ELECTRO-MOTIVE DIVISION • GENERAL MOTORS CORPORATION
SERVICE DEPARTMENT MAINTENANCE INSTRUCTION

DYNAMIC BRAKE LIMITING REGULATORS

DESCRIPTION

Optimum dynamic braking is achieved at the point where the maximum braking effort is exerted without exceeding the electrical rating of the components. The first applications of dynamic braking to Electro-Motive locomotives required the engineman to manually regulate this electric retarding brake. Although satisfactory operation was possible through manual regulation, constant adjustments had to be made in order to maintain the maximum braking strength without exceeding the current rating of the equipment.

The operational problems imposed by manual dynamic braking regulation have been entirely overcome with the application of the latest design current limiting regulator 8305972, Fig. 1, which replaces 8204395 and 8275707. Use of this regulator eliminates the need for extensive manual control, provides an excellent equipment safeguard, and increases dynamic braking efficiency. The increased efficiency results from the ability of the regulator to maintain a more uniform retarding effect throughout a wide range of grade and train conditions.

This current limiting regulator is a highly efficient and compact device which has been manufactured to close tolerances. The operator unit has a nonremovable cover for protection against dust and moisture. The mounting holes in the chassis have been provided with rubber grommets to minimize vibration. These and other features combine to make this regulator one which will provide "trouble-free" operation and a long service life with a minimum of attention.

The regulator is made up of two main sections, the operator unit and the chassis, Fig. 2. The enclosed operator unit consists of three major elements: a voltage sensitive operating coil, a contact finger assembly, and a movable contact actuating bar, Fig. 3 – typical operator unit. The 24 external contact prongs are connected to 20 normally closed internal contact fingers which form the base of the operator unit. The voltage sensitive operating coil magnetically attracts a spring loaded armature plate which is connected to the movable insulated actuating bar. This bar has a biased edge to open (or close) the contact fingers one at a time.

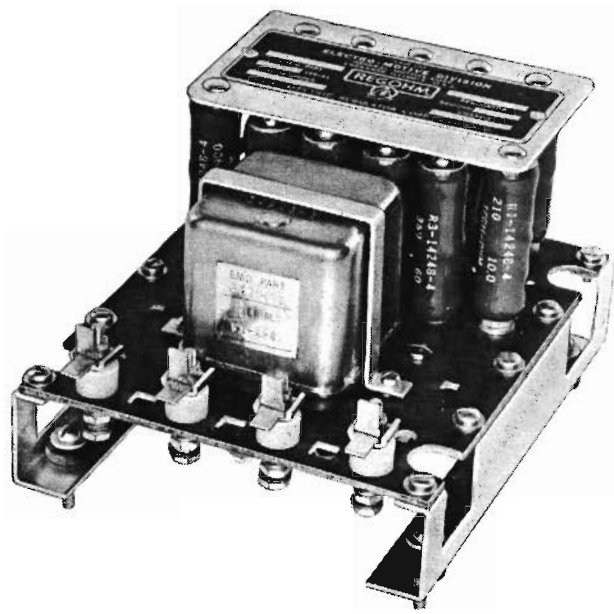

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Fig. 1 – Dynamic Brake Limiting Regulator

The chassis, Fig. 2, consists of an insulating base on which are mounted the operator, four terminal studs and eleven tapped resistors. The resistors are mounted in the upper portion of the chassis. Heat resisting insulated and color coded wiring connects the receptacle jack pins with the various taps on the eleven resistors and the four terminals.

*This bulletin is revised and supersedes previous issues of this number

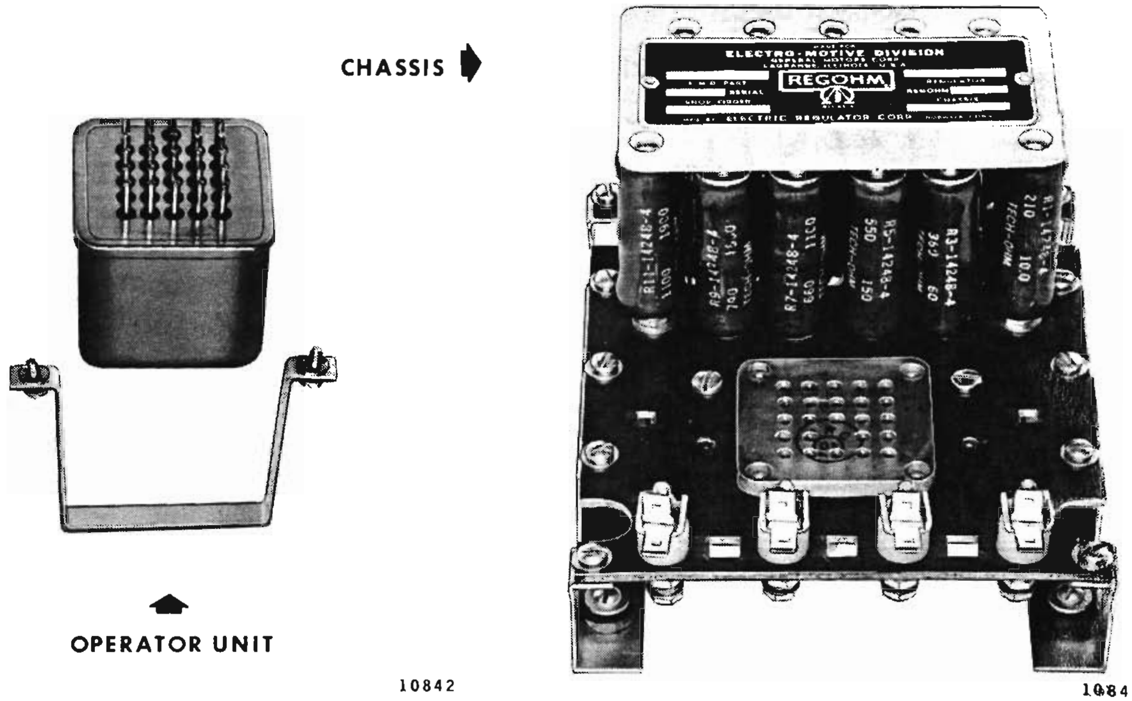

Fig. 2 – Operator Unit And Regulator Chassis

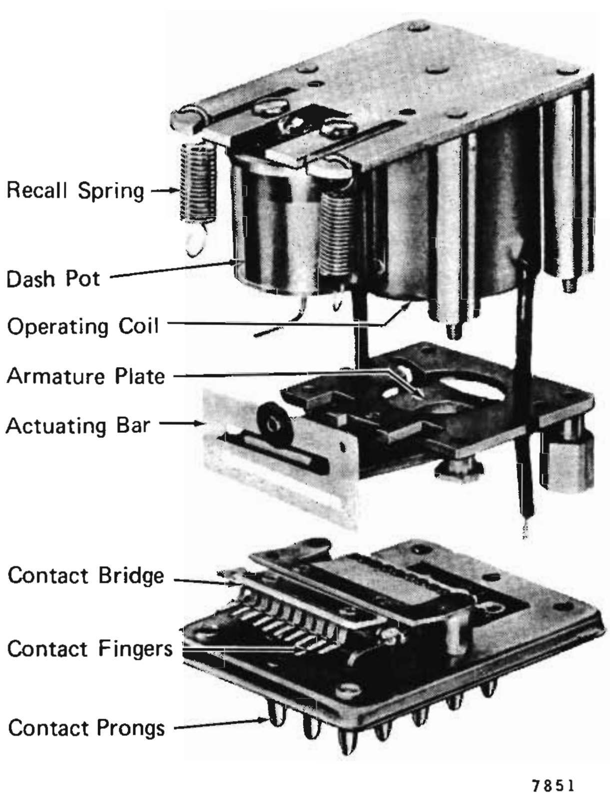

Fig. 3 – Typical Operator Unit

OPERATION

A schematic diagram of the dynamic brake regulator is shown in Fig. 4. Until the coil current reaches approximately 100 milliamperes, the resistance across terminals A-B is zero due to the normally closed cutout interlock. As the current beings to exceed 100 milliamperes in the operating coil, the spring loaded armature plate is attracted and moves to first open the interlock and then open the contact fingers, one at a time. The fingers are opened through action of the biased edge of the insulated actuating bar which moves with the armature. As the current in the operating coil continues to increase, the armature continues to move proportionally and open more contact fingers. The insulated actuating bar is spring loaded and connected to an air dashpot to prevent fluttering due to fluctuations of coil current.

Before the first contact finger is opened, the effective resistance across terminals A-B is the value of all the resistors in parallel. When the No. 1 finger opens, the circuit to the 10 ohm resistor is opened thus increasing the resistance across the A-B terminals of the regulator. This action progresses until all the contact fingers are open and

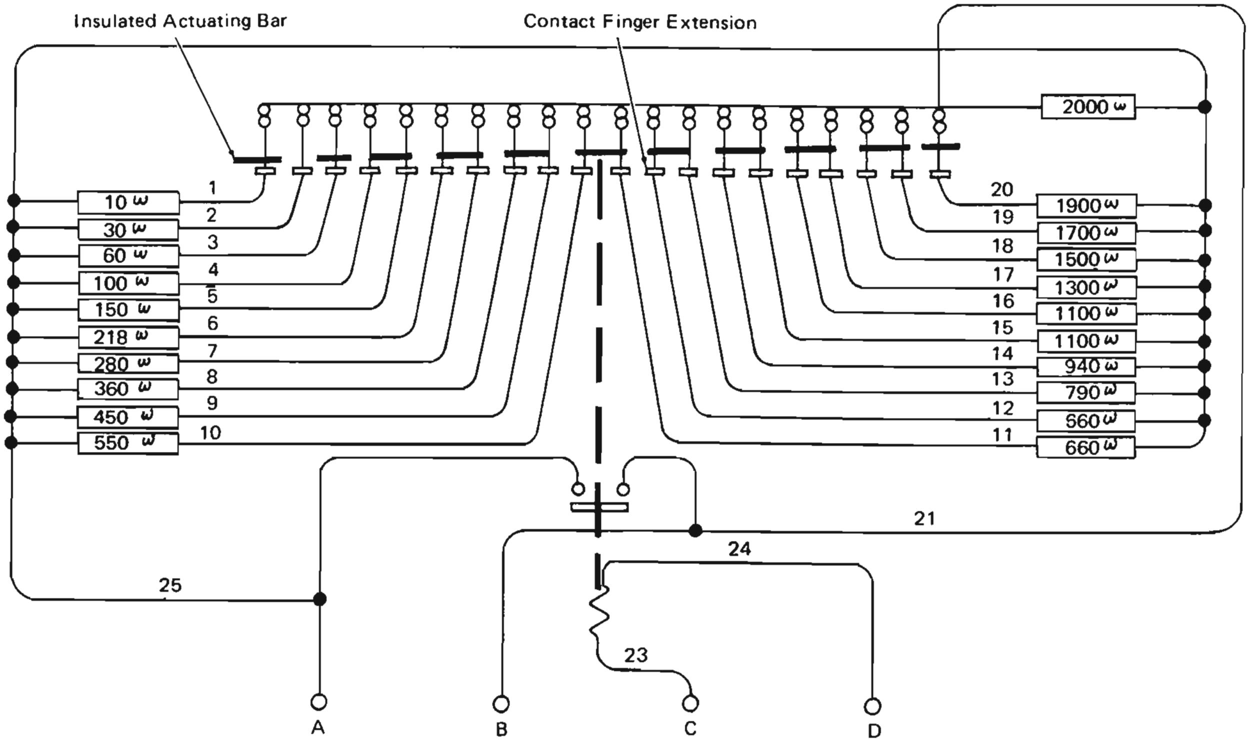

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Fig. 4 — Schematic Diagram — Internal Circuits

only the 2000 ohm resistor remains in the circuit. Listed below are the values of the internal resistance of the regulator across the A-B terminals as the contact fingers open progressively as shown in Fig. 4.

Steps		Resistance At Terminal A-B
Coil de-energized		0 Ohms
Cutout interlock opens		5.2 Ohms
Finger	1 open	10.9 Ohms
Finger	2 open	17.0 Ohms
Finger	3 open	23.5 Ohms
Finger	4 open	31.0 Ohms
Finger	5 open	39.5 Ohms
Finger	6 open	48.5 Ohms
Finger	7 open	58.5 Ohms
Finger	8 open	70.0 Ohms
Finger	9 open	83.0 Ohms
Finger	10 open	98.0 Ohms
Finger	11 open	115 Ohms
Finger	12 open	139 Ohms
Finger	13 open	168 Ohms
Finger	14 open	205 Ohms
Finger	15 open	252 Ohms
Finger	16 open	328 Ohms
Finger	17 open	438 Ohms
Finger	18 open	620 Ohms
Finger	19 open	975 Ohms
Finger	20 open	2000 Ohms

These resistance values do not correspond to the actual resistor values due to the fact that they are connected in parallel.

REGULATOR APPLICATION

Referring to Fig. 5, the traction motors are acting as generators during dynamic braking and their output must be limited to the capacity of the grid resistors. The shunt field transfer (SFT) relay or dynamic brake (BR) relay is energized during dynamic braking, consequently the interlocks of this relay are shown in their energized position in

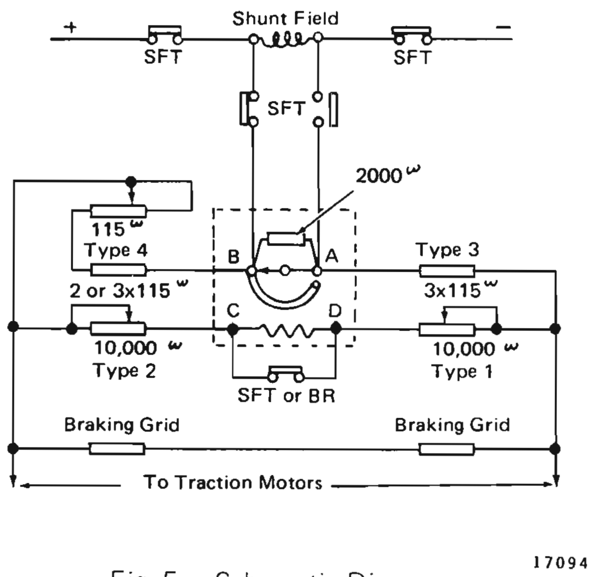

Fig. 5 – Schematic Diagram
Regulator Application

Fig. 5. The two factors governing the output of the traction motor under these conditions are locomotive speed and battery field excitation of the main generator. Battery field excitation is controlled by the engineman through the dynamic brake lever on the control stand, however, the regulator limits the current to the capacity of the grids regardless of the position of the dynamic brake lever.

The operating coil of the regulator, terminals C-D in Fig. 5, is in series with two 10,000 ohm variable resistors. These resistors are used to adjust the regulator limiting voltage. Additional fixed and variable resistors are also connected in series with the variable resistance of the regulator. They are used to keep the regulating current value within the rating of the regulator. Resistor settings to produce the proper regulator action for the various locomotive models and brake ratings are tabulated in the Table Of Resistor Settings, Fig. 6.

When the voltage generated by two traction motors in series reaches 980-990 volts for 700 ampere brakes or 840-850 volts for 600 ampere brakes, the regulator starts to function. The coil picks up and the cutout interlock which has shorted out the shunt field of the main generator and the internal resistance of the regulator up to this time, opens. This places the internal resistance of the regulator in parallel with the shunt field. The result is that a small bucking current now begins to flow through the shunt field. This creates a field which opposes the main generator battery field cutting down the effective main generator excitation to keep the current in the resistor grids at the desired value.

MAINTENANCE

The dynamic brake limiting regulator requires very little inspection or maintenance. Usually, all that need be done is an occasional visual inspection and check of external adjustments.

Visual Inspection

During periodic electrical inspections, the regulator should be given the following attention:

1. Check terminal connections for tightness.
2. Check for burned resistors or wires.
3. Observe that regulator mounting is secure.
4. Blow away any accumulated dirt or dust.

Preliminary Adjustment

Notice on Fig. 5 that the operating coil of the regulator, from terminal C to D is in series with two 10,000 ohm variable resistors designated as Type 1 and Type 2. These resistors are used to adjust the regulator limiting voltage. The variable resistance of the regulator, terminals A to B, is in series with additional fixed resistors and a variable resistor. These resistors are designated as Type 3 and Type 4.

To adjust the regulator for proper operation, proceed as follows:

1. Refer to Fig. 6, Table of Resistor Settings, and determine the proper preliminary setting ohmic value for the Type 1 and Type 2 resistors which will apply to the model locomotive and brake rating to which the regulator is applied.
2. Use an ohmmeter to position the slider on Type 1 and Type 2 resistors to obtain the proper preliminary ohmic value.
3. In the table, Fig. 6, the values listed for total resistance settings of Type 3 and Type 4 are the combined resistance of all the Type 3 and Type 4 resistors in series. The value shown is obtained by moving the variable resistor in the Type 4 bank until the proper value is obtained. Again, use a reliable ohmmeter to obtain the setting.

Model	Preliminary Settings No. 1 Resistor	Preliminary Settings No. 2 Resistor	Final Settings Total Resistance of No. 3 & No. 4	Quantity in No. 3	Quantity in No. 4	Final Adjustment Regulation Voltage	Brake Rating
F7, F9 GP7, GP9 GP18, GP20	4200 Ohms	5600 Ohms	790-800 Ohms	3 Fixed	3 Fixed 1 Variable	975-985 Volts	700 Amperes
SD7, SD9 SD18, SD24	4400	5400	760-770	3 Fixed	3 Fixed 1 Variable	975-985	700
E8, E9	5300	4500	670-680	3 Fixed	2 Fixed 1 Variable	975-985	700
F3, F5 F7, GP7	4360	4100	670-680	3 Fixed	2 Fixed 1 Variable	840-850	600
SW9	4300	4100	670-680	3 Fixed	2 Fixed 1 Variable	840-850	600
SW8	3500	4100	500-510	2 Fixed	2 Fixed 1 Variable	750-760	540
SW1200	4800	4300	670-680	3 Fixed	2 Fixed 1 Variable	910-920	600 (With 9 MPH max. braking)
Export 16C9, 13C9	–	4800	550-560	–	4 Fixed 1 Variable	480-490	300
18C7 (G16W)	3500	5000	550	2 Fixed	2 Fixed 1 Variable	840-850	600
18C9 (G16U)	7000	5000	790-800	3 Fixed 1 Variable	3 Fixed	1200 ± 5	375
13C9, 13A9, 13B9 9A9, 9B9, (G12U, GR12U, G8U, GL8U)	7000	5000	790-800	3 Fixed 1 Variable	3 Fixed	1200 ± 5	375
13A7, 13B7, 9A7, 9B7 (G26CW, GA18 G12W, G8W, GA8)	5000	3500	600	3 Fixed	2 Fixed 1 Variable	840-850	600
G22U	5000	7000	790-800	3 Fixed 1 Variable	3 Fixed	1200	370

NOTE: Settings as listed on respective Export wiring diagrams must be taken as final in all cases.

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Fig. 6 — Table Of Resistor Setting

Final Adjustment

For final adjustment of Type 1 and Type 2 resistors, use a motor-generator set and adjust the resistors to obtain the regulated voltage as noted in the table, Fig. 6.

Operator Bench Test

If operational trouble is experienced with the regulator, the operator unit, Fig. 2, should be removed from its chassis and given a bench check, using a spare chassis as shown in Fig. 8.

Proceed as follows:

1. Open the circuit to the interlocks of the SFT or BR relay which are across the coil of the regulator. See Fig. 7.

2. Disconnect all wires from the "A" terminal of the regulator.

3. Disconnect all wires from the 10,000 ohm resistor as shown in Fig. 7, and tape separately. Connect a (0 — 1000 volt) voltmeter

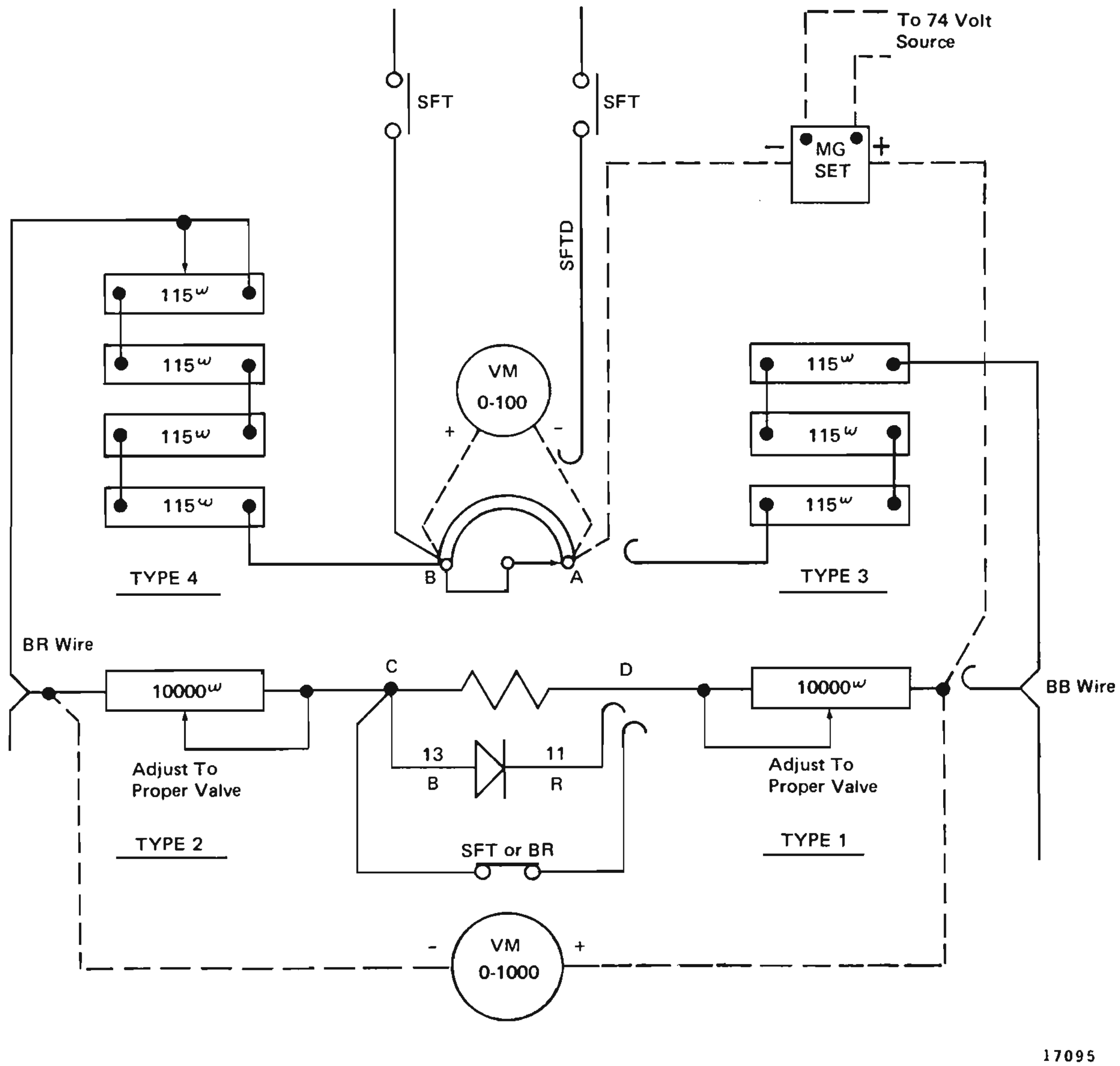

Fig. 7 — Resistor Adjustment

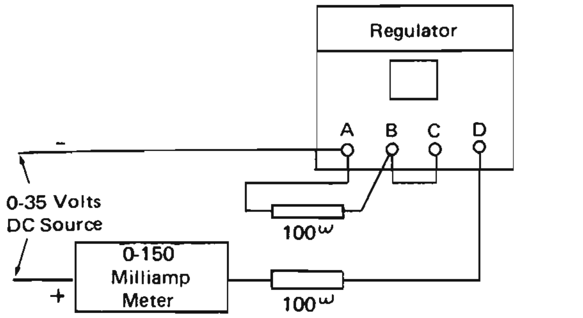

Fig. 8 – Bench Test Diagram

across the two 10,000 ohm resistors which are in series with the coil of the regulator.

Connect a (0 – 100 volt) voltmeter between terminals A and B with positive lead on B. Connect the negative lead of the motor generator set to A terminal of the regulator and connect the positive lead to the end of the 10,000 ohm resistor as shown in Fig. 7. Apply voltage and raise slowly to 1010 to 1070 volts. When the voltmeter across A and B reads between 30 to 80 volts, the voltmeter across the 10,000 ohm resistors should read between the limits specified in the Table of Resistor Settings, Fig. 6. If the voltage across the 10,000 ohm resistors is not within these regulation voltage limits, then the slide band on the 10,000 ohm resistors can be moved to increase or decrease resistance to obtain the specified regulation voltage.

NOTE: Do not move the slider band on the resistors with voltage applied to the circuit.

It is advisable to allow the temperature of the resistors to stabilize before making the final adjustment.

Bench Performance Test

In the event that the regulator does not function properly after completing the preceding adjustments, remove and replace the operator unit. If this does not solve the problem, the entire regulator assembly should be removed from the locomotive for a bench performance test.

NOTE: The operator unit is sealed and should not be opened. The internal adjustments must be set at the factory.

The bench performance test is merely to determine if the operator unit, chassis, or both are operating properly or need replacement.

Coil Resistance

Mount the regulator assembly in a vertical position on the workbench. Measure the coil resistance between terminals C and D. It should be 100 ohms ±10% at 20°C.

Regulator Resistance Check

1. With coil de-energized, measure resistance between A and B terminals. Resistance is 0 ohms.

2. With coil energized with 110 milliampere current, measure resistance between A and B terminals. Resistance should be approximately 2000 ± 10% ohms @ 20° C.

Should the resistance be lower than the 2000 ± 10% ohm value, the operator should be replaced and the value rechecked.

Operation

Parallel the resistance section (Terminals A-B) with a 100 ohm resistor. Connect terminals A and B in series with the operating coil (Terminals C-D) and a second 100 ohm resistor and a 0-150 milliammeter as shown in Fig. 8. To this closed loop circuit connect a 0-35 volt DC power source across which a voltmeter (0-50 volts DC) is placed. This circuit permits the regulator to maintain the operating current through the coil during a voltage range, beginning with the volts required to first move the regulator and the volts at which the regulator will have moved its full travel, and cut in all available resistance.

Increase the voltage slowly to the start of the operating range noting the gradual rise in the coil current. At approximately 100-105 milliamperes, the meter pointer will fall back several milliamperes. This is the operating current and start of regulation. Observe the voltage and the current. Continue raising the voltage slowly, noting that the current holds within ± 3% of that noted at the start of regulation. It is permissible for the current to fluctuate. When the current begins to definitely rise again in step with further increase in voltage it is a signal that the end of the operating range has been reached.

NOTE: Do not exceed 110 milliamperes of current or coil will be damaged, and take all readings with increasing voltage only.

Above operation must fall within the following values.

Regulation

Start	Finish
20-23 Volts	26-32 Volts

Operating Current

Mean Value	Range
100 ± 5 Milliamperes	Mean Value ± 3 Milliamperes

If the operator or entire regulator assembly does not qualify for service, the unit should be replaced and the defective operator or regulator sent to Electro-Motive for Factory rebuild.

MAINTENANCE DATA

Contacts — Resistor	20 N.C.
Interlock	1 N.C.
Coil Resistance	100 ± 10% Ohms at 20° C.
Coil Current — Operating	100 ± 5% MA — DC

Internal Regulating Resistance

Coil De-energized	0 Ohms
Coil Energized	2000 ± 10% Ohms Max.

Hi Pot Test

Terminals A-B to C-D	600 Volts RMS — 60 Cycles
Terminals A-B to Chassis	2400 Volts RMS — 60 Cycles
Terminals C-D to Chassis	2400 Volts RMS — 60 Cycles

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