Publication No. 1001a
March 1, 1945

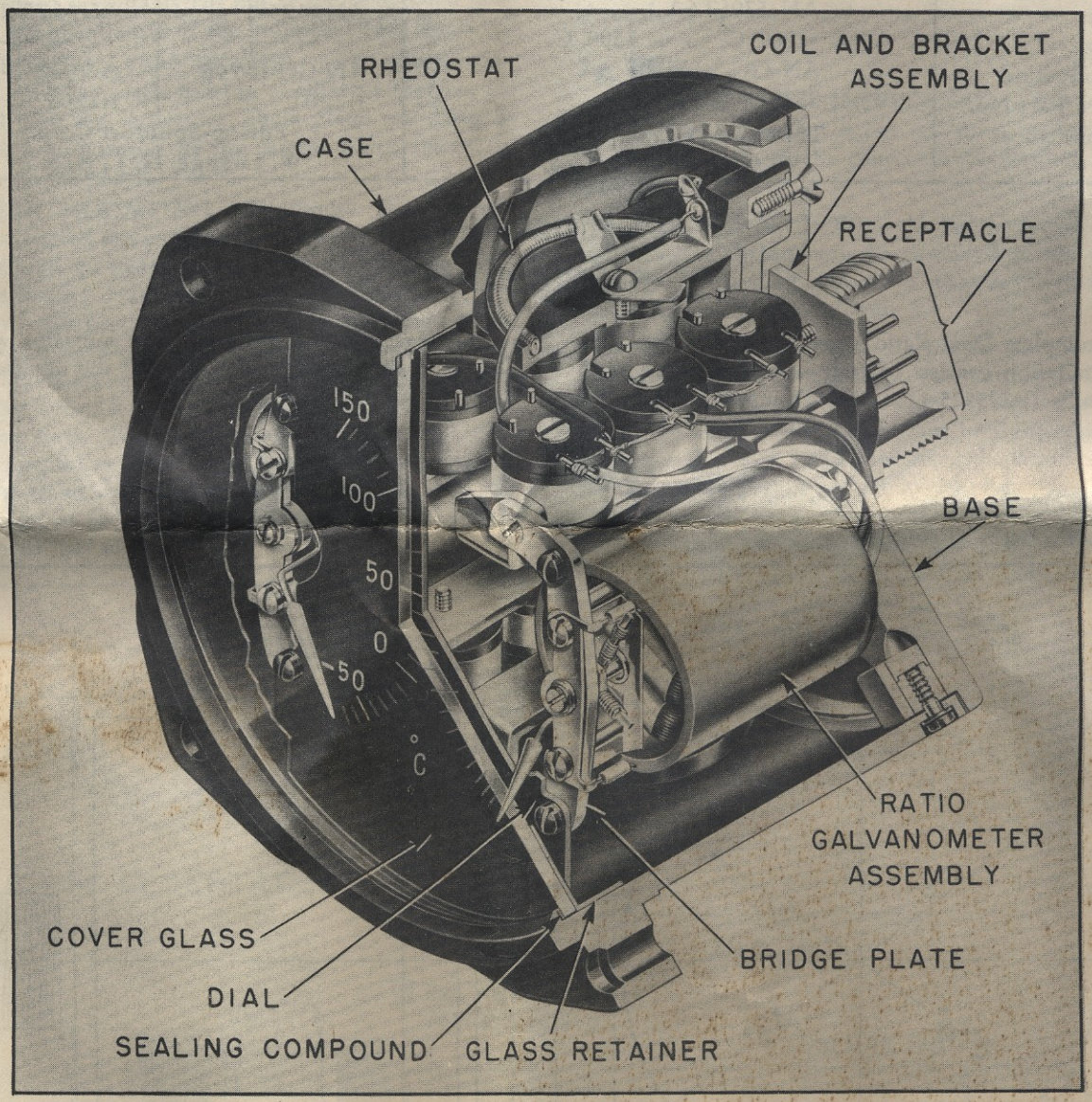
INSTALLATION INSTRUCTIONS

FOR THE

UNIVERSAL RATIO TYPE RESISTANCE THERMOMETER INDICATOR DUAL MODEL

AN PART No. AN 5795T6A

MANUFACTURER'S PART No. 33724



INSTRUMENT DIVISION

Thomas A Edison INC.

WEST ORANGE, NEW JERSEY, U. S. A.

REFER TO HANDBOOK AN 05-40B-9

SECTION I
INTRODUCTION

These Installation Instructions cover the following equipment:

	THERMOMETER INDICATOR, DUAL ELECTRICAL RATIO RESISTANCE TYPE	RESISTANCE BULBS	
		SHORT STEM	LONG STEM
Type	AN 5795T6A	AN5525-1	AN5525-2
Range	−70° C. to + 150° C.	———	———
Specification	AN-GG-I-522[redacted] A	AN-GG-B-796	AN-GG-B-796
Mfr's. Part No.	33724	B2201	B2202
Manufacturer	Thomas A. Edison, Inc., W. Orange, N. J., U. S. A.	Edison-Splitdorf Corp., W. Orange, N. J., U. S. A.	

SECTION II
DESCRIPTION

The complete Dual Ratio Type Resistance Thermometer installation consists of four main units: two resistance bulbs (AN5525-1 or 5525-2) installed where the temperature is to be measured; the indicator which is placed on the instrument panel; and the necessary connecting wiring.

SECTION III
INSTALLATION

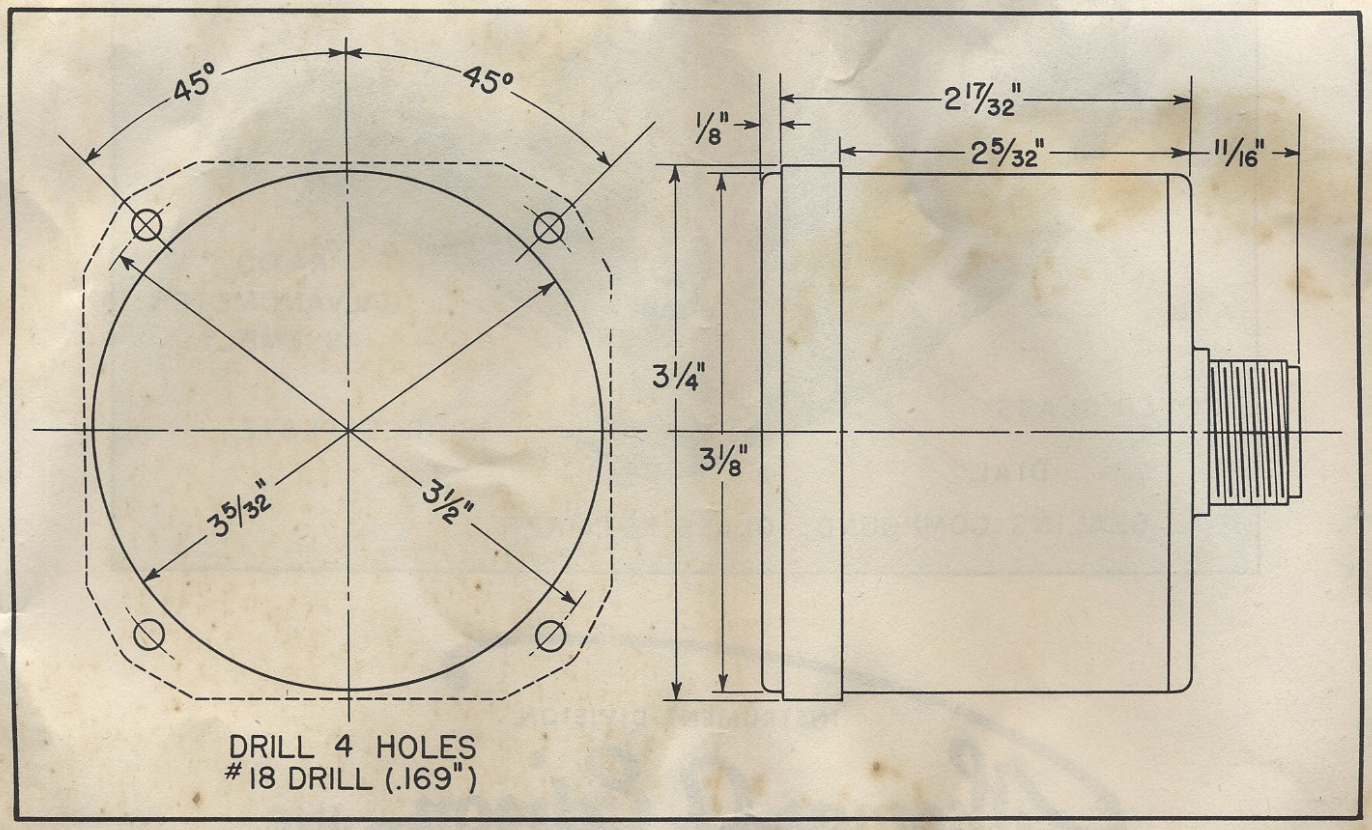


Figure 1—Mounting Dimensions for Indicator

1. INDICATOR.

a. PRELIMINARY INSPECTION.—After carefully unpacking the indicator, inspect it to make sure that neither the cover glass nor the bakelite case has been broken in shipment. When the indicator is gently rotated, the pointer should swing freely over the dial and return to a position off the low temperature end of the scale as the instrument comes to rest.

b. PANEL CUT-OUT.—The instrument panel of the airplane must be suitably cut out at the designated location for the installation of the indicator. (See figure 1.)

c. IDENTIFICATION PLATES.—Four identification plates (AN7515), each bearing a different caption, are supplied with the indicator. These plates are designed to be held in position by the screws which fasten the indicator to the panel.

d. REAR MOUNTING.—To mount the indicator from the rear of the panel, snap the four mounting nuts supplied with the instrument into the rear of the holes in the case flange. Place the indicator in position so that the round rim projects beyond the front surface of the panel, while the flange rests against its rear surface. Pass two of the case screws provided for the purpose through the upper holes in the panel and engage them in the mounting nuts. If an identification plate is to be installed, pass the two remaining mounting screws through the holes in its ends before inserting them through the lower holes in the panel thence into the mounting nuts. Tighten all four screws.

e. FRONT MOUNTING.—First attach the connector plug which is already connected to the airplane wiring, to the indicator if there is sufficient lead length to bring the cable through the hole in the panel. If there is not sufficient lead length, the connector plug will have to be attached to the indicator from the back of the panel. Next, pass the rear portion of the case through the panel cut-out described in paragraph *b*. With the rear surface of the flange resting against the panel, suitably secure the instrument in place, installing an identification plate, if required, by means of the two lower screws.

2. BULB.

a. PRELIMINARY INSPECTION. — Examine the bulb to make sure that it has not been bent or dented in shipment. Check the connector for broken, bent or loose pins.

b. MOUNTING HOLE.—A hole tapped with a 5/8-18 N.F.-3 thread must be provided in the specified location which must allow the necessary clearance for mounting the bulb. (See figure 2.)

c. MOUNTING.—Select the proper bulb and apply thread lube to its threads to prevent cutting or freezing. A copper-asbestos gasket (AN900-10) should always be used for sealing and the bulb must be tightened enough to prevent leakage. When inserting the connector plug, be sure to line up the groove in the plug with the guide pin in the receptacle. Reasonable care must be exercised in inserting or removing the plug to prevent twisting of

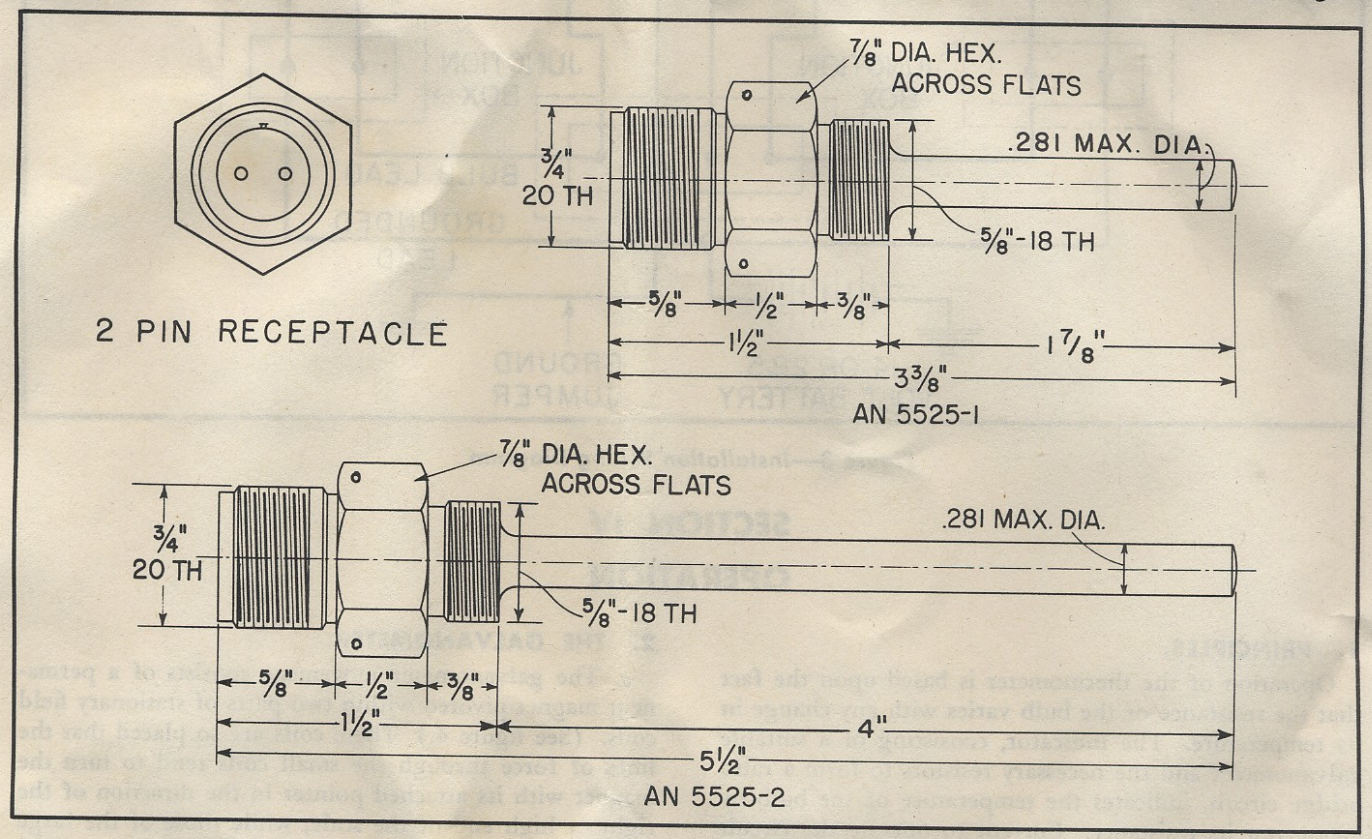


Figure 2—Bulb Mounting Dimensions

the bulb pins or contact terminals. *The inside element of the bulb may be damaged if an attempt is made to turn any portion of the plug other than the coupling nut.*

d. REMOVAL OF BULB.—When the bulb is removed, care must be exercised to avoid spilling oil, coolant or other liquids that may be contained in the section where the bulb is inserted.

3. WIRING.

a. Wiring should be done with low tension cable. Where connections are made at terminal blocks, they should be clean and tight to avoid excessive contact resistance. Be sure that correct voltage is connected to proper pin of the indicator. The indicator and bulbs should be connected as shown in figure 3.

b. To connect the cable to the bulb, use a two-conductor connector plug (AN 3106-12S-3S or AN 3108-12S-3S). The polarity is immaterial.

c. To connect the cable to the indicator, use a five-conductor connector plug (AN 3106-14S-5S or AN 3108-14S-5S). Either the "A" or the "D" pin is left unconnected, depending upon the voltage being used.

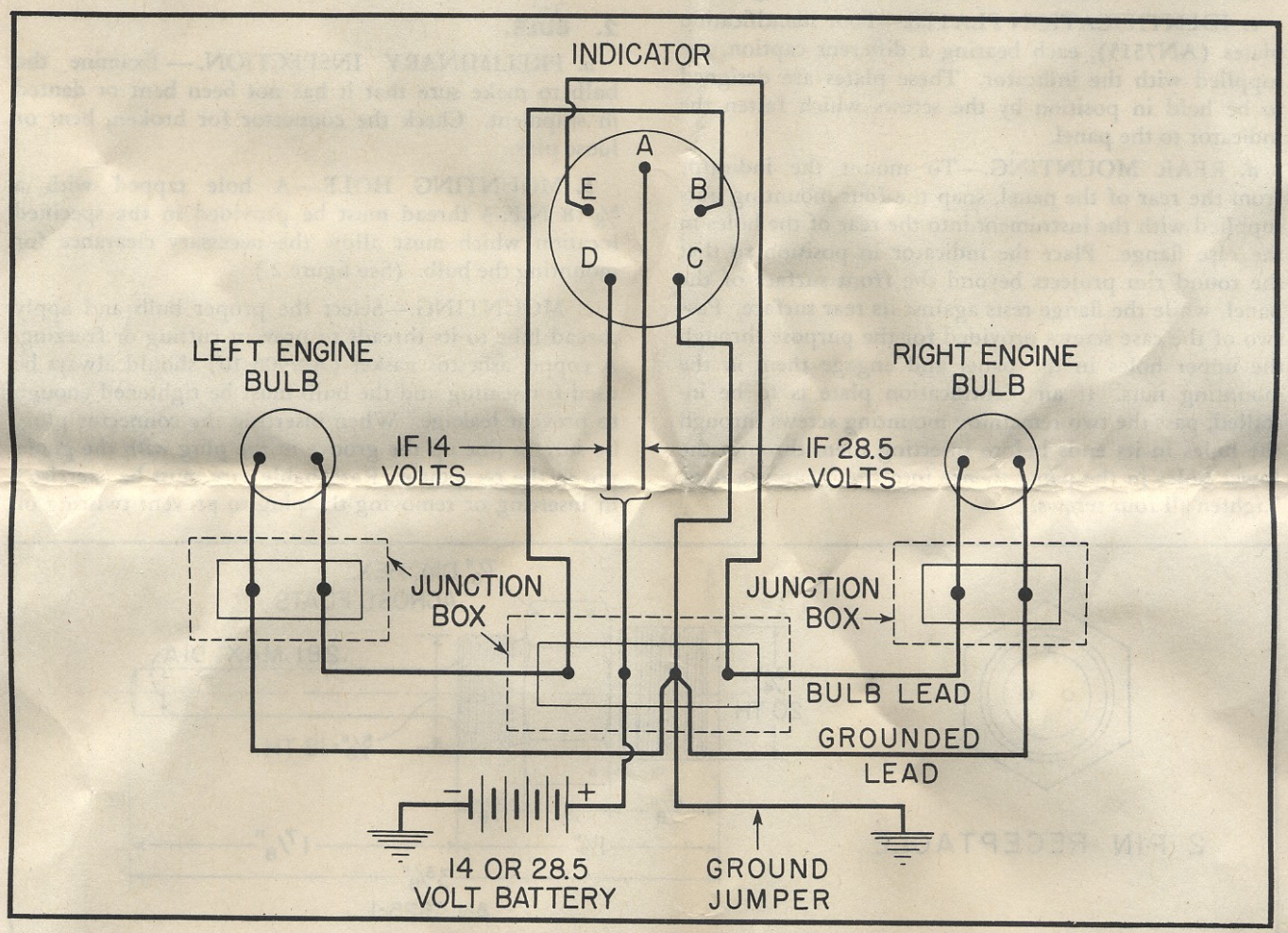


Figure 3—Installation Wiring Diagram

SECTION IV
OPERATION

1. PRINCIPLES.

Operation of the thermometer is based upon the fact that the resistance of the bulb varies with any change in its temperature. The indicator, consisting of a suitable galvanometer and the necessary resistors to form a ratio bridge circuit, indicates the temperature of the bulb by measuring its resistance. Current to operate the circuit is supplied by the electrical system of the airplane.

2. THE GALVANOMETER.

a. The galvanometer movement consists of a permanent magnet pivoted within two pairs of stationary field coils. (See figure 4.) These coils are so placed that the lines of force through the small coils tend to turn the magnet with its attached pointer in the direction of the right or high end of the scale, while those of the large coils tend to rotate it to the left or low end. These field

coils are supported by a copper housing within which the magnet vane rotates. The housing affects the movement of the magnet in such a way as to prevent excessive pointer oscillation. The entire galvanometer assembly is enclosed within a cylindrical magnetic shield or cup.

b. The design of the galvanometer movement is such that the pointer will swing off the low end of the scale if the voltage supply to the circuit fails. This is accomplished by a drift or pull-off magnet which is mounted on a bracket immediately above the field coils. The field of this tiny permanent magnet is just strong enough to cause the pointer to swing to the off-scale position when there is no current flowing through the field coils. Its position is pre-set to accomplish the secondary function of compensating for irregularities in the cup or shield which surrounds the movement assembly.

3. THE RATIO BRIDGE CIRCUIT.

a. Resistors "T", "V", "W" and "Y", constituting the fixed legs of the bridge circuit, are mounted on the main bracket of each movement, the resistance bulb in each case acting as the variable leg. (See figures 5 and 6.) Resistor "U", being connected between the terminals of the large and small field coils, determines the scale span of the galvanometer. Any change in the resistance of this portion of the circuit, such as may be caused by moving the arm on its end of the rheostat, will cause the pointer to move either toward or away from the center of the scale. On the other hand, a change in the value of the "T" resistor part of the circuit will cause the pointer to move farther toward either the high or low end of the scale. The "Z" resistor is placed in series with the small field coils to equalize their magnetic effect with

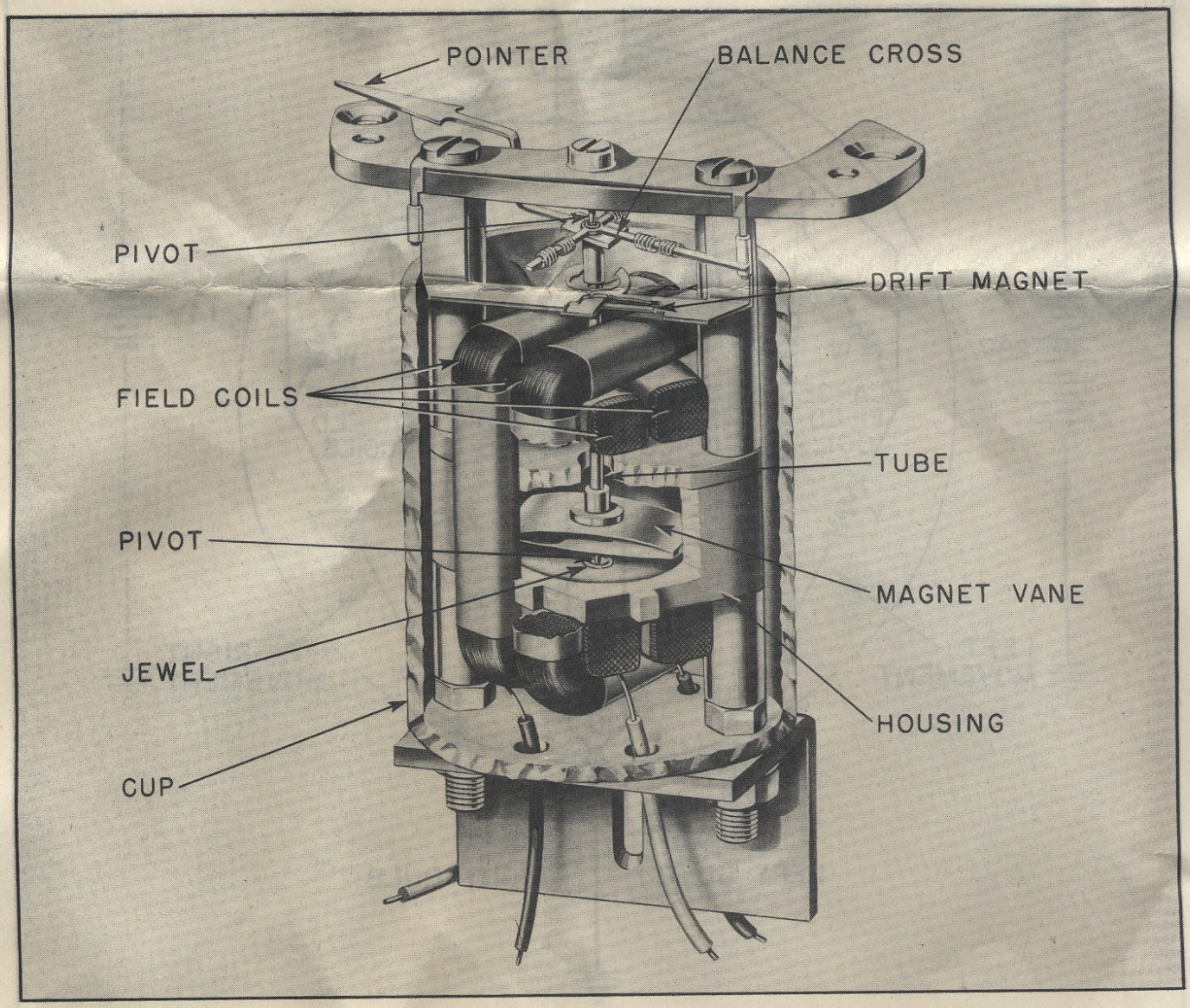


Figure 4—Cut-away View of Ratio Galvanometer Movement

that of the large field coils. Resistor "X" is a voltage dropping resistor used when 28 volts is applied, since the bridge circuit is designed to operate on 14 volts direct current.

b. When the bulb of the bridge circuit is at a temperature represented by the low end of the scale, the voltage at points P and R are the same, hence no current flows through the small field coils, while a maximum flows through the large ones. This causes the magnet vane to align itself with the axis of the large coils and the pointer indicates a temperature at the low end of the scale. Exactly the reverse condition exists when the bulb is at a temperature represented by the high end of the scale. For each intermediate temperature the magnet will assume a position depending upon the ratio of the currents in the large and small field coils. Variation in battery voltage will increase or decrease these coil currents, but will not affect their ratio. Thus the temperature indication is unaffected by normal fluctuations in battery voltage.

c. By the use of both manganin and copper wound resistors in various parts of the circuit the indicator is self-compensated to avoid incorrect readings due to changes in cabin temperature between −54°C. and +71°C. (−65⅕°F. and 159⅘°F.).

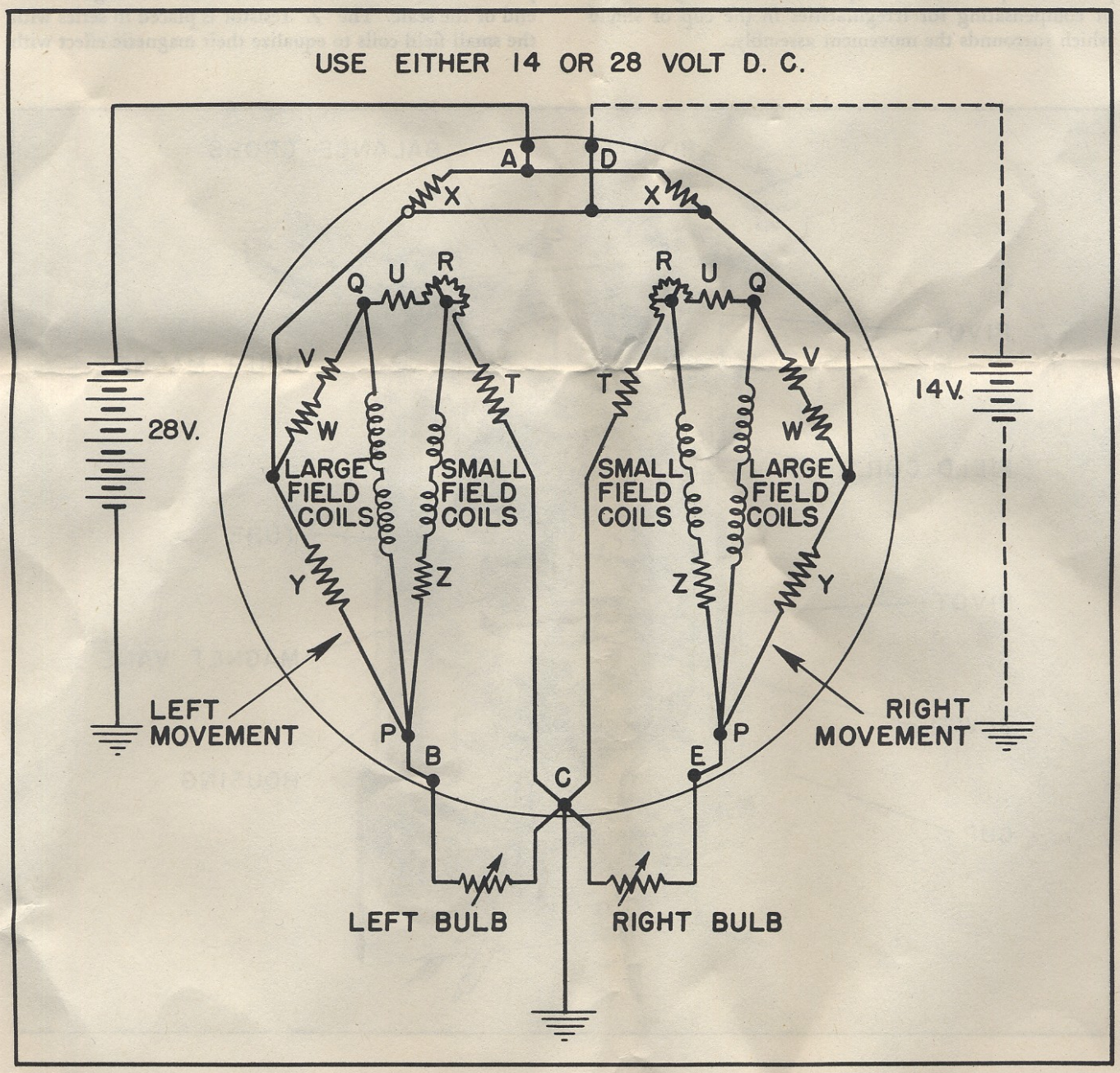


Figure 5—Schematic Wiring Diagram of Circuit

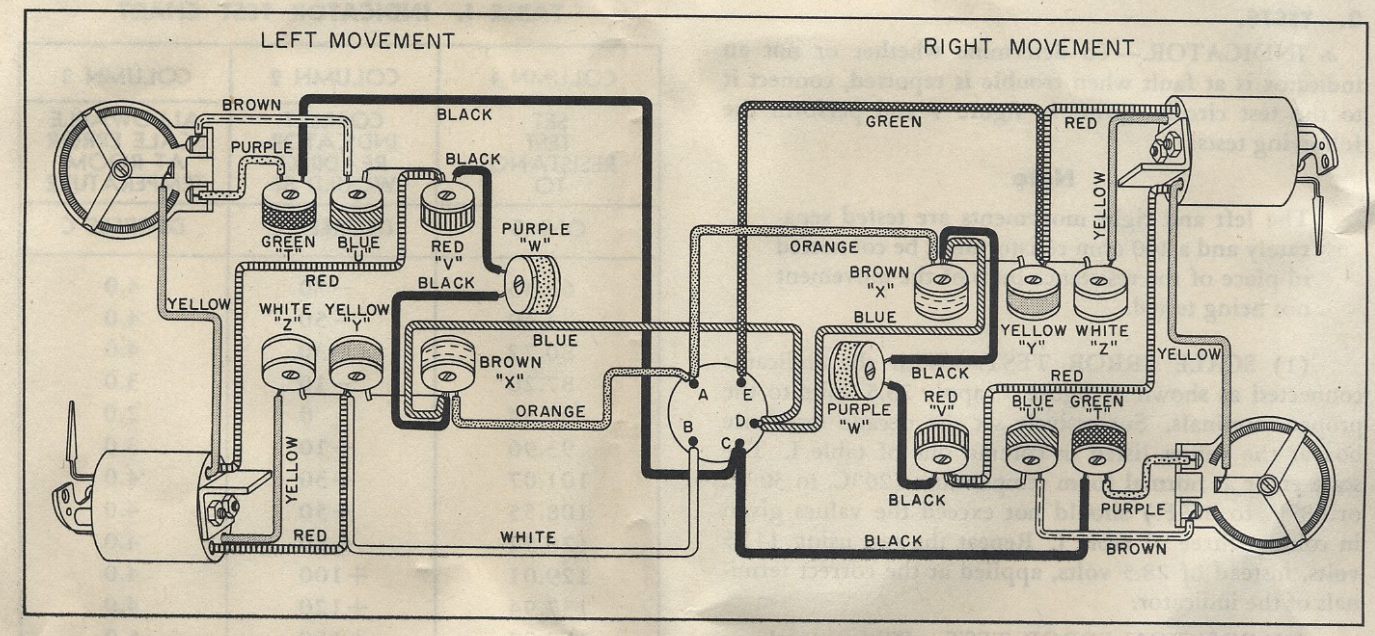


Figure 6—Pictorial Internal Wiring Diagram

SECTION V
INSTALLATION TROUBLES AND REMEDIES

1. DIAGNOSIS. The following troubles may be encountered in installations on aircraft. Check for causes in order listed. (See figure 3.)

TROUBLE	PROBABLE CAUSE	REMEDY
POINTER STAYS OFF LOW END OF SCALE	Panel switch open.	Turn switch to "ON".
	Defective panel switch.	Replace switch.
	Broken battery lead, ground jumper or grounded lead.	Repair or replace lead or jumper.
	Ground in bulb lead.	Repair or replace lead.
	Defective bulb.	Replace bulb.
	Defective indicator.	Replace indicator.
POINTER GOES OFF HIGH END OF SCALE	Broken grounded lead.	Repair or replace lead.
	Defective bulb.	Replace bulb.
	Defective indicator.	Replace indicator.
INDICATOR OPERATES INTERMITTENTLY	Defective panel switch.	Replace switch.
	Loose or broken battery lead or ground jumper.	Repair, replace or tighten lead or jumper.
	Defective bulb.	Replace bulb.
	Defective indicator.	Replace indicator.
EXCESSIVE POINTER OSCILLATION	Loose or broken lead or jumper.	Repair, replace or tighten lead or jumper.
	Defective bulb.	Replace bulb.
	Defective indicator.	Replace indicator.
OBVIOUSLY INCORRECT TEMPERATURE READING	Defective bulb.	Replace bulb.
	Defective indicator.	Replace indicator.
POINTER FAILS TO GO OFF SCALE WITH CURRENT OFF	Defective indicator.	Replace indicator.

2. TESTS.

a. INDICATOR.—To determine whether or not an indicator is at fault when trouble is reported, connect it to the test circuit shown in figure 7 and perform the following tests:

Note

The left and right movements are tested separately and a 100 ohm resistor must be connected in place of the resistance bulb of the movement not being tested.

(1) SCALE ERROR TEST.—With the indicator connected as shown in figure 7, apply 28.5 volts to the proper terminals. Successively set the decade resistance box at the values listed in column one of table I. The scale error at normal room temperature (20°C. to 30°C. or 68°F. to 86°F.) should not exceed the values given in column three of table I. Repeat the test using 14.25 volts, instead of 28.5 volts, applied at the correct terminals of the indicator.

(2) POSITION ERROR TEST.—With no voltage applied, the pointer should remain off scale at the low temperature end with the indicator in any position. The indicator should be lightly tapped during this test. With voltage applied, and the bulb resistance set at any desired value, the change in pointer indication produced by tipping the instrument from the normal operating position to a position 90° to the left or right, and also with the dial in the horizontal plane should be not more than 4°C. All readings should be taken while the indicator is being lightly tapped.

Apply voltage and resistance value so that the pointer is at some position on the scale, then disconnect the voltage and the pointer should return to the off scale position without tapping.

(3) FRICTION TEST.—Gradually vary the bulb circuit resistance until the pointer comes up to or down to any desired point on the scale. Note the reading, then tap the instrument lightly and again note the reading. The difference in reading before and after tapping shall be not more than 4°C.

b. BULB.—To test the bulb for partial or complete grounds, 100 volts direct current should be applied between the bulb housing and one of the terminals. The bulb should not have a leakage of less than 20 megohms at this voltage. If equipment for making the above test is not available, an ohmmeter may be used. For purposes of testing, the resistance between the bulb connector pins should be as shown in table II. Defective bulbs must be replaced as these bulbs are not designed to permit repairs.

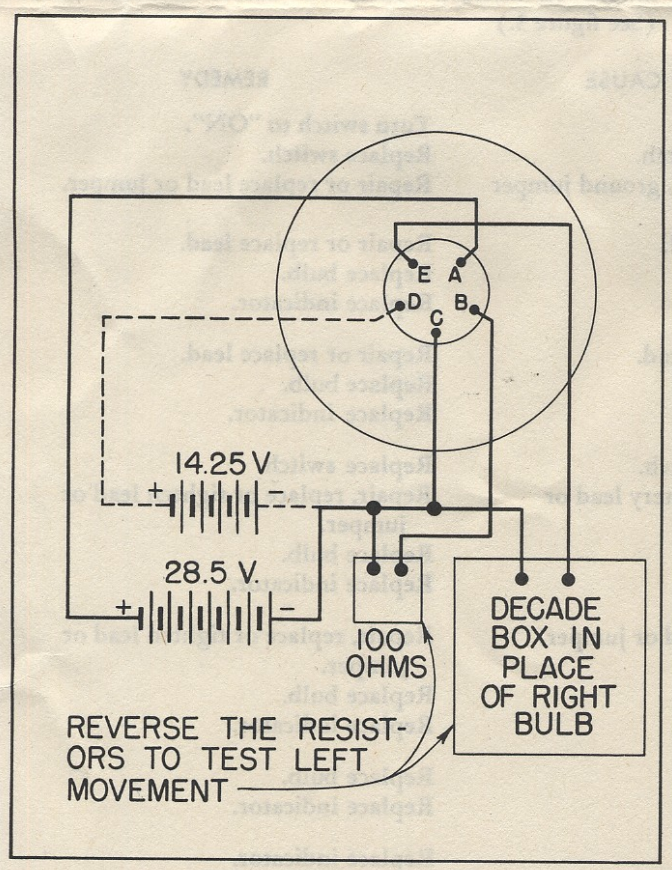


Figure 7—Indicator Test Circuit

TABLE I. INDICATOR TEST CHART

COLUMN 1	COLUMN 2	COLUMN 3
SET TEST RESISTANCE TO	CORRECT INDICATOR READING WOULD BE	ALLOWABLE SCALE ERROR AT ROOM TEMPERATURE
OHMS	DEGREES C	DEGREES C
68.43	−70	4.0
74.40	−50	4.0
80.72	−30	4.0
87.20	−10	3.0
90.54	0	2.0
93.96	+10	3.0
101.07	+30	4.0
108.55	+50	4.0
120.52	+80	4.0
129.01	+100	4.0
137.94	+120	4.0
152.07	+150	5.0

NOTE: The resistances listed in column 1 are the bulb resistance values plus .16 ohms for average lead resistance.

TABLE II. BULB TEST CHART

TEMPERATURE		BULB RESISTANCE	TOLERANCE
DEGREES C.	DEGREES F.	OHMS	±OHMS
0	32	90.38	0.30
20	68	97.31	0.30
30	86	100.91	0.30
100	212	128.85	0.40

SECTION VI

INDICATOR TROUBLES AND REMEDIES

1. DIAGNOSIS.
The following troubles may be encountered in indicators when tested as directed in section V, paragraph 2. Check for causes in order listed.

TROUBLE	PROBABLE CAUSE	REMEDY
POINTER STAYS OFF LOW END OF SCALE AT ALL TEST VALUES	Open green (T) resistor.	Replace resistor.
	Open brown (X) resistor.	Replace resistor.
	Open yellow (Y) resistor.	Replace resistor.
	Shorted purple (W) resistor.	Replace resistor.
	Open rheostat element.	Replace rheostat assembly.
	Open orange lead (28.5 volt).	Resolder or replace lead.
	Open blue lead (14.25 volt).	Resolder or replace lead.
	Open black lead.	Resolder or replace lead.
	Open purple lead.	Resolder or replace lead.
	Open jumper between yellow (Y) and brown (X) resistor.	Resolder or replace jumper.
POINTER STAYS OFF LOW END OF SCALE EXCEPT AT LOW TEST VALUES	Open white (Z) resistor.	Replace resistor.
	Open jumper between white (Z) and yellow (Y) resistor.	Resolder or replace jumper.
	Open small field coil.	Replace coil.
POINTER STAYS OFF LOW END OF SCALE UP TO MIDDLE TEST VALUES THEN GOES OFF HIGH END	Shorted blue (U) resistor.	Replace resistor.
POINTER GOES OFF HIGH END OF SCALE AT ALL TEST VALUES	Open red (V) resistor.	Replace resistor.
	Open purple (W) resistor.	Replace resistor.
	Shorted green (T) resistor.	Replace resistor.
	Shorted yellow (Y) resistor.	Replace resistor.
	Open green lead.	Resolder or replace lead.
	Open white lead.	Resolder or replace lead.
	Open lead between brown (X) and purple (W) resistors.	Resolder or replace lead.
	Open lead between red (V) and purple (W) resistors.	Resolder or replace lead.
POINTER GOES OFF HIGH END OF SCALE EXCEPT AT LOW TEST VALUES	Open large field coil.	Replace coil.
POINTER GOES TO APPROXIMATELY MID-SCALE POINT AT ALL TEST VALUES	Open blue (U) resistor.	Replace resistor.
	Open rheostat element.	Replace rheostat assembly.
	Open brown lead.	Resolder or replace lead.
	Open jumper between blue (U) and red (V) resistor.	Resolder or replace jumper.
ALL READINGS LOW	Shorted red (V) resistor.	Replace resistor.
	Open brown (X) resistor.	Replace resistor.
	Open orange lead.	Resolder or replace lead.
ALL READINGS HIGH	Shorted brown (X) resistor.	Replace resistor.
READINGS HIGH EXCEPT AT LOW TEST VALUE	Shorted white (Z) resistor.	Replace resistor.
EXCESSIVE POSITION ERROR	Rotor unbalanced.	Balance rotor.
	Defective rotor assembly.	Replace rotor assembly.
EXCESSIVE FRICTION	Dirty or defective upper jewel.	Clean or replace upper jewel screw.
	Dirty or defective lower jewel.	Clean or replace lower jewel screw.
	Worn or distorted pivots.	Replace pivots.
	Dirty pivots or housing.	Clean all parts.

2. TESTING AND REPAIRING.

Tests and repairs requiring the removal of the mechanism from the case of the indicator should be attempted only by experienced personnel in a place that is free from dust and dirt. In checking resistances, disconnect the unit being tested so that no other resistance will be in parallel with it. (See table III.) Field coils tested without disassembly of the galvanometer movement are connected in series as an assembly of two coils.

TABLE III. BRIDGE RESISTANCE DATA

RESISTOR OR COIL	RESISTANCE	TOLERANCE	WIRE		
	OHMS**	OHMS	APP. FT.	SIZE	MATERIAL
Green (T) Resistor	79	3.0	18	#32	Manganin
Blue (U) Resistor	25*	0.7	38	#38	Copper
Red (V) Resistor	85†	3.0	103	#39	Copper
Purple (W) Resistor	615	12.0	45	#37	Manganin
Brown (X) Resistor	430	10.0	31	#37	Manganin
Yellow (Y) Resistor	700	15.0	50	#37	Manganin
White (Z) Resistor	150 or less	5.0	120	#40	Copper
Large Field Coil, each—	140	15.0	——	——	——
(Assembly of two coils)	280	30.0	——	——	——
Small Field Coil, each—	120	15.0	——	——	——
(Assembly of two coils)	240	30.0	——	——	——
Rheostat Resistor Element	34 to 50	——	——	——	——

** Resistance of units checked while disconnected from circuit.
* At 25° C. 1/10 ohm per °C. † At 25° C. 1/3 ohm per °C.

SECTION VII
CALIBRATION

1. NORMAL CALIBRATION PROCEDURE.

Note

References to right and left rheostat arms apply to the top or left movement rheostat, hence on the bottom rheostat the opposite contact arm will be used for a given adjustment.

a. Connect the uncased indicator to the test circuit shown in figure 7, using 28.5 volts at the correct terminals, and set the decade resistance box to 108.55 ohms. Then balance the pointer.

b. Set the decade box to 90.54 ohms and adjust the right rheostat arm until the pointer is at 0°C.

c. Set the decade box to 137.94 ohms and adjust the left rheostat arm until the pointer is at 120°C.

d. Then set the decade box at all the resistances given in table I. It will be found that the instrument will be in approximate calibration. Use the right arm to vary the pointer position and left arm to increase or decrease the span of the scale.

CAUTION

Do not attempt to adjust calibration by changing the position of the drift magnet in any way.

2. WHITE (Z) RESISTOR CALIBRATION.

a. After any field coil has been changed it may be necessary to change the resistance value of the white (Z) resistor. To determine the necessary resistance, with the instrument still connected as for calibration, remove the white (Z) resistor and connect a second decade resistance box in its place.

b. Set the resistance of this second decade box to 90 ohms and proceed to adjust the rheostat arms as directed in paragraphs 1*b* and 1*c*.

c. Set the bulb decade box to 104.60 ohms, then increase or decrease the resistance of the white (Z) resistor decade box to a value necessary to cause the pointer to give a reading of approximately 40°C.

d. Again set the bulb decade box to 90.54 ohms and then to 137.94 ohms to be sure that the pointer still indicates 0°C. and 120°C. respectively. If necessary, readjust the rheostat arms and repeat the operation described in paragraph *c* until the necessary value is found on the white (Z) resistor decade box which gives the proper indication at these three test resistance values.

e. The resistance of the white (Z) resistor is not critical, a value within 5 ohms of that determined by the decade box being satisfactory.