



Instruction Manual For The Carpenter Diesel Engine Service Tool System

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It is important that you read all of these instructions including the warranty statement before beginning the procedures described herein. These instructions are intended to supplement the included Carpenter Tool System Video Tape. Watch the tape, read the instructions, then call us if you have a question.

These instructions assume you are servicing a 3116 engine. If you are servicing a 3114, consult your service manual or call us for the changes.

The Carpenter Tool System contains all special tools necessary to perform injector rack synchronization, injector timing and fuel setting on all Caterpillar 3116-3114 engines.

It is recommended that you have several other tools and materials on hand before beginning.

- The Caterpillar 3116-3114 service manual
- A 19mm wrench (used for timing)
- A flat head type screwdriver (used for timing)
- Solenoid (spanner) wrench
- Shop rags, towels

The following instructions are designed to work with the included Carpenter Tool System video tape. Be sure to watch the video tape and read **ALL** of these instructions carefully before beginning the tune-up procedures.

There are a number of procedures which make up a **complete engine tune-up**. The Carpenter Tool System increases your efficiency on three of these procedures. For other necessary procedures consult the Caterpillar engine service manual.

If there are any questions or comments please contact our technical support line at 1-800-901-2222. When in doubt...ASK! We're here to help.

Following is a brief description of each procedure.

Synchronization:

The term synchronization refers to the position of all injector racks in relationship to the rack at the number one injector. Each injector rack must be set to the same reference position or synchronized to number one, this will insure that the rack bar travel through the injector is the same on each cylinder. Having the injector racks synchronized will allow each cylinder to receive the same amount of fuel for combustion and will result in a smooth running engine.

Synchronization must be performed whenever an injector has been removed and replaced, even if the same injector is reinserted. It is also recommended to be performed as part of a routine tune-up. Proper synchronization is vital for optimum engine performance.

Timing:

Timing refers to **when** the fuel is injected into the cylinder. In order for the engine to run efficiently the fuel must be injected a set number of crankshaft degrees before top dead center (TDC).

Timing must be performed whenever an injector is removed and replaced, even if the same injector is reinserted. Checking and adjusting timing is also recommended as part of a routine tune-up. Improper timing can lead to poor engine performance and even serious engine damage.

Fuel Setting:

Fuel Setting must be checked and adjusted when the **number one injector** is removed or replaced, even if the same injector is reinserted. Improper fuel setting will affect the engine power and RPM. Improper fuel setting can also cause unacceptable emission levels. The Fuel Setting should only be adjusted by a professional and should only be set to the specification listed for the particular engine.

For more information on synchronizing, timing and fuel setting, consult the 3116-3114 service manual.

General Information about the Carpenter Tool System:

With these instructions you will be able to accurately set and adjust the injector synchronization, timing and fuel setting on the Caterpillar 3116 engine or 3126 engine. If any of the instructions are unclear or if you are in need of assistance, help is available through our Technical Support Line at **1-800-901-2222**.

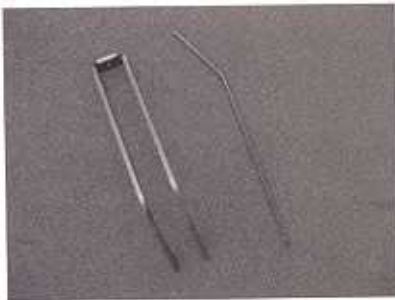
The Carpenter Tool System comes complete with the following components:



• Holding fixture with dial indicators
(#MRC-001U, METRIC-1, METRIC-2)



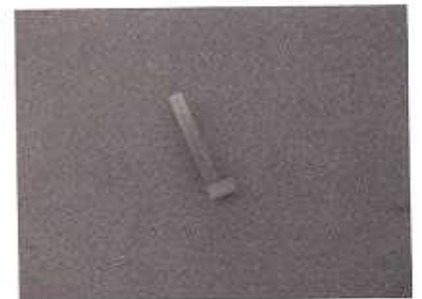
• Control linkage positioning tool
(#MRC-002U)



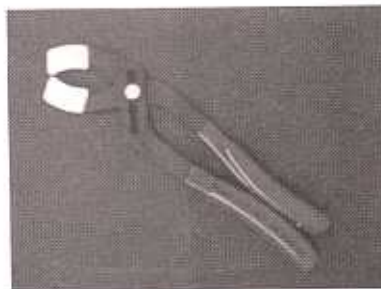
• Fuel setting wedge and pin
(#MRC-007, #MRC-006)



• Adjusting tool
(#MRC-005)



• Set block
(#MRC-008)



• Soft-jaw pliers
(#MRC-SJ2)



• Spanner wrench
(#MRC-SW2)

If any components are missing or damaged, contact us immediately!

Following is the procedure for performing all three operations (synchronizing, timing and fuel setting) in one servicing.

Injector Rack Synchronization:

1. Insert the holding fixture with dial indicators at the number one injector

Notice that the holding fixture has a stabilizing blade running approx. half way up its side. This blade fits between the injector spring and the intake valve spring at each cylinder. The shiny spring clip on the back of the fixture goes against the inside of the rocker housing. (See Fig. S-1) The combination of these two things keeps the fixture stable when it is inserted into the engine.

Notice the pivot arm on the back of the holding fixture. It is necessary to press the ball at the top of the pivot arm all the way in before inserting the fixture into the engine. Pushing it in will swing the bottom ball out and allow it to clear the end of the rack bar when inserted into the engine.

Insert the fixture into the engine as shown. (See Fig. S-2) Listen for the sound of a "snap" This is the sound of the bottom of the holding fixture seating against the injector base. At this point, the holding fixture is completely inserted and secure. Now you may release the top ball on the pivot arm.

2. Set double zero on the horizontal indicator.

It is now necessary to set the horizontal indicator to double zero. Double zero must be set with the stop pin of the number one injector against the injector base, or in the fuel off position.

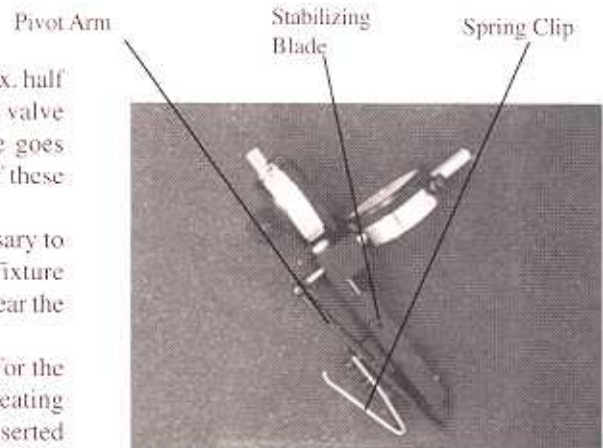
NOTE: When the fuel shut-off solenoid is in place, the spring pressure from the solenoid plunger keeps all racks in "fuel off" position and therefore all rack bar stop pins should be against their injector bases if nothing is hanging up or binding.

To set double zero on the horizontal dial indicator, loosen the red thumb screw on the side of the holding fixture and slide the indicator in or out until the small needle lines up on zero and tighten the thumb screw. Next, turn the bezel on the indicator until the large needle lines up on zero. This is double zero position. (See Fig. S-3).

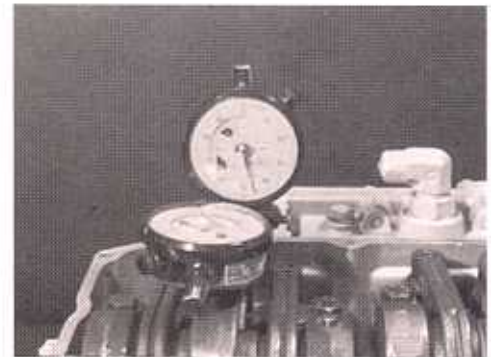
3. Install the control linkage positioning tool between the numbers 4 and 5 rocker arm supports.

The control linkage positioning tool is designed to hook around and grip the control linkage shaft. Once installed, the positioning tool **MUST** be left in place throughout the entire synchronization process. It can not be moved or loosened. If it is, the entire synchronization procedure will have to be restarted.

Although the Control Linkage Positioning Tool could be placed between any two rocker arm supports (except between No's 1 and 2), we **strongly recommend** installation between the numbers 4 and 5 rocker arms for easy access when servicing a truck engine in chassis.



(Fig. S-1) The Holding Fixture With Dial Indicators.



(Fig. S-2) The holding fixture with dial indicators at the number one injector.



(Fig. S-3) Loosen the thumb screw and adjust the indicator to double zero.

Take the positioning tool and make sure the thumb screw is backed out far enough so that the end of the bolt is inside of the threaded hole, any of the bolt sticking outside of the hook will cause interference and the positioning tool will not install properly; also make sure that the small limit screw is turned in until it is against the nylon spacer.

Hook the positioning tool around the shaft of the control linkage and allow the limit screw to rest on top of the cylinder head. Press down on the limit screw while tightening the clamping screw. This will assure that the limit screw is resting against the cylinder head when the clamping screw has been tightened. Tighten the clamping screw until it grips the shaft. (See Fig. S-4).

Now, we need to make sure that all stop pins are against their injector bases, and that the double zero we established at the number one injector is accurate. To do this, lightly move the control linkage positioning tool toward the push rod side, or away from the injector side of the engine. This will rotate the control linkage and move all rack bars toward the fuel OFF position and help free any rack bars which may be binding or hanging up.

Watch the horizontal dial indicator, if the needle does not move when the positioning tool is moved, then the rack bar is already in position and your double zero is accurate. If the indicator needle does move, pull and release the linkage positioning tool several times until the needle becomes stable and the rack bar is no longer hanging up. Once there is no sign of movement, reset your double zero on the horizontal indicator.

4. Remove or disengage the fuel shut-off solenoid.

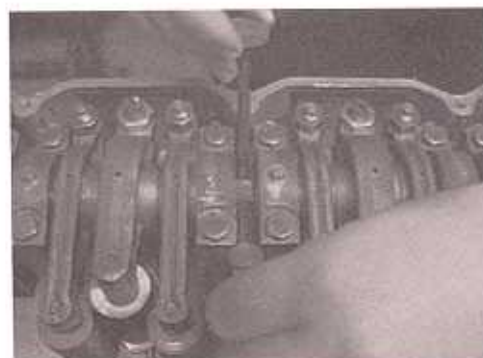
At this point you must remove the fuel shut-off solenoid. If the engine you are working on is equipped with a latch type solenoid it must be disengaged. When the solenoid is disengaged or removed, the rack bars become relaxed and move into the fuel on position. It is necessary for the rack bars to be in this relaxed position for setting and checking the synchronization.

Locate the fuel shut-off solenoid located just below the governor. Using the included spanner wrench to loosen and remove the solenoid. Locate the notches around the outer diameter of the solenoid where it is screwed into the governor (Fig. S-5). Line up the spanner wrench in one of these notches and use a 3/8" drive tool in the hole in the back of the spanner wrench for leverage to break the solenoid loose (Fig. S-6). Once the solenoid is loose, you should be able to screw it out the rest of the way by hand.

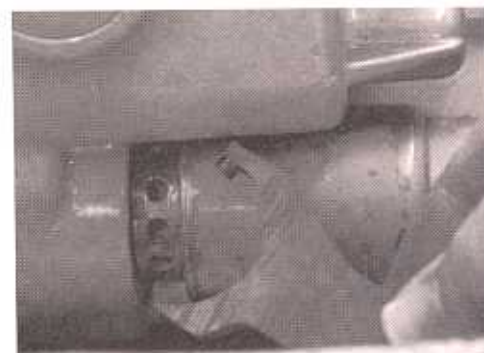
5. Adjust Synchronizing Reference Using the Control Linkage Positioning Tool Limit Screw.

The limit screw and limit arm on the Control Linkage Positioning Tool are used to establish a synchronizing reference at the number one injector. Once this reference is established, we will proceed to check and adjust all other injectors to match this one.

We will establish this reference by backing out the limit screw on the Control Linkage Positioning Tool until the dial indicator reaches 4.0mm. Begin by turning the limit screw counter clockwise and keeping pressure down on the screw so that it continues resting against the cylinder head (See Fig S-7). As you turn the screw you will see the horizontal indicator begin to move. When it reaches the 4.0mm reference dimension, stop turning the screw.



(Fig. S-4) Control Linkage Positioning Tool in place between rocker supports.



(Fig. S-5) Locate the notches on the solenoid and place the spanner wrench in position.



(Fig. S-6) Using a 3/8" drive tool, break loose the solenoid.

Next, rock the Control Linkage Positioning Tool by grasping the clamping screw and pulling it toward the push rod side of the engine until you feel it stop. Hold it there and make sure that your indicator reads double zero. If it does not, hold the linkage positioning tool there and reset the double zero.

Rock the linkage positioning tool back toward the injector side of the engine and assure that the indicator reads 4.0mm. If it does not, turn the limit screw on the linkage positioning tool the appropriate direction until it does.

Continue rocking the linkage positioning tool back and forth until the indicator reads double zero and 4.0mm at the push rod side and injector side respectively. When this is established, your synchronization reference is accurate and complete. **Once the reference has been established, do not move the limit screw until synchronization is complete.**

NOTE: Once this reference is established, the Control Linkage Positioning Tool **MUST NOT** be removed, loosened, or allowed to slip on the control linkage shaft until synchronization is complete. If the Linkage Positioning Tool does not stay clamped in this position, you **MUST** begin the synchronization process again.

6. Check and Adjust Synchronization on Cylinders 2-6.

Once the synchronizing reference is established, and the solenoid is removed, you are ready to check and adjust the synchronization on the remaining injectors. Remove the holding fixture and dial indicators from number one by pressing the top ball on the pivot arm all the way in and pulling straight up. Keep the top ball pushed in and insert the fixture at the number **two** injector. The fixture fits in exactly as it did at number one. Once it has been inserted and the "snap" is heard, release the top ball.

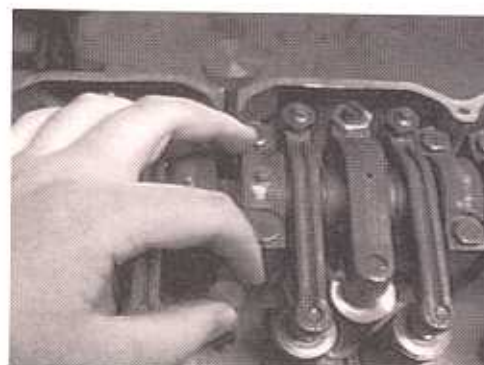
Now it is necessary to set double zero on the horizontal indicator. **You must reset double zero on the horizontal indicator whenever the holding fixture has been removed and reinserted!**

Just as on number one, double zero must be set at the fuel off position. We accomplish this by rocking the control linkage positioning tool toward the push rod side of the engine until it stops. This moved all rack bars to the fuel off position. Hold the linkage tool in this position while you adjust the horizontal indicator to double zero. Once you have established double zero on the horizontal indicator, rock the linkage tool back and forth a couple of times to make sure that it stays on double zero each time you stop on the push rod side.

When the linkage positioning tool is rocked to the injector side and the limit screw is resting against the cylinder head, the dial indicator should read 4.0mm \pm .02mm. If it does not, then this injector is not synchronized and needs to be adjusted. If the indicator does read 4.0mm \pm .02 mm then the injector is properly in sync and you may proceed to the next injector to be checked. Repeat this step for each injector. When an adjustment is necessary, refer to step number 7.

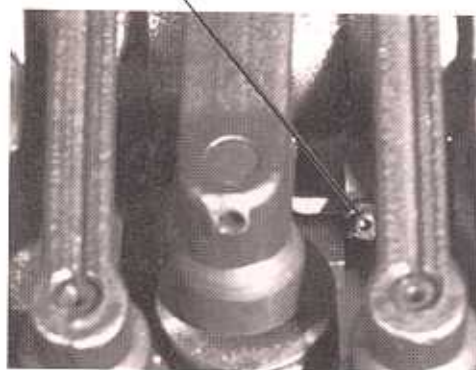
7. Adjust Synchronization.

Insert the adjusting tool and turn the set screw the appropriate direction (See Fig. S-8 and S-9) until the dial indicator reading is 4.0mm \pm .02mm. Then retighten the lock nut using the adjusting tool watching out for thread pull. Thread pull can cause the adjustment to change when the lock nut is tightened. If this occurs, readjusting may be necessary.



(Fig. S-7) Turn the limit screw counter clockwise while applying pressure down.

Synchronization
adjustment screw



(Fig. S-8) The synchronization adjustment screw.



(Fig. S-9) Use the adjusting tool to set the rack bar travel to the established reference.

Injector Timing:

1. Determine the timing dimension for your engine.

Before timing can be checked or adjusted you must first determine what the timing dimension for your engine should be. The timing dimension can be found on the valve cover information plate. Consult this plate to get the dimension before proceeding.

2. Check the timing indicator for calibration.

Next, make sure that the timing or vertical indicator has been properly calibrated. Take the set block included with the tool set and place the holding fixture on it as shown. (See Fig. T-1) The timing indicator should read double zero when placed on the set block. It is important to make sure that the surfaces of the set block and holding fixture are clean before attempting to check calibration.

If the indicator does not read double zero, adjust the bezel on the indicator until it does. The indicator has been preset at the factory for the double zero dimension and should only need adjusting if it has been dropped or jarred in some manner. It should however be checked to assure accuracy.

3. Determine the dial indicator reading.

The set block for calibration measures 62.0mm. In order to determine what the timing indicator should read it is necessary to subtract 62.0mm from the valve cover specification.

EXAMPLE: If the valve cover specification is 65.32mm then the procedure is as follows.

$$65.32\text{mm} - 62.0\text{mm} = 3.32\text{mm}$$

In this case 3.32mm is what the vertical indicator should read when checking timing. (The 65.32mm is provided only for an example and may differ from your engine's actual dimension).

4. Check timing on appropriate injectors.

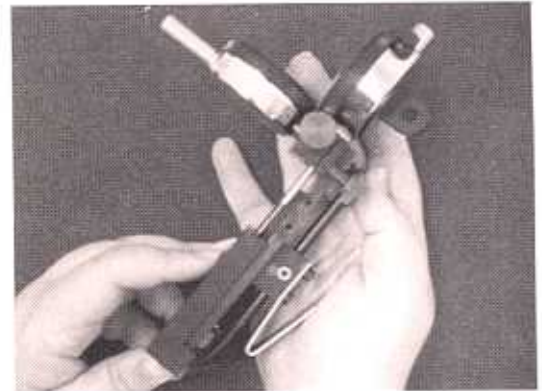
With the engine on number one TDC compression, you are in position to time injectors 3, 5 and 6. Be certain you are timing the correct injectors for the engine position. For more information about engine position consult the engine service manual.

Insert the holding fixture with dial indicators at the injector to be timed. Be sure the holding fixture is properly seated against the injector base (listen for the "snap"). With the holding fixture in place, look at the vertical indicator. If the reading on the indicator matches the number computed in the previous step +/- .05mm the timing is correct and no adjustment is necessary.

5. Adjust timing on appropriate injectors.

To adjust the timing on an injector loosen the lock nut located opposite the injector and turn the timing adjustment screw. (See Fig. T-2) Watch the indicator as the screw is turned, when the indicator reaches the correct reading, tighten the lock nut. Again, as with the synchronizing watch for thread pull. The reading can change because of the thread pull between the screw and lock nut. If this occurs, readjusting may be necessary.

When the timing is correct, remove the holding fixture and dial indicators. Continue until all available cylinders (3, 5 and 6) have been adjusted.



(Fig. T-1) Place holding fixture on set block. Make sure vertical indicator reads double zero.

6. Time the remaining injectors.

To check and adjust the timing on the remaining injectors (1, 2 and 4) it is necessary to rotate the engine to the proper position. Before repositioning the engine all tool components should be removed from the engine except for the control linkage positioning tool.

To position the engine rotate it clockwise one full turn and secure in place as described in the engine service manual. With the engine in this position, the number six cylinder is on TDC compression and you are ready to time injectors 1, 2 and 4.

Follow the same procedures for checking and adjusting timing on the remaining injectors as you did for the first set. **Be sure to time number one last as this will allow us to be in position to check and adjust the fuel setting later.**

Fuel Setting:

Before beginning the fuel setting procedure the holding fixture with dial indicators must be installed at the number one injector. It is also necessary to have the control linkage positioning tool installed as described earlier. All other tools should be removed from the engine.

1. Access the governor linkage.

After setting the timing on the number one injector it is time to check the fuel setting dimension on the engine. To check fuel setting we must first gain access to the governor linkage. The linkage can be accessed by removing the protective clip from the governor sleeve. Using the **soft-jaw pliers** (see Fig F-1), the sleeve must be broken loose by gripping the sleeve and rotating it back and forth. This will break loose the o-ring seal on the sleeve and allow it to be slid away from the governor to expose the linkage. Once the sleeve is loose, you may have to use a screwdriver or similar object to slide the sleeve back into the cylinder head. It is important not to leave any nicks or scratches of any kind on the sleeve while sliding it away. These marks could damage the governor seal. Consult the engine service manual for more information on accessing the governor linkage.

2. Determine the proper fuel setting dimension.

After exposing the governor linkage, the proper fuel setting dimension can be determined from the valve cover information plate. Consult the information plate before proceeding.

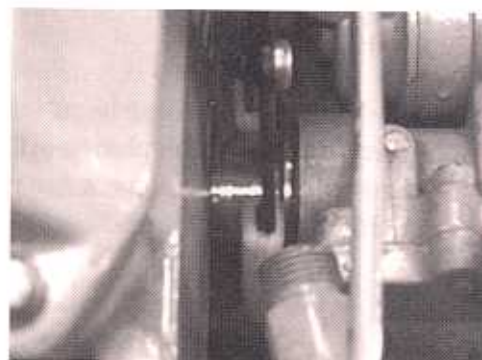
3. Set double zero on the horizontal indicator.

After determining the proper fuel setting dimension, set double zero on the horizontal indicator. Use the same procedure for setting double zero as in synchronizing. Move the control linkage positioning tool toward the push rod side of the engine and adjust the indicator.

NOTE: After setting double zero, remove the control linkage positioning tool from the engine. If left in position, it will rack movement and you will not be able to check or adjust the fuel setting properly.



(Fig. T-2) Adjust timing using a 19mm wrench and a flat head type screwdriver. Turn screw until the indicator matches the calculated reading.



(Fig. F-1) Use the soft-jaw pliers to break loose the governor sleeve and slide it back into the cylinder head.

4. Install the fuel setting rod and wedge.

After setting double zero on the horizontal indicator you must install the pin and wedge in the governor linkage.

Insert the pin through the hole in the governor linkage as shown. (See Fig. F-2) Depending on the model of the engine, it may be necessary to come in from the opposite side to insert the pin.

After inserting the pin, install the wedge between the governor sleeve and pin as shown. (See Fig. F-3) Make sure the wedge is in tight. This will keep the governor linkage in position while we check and adjust the fuel setting.

5. Check and adjust the fuel setting.

To check the fuel setting look at the horizontal indicator. If the indicator reading matches the valve cover specification then no adjustment is necessary.

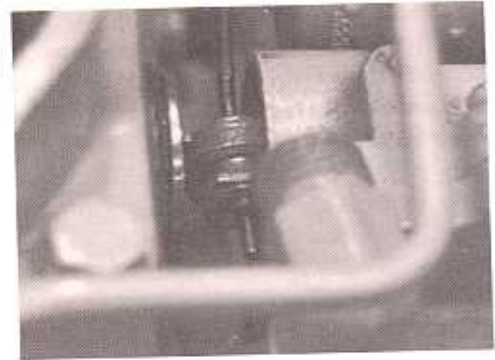
If the reading does not match the specification, use the adjusting tool to loosen the lock nut and turn the adjusting screw, located between the number one and number two rocker arm supports. (See Fig. F-3) until the indicator reading is correct. When the reading is correct, tighten the lock nut again, watching for thread pull.

When the fuel setting is complete remove all tools from the engine. Replace the fuel shut off solenoid and valve cover. This concludes the instructions for using the carpenter tool system. If there are any questions, please call us at 1-800-901-2222.

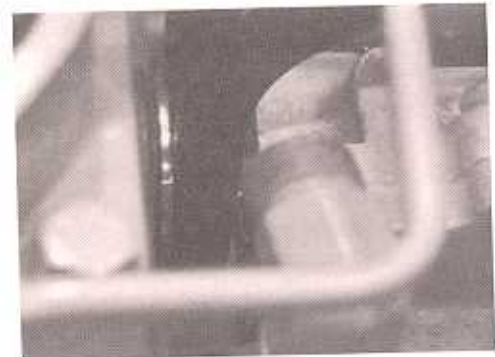
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(Fig. F-2) Insert the pin through the governor linkage.



(Fig. F-3) Install the wedge between the governor sleeve and pin.



(Fig. F-4) Using the adjusting tool to set the fuel setting. The adjustment screw is between the number one and number two supports.