

# SERVICE MANUAL

## INJECTION PUMP CALIBRATION

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### GENERAL

1. After an injection pump has been repaired or rebuilt, or if for any reason calibration of an injection pump is in question, the pump should be tested for all the requirements for proper performance. This is done by operating the pump on a calibration stand (Figure 5.1).

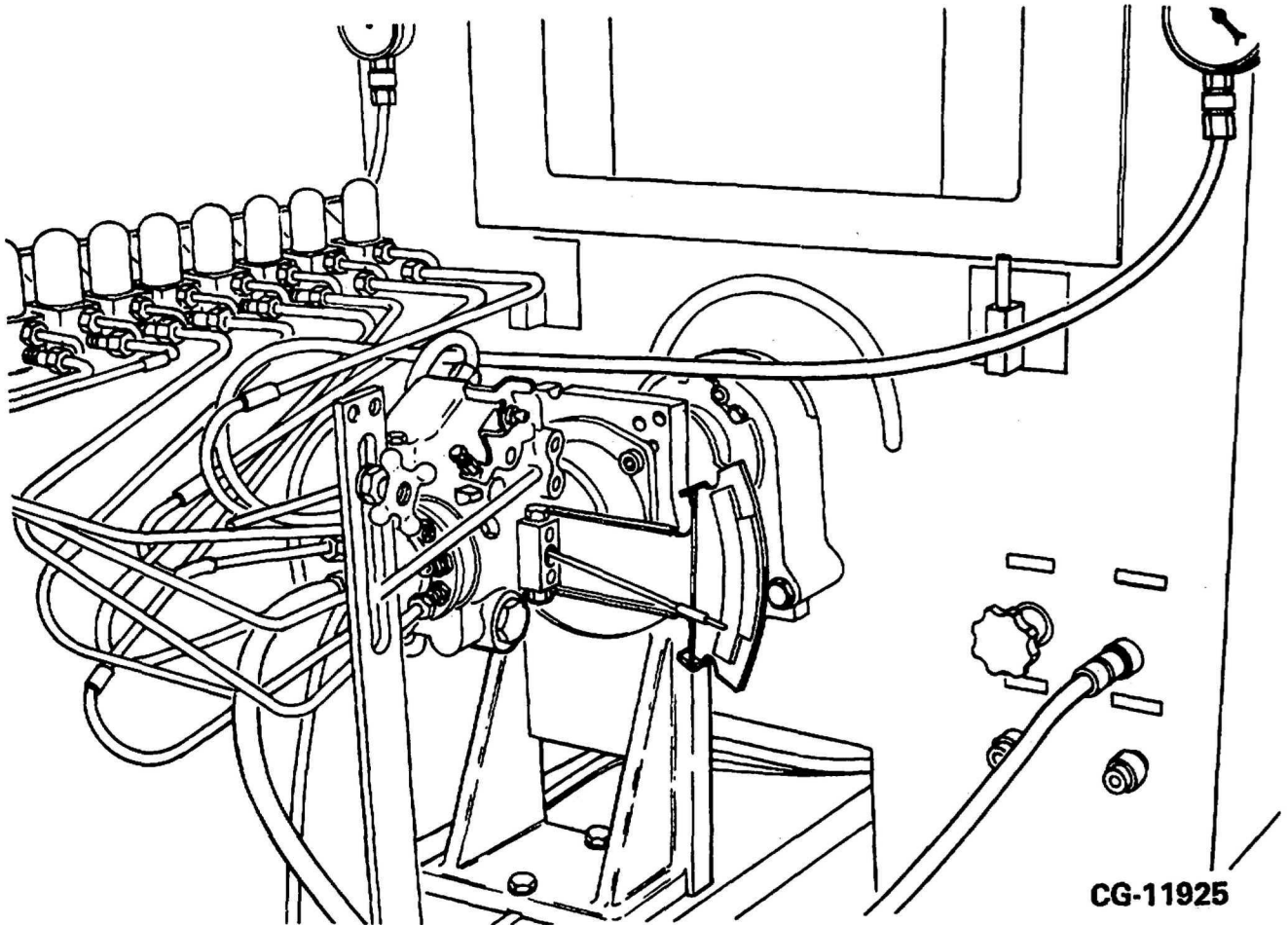


Figure 5.1. Pump Mounted on Calibration Stand (Flow Bench)

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### GENERAL (Continued)

2. Injection pump output is measured in graduates with cubic centimeter increments. Graduates correspond to engine cylinders. Eight (8) graduates are used to measure the flow of the Stanadyne injection pump used on the 8 cylinder 7.3 Liter Diesel Engine.

3. When reading calibrating oil levels in graduates, the top of the calibrating oil column will appear "cupped" with the center portion lower than each edge, this is called the meniscus. Read each graduate fuel column at the bottom of the meniscus ("cupped" center portion). (Figure 5.2)

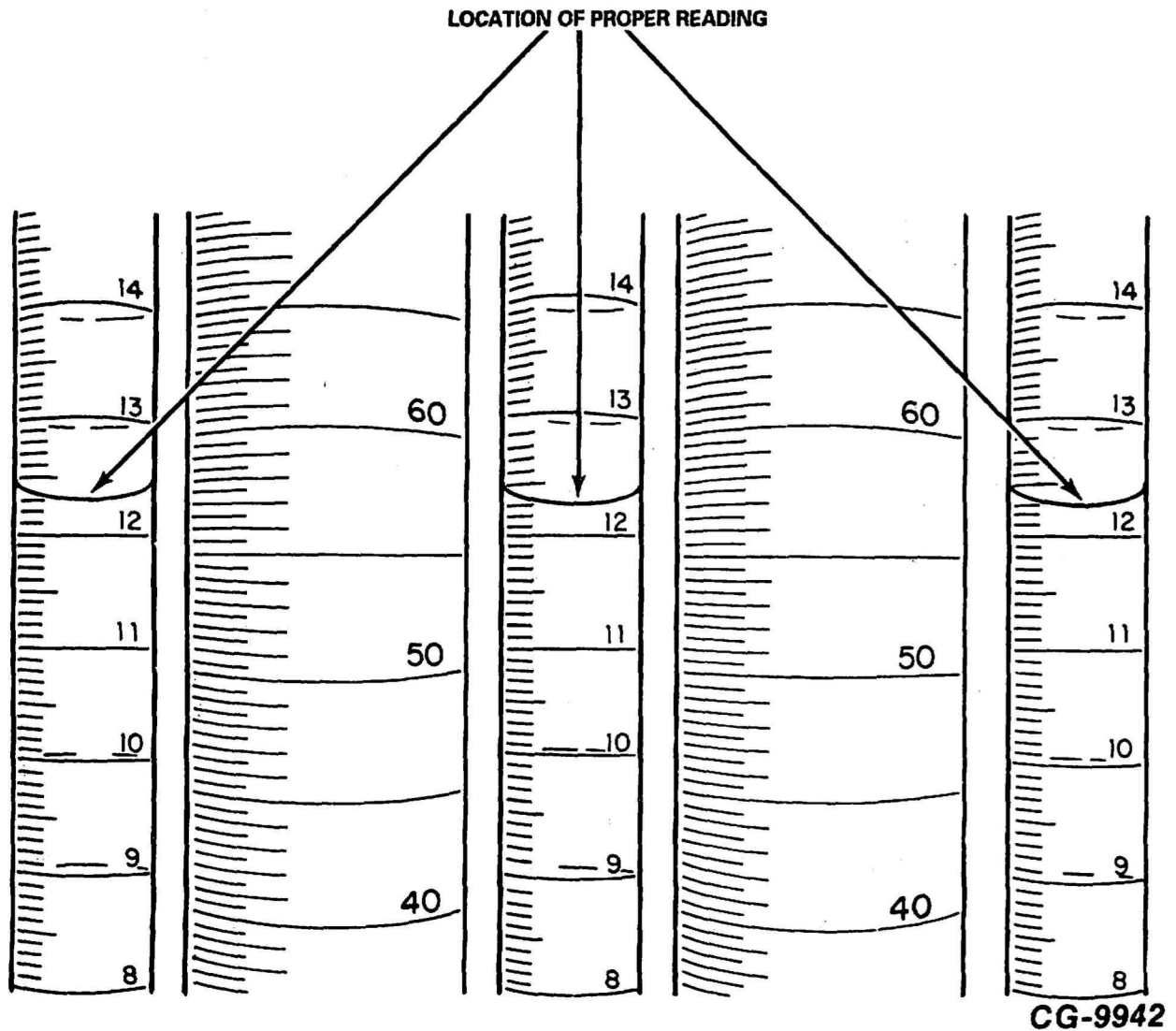


Figure 5.2. Reading Calibrating Oil Level in Graduates

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### TEST STAND REQUIREMENTS

1. The set of injection lines used for flow bench calibration is one of a number of standard sets. The standard set of test lines do not necessarily have the same length or inside diameter as the injection lines used on the engine. Flow bench injection lines for calibrating the 7.3L injection pump have a length of 25" and an inside diameter of .078". However, length of the engine injection lines is 18.73" with an inside diameter of .093". Standardized test lines have been developed so that a fuel injection service shop may service injection equipment from many different makes and models of engines using only a few sets of test lines.
2. Standardized test nozzles are also used for the same reason. Nozzles used to test the 7.3L injection pump are American Bosch .5mm orifice plate, with opening pressure of 1700 ± 25 psi.
3. Use of the proper test stand fluid is critical to obtaining proper injection pump calibration. An acceptable fluid must meet criteria in a number of areas including viscosity, color, corrosion protection, flash point, temperature and resistance to foaming.

RECOMMENDED CALIBRATION  
FLUID IS VISCOR NO. 1487\*  
AVAILABLE FROM:

VISCOSITY OIL CO.  
3200 South Western Avenue  
Chicago, Illinois 60608

4. Calibrating oil should be tested regularly using a viscor calibration fluid cup, and replaced when shown to be unacceptable. Oil should also be discarded whenever it becomes contaminated, discolored, or when the length of time for foam to settle in graduates exceeds 60 seconds.

**NOTE: The Viscor Test Kit consists of one calibration fluid cup and two charts, follow directions with the kit.**

\*Fluid must comply with:  
SAE-J967 STANDARD  
(latest revision)

**IMPORTANT: Calibrating oil stored in barrels should be stirred every two weeks to prevent varnish build-up.**

5. Temperature of oil in the test bench must be maintained between 110 degrees and 115 degrees Fahrenheit when testing the injection pump. Flow specifications are developed using fluid in this temperature range. Calibration with fluid of other temperatures can result in calibration errors.

**NOTE: The test bench should be equipped with a heater and thermostatic control to maintain the 43-46°C (110-115°F) temperature.**

6. The test bench must be equipped as follows:
  - a. A Zero Backlash Coupling - A zero backlash coupling reduces testing errors by smoothly transmitting the torque to the pump.
  - b. A Digital Tachometer - The superior accuracy of the digital tachometer is necessary for setting checkpoint speeds within the plus or minus 5 RPM allowed by the specifications.
  - c. A Variable Voltage Source - an adjustable voltage source is required to test the operation of the electric shutoff solenoid and to check the correct pull-in voltage point. This check ensures that the solenoid will operate in the event that the vehicle system voltage drops below normal. The operation of the housing pressure cold advance solenoid should also be checked.
  - d. Test Gauges - Required as follows:
    - A 0-160 psi pressure gauge calibrated in 1 psi divisions, to measure transfer pump pressure. The gauge should be located as close as possible to the pump, and the in-line shutoff should be at the pump.

\* Refer to the "Service Index Section" For Required Service Tool Information

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### TEST STAND REQUIREMENTS (Continued)

- A pressure gauge, calibrated 0-30 Hg. to measure housing pressure.
- A gauge, calibrated in vacuum 0-30 Hg. and pressure 0-15 psi in the supply line with a shutoff valve between the gauge and the tank, to test transfer pump lift inlet pressure.
- A flowmeter for measuring return oil should be used with a three-way valve which permits the flowmeter to be in use only during the return oil check. (Not illustrated in Figure 5.3).

- A temperature gauge, located at the pump inlet, to monitor inlet fuel temperature.

### 7. LOW PRESSURE PLUMBING is required as illustrated in Figure 5.3.

The test stand has a reservoir of calibrating oil. The supply pump is part of the test stand and can be adjusted to duplicate the inlet pressure provided by the supply pump. Specification calls for 5.0 psi  $\pm$  .5 psi at pump inlet. The orifice fitting helps to maintain consistent fluid temperature by recirculating a small amount of fluid back to the fluid reservoir.

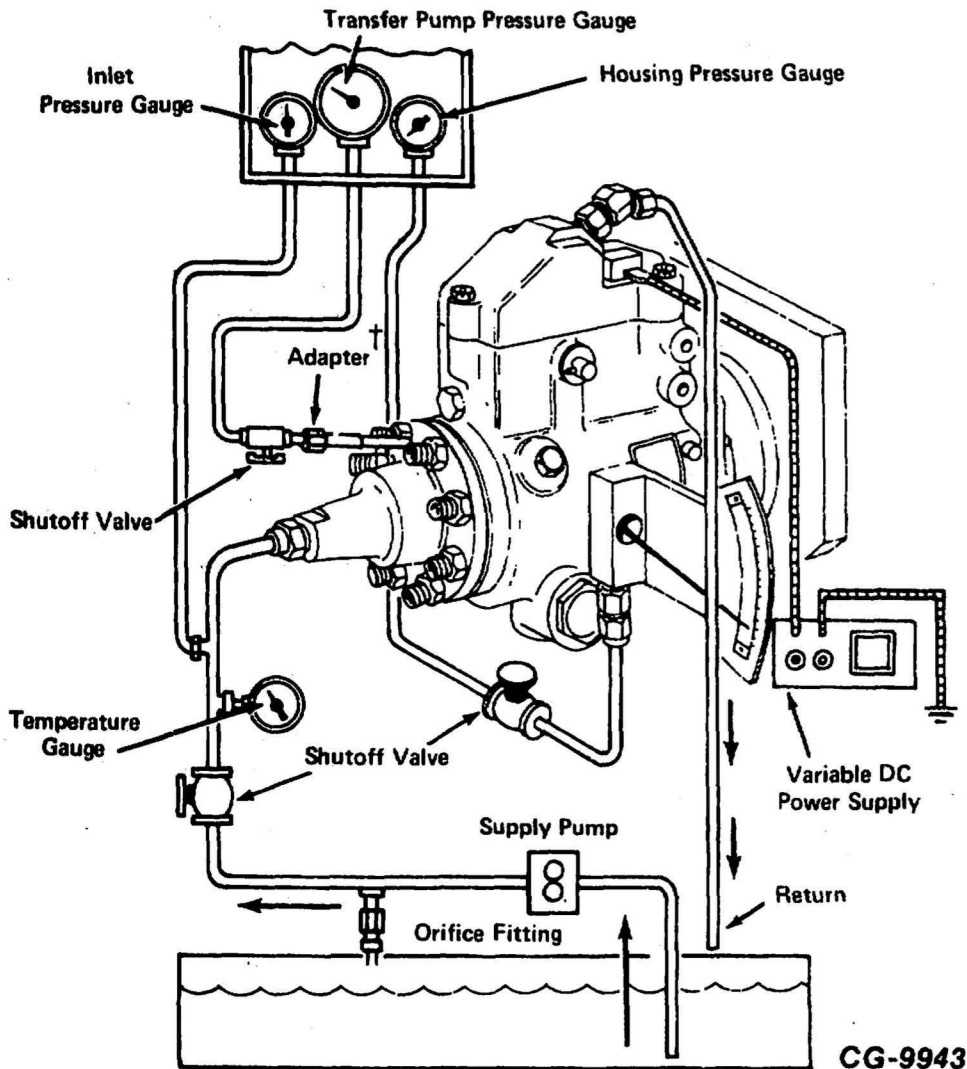


Figure 5.3. Low Pressure Test Bench Plumbing Circuit

† Transfer Pump Pressure Test Adapter (Stanadyne No. 21900)

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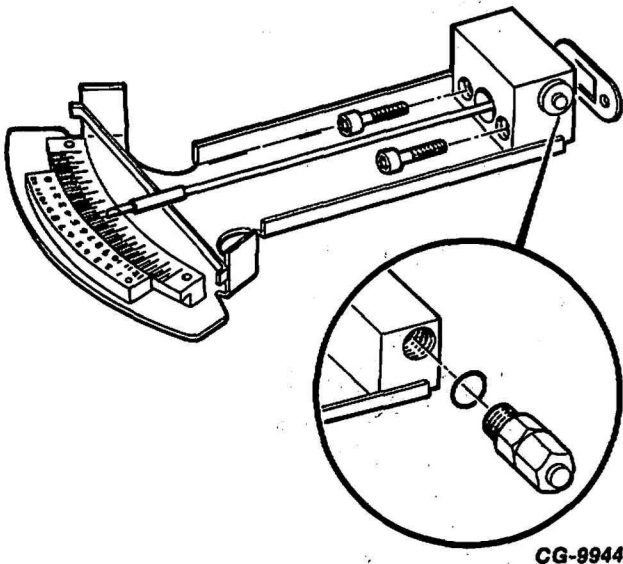
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### TEST STAND REQUIREMENTS (Continued)

Fuel temperature is monitored as close to the injection pump inlet as possible. A shutoff valve is provided in the inlet supply line for performing a transfer pump lift test. Inlet pressure gauge shows pressure provided by the supply pump. Transfer pump pressure is monitored by the transfer pump pressure gauge. A shutoff is provided between the injection pump and the transfer pump pressure gauge. The shutoff valve should remain closed when performing all tests and adjustments other than transfer pump pressure. This is because the gauge and line could act as an accumulator and disturb automatic advance and charging functions, resulting in false calibration readings. Housing pressure is monitored. A fuel return line must be provided.

8. Cam movement readout device (Figure 5.4) is required to measure cam advance. The advance indicator assembly (Stanadyne No. 23745) measures cam advance movement in 1/4 degree increments.

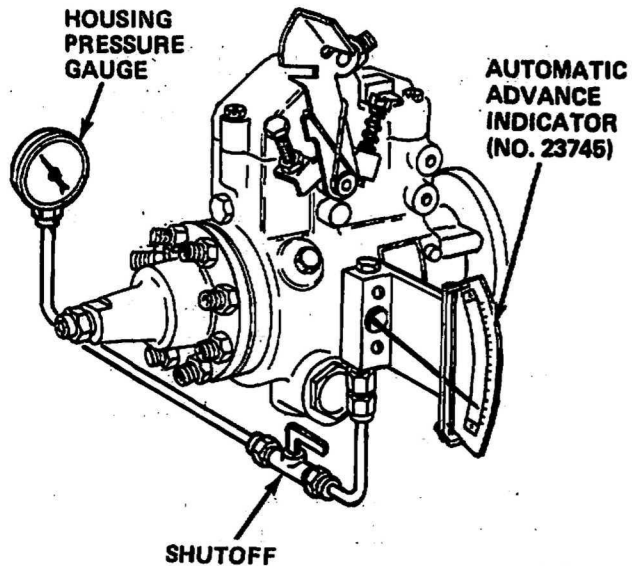


**Figure 5.4. Automatic Advance Indicator Assembly (No. 23745)**

**NOTE:** The gauge scale on the advance indicator assembly magnifies cam movement 10 times to provide easier, more accurate calibration of the automatic advance. The base contains two plugs, either of which may be removed in order to install a housing pressure tap which is provided in the kit.

9. Install advance indicator assembly (Stanadyne No. 23745) as follows:

- Remove side access cover and seal from pump.
- Mount the gauge using the screws and seal provided. (Figure 5.5).



**Figure 5.5. Automatic Advance Indicator Installed**

10. All fuel readings are taken at 1000 strokes for each cylinder.

- cc/1000 Strokes  
or  
• mm<sup>3</sup>/Stroke

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### TEST BENCH CALIBRATION PROCEDURE

**NOTE: All speeds are in engine RPM.**

1. Roller to Roller dimension:

Injection Pump P/N	Dimension	Maximum Eccentricity
1 811 303 C91 (130 HP)	1.968" ± .001"	.004" TIR
1 809 083 C91 (155 HP)	1.969" ± .001"	.004" TIR
1 809 096 C91 (170 HP)	1.973" ± .001"	.004" TIR

2. Linkage gap - .145 in. to .165 in.

3. Guide stud bottomed to one turn out of housing.

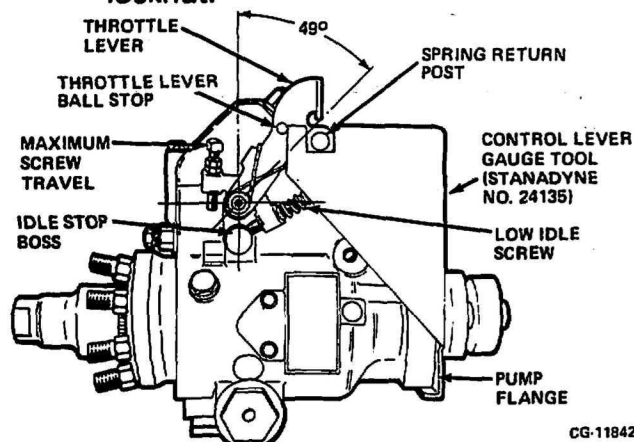
4. With pump mounted in control lever gauge tool (Stanadyne No. 24135) set low idle throttle position as follows: Refer to Figure 5.6.

a. Back out spring loaded low idle screw and maximum travel screw.

b. Position spring return post of throttle lever in slot on top of gauge so it is set at 49° (as measured between throttle lever centerline and return spring post centerline).

c. Adjust low idle screw until contact is made with idle stop boss.

d. Tighten maximum travel screw locknut.



**Figure 5.6. Setting Low Idle Control Lever Position**

5. Operate pump at 2000 RPM Wide Open Throttle (W.O.T.) for 10 minutes to bring pump up to operating temperature and clear air from system.

6. With pump at 650 RPM Low Idle (L.I.) perform the following steps:

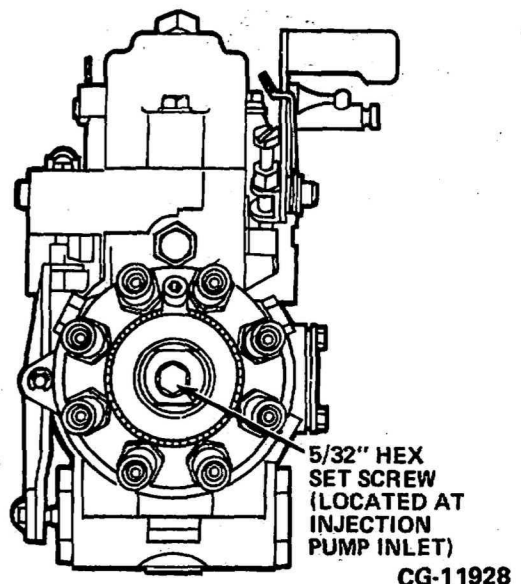
a. Open valve between transfer pump pressure tap and gauge. Check transfer pump pressure and close valve.

#### [Transfer Pump Pressure Adjustment Procedure]

b. With control lever in low idle position, adjust transfer pump pressure to 59 psi ± 1 psi as follows:

- Install fitting and adjustment tool (Stanadyne No. 26078) into fuel inlet port of injection pump and connect to fuel supply source.

- Using adjustment portion of tool, adjust 5/32" set screw located at fuel inlet port by turning screw clockwise to increase pressure and counter-clockwise to decrease pressure. Refer to Figure 5.7.



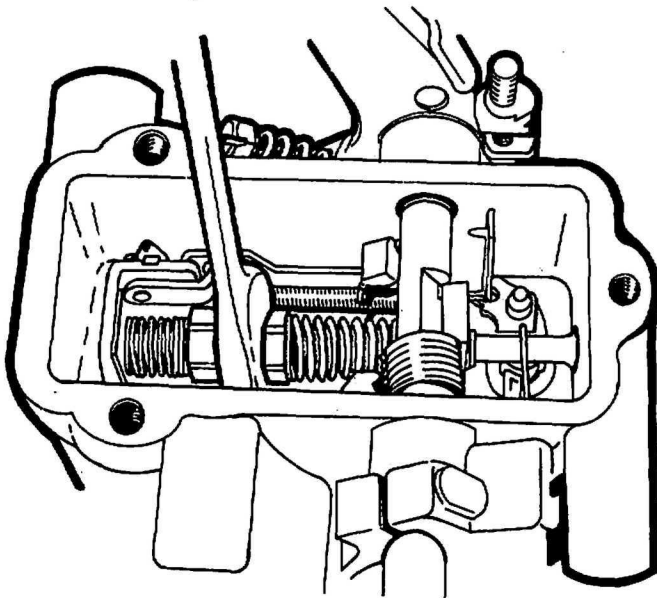
**Figure 5.7. Transfer Pump Pressure Adjustment**

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### TEST BENCH CALIBRATION PROCEDURE (Continued)

- c. With governor cover removed, adjust min/max governor assembly for 12-14 mm<sup>3</sup>/stroke (fuel reading with governor cover installed). (Figure 5.8)
- The min/max capsule is a right hand thread in the governor block.
  - Lengthen min/max assembly to increase flow.
  - Shorten min/max assembly to decrease flow.
  - Final flow check must be made with the governor cover installed.
- d. Check housing pressure with throttle in low idle position. Specified pressure is 8-12 psi.



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**Figure 5.8. Min/Max Governor Adjustment**

- e. With pump still operating at 650 RPM in low idle position, energize housing pressure cold advance (HPCA) solenoid with  $10.0 \pm 0.2$  volts using a variable voltage source. Check housing pressure. Specified pressure is 1 psi max.

7. With pump at rated RPM (W.O.T.) perform the following checks:

- a. Assure test stand boost pressure at injection pump inlet is set to 4.5-5.5 psi.
- b. When air bubbles clear from the return line, set transfer pump pressure as follows:

<u>Injection Pump P/N</u>	<u>Engine HP</u>	<u>Transfer Pump Pressure Specs.</u>
1 811 303 C91	130	89-91 psi
1 809 083 C91	155	94-96 psi
1 809 096 C91	170	94-96 psi

(Refer to step 6b for Transfer Pump Pressure Adjustment procedure).

- c. Adjust return oil to 275-600 cc/min. (Change vent screw).

8. With pump at 400 RPM (W.O.T.) proceed as follows:

- a. De-energize E.T.R., fuel delivery should be as follows:

<u>Injection Pump P/N</u>	<u>Engine HP</u>	<u>Maximum Fuel Delivery</u>
1 811 303 C91	130	4mm <sup>3</sup> /stroke
1 809 083 C91	155	3mm <sup>3</sup> /stroke
1 809 096 C91	170	3mm <sup>3</sup> /stroke

- b. Move control lever to low idle, check E.T.R. for pull-in with  $10.0 \pm 0.2$  volts. Fuel delivery should be 15mm<sup>3</sup>/stroke min.

**NOTE:** If voltage required to pull-in E.T.R. exceeds  $10.0 \pm 0.2$  volts, E.T.R. should be replaced.

- c. Check for minimum lift of 18" Hg. at 400 RPM (W.O.T.). If transfer pump cannot draw at least 18" Hg. it is leaking internally. Check the end cap O-ring for damage, if O-ring has no damage, replacement of transfer pump may be necessary.



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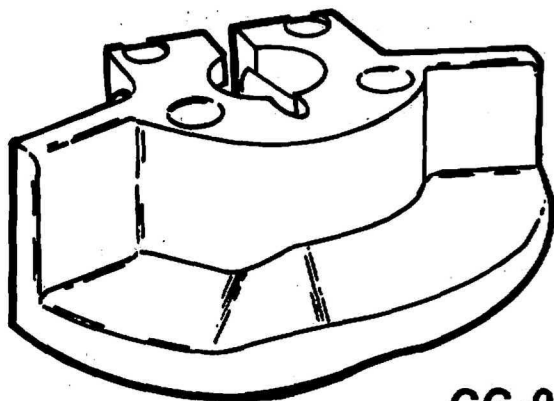
### TEST BENCH CALIBRATION PROCEDURE (Continued)

**IMPORTANT:** For the remainder of the setting and checking procedures, maintain the face cam to control shaft end play to .004"-.006", as measured between washer and the pump housing on the control lever side. Refer to Figure 4.48, Section 4.

9. With pump at rated RPM (W.O.T.) [roller to roller set point], proceed as follows:

a. Back out face cam screw and rotate the face cam to its maximum lift position in contact with cam roller.

1. Note high point on face cam (Figure 5.9).
2. Face cam at high point will result in maximum retarding.



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**Figure 5.9. Face Cam**

- Adjust advance trimmer screw as follows:

<u>Injection Pump P/N</u>	<u>Engine HP</u>	<u>Cam Advance - Nominal</u>
1 811 303 C91	130	3.5°
1 809 083 C91	155	4.5°
1 809 096 C91	170	4.5°

b. Set fuel delivery as follows and recheck cam advance:

<u>Injection Pump P/N</u>	<u>Engine HP</u>	<u>Fuel Delivery Setting (mm<sup>3</sup>/Stroke)</u>
1 811 303 C91*	130	47.00 ± .5
1 809 083 C91+	155	50.75 ± .5
1 809 096 C91+	170	56.50 ± .5

\*De-energize E.T.R., check fuel delivery for 4.0mm<sup>3</sup>/stroke maximum. Re-energize E.T.R.

+De-energize E.T.R., check fuel delivery for 3.0mm<sup>3</sup>/stroke maximum. Re-energize E.T.R.

10. Set pump speed to RPM (W.O.T.) as indicated below and proceed as follows:

a. Set governor breakaway with guide stud for:

<u>Injection Pump P/N</u>	<u>Engine HP</u>	<u>Set Speed To</u>	<u>Specifications (mm<sup>3</sup>/Stroke)</u>
1 811 303 C91	130	2850	47.5 ± 1.5
1 809 083 C91	155	3150	49.5 ± 1.5
1 809 096 C91	170	3150	55.0 ± 1.5

- Using a 3/16" Allen head wrench and a 1/2" open end wrench, adjust guide stud. Refer to Figure 5.10.

b. After setting is obtained tighten guide stud nut to 85 ± 5 lbf-in.

c. Check dimension between outboard side of guide stud nut and outboard side of guide stud as shown in Figure 5.11. Dimension should not exceed .400 in. max.

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### TEST BENCH CALIBRATION PROCEDURE (Continued)

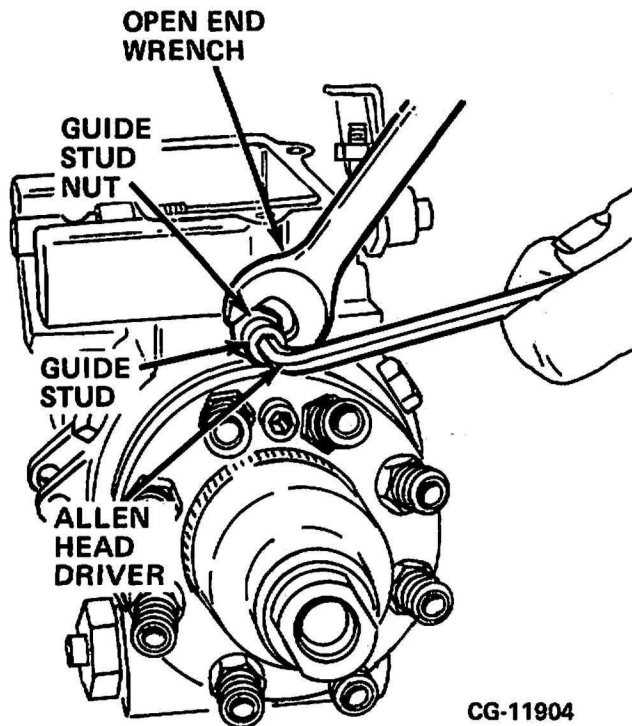


Figure 5.10. Adjusting Guide Stud

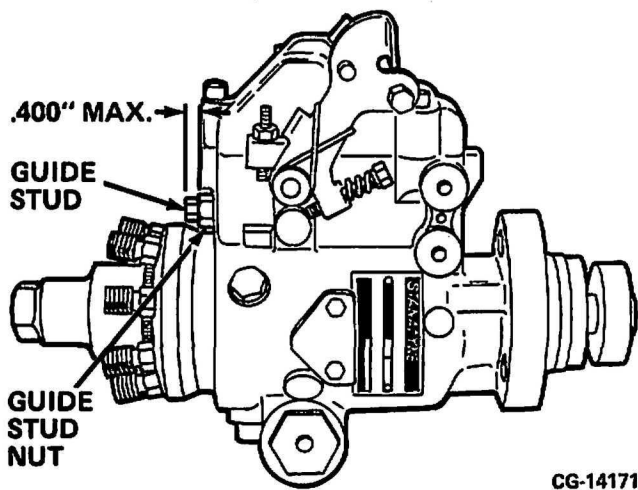


Figure 5.11. Maximum Dimension Between Top of Guide Stud Nut and Guide Stud

11. Set pump speed to 1400 RPM and proceed as follows:

- a. Adjust control lever for 27-29mm<sup>3</sup>/stroke and rotate face cam to obtain  $2.5 \pm .25$  cam advance.

**NOTE:** Use .515" gauge block (made locally) between high speed stop and tab on pump for setting delivery and Automatic Advance Indicator Assembly (SE-23745).

- b. After setting is obtained, tighten face cam screw to  $30 \pm 2$  lbf-in. using Torx Bit Socket (Stanadyne No. 22939).

**IMPORTANT:** Maintain face cam to control shaft end play to .004" to .006".

- c. With control lever at 28mm<sup>3</sup>/stroke position, align 0° on control lever protractor (Stanadyne No. 22089), with center rib on rocker lever. Refer to Figure 5.12.

Release throttle and rotate 44° toward W.O.T. position. Adjust lever stop screw to this 44° setting.

- d. Scribe a line on the throttle boss in alignment with the edge of the face cam to provide a reference for throttle shaft movement.

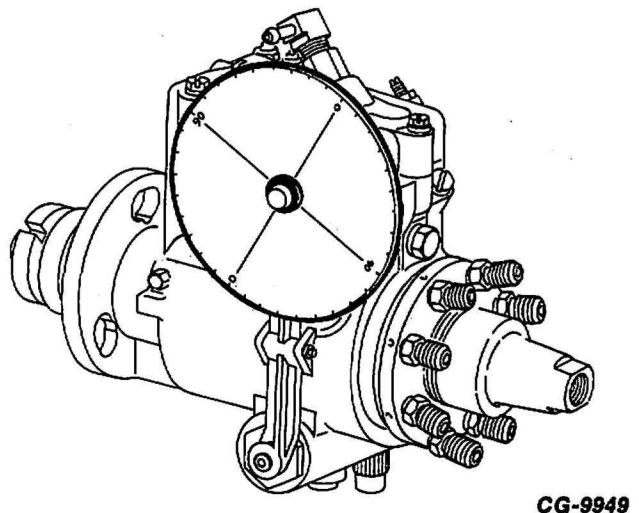


Figure 5.12. Control Lever Protractor (Stanadyne No. 22089)

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### TEST BENCH CALIBRATION PROCEDURE (Continued)

e. Check face cam torque retention as follows:

1. Install Face Cam Torque Socket Tool (Stanadyne No. 22977) on throttle shaft and engage the face cam as shown in Figure 5.13.
2. Apply a force of 22 lbf-in. to the face cam through the Torque Socket Tool (Stanadyne No. 22977).

**IMPORTANT: The face cam should not rotate on the shaft.**

3. If rotation of the face cam occurs at or below 22 lbf-in., remove the face cam and inspect the throttle shaft for wear.

If no throttle shaft wear is evident, install a new face cam and screw, reset face cam position, step 11a (recheck 9a and b), on the flow bench then repeat face cam torque retention check 11e, 1 thru 3. Apply retaining compound - Loctite #290 to face cam screw prior to final torque.

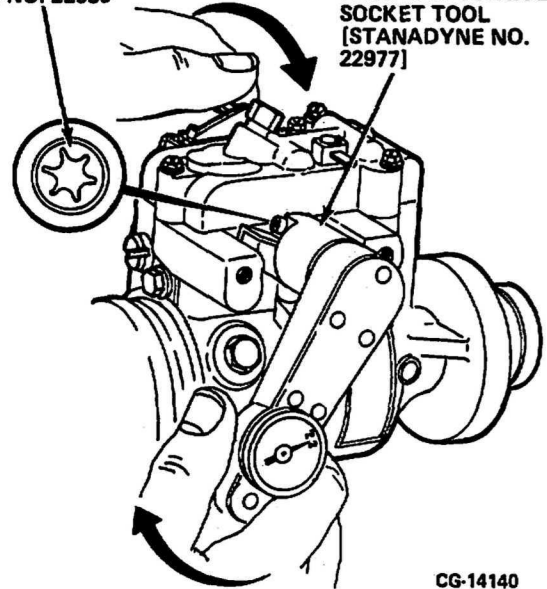
12. Perform pump calibration check point tests:

**IMPORTANT: Maximum cylinder to cylinder variation is  $\pm 4$ mm /stroke from the average of all cylinders. Check point sequence must be followed as listed.**

**NOTE: Setting of injection pump is now complete. Any changes in settings made after this point will require retesting of pump starting with step 9.**

TORX SOCKET HEAD  
SCREW - USE STANADYNE  
TOOL NO. 22939

FACE CAM TORQUE  
SOCKET TOOL  
[STANADYNE NO.  
22977]



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**Figure 5.13. Checking Face Cam Torque Retention (22 lbf-in.)**

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## INJECTION PUMP CALIBRATION

### INJECTION PUMP P/N 1 811 303 C91 130 Bhp @ 2700 RPM

CHECK POINTS	ENGINE RPM $\pm$ 10	THROTTLE POSITION	DELIVERY mm <sup>3</sup> /stroke	CAM MOVEMENT (°)	SOLENOID	
					ETR	HPCA
A	2700	WOT (RATED)	47.0 $\pm$ .5	3.50° $\pm$ .25°	ON	OFF
B	2700	LI	---	9.5° $\pm$ .5°	OFF	
C	2850	WOT	45.5 $\pm$ 1.5	---	ON	
D	3150	WOT	15 MAX.	---		
E	2200	WOT	---	SEE NOTE A		
F	1400	WOT	50.5 $\pm$ 1.5	---		
G	1400	ADJ	28 $\pm$ 1	3° $\pm$ .25°		
H	650	LI	13 $\pm$ 1*	5.25° $\pm$ .5°		
I	650	LI	---	SEE NOTE B		
J	150	WOT	30 MIN	---		
K	TOTAL THROTTLE TRAVEL FROM LI TO WOT TO BE 65° $\pm$ 5°.					ON
						OFF

### INJECTION PUMP P/N 1 809 083 C91 155 Bhp @ 3000 RPM

CHECK POINTS	ENGINE RPM $\pm$ 10	THROTTLE POSITION	DELIVERY mm <sup>3</sup> /stroke	CAM MOVEMENT (°)	SOLENOID	
					ETR	HPCA
A	3000	WOT (RATED)	51 $\pm$ .5	4.50° $\pm$ .25°	ON	OFF
B	3000	LI	---	9.5° $\pm$ .5°	OFF	
C	3150	WOT	49.5 $\pm$ 1.5	---	ON	
D	3470	WOT	15 MAX.	---		
E	2500	WOT	---	SEE NOTE A		
F	1400	WOT	56.5 $\pm$ 1.5	---		
G	1400	ADJ	28 $\pm$ 1	2.5° $\pm$ .25°		
H	650	LI	13 $\pm$ 1*	5.0° $\pm$ 1.0°		
I	650	LI	---	SEE NOTE B		
J	150	WOT	33 MIN.	---		
K	TOTAL THROTTLE TRAVEL FROM LI TO WOT TO BE 65° $\pm$ 5°.					ON
						OFF

\* May be reset using low idle screw.

NOTE A: 1.25°  $\pm$  0.5° less than reading obtained in check point "A".

NOTE B: 1.75°  $\pm$  0.5° greater than reading obtained in check point "H".

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INJECTION PUMP P/N 1 809 096 C91  
170 Bhp @ 3000 RPM

CHECK POINTS	ENGINE RPM $\pm 10$	THROTTLE POSITION	DELIVERY mm <sup>3</sup> /stroke	CAM MOVEMENT (°)	SOLENOID		
					ETR	HPCA	
A	3000	WOT (RATED)	56.5 $\pm$ .5	4.5° $\pm$ .25°	ON	OFF	
B	3000	LI	---	9.5° $\pm$ .5°	OFF		
C	3150	WOT	53 $\pm$ 1.5	---	ON		
D	3470	WOT	15 MAX.	---			
E	2500	WOT	---	SEE NOTE A			
F	1400	WOT	62 $\pm$ 1.5	---			
G	1400	ADJ	28 $\pm$ 1	2.50° $\pm$ .25°			
H	650	LI	13 $\pm$ 1*	5° $\pm$ 1°			
I	650	LI	---	SEE NOTE B			ON
J	150	WOT	38 MIN	---			OFF
K	TOTAL THROTTLE TRAVEL FROM LI TO WOT TO BE 65° $\pm$ 5°.						

\* May be reset using low idle screw.

NOTE A: 1.25°  $\pm$  0.5° less than reading obtained in check point "A".

NOTE B: 1.75°  $\pm$  0.5° greater than reading obtained in check point "H".

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### TEST BENCH CALIBRATION PROCEDURE (Continue)

#### 13. Air time pump using Air Timing Fixture No. 24205 as follows:

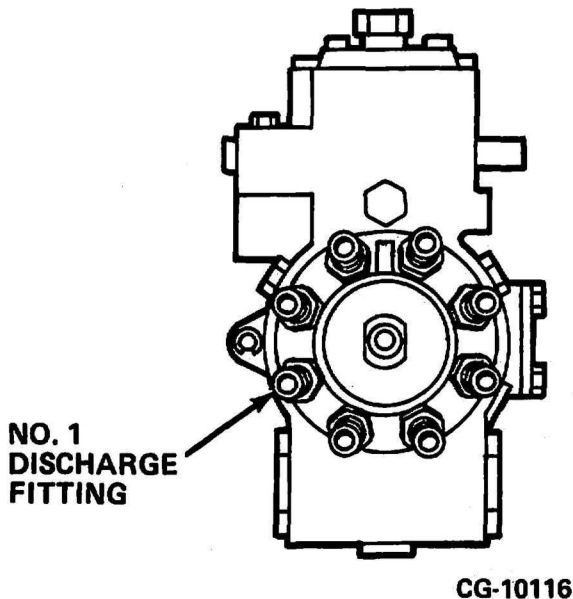
- a. To check the existing timing line, pre-set the air timing tool as follows:

Injection Pump P/N	Engine HP	Specification
1 811 303 C91	130	-9.5°
1 809 083 C91	155	-8.0°
1 809 096 C91	170	-8.0°

- b. Rotate the pump drive shaft to locate the dowel pin at the 5 o'clock position as viewed from the drive end.
- c. Install the air timing fixture (Stanadyne No. 24205) to the pump making certain that the dowel pin engages the hole in the tool. Connect a supply of dry filtered air at 60 to 100 psi to the number "1" discharge fitting, Figure 5.14.

- d. With governor top cover removed and control lever in wide open position [to assure advance piston is in full retard position against power side plug] rotate air timing tool in direction of rotation, until cam rollers can be felt making contact with cam ring.

**IMPORTANT:** Repeat several times by first turning the fixture opposite the direction of rotation, followed by turning in the direction of rotation to get a positive "feel" for when the rollers first make contact with the cam ring.



**Figure 5.14. Location of Number "1" Discharge Fitting**

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### TEST BENCH CALIBRATION PROCEDURE (Continued)

e. With the beginning of injection located, finger tighten the knurled screw on the fixture against the housing to retain the fixture in position. Figure 5.15.

f. Check the timing mark by replacing the spring and scribe with the optical gauge. If required, remark housing flange as follows:

1. Remove timing fixture from pump.
2. Cover drive shaft and pilot area of pump with a clean cloth to prevent entrance of filings into bearing and seal area.

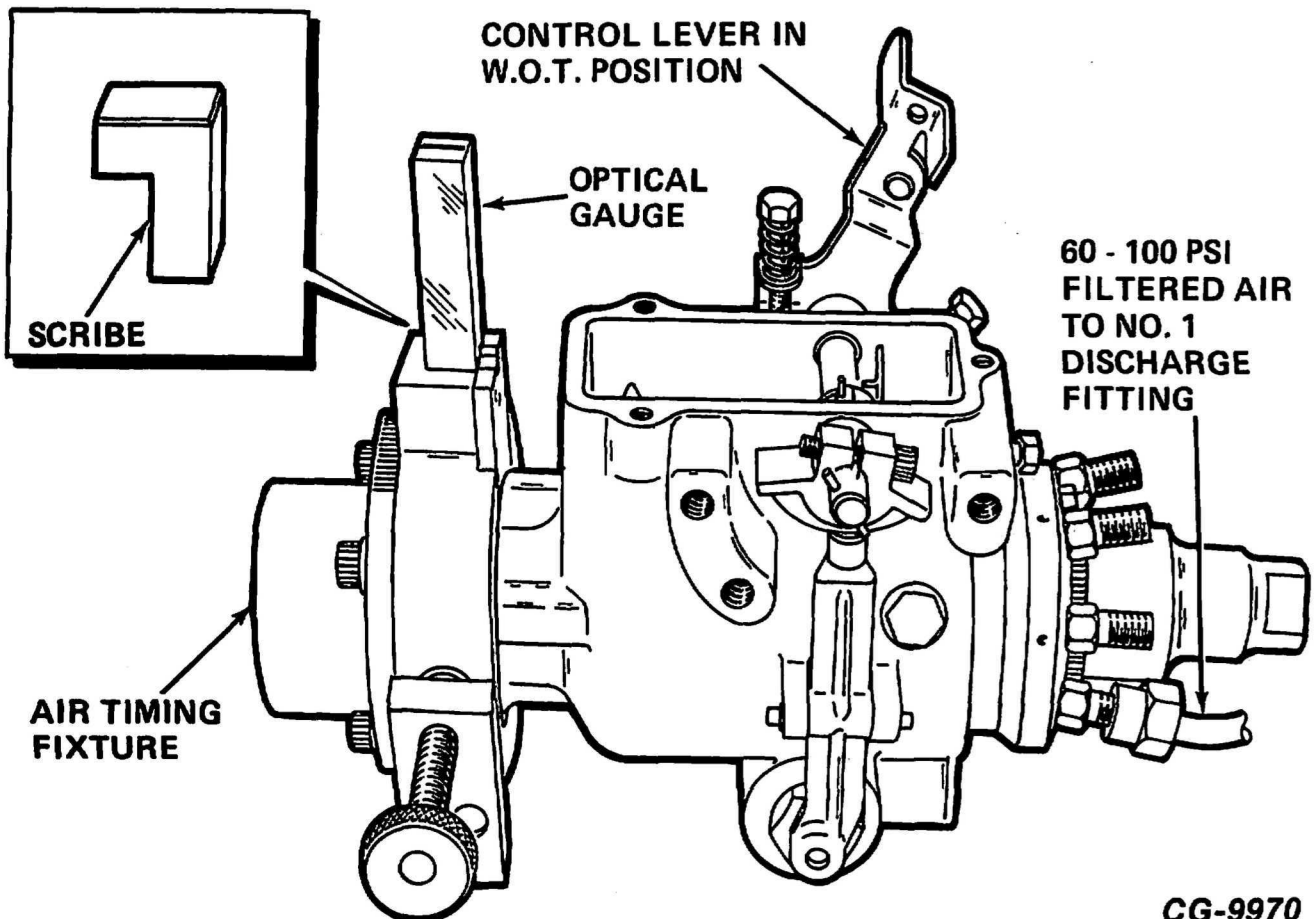
3. File off old mark.

4. Reinstall timing fixture to pump with scribe assembly. Repeat 13a-f for finding beginning of injection.

5. Lock gauge to pump and tap, scribe with mallet to place a new timing mark on pump flange.

14. Secure the following with Loctite #290:

- Maximum travel adjusting screw
- Face cam screw
- Servo advance adjusting screw



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Figure 5.15. Air Timing the Pump, Using Air Timing Fixture No. 24205