INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

EXPLORING COIL TEMPERATURE INDICATORS

GENERAL

Cases

The form of case used for the temperature indicator instrument is dependent upon the type of the instrument. This is explained in detail in separate instructions for the basic instrument.

Mechanism

The mechanism is of the permanent-magnet, moving-coil type.

DESCRIPTION AND APPLICATION

These temperature indicators operate on the resistance exploring coil principle, the exploring coil forming one branch of a Wheatstone bridge, which is energized from a direct-current source. The instrument mechanism measures the degree of balance of the bridge.

The exploring coils are located at the point where the temperature is to be measured, such as being embedded in machinery windings, and are made with copper wire to an exact resistance of 10 ohms at 25°C. Because of the temperature resistance coefficient of copper, the resistance of the exploring coil provides a measure of temperature. Usually several exploring coils are used with each indicator. By means of a selector switch the indicator may be connected to any desired exploring coil.

When the exploring coil is at a predetermined temperature the bridge is in balance and no voltage exists on the instrument mechanism. This point is called the balance temperature and is shown by a special mark on the scale of the instrument. At any other temperature the resistance of the exploring coil is different and there will be an unbalance of the bridge. This results in a voltage across the instrument mechanism which is indicated by the pointer position. This voltage difference is dependent upon the resistance of the exploring coil and thus the scale can be calibrated in terms of the temperature of the exploring coil.

At the balance temperature the indication will be independent of the control circuit voltage. At other temperatures the error due to incorrect voltage is small and can be neglected for ordinary variations in voltage. For any reading and any incorrect control voltage the true reading, if desired, can be found as follows:

$$T = B - \left[\frac{E}{E_1}(B - T_1)\right]$$

B = Balance point temperature
E = Rated control voltage
E_1 = Actual control voltage
T = True temperature
T_1 = Observed temperature

For example if:

Balance point temperature = 100°C
Observed temperature = 80°C
Rated Control Voltage = 20 Volts
Actual Control Voltage = 18 Volts

$$T = 100 - \frac{20}{18}(100 - 80)$$

$$T = 100 - 22.2$$

T = 77.8° or an error of 80° - 77.8° = 2.2°

The d-c current required to operate the complete temperature indicator is 110 milliamperes. The current through the exploring coil will be a maximum of 60 milliamperes. The exploring coils must be so proportioned that the 60 milliampere current will not cause appreciable self-heating and thus cause an objectionable error from this source.

INSTALLATION

The complete temperature indicator includes the instrument proper, the selector switch, a control voltage adjusting rheostat, exploring coils and other auxiliary equipment to reduce the supply voltage if necessary or to convert from alternating current to direct current.

The leads to the exploring coils may be of any length but their resistance should be kept within the limits shown on the applicable wiring diagram. It is also important that some of the different leads have similar resistance values as is indicated on the applicable wiring diagrams.

In the wiring diagrams alternate types of wiring are shown. The title of each diagram explains the type of application for which it is best suited.

It will be noticed that in the various wiring schemes, different kinds of selector switches are required, depending upon the application. For all applications the switch or switches must have enough points to connect to the required number of exploring coils plus one point for the calibrating position and one point for the "OFF" position. The type of switch used must be such that it does not

introduce an appreciable contact resistance. Where more than one grouping of exploring coils are connected to a single indicator, it is desirable to use selector switches which are operated by a removable key or handle which may be removed only in the "OFF" position of the switch. With such an arrangement one key or handle should be used for all switches.

It will be seen from the wiring diagrams that some types of instruments require no external bridge box. In these the bridge is inside the instrument. In all types the calibrating resistor is either inside the instrument or in the bridge box when the latter is required.

Insulation

Exploring coil temperature indicators are insulated for voltage between the panel on which mounted and the terminals, as indicated in the separate instructions for the basic instrument, the same as for a d-c milliammeter or ammeter.

Grounding of Cases

The practices for grounding of instrument cases should be the same as indicated in the separate instructions for the basic instrument.

Control Voltage

These exploring coil temperature indicators are calibrated for 20 volt d-c control. It is usually considered desirable to use a source somewhat above 20 volts so the control voltage adjusting rheostat may be used to obtain the exactly correct value.

If the available control voltage source is appreciable higher than 20 volts, an external resistor is used as shown in the wiring diagrams, to reduce the voltage to the proper value.

If the available control source is alternating current, a rectifier may be used for converting to direct current. A special rectifier is available for providing 20 volts d-c for operation from 105 to 132 volts, 45 to 65 cycles a-c.

If the special rectifier is used this rectifier is provided with a self-contained rheostat. The purpose of this rheostat is to provide for initial adjustment depending upon the basic a-c voltage and frequency, and future adjustments of it are seldom necessary. The regular control voltage rheostat which is mounted to be accessible from in front of the mounting panel should still be provided to permit routine adjustments.

Mounting

If external components are used provision must be made for their mounting. The control voltage adjusting rheostat should be mounted where it is easily accessible for adjustment, preferably from in front of the mounting panel and near the instrument.

Drill panels or other mounting means according to the drilling plan in the detailed instruction leaflet furnished with the instrument and in the instructions for the external components as shown in this instruction leaflet. Mount apparatus with hardware supplied with same or as otherwise indicated.

Wiring

Wire apparatus, including external components where required, using wire which is insulated to withstand the voltage and other conditions which will be encountered in service. The resistance of the external wiring must conform to the values shown on the applicable wiring diagram.

Installation Adjustment

With the switch in the "OFF" position, using the instrument zero adjuster, set the pointer at the red mark or "balance point" on the scale.

With the switch in the calibrating position and the circuit energized the indicator should show 0°C. If the indicator reads above or below 0°C it will be necessary to change the control voltage by adjustment of the rheostat. It is by this means that the control voltage is set at the proper value.

With the switch in the calibrating position a fixed calibrating resistor located in the instrument or in the external bridge box is connected in the circuit. This resistor is 9.037 ohms which is equivalent to the resistance of a 10-ohm exploring coil at 0°C. Thus with the calibrating resistor connected in the circuit, the instrument should read 0°C on the scale.

MAINTENANCE

The bridge circuit consists of fixed resistors and no adjustments should be necessary. Calibration of the instrument proper is covered in the separate instructions for the basic instrument, the same as for a d-c milliammeter or ammeter.

The following table gives the resistance of the exploring coils for which this instrument is calibrated, for various temperatures:

Temperature In Degrees C	Resistance In Ohms
0	9.037
25	10.000
50	10.962
100	12.887
150	14.812
200	16.737
300	20.587

REPAIRS AND RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. When returning an instrument for repairs, obtain a return material tag from your dealer or your nearest Westinghouse Sales Office, to insure proper identification at the factory.

Orders for renewal parts should include the name of the part and the style and serial number of the apparatus appearing on the dial or nameplate.

OUTLINE AND DRILLING PLANS

The outline and drilling plan of the basic instrument is as shown in the separate instrument instruction leaflet for a self-contained, 5-ampere d-c ammeter except where the bridge and calibrating resistor is self-contained in the instrument. These self-contained instruments have five terminals and are separately shown in the instrument instruction leaflet.

Outline and drilling plans for the various external components, except selector switches, are shown in this instruction leaflet. Outline and drilling plans for selector switches should be according to the exact type and kind of switch used.

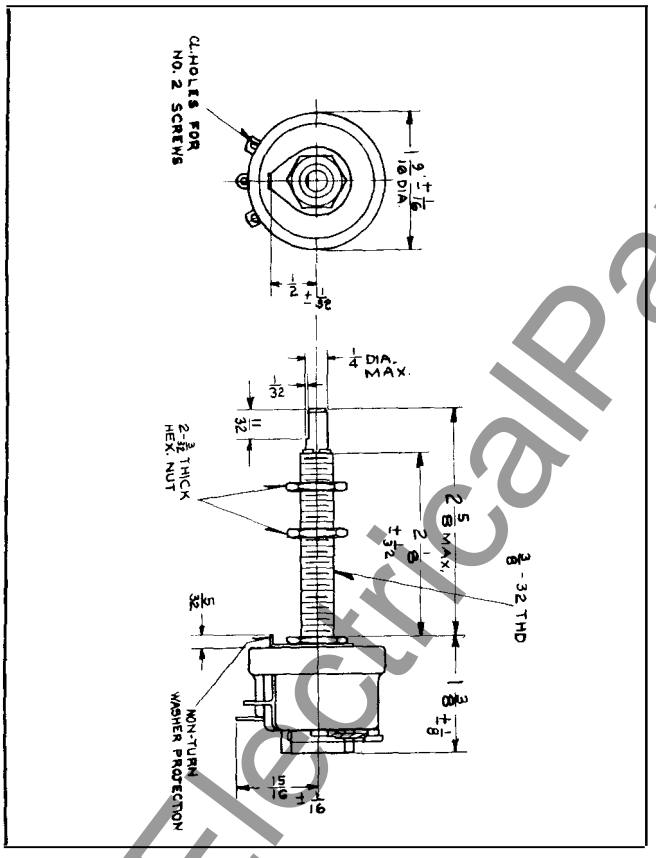


Fig. 1—Control Voltage Adjusting Rheostat

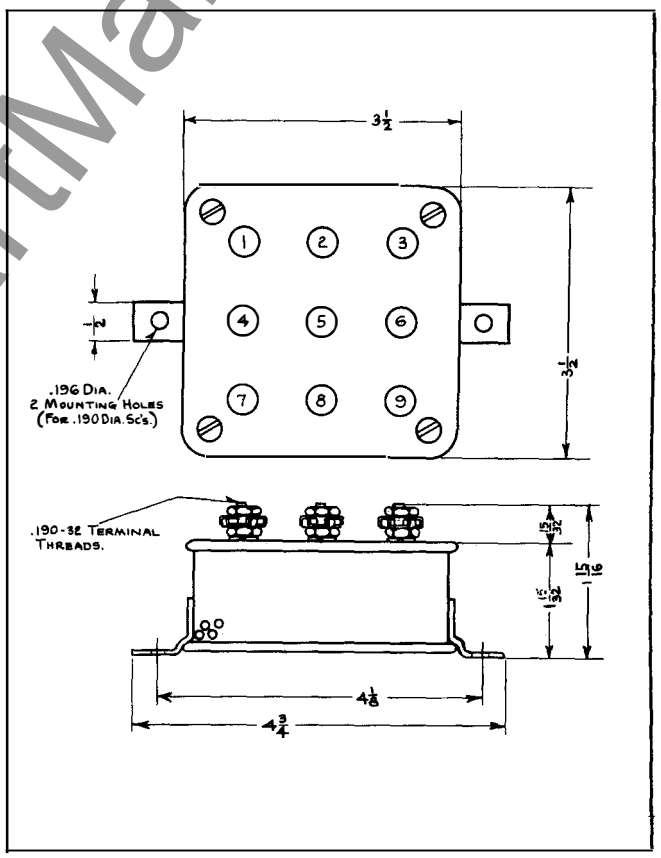


Fig. 2—External Bridge Box. Use Terminal Positions 4, 5, 6, 7, 8 and 9.

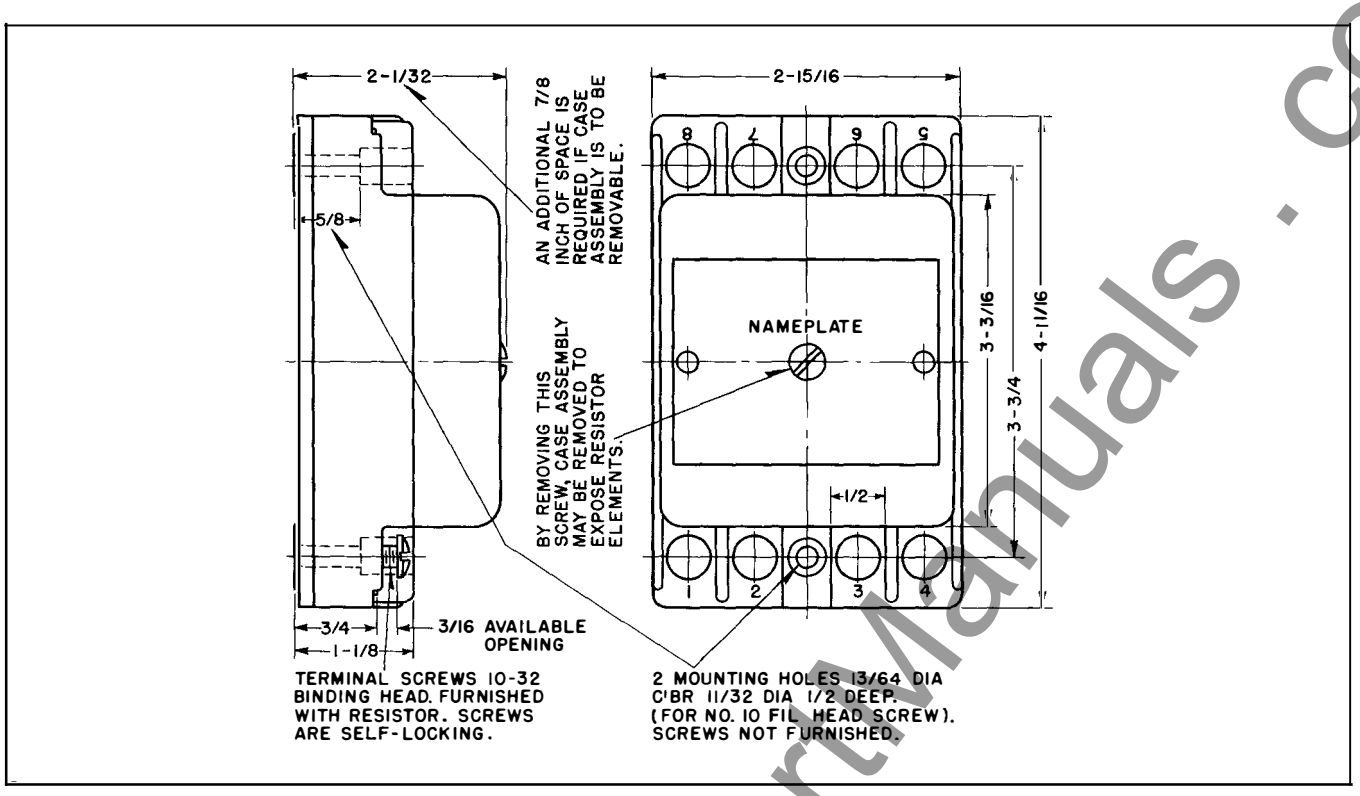


Fig. 3 – External Resistor for d-c Control Voltage. Use Terminal Positions 1 and 4.

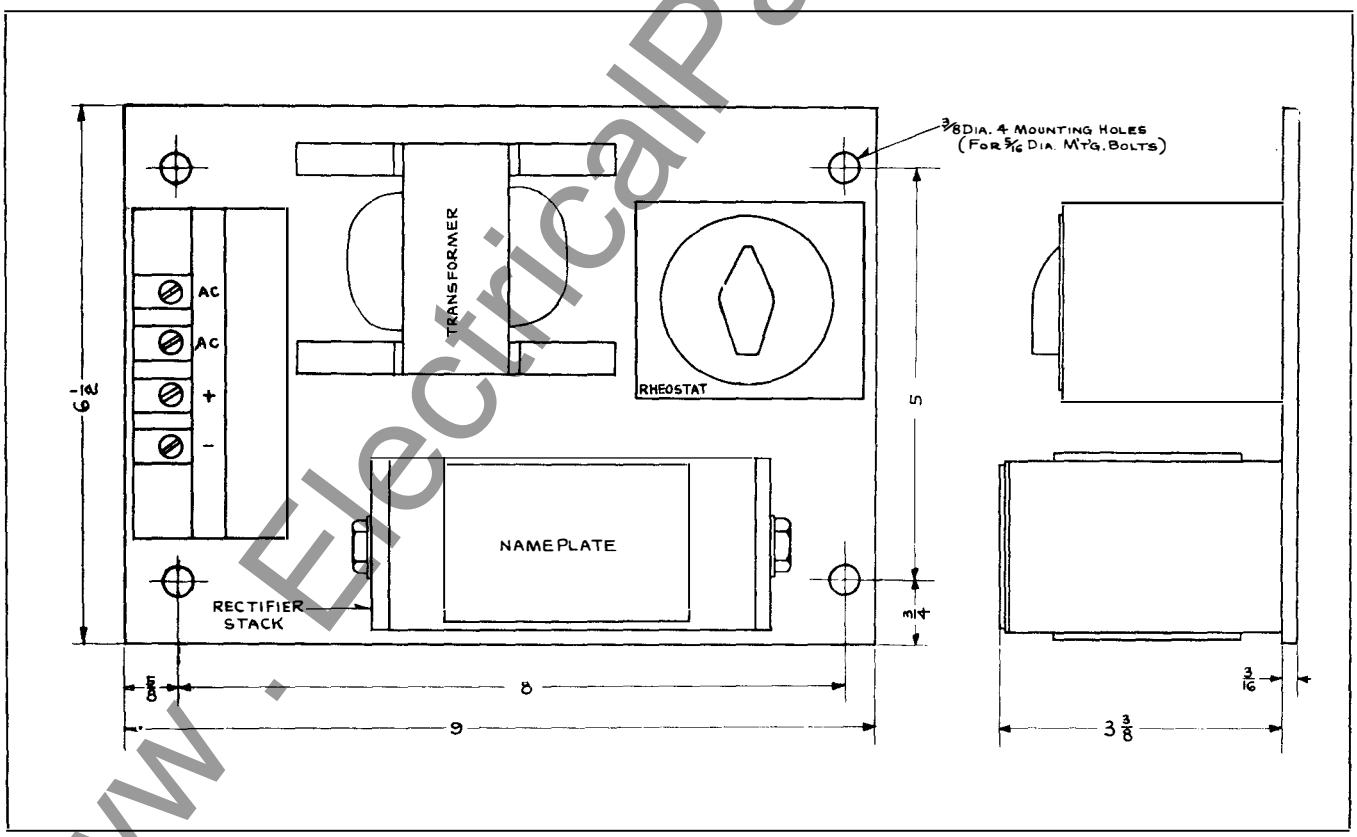
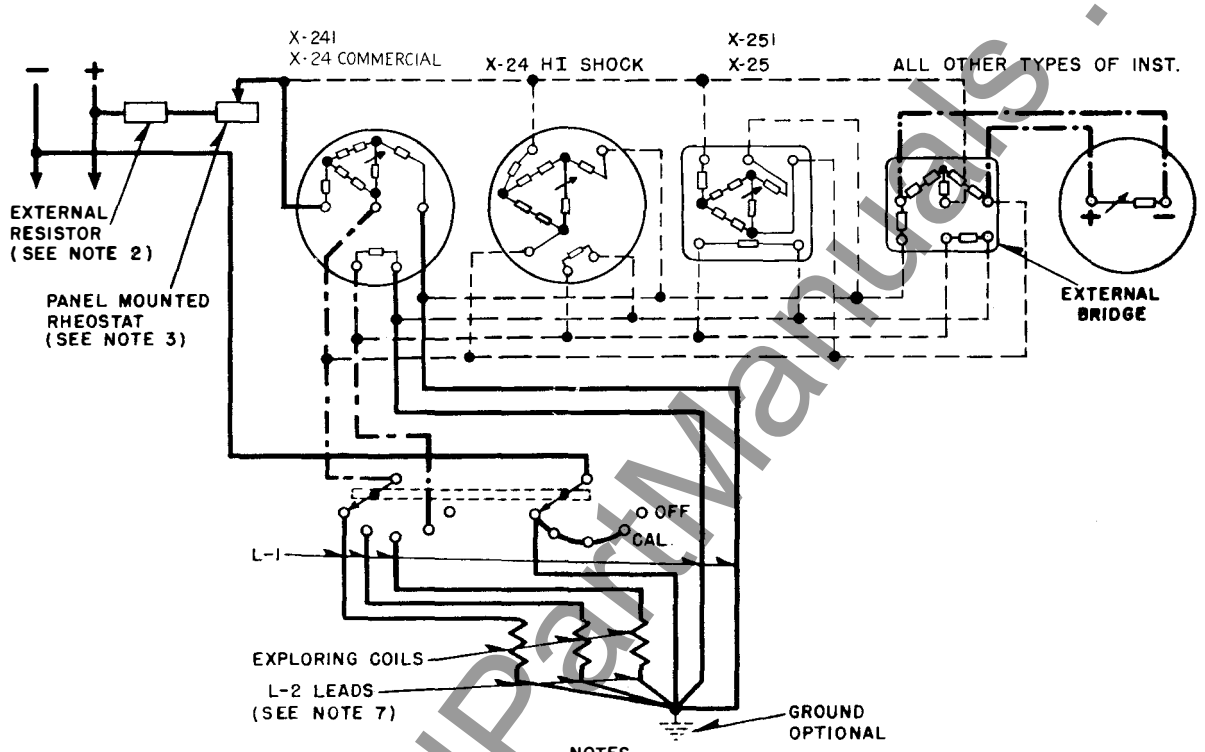


Fig. 5—Rectifier for 105 to 132 Volt, 45 to 65 Cycle Control Voltage.

WIRING DIAGRAMS

REAR VIEW



NOTES

1. FOR SIMPLIFICATION THE CONNECTIONS FOR ALL TYPES OF INSTRUMENTS ARE SHOWN IN THIS DIAGRAM. ONE INSTRUMENT ONLY IS TO BE USED FOR EACH INSTALLATION.

2. USE EXTERNAL RESISTOR ABOVE 50 VOLTS.

3. USE ONE RHEOSTAT, EXCEPT FOR 205 TO 260 VOLTS USE TWO IN SERIES. WHEN TWO ARE USED, ONE MAY BE BACK OF PANEL.

4. SWITCH CONTACTS TO EXPLORING COILS MUST MAKE BEFORE BREAK.

5. INDIVIDUAL L-1 LEADS MAY HAVE A MAXIMUM RESISTANCE OF 3 OHMS EACH.

6. ALL L-1 LEADS MUST BE WITHIN 0.02 OHM OF THE SAME RESISTANCE.

7. L-2 LEADS SHOULD NOT EXCEED 0.02 OHM EACH.

8. LEADS SHOWN IN DOT-DASH MUST NOT EXCEED 0.02 OHM EACH.

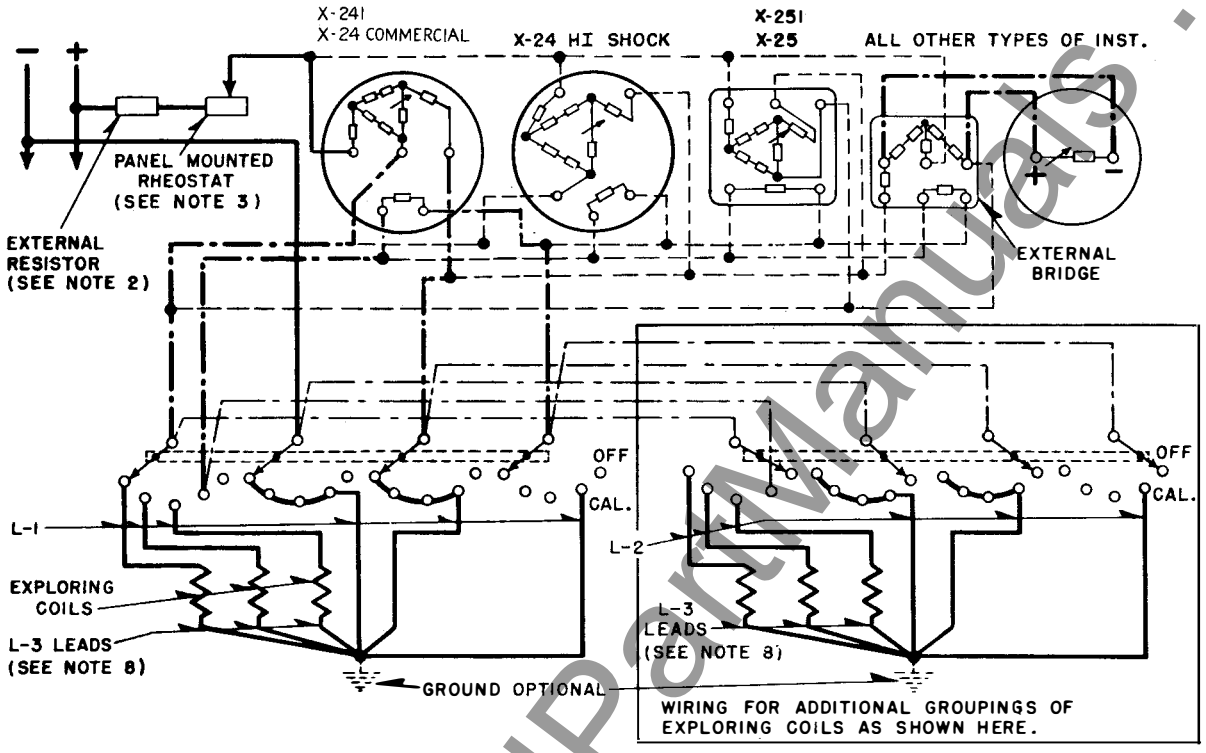
9. EACH RESISTANCE TOLERANCE OR LIMIT STATED WILL PREVENT ERRORS FROM THIS SOURCE OF GREATER THAN ONE PERCENT. ANY INCREASE WILL CAUSE AN APPROXIMATELY PROPORTIONAL ERROR.

Fig. 6—Exploring Coil Type Temperature Indicator.

Wired for Single Group of Exploring Coils and With Single Lead Compensation, for Use Where the Exploring Coils are Closely Spaced.

WIRING DIAGRAMS

REAR VIEW



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2. USE EXTERNAL RESISTOR ABOVE 50 VOLTS.

3. USE ONE RHEOSTAT, EXCEPT FOR 205 TO 260 VOLTS USE TWO IN SERIES. WHEN TWO ARE USED, ONE MAY BE IN BACK OF PANEL.

4. SWITCH CONTACTS TO THE EXPLORING COILS MUST MAKE BEFORE BREAK.

5. INDIVIDUAL L-1 AND L-2 LEADS MAY HAVE A MAXIMUM RESISTANCE OF 3 OHMS EACH.

6. ALL L-1 LEADS MUST BE WITHIN 0.02 OHM OF THE SAME RESISTANCE. ALL L-2 LEADS MUST BE WITHIN 0.02 OHM OF THE SAME RESISTANCE.

7. TO AVOID ADJUSTMENT OF THE RHEOSTAT BETWEEN GROUPS OF EXPLORING COILS, L-1 AND L-2 LEADS SHOULD BE WITHIN 0.4 OHM OF THE SAME RESISTANCE.

8. L-3 LEADS MUST NOT EXCEED 0.02 OHM EACH.

9. LEADS SHOWN IN DOT-DASH MUST NOT EXCEED 0.02 OHM EACH.

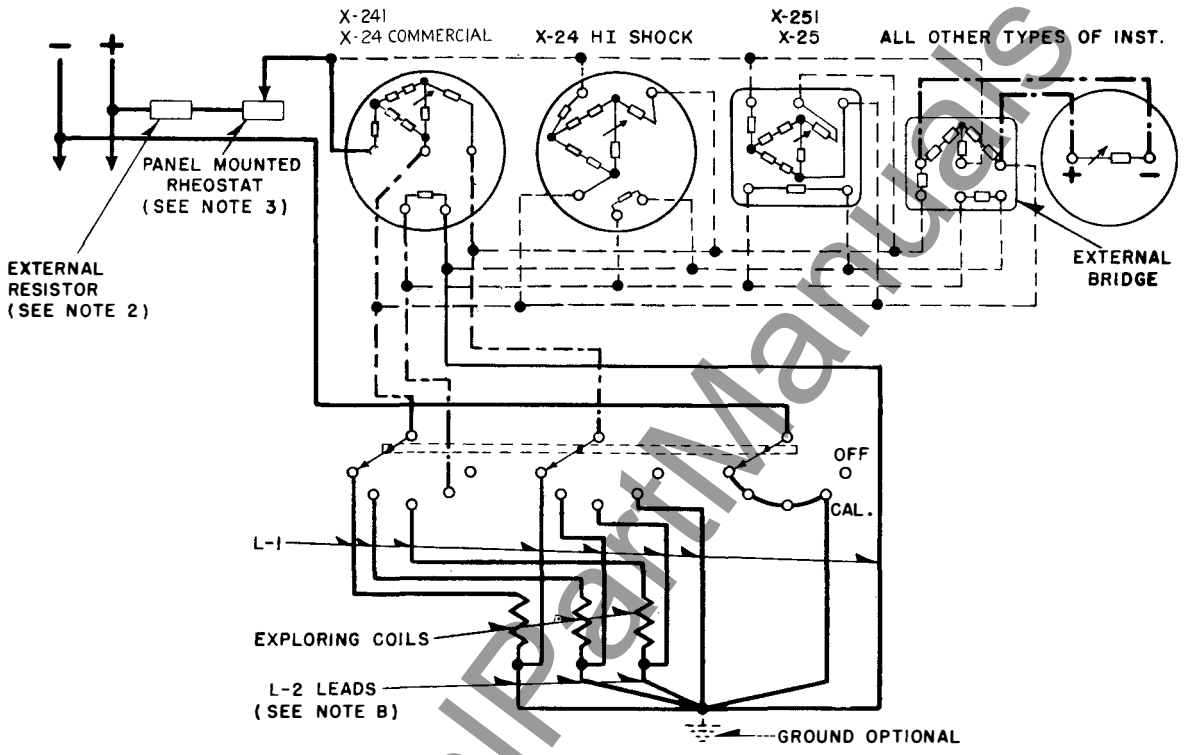
10. EACH RESISTANCE TOLERANCE OR LIMIT STATED WILL PREVENT ERRORS FROM THIS SOURCE OF GREATER THAN ONE PERCENT. ANY INCREASE WILL CAUSE AN AN APPROXIMATELY PROPORTIONAL ERROR.

Fig. 7—Exploring Coil Type Temperature Indicator.

Wired for Multiple Groups of Exploring Coils and With Single Lead Compensation, for Use Where the Exploring Coils of Each Group are Closely Spaced.

WIRING DIAGRAMS

REAR VIEW



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3. USE ONE RHEOSTAT, EXCEPT FOR 205 TO 260 VOLTS USE TWO IN SERIES. WHEN TWO ARE USED, ONE MAY BE IN BACK OF PANEL.

4. SWITCH CONTACTS TO EXPLORING COILS MUST MAKE BEFORE BREAK.

5. INDIVIDUAL L-1 LEADS MAY HAVE A MAXIMUM RESISTANCE OF 3 OHMS EACH.

6. ALL PAIRS OF L-1 LEADS MUST BE WITHIN 0.4 OHM OF THE SAME RESISTANCE.

7. THE RESISTANCE OF THE SEPARATE LEADS IN EACH PAIR OF L-1 LEADS MUST BE WITHIN 0.02 OHM OF EACH OTHER.

8. L-2 LEADS MUST NOT EXCEED 1 OHM EACH.

9. LEADS SHOWN IN DOT-DASH MUST NOT EXCEED 0.02 OHM EACH.

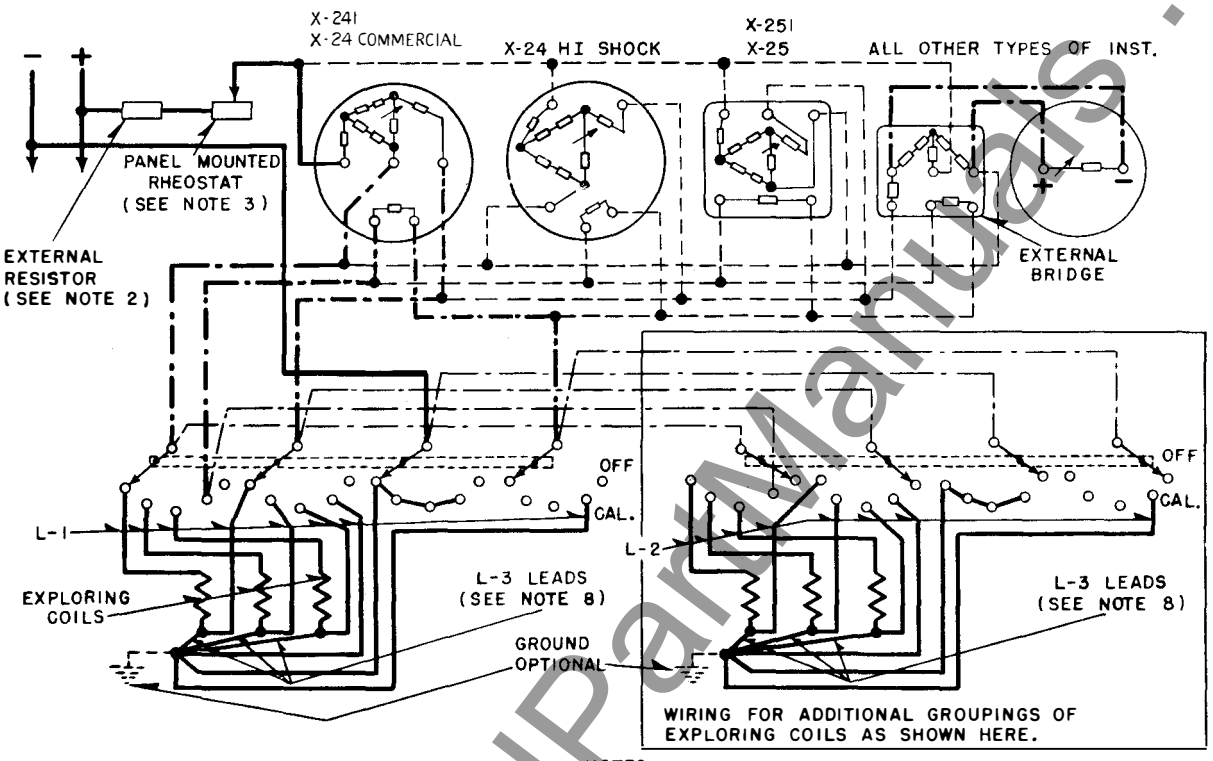
10. EACH RESISTANCE TOLERANCE OR LIMIT STATED WILL PREVENT ERRORS FROM THIS SOURCE OF GREATER THAN ONE PERCENT. ANY INCREASE WILL CAUSE AN APPROXIMATELY PROPORTIONAL ERROR.

Fig. 8—Exploring Coil Type Temperature Indicator.

Wired for a Single Group of Exploring Coils with Paired Lead Compensation to Permit Wide Separation of Exploring Coils in the Group.

WIRING DIAGRAMS

REAR VIEW



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4. SWITCH CONTACTS TO THE EXPLORING COILS MUST MAKE BEFORE BREAK.

5. INDIVIDUAL L-1 AND L-2 LEADS MAY HAVE A MAXIMUM RESISTANCE OF 3 OHMS EACH.

6. ALL PAIRS OF L-1 LEADS MUST BE WITHIN 0.4 OHM OF THE SAME RESISTANCE. ALL PAIRS OF L-2 LEADS MUST BE WITHIN 0.4 OHM OF THE SAME RESISTANCE.

7. THE RESISTANCE OF THE SEPARATE LEADS IN EACH PAIR OF L-1 AND L-2 LEADS MUST BE WITHIN 0.02 OHM OF EACH OTHER.

8. L-3 LEADS MUST NOT EXCEED 1 OHM EACH.

9. TO AVOID ADJUSTMENT OF THE RHEOSTAT BETWEEN GROUPS OF EXPLORING COILS, L-1 AND L-2 PAIRS OF LEADS SHOULD BE WITHIN 0.4 OHM OF THE SAME RESISTANCE.

10. LEADS SHOWN IN DOT-DASH MUST NOT EXCEED 0.02 OHM EACH.

11. EACH RESISTANCE TOLERANCE OR LIMIT STATED WILL PREVENT ERRORS FROM THIS SOURCE OF GREATER THAN ONE PERCENT. ANY INCREASE WILL CAUSE AN APPROXIMATELY PROPORTIONAL ERROR.

Fig. 9—Exploring Coil Type Temperature Indicator.

Wired for Multiple Groups of Exploring Coils and With Paired Lead Compensation to Permit Wide Separation of Exploring Coils in Each Group.

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