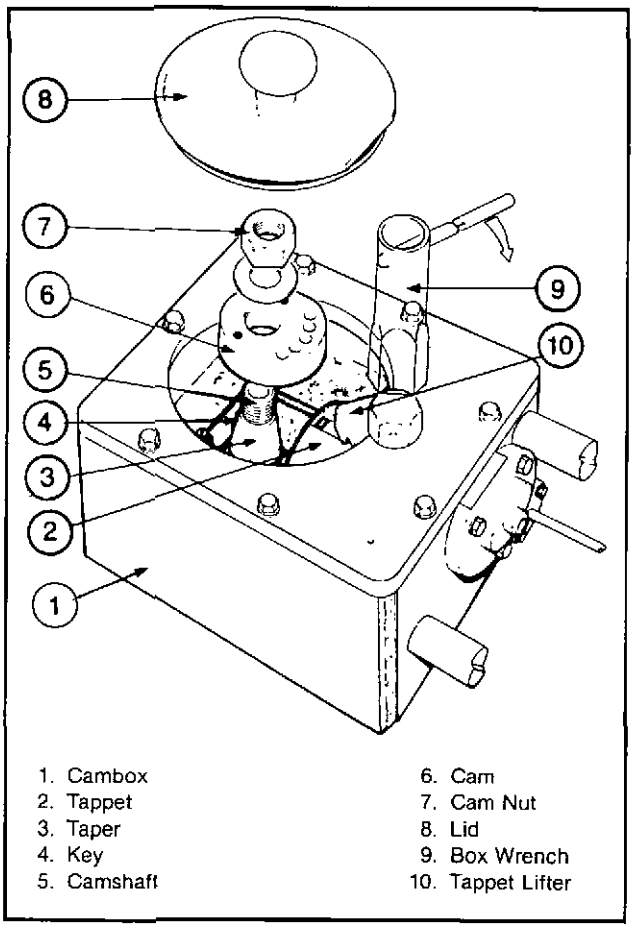
Fig. 2-48. The 3375317 Injector Test Stand

Flow Testing PT (type D) and PT (type D) Top Stop Injectors on 3375317

Preparing the Test Stand

The description of the 3375317 Test Stand is in section four.

1. Check the test oil tank level daily. Add test oil if necessary to about 1/2 inch [13 mm] below the top of the sight gauge. Use only the type specified by Cummins.
2. Turn on the main switch on the control panel, Fig. 2-48.
3. Press the test oil system ON button. The system will automatically bring the test oil temperature up to 104° F [40° C]. This is the proper operating temperature.
4. Select the correct cam for the injector to be tested.The chart on the inside of the cam storage box lid identifies the cam to be used, 9, Fig. 2-48.



1. Cambox
2. Tappet
3. Taper
4. Key
5. Camshaft
6. Cam
7. Cam Nut
8. Lid
9. Box Wrench
10. Tappet Lifter

Fig. 2-49. Install an injector cam in the cambox

5. Move the clamping control handle to the unclamp position, 20, Fig. 2-48. Remove the transparent cam box lid. Rotate the tappet away from the camshaft. Use the box wrench and T-bar. Fig. 2-49.
6. Remove the cam nut from the top of the camshaft. Turn the nut counterclockwise with the same wrench. Remove the washer and cam, and replace the cam with the correct cam.
7. Tighten the nut only until the camshaft begins to turn. Loosen the tappet with the box wrench and T-handle. Replace the lid.

Loading the Injector

1. Select the correct injector adapter and link from the storage box. The chart on the inside of the lid identifies the parts to be used with each type of injector, 18, Fig. 2-48. Use adapter 3376210 to test 10 Liter (L10) engine injectors.
2. Assemble the adapter to the injector, Fig. 2-50.
3. To load the injector, raise the guard, Place the injector, adapter and link in position, Fig. 2-51.

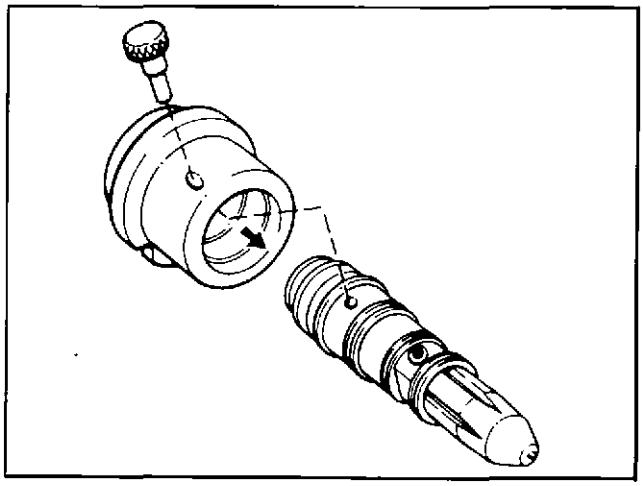


Fig. 2-50. Adapter used on the PT (type D) injectors

Note: Top stop style injectors must be tested with the nut and the top stop adjusted. The flow values in 3379664 are with the top stop adjusted. Use cams No. 169 and 230 to test the top stop injectors.

4. The two milled cut-outs in the adapter must register with the two parallel bars that protrude from the clamp plate. The nose of the injector must be supported by the vee block which is attached to

one of the parallel bars. The link must rest in the vee support plate between the cambox tappet and the back of the clamp plate.

5. If the injector orifice plug was removed during disassembly, install a new orifice plug. Torque the plug to 8 to 10 in-lb [.9 to 1.1 N•m] with 3376177 torque wrench. The approximate orifice plug size is in Bulletin No. 3379664.
6. Lower the guard.

Clamping the injector

1. Pull the clamping valve hand toward you until it is against its stop. This will automatically cause the correct sealing and clamping loads to be applied to the injector.
2. The clamping control valve lever, in the clamp position, prevents the guard from being raised.

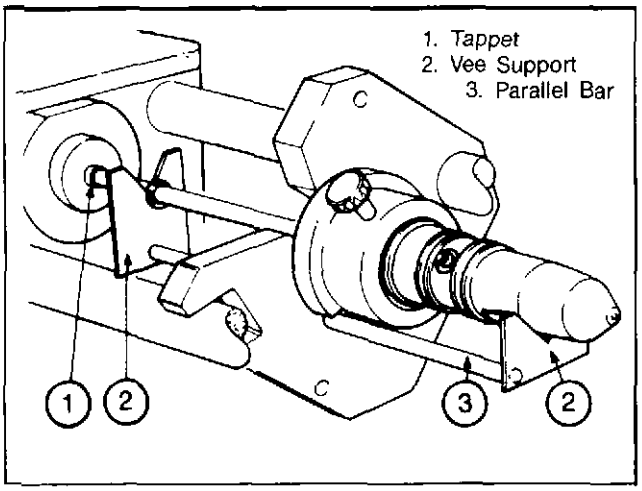


Fig. 2-51. Load the injector into the test stand

3. Check the test stand parts alignment. A stamped line on the seal cylinder flange and a square notch cut out of the steel strip which covers it, must be within tolerance. The line must be positioned within the width of the notch. Change the combination of cam, link, adapter and injector to correct the alignment. Fig. 2-52.

Caution: Do not proceed further until the correct combination is installed in the machine as indicated by the cylinder flange line.

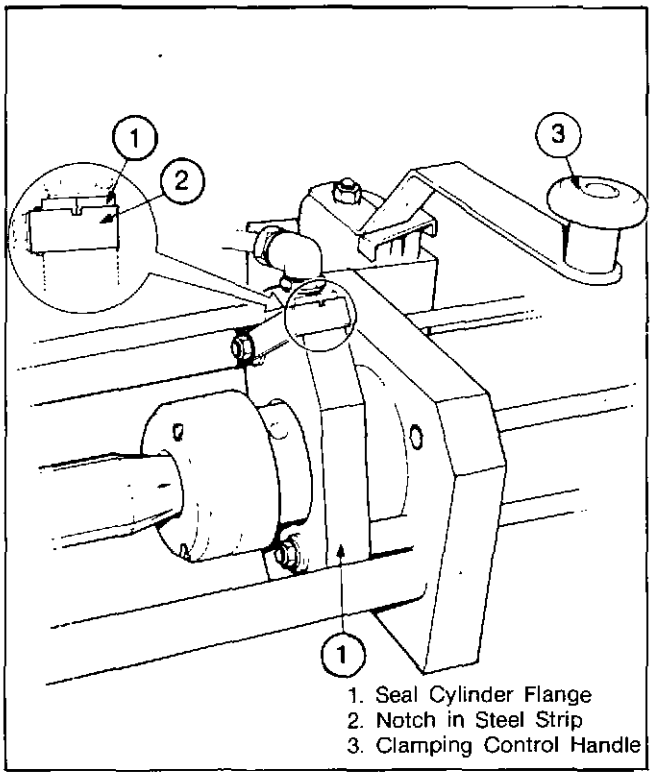


Fig. 2-52. Check the parts alignment

Flow Testing PT (type D) and PT (type D) Top Stop Injectors

Injector Flow Specifications

The injector flow specifications are in Bulletin No. 3379664.

Lowering the Handle Lever

1. Check to be sure the O-ring, in the self-sealing valve in the test oil inlet connection, is in position. *This O-ring seals against the injector orifice plug* when the handle lever is lowered, Fig. 2-53.
2. The adapter positions the injector orifice plug *correctly for the self-sealing valve in the test oil* inlet connection.
3. When the handle lever is lowered, the self-sealing valve will lift off of its seat and 100 psi [689 kPa] test oil is fed to the injector orifice plug.
4. Lower the handle lever. Lock it in position with the over center locking action. Test oil will flow from the injector drain port.

Note: Be certain the test oil line valve is open.

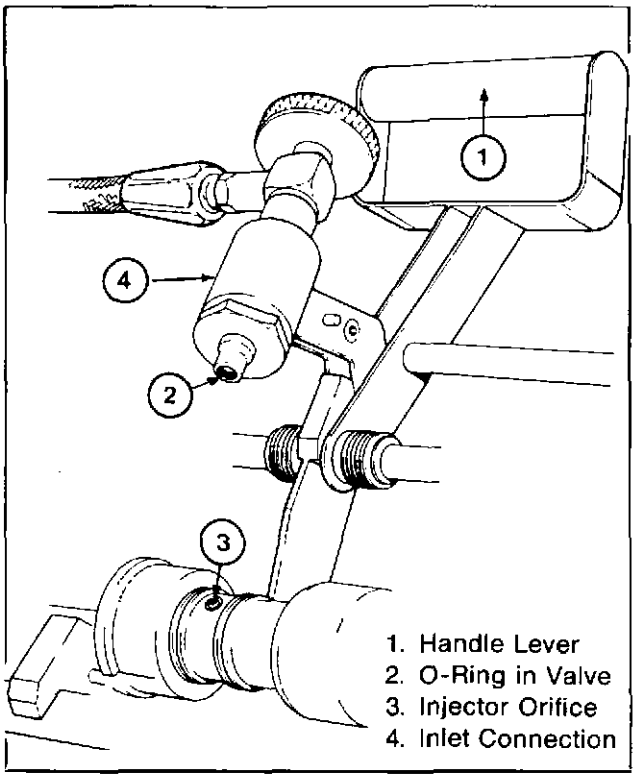


Fig. 2-53. Handle lever and inlet connection

Start the Main Drive

1. Press the main drive start button and the cambox will be driven at 1050 rpm by the main motor.
2. Injected test oil will now be passing through the nose cone assemby and the metering unit body.

Stabilizing Injector Flow

1. Press the main drive start button.
2. Press the metering button; do not hold in. The dial indicator will display the flow of the injector in cubic centimeters per stroke.

Note: Take several readings until the flow stabilizes. When the metering unit or the injector is cold, the readings will vary.

3. When the readings stabilize, stop the main drive by raising the handle lever. After the motor has stopped, press the metering button. Then set the dial indicator to zero with the adjusting screw. Fig. 2-54.

Checking Injector Flow

1. Lower the handle lever to re-start the drive, and press the metering button. Watch the small hand on the dial to see if it turns more than one revolution.

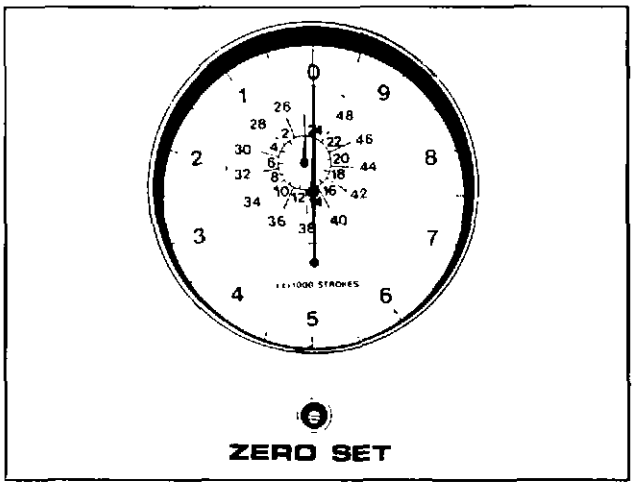


Fig. 2-54. Zero the dial indicator gauge

2. Read the output flow of the injector. The small hand makes one revolution for each 250 cc of output flow per 1000 strokes, and the large hand makes one revolution for 10 cc of output flow per 1000 strokes. (1 cu. mm/stroke = 1 cc/1000 strokes.)
   a. If the small hand has made less than one revolution, use the inner ring figures (2 to 24) and multiply by 10. Add the reading of the large hand. Figs. 2-55 and 2-56.
   b. If the small hand has made more than one revolution, use the outer ring of figures (26 to 48) and multiply by 10. Add the reading of the large hand. Figs. 2-57 and 2-58.
3. If the delivery is greater than that specified, a new orifice plug must be installed in the injector. If the delivery is less than specified, the orifice plug can

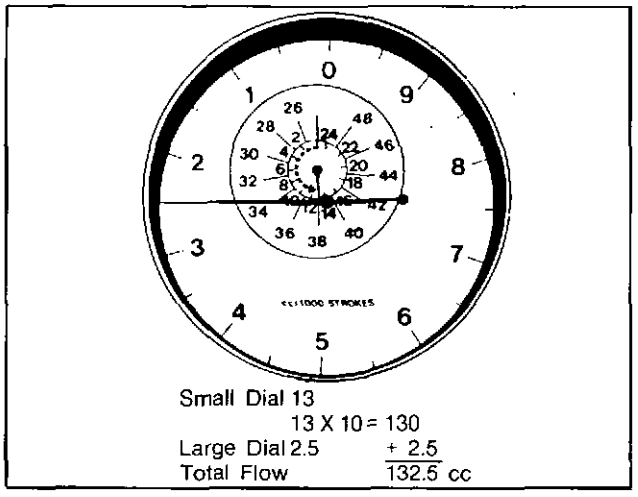


Fig. 2-55. Reading 132.5 cc injector flow

be adjusted with the use of 3376135 or 3375408 Burnishing Tool.

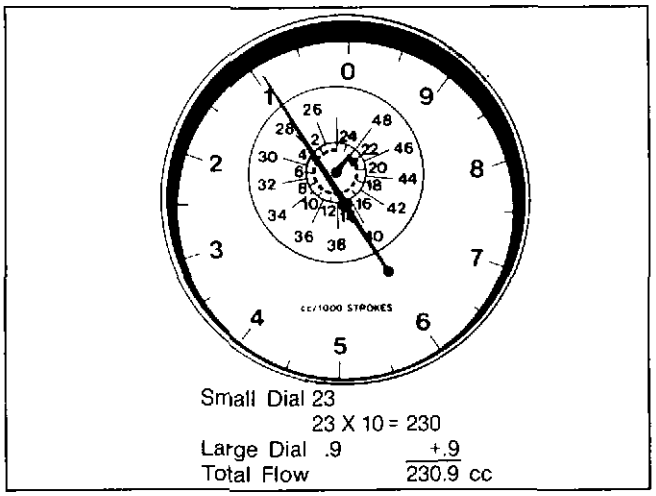


Fig. 2-56. Reading 230.9 cc injector flow

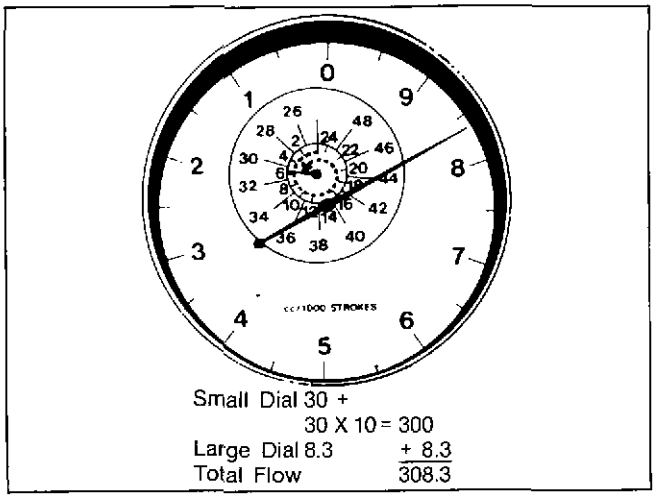


Fig. 2-57. Reading 308.3 cc injector flow

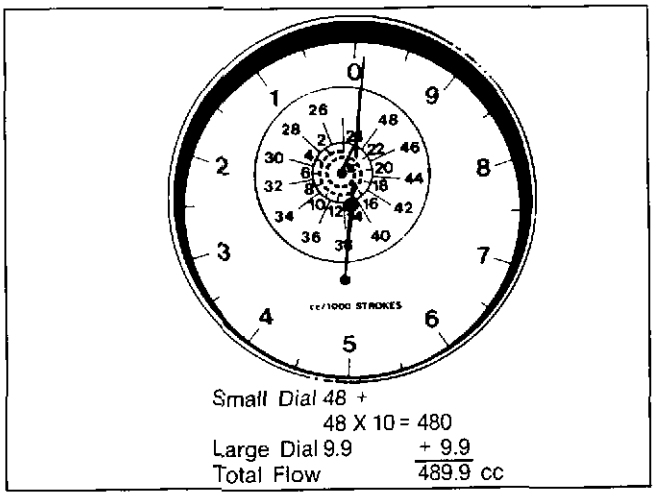


Fig. 2-58. Reading 489.9 cc injector flow

Caution: Do not unclamp the injector until the main drive has stopped. However, do not leave the injector clamped more than one minute after stopping the main drive. Damage to the injector test stand can result.

4. The measurement of the orifice plug diameter can be taken with ST-1332 Orifice Size Gauge. Fig. 2-59. Table 2-5 lists injector orifice plugs with a range of orifice diameters from 0.015 inch [0.38 mm] to 0.070 inch [1.78 mm] for all Cummins *injector applications.*

Recheck Limits on 3375317 Test Stand

The acceptable variance between 3375317 Injector Test Stands for PT (type D) injectors is +1.5 or −1.5 MM^3/stroke from the published calibration flow. For example, the calibration tolerance is 163.5 to 165.5 and the recheck limit would be 162 to 167 on a test stand other than the one the injector was originally calibrated on.

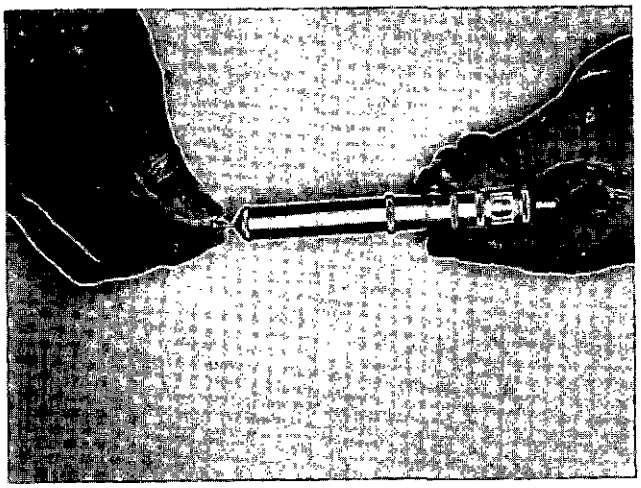


Fig. 2-59, (F60143). Check orifice with the orifice size gauge

Burnish the Injector to Increase the Flow

1. Cummins specifies a setting tolerance for each type and model of injector. The injector orifice is burnished using burnishing tool 3376135 or 3375408, until the correct output is obtained.

Caution: When you use ST-708-1 Burnishing Tool Point on an orifice plug that is .026 inch [.66 mm] or larger, you must grind 1/32 inch [.794 mm] off of the end of the point. If the end is not ground off, you will punch a hole through the adapter into the plunger area. This will cause lubricating oil dilution.

2. The test stand is designed to permit burnishing without having to remove the injector from the test stand.

3. Having taken a reading, raise the handle lever to stop the main drive and reveal the injector orifice. If the flow is low, burnish the orifice. If the flow is high, change to a smaller orifice.

   a. Use the injector orifice plug torque wrench, tool no. 3376177, to install the orifice plug.

4. Use the slide hammer of service tool 3376135 to burnish the injector orifice plug, Fig. 2-60.

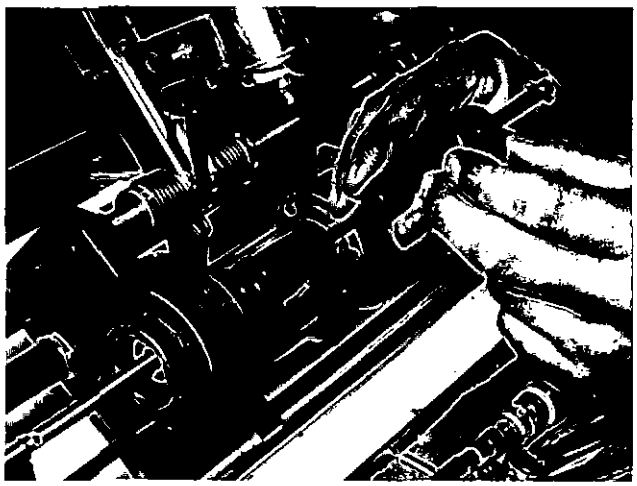


Fig. 2-60. Burnish the PT injector with 3376135

5. Lower the handle lever to restart the main drive. Check the delivery. When the correct output flow is achieved, remove the injector from the test stand.

Table 2-5: Injector Orifice Plugs

Straight Part Number	Inside Diameter Inch [mm]	Flanged Part Number	Inside Diameter Inch [mm]
163065	0.015 [0.38]	177283	0.015 [0.38]
163066	0.016 [0.41]	177284	0.016 [0.41]
163067	0.017 [0.43]	177285	0.017 [0.43]
148338	0.018 [0.46]	177286	0.018 [0.46]
163068	0.019 [0.48]	177287	0.019 [0.48]
163069	0.020 [0.51]	177288	0.020 [0.51]
163070	0.021 [0.53]	177289	0.021 [0.53]
163071	0.022 [0.56]	177290	0.022 [0.56]
149726	0.023 [0.58]	177291	0.023 [0.58]
163072	0.024 [0.61]	177292	0.024 [0.61]

Table 2-5: Injector Orifice Plugs (Cont'd.)

Straight Part Number	Inside Diameter Inch [mm]	Flanged Part Number	Inside Diameter Inch [mm]
163073	0.025 [0.64]	177293	0.025 [0.64]
163074	0.026 [0.66]	177294	0.026 [0.66]
163075	0.027 [0.68]	177295	0.027 [0.68]
163076	0.028 [0.71]	177296	0.028 [0.71]
163077	0.029 [0.74]	177297	0.029 [0.74]
163078	0.030 [0.76]	177298	0.030 [0.76]
160379	0.031 [0.79]	177299	0.031 [0.79]
128132	0.032 [0.81]	179332	0.032 [0.81]
128133	0.033 [0.84]	179333	0.033 [0.84]
128134	0.034 [0.86]	179334	0.034 [0.86]
128135	0.035 [0.89]	179335	0.035 [0.89]
131092	0.036 [0.91]	179336	0.036 [0.91]
131093	0.037 [0.94]	179337	0.037 [0.94]
131094	0.038 [0.97]	179338	0.038 [0.97]
131095	0.039 [0.99]	179339	0.039 [0.99]
131096	0.040 [1.02]	179340	0.040 [1.02]
131097	0.041 [1.04]	179341	0.041 [1.04]
131098	0.042 [1.07]	179342	0.042 [1.07]
132800	0.043 [1.09]	179343	0.043 [1.09]
132801	0.044 [1.12]	179344	0.044 [1.12]
132802	0.045 [1.14]	179345	0.045 [1.14]
131099	0.046 [1.17]	179346	0.046 [1.17]
131100	0.047 [1.19]	179347	0.047 [1.19]
131101	0.048 [1.22]	179348	0.048 [1.22]
131102	0.049 [1.24]	179349	0.049 [1.24]
131103	0.050 [1.27]	179350	0.050 [1.27]
131104	0.051 [1.29]	179351	0.051 [1.29]
131105	0.052 [1.32]	179352	0.052 [1.32]
131106	0.053 [1.35]	179353	0.053 [1.35]
131107	0.054 [1.37]	179354	0.054 [1.37]
131108	0.055 [1.40]	179355	0.055 [1.40]
132803	0.056 [1.42]	179356	0.056 [1.42]
132804	0.057 [1.45]	179357	0.057 [1.45]
132805	0.058 [1.47]	179358	0.058 [1.47]
132806	0.059 [1.50]	179359	0.059 [1.50]
132807	0.060 [1.52]	179360	0.060 [1.52]
132808	0.061 [1.55]	179361	0.061 [1.55]
132809	0.062 [1.57]	179362	0.062 [1.57]
132810	0.063 [1.60]	179363	0.063 [1.60]
132811	0.064 [1.63]	179364	0.064 [1.63]
132812	0.065 [1.65]	179365	0.065 [1.65]
132813	0.066 [1.68]	179366	0.066 [1.68]
132814	0.067 [1.70]	179367	0.067 [1.70]
132815	0.068 [1.73]	179368	0.068 [1.73]
132816	0.069 [1.75]	179369	0.069 [1.75]
132817	0.070 [1.78]	179370	0.070 [1.78]

Remove the Injector from the Test Stand

1. To remove the injector, raise the handle lever, push the clamping control valve to the "unclamp" position and raise the guard. The injector with the adapter and link can now be removed.

Caution: Wait until the main drive has stopped turning before unclamping the injector.

2. Remove the adapter and link from the injector.

Short Instructions

1. Install injector with adapter.
2. Lower guard.
3. Clamp injector.
4. Check alignment.
5. Lower handle lever.
6. Start main drive.
7. Press metering button.
8. Check injector flow.
9. Burnish injector (if needed).
10. Remove injector.

Correlation of ST-790 and 3375317 Injector Test Stand Flow Values

The injector flow values are different between injector test stands No. ST-790 and 3375317. The flow of ST-790 is measured in cc (cubic centimeters). The flow of 3375317 is measured in mm^3/stroke (millimeters cubed per stroke). This is the amount of test oil injected, each time the plunger seats on the cup.

The flow values for the injectors are in Bulletin No. 3379664.

CAUTIONS

Only Lower The Handle Lever When The Injector Is Correctly Clamped

If you try to lower the handle lever when the injector is not clamped correctly and the self-sealing valve does not align with the injector orifice, **YOU WILL GET SPRAYED WITH TEST OIL.**

Do Not Leave The Injector Clamped For Longer Than One Minute After Stopping The Main Drive

If you do and the camshaft has not stopped at the index position, the very slight leakage past the datum spool valve will cause the clamp piston to move towards the cambox. When the clamping control valve is moved to the "unclamp" position or when the main drive is restarted, the injector plunger will "bottom" in the cup before the injector cam has reached a full lift.

This will probably break the link, may cause permanent damage to the test stand and may scrap the injector.

Do Not Unclamp The Injector Until The Main Drive Has Stopped

If, having raised the handle lever to stop the main drive, you unclamp before the camshaft has stopped turning, you will cause the indexing mechanism to engage with a rotating heart cam.

This will damage the indexing mechanism and can make your test stand unuseable.

Use Only The Flanged Type "Button Head" Injector Balance Orifice Plugs

The test oil inlet connection O-ring will not seal against the straight type orifice plugs.

Do Not Exceed The Specified Service Times

The time between service periods is in hours. The hour meter on the test stand is connected to the test oil pump. See the Maintenance Schedule in section four for the service periods. Do not exceed the time limits of the service periods.

PT (type D) and PT (type D) Top Stop Injector Troubleshooting

The following list of problems is of importance when troubleshooting the PT (type D) injectors.

Check 1 — Unable to get the Correct Plunger to Cup Alignment

Cause	Correction
Defective or dirty cup.	Test the cup spray pattern on service tool 3376350. Clean inspect and repair.
Improper assembly techniques.	Assemble with correct tools and procedure.
Defective plunger.	Clean and inspect.
Defective barrel face surfaces.	Clean, inspect and repair.
Damaged retainer cup seating shoulder or threads.	If the damaged areas cannot be cleaned up, replace the part.
Improper cup alignment.	Check the cup to plunger alignment.

Check 2 — Defective Barrel to Adapter Seal

Cause	Correction
The gasket, when required, is torn or creased at the time of assembly.	Install a new gasket each time the barrel is removed from the adapter on 5/16 inch [7.94 mm] type injectors. All 3/8 inch [9.52 mm] type injectors built after January, 1969 do not require a gasket. All 5/16 inch type injectors built after January, 1982 do not require a gasket.
Adapter or barrel face is damaged.	Lap the surface.
Roll pins or spiral pins are damaged which prevent the barrel and/or gasket from seating properly.	Inspect and replace if interference occurs.

Check 3 — Test Oil Leaking Around Cup Retainer

Cause	Correction
Barrel cracked.	Inspect and replace with a barrel plunger assembly.
Leaking barrel plugs.	Stake plugs with a punch.
Defective barrel to cup seal.	Lap the surface.

Check 4 — Plunger Sticks or Scuffed

Cause	Correction
Cup to plunger misalignment.	Assemble correctly.
Mounting capscrews not torqued evenly.	Check the capscrew torque.
Water or dirt in the test oil.	Change the filter and drain the water from the bottom of the test oil tank and check for dirt in the tank.
Carbon build up on the plunger.	Clean and adjust the injector travel. See Check 8. Install chrome plated plunger injectors.
Injector cup is over torqued.	Check the cup torque.

Check 5 — Loose or Broken Plunger Coupling Swage Joint

Cause	Correction
Coupling not swaged deep enough into the plunger.	Attempt to rotate by hand — replaced if defective.
Wrong spring used.	J and C injector springs can be mixed with the PT (type D) springs. PT (type D) springs are 1/16 inch [1.59 mm] longer, have 0.187 inch [4.75 mm] diameter wire with a slightly larger outside diameter.

Check 6 — Excessive Link Wear

Cause	Correction
New link placed in old socket.	Mark links when removed.
5/16 inch [7.94 mm] link turned end for end at time of assembly.	Part number should be installed in up position.

Check 7 — Bright Polished Spots at Top and Bottom of Plunger 180 Degrees Apart

Cause	Correction
Bearing pattern on plunger.	This is normal wear. Unless metal is displaced or wear is measurable, plunger may be reused.

Check 8 — Carbon Inside of Injector Cup and on Lower Plunger

Cause	Correction
Loose injector adjustment.	Clean and adjust injectors.
Plunger not seating completely in cup.	Clean and retorque cup retainer.
Low fuel cetane rating, water or sulfur in fuel.	Clean and reassemble the injectors. Fill the tanks with correct fuel.
Air in cup.	Install direct feed barrel and plunger assemblies.

Check 9 — Injector Cup Cracked

Cause	Correction
Injector adjusted too tight.	Replace the cup and adjust properly.
Injector or fuel pump over-fueled.	Replace the cup, check the injector and fuel pump calibration.
Carbon in cup seat.	Replace the cup. See Check 8.
High exhaust temperature.	Check the exhaust back pressure.

Check 10 — Cup Tip Failure

Cause	Correction
Injector overfueled or excess carbon.	Replace the cup, check the injector and fuel pump calibration.
Plunger not seated in cup.	Correct the installation.
Plunger not seated in cup.	Adjust the plunger travel.
Injector loose in head.	Check the installation.
Cup tip flattened.	Handle carefully.
Cup cleaned with wire brush.	Clean with Ultra-sonic cleaning tank. Service Tool 3375000 or 3376665.

Check 11 — Plunger Tip Shoulder (at top of cone angle) Destroyed

Cause	Correction
Plunger tip cleaned with crocus cloth.	Clean in Service Tool 3375000 or 3376665.

Check 12 — Injector O-rings Damaged

Cause	Correction
Injector installed in head wrong.	Snap injector into the bore, don't pull down with the mounting capscrews.
Injector O-rings twisted.	Install the O-rings correctly.

PT Flanged and PT (type D) Flanged Injectors

These injectors contain an adjustable orifice plug in the inlet drilling which is changed to adjust the flow through the injector. Flanged injectors are used on engines with external fuel manifolds and are mounted with capscrews through the flanged areas of the injector body. Fig. 3-1 and Fig. 3-2.

Disassembly

Flanged Injectors

1. Lift out the injector plunger and spring. Remove the spring from the plunger and then place the plunger in the body.

Note: The injector bodies or barrels and plungers are class fit. Do not interchange these parts.

2. Place the injector in ST-1298 or 3375084, Holding Fixture, on the 3375100 Locating Plate. Place the retainer wrench on the injector.

Note: Do not remove the adjustable orifice plug from the inlet counterbore.

3. Loosen the cup but do not remove, Fig. 3-3.
4. Remove the injector cup only after deactivating the air cylinder or loosening the special stud.

Caution: Do not place the injector body in a vise to remove the injector cup.

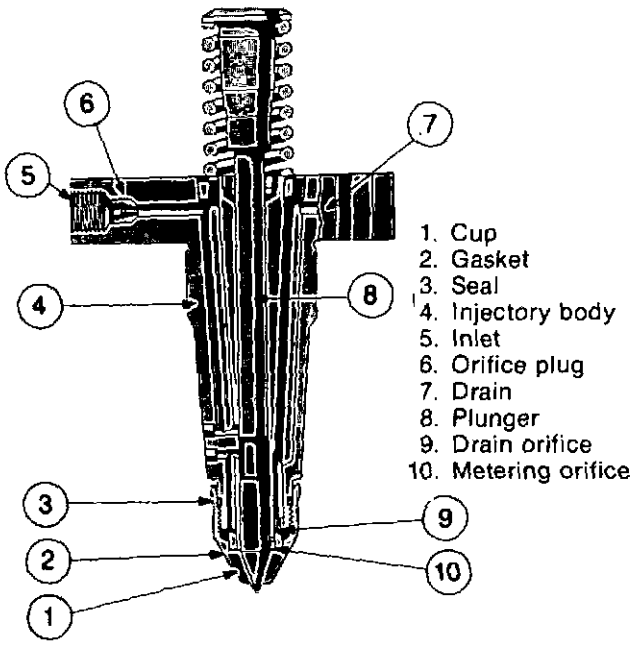


Fig. 3-1, (FWC11). Flanged injector cross-section

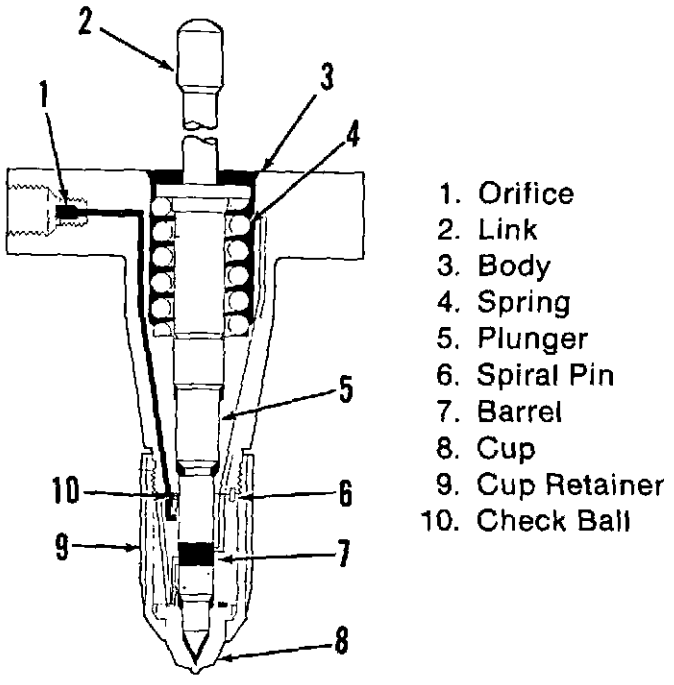


Fig. 3-2, PT (type D) Flanged injector cross-section

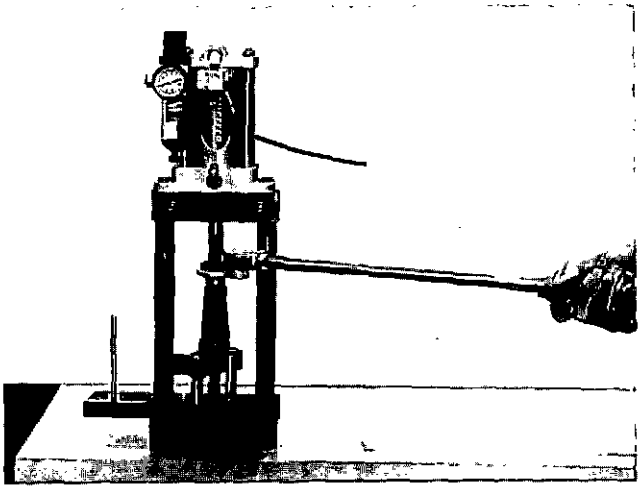


Fig. 3-3, (F60236). ST-1298 with flange injector

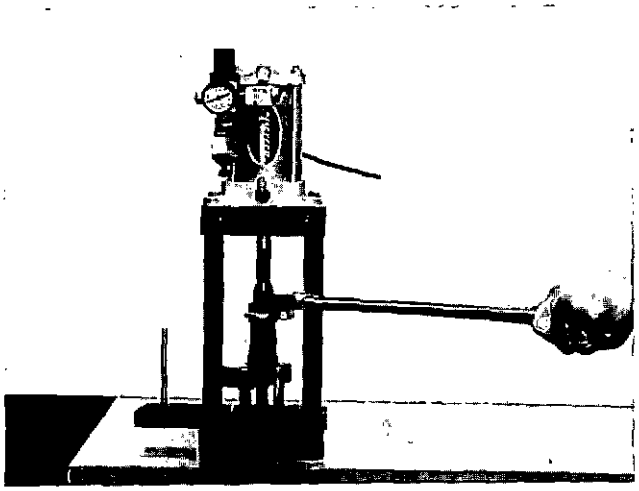


Fig. 3-4, (F60309). Loosen the flanged injector cup retainer

Table 3-1: Injector Cup Wrenches

Engine Series	ST No.	Number of Splines
H-NH, V12	ST-933	6
J-C	ST-934	6

Table 3-2: Injector Cup Wrenches Flanged, Used with ST-1298 or 3375084

Engine Series	ST No.	Number of Splines
H-NH, V12	ST-1303	6
H-NH, V12 PT (type D)	ST-995	6
J-C	3375048	6

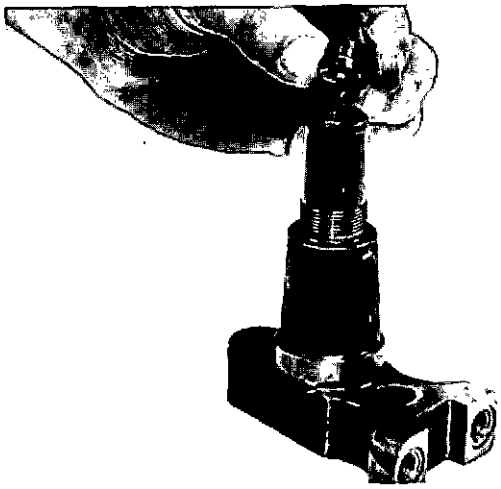


Fig. 3-5, (F60310). Remove the flanged injector cup

PT (type D) Flanged Injector

1. Lift out the injector plunger and spring.
2. Place the injector in the holding fixture, Tool No. ST-1298 or 3375084.
3. Use the cup retainer wrench, Tool No. ST-995, to loosen the cup retainer, Fig. 3-4.
4. Remove the injector from the holding fixture.
5. Hold the injector with the cup up and screw the cup retainer off of the adapter. Remove the cup, Fig. 3-5.
6. Hold the barrel against the adapter and turn the injector so the barrel is down. Remove the barrel. **DO NOT LOSE THE CHECK BALL.**
7. Remove the check ball from the barrel, Fig. 3-6.

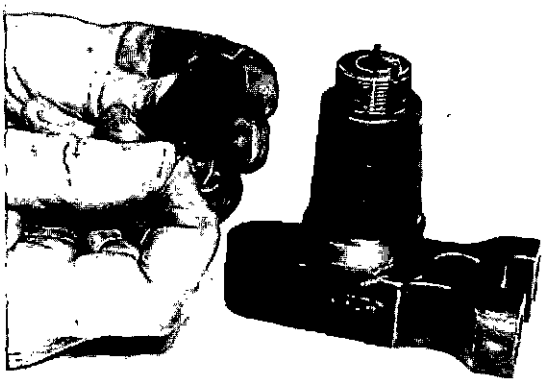


Fig. 3-6, (F60190). Remove the check ball from the barrel

Cleaning

1. Clean the injector parts thoroughly of any carbon varnish. Soak the parts in a solvent. Ultra-sonic cleaning in Service Tool 3376665 or 3375000 is recommended for the body or barrel, plunger and cup.
2. Neutralize the solvent after cleaning by dipping the parts in mineral spirits.
3. Dry with compressed air.
4. Use lint free towels during the disassembly and assembly of the injectors.
5. A clean shop, clean tools, and good cleaning practices are essential to good injector repair. Most injector failures occur because of dirt. Clean all parts before assembly.

Caution: Do not use drills or other instruments to clean the cup holes. This will alter the size of the holes. Wires may be used if a smaller size wire is used than the spray hole. Do not use a wire brush or crocus cloth to clean the cup tip area.

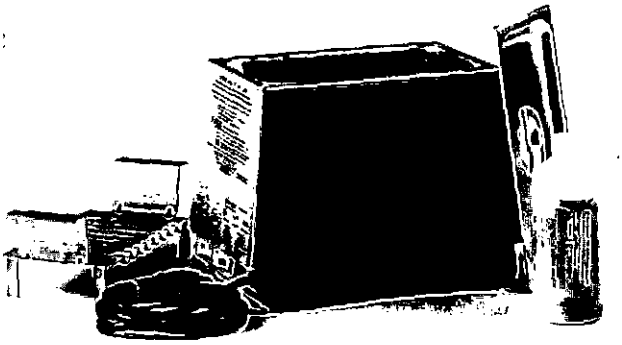


Fig. 3-6A. Ultra-sonic cleaner, Tool No. 3376665

Fig. 3-6B. Ultra-sonic cleaner, Tool No. 3375000 or 3375001

Inspection

Injector Plunger of Flanged Injector

1. Check closely for metal seizure. As a rule, this is the only true indication of scuffing or scoring.
2. Bright spots or surface disruption at the top of the plunger, on the opposite side at the bottom of the plunger or at the mid-point, usually are normal results of rocker lever thrust action. Unless metal is displaced, or wear is measurable at these points, the plunger may be reused. If worn excessively, return the body and plunger to a Cummins Rebuild Location for fitting of a new plunger.
3. Narrow streaks running the length of the plunger usually are the result of the varying thickness of the penetrant treatment used to prevent rusting. The plunger is satisfactory for reuse unless a surface disruption is evident.

PT Flanged Injector Body or Adapter Threads

1. If the connection threads in the body or adapter require repair, clean the threads with a 1/2-20 tap.
2. Repair the connection gasket surface if mutilated with ST-542.
   a. Screw the pilot of ST-542 into the inlet or drain connection to be spot faced.
   b. Pilot the cutter of ST-542 over the pilot.
   c. Turn the cutter until a good gasket seat is cut, Fig. 3-7.

Fig. 3-7, (F60164). Repair the inlet and drain connection surfaces with ST-542

   d. Clean the body or adapter thoroughly after repair.

Injector Body Inspection of Flanged Injector.

1. Inspect the injector body plunger bore for scoring. If the scores are not too deep, the injector body must be returned to a Cummins Rebuild Location to be honed and fitted with an oversized plunger.
2. Use a strong magnifying glass to check for burrs, carbon and distorted radii in the orifices. When injector orifices or gasket seats are damaged, the injector will not function properly. Do not attempt cleaning with wires, plug gauges, etc. Use solvent cleaners.

Adapter — PT (type D) Flanged

1. Check the balance orifice for burrs or other obstructions.
2. Inspect both fuel passages to be certain they are open.
3. Inspect the cup retainer threads for damage.

Injector Barrel — PT (type D) Flanged

1. Inspect the injector barrel plunger bore for scoring. If the injector will pass the ST-990 or 3375375 leakage test, the barrel is usable. If the leakage is too high, the barrel and plunger must be replaced.
2. Use a strong magnifying glass to check for burrs, carbon and distorted radii in the orifice. When the metering orifice is damaged, the injector will not function properly. Do not attempt cleaning with wires, plug gauges, etc. Use solvent cleaners.
3. Check the fuel passage plugs for looseness and the barrel for cracks.
4. Check the injector barrel surfaces for mutilation and flatness in the black area as shown in Fig. 2-16.
   a. Thoroughly clean and dry the barrel of all oil film before bluing.
   b. Use a surface plate (preferably a lapping plate) and "bluing" to check for surface flatness.
   c. If mutilation or unevenness are found, lap to repair. Use Grade A 280 grit lapping compound.

d. Do not use crocus cloth or a wire brush on the barrel and cup contact area.

Check Ball and Seat — PT (type D) Flanged

1. Check the ball seat in the barrel for nicks or burrs.
   a. Do not attempt to improve the check ball seat by inserting a ball and tapping. The barrel is as hard as the ball and will damage the ball if attempted.
   b. If the seat is marred, replace the barrel and plunger assembly.
2. If any wear or mutilation is found, replace the ball.
3. Check the depth of the check ball seat. When the ball is in place, it must not be more than 0.055 inch [1.40 mm] below the barrel surface, Fig. 2-19.

Injector Barrel/Check Ball Tester

The injector barrel check ball tester allows tests to be performed prior to the assembly of the barrel to the injector adapter. This makes it quicker and easier to ensure that the check ball or check ball seat in the injector barrel is within the acceptable limits, Fig. 2-20.

1. The injector barrel check ball tester is used with service tool, Part No. 3375375 or ST-990. It uses only the regulated air supply, the two air lines, and the "air flow" flowmeter.
2. The check ball and seat must be wet with calibration fluid.
3. Install the barrel in the testing fixture.

Installation and Operation

1. Attach one air supply hose to the lower connection and one hose to the upper connection, Fig. 2-21.
2. Position knobs on service tool, Part No. 3375375 or ST-990 to their normal location.
3. Use normal pressure, 80 psi [552 kPa] for check ball test. The leakage must be less than 12 units at 80 psi.
   a. An optional procedure is to test the leakage at 60 psi [414 kPa]. The leakage must be less than 8.5 units at 60 psi.
4. Observe test results on the air flow flowmeter.
5. Switch air supply on and off several times to make sure the check ball is in the seat.

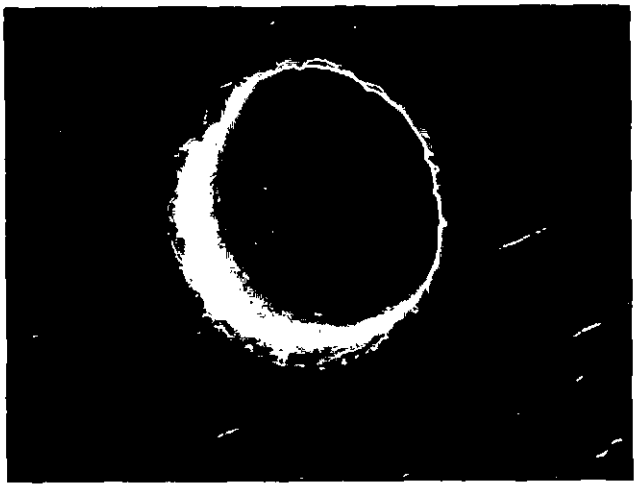


Fig. 3-8, (F60295). New injector cup hole (enlarged)

Injector Cup — PT (type D) Flanged

1. Inspect the injector spray holes and tip with a magnifying glass. Compare them with a new cup, Fig. 3-8. Discard the cup if any of the following conditions exist.
   a. Abrasive wear: This wear can begin internally; therefore, inspect both the interior and exterior.
   b. Corrosion and erosion damage and the effect of excessive heat: This condition usually results from high water, acid or sulphur content in the fuel or from overloaded operating conditions, Figs. 3-9 and 3-10.
   c. Enlarged or distorted spray holes: This is caused by wire brushing, cleaning with drills or other instruments and high mileage, Figs. 3-11.

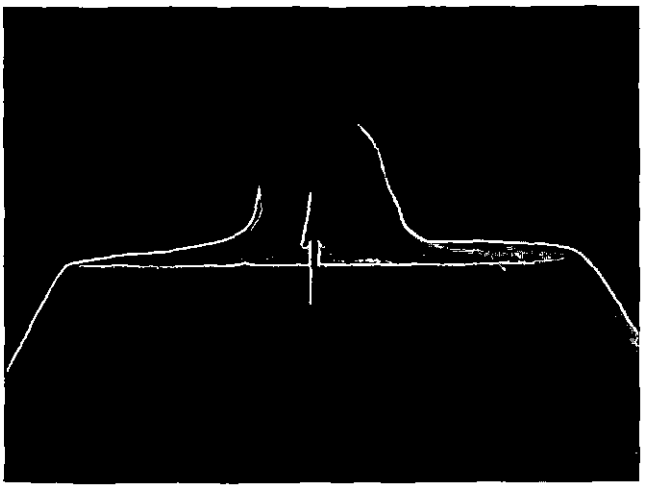


Fig. 3-9, (F60284). Eroded injector cup tip and holes

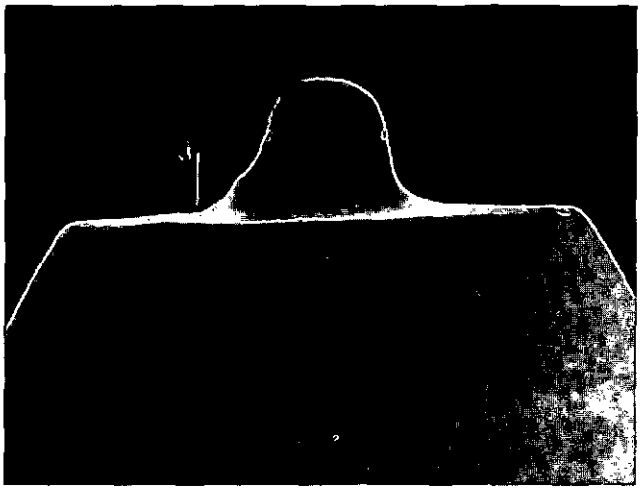


Fig. 3-10, (F60285). Exhaust side of injector cup eroded away

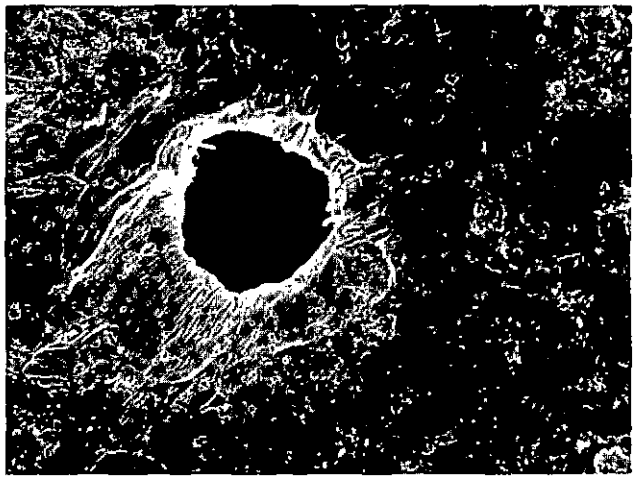


Fig. 3-11, (F60296). Injector cup hole after being wire brushed (enlarged)

Caution: Never alter the size of the injector cup spray holes.

2. Many injector cups will show some erosion. The holes can be worn away on the outside surface but the hole size has not changed. The cup tip wall thickness has very little erosion. Reuse these cups.

3. Inspect the cup for plunger seat pattern. Select a new plunger and coat with Prussian Blue. Insert the plunger in a cup and rotate 90 degrees. If plunger seat covers a 40 percent continuous area around the cup cone or plunger bore, it is possible the cup may be reused. The cup must pass the ST-990 or 3375375 cup-to-plunger leak test. Fig. 3-12.

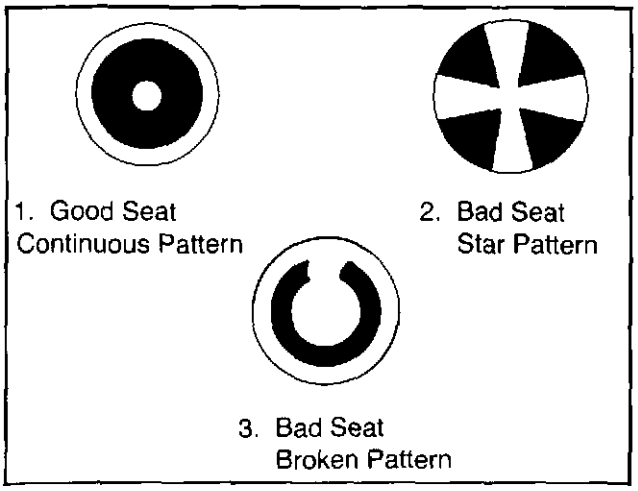


Fig. 3-12, (F60108). Seat pattern of plunger in cup

Caution: The plunger must seat in the cup from 1/4 of the upper cone area to the full cone area. Reject a cup that seats in lower 1/4 cup tip area. If a cup seats in the tip area, it must seat more than 1/2 of cone area to be accepted.

4. Check the injector cup barrel surface for mutilation and flatness.

   a. For mutilation, check in the area (black area) as shown in Fig. 3-13.

   b. Use a flat steel plate (preferably a lapping plate) and "bluing" to check for surface flatness.

   c. If mutilation or unevenness are found, mark for repair.

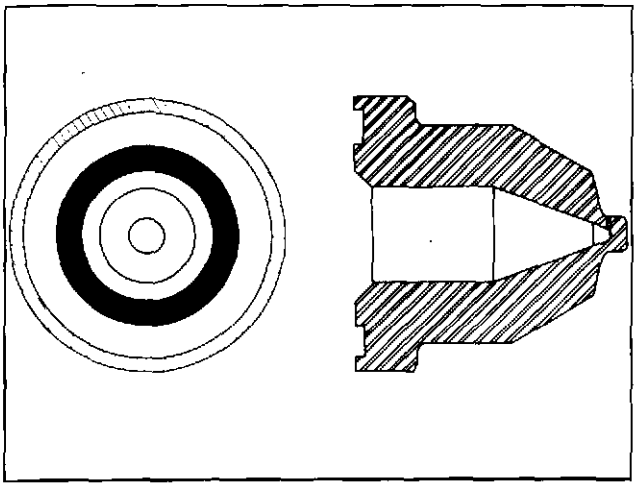


Fig. 3-13, (F60161). Cup surface at barrel contact area

Cup Retainer — PT (type D) Flanged

1. Inspect the threads for damage.
2. Check the outside cone area for nicks or burrs which could prevent proper seating with the sleeve in the head.
3. Inspect the inside of the cone area on the cup seating ledge for nicks or burrs which could prevent the cup from seating.

Injector Spring of All Flanged Injectors

1. Check the spring for excessive wear or mutilation.
2. Test the spring tension on the spring tester, 3375182, Fig. 2-30.
3. If the injector springs compress to the dimensions shown at less than the load indicated under "worn limits", the springs must be discarded, Table 2-3.

Injector Cup of All Flanged Injectors

1. Inspect the injector cup spray holes and tip with a magnifying glass. Compare them with a new cup. The cup must pass the cup spray test. Discard the cup if it is damaged.

Replace the Plunger Link of the Flanged Injector

1. Replace the plunger link if worn excessively, Fig. 3-14. If the wear can be seen or felt, it is excessive.
2. The procedure to remove the E ring is as follows:
   a. Place the plunger in a suitable holding device, such as a block of soft wood, with the spring retainer upward.
   b. Use a hammer and a punch with a 1/16-inch point to break off the "ears" of the plunger link retaining ring. Remove the link and the remaining pieces of the retaining ring.

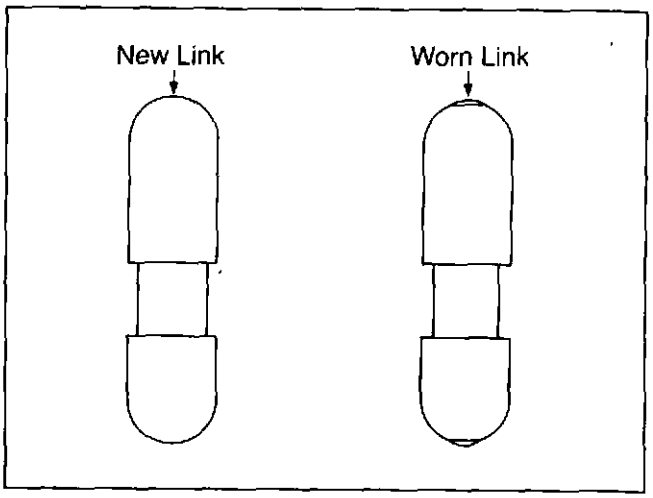


Fig. 3-14, (F60165). Plunger link wear

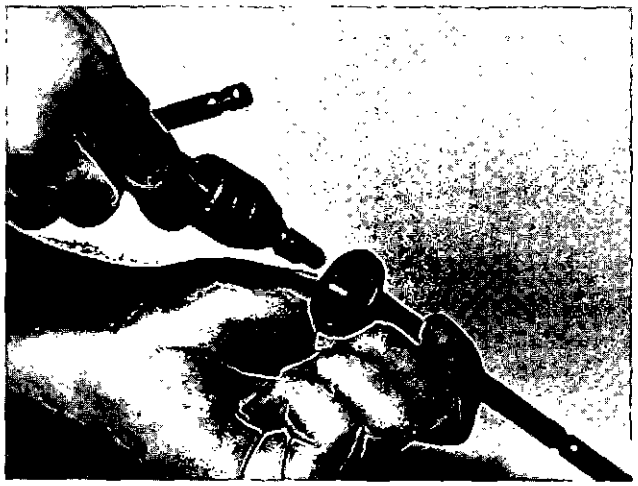


Fig. 3-15, (F60110). Use the tap holder to pull the link

3. A collet type hand tap holder can be used to pull the sleeve type injector link, Fig. 3-15.

Note: Do not put the plunger in a vise to pull the link.

4. Place the new retaining ring on the new plunger link and press the link into place, Fig. 3-16. If it is a sleeve type retainer, press the retainer flush to 0.010 inch [0.254 mm] below the bore surface.

Caution: Handle the injector plunger with care to prevent damage which could render it useless.

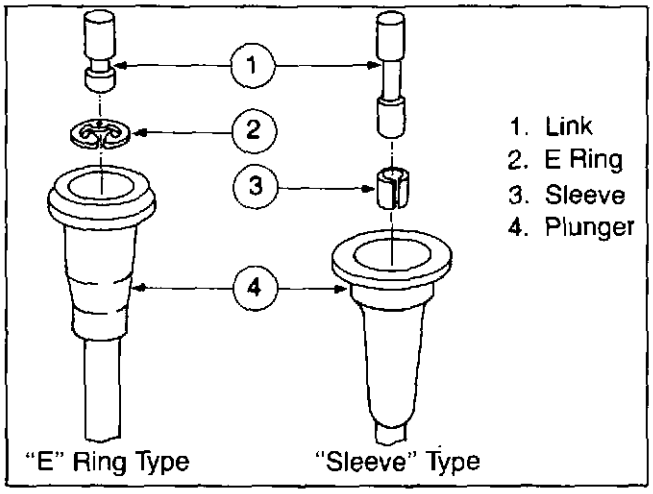


Fig. 3-16, (F60111). Plunger link assemblies

Assembly

PT (type D) Flanged Injectors

1. Drop the check ball into the top of the barrel.

Caution: Be certain all mating surface parts are clean and free of burrs or other imperfections which will result in incorrect flow or torque. Lap to repair.

2. Hold the barrel with the check ball up and install the adapter on the barrel.
3. Immerse the injector plunger in clean injector test oil and install it in the adapter without the spring.
4. Turn the adapter and barrel with the barrel up and place the cup on the barrel, Fig. 3-17.
5. Lubricate the cup flange contact area of the cup retainer with engine lubricating oil and assemble to the adapter. Screw the retainer down finger tight and loosen 1/4 turn.

Note: The ST-1298, 3375084 and 3375536 are three types of injector loading fixture tools.

Fig. 3-17, (F60314). Install the cup on the flanged barrel

6. Insert the injector into the loading fixture.
7. Tighten the cup retainer with the ST-1072 Crowsfoot Wrench and ST-995 Retainer Wrench to 55 ft-lb [75 N•m], Fig. 3-18.
8. Remove the injector from the loading fixture. Do not hit the cup on the stud.
9. To check the cup to plunger alignment by hand, remove the plunger and coat it with either clean fuel oil or test oil. Install the ST-1089 on the plunger.

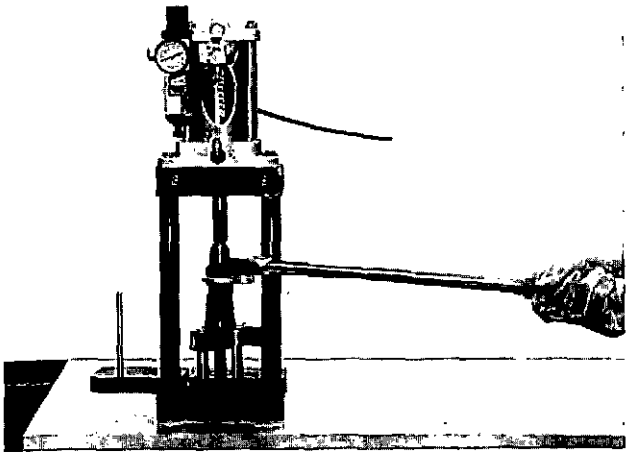


Fig. 3-18, (F60311). Torque the cup retainer-injector in ST-1298

10. Hold the injector in a vertical position (cup down) and allow the plunger to drip a few drops of oil into the cup.
11. Insert the plunger about 1/2 inch [12.7 mm] into the barrel to be certain the plunger is started straight.
12. Push the coupling with the palm of your hand to seat the plunger in the cup and rotate 90 degrees while holding the plunger firmly against the cup seat, Fig. 3-19.
13. Hold the injector with the cup up and the plunger will slide out when the injector is lifted quickly.
14. If the plunger does not slide out, remove the plunger, coat the tip and repeat the test.

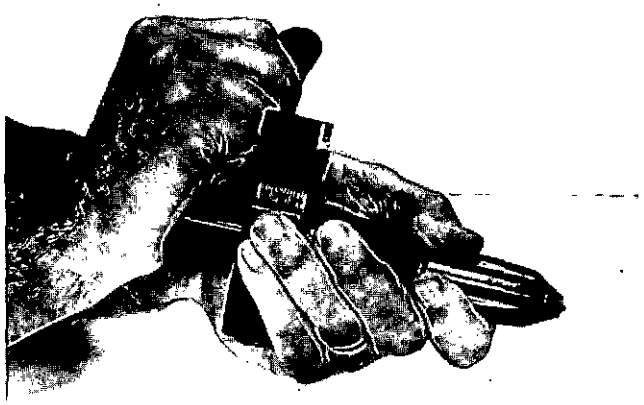


Fig. 3-19, (F60312). Check the plunger to cup binding

15. To check the injector plunger sticking in the PT (type D) and flanged injectors, use 3375209 Injector Plunger Sticking Checking Tool, Fig. 3-20. See section four for the operating instructions.

16. Remove the plunger from the adapter and lubricate the plunger with test oil. Install the spring on the plunger and insert into the adapter.

Note: If the injector is to be checked for leakage or the cup is to be spray tested, do not install the spring.

17. Check the plunger leakage on 3375375 as described in section four.

18. Check the cup spray pattern on 3376350 or ST-668 as described in section four.

19. Another method of checking for open cup spray holes is as follows:

    a. Remove the plunger and spring.

    b. Fill the barrel and cup full of fuel oil.

    c. Insert the plunger with an ST-1089, less spring, into the injector and force fuel out of the spray holes, Fig. 3-19.

    d. Remove the plunger and install the spring.

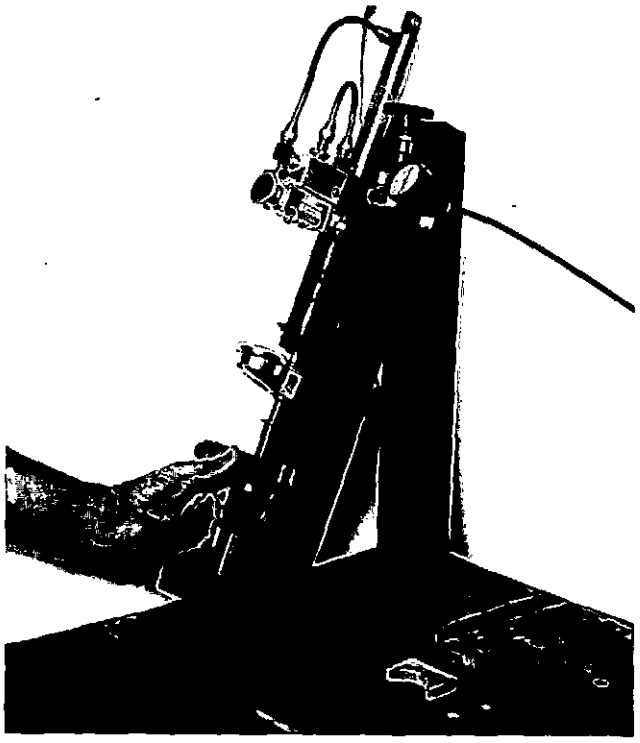


Fig. 3-20, (F60315). Injector in the plunger sticking tool

Warning: At any time fuel is forced from the cup spray holes, be sure to keep hands or body out of the spray steam to prevent injury.

Flanged Injector Assembly

1. Install a new cup O-ring each time the cup is removed.

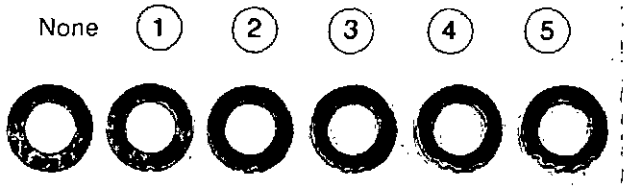


Fig. 3-21, (F60113). Injector cup gasket markings

2. Select a new injector cup gasket corresponding to plunger body size, Fig. 3-21. See Table 3-3. See Fig. 3-22 for the location of the size markings on the plunger and Fig. 3-23 for the body markings.

Note: When the PT flanged injectors are fitted with oversize plungers, thicker cup gaskets are used to provide the original relationship between the plunger and the metering orifice.

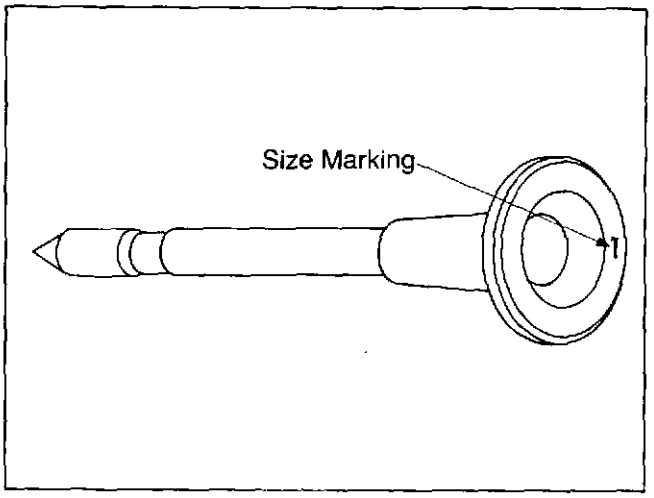


Fig. 3-22, (F60114). Size marking location on the plunger

3. Install the proper cup on the injector body finger tight. Back the cup up one-half turn.
4. Immerse the injector plunger in clean injector test oil and install the plunger in the body without the spring. Place the injector in ST-1298 or 3375084 to align the plunger in the body. Tighten the cup to 55 ft-lb [75 N•m].

Note: Since two types of injector cup wrenches have been used, three spline and six spline, always use the six spline wrench if possible.

Note: Unless the proper gasket is used with the corresponding body and plunger, the engine will develop a miss on the cylinder containing the improperly rebuilt injector.

5. Check the injector assembly plunger seating on 3375375, ST-570 or ST-990, preferably 3375375 if available.
6. Remove the injector plunger from the body. Lubricate the plunger with test oil. Install the injector spring and plunger in the body. Check to see that it does not bind as it seats in the cup.
7. Check the cup spray pattern as described in that section. If the spray pattern tools are not available, fill the injector body two-thirds full of clean fuel. Insert the plunger forcing the fuel out of the cup spray holes to see that they are open and clean.

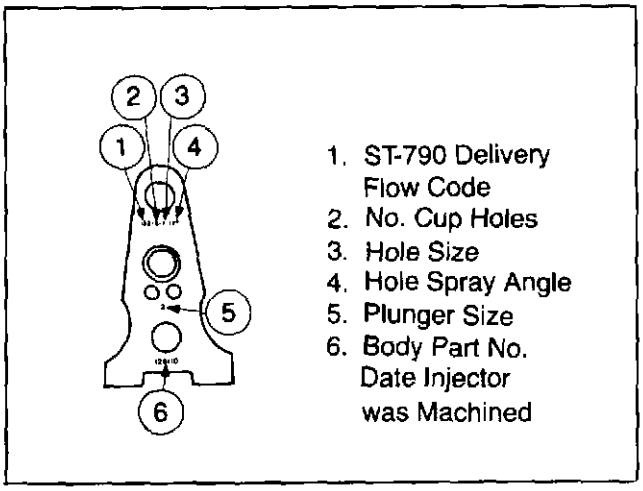


Fig. 3-23, (F60115). Size markings on flanged injector body

Table 3-3: Injector Cup Gasket Data

Engine Series (Service)	Cup Gasket Part No.	Gasket Notches	Thickness In. [mm]	Body and Plunger Size Markings
H, NH, V-12,	62409	None	0.0159 [0.4038]	A, B, C, D, 0, 1, 2, 3, 4, 5, 6, 7, 8
	109247	1	0.0201 [0.5105]	11, 12, 13, 14, 15, 16, 17, 18, 19, OP, P, 2P, 3P, 0S, 1S, 2S, 3S
	109248	2	0.0224 [0.5689]	20, 21, 22, 23, 24, 25, 0SS, 2SS, 3SS
	117994	3	0.0282 [0.7162]	30, 31, 32, 33, 34, 35, 0SSS, 1SSS, 2SSS, 3SSS
	131270	4	0.0315 [0.8001]	42, 43, 44, 45, 0SSSS, 1SSSS, 2SSSS, 3SSSS
	131758	5	0.0355 [0.9017]	52, 53, 54, 55
C, J	62410	None	0.0159 [0.4038]	A, B, C, D, 0, 1, 2, 3, 4, 5, 6, 7, 8
	109249	1	0.0201 [0.5105]	11, 12, 13, 14, 15, 16, 17, 18, 19, 1P, 2P, 3P, 0S, 1S, 2S, 3S
	109252	2	0.0250 [0.6350]	20, 21, 22, 23, 24, 25, 0SS, 1SS, 2SS, 3SS
	117995	3	0.0282 [0.7162]	30, 31, 32, 33, 34, 35, 0SSS, 1SSS, 2SSS, 3SSS
	131269	4	0.0315 [0.8001]	42, 43, 44, 45, 0SSSS, 1SSSS, 2SSSS, 3SSSS
	131757	5	0.0355 [0.9017]	52, 53, 54, 55

Leakage Checks

The injector leakage tester, Service Tool No. 3375375, will measure the injector plunger to barrel leakage, plunger to cup leakage and injector check ball leakage. These checks will determine if the injector is to be exchanged or can be calibrated and reused in an engine.

See section four for the leakage check procedure.

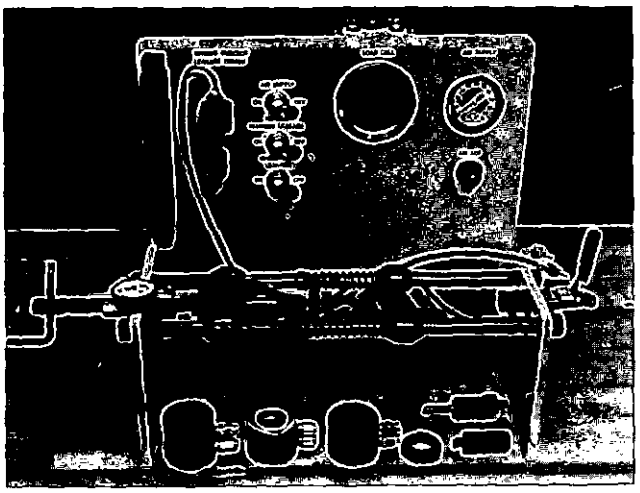


Fig. 3-23A. Leakage tester, Tool No. 3375375

Leakage Specifications

Cup to Plunger Tip Leakage

If no bubbles appear within 10 seconds, or if the time between bubbles is more than 5 seconds, the cup to plunger seating is acceptable. If unacceptable, retorque the cup.

Barrel to Plunger Leakage

The maximum leakage on a rebuilt injector is 4.5 units.

If the leakage exceeds the specifications, mark the injector for plunger replacement.

Check Ball Leakage

If the leakage is over 12 units at 80 psi [552 kPa] rework the check ball seat.

An optional method is to check the leakage at 60 psi [414 kPa] at 8.5 units.

Flow Testing the Flanged Injectors on Service Tool 3375317

The main difference between testing the cylindrical and the flanged injectors is in the use of the handle lever arm which is used only to "enable" starting and to stop the main drive when testing the flanged injectors. It is not used to supply test oil to the injector.

Installing the Flanged Injector

1. Stop the test oil system by pressing the test oil system "off" button.
2. Remove the test oil line from the handle lever arm by removing the knurled knob and test oil line connection.
3. Lower the guard and turn the anti-splash flap counterclockwise to get access to the injector.
4. Select the proper adapter and link and position the injector in the machine, Fig. 3-24. The notches in the adapter must align with the two bars that protrude from the clamp plate.
5. Install the injector drain by-pass pipe in the injector drain port.
6. Attach the test oil supply line to the injector inlet port. The knurled knob will screw into the inlet port, Fig. 3-25.

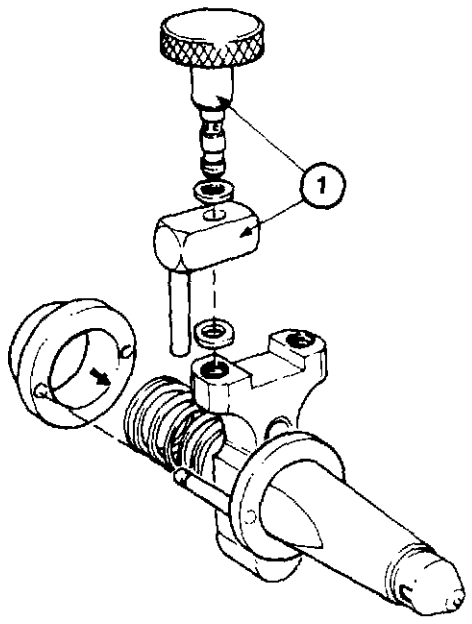


Fig. 3-24. Flanged Injector Adapter for 3375317

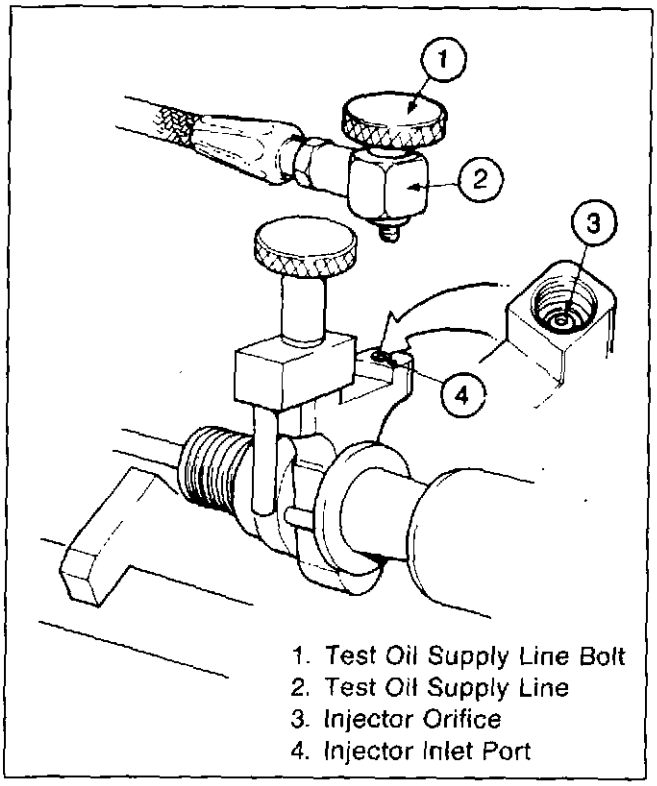


Fig. 3-25. Connect the test oil supply to a flanged injector

7. Clamp the injector in the test stand. Check the parts alignment.

Stabilizing the Flanged Injector Flow

1. Start the test oil system.
2. Lower the handle lever arm. Although the handle lever arm is not used to supply test oil to the injector, it must still be lowered in order to enable the main drive to start by putting a micro-switch in the correct mode.
3. Press the metering button; do not hold it in. The dial indicator will display the output flow of the injector in cubic millimeters per stroke.

Note: Take several readings until the output flow stabilizes. When the metering unit or the injector is cold, the readings will vary.

Checking the Flanged Injector Flow

1. When the readings stabilize, stop the main drive by raising the handle lever arm. After the motor has stopped, press the metering button. Then set the dial indicator to zero with the adjusting screw.

2. Lower the handle lever arm to re-start the drive, and press the metering button. Watch the small hand on the dial to see if it turns more than one revolution.

3. Read the output flow of the injector. The small hand makes one revolution for each 250 cc of output flow per 1000 strokes, and the large hand makes one revolution for 10 cc of output flow per 1000 strokes. (1 cu. mm/stroke = 1 cc/1000 strokes).

   If the small hand has made less than one revolution, use the inner ring figures (2 to 24) and multiply by 10. Add the reading of the large hand, Figs. 3-26 and 3-27.

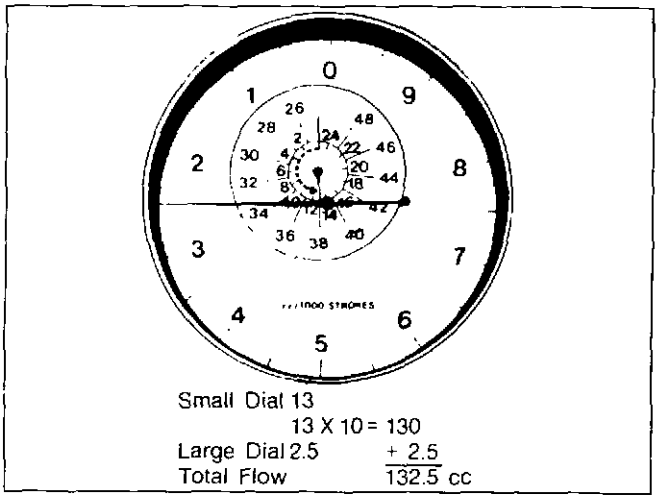


Fig. 3-26. Reading 132.5 cc injector flow

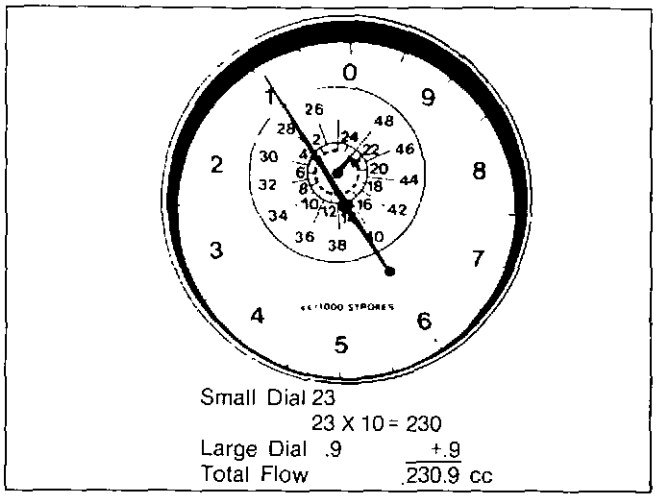


Fig. 3-27. Reading 230.9 cc injector flow

If the small hand has made more than one revolution, use the outer ring of figures (26 to 48) and multiply by 10. Add the reading of the large hand, Figs. 3-28 and 3-29.

4. If the delivery is different than specified in Bulletin 3379664, a new orifice plug must be installed in the injector.

Caution: Do not unclamp the injector until the main drive has stopped. However, do not leave the injector clamped more than one minute after stopping the main drive. Damage to the injector or test stand could result.

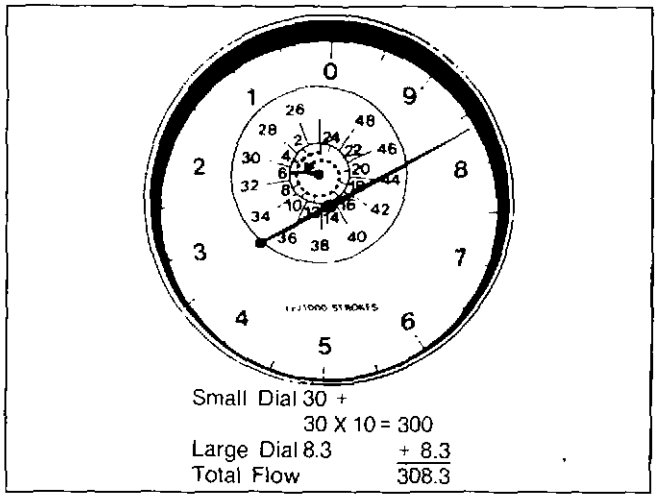


Fig. 3-28. Reading 308.3 cc injector flow

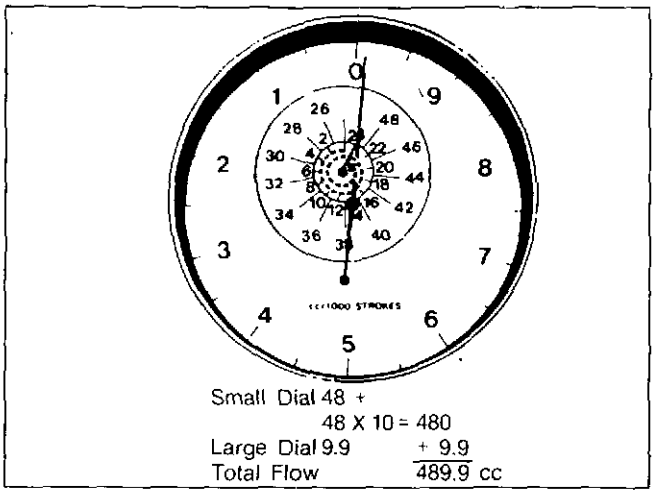


Fig. 3-29. Reading 489.9 cc injector flow

Remove the Flanged Injector from the Test Stand

1. Raise the handle lever arm and unclamp the injector when the main drive has stopped.
2. Close the test oil line valve or switch off the test oil system.
3. Disconnect the test oil line knurled bolt from the injector inlet port. Remove the drain pipe assembly.
4. Raise the guard and remove the injector, adapter and link.
5. Remove the adapter and link from the injector.

Service Tools

Description

This section contains the service tools that are required to assemble and test the injectors. See the service tool catalog, Bulletin No. 3377971, for a complete parts listing of the tools. The major tools in this section are listed in Table 4-1. See Table 1-1 for a complete list of injector service tools.

Table 4-1: Injector Service Tools

Tool No.	Description
3375160	Top Stop Setting Fixture
3375209	Check Plunger Sticking
3375317	Test Stand
3375366	Test Stand Audit Kit
3375375	Leakage Tester
3376350	Cup Spray Tester
ST-790	Test Stand

Top Stop Setting Fixture — PT (type D) Injector Service Tool No. 3375160

1. The top stop setting fixture is used to set the plunger travel of the PT (type D) top stop injector, Fig. 4-1.

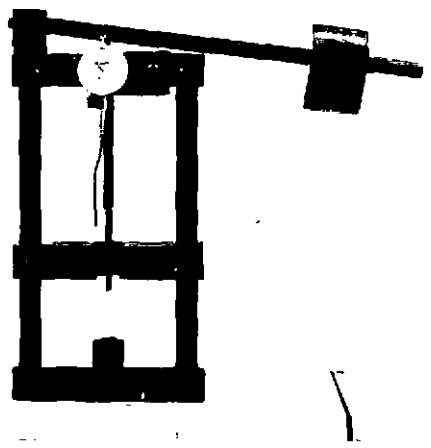


Fig. 4-1. 3375160 Top Stop Setting Fixture

Note: If the injector is to be checked for leakage or the cup is to be spray tested, do not adjust the top stop now.

2. If the top stop injector is to be calibrated on the 3375317 test stand, adjust the top stop before calibrating the injector. If the top stop injector is to be calibrated on ST-790 test stand, adjust the top stop after the injector is calibrated.

Assembly of the Setting Fixture

1. The setting fixture must be assembled according to the following instructions or it will not operate correctly.

   a. Locate the center of the weight on the operating lever, 10-3/16 inches [259 mm] from the centerline of the dowel pin, Fig. 4-2.

   b. Adjust the horizontal support bar so that it is 4 inches [102 mm] above the top surface of the bottom bar, Fig. 4-3.

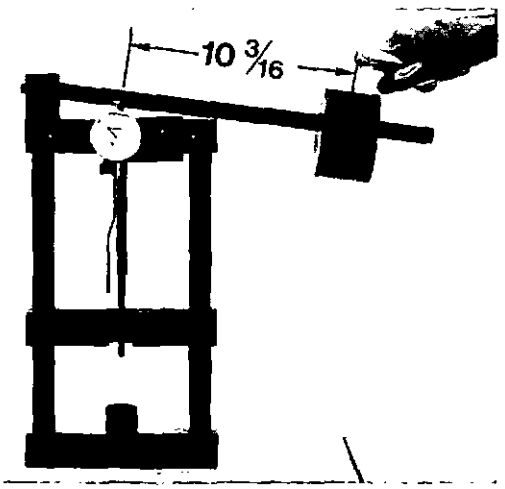


Fig. 4-2, (F60300). Set the setting fixture weight

Note: In 1982 the flats to hold the injector were machined into the horizontal bar. In June, 1981 the body wrench, Part No. 3375102, was welded to the bottom of the horizontal bar. Adjust this bar 4-1/4 inches [108 mm] above the bottom bar.

   c. Locate the indicator plate in the lowest of the two positions, Fig. 4-2.

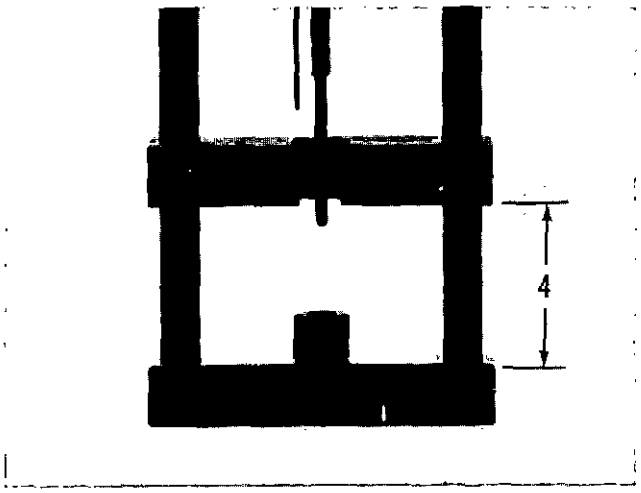


Fig. 4-3, (F60301). Adjust the distance between the bars

Adjust the Top Stop

1. Install the top-stop screw and locknut into the injector until approximately two of the top threads of the stop protrude above the locknut. This is a reference point only.
2. Lift the dial indicator extension.
3. Install the injector in the setting fixture. The wrench flats on the adapter will locate the injector in the fixture. The cup must be centered over the cup seat, Fig. 4-4.
4. Adjust the cup seat up against the injector cup. Tighten to 100 to 115 in/lbs (11 to 13 N•m) torque, Fig. 4-5.
5. The indicator extension must be in contact with the plunger or ring on the plunger coupling. Make sure the extension is not positioned on an etched part of the surface.
6. Bottom the injector plunger in the cup with the fixture handle. Set the dial indicator to zero, Fig. 4-6.

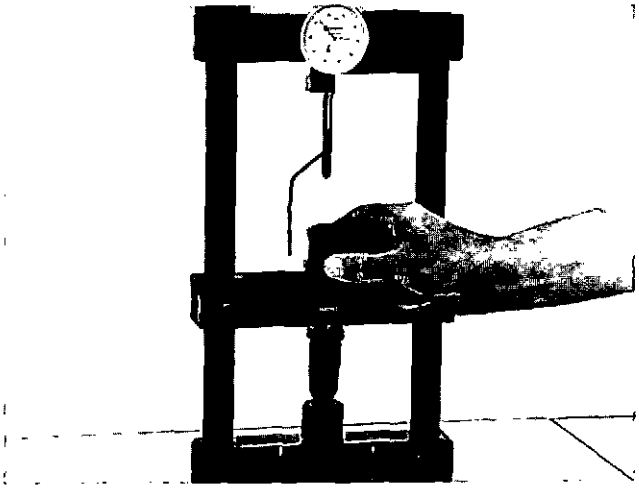


Fig. 4-4, (F60228). Install the injector into the 3375160 Setting Fixture

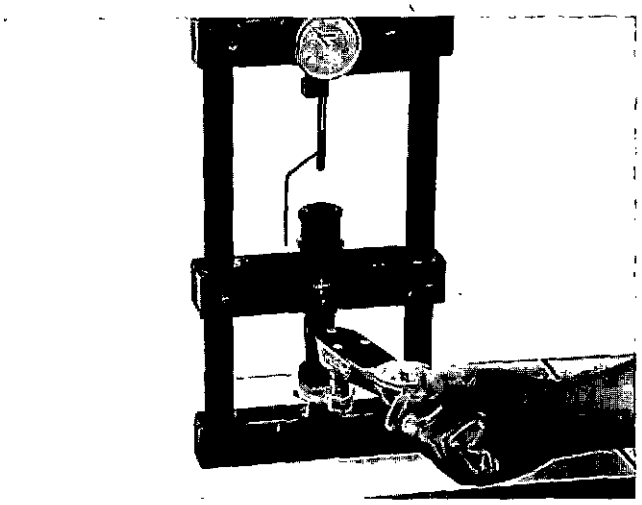


Fig. 4-5, (F60229). Tighten the injector in the fixture

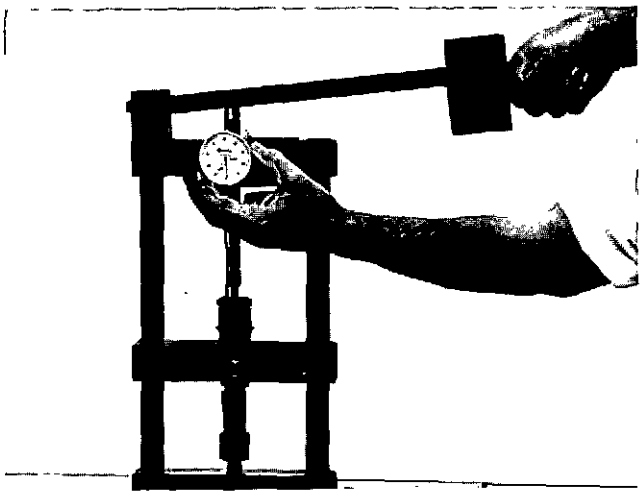


Fig. 4-6, (F60230). Bottom the plunger and zero the dial indicator

7. Release the plunger slowly and observe the travel required until the plunger spring retainer or washer contacts the injector top-stop.

Caution: Do not lift up the lever.The weight on the lever simulates zero lash when the injector is in the engine.

8. Bottom the plunger again and adjust the stop up or down with the 3375165 wrench. The travel must equal that indicated in Bulletin 3379664 (± 0.0005 inch [.013 mm]) under "Top Stop Set", Fig. 4-7.

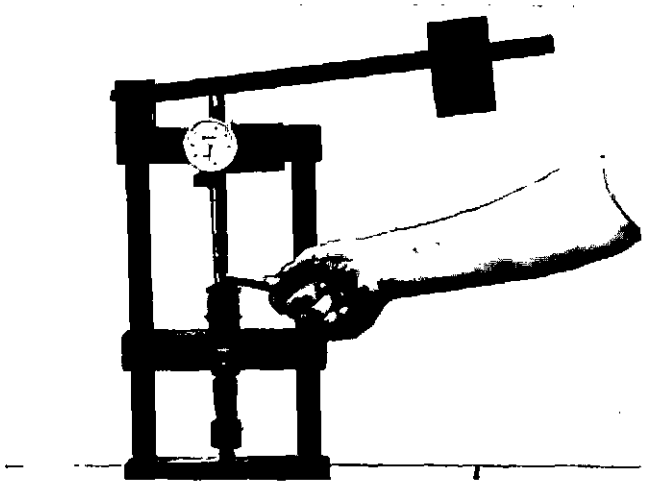


Fig. 4-7, (F60231). Adjust the top stop setting of the injector

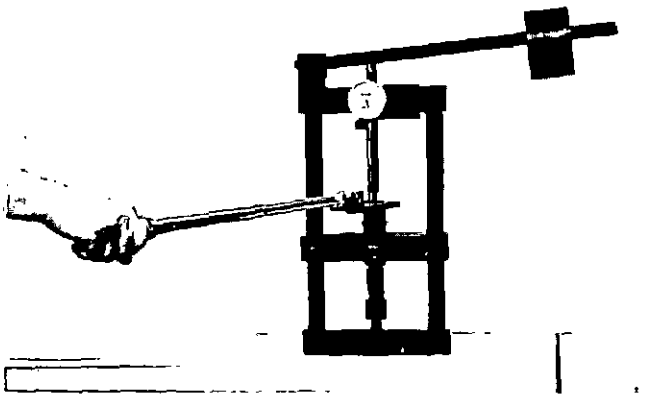


Fig. 4-8, (F60232). Tighten the locknut on the top stop injector

Note: When rechecking the travel of injectors or from one assembly stand to another, the tolerance is ± .001 inch [0.025 mm].

9. Tighten the stop locknut with the 3375166 crowsfoot wrench to 55 ft/lb [75 N•m] torque, Fig. 4-8. Recheck the travel to make sure it was not changed by tightening the locknut.

Injector Sticking Plunger Checking Tool
Service Tool No. 3375209

1. The 3375209 Injector Sticking Plunger Checking Tool is used to check the injectors for sticking plungers, Fig. 4-9.

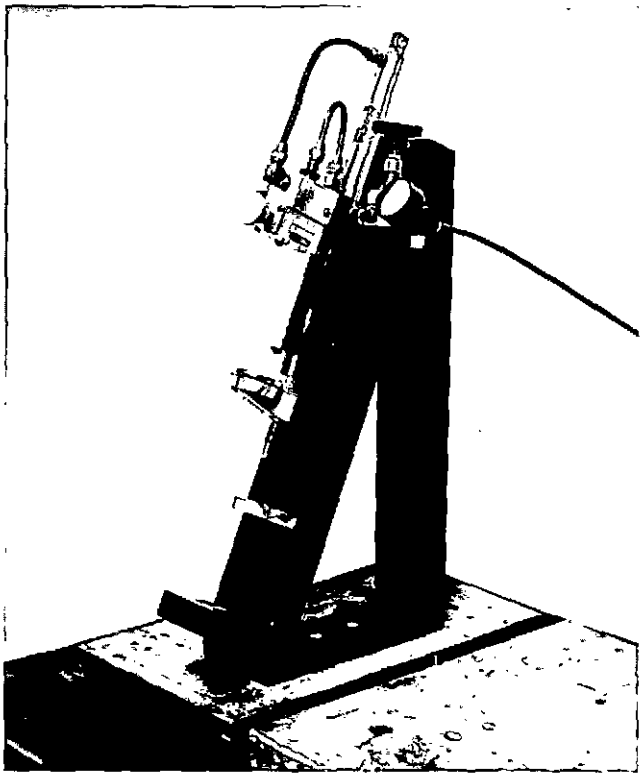


Fig. 4-9, (3375209). Injector Plunger Sticking Tool

2. With calibrated pressure on the plunger, the injector adapter is rotated. The amount of torque needed to turn the injector will indicate whether the plunger is free in its bore.
3. The spring must be removed from the injector.

Checking the Plunger Sticking

1. Connect the tool to a shop air supply of at least 30 psi (207 kPa).
2. Place the injector in the tool with the cup in the lower bearing.
3. Loosen the setscrews on the torque wrench stem. Set the torque wrench plunger cone one inch [25.4 mm] above the injector plunger surface. Tighten the setscrews on the torque wrench.
4. Actuate the air cylinder and adjust the pressure regulator to 30 ± 2 psi (207 ± 14 kPa).
5. Rotate the injector adapter and observe the reading, Fig. 4-10.
6. If the reading is greater than 2 in. oz. (32 oz.) [0.226 N•m], remove the injector and put it in the ST-1298 or 3375084 Holding Fixture.

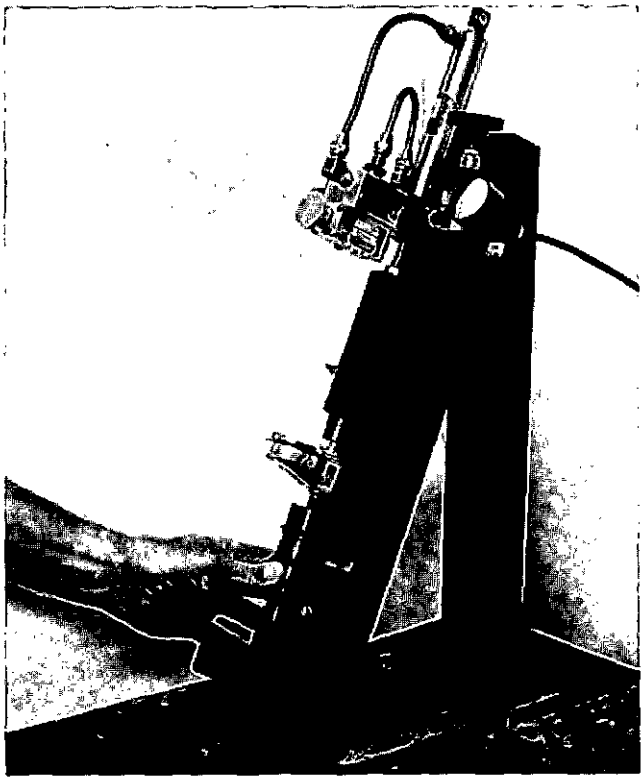


Fig. 4-10, (F60302). Rotate the injector adapter and observe the reading

7. Loosen and tighten the cup retainer to the specifications.

Maintenance

Keep the tool in a clean dry place. Wipe occasionally with a lightly oiled rag.

Injector Leakage Tests Service Tool No. 3375375

1. The 3375375 Injector Leakage Tester is used to check the injector leakage in the following areas:
   a. The barrel or body to plunger leakage is checked in the area below the metering orifice.
   b. The cup to plunger seat leakage is checked.
   c. The check ball leakage in the PT (type D) injector barrel is checked.
2. To install the leakage tester, see the assembly and installation bulletin that is shipped with the tool, Fig. 4-11.

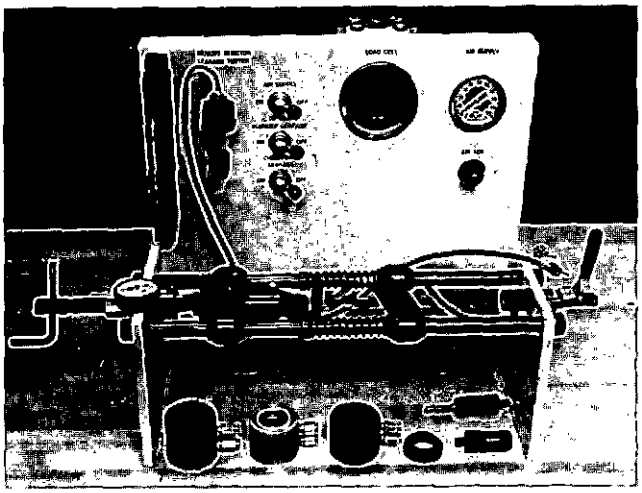


Fig. 4-11. 3375375 Injector Leakage Tester

Altitude Compensation

The leakage tester is altitude sensitive. When it is used to check barrel to plunger or body leakage, the unit readings must be corrected to allow altitude variations. For every 1000 feet [305 m] of altitude rise above 600 feet [183 m], 0.2 units must be subtracted from the unit reading. See Table 4-2.

Table 4-2: Leakage Tester Altitude Compensation

Altitude	*Units of Compensation*
sea level	add 0.012 units
600 ft.	none
1100 ft.	subtract 0.1 units
1600 ft.	subtract 0.2 units
2100 ft.	subtract 0.3 units
2600 ft.	subtract 0.4 units
3100 ft.	subtract 0.5 units
3600 ft.	subtract 0.6 units
4100 ft.	subtract 0.7 units
4600 ft.	subtract 0.8 units
5100 ft.	subtract 0.9 units
5600 ft.	subtract 1.0 units
6100 ft.	subtract 1.1 units
6600 ft.	subtract 1.2 units
7100 ft.	subtract 1.3 units
7600 ft.	subtract 1.4 units
8100 ft.	subtract 1.5 units
8600 ft.	subtract 1.6 units
9100 ft.	subtract 1.7 units
9600 ft.	subtract 1.8 units
10100 ft.	subtract 1.9 units
10600 ft.	subtract 2.0 units

Example: If your shop is 6,600 feet [2012 m] above sea level, you must subtract 1.2 (6 × 0.2) units from your unit measurement. Altitude does not affect cup to plunger leakage check.

Operating Instructions for 3375375

Injector Installation — PT Flange Type

1. Remove the strainer and drain fittings from the injector and install two 3375459 Fittings in their place.
2. Remove the spring and replace the plunger.
3. Install the 3375373 Link into the plunger of the standard flanged injector. Use 3375396 Link for the PT (type D) flanged injector.
4. Place the assembly into the injector guide from the locking lever end. Align the hold down capscrew hole on the injector flange with the pin on the injector guide.
5. Secure the assembly by clamping the locking lever, Fig. 4-12. Install the black hose in the injector drain (port nearest operator) and the white hose in the supply port.

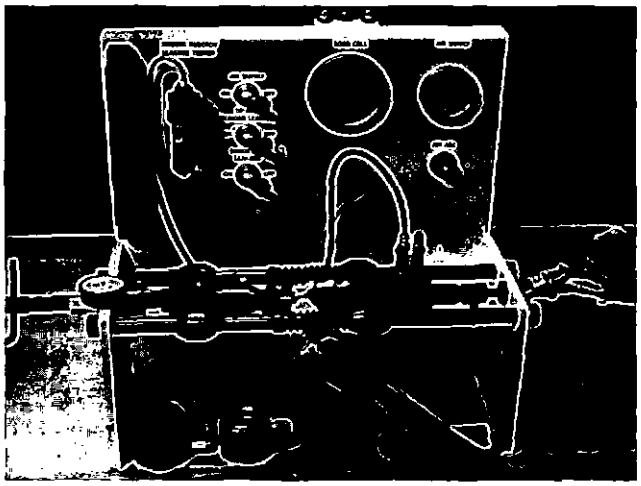


Fig. 4-12, (F60244). Install the injector in the leakage tester

Injector Installation — PT (type D) Injectors

1. Remove the balance orifice clip and screen.
2. If this is a top stop injector, remove the top stop nut, screw, and spring (spring must be removed on all injectors).
3. Select the appropriate adapter pot. The pot for K-Series injectors is stamped "K" or 3375440. Use 3376211 pot for the 10 Litre engine. Use the unmarked pot or 3375395 for the other series.
4. Lubricate the O-rings and insert the injector into the adapter pot.

Note: Damaged O-rings can cause false readings.

5. Install a 3375397, for PT (type D), in the top of the injector plunger and tighten the knurled knob to lock it in place.
6. Place the 3375401 Adapter over the injector top with the largest diameter against the injector flange.
7. Insert the 3375396 Link into the 3375397 Adapter for the standard PT (type D) and use the 3375398 Link for "K" engines without the 3375397 Adapter. Install the entire assembly into the injector guide, link end first. Secure in place with the locking lever, Fig. 4-12.
8. Install the supply and drain hoses to the fittings on the adapter pot. The white hose must be toward the injector cup.

Note: The white hose is the supply. The black hose is the drain.

Checking Procedure

Cup to Plunger Seat Test

1. Adjust the air pressure to 60 psi [414 kPa]. See Step 2 under "Installation". Perform this step if not previously done. Normally, Step 2 is only required on the first set up.
2. Adjust the hand crank to show 200 pounds on the load cell gauge.

Caution: Never "peg" the load cell gauge; accuracy will be lost.

3. With the air supply valve off, turn the cup seat plunger leakage valve ON.

Note: The air supply valve must be off whenever the other valves are switched either on or off. Otherwise, the flow of air can blow the oil from the bubble checker.

4. Turn the air supply valve ON and look for bubbles in the bubble checker. If no bubbles appear within 10 seconds, or if the time between bubbles is more than 5 seconds, the cup to plunger seating is acceptable, Fig. 4-13. If unacceptable, retorque the cup.

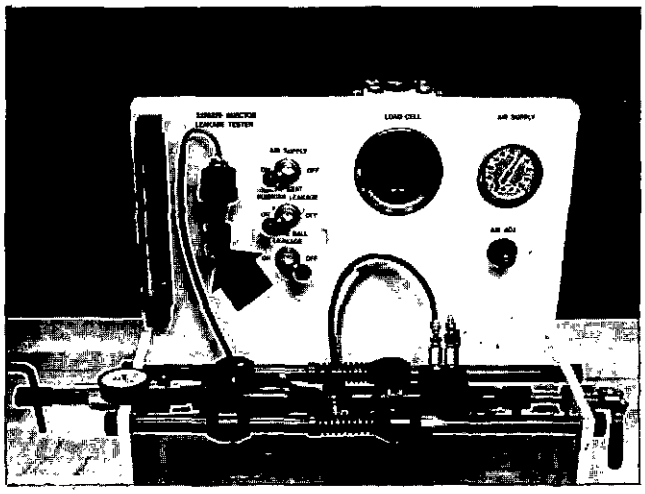


Fig. 4-13, (F60246). Check the cup to plunger seating

5. Turn the air supply valve OFF before removing the injector.

Note: If the test results are acceptable, proceed with the "Barrel to Plunger Test."

Barrel or Body to Plunger Test

1. Adjust the air pressure to 60 psi [414 kPa].
2. Adjust the hand crank to show 200 pounds on the load cell gauge.

Note: Never "peg" the load cell gauge; accuracy will be lost.

3. Zero the dial indicator.
4. Back out the hand crank 0.048 inch [1.22 mm] as measured on the indicator.

Note: *Keep a light pressure on the load cell plunger* toward the indicator while turning the crank.

5. With the air supply OFF, turn the tip seat plunger leakage valve ON.
6. Turn the air supply valve ON.
7. Gently rotate the injector plunger in small increments, and watch the flowmeter for the highest reading, Fig. 4-14.

Note: Do not hold the plunger while checking the leakage. A zero reading on the flowmeter indicates no leakage.

8. If the leakage exceeds the specifications in Table 4-3, *mark the injector for plunger replacement.*
9. Turn the air supply valve OFF before removing the injector.

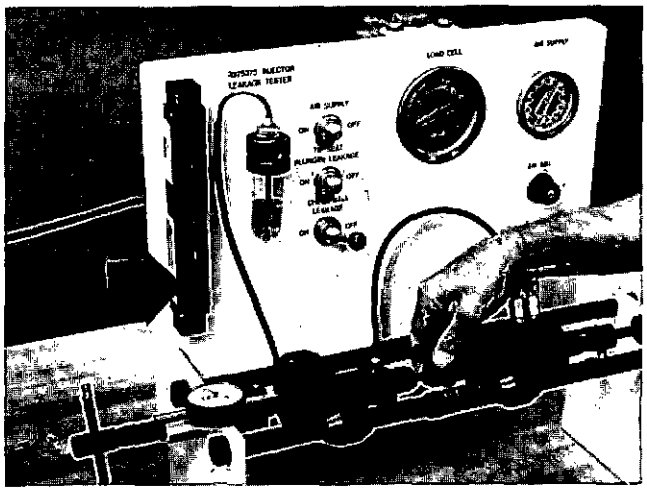


Fig. 4-14, (F60247). Measure the plunger to body or barrel leakage

Note: *If the leakage is within the specifications,* proceed with the "Check Ball Leakage Test".

Table 4-3: 3375375 Leakage Tester Data — Units

Injector	New	Used
PT H/NH Flanged	6.5	9.5
J/C Flanged	5.5	8.5
PT (type D) 3/8 inch Plunger	2.5	4.5
PT (type D) 5/16 inch Plunger	2.2	4.5

Check Ball Leakage Test

1. With the plunger still in the retracted position (0.048 inch [1.22 mm] on the indicator), and the tip seat plunger leakage valve and the air supply valve OFF, turn the check ball leakage valve ON.
2. Turn the air supply valve ON and adjust the air pressure to 80 psi [522 kPa].
3. Observe the flowmeter, Fig. 4-15. If the reading exceeds 12 units of leakage (Service Limit) at 80 psi or 8.5 units at 60 psi, rework the seat. The ball and the seat must be wet with calibration fluid before the leakage test can be performed. In some cases, replacing the check ball is all that is required.

Note: Before reworking the seat area, make sure that the check ball and the seat have been thoroughly cleaned. A very small particle of debris can give an excessive flowmeter reading.

Reworking injector check ball seat:

4. If a PT (type D) injector check ball is to be

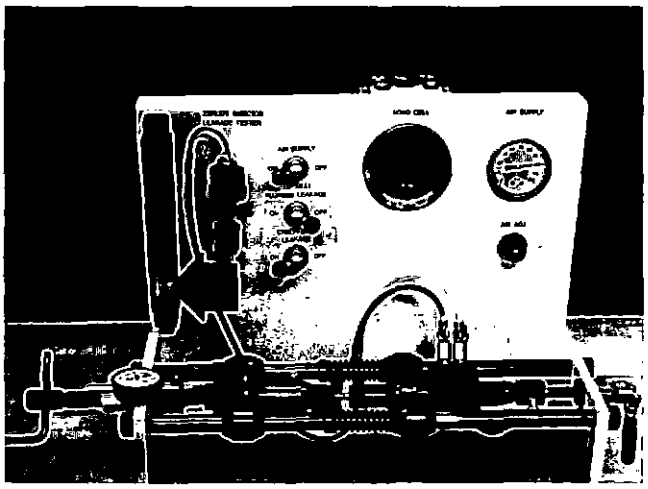


Fig. 4-15, (F60248). Read the flowmeter for check ball leakage

reworked, the check ball may be seated by slightly lapping a ball to the seat. A check ball welded to the end of a small rod may be used to lap the seat. Use 600 grade paste lapping compound.

Note: All check ball leakage values are based upon using a **fiber ball** in the leakage tester flowmeter. **Do not use a steel ball in the leakage tester flowmeter.**

5. When the check ball is on the seat, it must be .030 to .055 inch [.76 to 1.40 mm] below the barrel surface.

Note: If the lowest reading on your flowmeter is 1, that is one unit. If your lowest reading is 10, that is one unit.

6. If the leakage is acceptable, turn the air supply and the check ball leakage valve OFF before removing the injector.
7. Remove and reassemble the injector.

Troubleshooting

Occasionally the tip seat plunger leakage valve may leak air pressure through the bubble checker and the flowmeter causing inaccurate assessment of the injector quality. A quick method for checking this failure is to remove the white line from the injector pot and hold your thumb over the disconnect. If bubbles appear in the bubble checker or the ball in the flowmeter rises, the valve is leaking. Take appropriate repair or replacement action.

Damaged O-rings on the injector adapter can cause false readings.

Maintenance

1. Select a clean used injector of known leakage. Store in a clean, secure place for periodic checking of the 3375375 over extended periods of use.
2. Drain the sediment from the air inlet as required. If the yellow indicator appears in the upper bulb, remove the filter and clean in solvent.
3. Be sure the flowmeter vent is not obstructed in any way. Oil or mist entering the flowmeter will cause the float to stick.
4. All fittings must be kept tight and free from air leaks.
5. Drain the separator regularly and clean its sintered filter in solvent twice a year.
6. Change the dry type filter twice yearly under normal operating conditions.

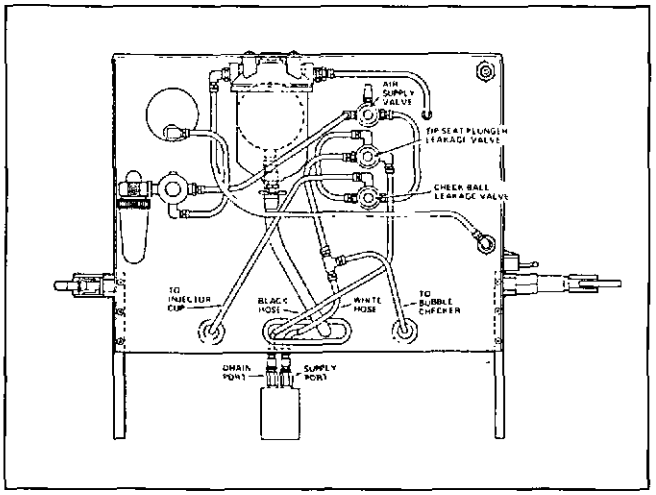


Fig. 4-16. 3375375 Leakage Tester Valve Arrangement (rear of panel)

Injector Cup Spray Tester Service Tool No. 3376350

1. The 3376350 Injector Cup Spray Tester is used to check the injector cup spray pattern.
2. The spray tester is designed to make sure that all of the spray holes are open and spraying in a uniform pattern, Fig. 4-17.

Introduction

1. The 3376350 Injector Cup Spray Tester allows testing the cup spray pattern prior to assembling the cup to the injector.

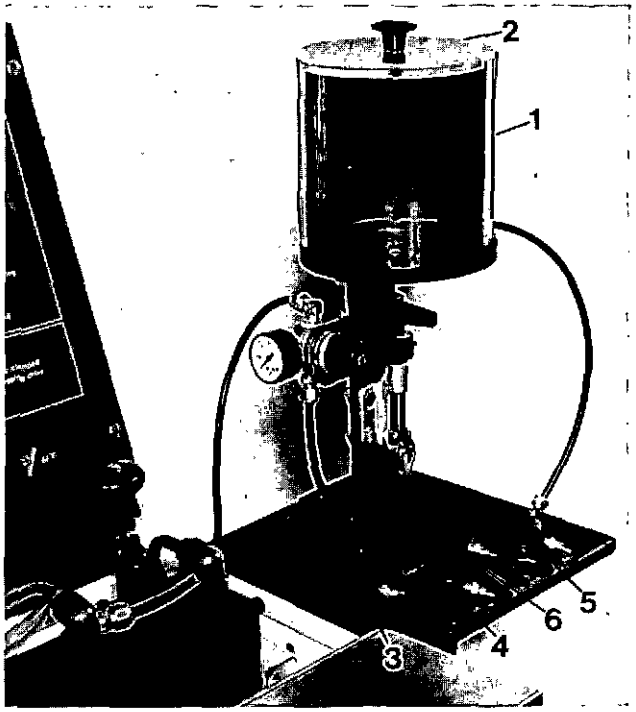


Fig. 4-17. 3376350 Injector Cup Spray Tester

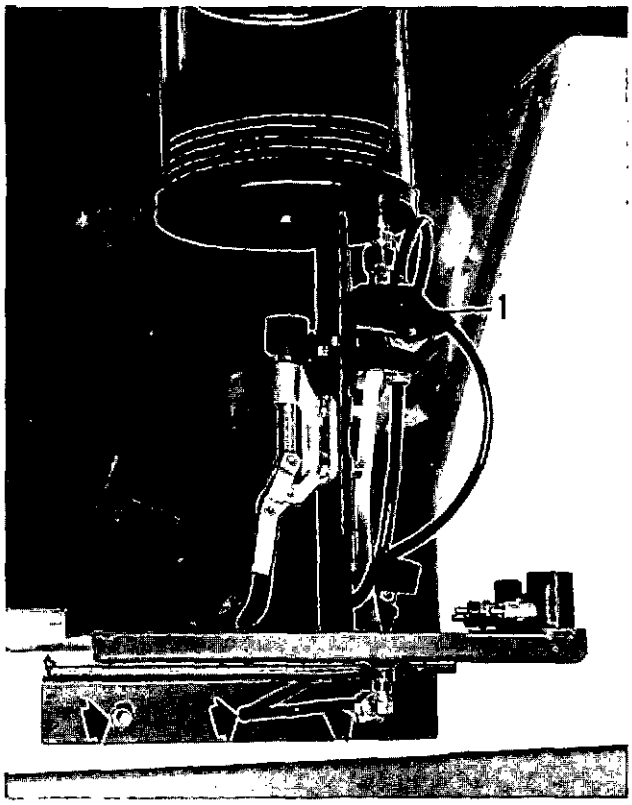


Fig. 4-18. Spray Tester mounted to 3375317 Injector Test Stand

2. Reference lines are inscribed on the plexiglass cylinder to indicate spray above or below one of the reference lines.
3. *To determine which scribed line to use for reference,* place a new (known angle) cup in the tester.
4. Observe the location of the spray on the plexiglass cylinder and retain for future use.
5. A normal spray angle tolerance for used injector cups is plus or minus two degrees. The distance from one scribed line to the other represents approximately five degrees.
6. If a new cup is spraying exactly on one of the scribed lines, the tolerance will be slightly less *than plus or minus one-half the distance between* the scribed lines on each side of the base line.

Installation Instruction to the 3375317 Injector Test Stand

The 3376350 Injector Cup Spray Tester design requires a pressure source of clean injector test oil. The tester can be attached easily to the 3375317 Injector Test Stand, and is recommended, to provide the required source of clean injector test oil, Fig. 4-18.

1. *Drill three holes to match the holes for the angle* mounting bracket attached to the base of the tester. The two outer holes are required to mount the tester. The center hole is required for the drain hose, which allows the tester to drain into the tray of the Injector Test Stand. See arrows, Fig. 4-18.
2. Remove the clamp cylinder "unclamp" pressure fitting from the top of the clamp cylinder, (Ref. arrow, Fig. 4-17). Use R drill (.339 inch) and 1/8 NPT tap to drill and tap the side of the pressure *fitting.*
3. Clean the fitting thoroughly and install the pressure fitting to the clamp cylinder. Connect the pressure supply hose.
4. Install the 1/8 NPT pressure fitting (supplied with the spray tester) into the clamp cylinder pressure fitting and then attach 1/4 inch spray tester supply hose to the fitting.

Installation Instructions for the STU-790 (HA280) or ST-790 Injector Comparator

1. Screw the 3376402 Adapter (ordered separately) onto the fuel supply banjo fitting as if it were

being attached to the injector pot.

2. Attach the tester supply hose to the opposite end of the adapter.
3. On the STU-790 (HA280) adjust the test oil pressure control valve fully counterclockwise to the full open position given a nominal feed pressure of 40 PSI.
4. On the ST-790, adjust the test oil pressure control valve as required to obtain approximately 40 to 50 PSI.
5. The tester may be attached to or rest on a stand close to the injector test oil supply pressure. The tester should be mounted high enough to allow the fluid to drain into the comparator tray.

Testing the Injector Cup Spray

1. Select the appropriate injector cup spray adapter for the type of cup to be tested. Four adapters are included for testing: Standard PTD, Small V, K, and Flange Injector Cups, Ref. 3 thru 6 Fig. 4-17.
2. Insert the cup adapter into the clamp adapter and attach the supply hose. Tighten the setscrew to hold the cup adapter.
3. Put an injector cup into the adapter.

Note: Make sure the O-ring is in the clamp adapter.

4. Raise the clamp lever to clamped position. Observe and/or feel the clamp force required. Only a moderate clamp force is necessary to seal the cup against the O-ring in the adapter.

Note: The upright support is slotted to allow adjustment of clamp force as required.

5. Move the on-off ball valve to "off" position, Fig. 4-18.
6. Check all 1/4 inch [25.4 mm] hose fitting locknuts to be sure they are tight before starting the injector test stand.
7. Start the injector test stand and adjust the pressure regulator on the tester to show 8 to 10 psi on the pressure gauge, Fig. 4-17.

Caution: Do not try to calibrate injectors at the same time the spray tester is operating. The tester will only operate with the injector test stand in the unclamped position.

Note: Calibration fluid does not need to be at the normal operating temperature to use the spray tester. A good time to check cup spray patterns is when the

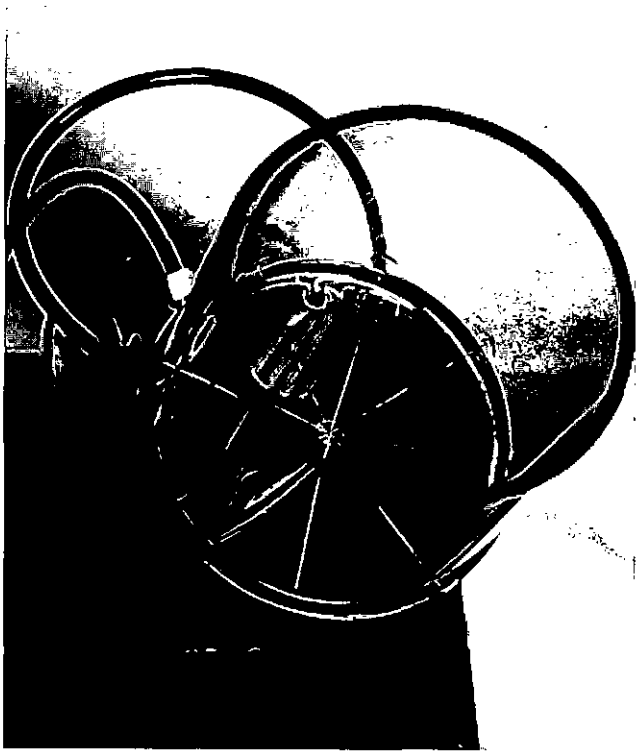


Fig. 4-19. Spray Tester in operation with the top removed

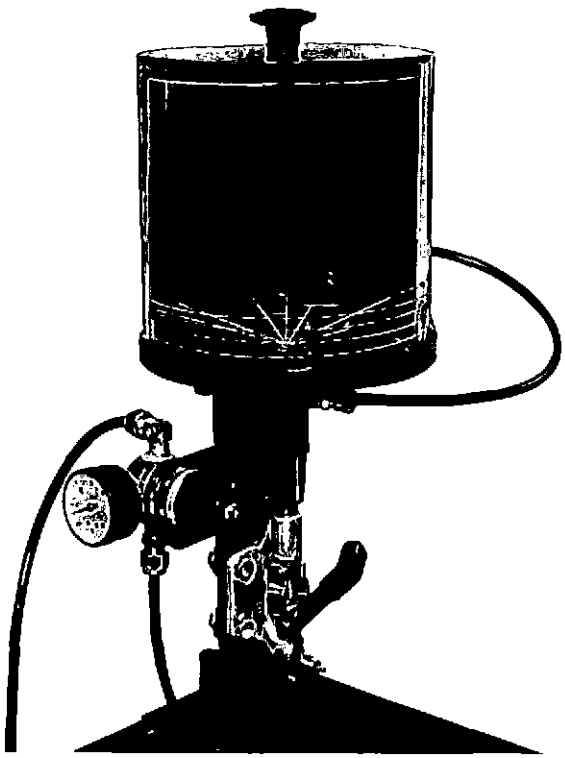
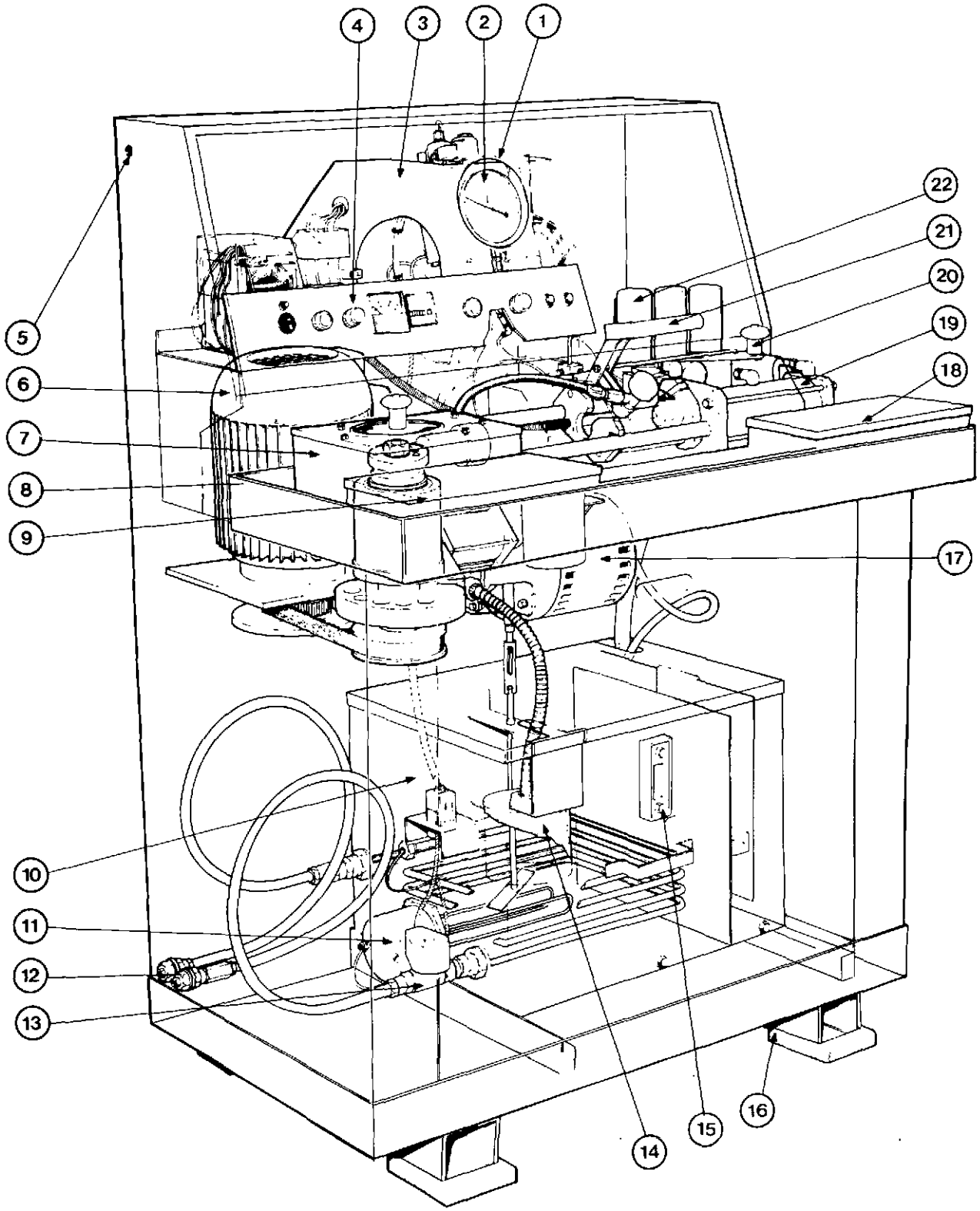


Fig. 4-20. Spray Tester in operation



1. Front Panel
2. Dial Indicator
3. Electrical Chassis
4. Control Panel (Part of 3)
5. Main Electrical Supply
6. Camshaft Drive Motor
7. Cambox
8. Top Tray
9. Storage Box (cams etc.)
10. Test Oil Tank.
11. Test Oil Tank Heater
12. Cooler Connections
13. Cooler Solenoid
14. Main Test Oil Filter
15. Test Oil Sight Gauge
16. Anti-vibration rubber pads
17. Test Oil Pump Motor
18. Storage Box (Adapters & links)
19. Injector Clamping Cylinder
20. Control Handle (clamping)
21. Handle Lever Arm
22. Deadweight Valves

Fig. 4-21. The 3375317 Injector Test Stand

Injector Test Stand is first turned on and fluid is warming up. This way it will not interfere with the normal operation of flowing injectors.

8. Move the on-off valve to "on" position.
9. Observe the spray pattern of the injector cup to see which scribed line the spray pattern is nearest to. Compare this mark with that found with the known angle cup, Figs. 4-19 and 20.

Note: When testing "used" cups, if spray hole(s) appear to be plugged or spraying a fuzzy pattern, remove the cup and reverse flow with shop air. A 1/4 inch plastic hose tip extension (approximately 1 inch long) on the end of the air nozzle can be placed over the injector nozzle end to reverse flow the nozzle tip to remove small restrictions in the spray holes. If this procedure is ineffective, clean the cup in a sonic cleaner again. Make sure the sonic cleaner is not dirty. If this is still ineffective, discard the cup.

10. Move the on-off valve to the "off" position.
11. Lower the cup and remove the injector cup from the tester.
12. If the cup is acceptable, assemble it to the injector.

Injector Test Stand Installation Service Tool No. 3375317 (3375410)

Introduction

The 3375317 Injector Test Stand must be purchased as 3375410 Injector Calibration Kit, Fig. 4-21. The Service Tool Catalog contains a complete parts breakdown of this test stand. The 3375366 Test Stand Audit Kit is not included in 3375410.

3375410 Injector Calibration Kit
This kit contains:
3376135 Injector Burnishing Tool
3375365 Calibration Fluid (30 Gal).
3375421 Injector Calibration Test Stand Kit
This kit contains:
3375317 Injector Test Stand
3375367 Installation and Training Kit
This kit contains:
Installation of the Test Stand
On Site Test Stand Training
Test Stand Operation Manual
Audit Kit Manual

1. The 3375317 Injector Test Stand was designed and developed to test and measure the flow of all Cummins injectors. This test stand is faster, quieter and more accurate than the ST-790 Injector Test Stand.
2. Burnishing the injector orifice is the only way to adjust the injector fuel delivery on 3375317. The test stand is the reference standard and the master injectors are not required.
3. In order to make sure that the test stand remains accurate, an audit kit is used to check the functions which will affect the injector flow. The procedures for using the audit kit are explained after this section.

Serial Number

716-0006/B/6

- 6 — 220 Volt, 3 phase and ground, 60 Hz
- B — Modification Standard
- 0006 — Machine Serial Number (Unique)
- 716 — Product Code Number

The serial number of the test stand appears on the identification plate on the left side of the base and must be listed in any parts or service request.

A typical serial number with an explanation is given above.

Test Stand Requirements

Location

1. The location selected for the test stand must be clean and free of dust or dirt. Cleanliness is essential in all matters relating to testing, calibrating and servicing of fuel injection equipment. This not only applies to the location, but also to the cleaning facilities, tool and accessories used and to the handling of component parts.
2. The location must be flat and level.

Main Electricity Supply

1. The electrical supply to the test stand must be 220 or 460 Volts ± 10%, 3 phase and ground, 50 or 60 Hz. Internal connections can be made to adapt the test stand to the available voltage.
2. Wire size must be at least No. 12 with 3 wires and ground (12-3 — w/ground).
3. Conduit entry is from the left or right side through a 7/8 inch [22 mm] diameter hole in console.

Cooling Water Supply

1. The cooling water supply inlet temperature must be below 80° F [27° C].
2. The inlet water pressure must be above 40 psi [276 kPa].
3. The water outlet is drained by gravity.
4. External pipe size is to be at least 3/8 inch [10 mm] outside diameter nylon tube.

Ambient Air Temperature

1. The air temperature in the test room must be 60 to 90° F [15 to 32° C].
2. The company cannot be held responsible for any calibration errors which occur if the test stand environment does not meet the foregoing specification.

Installation

1. The 3375317 Injector Test Stand must be installed by a factory authorized service man. The service man will also run the test stand through a complete testing procedure with the audit kit.
2. The following items can be completed before the service man arrives.
   a. Level the test stand.
      1) Place the test stand in position on the rubber feet provided. Remove the front cover.
      2) Place the steel plates under the test stand feet until the deadweight dashpot tops are horizontal-both from left side to right side and front to back of machine. Use a level, place on top of the deadweight dashpots, to level the test stand, Fig. 4-22. Replace the front cover.

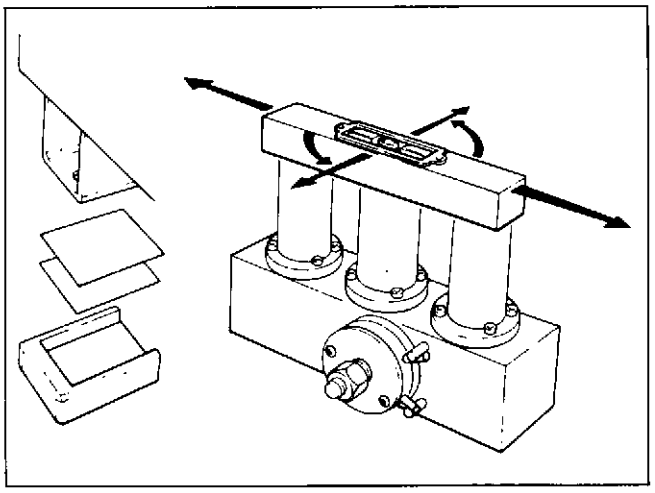


Fig. 4-22. Level the test stand

   b. Fill the test oil tank with test oil by pouring the oil into the top tray at the right hand side of the clamp cylinder. The oil level in the tank must be approximately 1/2 inch [13 mm] below the top of the sight gauge. The tank will hold about 10 gallons (8 Imp. gallons) [38 liters].

Caution: Use only oil to SAE Specification J967D. Cummins Part No. 3375364, in 55 gal. drums and 3375365 in 30 gal. drums. Calibration errors will occur if other test oil is used.

   c. Connect the cooling water supply and drain using 3/8 inch [10 mm] outside diameter nylon tube. Tube nuts and sleeves are supplied with the machine.
   d. Fill the cambox with SAE 30 grade automotive engine oil until the level just covers the datum cam follower link. Place a few drops of oil on the exposed part of the tappet.
   e. The electrical supply line can be run up to the test stand. Do not connect the electricity to the test stand. The service man must inspect the motors, transformers, heater and other internal electrical connections before connecting the electrical supply line to the test stand.

Description of the 3375317 Test Stand Parts

Cambox, Cams and Indexing

1. The cast iron cambox contains a vertically mounted camshaft held in the heavy duty taper roller bearings.
2. The injector cam is mounted on the upper end of the camshaft on a non-stick taper and is driven by a key and keyways. Cam changes can be made easily and quickly, and any number of cams can be used.
3. A transparent cambox lid enables the type of cam on the camshaft to be identified.
4. Injector cam indexing occurs automatically when an injector is unclamped. This is achieved by means of a heart shaped cam on the bottom of the camshaft and a hydraulic cylinder and cam

follower. The indexing mechanism also provides a means of holding the camshaft when the injector cam changes are made.

5. The heart shaped cam is a dynamically balanced flywheel and provides the signal for the electronic stroke counter by means of a peg and magnetic pick up.

Camshaft Drive

1. The motor is a 1-1/2 horsepower synchronous motor, totally enclosed and fan cooled. Electrical characteristics are determined by the location.
2. The camshaft is driven by a timing belt and toothed pulleys on the motor and camshaft. The ratio of the pulleys is such that the camshaft has a running speed of 1050 rpm.

Test Oil and Service Hydraulic System

Tank

1. The tank has a capacity of 10 U.S. gallons [38 liters] with a heater, cooler, stirrer, thermistor, sight glass, drain plug, float level switch and a sludge compartment with a magnetic filter bar.
2. The tank is supported on two channels in the base and can be pulled on to a pallet placed in front of the machine for draining and cleaning.
3. A solid state controller, in the tank, automatically controls the test oil temperature to 104° F [40° C] at the injector.

Filter

The filter on model D and later test stands is Cummins Part No. 154709 (FF105) fuel filter. The pleated paper filter, on models A, B and C, is totally submerged and has a micron absolute filter.

Test Oil Pump and Motor — close coupled

The gear pump delivers 1.68 gpm [6.36 lpm] at 1800 rpm with a 1 horsepower induction motor, 3 phase with overload protection. The stirrer drive is taken from the motor shaft by a pair of cross helical gears having 3:1 reduction producing a stirrer speed of 600 rpm.

Inertia Damper

The inertia damper is a coil of 24 inches [609 mm] long, 3/32 inch [2.4 mm] diameter bore and 1/4 inch [6.3 mm] outside diameter steel capillary tubing. This coil of tubing acts as an inertia damper to reduce pump teeth and pump cyclic pressure variations.

Deadweight Pressure Control Valves

Test oil is supplied to a deadweight valve block by the inertia damper where three separate valves operate in series. They generate pressures of 100, 74 and 12 psi [689, 510, 83 kPa] which are used as follows:

100 psi: [689 kPa]	Injector test oil supply Seal cylinder providing sealing force Unclamp cylinder providing unclamping force
74 psi: [510 kPa]	PT injector clamping force
12 psi: [83 kPa]	Not currently used

Plenum Chamber

A 1 quart [1 liter] capacity steel plenum chamber is teed into the line connecting the 100 psi [689 kPa] supply to the injector orifice. Its purpose is to minimize pressure fluctuations due to the injector metering cycle.

Rotary Control Valve

A rotary control valve is used to control the indexing, clamping and sealing functions. It is fed with two of the three hydraulic pressures from the deadweight valve block.

Pressure Select Valve

1. The pressure select valve, on the front face of the deadweight valve block, is set at 74 psi [510 kPa] clamp pressure. This pressure is piped to the clamping rotary control valve.
2. The 12 psi [83 kPa] is not used.

Handle Lever Arm

The handle lever arm is an over center toggle clamp which connects a self-sealing valve to the injector orifice.

Injector Sealing and Clamping

1. The injector is held horizontally in the test stand. A dual piston clamp head assembly provides independent sealing and clamping loads on the injector body and plunger respectively.
2. The clamp head is hydraulically operated by the pressures generated in the test oil system and is controlled by means of the rotary clamping control valve.

Sealing Force

The injector cup is constantly loaded against the nylon seal in the nose cone assembly with a force of 167 lb. [75 kg].

Clamping Force

1. The combined injector, nose cone and sealing assembly are loaded against the indexed injector cam by the injector link and cambox tappet.
2. A clamping force of 380 lb [172 kg] is provided by the deadweight control valve.

Clamping Force Datum Spool Valve

1. A spool valve, driven by a link from a fixed cam on the cambox camshaft, permits the clamping load to be relocated every cycle. This occurs during top dwell (outer base circle) for PT injectors.
2. It ensures that the relative positions of the injector cam and injector body are the same every cycle which means that the injector fuel metering cycle is maintained constant.

Nose Cone Assembly

1. A plate type non-return valve simulates cylinder back pressure and prevents back flow of injected fuel into the injector during plunger retraction.
2. A replaceable conical nylon seat provides the seal between the injector cup and nose cone assembly.

Injector Location and Adapters

Cylindrical Injectors

1. Ring adapters are provided for all types of cylindrical injectors. The injectors are located in the adapters such that the balance orifice is always aligned with the self-sealing valve in the fuel arm.
2. Links are provided for all types of cylindrical injectors.

Flanged Injectors (H-NH, J and C)

1. Two piece ring adapters are supplied for 5/16 inch and 3/8 inch flanged injectors. The ring which engages the clamp plate is common to both sizes.
2. A link is supplied which is used with both sizes of flanged injector.
3. A drain pipe assembly is supplied which fits both sizes of injectors and is used to direct the drain flow into the test stand top tray.

Metering System

1. The metering system is a positive piston displacement system with a dial indicator display of injector output. Injector output is measured over 50 injections.

Capacity 500 cc/1000 strokes
(1 cc/1000 strokes = 1 mm^3/stroke)
Resolution $\pm$ 0.1 cc/1000 strokes

2. The solid state electronic stroke counter is a proprietary item. The start and end of metering are phased to the camshaft flywheel which provides the signal by means of a peg and magnetic pick-up. Injection chopping is therefore eliminated.

Storage Boxes

1. Storage boxes are provided on the left and right sides of the top tray for storage of cams, adapters and links.
2. Refer to the manual in the test stand for a more detailed parts explanation.

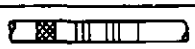
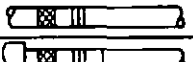
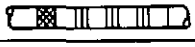
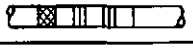
Cam Code	Injector Type	Link Identity	Cam Code	Injector Type	Link Identity
C/PT	3/8" PTB, PTC long link		C/PT	3/8" PTD Top Stop (Top Stop Removed)	
C/PT	3/8" PTB, PTC med. link		.169 Small Cam	3/8" PTD Top Stop (Preset)	
C/PT	3/8" PTB, PTC short link		.230 Big Cam	3/8" PTD High Capacity Top Stop (Preset)	
C/PT	5/16" PTB, PTC ball end		C/PT	5/16" PTD	
C/PT	5/16" PTB, PTC std. end		C/K-PTD	K-PTD	
C/PT	H-NH, J-C Flanged		C/PT	3/8" PTD Flanged	
C/PT	3/8" PTD		C/K-PTD	3/8 PTD Top Stop Hi-Cap (Top Stop Removed)	

Fig. 4-22A. The 3375317 test stand cam and link table

3375317 Injector Test Stand Troubleshooting

Complaint	Probable Cause	Solution
Low Flow 3-5 cc or scattered	Dirty Nose Cone	Disassemble, clean valve plates. Lap if necessary to pass audit check.
3-5 cc or scattered	Handle lever arm nozzle O-ring covering injector orifice (deteriorated)	Replace O-ring.
2 cc	Test oil filter in tank plugged	Replace filter.
2 cc	Inline filter to metering unit dirty	Clean in sonic cleaner.
2-10 cc low	Shot countercircuit erratic Gear pump pressure low	Wiggle PL2 wire. Check pressure-replace gear pump as required.
	Gear pump drive slipping	Tighten drive coupling setscrew.
2 cc	Weak handle lever arm spring	Tighten collar or replace spring.
3-10 cc or scattered	Worn cam drive key	Replace key.
2 cc	Handle lever arm worn at pivot points	Replace handle lever arm assembly.
2 cc	Metering head filter plugged	Clean in sonic cleaner.
Scattered	Stand unlevel	Level stand-recheck deadweights 100 psi and 74 psi.
Scattered	Deteriorated fuel arm supply hose	Replace hose.
	Wrong Cam	Replace as required.
	Wrong Link	Replace as required.
10-20 cc low on top stop injectors	Trying to flow top stop with wrong cam	Install correct cam.
Stand running hot	Temperature indicator out of adjustment	Check test oil temperature with thermometer and adjust temperature indicator accordingly.
	Water inlet solenoid valve stuck closed	Disassemble valve and clean and replace.
	Temperature control reostat improperly adjusted	Adjust as required.
	All above fails to correct problem	Replace printed circuit board or heat sink.
Clamping index mark does not line up	Wrong cam	Replace as required.
	Wrong link	Replace as required.
	Datum valve sticking	Observe datum valve position and correct sticking problem — clean as required.

Complaint	Probable Cause	Solution
	Datum valve cam follower roller deteriorated	Remove and replace with new roller.
Clamp cylinder will not clamp or clamps slowly or link is loose when clamped	Datum valve sticking	Observe datum valve position and correct sticking problem — clean as required.
	Datum valve cam follower roller deteriorated	Remove and replace with new roller.
	Rotary clamp valve restriction	Remove and clean.
	74 psi deadweight not working properly	Clean and adjust with trim washers as required.
	Seals leaking in clamp cylinder	Replace seals.
	Datum valve leaking	Replace with new parts.
Counter quit working	Broken electrical signal	Wiggle PL2 wire on printed circuit board.
	Broken electrical signal	Magnetic pickup on heart cam not adjusted properly.
	Metering inlet solenoid valve sticking or inoperative	Check voltage to coil — replace oil as required or correct cause.
Counter dial hand does not repeat	Dial hand slipping on spindle or sticking	Replace dial indicator assembly.
	Metering inlet solenoid valve sticking or inoperative	*Check voltage to coil or replace oil* as required or correct cause.
Deadweights bouncing	Air in system	Tighten all suction connections.
Deadweight jumps too high when pump is turned on, knocks can off, squirts test oil	Air in system	Bleed piston by pouring test oil on top of piston and work piston up and down by hand (pliers, etc.)
	Rough mating surface of bottom of piston and valve plate.	Disassemble and lap surface together — reassemble and repeat step just above to bleed air.
Main Drive Motor will not run	Handle lever arm gap excessive	Reset to .080/.100.
	OL1 or OL2 kicked out	Reset or replace if reset is ineffective.
	Start switch defective	Repair or replace.
	No 3 phase power	Find fault.
	No 24 volts to switches	Find fault.
	Bad contactor(s)	Replace.
Stand running cold	Cooling solenoid stays on (energized). Water running continuously out the drain	Replace heat sink and/or PCB.

Injector Test Stand Audit Kit Service Tool No. 3375366

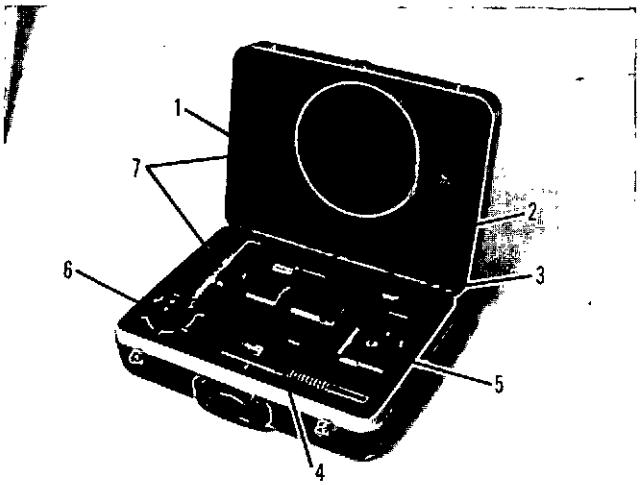
The 3375366 Injector Test Stand Audit Kit is used to check the calibration of a 3375317 Injector Test Stand. The test stand must be periodically checked to make sure of the reliability of the output display. Master injectors are not used to check a 3375317 Injector Test Stand, Fig. 4-23.

Introduction

These instructions include the data required to prepare the Injector Test Stand, conduct tests and make adjustments as required. Follow all of the instructions in the outlined sequence.

Preparing 3375317 Injector Test Stand

1. Install a 178A cc PT (type D) Injector and run the test stand for approximately 30 minutes.
2. Remove the front top panel from the test stand.



1. Case (Only)
2. Viscometer
3. Thermometer
4. Dummy Injector Link, & Spring
5. Dead Weight Tester Baseplate
6. Pressure Gauge (0-600)
7. Test Oil Drain Adapter Kit Time-Viscosity Chart Viscosity-Temperature Chart

Fig. 4-23. 3375366 Audit Kit

Test Oil Temperature Check

The purpose of this check is to establish test oil temperature and calibrate the temperature display green band to cover a range of 103° to 105° F [39.5° to 40.5° C]. The injector test stand must be operating during this check.

1. Fill the thermometer well with test oil and insert the audit kit thermometer, Fig. 4-24. Allow five minutes for the temperature to stabilize.

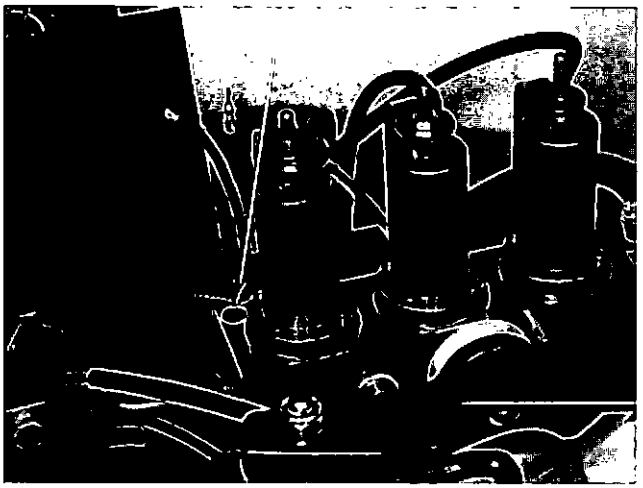


Fig. 4-24. Thermometer well

2. If the stabilized temperature is other than 104° F [40° C] rotate the potentiometer screw (1, Fig. 4-25) as required to increase or decrease the indicated temperature. Rotate the screw clockwise to increase, or counterclockwise to decrease the temperature. Allow 15 minutes for the temperature to stabilize.

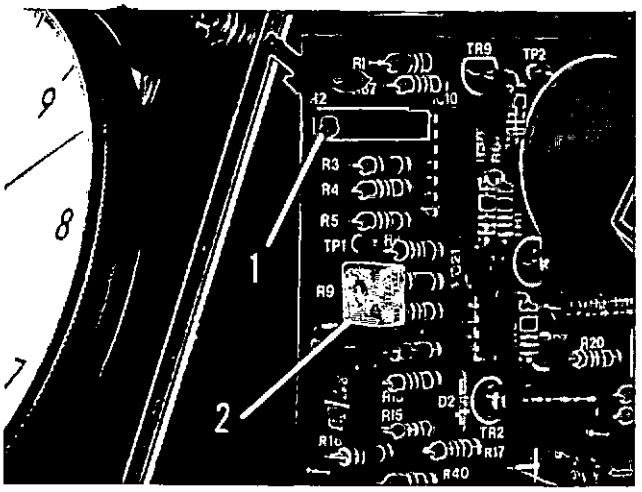


Fig. 4-25. Temperature control circuit board

3. Adjust the potentiometer (2, Fig. 4-25) to center green band on temperature display.

Oil Viscosity Check

The purpose of this check is to determine the test oil viscosity. The oil temperature check must be completed before making this check.

Use the Viscometer Cup (in the audit kit) and a stop watch (not included in the audit kit).

Note: The Injector Test Stand must be stopped while this check is being performed.

1. Unplug the heater cord. Remove the reservoir holding pins and lift stir rod coupling. Slide the reservoir to the front of the stand and remove the reservoir cover.
2. Submerge the viscometer cup into the test oil in the reservoir. Allow 10 minutes for the cup and test oil temperature to stabilize.
3. Raise the cup, by the handle, from the test oil by a smooth rapid motion. Use care to keep the cup level.
4. Start the stop watch when the top of the cup breaks the test oil surface.

Note: The cup must be held steady until the oil level falls below the cup lip.

5. Stop the stop watch when the last drop of test oil drains through the cup drain hole.

Note: The difference between the times must be within one second.

6. Repeat steps 2, 3, 4 and 5 and average the times required for the oil to drain from the cup.

Note: Chart 1, Time-Viscosity, and Chart II, Viscosity-Temperature, are included in the audit kit. The kit charts are specifically prepared for the viscometer included in the kit and assigned the same serial number as the kit. The serial number is stamped on the lower right corner of each chart. The boxed-in number on the upper right corner is the Cummins Test Oil number.

7. Locate the average time point (step 6) on the left side (Efflux Time-Seconds) of Chart I. Follow the related line to the right to the point where it intersects the diagonal line. Follow the intersection point downward to the bottom line (Viscosity-Centistokes) and read the viscosity.
8. Locate the viscosity point established in step 7 on the left side (Kinematic Viscosity, Centistokes) of Chart II. Follow the related line to the right. Locate the 104° F [40° C] point on the bottom line (Temperature, Degrees Fahrenheit) and follow the related line upward to the point where it intersects the line extended from the left side.

Note: Only the 104° F [40° C] point can be used for this check since that was the test oil temperature set during step 2 of the Test Oil Temperature Check.

If the intersection point of the bottom and left side line falls between the minimum and maximum fluid specifications diagonal lines, and no visible foreign matter is in the oil, the oil is suitable for further use. If the intersection point falls outside the diagonal lines, the test oil must be replaced. Replace the oil with 3375364 or 3375365 Cummins Test Oil.

9. Slide the reservoir into the operating position. Replace the bottom cover. Replace the stir rod drive coupling and the holding pins.
10. Connect the tank heater plug.

Test Oil Gear Pump Test

1. Remove the 6 mm plug from the test oil junction block.
2. Connect the pressure gauge in the audit kit, adapter and valve to the junction block, Fig. 4-26. Install the tubing cap on the gauge assembly tee.
3. Start the test oil system. Open the valve and check the indicated pressure. The pressure must be 400-410 psi [2757-2826 kPa].
4. If the indicated test oil pressure is below 400 psi [2757 kPa], perform the following checks and take corrective actions as required.
   a. Check the test oil supply. Add test oil if required.
   b. Bleed any trapped air from the gauge line by loosening the tubing cap at the gauge sufficiently so test oil seeps from the loosened cap. Tighten the cap.
   c. Check the geat pump drive for slippage. Make repairs as required.
   d. Check that the motor wires are properly and securely connected.
   e. Check the gear pump motor electric circuit. Replace the motor if required.
   f. Check the tank filter for restriction or make sure the filter is submerged in the tank.

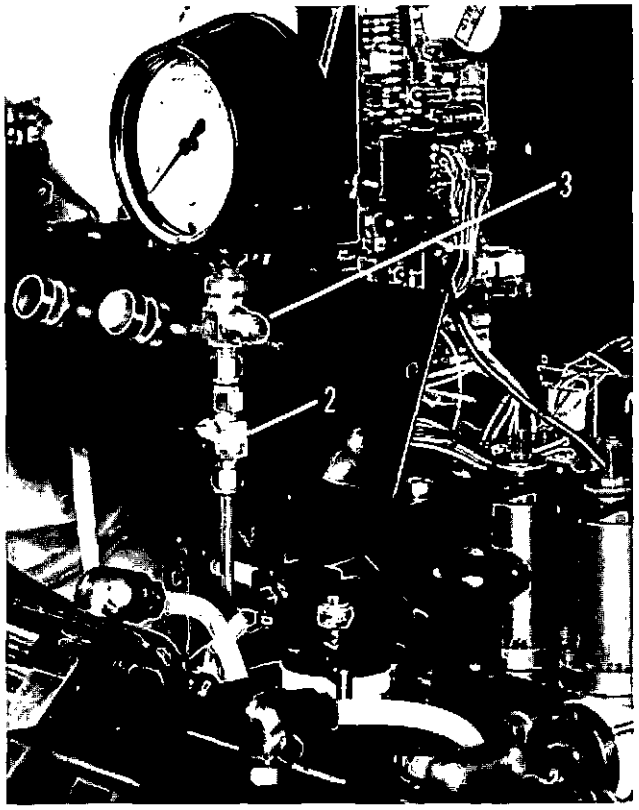


Fig. 4-26. Gear pump test hook-up

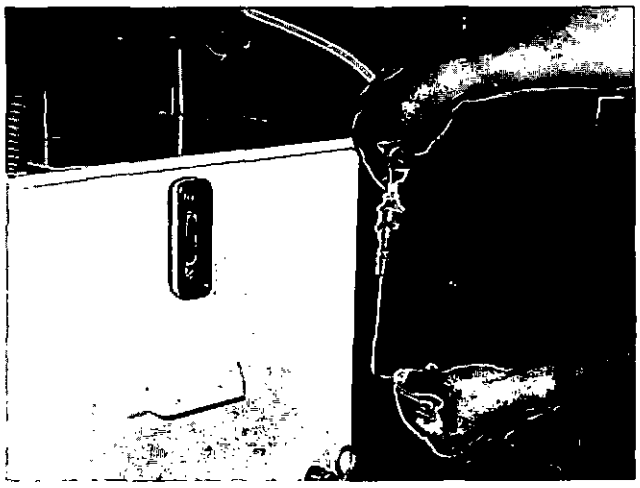


Fig. 4-27. Adjust the gear pump pressure

g. Adjust the gear pump by-pass orifice, Fig. 4-27.

Note: If the test oil pressure is still below 400 psi [2757 kPa] and the by-pass orifice has been adjusted all of the way in, replace the gear pump.

5. When the test oil pump pressure is within the limits, close the gauge valve.

Assembling the Dead Weight Tester

Tools required: Dummy Injector and Link (4, Fig. 4-23), Dead Weight Tester (5, Fig. 4-23), Pressure Gauge (6, Fig. 4-23), 3/8 inch Adapter Pot, Dead Weights and Metric Open End Wrench Set (not included in the audit kit).

1. Place the dead weight tester baseplate on a solid surface.
2. Place the 11.5 psi [79 kPa] dead weight and stem into the barrel in the center of the baseplate, Fig. 4-28.

Note: The 11.5 psi [79 kPa] dead weight and stem are used for all pressure checks. Additional weights are placed on the 11.5 psi [79 kPa] dead weight for higher pressure checks.

3. Loosen the brass thumbscrew from the baseplate corner. Install the dead weight retainer by inserting the retainer under the thumbscrew. Tighten the thumbscrew.
4. Connect nylon hose SAE compression fitting to the fitting in the baseplate.
5. Remove the 6 mm plug from the clamp cylinder

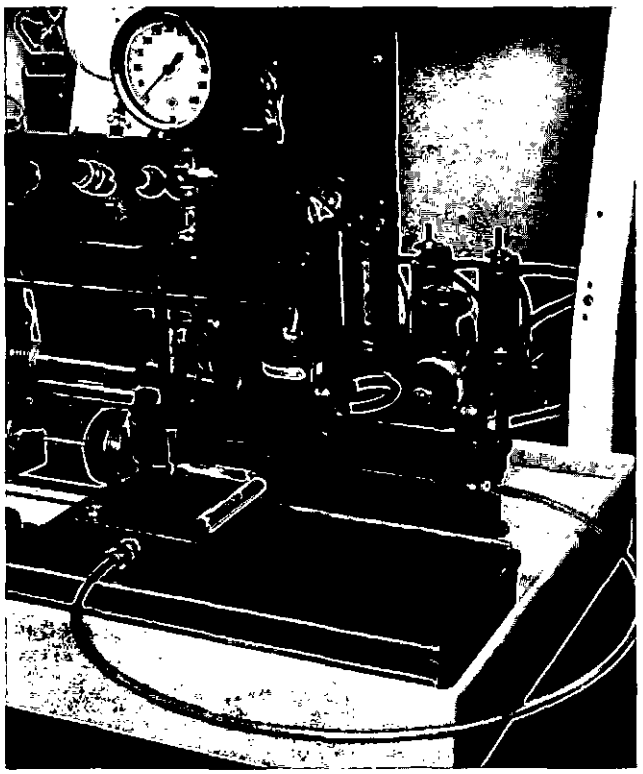


Fig. 4-28. The 3375450 Dead Weight Tester is connected to the end plate

end plate and connect the nylon hose 6 mm fitting from the dead weight tester baseplate to the plug port. Place the dead weight tester on the work tray.

12 PSI [83 kPa] Clamp Pressure Check (For Future Injectors)

The test stand is set for 74 psi [510 kPa]. This check can only be made by the Cummins authorized service man. The test stand and the main drive must be off before starting this check.

1. Level the dead weight tester by turning the three socket head screws, as required, to center the level gauge bubbles. Spin the dead weight and stem to relieve friction.

Note: The dead weight and stem must float freely in the barrel.

2. Move the clamp plate section valve to the extreme left, 12 psi [83 kPa] or PTE position.
3. Remove the dummy link from the Dummy Injector. Install the injector into a 3/8 inch PT (type D) pot and install the positioning pin furnished with the test stand.

Note: This series of tests is performed with the dummy link and spring removed.

4. Install a K or PT (type D) cam furnished with the test stand.
5. Install the 6 mm plug removed from the cylinder clamp (step 5, Assembling Dead Weight Tester) end clamp in the dummy injector.
6. Check that an O-ring is installed in the nozzle end before engaging the handle lever arm. Start the test oil pump drive motor. Clamp the dummy injector in the test stand. Engage the handle lever arm and start the test stand main drive.

Note: Apply slight hand pressure to the dead weight to keep it stable while air is being purged. The dead weight and stem must float free.

7. Bleed the air from the hose by loosening the tube fitting in the baseplate.
8. Place the 1 psi [6.9 kPa] trim weight (included in Audit Kit) on the roll pin in the dead weight stem. The dead weight and stem must fall. If not, the 12 psi [83 kPa] clamp pressure is high. Decrease the clamp pressure by removing enough trim weights from the top hanger bracket so the dead weight and stem fall.
9. Remove the 1 psi [6.9 kPa] trim weight. The 11.5 psi [79 kPa] dead weight and stem must float free. If not, the 12 psi [83 kPa] clamp pressure is low. Increase the clamp pressure by adding enough trim weights to the top hanger bracket so the 11.5 psi [79 kPa] dead weight and stem float free.
10. When steps 8 and 9 are completed, the 12 psi [83 kPa] clamp pressure is accurately adjusted at 12 psi [83 kPa].
11. Lift the handle lever arm up. Stop the test stand main drive.

74 PSI [510 kPa] Clamp Pressure Check (PT Injectors)

Note: This check is required for all PT injectors. The test stand must be off before starting this test.

1. Loosen the dead weight retainer thumbscrew. Move the retainer and add the 73.5 psi [506 kPa] dead weight (included in audit kit) to the 11.5 psi [79 kPa] dead weight stem. Replace the retainer and tighten the retainer thumbscrew.
2. Level the Dead Weight Tester by turning the three socket head screws as required to center the level gauge bubbles. Spin the dead weight and stem to relieve friction.

Note: The dead weight and stem must float freely in the barrel.

3. The clamp plate selection lever (1, Fig. 4-29) is set at the extreme right, 74 psi [510 kPa] or PT position.
4. Remove the dummy link from the Dummy Injector (4, Fig. 4-23). Install the injector into a 3/8 inch pot and install the positioning pin furnished with the test stand.
5. Install the K or PT (type D) cam furnished with the test stand.
6. Remove the 6 mm plug from the clamp cylinder.
7. Install the 6 mm plug removed from the clamp cylinder end plate (step 5, Assembling Dead Weight Tester) in the dummy injector.
8. Check that an O-ring is installed in the dummy injector. Start test oil system drive motor. Clamp the dummy injector in the test stand. Engage the handle lever arm and start the test stand main drive.

Note: Apply slight hand pressure to the dead weight to keep it stable while air is purged.

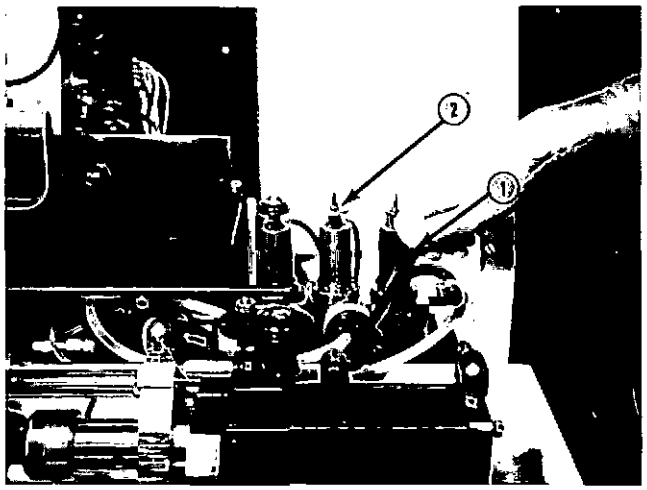


Fig. 4-29. Clamp pressure selection lever is set at the 74 psi position

9. Remove the air from the hose by loosening the tube fitting in the baseplate.
10. Place the 1 psi [6.9 kPa] trim weight (included in audit kit) on the roll pin in the dead weight stem. The dead weight and stem must fall. If not, the 74 psi [510 kPa] clamp pressure is high. Decrease clamp pressure by removing enough trim weights from the top hanger bracket (2, Fig. 4-29) so the dead weight and stem fall.
11. Remove the 1 psi [6.9 kPa] trim weight. The 73.5 psi [506 kPa] dead weight and stem must float free. If not, the 73.5 psi [506 kPa] clamp pressure is low. Increase pressure by adding enough trim weights to the top hanger bracket (2, Fig. 4-29) so the 73.5 psi [506 kPa] dead weight and stem float free.
12. When steps 9 and 10 are completed, the 74 psi [510 kPa] (PT) clamp pressure is accurately adjusted at 74 psi [510 kPa].
13. Lift the handle lever arm up. Stop the test stand main drive.
14. Remove the plug from the dummy injector. Disconnect the hose from the clamp cylinder. Install the plug removed from the dummy injector.

100 PSI [689 kPa] Injector Supply Pressure

Tools required: Dummy Injector and Link (1, Fig. 4-23), Dead Weight Tester (5, Fig. 4-23), Pressure Gauge (6, Fig. 4-23), 3/8 inch Adapter Pot and Metric Open End Wrench Set (not included in audit kit).

1. Loosen the dead weight retainer thumbscrew and move the retainer. Remove the 73.5 psi [506 kPa] dead weight.

Note: The 11.5 [79 kPa] dead weight must not be removed.

2. Add the 99.9 psi [688.7 kPa] dead weight (included in audit kit) to the dead weight stem. Replace the retainer and tighten the retainer thumbscrew.
3. Connect the dead weight tester 6 mm fitting and dummy injector connection with the nylon hose, Fig. 4-30.
4. Level the dead weight tester by turning the three socket head screws, as required, to center the level gauge bubbles. Spin the dead weights and stem to relieve friction.

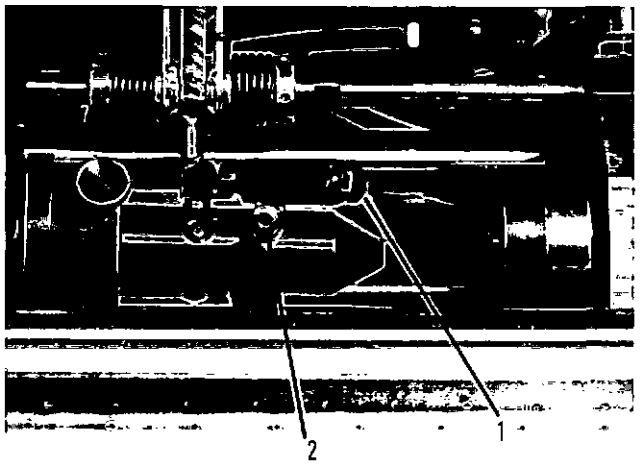


Fig. 4-30. Dummy injector connections

Note: The dead weight and stem must float freely in the barrel.

5. Check that a K or PT (type D) cam, installed during the clamp pressure test, is still installed. Start the test oil system motor. Clamp the dummy injector in the test stand.
6. Lower the handle lever arm and start the main drive.

Note: Apply slight pressure to the dead weight to keep it stable while the air is being purged.

7. Check that the test oil is flowing from the injector drain.
8. Place the 0.2 psi [1.4 kPa] trim weight (included in audit kit) on the roll pin in the dead weight stem.

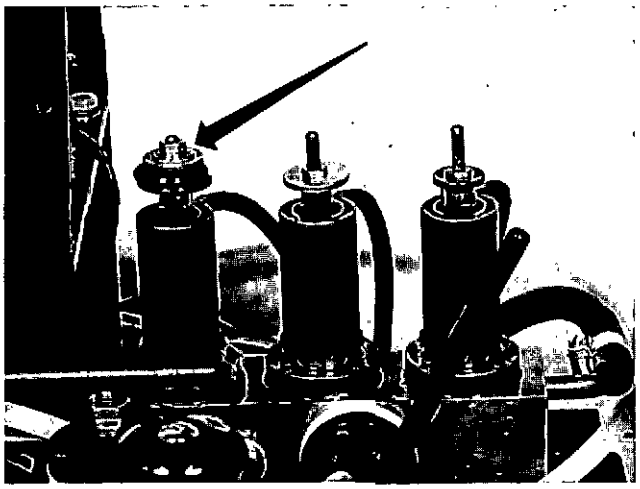


Fig. 4-31. 100 psi supply pressure valve

The 99.9 psi [688.7 kPa] dead weight and stem must fall. If not, the 100 psi [689 kPa] supply pressure is high. Decrease the pressure by removing enough trim weights from the top hanger bracket, Fig. 4-31.

9. Remove the 0.2 psi [1.4 kPa] trim weight. The 99.5 psi [686 kPa] dead weight and stem must float free. If not, the 100 psi [689 kPa] supply pressure is low. Increase the pressure by adding enough trim weights to the top hanger bracket so the 99.5 psi [686 kPa] dead weight floats free.
10. When steps 8 and 9 are completed the supply pressure is accurately adjusted at 100 psi [689 kPa].

Assembling Nose Cone for Checks

Tools required: Dummy Injector and Link (1, Fig. 4-23), Pressure Gauge (6, Fig. 4-23), tubes and fittings for making a tee and connecting the gauge. Tubes and fittings are included in the audit kit.

1. Disconnect the nose cone outlet pipe.
2. Remove the tubing cap (3 Fig. 4-26) from the pressure gauge. The pressure gauge is still connected to the junction block.
3. Install the 6 mm plug, removed from the test oil junction block, into the dummy injector connection, (1, Fig. 4-30).

Nose Cone Leak Check

1. Install the hose with the SAE compression fitting and the 6 mm fitting from the nose cone outlet opening to the gauge tee, Fig. 4-32.
2. Close the pressure gauge valve and start the test oil system.
3. Open the valve and check for external leaks at the plate valve, joints, seals, etc.
4. Close the valve. If the gauge pressure falls below 350 psi [2413 kPa] in 60 seconds, the leak rate is excessive. If the leak is past the check valve, disassemble the nose cone, lap as necessary, clean and reassemble. If leak(s) occur at other points repair as necessary.
5. Turn the test stand off.

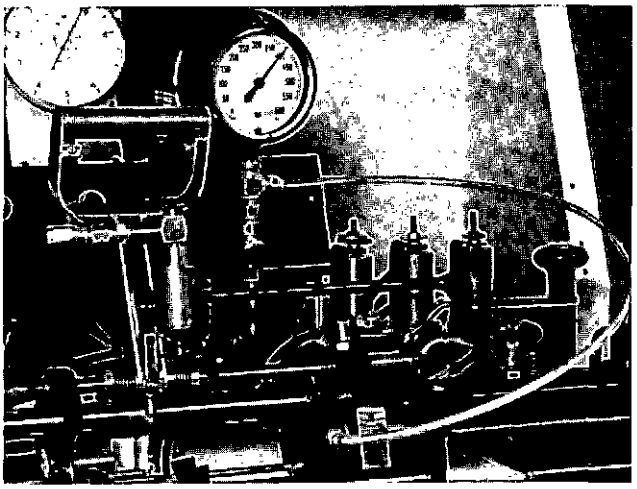


Fig. 4-32. Nose cone leak check plumbing

Nose Cone Flow Pressure Check

1. Close the pressure gauge valve and remove the

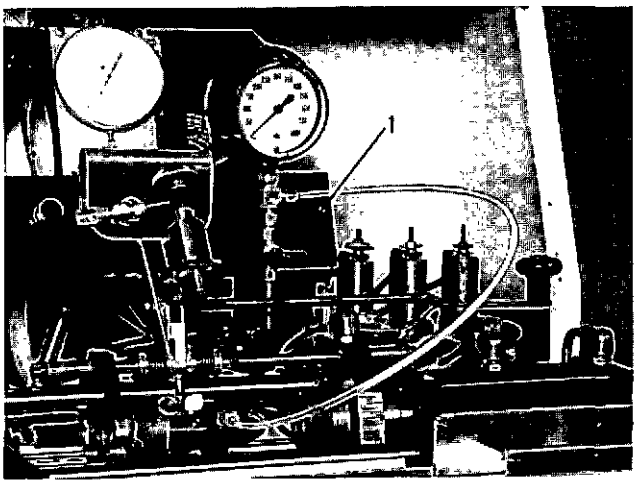


Fig. 4-33. Flow pressure check plumbing

hose from the nose cone outlet. Install the hose to the outlet in the dummy injector, Fig. 4-33.

2. Start the test stand and clamp the dummy injector in test stand.

Note: Be sure the nose cone is positioned to drain the test oil into the tray.

3. Open the valve and check the pressure. The pressure must be 350 ± 25 psi [2430 ± 172 kPa].

4. If the pressure is not within limits, remove the nose cone end cap and adjust the pressure screw, Fig. 4-34.

Note: Turn the screw clockwise to raise the pressure and counterclockwise to lower the pressure.

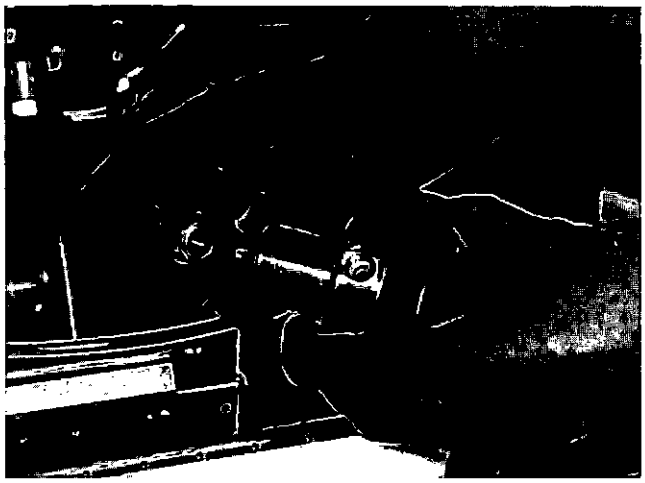


Fig. 4-34. Remove the nose cone end cap

Check Valve Leakage Test

Note: A check valve leakage test must only be made after the nose cone flow pressure check is completed.

1. Start the test stand and clamp the dummy injector in the test stand.

Note: Be sure the nose cone is positioned to drain the test oil into the tray.

2. Close the valve quickly and check the pressure. The pressure must remain above 150 psi [1034 kPa] for a minimum of 30 seconds.

3. If the pressure does not meet the specification, open and close the valve several times to flush the dirt from the nose cone and repeat test.

4. If nose cone still will not hold pressure, disassemble, lap the plate valve and seat separately, clean and reassemble.

Clamp Head/Datum Valve Leakage Test

1. Stop the test stand and remove the injector link support.

2. Install the dummy injector, link and spring, 4, Fig. 4-23.

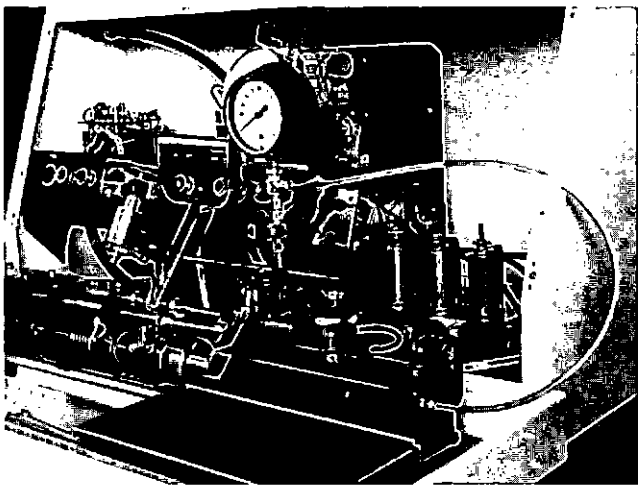


Fig. 4-35. Datum valve leakage test plumbing

3. Remove the plug from the clamp cylinder end plate.

4. Install the 6 mm to SAE connector in the end plate plug port. Connect the nylon hose from the pressure gauge to the connector.

Note: The pressure gauge is still connected to the junction block.

5. Turn the test oil system motor on. Clamp the dummy injector. Check the pressure gauge. Rotate the cam 180 degrees by hand with the cam socket and handle. Observe the pressure gauge.

6. Turn the test oil system off. If the indicated pressure remains above 35 psi [241 kPa] for 60 seconds, the datum valve is satisfactory. If the indicated pressure falls below 35 psi [241 kPa] in less than 60 seconds check for datum valve leaks.

7. If the gauge reading remains above 35 psi for 60 seconds, switch the test oil system back on. If the gauge reading does not raise more than two psi in 60 seconds, the datum valve is satisfactory.

8. The datum valve must pass both steps 6 and 7.

9. If the datum valve is not leaking, check the clamp piston seal, the clamp cylinder end plate gasket and all fittings for leaks. Repair as required.

Maintenance of the Audit Kit Tools

Clean the kit tools after each use. Place the tools in the case and store the case in a dry location.

Maintenance Schedule of 3375317 Injector Test Stand

Do Not Exceed The Specified Service Times

The time between service periods is in hours. The hour meter on the test stand is connected to the test oil pump. Do not exceed the time limits of the service periods.

After each 200 hours of operation:

1. Change the test oil — use oil to SAE Spec. J967D. Cummins Part No. 3375364 in 55 gal. drums or 3375365 in 30 gal. drums.

Note: Test oil can be used longer if the viscosity is between 2.4 and 2.9 centistokes at 104° F [40° C].

2. Change the test oil filter.
3. Clean the magnetic filter bar.
4. Clean the metering unit filter. This filter is located in line between the nose cone and the metering unit.
5. Replace the handle lever arm shut-off valve O-ring.
6. Apply grease to the stirrer drive shaft gears and bushings.
7. Lightly oil the stirrer drive shaft bushings.

After each 1000 hours of operation:

1. Change the cambox oil, use Automotive Engine Oil SAE 30W.
2. Adjust the drive belt tension. There must be about 1/2 inch [13 mm] deflection of the belt when pressed by thumb at the midpoint between pulleys. Adjust the tension by loosening the motor capscrews and sliding the motor.
3. Lightly oil the index lever roller bearings.
4. Lightly oil the index lever pivot.
5. Lightly oil the index cylinder pivot bushings.
6. Lightly oil the handle lever arm pivot points.

Note: To check the datum valve, the camshaft must be at the index position. Hold the rod to be certain the lever roller is in contact with the camshaft when adjusting the datum valve.

7. Check the datum valve adjustment. The spool shaft must be flush ± 0.010 inch with its housing when viewed from the right side of the test stand. To adjust, remove the spring retainer from the datum valve, loosen the spool locknut and rotate the spool to adjust. Tighten the locknut, readjust the spring and tighten the spring retainer.
8. Check the magnetic pickup to the heart shaped camshaft peg clearance. Adjust until the clearance is 0.005 to 0.010 inch [0.13 to 0.24 mm].
9. Check the handle lever arm center line position relative to the adapter plate. Adjust if the handle lever arm nozzle repeatedly fails to align with the injector balance orifice. The handle lever arm center line must be 2.50 to 2.54 inch [63.5 to 64.5 mm] from the adapter plate.
10. Check the minimum clearance between the index roller and the heart shaped cam at the index position. Clearance is 0.005 to 0.015 inch [0.13 to 0.38 mm]. The nylon roller must spin freely by hand when the cam is in the index position. Adjust by loosening the index piston rod locknut and rotating the piston rod. The test oil pump must be switched off for easier adjustment.

Note: Do not damage the piston rod.

After 5000 hours of operation:

The test stand must be completely checked out for a possible major overhaul.

ST-790 Operation and Calibration

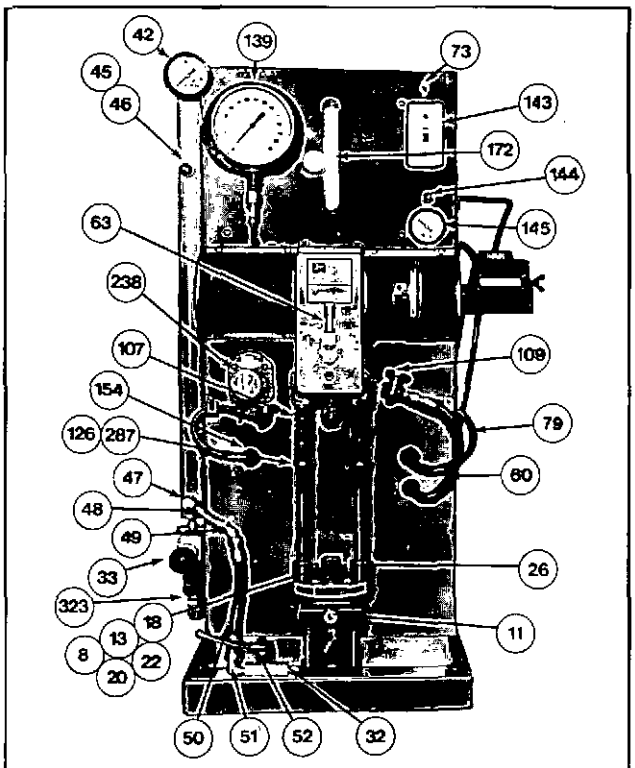
Injector Test Stand — ST-790

The ST-790 Injector Test Stand is used for testing and calibrating Cummins injectors. The test stand must be properly installed and calibrated to obtain the highest accuracy possible, Fig. 4-36.

The test stand counts injection strokes, supplies fuel at a specified pressure, and measures the delivery in a glass graduate.

Fuel Pump and Injector Test Stand Audit Kit, 3375187

The Audit Kit is used to master check the performance of the ST-790 and ST-848 Test Stands. Fig. 4-37.



ST-790-8	Orifice Screw (.013)	ST-790-73	Vial Light Switch
ST-790-11	Exhaust Muffler	ST-790-79	Inlet Hose
ST-790-13	Seat Block	ST-790-107	Tie Rod Spring
ST-790-18	O-ring	ST-790-108	Cover Assembly
ST-790-20	Orifice Screw (.011)	ST-790-109	Inlet Connection
ST-790-22	Check Valve Spring	ST-790-126	Tie Rod Bushing
ST-790-26	Tie Rod Spacer	ST-790-139	Fuel Pressure Gauge
ST-790-32	Hex Nipple	ST-790-143	Start & Stop Switch
ST-790-33	Air Valve	ST-790-144	Flow Start Switch
ST-790-42	Air Gauge	ST-790-145	Temperature Gauge
ST-790-45	O-ring	ST-790-154	Hose Grommets
ST-790-46	Hyd. Oil Level Sight Gauge	ST-790-172	Vial Graduate
ST-790-47	Elbow	ST-790-238	Pressure Regulator
ST-790-48	Hyd. Fluid Sight Glass	ST-790-287	Tie Rod
ST-790-49	Elbow	ST-790-323	Air Valve
ST-790-50	Hose Assembly	ST-790-335	Orifice (.020)
ST-790-51	Valve Elbow	ST-790-338	Counter
ST-790-52	Hydraulic Valve	ST-790-363	Orifice (.026)
ST-790-60	Inlet Hose		
ST-790-63	Sight Glass		

Fig. 4-36, (F60122). Injector test stand ST-790

The kit includes one ST-1210, 132CC, one ST-1262 185A, one ST-1306 178A CC Master Injectors for the ST-790 Test Stand, and a master fuel pump for the ST-848 Test Stand. Also included are the spare parts for both of the test stands, consisting of those which most frequently require replacement. In addition, a master gauge used in checking the test stand gauge calibration is a part of the kit. This kit is available through the Cummins Service Tools Center.

Operation of ST-790

1. A motor driven shaft and a cam are housed in the cam box. The cam actuates the vertical push rod at the bottom on the housing.
2. The push rod is connected to the injector by a link so the injector plunger will be actuated by the cam action just as it is in the engine, Fig. 4-38.
3. The injectors are clamped in the test stand by hydraulic pressure from the cylinder, piston rod and injector seat. The injector seat contains a removable orifice to restrict the metered test oil flow and causes a back pressure simulating the compression pressures as found in the engine. Be sure to use the correct size seat orifice, Fig. 4-39.
4. Before clamping the injector in the test stand, the cam must be timed by rotating the timing wheel so the wheel mark and pointer are aligned, Fig. 4-40.

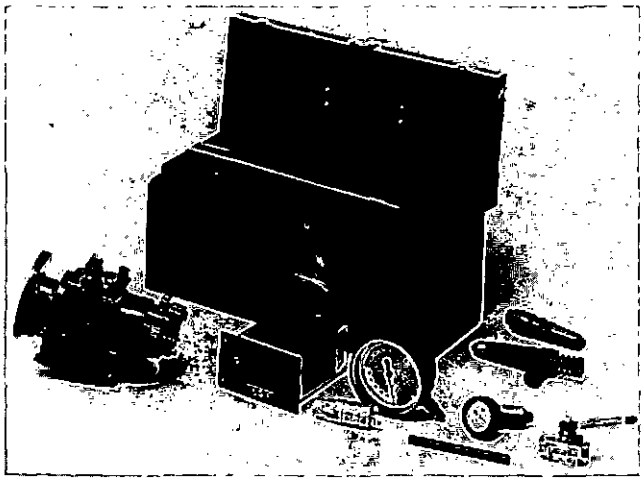


Fig. 4-37, (3375187) The test stand audit kit

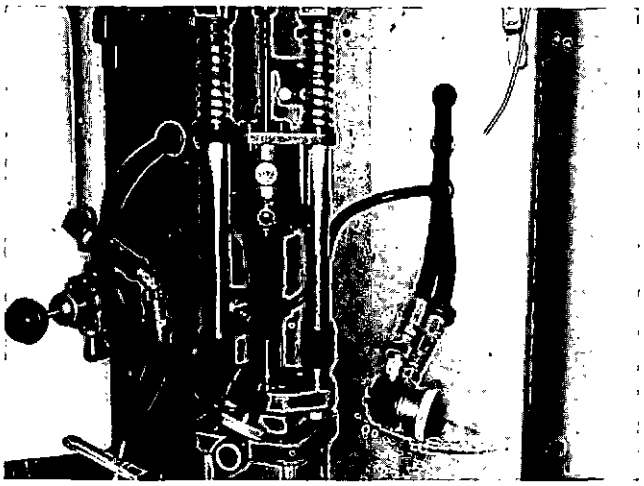


Fig. 4-38, (F60208). The link and injector in position

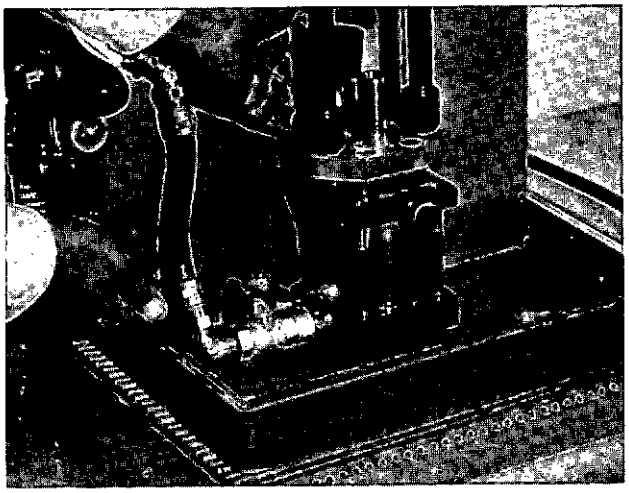


Fig. 4-39, (F60124). The clamping cylinder and seat

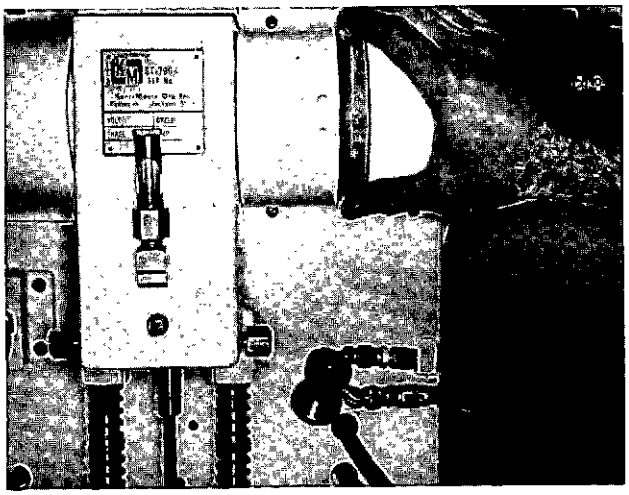


Fig. 4-40, (F60125). Align the timing wheel mark and the pointer

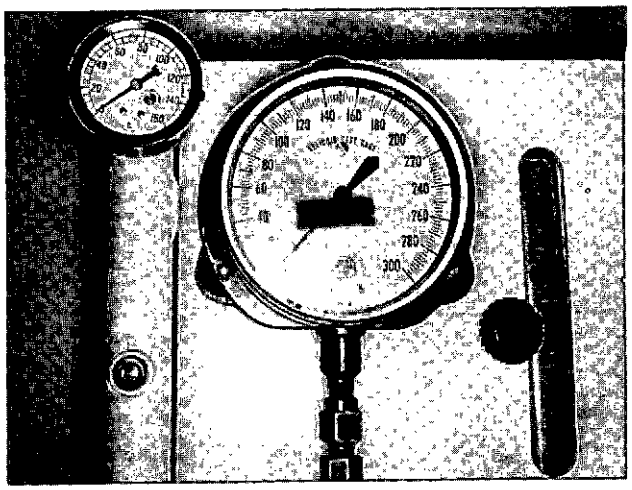


Fig. 4-41, (F60209). The air pressure and test oil pressure gauges

5. Shop air pressure, regulated by an air regulator, is used to apply a balanced force on the hydraulic system, Fig. 4-41. The air gauge at the top of the hydraulic reservoir is used as a reference indicating that pressure has not changed, after being set when using a load test cell during the test stand calibration.
6. When the air valve is opened, air travels up the pipe in the center of the tube type hydraulic reservoir and exerts a downward pressure against the column of hydraulic fluid.
7. When both the air valve and the hydraulic valve are opened, hydraulic fluid is admitted under the piston in the cylinder and lifts the injector into the clamped piston. Any leak in the hydraulic clamping system will directly affect the injector loading and must not be permitted, Fig. 4-42.

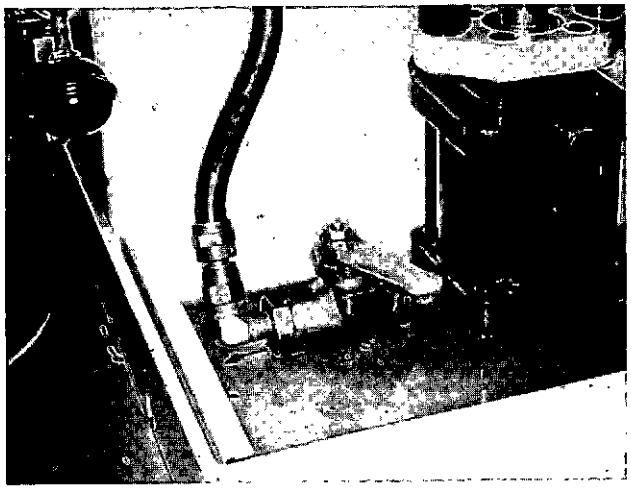


Fig. 4-42, (F60127). The hydraulic valve

8. In the clamped position and with the appropriate link in place, tension on the injector is the same as it is in the operating engine. Use of the improper link will affect the clamp load and upset the delivery values.
9. The test oil is delivered to the injector through the inlet connector, Fig. 4-43. Test oil pressure here is controlled at this point by a connecting line and a pressure regulator.
10. The second connection, with the clear plastic line, is the injector drain connection which carries the drain test oil from the injector back to the tank.
11. During the test stand operation, the operator

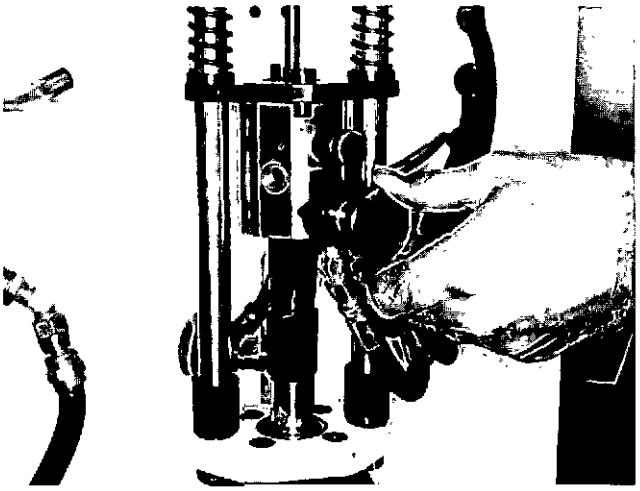


Fig. 4-43, (F60128). Attach the test oil inlet connector

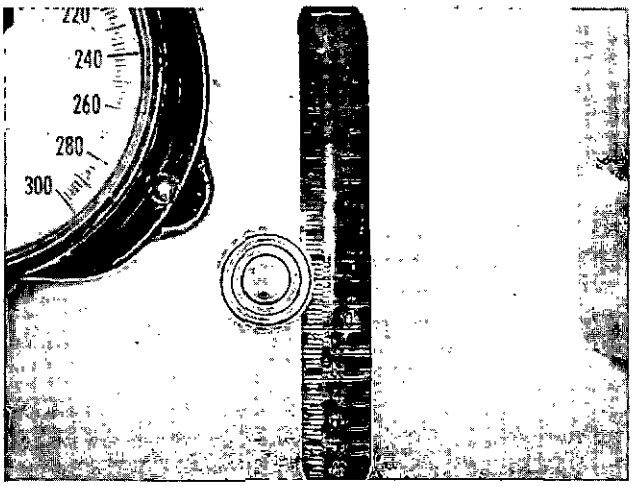


Fig. 4-44, (F60129). Measure the test oil in the vial

starts a test cycle which diverts test oil to the vial so the amount of test oil being injected can be measured, Fig. 4-44.

12. Test oil is delivered to the vial during a measured number of strokes as recorded by the counter.

13. A master injector which has been previously calibrated at the factory is used in setting the test stand prior to adjusting the other injectors for test oil delivery. **The master injector must never be tampered with.**

Note: A cylindrical injector in a pot provides the same conditions as the flanged injectors.

Calibrating the ST-790 Test Stand

1. Before operating the test stand make sure that the cam box is filled to the top level of the sight glass with clean SAE 30 non-foaming lubricating oil, Ref. 63, Fig. 4-36.

2. Fill the hydraulic fluid reservoir to the bulb level with clean Type A automatic transmission fluid. Be careful not to allow oil to enter the standpipe in the center of the reservoir, Ref. 46, Fig. 4-36.

3. The test oil tank on the stand must be kept at least 3/4 full of Cummins 3375364 test oil.

4. Align the timing mark (Fig. 4-40) and open the hydraulic valve. Place the load cell, ST-790-5111, in the test stand and clamp it in place by opening the air valve. Fig. 4-45.

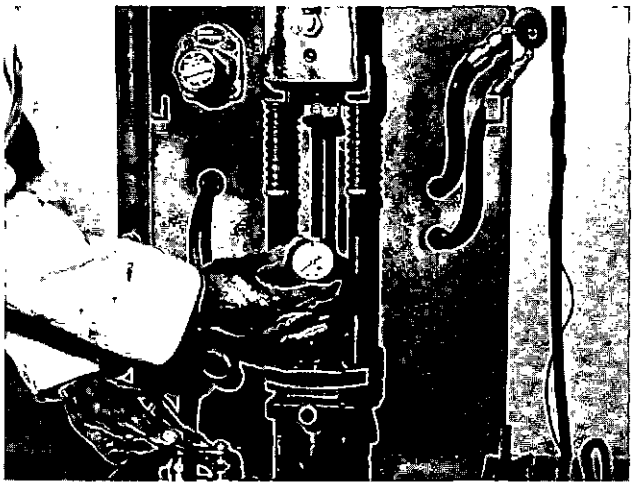


Fig. 4-45, (F60131). Install the ST-789 load cell

Note: Never operate the test stand with the load cell in position.

5. Adjust the air pressure by turning the knurled button on the air regulator until the load cell indicates within the marked band on the load cell gauge. Lock the knurled button in place with the locknut. Note the air gauge pressure (gauge at top of Hydraulic Reservoir), Fig. 4-46. The load cell must be between 370 and 390 when adjusted within the marked band on the dial.

6. Remove the load test cell by returning the air valve knob to the center position. With the cylinder rod in the down position, check to make sure the hydraulic fluid shows in the hydraulic oil level.

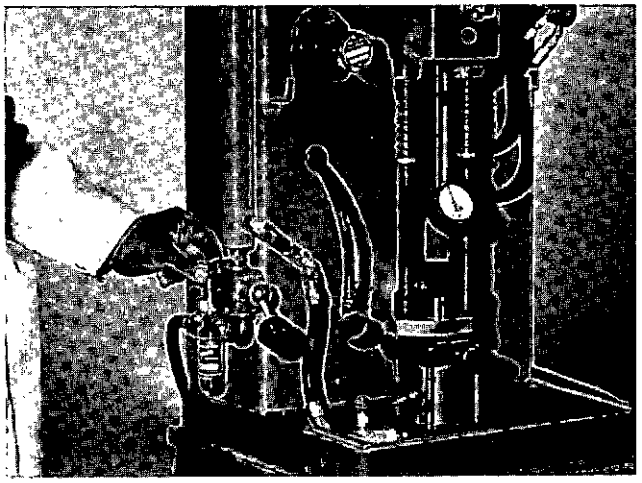


Fig. 4-46, (F60132). Adjust the air pressure

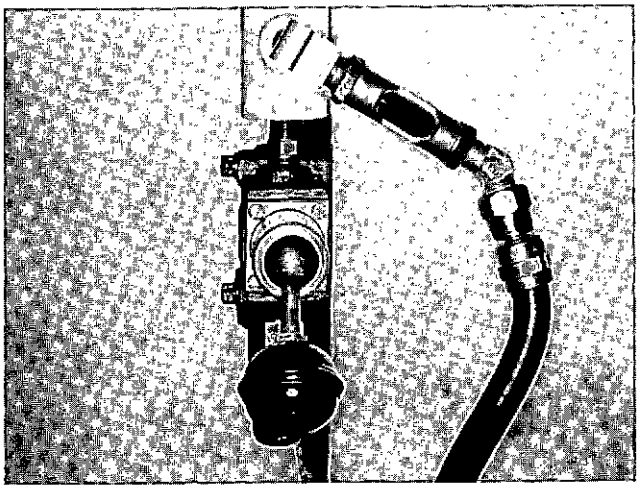


Fig. 4-47, (F60133). The hydraulic fluid sight glass

7. Open the air valve. While the cylinder rod is at the top of its travel, check to make sure there is no air in the hydraulic fluid sight glass, Fig. 4-47.

8. Make sure the injector seat contains a 0.020 inch [0.51 mm] restrictor orifice when calibrating the test stand with a 132 cc flow injector. Use a 0.026 inch [0.66 mm] orifice when calibrating the test stand with a 178A or a 185A cc flow injector, Fig. 4-48.

9. Place the adapter plate over the master injector, ST-768, ST-1210, ST-1262 or ST-1306, and engage the locator in the injector mounting holes. Make sure the seat is retracted and the timing marks are aligned at the timing wheel, Fig. 4-40.

10. Position the test stand link (marked NVH, NH, H) over the injector plunger link and place the assembly in the injector seat, tip the assembly back until the link is below the machine push rod. If necessary, adjust the bracket so the link is aligned but not rubbing.

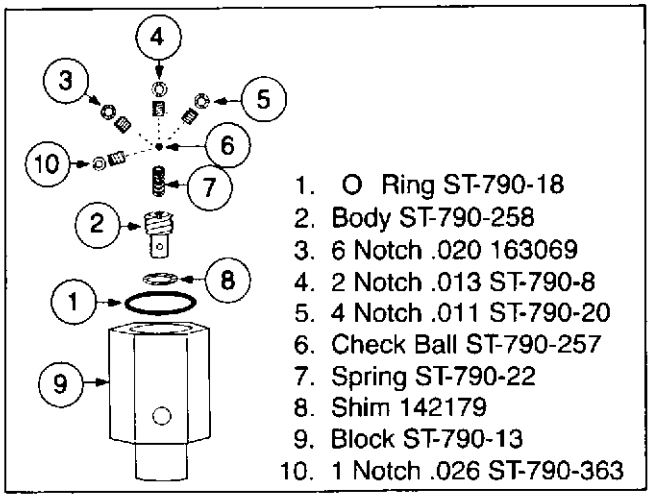


Fig. 4-48, (F60134). Injector seat restrictor orifice

11. Open the air valve and as the injector goes in the clamped position, make sure the link is properly aligned and engaged, Fig. 4-49.

12. Check the air pressure gauge at the top of the hydraulic reservoir as originally established with the load test cell. Close the hydraulic valve to lock the injector in the clamped position. Connect the inlet and drain connectors to the injector, Fig. 4-50.

Caution: To avoid damage to the master injector, do not use the ST-708 Burnishing Tool when setting up the test stand.

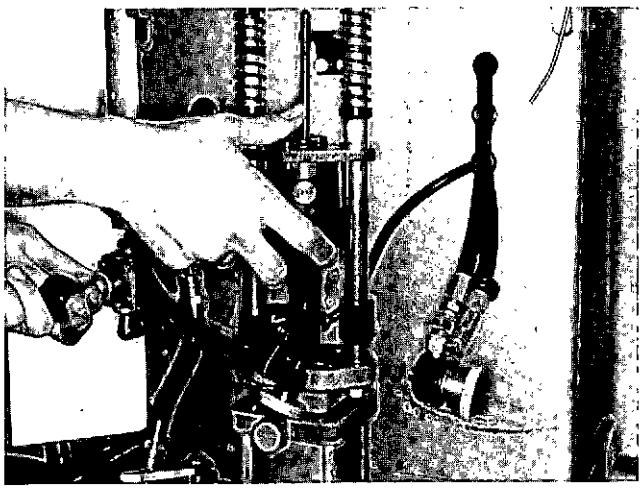


Fig. 4-49, (F60135). Position the assembly in the test stand

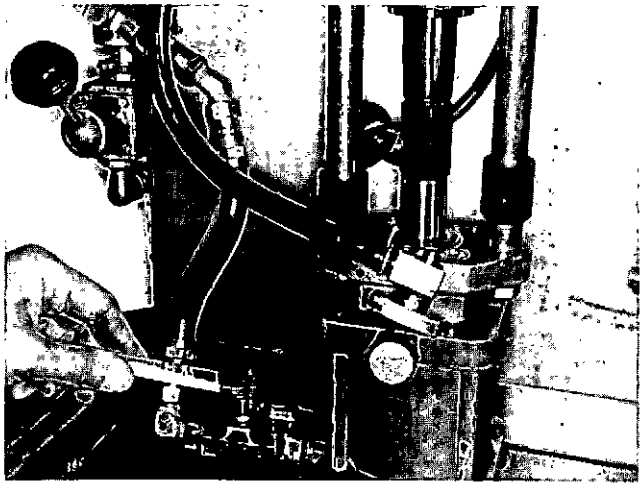


Fig. 4-50, (F60136). Close the hydraulic valve to clamp the injector

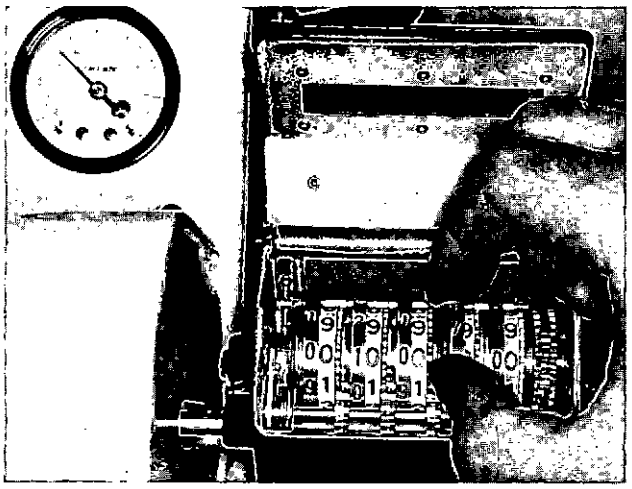


Fig. 4-52, (F60138). Start the counter at zero

13. Start the test stand motor.

Note: Test oil must be a minimum of 90° F [32° C]. If the temperature is not up to 90° F [32° C], the test stand must be warmed up on a standard injector, not the master injector. If the temperature exceeds 95° F [35° C], increase the cold water flow. If the temperature exceeds 135° F [57° C], drain and replace with new test oil.

14. Adjust the test oil pressure by turning the regulator knob until the pressure gauge shows 120 psi [827 kPa]. If this pressure cannot be achieved, the trouble is probably due to a sticking regulator, or to a worn gear pump, Fig. 4-51. A pressure of 120 psi [827 kPa] must be maintained at all times during the calibration and testing.

15. All of the counter wheels must be set at zero as a starting point, Fig. 4-52.

16. Shift the silver-colored counter wheels to the right, rotate as necessary then release them to indicate 1020 or 820 strokes. Rotate the empty vial into position by turning the vial knob.

Note: Some test stand counters are of a different design.

17. Clear the counter by rotating with the thumb screw for one complete revolution. All white counter wheels must show zero, Fig. 4-53.

18. Engage the counter and divert the test oil to the vial for measurement by pressing and releasing the red flow start switch.

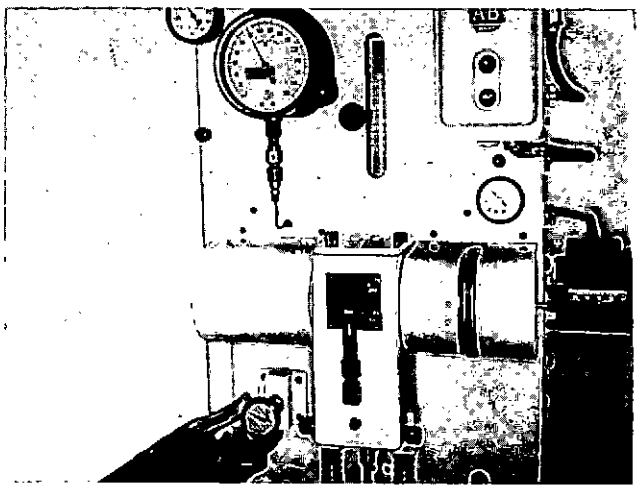


Fig. 4-51, (F60137). Adjust the test oil pressure to 120 psi

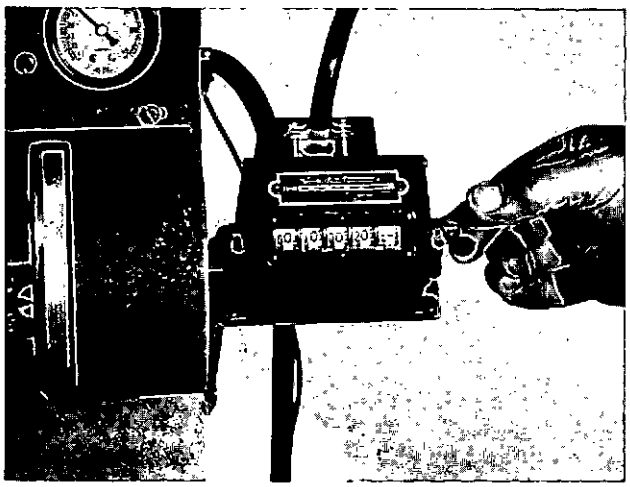


Fig. 4-53, (F60139). Clear the stroke counter

19. Stir the test oil with a rod to settle out the foam; then, check the amount collected in the vial at the end of the counter strokes.
20. Look directly into the vial at the test oil level to avoid parallax. If this reading shows 129 cc which is 3 cc below the ST-1210 injector master delivery specifications (132 cc @ 120 psi), or another value, repeat the test, Fig. 4-54.
21. Dump the test oil from the vial and repeat the test at least twice to make sure the results are consistent.
22. If 3 cc low, it will be necessary to set the counter up to approximately 1043 strokes or about 7 to 8 strokes for each cc. Roll the counter back. All white counter wheels must show zero.

Note: If the counter is set beyond 1050 or 850 strokes, it is a good indication the test stand is not properly installed or calibrated.

23. Repeat the tests and adjust the counter as necessary, to obtain 132 cc delivery at 120 psi [827 kPa] with the test oil temperature at 90 to 95° F [32 to 35° C], while the ST-1210 master injector is in the test stand. Check the readings for three cycles to make sure of the repeatability. After each four cycles, reclamp the injector to make sure of maximum accuracy. At this point, the test stand is correctly calibrated.

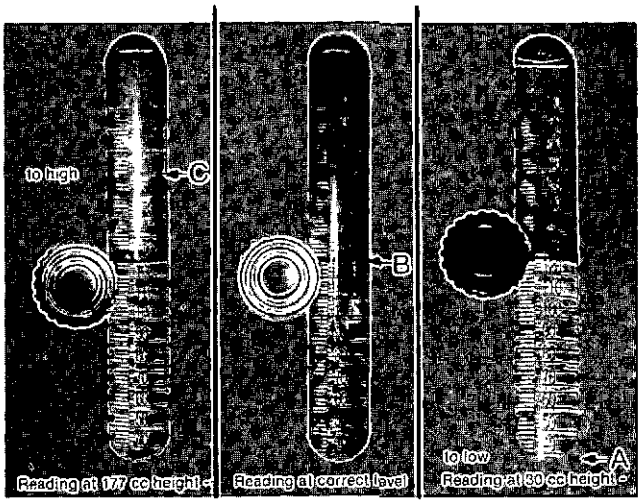


Fig. 4-54, (F60210). Read the vial test oil level at the correct height

Note: In reading the level of test oil in the vial, be certain to read it at the test oil level, Fig. 4-65. When reading at the "C" height, you are too high. The reading at "B" is the correct height. You are not looking up or down at the test oil level, thereby avoiding parallax. Read the correct cc at the point where the test oil appears to change color.

Flow Testing PT Injectors on Service Tool No. ST-790

Flow Testing Adjustable Delivery Injectors On ST-790

Remove the master injector ST-1210, ST-768, ST-1262 or ST-1306 from the test stand after calibrating the test stand. If the test stand is not calibrated, see ST-790 Operation and Calibration.

Install the correct restrictor orifice plug in the cup seat. Tighten the plug to 6 in-lb [0.7 N•m], Fig. 4-55.

1. The 0.0115 inch [0.292 mm] orifice has four notches.
2. The 0.013 inch [0.33 mm] orifice has two notches.
3. The 0.020 inch [0.66 mm] orifice has one notch.

Note: Delivery for the injectors, listed in Bulletin No. 3379664 under heading "Aprox. Strokes" as 800, can be established by setting the ST-790 Stand with ST-1262 or ST-1306 Master Injector.

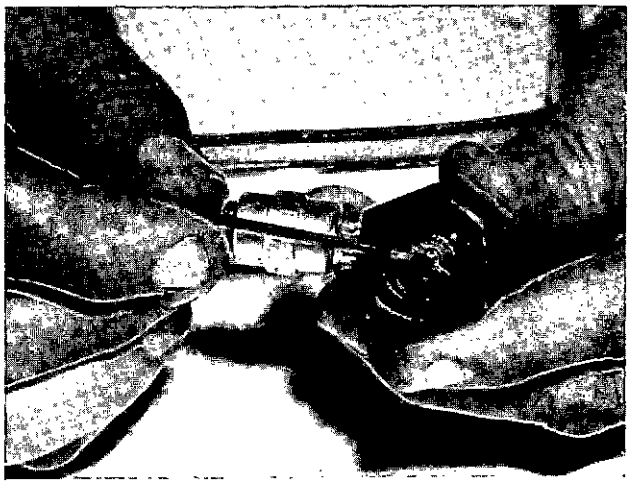


Fig. 4-55, (F60142). Install the restrictor orifice

Comparing Injector Flow with ST-1129

A flowmeter, ST-1129, is available to provide a quick comparative indication of injector flow on the ST-790 Test Stand without running through a complete test cycle. However, this flowmeter is in no way meant to replace the present method of measuring the injector delivery, Fig. 4-56.

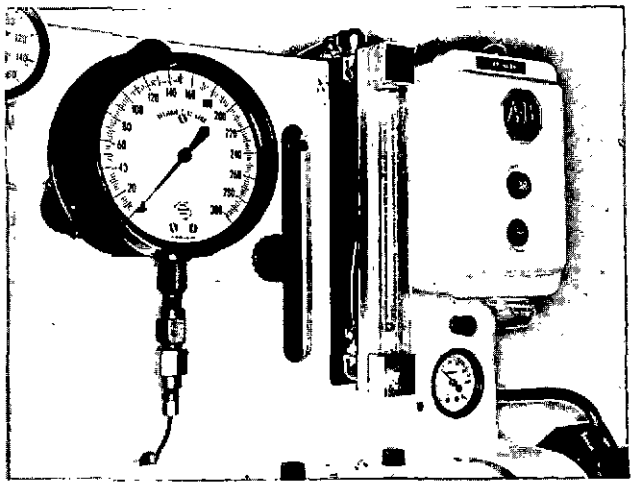


Fig. 4-56, (F60221). Front view of ST-790 with ST-1129 installed

Operating Instructions for ST-1129

1. Assemble the first injector, of the set to be flowed, *into the ST-790 stand per normal procedure and* complete the calibration.
2. Before removing the injector from the ST-790, note the flowmeter value.
3. Install the second injector, start the test stand and observe the flow value. Do not hit the flow stand button. Compare it with the previous injector and burnish or replace the orifice until the reading is slightly below the first injector.
4. Complete the calibration of the injector.

A little practice with the flowmeter will save considerable time in "burnishing in" the injectors to reach the correct flow value.

Calibrating the Flanged PT Injectors on ST-790

1. Assemble the appropriate link (Table 4-5) and adapter to the injector.
2. Slide the appropriate tie rod spring retainers against the springs for the injector.

Note: When flowing J or C engine series injectors, the hold-down plate must be reversed and the "J" spacers on both tie rods are to be used. The "J" spacer also must be used when flowing V6-140, V8-185, V-504 or V-555 engine series injectors.

3. Position the injector in the test stand with the class size mark on the plunger between the inlet and drain ports.

Note: Check the injector cup to make certain all of the *carbon has been removed from the cup seating area.*

4. Check the injector flow specifications in Bulletin No. 3379664 for the model injector to be tested. Set the pressure at 120 psi [827 kPa] prior to depressing the flow start switch. Pressure must be maintained at 120 psi [827 kPa] during the injector test. Run the injector through a test cycle at 120 psi [827 kPa] and check the cc delivered in the vial.
5. If the test oil delivery is above or below the proper flow specifications, remove the adjustable delivery orifice plug from the injector inlet.
6. Select a larger or smaller inside diameter orifice plug to bring the flow to the proper value. See Table 4-4.
7. Install a new orifice plug and tighten to 8 to 10 in-lb [11 to 14 N•m] torque with a torque screwdriver, 3376177 or ST-1090 Torque Wrench.
8. Run the injector through additional test cycles as necessary until the orifice plug used will bring the delivery into the proper value. Note the plug size range in Table 4-4. If outside the range, perform the "Plunger to Body Leakage Test".

Note: Never use the first reading as a final value.

Note: Use ST-1332 to check the orifice plug inside diameter. The tool is especially helpful if the orifice plugs become mixed. Measure the orifice plug at the base end (not the wrench end) as shown in Fig. 4-57.

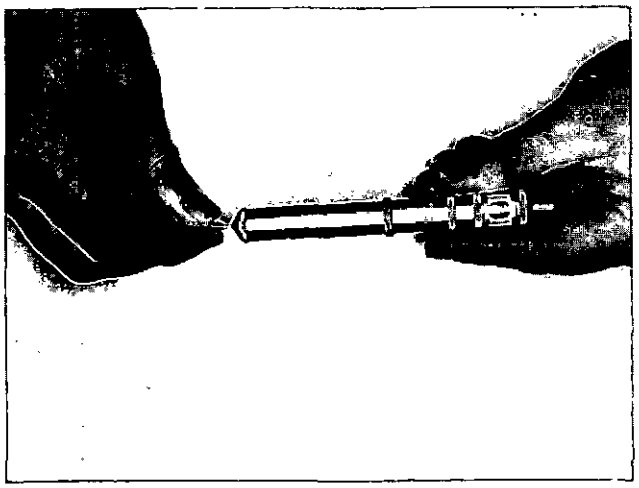


Fig. 4-57, (F60143). Check the orifice with the orifice size gauge

Table 4-4: Injector Orifice Plugs

Straight Part Number	Inside Diameter Inch [mm]	Flanged Part Number	Inside Diameter Inch [mm]
163065	0.015 [0.38]	177283	0.015 [0.38]
163066	0.016 [0.41]	177284	0.016 [0.41]
163067	0.017 [0.43]	177285	0.017 [0.43]
148338	0.018 [0.46]	177286	0.018 [0.46]
163068	0.019 [0.48]	177287	0.019 [0.48]
163069	0.020 [0.51]	177288	0.020 [0.51]
163070	0.021 [0.53]	177289	0.021 [0.53]
163071	0.022 [0.56]	177290	0.022 [0.56]
149726	0.023 [0.58]	177291	0.023 [0.58]
163072	0.024 [0.61]	177292	0.024 [0.61]
163073	0.025 [0.64]	177293	0.025 [0.64]
163074	0.026 [0.66]	177294	0.026 [0.66]
163075	0.027 [0.68]	177295	0.027 [0.68]
163076	0.028 [0.71]	177296	0.028 [0.71]
163077	0.029 [0.74]	177297	0.029 [0.74]
163078	0.030 [0.76]	177298	0.030 [0.76]
163079	0.031 [0.79]	177299	0.031 [0.79]
128132	0.032 [0.81]	179332	0.032 [0.81]
128133	0.033 [0.84]	179333	0.033 [0.84]
128134	0.034 [0.86]	179334	0.034 [0.86]
128135	0.035 [0.89]	179335	0.035 [0.89]
131092	0.036 [0.91]	179336	0.036 [0.91]
131093	0.037 [0.94]	179337	0.037 [0.94]
131094	0.038 [0.97]	179338	0.038 [0.97]
131095	0.039 [0.99]	179339	0.039 [0.99]
131096	0.040 [1.02]	179340	0.040 [1.02]
131097	0.041 [1.04]	179341	0.041 [1.04]
131098	0.042 [1.07]	179342	0.042 [1.07]
132800	0.043 [1.09]	179343	0.043 [1.09]
132801	0.044 [1.12]	179344	0.044 [1.12]
132802	0.045 [1.14]	179345	0.045 [1.14]
131099	0.046 [1.17]	179346	0.046 [1.17]
131100	0.047 [1.19]	179347	0.047 [1.19]
131101	0.048 [1.22]	179348	0.048 [1.22]
131102	0.049 [1.24]	179349	0.049 [1.24]
131103	0.050 [1.27]	179350	0.050 [1.27]
131104	0.051 [1.29]	179351	0.051 [1.29]
131105	0.052 [1.32]	179352	0.052 [1.32]
131106	0.053 [1.35]	179353	0.053 [1.35]
131107	0.054 [1.37]	179354	0.054 [1.37]
131108	0.055 [1.40]	179355	0.055 [1.40]
132803	0.056 [1.42]	179356	0.056 [1.42]
132804	0.057 [1.45]	179357	0.057 [1.45]
132805	0.058 [1.47]	179358	0.058 [1.47]
132806	0.059 [1.50]	179359	0.059 [1.50]
132807	0.060 [1.52]	179360	0.060 [1.52]

Table 4-4: Injector Orifice Plugs (Cont'd.)

Straight Part Number	Inside Diameter Inch [mm]	Flanged Part Number	Inside Diameter Inch [mm]
132808	0.061 [1.55]	179361	0.061 [1.55]
132809	0.062 [1.57]	179362	0.062 [1.57]
132810	0.063 [1.60]	179363	0.063 [1.60]
132811	0.064 [1.63]	179364	0.064 [1.63]
132812	0.065 [1.65]	179365	0.065 [1.65]
132813	0.066 [1.68]	179366	0.066 [1.68]
132814	0.067 [1.70]	179367	0.067 [1.70]
132815	0.068 [1.73]	179368	0.068 [1.73]
132816	0.069 [1.75]	179369	0.069 [1.75]
132817	0.070 [1.78]	179370	0.070 [1.78]

Table 4-5: ST-790 Test Stand Link Data

Engine Series	Engine Bore & Stroke Inch [mm]	Link Marking
J	4-1/8 × 5 [105 × 127]	J, C
C	4-7/16 × 5 [113 × 127]	J, C
H-NH	4-7/8 × 6 [124 × 152]	H, NH, NVH
	5-1/8 × 6 [130 × 152]	H, NH, NVH
	5-1/2 × 6 [140 × 152]	H, NH, NVH
V12	5-1/8 × 6 [130 × 152]	H, NH, NVH
	5-1/2 × 6 [140 × 152]	H, NH, NVH
*V6-200, V8-265	5-1/2 × 4-1/8 [140 × 105]	V8, V6, 5-1/2 × 4-1/8
**V6-200, V8-265	5-1/2 × 4-1/8 [140 × 105]	V8, V6, 5-1/2 × 4-1/8A
V8-350, VT8-430	5-1/2 × 5 [140 × 127]	V8, 5-1/2 × 5
V6-140, V8-185	4-5/8 × 3-1/2 [117 × 89]	ST-838-2, 790-332

*Use with short injector link (Part No. 140470 which extends approximately 29/32 inch above spring flange).

**Use with long injector link (Part No. 170948 which extends approximately 29/32 inch above spring flange).

PT (type D) Injector Calibration

The ST-790 Test Stand is used to flow test the injector assembly by measuring the test oil delivery. The injector is actuated under controlled conditions closely simulating the actual operating conditions of the engine. The test stand counts the injection strokes and supplies test oil at a specified pressure. Injector delivery is measured in a glass graduate.

Note: The top stop adjustment is made after the top stop type injector is calibrated.

1. Remove the master injector from the test stand after calibrating the test stand. Install the restrictor orifice in the cup seat, see Bulletin No. 3379664, Fig. 4-55 and tighten to 6 in-lb [0.7 N•m].

   a. The 0.020 inch [0.51 mm] orifice has six notches.

   b. The 0.026 inch [0.66 mm] orifice has one notch. Injectors with a flow of more than 150 cc, require the 0.026 inch [0.66 mm] orifice.

Note: Delivery for the injector with approximate strokes of 800 in Bulletin No. 3379664 can be established by setting the ST-790 Stand with a 132 cc master injector, then turning back the counter by 20 percent.

Example: If the test stand counter was read at 1050 with the master, the injectors to be tested would be run at 840 counter strokes.

You can calibrate the ST-790 Injector Test Stand with the ST-1306 Master Injector and determine the number of strokes (approximately 800) required to produce the 178 cc @ 120 psi. Reduce the strokes by 25 percent for -B (600 stroke) injectors.

If 80 psi is required, set the stand with an ST-1306 Master Injector still in the test stand. Using the strokes determined above, reduce the pressure downward from 120 psi until 148 cc flow is produced. Use this lower pressure to calibrate the 80 psi injectors.

Calibrate the high capacity injectors with the "K" cam in the test stand. The first high capacity barrel was Part No. 3009469.

Calibrate all "K" engine injectors with the K cam in the test stand.

2. Lubricate the inside of Service Tool 3376210, 3375086, ST-1058 or ST-1254 Body with test oil so the injector O-rings will slide into the adapter without damage to the O-rings. ST-1254 is used with the "K" injectors.

3. Seat the injector in the body so the injector inlet aligns with the body inlet holes, Fig. 4-58. Tighten the locating screw, Fig. 4-59.

4. Remove the spring and plunger from the injector adapter. Leave the spring off and install the plunger.

5. Perform the ball valve seating check on 3375375 or a converted ST-990 before calibrating the injector. An alternate method of checking the ball seat is as follows:

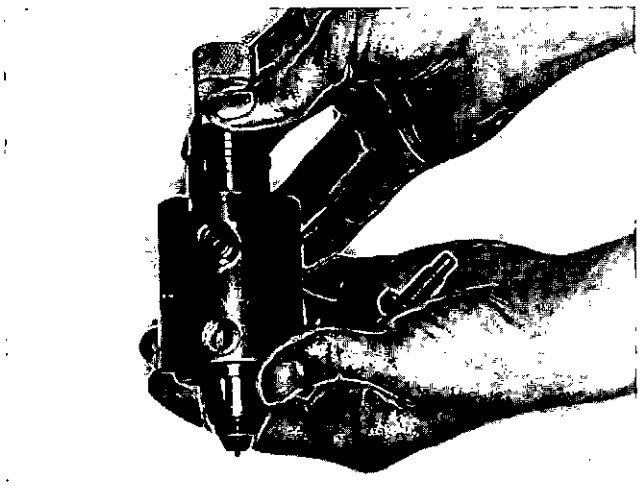


Fig. 4-58, (F60203). Center the injector inlet in the ST-1058 inlet hole

Fig. 4-59, (F60212). Tighten the ST-1058 locating screw

a. Attach the test stand inlet pressure line to the drain connection of Service Tool 3376210, 3375086, ST-1058, or ST-1254 Body.

b. Hold the injector plunger down against its seat in the injector cup with the injector in a vertical position. The assembly may be held by hand. Do not place it in the test stand holding device. Fig. 4-60.

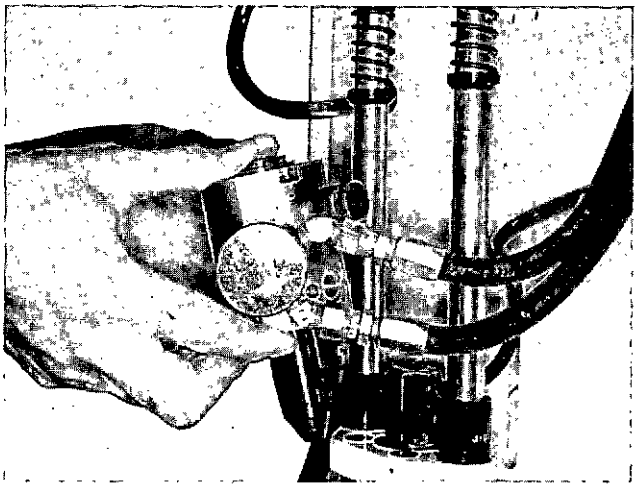


Fig. 4-60, (F60213). Check leakage at the inlet port

Note: Make sure the ST-708-1 Needle is retracted.

c. Turn on the test stand, and adjust the pressure to 150 psi [1034 kPa].

d. Check the orifice plug inlet opening of Service Tool 3376210, 3375086, ST-1058 or ST-1254 Body for leakage past the ball valve.

Note: Make sure the plunger is seated in the cup.

e. If leakage is observed, the ball must be replaced. Slight seepage is not harmful.

6. Install the injector in Service Tool 3376210, 3375086, ST-1058 or ST-1254 Body. Disconnect the inlet pressure line from the drain connection of the body. Remove the injector plunger.

7. Seat the injector so the injector inlet aligns with the body inlet hole, after the injector adapter is located in the sleeve.

8. The location screw must seat in the hole of the adapter.

9. Check to be sure the injector inlet is centered in the body inlet hole, to prevent breaking ST-708-1 Burnishing Tool point when it is installed later.

10. Install the spring and plunger into the injector.

11. Assemble the retainer plate over the injector with the pins engaged in the body.

12. Position the injector in the test stand with the correct adapter link. See Table 4-6.

Table 4-6: ST-790 Test Stand Link Data PT (type D)

Engine Series	Length Inch [mm]	Link Marking
NH, NT, Super 250/270, H-855, N-927, V6-200, V8-265, V-903	6.5 [165]	ST-790-331
KT	6.3 [160]	ST-790-362
V6-140, V8-185, V6-378 V8-504, V-555	7.0 [178]	ST-790-329

Note: All tests on the test stand are performed without a screen on the injector.

13. Assemble the ST-708 Burnishing Tool into the test stand injector inlet connector. Fig. 4-61. Retract the needle by pulling out the small knob. With the needle retracted, the ST-708 Tool may be left in the connector during all test operations.

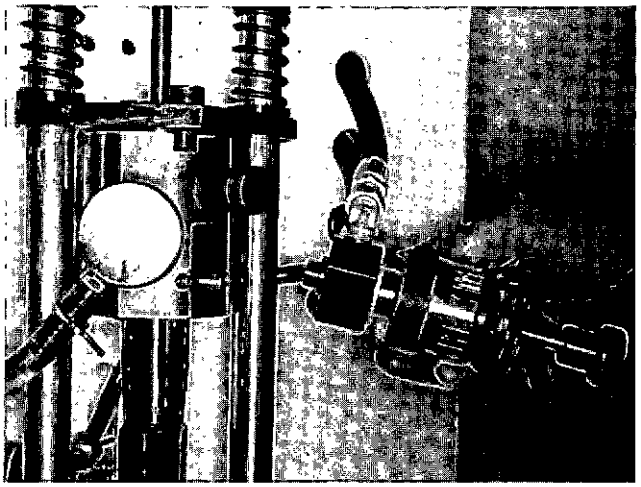


Fig. 4-61, (F60214). ST-708 installed in the inlet connection

14. Install the connector and ST-708 Tool into the Service Tool 3375086, ST-1058 or ST-1254 Body inlet by screwing in the large knob section, Fig. 4-62.

Note: The injector delivery is adjusted by burnishing

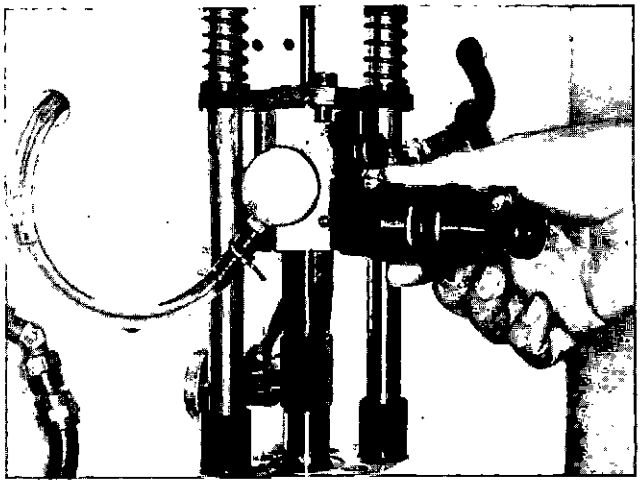


Fig. 4-62, (F60215). Assemble the ST-708 Tool to the adapter pot

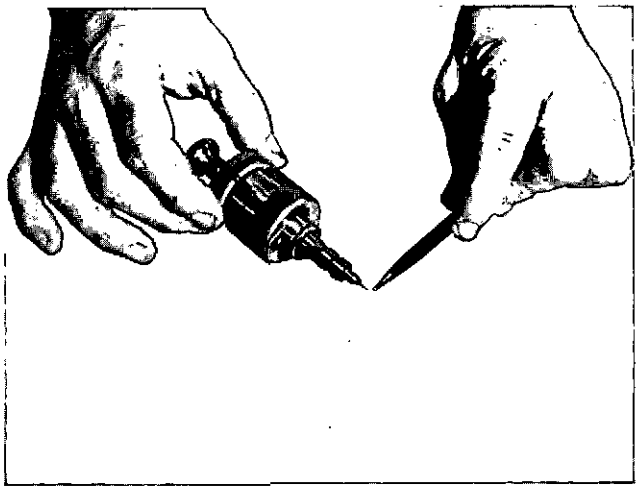


Fig. 4-63, (F60152). ST-708 Burnishing Tool point

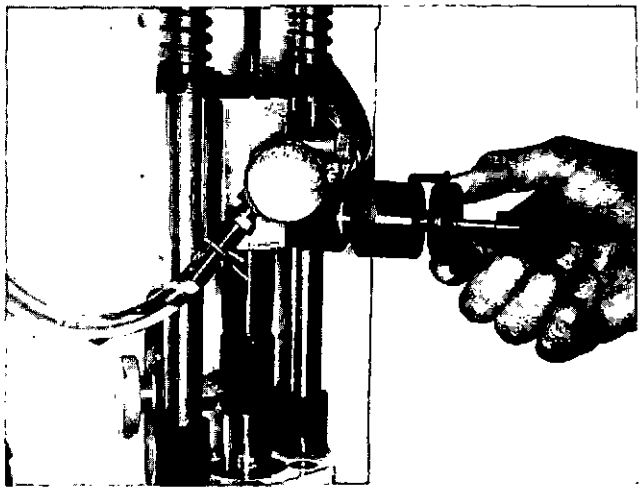


Fig. 4-64, (F60216). Knob spacing of ST-708

the inlet orifice plug with ST-708 instead of changing the plug. The replaceable needle point, ST-708-1, is the burnishing member, Fig. 4-63.

15. Install the drain connection.

Run the injector through a test cycle and check the cc delivery. If the delivery is lower than the specifications given in Bulletin No. 3379664, turn the knob with the indicator point until it is spaced 3/8 inch [9.5 mm] from the large knob, Fig. 4-64.

Caution: The ST-708-1 must be used with extreme caution when sizing the hi-flow injectors. Do not damage the injector body under the orifice plug.

16. Slowly push the small knob in until you feel the needle enter the orifice plug inside diameter. Then turn the knob counterclockwise to lock the needle shaft to the larger knob with the indicator. Turn the indicator knob in until you feel the needle contact the plug. Index the indicator with a mark on the largest knob and advance one mark. Fig. 4-65.

Note: The test stand must be running while burnishing the orifice with ST-708.

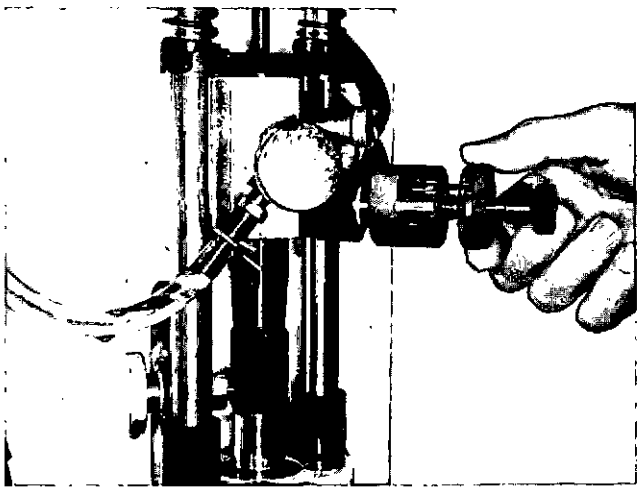


Fig. 4-65, (F60217). Burnish operation

17. Back off the adjusting screw and retract the needle. Check the delivery.

18. If the delivery is more than specified in Bulletin No. 3379664, a new adjustable orifice must be installed in the injector. See Table 4-4. Tighten the orifice plug to 8 to 10 in-lb [0.9 to 1.1 N•m] torque with an ST-1090 or 3376177.

Note: Orifice plugs have flanges and require a gasket between the flange and the adapter.

19. New inlet orifice plugs contain enough stock in the inside diameter so a small displacement of metal, by burnishing, will increase the delivery. The amount of displacement is limited so several orifice plugs are required to cover the delivery for all the engine models from low to high horsepower. See Table 4-4.
20. After each four cycles, reclamp the injector to make sure of maximum accuracy. When the delivery is correct, remove the inlet and drain connection.
21. Remove the injector from the test stand.
22. Remove the adapter plate and body from the injector adapter.
23. Insert the disc screen over the orifice plug and assemble the retainer ring to hold the screen in place.
24. Insert the link in the plunger coupling and store in a clean place until needed.
25. When a 5/16 inch [7.9 mm] link is used, always keep the part number up. This link has a 5/16 inch [7.9 mm] ball on both ends.
26. A 1/2 inch [12.7 mm] diameter ball link is currently being used to improve the wear resistance of the upper ball end. This link has several optional shapes of the upper end. The 1/2 inch [12.7 mm] diameter can be from 3.4 inch [19 mm] to 2 inches [51 mm] long, down the link. These 1/2 inch [12.7 mm] links can be mixed in an engine. Do not use 1/2 inch [12.7 mm] links with old rocker levers unless they are converted to take the new 1/2 inch [12.7 mm] sockets.

Injector Recheck Specifications

The acceptable variance between the ST-790 injector test stands is +1 or -2 cc from the published calibration flow code or the code stamped on the injector.

Example: An injector stamped with a flow code of 183 would be acceptable if it flows 181 to 184 cc on a stand other than the one used to calibrate the injector.

STU-790 Injector Comparator

The STU-790 Injector Comparator (made in the U.K.) is used in some shops rather than the ST-790 Injector Test Stand. This manual is written around the ST-790. The method of reading the injector output varies with the two machines; however, an instruction manual is included with the STU-790 Injector Comparator explaining the differences.

Following are the conversion factors necessary if an -A (80 percent strokes), or -B (60 percent strokes) or -C (80 percent strokes @ 80 psi) injector is being calibrated.

1. Master the machine with the master injector as described in STU-790 Instruction Manual. If KT Series Injectors are being calibrated on a comparator built before 1974, a K cam conversion kit must be installed.
2. The delivery values using -A code (80 percent of 1000 strokes or sometimes referred to a -20 percent strokes) are calculated by multiplying the required flow by 5/4.

Example: A 178-A coded injector should produce $\frac{178 \times 5}{4}$ = 222.5 cc on STU which will appear on the indicator as 22.25. See Table 4-7.

3. The delivery values using -B code (60 percent of 1000 strokes or sometimes referred to as -40 percent strokes) are calculated by multiplying the required flow by 5/3.

Example: A 185-B coded injector should produce $\frac{185 \times 5}{3}$ = 308.3 cc on STU which

Table 4-7: STU-790 and 3377041 Indicator Reading

Injector Code	Strokes (% 1000)	Equivalent Indicator Reading on STU-790
153A	80%	19.12 [191.2 cc]
158A	80%	19.75 [197.5 cc]
163A	80%	20.37 [203.75 cc]
169A	80%	21.12 [211.2 cc]
178A	80%	22.25 [222.5 cc]
180A	80%	22.50 [225.0 cc]
181A	80%	22.62 [226.25 cc]
181C	*80%	22.50 [225.0 cc]
183A	80%	22.87 [228.75 cc]
185A	80%	23.12 [231.25 cc]
185B	60%	30.83 [308.3 cc]
190A	80%	23.75 [237.5 cc]
185B	60%	30.83 [308.3 cc]

*Run at nominal 80 psi instead of 120 psi.

will appear on the indicator as 30.83.

4. The flow tolerance on -A code injectors is +1 cc/-0 cc based on 1000 strokes total flow.

Example: A 178-A injector would have a 222.5/221.5 cc allowable flow range.

5. The flow tolerance on -B code injectors is determined by multiplying the flow limits of the injector by 5/3 as indicated in step 3.

Example: A 185-B injector has an allowable flow range of 184-185 cc at 600 strokes which is 308.3/306.7 cc for 1000 strokes when calculated as described above.

6. The flow tolerance on -C code injectors is determined by multiplying the flow limits of the injector by 5/4 the same as -A code except calibrate at 80 psi instead of 120 psi for all others.

To master the STU-790 to 80 psi nominal, use an ST-1306 Master Injector. Adjust the STU-790 until an actual delivery of 185 cc is measured. Maintain the pressure, found with 185 cc, and calibrate the -C code injector to the value determined by multiplying the flow code by 5/4.

Example: $\frac{185 \times 5}{4}$ = 225.0 on STU-790 which appear as 22.5 on indicator.

3377041 Injector Comparator

The 3377041 Injector Comparator (made in the U.K.) supersedes the STU-790 Comparator.

The installation and operation instructions for this tool are shipped with the tool.

The 3377041 Comparator measures the same injector delivery as the STU-790 Comparator. When checking the injector flow on the 3377041 Comparator use the flow specifications of STU-790 and Table 4-7.

Injector Test Stand Maintenance — ST-790

To obtain the best service life from the ST-790 Injector Test Stand, the following maintenance practice must be observed.

Roller Tappet and Cam Assembly

The roller tappet and cam assembly will wear, just as any moving assembly, and will require maintenance.

1. If the tappet is worn, it must be replaced as soon as possible to prevent excessive wear on the cam.
2. Do not assemble a new tappet with a scuffed cam. If the scuffing cannot be removed with a fine hone, the cam must also be replaced.
3. If the cam is worn into the shaft by more than 0.002 inch [0.051 mm], the shaft must also be replaced. This condition will cause undue loading on the cam, tappet and bearings.
4. Align the cam to track 100 percent on the tappet roller.
5. Torque the clamp type ring to 8 to 10 ft-lb [16 to 20 N•m] or tighten the setscrew in the cam hub securely and install a second setscrew on top of the original one as a "jam screw."

Changing the Oil and Filter

When changing the oil and filters in the test stand, adjust the regulator to the lowest possible pressure during pump pick-up. This will prevent air from being forced into the gauge line. If a slow gauge hand response does occur, it is an indication that air has entered the system. Remove the air from the line or gauge.

ST-790 Troubleshooting

This section of the manual should be fully understood by the Injector Test Stand Operator. Through this knowledge he will be able to correct the test stand problems and produce a properly calibrated injector.

The ST-790 Injector Test Stand is used to calibrate Cummins injectors. This test stand will provide accurate balancing and testing of Cummins injectors in order to produce the desired engine performance.

There have been reports of erratic results, but investigators have revealed that the cause for such problems falls into three basic categories.

1. **Mechanic and/or Tester Error:** (Not confined to injector calibration alone. Includes the pump calibration, engine and chassis dynamometer checks, etc.)

a. Calibrating a specific injector model to the wrong flow value.

b. Calibrating a specific fuel pump model to the wrong value.

c. Lack of familiarity with this bulletin and/or Bulletin No. 3379068, 3379182, 3379101, 3379084, 983533 and 3379664.

d. Use of the wrong injector assembly in a specific engine model.

e. Use of camshaft and pistons other than those shown in the CPL.

f. Restricted intake air to the engine.

g. Excessive exhaust back pressure.

h. Restricted fuel supply to the engine.

i. Aerated fuel supply to the engine.

j. Excessively high oil level in the engine crankcase.

2. **Instrumentation Errors:** (Range all the way from the gauge used on the cup-to-plunger seat check, to the load indicator on the chassis dynamometer.)

   a. Erroneous fuel manifold pressure gauges on the engine and/or chassis dynamometer.

   b. Erroneous flowmeters.

   c. Erroneous dynamometer load indicators.

3. **ST-790 Maintenance Status:**

   a. Use of hose lengths, diameters, and resiliencies other than those which are specified.

Caution: Do not replace any hose or lines on the ST-790 Test Stand with other than the correct ST hose as specified in the tool catalog. Hose on the ST-790 must be replaced periodically since rubber in the hose hardens with age causing resonance variables.

b. Test oil routing which is not to specifications.

c. Filter assemblies which have a different dampening effect on the system.

d. Critical components of the test stand such as the check valve, gauge and hydraulic injector clamping, poorly maintained.

Troubleshooting the ST-790

Injector calibration problems are discovered by inconsistent results in the service injector or the inability to flow injectors which have been calibrated at the factory, or at other locations, to the proper specifications. When an injector calibration problem is indicated, the following troubleshooting guide is to be used in the diagnosis and correction of the problem. All injector calibration complaints have been found to fall into the five basic categories as follows:

1. Stand repeatability. Stand will not repeat consistently on any given injector.

2. Poor results on all injector models. Injectors do not perform well in the engine and do not correlate with injectors calibrated on the other stands.

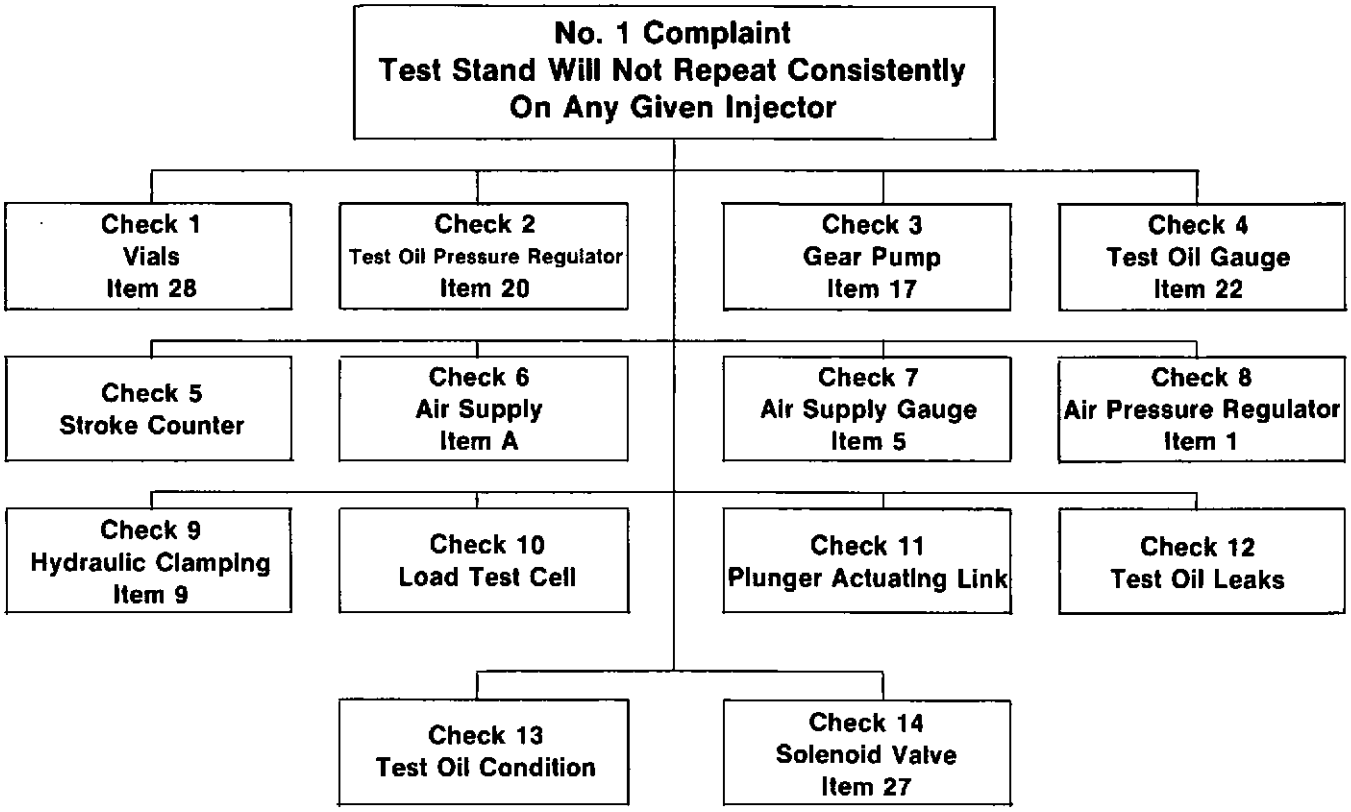
3. 800 stroke injectors heavily overfueled. 1000 stroke injectors slightly underfueled. Reasonable results on all other injectors.

4. All injectors overfueled.

5. All injectors underfueled.

Complaints and Corrections

Charted on the following pages are the complaints, showing the items to check for correction of the complaints. Each check is numbered, and the item numbers from Fig. 4-66 are given for quick location, so you can go immediately to the tabulated description of the causes and corrective action as necessary.



Check 1 — Vials

Cause	Correction
Differential of 1 cc or more between the vials.	Remove the vials and check their relative accuracy by filling one to various levels and pouring into the other vial. If there is significant variation between the two vials, mark the vials (spot of paint on one) and record the relative variation for future reference in troubleshooting. If the differential is significant at 132 cc, choose one vial (the one marked with a spot of paint above) for machine calibration use and when troubleshooting the machine. Replace with correctly calibrated vials as soon as possible.
Metered test oil partially misses the vials.	Adjust the solenoid outlet line so that 100 percent of the metered test oil enters the vials. (For minimum test oil foam, direct the stream of test oil against the side of the vial).
Foam prevents the accurate reading of the test oil delivery in the vials.	Foam will settle in approximately one minute. To prevent this time loss, a 1 inch diameter hole can be cut in the top panel (with the panel removed) and the foam can be stirred with a wire or rod.

Check 2 — Test Oil Pressure Regulator

Cause	Correction
Regulator sticking. (Indicated test oil pressure erratic.)	Clean and/or replace the regulator as required to maintain the pressure at 120 psi [827 kPa].
Regulator is not plumbed into the test oil circuit per the conversion instructions.	Change the plumbing to the right size and length.

Check 3 — Gear Pump

Cause	Correction
Pressure regulator is operating properly but the pressure in excess of 120 psi [827 kPa] cannot be obtained with an 800 stroke injector installed.	Change the gear pump as required. (For gear pump delivery specifications and gear pump checking procedure see Complaint No. 5.)

Check 4 — Fuel Gauge

Cause	Correction
Excessive gauge vibration due to machine vibration carrying through the gauge mounts.	Install new gauge mounts.
Hydraulic pulsations being carried into the gauge because the damping valve is not being properly adjusted.	Adjust the adjustable damping valve, Fig. 4-66, item No. 21.
Excessive gauge hand vibration due to improper damping in gauge line.	With ST-1210 or ST-768 Master Injector running in the test stand, adjust the needle valve in the gauge line until the gauge hand flutter is eliminated but the gauge hand is responsive to any change in the pressure. This adjustment must be made only with the ST-1210 or ST-768 Master Injector and before the machine is calibrated with the master.
Gauge out of calibration.	Check with a dead weight tester or a master gauge at 120 psi [827 kPa], which is the operating pressure. Adjust the dial hand with the adjusting screw.
Improper plumbing.	Make sure the plumbing agrees with Fig. 4-66. Do not add extra fittings, lines, etc.

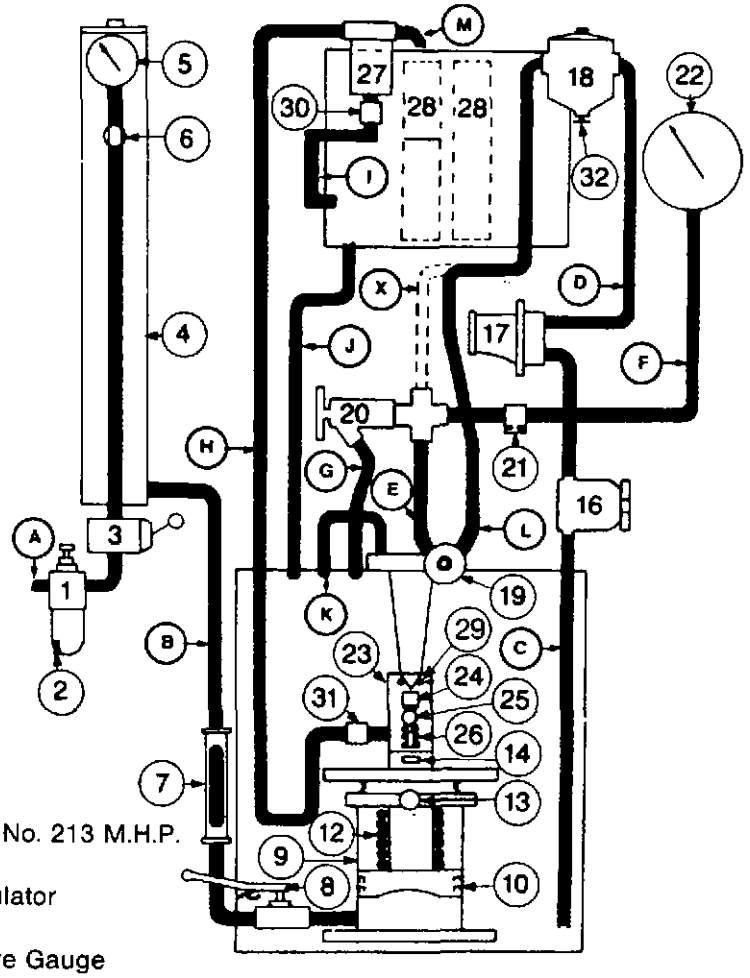
Check 5 — Stroke Counter

Cause	Correction
Stroke counter improperly set.	Counter wheels must be set and locked for the correct number of strokes. The numbers must then be cleared to "0" by rotating the thumb screw for at least one complete revolution.
Stroke counter engagement faulty.	Align the counter shaft with the drive shaft. See Fig. 4-67.
Stroke counter fails to disengage.	Increase the tension on the counter return spring at the rear of the panel.
Stroke counter gears damaged or worn.	Check visually while holding the cover back and correct as required.

ST-790 Test Stand and Hydraulic System Legend

1. Air Regulator and Filter
2. Filter Drain
3. Air Valve
4. Hydraulic Reservoir
5. Air Pressure Gauge
6. Hydraulic Oil Level Gauge
7. Sight Glass
8. Hydraulic Lock Up Valve
9. Hydraulic Loading Cylinder
10. Piston
11. Piston Rod
12. Piston Return Spring
13. Cylinder Breather
14. Bleed Plug
15. Test Oil Tank
16. Test Oil Strainer
17. Gear Pump
18. Test Oil Filter (Part No. 105204)
19. Injector Inlet Connector
20. Pressure Regulator
21. Dampening Valve
22. Test Oil Pressure Gauge
23. Injector Seat Assembly
24. Restrictor Orifice
25. Check Ball
26. Spring
27. Solenoid Valve
28. Vials
29. "O" Ring (Goshen Part No. GRG-27-12) (Parket Part No. 2-114) (Linear Part No. 11-114)
30. 0.035 Orifice
31. Secondary Check Valve
32. Filter Drain Cock

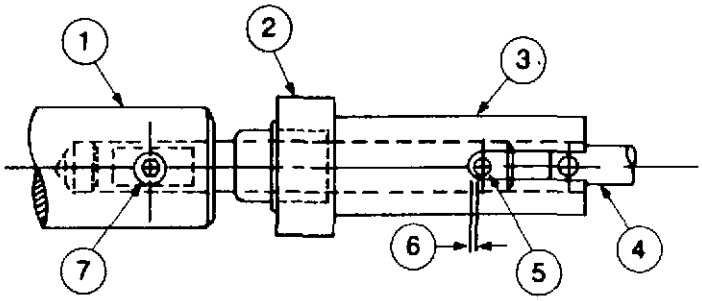
G. By-Pass Test Oil From Pressure Regulator (3/16 I.D. × 3/8 O.D. × 9½" Long Clear Vinyl Tubing)
H. Metered Test Oil To Vials (3/16 I.D. × 5/16 O.D. × 40" Long Clear Vinyl Tubing)
I. By-Pass Test Oil From Solenoid Valve (3/16 I.D. × 3/8 O.D. × 7" Long Clear Vinyl Tubing)
J. Drain Test Oil (5/16 I.D. × ½ O.D. × 14" Long Clear Vinyl Tubing)
K. Injector Return Test Oil (5/16 I.D. × ½ O.D. × 22" Long Clear Vinyl Tubing)
L. Test Oil From Filter Outlet To Injector Inlet Connector (Stratoflex No. 213 M.H.P. No. 4 37½" Length)
M. Test Oil From Solenoid To Vial (⅛ × 2¼" Long Copper Tubing)
X. Original Plumbing (Omit)



A. Air In.
B. Hydraulic Fluid
C. Test Oil From Tank To Pump
D. Test Oil From Pump To Filter Inlet (Stratoflex No. 213 M.H.P. No. 4 21" Length)
E. Test Oil From Injector Inlet To Pressure Regulator (Stratoflex No. 213 M.H.P. No. 4 21" Length)
F. Test Oil From Pressure Regulator To Pressure Gauge (3/16 × 18" Copper Tubing)

Fig. 4-66, (F60158). The test stand hydraulic system

1. Camshaft
2. Collar
3. Driver
4. Counter Shaft
5. Cross Pin
6. 1/32 Inch Clearance
7. Set Screw



If 1/32 inch clearance has been affected because of loose setscrew or any other condition, the following steps must be taken to obtain proper clearance.

1. Loosen setscrew so that the shaft slides freely in the housing.
2. Manually engage the clutch by fully depressing the solenoid (inside main housing). With the clutch held in this position, the cross pin in the clutch shaft must be positioned to clear the end of the "U" slot in the clutch driver by approximately 1/32 inch.
3. Tighten the setscrew against the flat on clutch shaft.
4. Check the operation, if the solenoid is noisy (loud hum or chatter) recheck Step No. 2.

Fig. 4-67, (F60160). Position of the collar and drive clutch assembly

Check 6 — Air Supply

Cause	Correction
Shop air pressure of less than 80 psi [552 kPa].	Supply air pressure of 80 psi [552 kPa] or more.
Air supply is on common line with other air actuated equipment which causes itermittent pressure drop.	Re-arrange the equipment so that the ST-790 is on a circuit which has constant air pressure.

Check 7 — Air Supply Gauge

Cause	Correction
Psi setting does not agree with the load test cell reading.	Check both the air gauge and load test cell when the relationship between the gauge and cell changes by more than 3 psi [21 kPa].
Air gauge hangs up at a certain point regardless of regulated pressure.	Clean and adjust the hand to clear the face or replace as necessary.
Air gauge is erratic. It does not repeat consistently when actuated several times at the same pressure.	Check the inlet for obstruction, gauge hand for hanging up and correct or replace as necessary.

Check 8 — Air Pressure Regulator

Cause	Correction
Excessive moisture.	Drain the regulator bowl each day by releasing the spring loaded valve. Clean the filter by removing the bowl, wash in solvent and air dry.

Cause (Cont'd)

Regulated pressure "creeps".

Correction (Cont'd)

Remove the top housing, valve seat and valve assembly. Inspect the disc and seating surface of the valve seat.

Inspect the valve guide and valve guide recess for foreign particles. Clean all parts thoroughly.

While the top housing is removed for the preceding step, check the diaphragm and slip ring and replace the faulty parts.

Check 9 — Hydraulic Clamping

Cause

Leaks — (hydraulic clamping system).

This can be verified by the following check:

1. Clamp the load-cell in the stand.
2. If after 3 minutes the load-cell reading changes position by more than 20 lbs [9.07 kg].
3. Dry all plumbing connections and watch for seepage with the air valve closed and with it open.

Correction

(See below for specific corrections.)

Check for leaks at the bleed plug and correct as required.

Correct as required.

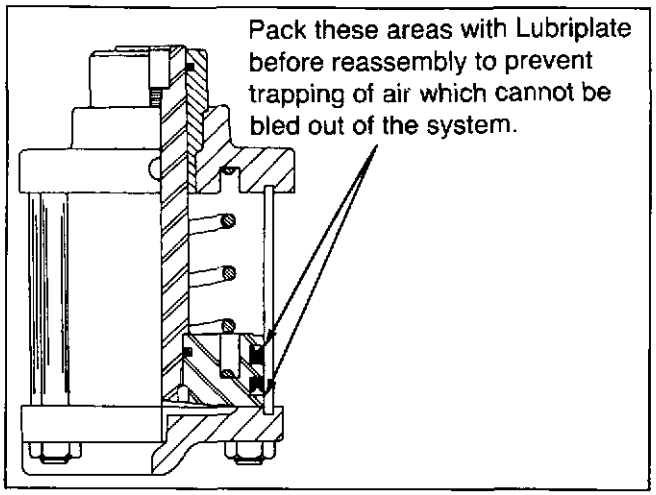


Fig. 4-68, (F60159). Hydraulic loading cylinder

4. If no external seepage is indicated and the condition still persists, one of the following exists.

   a. Leakage past the piston sealing rings. (This is accompanied with a loss of fluid from the reservoir and the appearance of oil out of the cylinder vent when the piston is actuated to the top travel.)

   Replace the sealing rings as required. (See Fig. 4-68 for assembly instructions.)

   b. Hydraulic lock-up valve leaking. (This can be checked by placing the valve in a closed position and applying air pressure. Indicated travel of the piston rod verifies a leaking hydraulic lock-up valve.)

   Repair or replace as required.

Check 10 — Load Test Cell

Cause	Correction
The gauge on the load cell has become miscalibrated as a result of mis-handling such as dropping or excessive loading.	Check the load cell on a valve spring tester at 380 lbs [172 kg] load. The load cell should read 380 lbs [172 kg]. Correct the gauge with the recalibration screw on the gauge face.

Check 11 — Plunger Actuating Link

Cause	Correction
Use of the wrong injector model link causing the hydraulic piston return spring to be worked at a height other than when checking the load cell.	Use correct link for the injector being calibrated.
Plunger actuating link binding on link guide bracket.	Inspect the link visually and during running of the stand and replace if necessary.
Plunger actuating link distorted or cracked on the socket and causing cocking during the operation of the stand.	Align the link guide bracket so that it does not contack the link at any point.

Check 12 — Test Oil Leaks

Cause	Correction
Cup seat O-ring leaking. (Leak can appear as mist).	Replace the O-ring with a new one. If an O-ring of a larger crosscut diameter is used, the injector can bounce on the cup seat and thus affect transfer groove and metering orifice timing. Any bouncing of the injector on the cup seat must be corrected.
Cup seat block-to-solenoid line (line H in Fig. 4-66) leaking in between the tank and front panel. (To check this, route line H temporarily in front of the panel and operate test stand.)	
Visual leaks.	Correct as necessary, remove the rear panel.

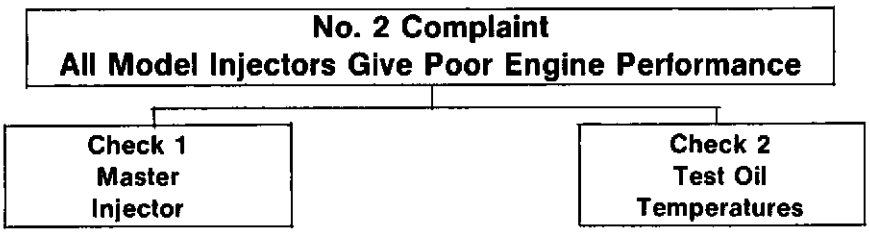
Check 13 — Test Oil Condition

Cause	Correction
Improper test oil or dilution.	Keep the tank 3/4 full of Cummins 3375364 Test Oil. Use of oil not meeting these specifications or diluted until the viscosity or specific gravity values are affected will cause improper calibration.
Test oil brown in appearance.	New oil is clear in appearance and becomes amber during use, never use when brown.
Dirty test oil.	Based on 8 hours per day, clean the filter and change *the oil monthly or after 160 hours of operation.*
Test oil aerated.	It is normal for the drain on flange-type injectors to appear "milky".

Cause (Cont'd)	Correction (Cont'd)
	The PT (type B) (type C) and PT (type D) drain should normally be clear. Fuel in the cup seat block-to-solenoid line (line H, in Fig. 4-66) must always appear clear with all injector models. It must be possible to disconnect the injector inlet line immediately after shutting off the test stand without evidence of any compressed air in the system.
Low oil level in tank.	Fill tank to 3/4 full or above.
Air not completely expelled from system after the filter change or after having the lines disconnected for other reasons.	Without breaking the test oil line connections, remove the filter assembly from its mounting bracket. With the filter assembly in the inverted position and the test stand running at low pressure, bleed the filter at the drain cock until the oil is free of air.
Air leak between the supply tank and gear pump suction. 1. Strainer cap loose or cap gasket missing. 2. Air leaks in strainer-to-gear pump section line or at connections.	Correct at required.

Check 14 — Solenoid Valve

Cause	Correction
Solenoid leaking test oil into the bypass line during the test cycle.	Check for foreign particles and pitted valve or seat. Clean, repair or replace as necessary.
Improperly installed solenoid valve (incoming test oil line connected to the discharge port and the vial line connected to the inlet port) causing excessive restriction on the metered test oil.	Check identification on the solenoid valve inlet port to which line from the injector cup tip must be connected is stamped IN. Directly opposite is the discharge port which must be connected to the vial line. Correct if necessary.
Solenoid valve sticks and fails to divert the test oil to the vial at the instant the counter actuating switch is depressed.	Clean the valve until it operates freely or replace.
The 0.035 inch [0.89 mm] orifice below the solenoid is partially clogged with foreign particles. This causes excessive restriction, which expands the injector-to-solenoid line (line H, Fig. 4-66), while the test oil is being by-passed but regains normal size and empties excess test oil into the vial when the test cycle is started.	Clean as required.



Check 1 — Master Injector

Cause

Master injector out of calibration.

Correction

This can be substantiated or disproved by calibrating a set of injectors at 132 cc and engine testing them. If the fuel rate vs. manifold pressure relationship is not within specifications, a miscalibrated master injector is verified. During this check the utmost accuracy is required in weighing the fuel and recording the manifold pressure. The correct camshaft and pistons as listed on the CPL must be used during this test.

Replace the faulty master with a new master ordered from the factory. Clean and correct the faulty master, and use it in an engine. Never use an injector as a master after it has been taken apart or changed in any way.

Check 2 — Test Oil Temperature

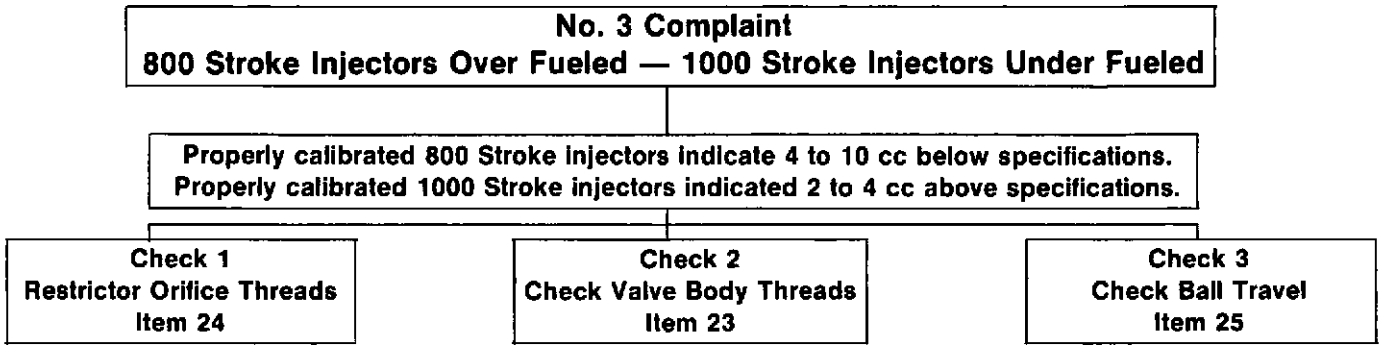
Cause

Test oil at excessively high or low temperature.

Correction

Setting up the test stand or calibrating injectors while the test oil is at excessively low or excessively high temperatures.

Check the test oil temperature indicator against a master thermometer and compensate as necessary for any existing differential. Connect cold or hot water lines to the heat exchanger at the back of the tank to maintain the test oil temperature at the required 90 to 95° F [32 to 35° C]. If temperature exceeds 95° F [35° C], increase the cold water flow. If temperature exceeds 135° F [57° C], drain and replace with new test oil.



Check 1 — Restrictor Orifice Threads

Cause

Leakage around the restrictor orifice threads.

Correction

Torque the restrictor orifice into the check-valve body at 6 in-lb [0.7 N•m].

Check 2 — Check Valve Body Threads

Cause

Leakage around the check-valve body threads.

Correction

Use a gasket (0.030 in [0.76 mm] throttle adjusting shim) under the check-valve body. Torque the check-valve body into the cup seat block at 10 to 12 in-lb [1.1 to 1.4 N•m].

Check 3 — Check Ball Travel

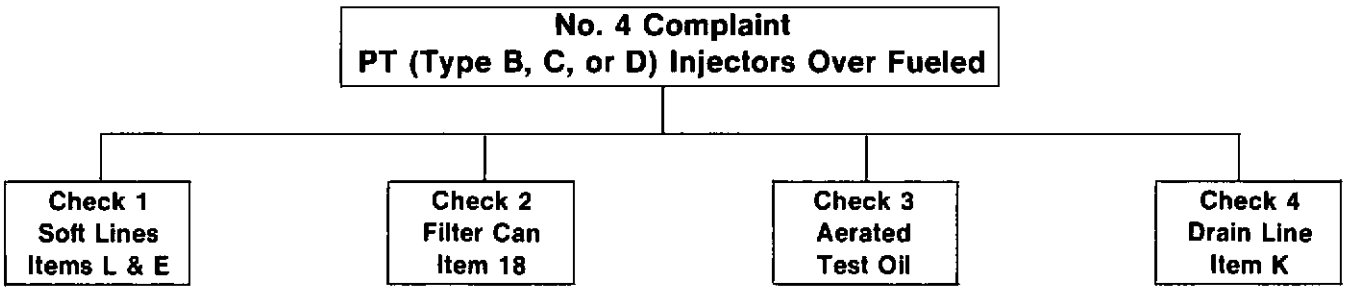
Cause

Loss of ball-travel caused by over-tightening of the restrictor orifice and consequent stripping of orifice threads.

Caution: Never try to attain the proper ball travel by loosening the orifice as this will cause leakage around the threads and defeat the purpose of the restrictor and check valve.

Correction

Orifice must be replaced if the threads are damaged. Orifice torque is 6 in-lb [0.7 N•m]. Ball travel is 0.020 to 0.030 inch [0.51 to 0.76 mm] with the orifice torqued in position (for assembly diagram refer to Fig. 4-59).



Check 1 — Soft Lines

Cause

Use of a filter-to-injector and injector-to-regulator lines (lines L and E in Fig. 4-66) which are softer and more resilient than those supplied with test stand.

Correction

Install lines of material and length shown in Fig. 4-66.

Check 2 — Filter Can

Cause

Original filter has been replaced with one which is larger or has a softer can, such as a Cummins throw-away filter.

Correction

Replace with a standard filter per Fig. 4-66.

Note: Be sure that the filter is installed in the correct location in the circuit.

Check 3 — Aerated Test Oil

Cause

Aerated test oil.

Correction

See "Causes and Corrections" under Check 13 of "Test Stand will not repeat consistently on any given injector".

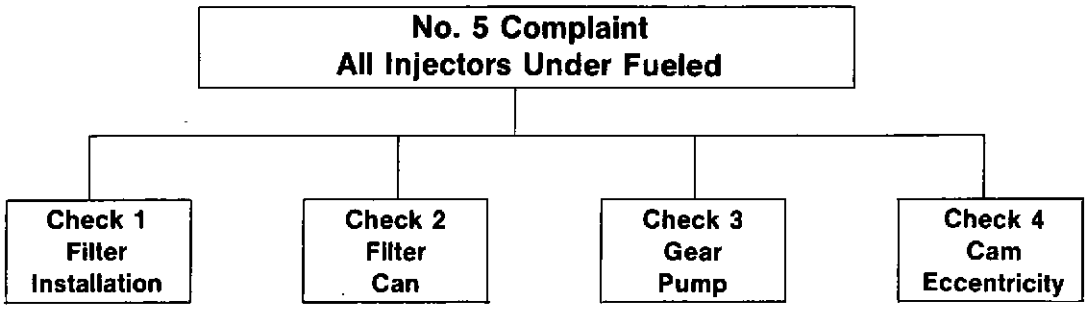
Check 4 — Drain Flow Lines

Cause

Use of a line with less than 5/16 inch [7.95 mm] I.D. or crimp caused by a sharp bend in the drain line.

Correction

Replace per line K in Fig. 4-66.



Check 1 — Filter Installation

Cause

Removal of the filter assembly from the circuit.

Installation of the filter assembly in the suction side of the gear pump.

Correction

Install the filter.

Filter assembly must be in the specified location as shown.

Check 2 — Filter Can

Cause

Installation of a smaller or more rigid than standard filter can.

Correction

Filter must be of the specified type.

Check 3 — Gear Pump

Cause

Low gear pump delivery.

Correction

With the pressure regulator by-pass line (line G, in Fig. 4-66) completely blocked, check the gear pump against a 0.045 inch [1.14 mm] orifice installed in line L.

The gear pump is acceptable if it delivers 80 to 120 psi [552 to 827 kPa] during this check.

Cause (Cont'd)

Correction (Cont'd)

If the gear pump delivers less than 80 psi [552 kPa], check the test oil strainer for clogging. Check the pump suction restriction and clean if necessary. The gear pump may need replacing.

Check 4 — Cam Eccentricity

Cause

Cam base circle eccentricity.

Correction

Check as follows:

1. Align the timing wheel mark and pointer.
2. Install the ST-790-5111 load cell with the regulated air pressure set to 380 lbs [172 kg] load.

   Repeat the clamping several times to make sure that the setting of the clamping load is correct.
3. Close the hydraulic valve while the load cell is clamped in position and turn the timing wheel slowly by hand.
4. If the load cell indicates more than 50 lbs [22.7 kg] increase above the clamping load, the cam and/or shaft and/or cam follower must be replaced.

NOTES

Fuel Lines, Fittings and Connections

Fuel Tubing and Fittings

The fuel lines and fittings act as the vehicles to carry fuel to the fuel pump, from the fuel pump to injectors and to return the unused fuel to the fuel tanks. In all cases the restrictions must be kept at the lowest possible value.

Reject any fuel tubing or tubing fittings that are:

1. Not the standard size or length.

Caution: Note Fig. 5-1, which illustrates two different angle fittings used on Cummins wire braid hose. Failure to use the proper combinations can cause air or fuel leaks.

2. Twisted or bent out of shape.
3. With damaged threads.

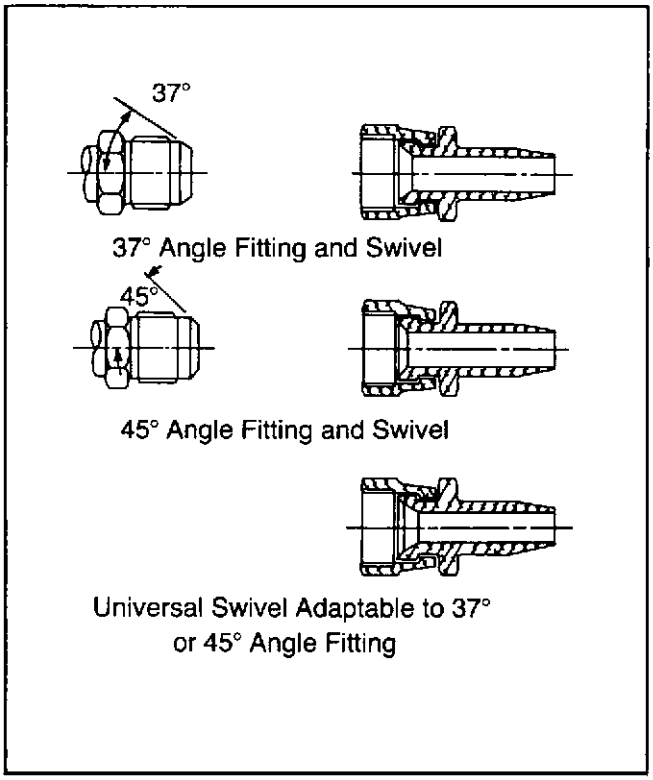


Fig. 5-1, (F60184). Wire braid hose fittings and swivel angles

Fuel Lines

See Table 5-1 for line sizes (hose or steel tubing) used in the fuel system. Hose used must consist of a seamless synthetic rubber inner tube reinforced with a fabric braiding and wire braiding, and covered with a synthetic rubber coating. The hose must be capable of handling fluids ranging in temperature from –40° F [–40° C] to 200° F [94° C] and pressure to 250 psi [1720 kPa].

Table 5-1: Fuel Lines — Minimum Size

Fuel Line Usage	Hose Size No.	Steel Tube Size O.D. In. [mm]	Maximum Restriction In. [cm]
Fuel suction	*10	5/8 [15.9]	3 [10.2] Hg
Injector return	** 8	1/2 [12.7]	4 [10.2] Hg
PT (type R) fuel pump return	6	3/8 [9.5]	——
Integral gear pump bleed or cooling kit	4	1/4 [6.3]	
KT-2300 suction	12	3/4 [19.0]	4 [10.2] Hg
KT-2300 return	10	5/8 [15.9]	
KTA-3067 suction	16	1 [25.4]	4 [10.2] Hg
KTA-3067 return	10	5/8 [15.9]	
AFC air supply	4	1/4 [6.3]	
AFC fuel return	4	1/4 [6.3]	
Aneroid fuel lines	5	5/16 [7.9]	

*Hose No. 10 or 12 - Must be 1/2 in. [12.7 mm] I.D. minimum.

**Hose No. 8 or 10 - Must be 13/32 in. [10.3 mm] I.D. minimum.

Fuel Line Check Valves

1. Check valves, Part Numbers 185505 and 178079 can be used in place of the fuel float tank on engines with PT (type B, C or D) injectors if the overhead fuel storage tank is not over five feet [2.4 m] above the injectors.

   a. Install a low pressure check valve, 178079, (identity No. 230B-3PP-3) in the injector drain line from the cylinder heads. The check valve must be placed as near the engine as possible, preferably within eighteen inches [45.7 cm] of the drain outlet from the cylinder heads.

   b. A high pressure check valve, 185505 (identity No. 239B-3PP-3) must be installed in the fuel line between the fuel pump and the injectors.

The supply line check valve and the drain line check valve must be used together.

2. The drain line must be piped into the storage tank above the maximum fuel fill level.
3. An alarm system wired into the circuit with the *lubricating oil pressure warning switch and the* fuel pump shutdown valve must be used in the installation.
4. A fuel supply line check valve, Part No. 217196, is available to prevent fuel drain back and reduce associated hard starting problems. This valve must be installed at the fuel out side of the fuel filter head, replacing the fuel fitting, except when the filter is mounted on the fuel pump. Check valve 217196 cannot be used on pump mounted fuel filter.
5. Check valve, Part No. 219022, is used on engine models with the rail dump aneroid, AR-40600/ series. When using AR-40600 series aneroids which have starting check valve omitted, check valve 219022 must be installed in fuel supply line to aneroid.

Fuel Drain Restriction Versus Pressured Refueling Systems

Pressurized fueling systems are in use at some construction job sites. These systems can have an adverse effect on engine components. These systems are currently designed so that the fuel tanks are pressurized while fueling the equipment and remain pressurized for a period after fill. This pressure can vary from two to eight (2 to 8) psi which will create excessive fuel drain line restriction.

Cummins recommendation on fuel drain line restriction is limited to 2.5 inches of mercury (Hg) or 1.2 psi without overhead tanks.

When overhead tanks are used an additional 4 inches of mercury (Hg) or 1.96 psi is permissible to compensate for the static head pressure of fuel created by the overhead tank. (A total of 6.5 inches of mercury or 3.08 psi or a maximum fuel level of five feet above the injectors.) When overhead fuel tanks are used, a check valve must be incorporated in the fuel return line and pressure line. A special fuel pump calibration is required when 6.5 in. [165 mm] fuel drain line restriction is present.

Use of the pressurized fuel system can cause the following type of complaints:

1. Performance complaints with the AFC fuel system making the AFC inoperative, resulting in poor acceleration complaints.
2. Hydraulic locking of the engine due to excessive fuel in the cylinders caused by fuel draining back through the return line or an open shutdown valve.

Pressurized fueling operates successfully, providing the tank returns to atmospheric pressure after fueling and before engine operation.

PT Fuel Pump Inlet Fittings

O-ring seal type fuel inlet (suction) fittings are now being used in PT fuel pumps to reduce the possibility of air leakage and to shorten assembly time. Threads on the revised fittings are 3/4 inch [19.05 mm] by 16 UNF thread; the old-style fittings had 3/8 inch [9.5 mm] NPTF threads. The old and revised style fittings are illustrated in Fig. 5-2.

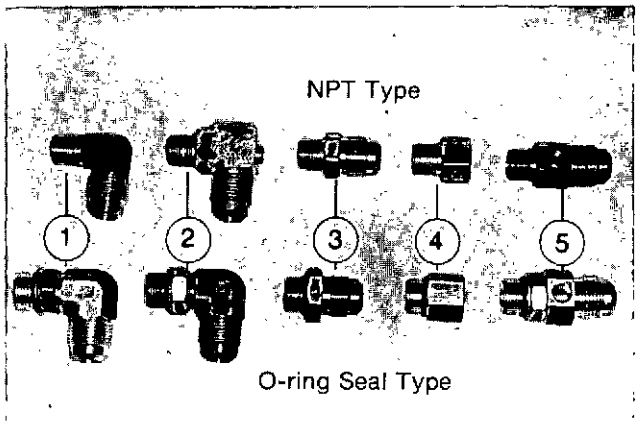


Fig. 5-2, (F60222). PT Fuel Pump inlet fittings

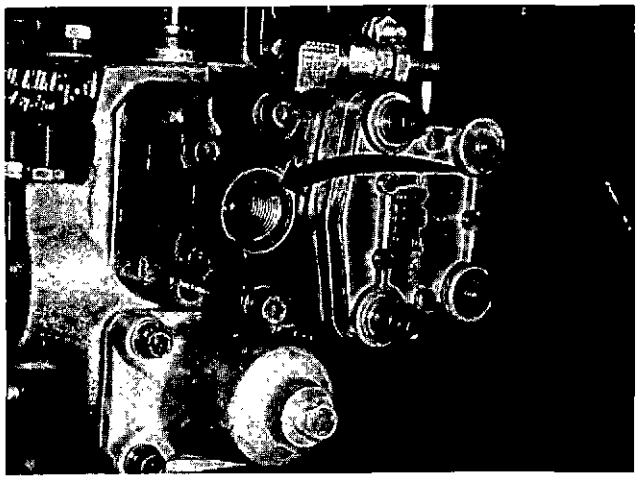


Fig. 5-3, (F5243). Fuel inlet connection on the gear pump

Gear Pump Change

PT gear pumps have been changed to accommodate the larger diameter fitting and the fitting O-ring seal. Fig. 5-3 illustrates the gear pump as machined for the revised-style fittings.

Part numbers of the gear pumps were not changed. Both old and revised-style fittings must be carried in stock to accommodate either "old or revised" gear pumps as required.

Flexible Fuel Lines

Flexible fuel lines on the NH (855) Series Engines are available for high vibration applications, such as cement trucks, as replacement of the metal fuel supply tube.

Fuel Supply and Drain Tubes Braces and Clamps

Fuel tube braces and clamps are available for engines that have vibration complaints. Braces and clamps can be used to reduce tube vibration and stress at the tube connection locations.

Two Piece Fuel Manifold for KT/KTA-2300 and 3067 Series Engines

A two piece fuel manifold is available for the above engines. Some one-piece design fuel manifolds have had a cracking complaint. The two-piece manifold corrects this complaint by using a separate connection block for each section. Conversion kits are available.

Sealastic Fuel Tubing Fitting Procedures for the K/KT-2300 and KTA-3067 Engine

The correct assembly procedure for using the sealastic fuel tubing fittings for 5/16 inch [7.94 mm] and 3/8 inch [9.53 mm] outside diameter tubing is as follows:

1. Install the fuel fitting nut and the ferrule seal (1) and (2) of Fig. 5-4 over the fuel tube(s). **Do not** install the ferrule into the machined counterbore in the fuel block and then pass fuel tube through the ferrule. This can result in a damaged ferrule and/or an improperly located fuel tube.
2. Install the fuel tube so that the tube end rests against the machined stop in the fuel block, Fig. 5-4.

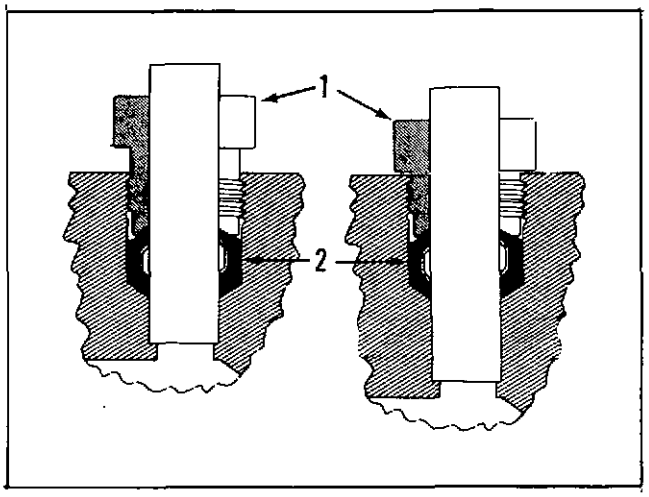


Fig. 5-4. (F60291). Sealastic fuel tubing fitting in the fuel block

Note: The sealing ferrule (2), Fig. 5-4 is available separately.

3. Locate the ferrule carefully into the fuel block and tighten the fuel fitting nut finger tight only. Tighten the nut a further 3/4 turn using a suitable wrench. **Do not** overtighten as damage to the fuel tube and ferrule will occur.

Note: In 1982 the fitting nut was shortened. The nut will now screw down against the fuel block.

4. Before tightening the fuel fitting nut make sure that **both** ends of tube are fully engaged and seated in their counterbores.

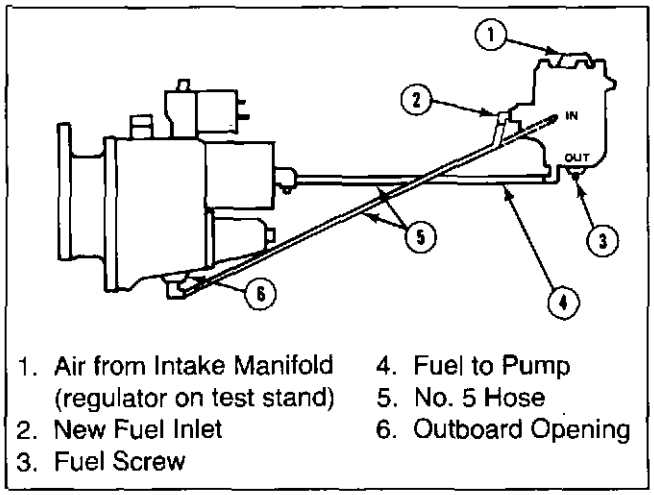
Fuel Control Valve Option for KT/KTA-2300 Engines

A 3015192 Fuel (Bank) Control Valve is available for KT/KTA-2300 construction engines. This valve is standard on all KTA-3067 construction engines.

The 3015192 Fuel Control Valve will allow the operation of the engine on one bank when fuel rail pressure drops below 10 psi. This will control white smoke during cold starts and while idling during cold weather.

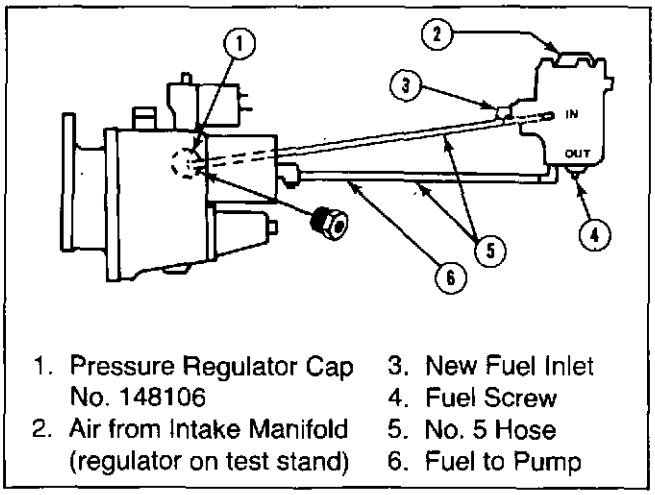
The 3015192 Fuel Control Valve is used in place of the fuel distribution block and must be used with the 178079 and 185505 Check Valves.

On engines using the VS throttle assembly, (automotive throttle blocked open) recalibration of the fuel pump is not required unless check valve(s) are added. (Engines currently equipped with check valves do not require recalibration).



1. Air from Intake Manifold (regulator on test stand)
2. New Fuel Inlet
3. Fuel Screw
4. Fuel to Pump
5. No. 5 Hose
6. Outboard Opening

Fig. 5-5, (F5245). Aneroid piping for the PT (type G) fuel pump

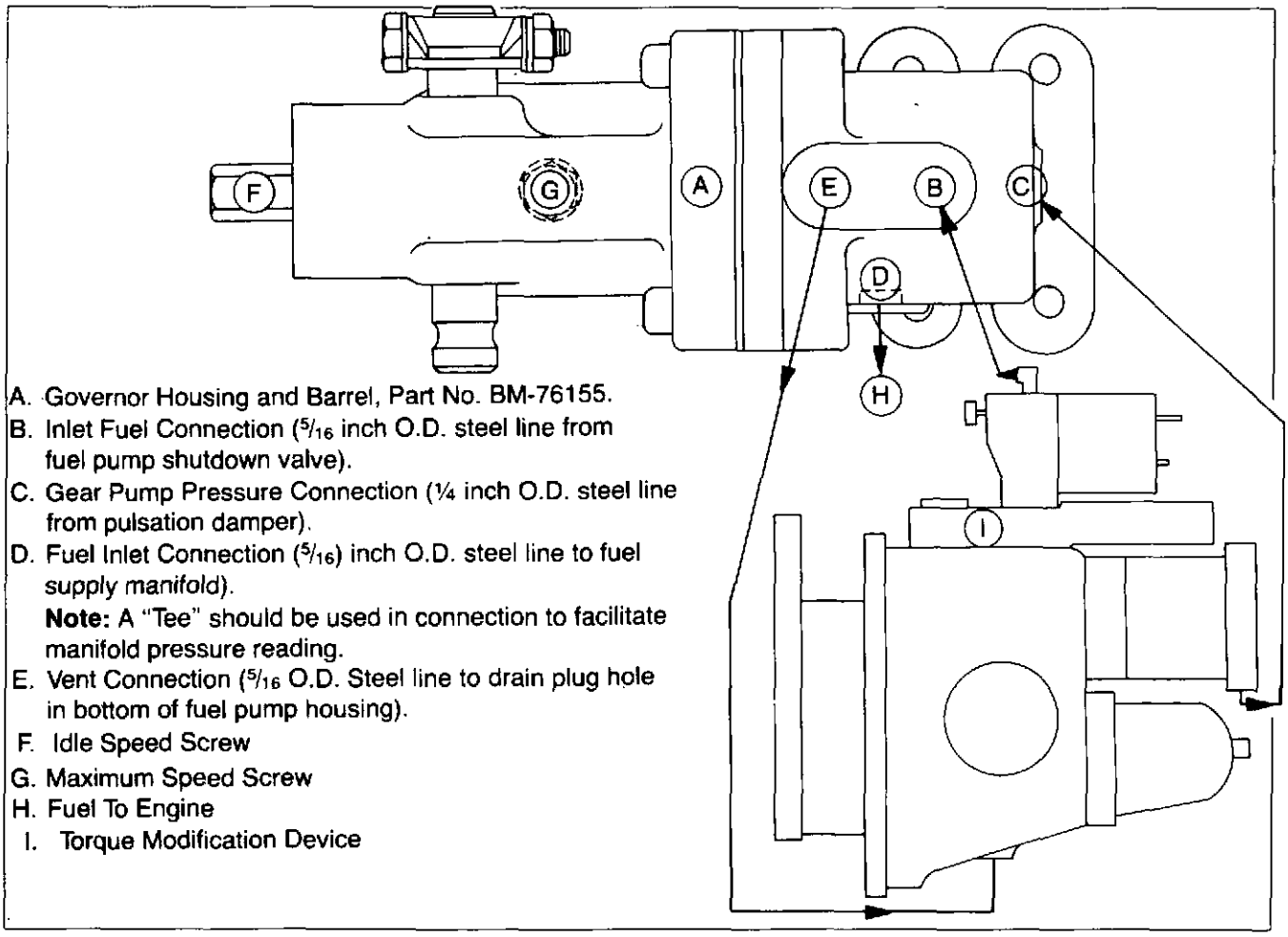


1. Pressure Regulator Cap No. 148106
2. Air from Intake Manifold (regulator on test stand)
3. New Fuel Inlet
4. Fuel Screw
5. No. 5 Hose
6. Fuel to Pump

Fig. 5-6, (F5246). Aneroid piping for the PT (type G) fuel pumps with an MVS governor and a PT (type G) VS fuel pump with aneroid housing Part No. 218081.

On engines using the automotive throttle, the 143849 Weight Assist Spring is required to maintain low idle droop (load) requirements.

Refer to the calibration code to determine the weight assist spring part number, change as required.



A. Governor Housing and Barrel, Part No. BM-76155.
B. Inlet Fuel Connection ($^5/_{16}$ inch O.D. steel line from fuel pump shutdown valve).
C. Gear Pump Pressure Connection (¼ inch O.D. steel line from pulsation damper).
D. Fuel Inlet Connection ($^5/_{16}$) inch O.D. steel line to fuel supply manifold).
Note: A "Tee" should be used in connection to facilitate manifold pressure reading.
E. Vent Connection ($^5/_{16}$ O.D. Steel line to drain plug hole in bottom of fuel pump housing).
F. Idle Speed Screw
G. Maximum Speed Screw
H. Fuel To Engine
I. Torque Modification Device

Fig. 5-7, (F5289). Piping diagram for remote mounted MVS governor to PT (type G) Fuel Pump with T.M.D.

Fuel Inlet and Drain Connections

Assemblies included in this section are the fuel inlet and drain connections. The connections carry the fuel from the injector lines into the flanged type injectors.

Fuel connections are used only with the flanged injectors.

1. Remove the strainer screen from the inlet connection, Fig. 5-8.
2. Clean the screen in solvent and dry with an air jet. Direct the air in the reverse direction of fuel flow.
3. Replace the strainer screen in the inlet connection.
4. Inspect the threaded end of all connections. Replace if the threads are damaged.
5. Replace the copper gasket, rubber O-ring and retainer.

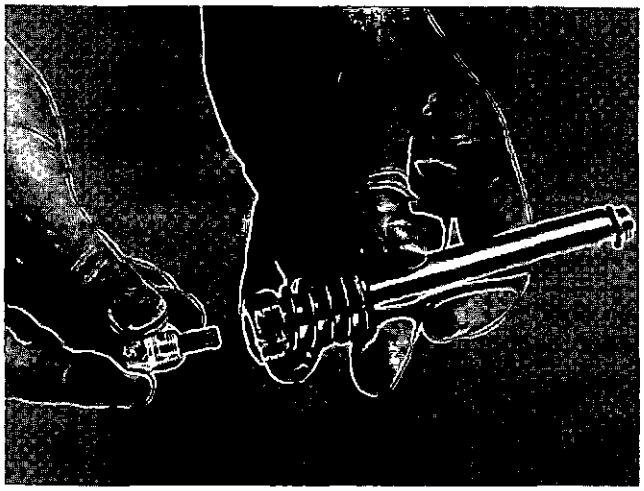


Fig. 5-8, (N10601). Remove the injector inlet screen

NOTES

Injector Parts Specifications

	Usable Limit	New Minimum	New Maximum
Plunger			
Plunger Coupling Flange — inch [mm]	0.144 [3.66]		
Plunger Spring Retainer Wear — inch [mm]	0.003 [0.076]		
Plunger Rotation Test on 3375209 — in. oz. [N•m]	2 [0.226]		
Barrel			
Check Ball Groove Depth (Made in 1982) — inch [mm]		0.108 [2.74]	0.130 [3.30]
Check Ball Groove Width (Made in 1982) — inch [mm]		0.070 [1.78]	0.105 [2.67]
Check Ball Depth — inch [mm]	0.055 [1.40]	0.030 [0.76]	
Leakage Checks			
Check Ball at 80 psi — Units	12		
Check Ball at 60 psi (optional) — Units	8.5		
Cup to Plunger Seat			
No bubbles in 10 seconds or			
5 seconds between bubbles			
Barrel or Body to Plunger			
See Table 6-8.			
Cup Spray Test on 3376350			
Plus or Minus one half the distance between			
the scribed lines			
Adapter			
Dimple above Check Ball — inch [mm]	0.010 [0.25]		
Orifice Plug Torque — in. lb. [N•m]		8 [0.9]	10 [1.1]
Top Stop Locknut — ft. lb. [N•m]		53 [72]	57 [77]
Injector Spring			
Squareness for Top Stop Injectors Only — inch [mm]	0.016 [0.41]		
Spring Data — See Table 6-4			
Recheck Limits			
Injector Flow on ST-790 cc		-2	+1
Injector Flow on 3375317 — mm^3/stroke		-1½	+1½
Top Stop Setting — From One Test Stand to Another — inch [mm]		-0.001 [0.025]	+0.001 [0.025]

Table 6-1: Injector Cup Retainer Torques — with Crowsfoot Wrench ST-1072

Engine Series	Retainer Torque
V6-140, V8-185, V-555	43/47 ft-lb [58/64 N•m]
KT	65/70 ft-lb [88/95 N•m]
NH, V6-200, V8-265, NT, V12, V-903	53/57 ft-lb [72/77 N•m]

Table 6-2: Cup Contact Area of Barrel

Engine Series	"A" Dia. Inch [mm]	"B" Dia.	"C" Dia.	"D" Dia.
V6-200, V8-265, V-903, NH, NT, V12	0.400 [10.16]	0.540 [13.72]	0.170 [18.03]	0.820 [20.83]
V6-140, V8-185, V-504, V-555	0.337 [8.56]	0.480 [12.19]	0.650 [16.51]	0.706 [17.93]

Table 6-3: Injector Flow and Approximate Orifice Plug Size

ST-790 Flow	3375317 Flow	Orifice Plug	ST-790 Flow	3375317 Flow	Orifice Plug	ST-790 Flow	3375317 Flow	Orifice Plug
95		.017	151		.023	190A	220.5	.032
100	92.5	.019	163	151.5	.024	185B	285.5	.030
114	105.5	.019	167	154.5	.024	181C	198	.037
117	108.5	.021	172	159.5	.024	164E	365	.038
118	109.5	.022	178	164.5	.024	119AK	98	.022
121	112.5	.020	183	169.5	.025	153AK	124	.019
122	113.5	.019	185	171.5	.024	162AK	132	.023
125	115.5	.025	153A	182.5	.042	180AK	146	.021
126	116.5	.025	163A	188.5	.027	190AK	155	.022
132	122.5	.024	178A	205.5	.029	176BK	192	.026
140	129.5	.023	183A	211.5	.029	190BK	202	.028
145	135.5	.023	185A	215.5	.025	192DK	243	.034

Table 6-4: Injector Spring Data

Part No.	Approximate Free Length Inches [mm]	No. Coils	Wire Dia. Inches [mm]	Load Required to Compress Springs to Length: Length Inch [mm]	New Min. Lb. [kg]	New Max. Lb. [kg]	Worn Limit Lb. [kg]
9337 Flanged C, J	1-7/8 [47.6]	8-1/2	0.177 [4.50]	1-9/16 [39.7]	135 [61]	149 [68]	130 [59]
62123 Flanged H, NH, NT, V12 5-1/8"	2-1/32 [51.6]	7	0.1875 [4.77]	1-9/16 [39.7]	135 [61]	149 [68]	130 [59]
8091-1 Flanged L, LR, LRT	2-7/16 [61.9]	7	0.2625 [6.65]	1-7/8 [47.6]	228 [163]	252 [114]	218 [99]
128040 Cylindrical Injector PT-B, C V-903, V8-265, V12 5-1/2"	2-1/2 [63.5]	*7	0.1875 [4.77]	1.975 [50.2]	133 [60]	147 [67]	128 [58]
166009 PT-D, NH, NT, N14, L10, V12 5-1/2", V6-378, V8-504, V-555 — Color Code White	1.95 [49.7]	8	0.187 [4.75]	1.663 [42.2]	143.25 [65]	158.75 [72]	138 [63]
205464 PT-D, KT-6, KTA-2300, KTA-3067 — Color Yellow	2.82 [7.16]	11	0.187 [4.75]	2.40 [61]	134.25 [60.9]	149.75 [67.9]	129 [58.5]

*Earlier model springs have 9.5 coils with two closely spaced. These may be used interchangeably.

Table 6-5: Leakage Tester Altitude Compensation

Altitude	Units of Compensation
sea level	add 0.012 units
600 ft.	none
1100 ft.	subtract 0.1 units
1600 ft.	subtract 0.2 units
2100 ft.	subtract 0.3 units
2600 ft.	subtract 0.4 units
3100 ft.	subtract 0.5 units
3600 ft.	subtract 0.6 units
4100 ft.	subtract 0.7 units
4600 ft.	subtract 0.8 units
5100 ft.	subtract 0.9 units
5600 ft.	subtract 1.0 units
6100 ft.	subtract 1.1 units
6600 ft.	subtract 1.2 units
7100 ft.	subtract 1.3 units
7600 ft.	subtract 1.4 units
8100 ft.	subtract 1.5 units
8600 ft.	subtract 1.6 units
9100 ft.	subtract 1.7 units
9600 ft.	subtract 1.8 units
10100 ft.	subtract 1.9 units
10600 ft.	subtract 2.0 units

Table 6-6: Fuel Lines — Minimum Size

Fuel Line Usage	Hose Size No.	Steel Tube Size O.D. In. [mm]	Maximum Restriction In. [cm]
Fuel suction	*10	5/8 [15.9]	3 [10.2] Hg
Injector return	** 8	1/2 [12.7]	4 [10.2] Hg
PT (type R) fuel pump return	6	3/8 [9.5]	——
Integral gear pump bleed or cooling kit	4	1/4 [6.3]	
KT-2300 suction	12	3/4 [19.0]	4 [10.2] Hg
KT-2300 return	10	5/8 [15.9]	
KTA-3067 suction	16	1 [25.4]	4 [10.2] Hg
KTA-3067 return	10	5/8 [15.9]	
AFC air supply	4	1/4 [6.3]	
AFC fuel return	4	1/4 [6.3]	
Aneroid fuel lines	5	5/16 [7.9]	

*Hose No. 10 or 12 - Must be 1/2 in. [12.7 mm] I.D. minimum.

**Hose No. 8 or 10 - Must be 13/32 in. [10.3 mm] I.D. minimum.

Table 6-7: Injector Cup Gasket Data

Engine Series (Service)	Cup Gasket Part No.	Gasket Notches	Thickness In. [mm]	Body and Plunger Size Markings
H, NH, V-12, V6-200, V8-265, V8-350 and VT8-430	62409	None	0.0159 [0.4038]	A, B, C, D, 0, 1, 2, 3, 4, 5, 6, 7, 8
	109247	1	0.0201 [0.5105]	11, 12, 13, 14, 15, 16, 17, 18, 19, OP, P, 2P, 3P, 0S, 1S, 2S, 3S
	109248	2	0.0224 [0.5689]	20, 21, 22, 23, 24, 25, 0SS, 2SS, 3SS
	117994	3	0.0282 [0.7162]	30, 31, 32, 33, 34, 35, 0SSS, 1SSS, 2SSS, 3SSS
	131270	4	0.0315 [0.8001]	42, 43, 44, 45, 0SSSS, 1SSSS, 2SSSS, 3SSSS
	131758	5	0.0355 [0.9017]	52, 53, 54, 55
C, J, V6-140, and V8-185	62410	None	0.0159 [0.4038]	A, B, C, D, 0, 1, 2, 3, 4, 5, 6, 7, 8
	109249	1	0.0201 [0.5105]	11, 12, 13, 14, 15, 16, 17, 18, 19, 1P, 2P, 3P, 0S, 1S, 2S, 3S
	109252	2	0.0250 [0.6350]	20, 21, 22, 23, 24, 25, 0SS, 1SS, 2SS, 3SS
	117995	3	0.0282 [0.7162]	30, 31, 32, 33, 34, 35, 0SSS, 1SSS, 2SSS, 3SSS
	131269	4	0.0315 [0.8001]	42, 43, 44, 45, 0SSSS, 1SSSS, 2SSSS, 3SSSS
	131757	5	0.0355 [0.9017]	52, 53, 54, 55

Table 6-8: 3375375 Leakage Tester Data — Units

Injector	New	Used
PT (type B) H/NH Flange	6.5	9.5
J/C Flange	5.5	8.5
PT (type C) 3/8 inch Plunger	3.5	4.5
PT (type D) 3/8 inch Plunger	2.5	4.5
PT (type D) 5/16 inch Plunger	2.2	4.5

Table 6-9: ST-790 Test Stand Link Data PT (type D)

Engine Series	Length Inch [mm]	Link Marking
NH, NT, Super 250/270, H-855, N-927, V6-200, V8-265, V-903	6.5 [165]	ST-790-331
KT	6.3 [160]	ST-790-362
V6-140, V8-185, V6-378, V8-504, V-555	7.0 [178]	ST-790-329

Table 6-10: STU-790 and 3377041 Indicator Reading

Injector Code	Strokes (% 1000)	Equivalent Indicator Reading on STU-790
153A	80%	19.12 [191.2 cc]
158A	80%	19.75 [197.5 cc]
163A	80%	20.37 [203.75 cc]
169A	80%	21.12 [211.2 cc]
178A	80%	22.25 [222.5 cc]
180A	80%	22.50 [225.0 cc]
181A	80%	22.62 [226.25 cc]
181C	*80%	22.50 [225.0 cc]
183A	80%	22.87 [228.75 cc]
185A	80%	23.12 [231.25 cc]
185B	60%	30.83 [308.3 cc]
190A	80%	23.75 [237.5 cc]
185B	60%	30.83 [308.3 cc]

*Run at nominal 80 psi instead of 120 psi.

Cummins Service Publications

The following Cummins Service Publications concerning the Cummins PT Fuel System can be purchased from any Cummins Distributor or Cummins Dealer.

Many publications have been translated into other languages. Cummins Distributors or Cummins Dealers have information on which publications are available in languages other than English.

For information about any Cummins publications, contact your local Cummins Distributor or Dealer.

Fuel Pump Calibration Information

Bulletin Number	Publication Description
3379182	Codes 3200 and up — from Jan., 1976 to July, 1982
3379068	Codes 2300 to 3199 — from Jan., 1970 to Dec., 1975
3379077	Codes issued between Oct., 1963 and Dec., 1969
983533	Codes issued before Oct., 1963 — No Flowmeter Method
3379101	PT (type R) Fuel Pump Calibration Manual
3379084	Fuel Pump Rebuild and Calibration Procedures

Injector Manuals

3379071	Injector Rebuild Manual
3379664	Injector Parts, Flow and Cross Reference

Fuel System Wall Charts

Full Size	Training Charts	
3379081	3379291	PT (type G) AFC Fuel Pump Cross Section and Flow
3379082	3379292	PT (type G) AFC -VS Fuel Pump Cross Section and Flow
3379080	3379237	PT (type D) Top Stop Injector Fuel Injection Cycle
3379103	3379290	PT (type G) Fuel System Flow Diagram — All Injectors
3379131	3379293	PT (type G) Non AFC Fuel Pump Cross Section and Flow
3379485	3379295	PT (type G) AFC Fuel Pump Parts — July, 1979
3379172	3379294	PT (type H) AFC Fuel Pump Cross Section and Flow
983651		PT (type D) Injector In Line and Vee Series Engines

Miscellaneous Publications

3379090	Guide to Troubleshooting
3379133	Control Parts List
3379022	Governors Used on Cummins Engines
3379144	Fuel Systems Publications Rack Program
3379208	Fuel Systems Publications Rack Update Subscription Service
	Cummins Training Aids Catalog

Cummins Installation Recommendations

952849	Automotive Fuel System
3382576	Marine Fuel System
3382409	Construction, Mining, Logging, Agriculture, Fire Pump, Generator Sets, and Stationary Power Fuel System

Cummins Service Publications (Continued)

Film Recall Booklets (These publications have 33 mm slide training films available)

3387049-OR	PT (type G) AFC Fuel Pump Calibration
985577-R	PT (type G) Fuel Pump Calibration
983601-R	Principles of PT Mechanical Governors
983602-R	PT (type G) Fuel Pump Operation and Adjustment
983603-R	PT (type R) Fuel Pump Operation and Adjustment
983604-R	PT (type B and C) Injectors
983608-R	Cummins PT Injectors
983609-R	Theory of Cummins PT Fuel System
983658-R	Cummins PT (type D) Injector
985576-R	Injector Calibration
985575-R	Injector Leakage Tester ST-990
983657-R	PT (type D) Injector Disassembly and Assembly
985605-R	Cummins Aneroids
985618-R	Troubleshooting PT Fuel System — Program 1
985620-R	Troubleshooting PT Fuel System — Program 2
985621-R	Troubleshooting PT Fuel System — Program 3
985622-R	Troubleshooting PT Fuel System — Program 4
3387050-R	PT (type G) AFC Fuel Pump Operation and Adjustments
3387066-R	PT (type G) AFC Fuel Pump Troubleshooting
3387137-R	Troubleshooting Driveability Complaints

Index

Tables

NOTES

Cummins Engine Company, Inc.
Service Publications Comment Form

Suggested improvements? Errors? Please let us know.

Name			(AC) Tel No. ( )
Company			Bulletin No.
Address			Printing Date
City	State	Zip	Page No.

Comment/Correction

Signed Date

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 15 • COLUMBUS, INDIANA 47202

Postage Will be Paid By

Service Operations Dept. 80203
Cummins Engine Company, Inc.
Box 3005
Columbus, Indiana 47202-3005

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 15 • COLUMBUS, INDIANA 47202

Postage Will be Paid By

Service Operations Dept. 80203
Cummins Engine Company, Inc.
Box 3005
Columbus, Indiana 47202-3005

Cummins Engine Company, Inc.
Service Publications Comment Form

Suggested improvements? Errors? Please let us know.

Name			(AC) Tel No. ( )
Company			Bulletin No.
Address			Printing Date
City	State	Zip	Page No.

Comment/Correction

Signed Date

Cummins Engine Company, Inc.
Box 3005
Columbus, Indiana, U.S.A. 47202-3005
Cable: CUMDIEX COLUMBUS

Registered Office:
Cummins Engine Company, Ltd.
46-50 Coombe Road, New Malden
Surrey, England KT3 4QL
Cable: INTCUMLON MALDEN
Registration No. 573951 England

Bulletin No. 3379071-06, Printed in U.S.A. 12-82