ELECTRO-MOTIVE

M.I. 4506

MAINTENANCE INSTRUCTION

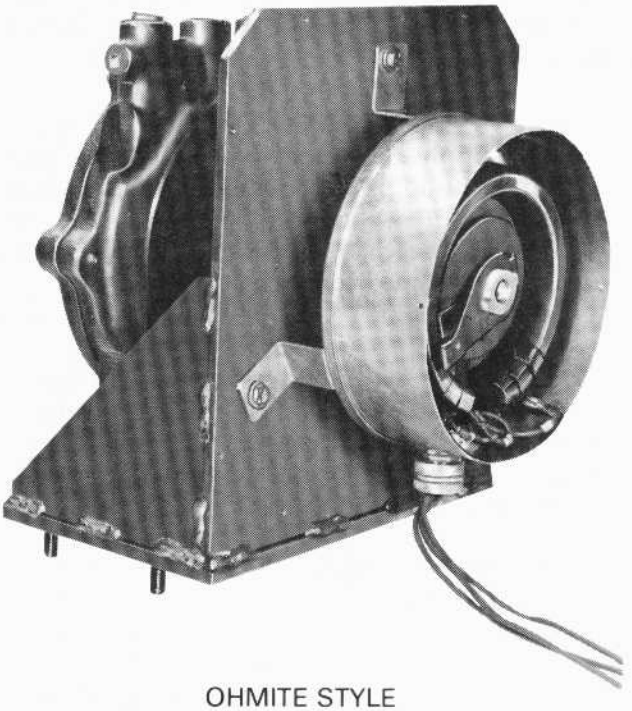
LINEAR LOAD REGULATORS

INTRODUCTION

The load regulators, Fig. 1, described in this instruction are linear-type rheostats driven by hydraulically operated vane motors. The load regulator operates in conjunction with the engine governor to provide an efficient system of locomotive load control.

A pilot valve in the engine governor controls a flow of engine oil under pressure to drive the vane motor clockwise or counterclockwise through an arc of approximately 300 degrees, thereby positioning the rheostat brush arm and regulating the output of the main generator by varying a signal to the load control system that controls excitation of the generator field. Control of generator field excitation results in control of the load on the engine. Load control of the engine by the governor permits the governor to maintain engine speed with regulation of power at the correct level for a given speed.

In order for the load control system to function as intended, the engine governor should have the proper settings and adjustments, which vary with the different locomotive models. It is therefore, recommended that the Engine Maintenance and Locomotive Service Manuals be consulted for information on engine governors and load regulator operation.



OHMITE STYLE

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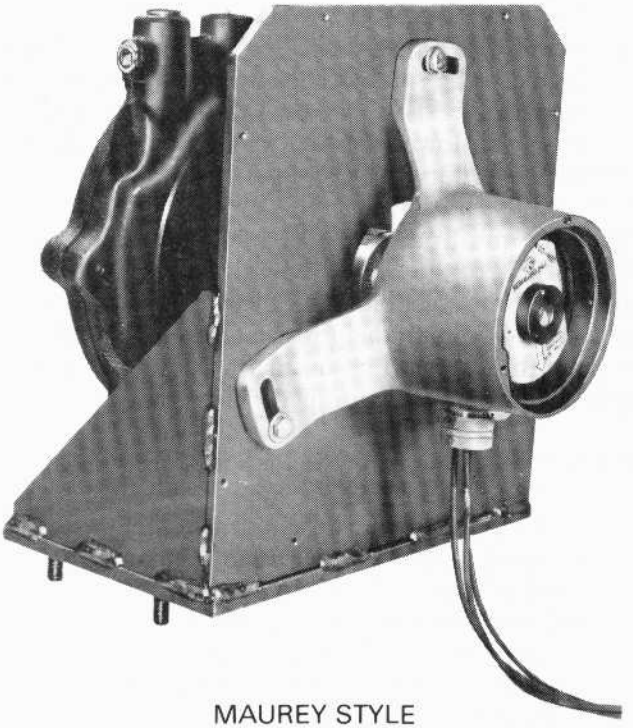

MAUREY STYLE

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Fig. 1 – Load Regulator Assembly

MAINTENANCE

To ensure continued satisfactory operation, the load regulator assembly should be inspected and cleaned at intervals outlined in the Scheduled Maintenance Program.

INSPECTION AND CLEANING OF RHEOSTAT

1. Remove the weatherproof cover from the rheostat assembly. A screwdriver may be used to pry off the cover, which is sealed with RTV silicone rubber.

2. Using low pressure air, blow dust and dirt from the rheostat assembly. Cleanliness is particularly important between the exposed rheostat windings. Alcohol or mineral spirits and a medium hard brush may be used to clean windings.

3. Check that rheostat windings are firmly attached to the ceramic core. If any windings are loose or appear burnt or worn, or if the ceramic core is cracked, replace rheostat assembly. Refer to Rheostat Replacement for proper procedure.

4. Check that all wiring connections are tight.

5. Check for oil leakage and check connections of lube oil piping to the vane motor.

6. The following checks require that the load regulator be rotated back and forth through its entire travel. To rotate the vane motor, manually raise and lower the load control pilot valve in the governor with the engine running.

Another method of rotating the vane motor manually is to alternately energize and de-energize the overriding solenoid ORS by using a jumper wire to apply 74 volts to the positive terminal of ORS or by operating the switch on the faceplate of the TH module on units so equipped.

Check the following as the load regulator rotates:

- Check that wiper arm is in firm contact with the rheostat windings when load regulator rotates from minimum to maximum position. Replace rheostat if wiper arm does not move smoothly across the windings while maintaining firm contact with the windings. Wiper arm pressure is fixed and non-adjustable.

- Electrically isolate the load regulator and check rheostat total resistance between terminals 1 and 2. Resistance should be 1500 ohms $\pm$ .25%. Replace load regulator if resistance is not within tolerance.

- Check rheostat electrical alignment using the following steps.

  a. Open battery knife switch and remove wire tagged 1, 2, and 3. Impress 74 volts between terminals 1 and 2. Positive to terminal 1.

  b. Connect a voltmeter as follows, positive to terminal 1, negative to terminal 3.

  c. Meter should read zero with load regulator shaft rotated counterclockwise (facing rheostat winding) to stop and 0.5 ± 0.2 volts when shaft is rotated 2° clockwise.

  If readings are not as specified, loosen the three rheostat assembly mounting bolts slightly and adjust rheostat until readings are correct.

RHEOSTAT REPLACEMENT

The load regulator rheostat has three leads exiting through a water proof strain relief bushing. On most locomotive models these wires run through conduit to the AC electrical cabinet. On other models the wires end in the high voltage electrical cabinet or an auxiliary cabinet. The wires are labeled 1, 2, and 3 at both ends.

Two different manufacturers, Ohmite and Maurey currently supply the linear-type load regulator rheostats. Although electrically identical, slight differences occur in mounting and wiring the two rheostats. Therefore, a separate replacement procedure is included for each style rheostat.

CAUTION

Do not cut leads to splice in new rheostat unless absolutely certain of correct wiring. Incorrect wiring will prevent the unit from loading or result in destroying the load regulator rheostat.

OHMITE STYLE RHEOSTAT REPLACEMENT

CAUTION

Open battery knife switch to prevent short circuiting battery during rheostat replacement.

1. Remove sealed cover from rheostat, Fig. 2.

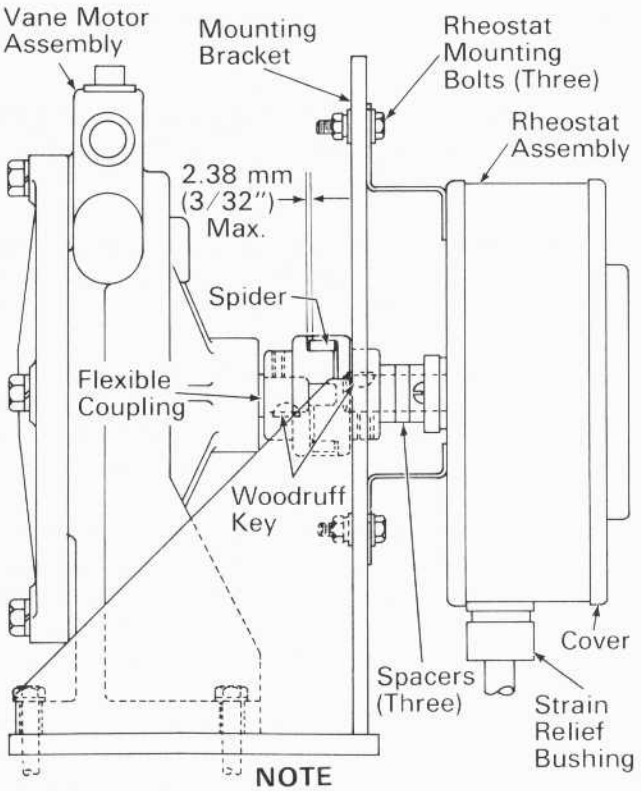


Fig.2 - Installing Ohmite Style Rheostat

2. Remove wires numbered 1, 2, and 3 from push-on terminal connections.

3. Unscrew the strain relief fitting nut at the bottom of the rheostat housing. Pull the three wires and rubber grommet down through the bottom of the strain relief bushing.

4. Remove the three rheostat mounting bolts from the mounting bracket. Remove rheostat from remainder of load regulator assembly.

5. Remove flexible coupling half, woodruff key, and spacers from the removed rheostat. Install these pieces on the new rheostat as shown in Fig. 2. Leave flexible coupling half setscrew loose.

6. Rotate vane motor counterclockwise to stop. Facing rheostat window, rotate rheostat drive shaft counterclockwise to stop. Mount new rheostat to bracket and install mounting bolts finger tight. Place spider between flexible coupling halves.

7. Repeat Steps 1, 2, and 3 above with new rheostat.

8. Align rheostat electrically using the following steps.

   a. Impress 74 volts between terminals 1 and 2. Positive to terminal 1. Refer to Fig. 3 for terminal location.

   b. Connect a voltmeter as follows, positive to terminal 1, negative to terminal 3.

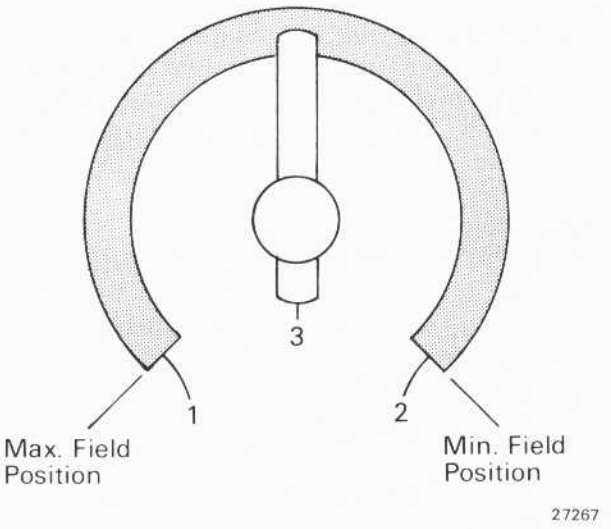


Fig.3 - Rheostat Wiring, View Facing Rheostat

   c. Meter should read zero with load regulator shaft rotated counterclockwise (facing rheostat window) to stop and 0.5 ± 0.2 volts when shaft is rotated 2° clockwise.

   Adjust rheostat positioning until readings are correct, then tighten mounting bolts. After adjustment is complete, recheck alignment. Voltmeter must read zero when shaft is rotated counterclockwise to stop.

9. Insert the three leads and rubber grommet, previously removed, into the new rheostat. Connect the wires to push on terminals as shown in Fig. 3. Screw the strain relief fitting nut onto the new rheostat and tighten.

10. Place a bead of RTV rubber inside the rim of the rheostat cover. Install cover on rheostat and tighten mounting screws.

11. Adjust flexible coupling clearance as shown in Fig. 2. Apply thread sealant to setscrew and tighten.

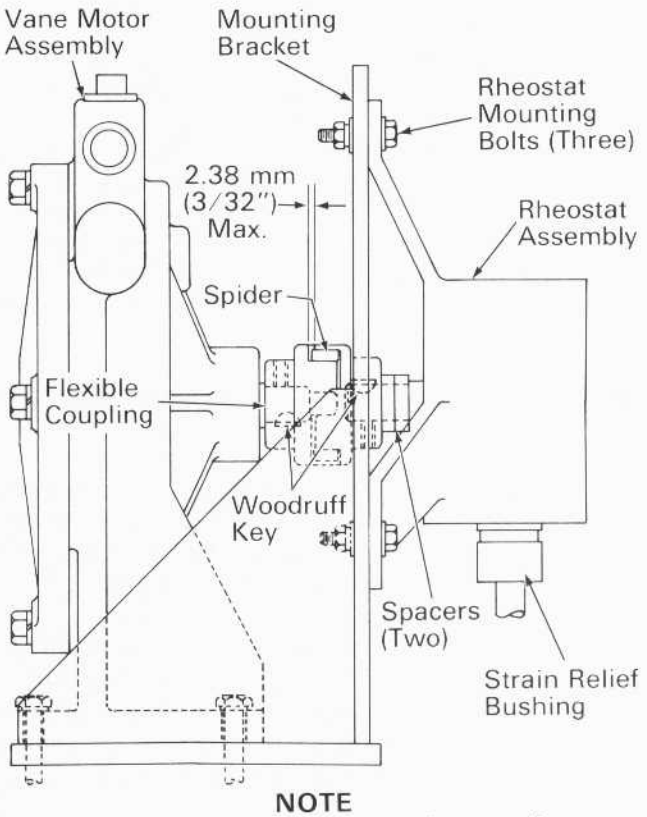
MAUREY STYLE RHEOSTAT REPLACEMENT

CAUTION

Open battery knife switch to prevent short circuiting battery during rheostat replacement.

1. Remove the three rheostat mounting bolts from the mounting bracket. Remove rheostat from remainder of load regulator assembly.

2. Remove flexible coupling half, woodruff key, and spacers from the removed rheostat. Install these pieces on the new rheostat as shown in Fig. 4. Leave flexible coupling half setscrew loose.



NOTE

Apply thread sealing compound to coupling setscrew.

27268

Fig.4 – Installing Maurey Style Rheostat

3. Rotate vane motor counterclockwise to stop. Facing rheostat window, rotate rheostat drive shaft counterclockwise to stop. Mount new rheostat to bracket and install mounting bolts finger tight. Place spider between flexible coupling halves.

4. Align rheostat electrically using the following steps.

   a. Impress 74 volts between wires tagged 1 and 2. Positive to wire tagged 1. Refer to Fig. 3 for rheostat wiring.

   b. Connect a voltmeter as follows, positive to wire tagged number 1, negative to wire taged number 3.

   c. Meter should read zero with load regulator shaft rotated counterclockwise (facing rheostat window) to stop and 0.5 ± 0.2 volts when shaft is rotated 2° clockwise.

   Adjust rheostat positioning until readings are correct, then tighten mounting bolts. After adjustment is complete, recheck alignment. Voltmeter must read zero when shaft is rotated counterclockwise to stop.

5. Remove wires from old rheostat. Securely fasten wire leads from new rheostat to the old wires. At the electrical cabinet pull wires through conduit using a suitable lubricant if necessary. Attach new wires to their proper location in the electrical cabinet.

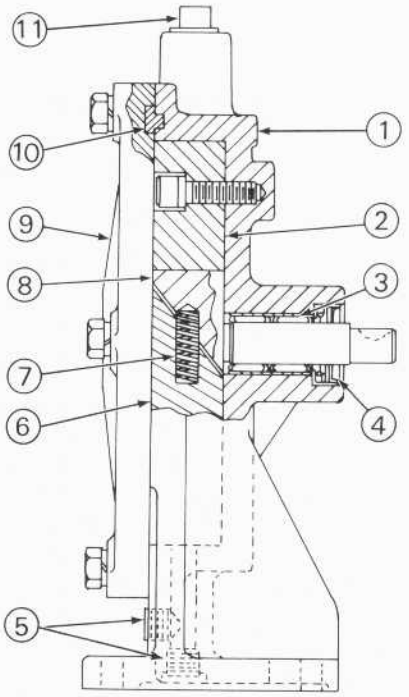
6. Adjust flexible coupling clearance as shown in Fig. 4. Apply thread sealant to setscrew and tighten.

VANE MOTOR DISASSEMBLY, FIG. 5

Disconnect lube oil piping. Remove drain plug to drain oil from vane motor. Remove vane motor assembly from unit and place on workbench for convenience of further disassembly.

Check vane motor shaft end play. It should be not less than 0.05 mm (.002") or more than 0.13 mm (.005"). Remove the six 3/8" hex-head bolts from vane motor cover. Remove cover and gasket. Discard gasket and apply a new one at assembly. Remove vane, compression spring, and shaft. Handle parts carefully as they are manufactured to close tolerances to minimize oil leakage. Remove plugs and ball check valves.

After disassembly, all parts of the vane motor should be thoroughly cleaned and inspected. Parts showing excessive wear or damage should be replaced.



1. Motor Housing
2. Motor Segment
3. Needle Bearing
4. Oil Seal
5. Pipe Plug - 1/4"
6. Vane
7. Compression Spring
8. Shaft
9. Motor Housing Cover
10. Gasket
11. Governor Connections

27458

Fig.5 - Vane Motor Assembly

The vane motor may be assembled by reversing the procedure outlined above for disassembly. After assembly, the vane motor should be installed and completely checked for proper performance.

LOAD REGULATOR TIMING

The rate at which the load regulator or contact arm moves when oil flows into the vane motor is very important from the standpoint of load control stability. The load regulator pilot valve is built into the electro-hydraulic and electro-pneumatic governors and it operates within a special ported bushing. The number, size, and location of ports in such bushings automatically controls the rate of oil flow to or from the load regulator and proper timing is ensured.

Several types of bushings are used, depending on locomotive application. Some have four ports and other five ports. Whenever a governor is changed or the load regulator pilot valve and bushing is replaced, care should be exercised to make sure the replacements are identical to those removed. For identification of proper components to be used on various locomotives, consult the EMD Locomotive Replacement Parts Catalog.

SETTING OF ORS AND LOAD CONTROL PILOT VALVE

Refer to the Engine Maintenance Manual for complete information on the settings and adjustments of the ORS, the engine injector rack linkage, and the governor load control pilot valve. These items are all concerned with locomotive power and load control and should be given careful attention.

FLUSHING LOAD REGULATOR

Flushing of load regulators as a routine maintenance practice is unnecessary. They are equipped with ball check valves which allow a constant circulation of oil through the vane motor when the vane is in either extreme of its travel. The load regulator is therefore being flushed during normal operation and will be kept clean in this manner. Any air trapped in the vane motor or piping will similarly be purged as soon as the engine is started and oil circulation begins.

Whenever it becomes necessary to remove the vane motor cover for inspection of interior components, the motor should first be drained. This is easily done by removing the 1/4" pipe plug, Fig. 5, from the drain hole at the bottom center of the vane motor. When replacing the vane motor cover a new cover gasket should be installed as shown in Fig. 5.

VANE MOTOR OIL LINE CONNECTIONS

Refer to Fig. 6, if necessary to replace load regulator vane motor to governor oil line connections. As shown, the top fitting on the governor will be at higher pressure than the bottom fitting when a decrease in excitation is necessary. The opposite is true when an increase in excitation is called for.

Further explanation of the governor operation is provided in the Engine Maintenance Manual.

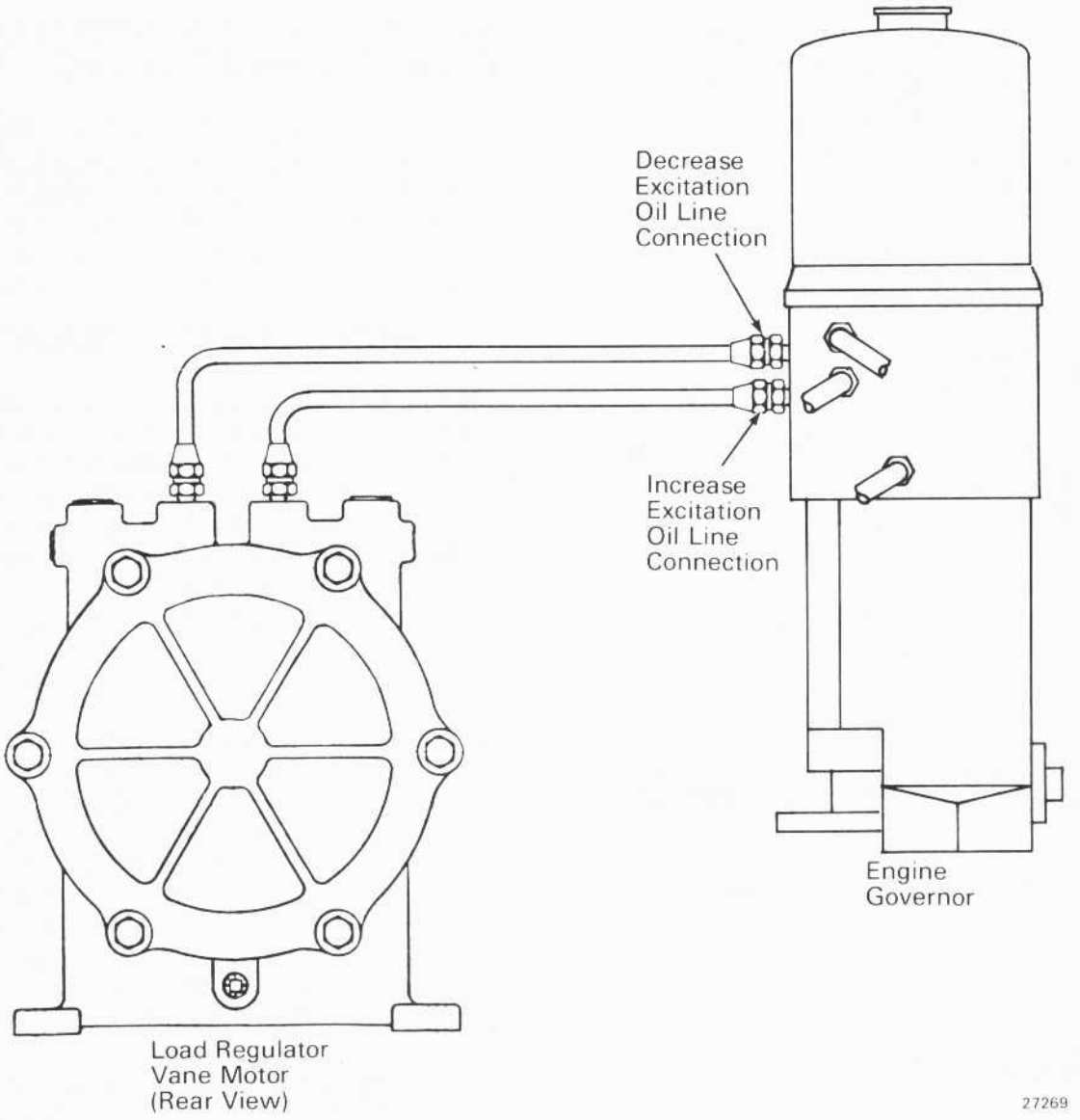


Fig.6 – Load Regulator Vane Motor-To-Governor
Oil Line Connection

SERVICE DATA

SPECIFICATIONS

Total Rheostat Resistance (Terminals 1 to 2)	1500 ohms ± .25%
Vane Motor Shaft End Play	0.05 mm to 0.13 mm (.002" to .005")

REPLACEMENT PARTS LIST

Woodruff key	103904
Vane Motor Shaft Needle Bearing	148410
Vane Motor Housing Gasket	8048814
Flexible Coupling (Includes Spider)	8152406
Vane Motor Shaft Oil Seal	8332959
Thread Sealant (250 cc bottle)	9085183
Rheostat (Linear Type)	9322456

TORQUE VALUES

Vane Motor Housing Bolts	32.5 N·m (24 ft-lbs)
Rheostat Mounting Bolts	8.1 N·m (6 ft-lbs)
Vane Motor Mounting Bolts	32.5 N·m (24 ft-lbs)

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Electro-Motive Division Of General Motors La Grange, Illinois 60525

Litho in U.S.A.