DIRECTIONS

177124 *Issue* 5

8690 MILLIVOLT POTENTIOMETER

LEEDS & NORTHRUP

CONTENTS

Leeds and Northrup 8690 Millivolt Potentiometer.max

SPECIFICATIONS

RANGE	−11.0 mv to +101.0 mv
LIMITS OF ERROR	±(0.05% of reading + 20 μv) without ref. jct. comp. ±(0.05% of reading + 40 μv) with ref. jct. comp.
MEASURING DIALS	Millivolt dial, 9 x 10 millivolts and a minus (−) position. Slidewire, 0-11 millivolts, smallest division 0.02 millivolt.
REF. JCT. COMP. RANGE	0-5 millivolts (uncalibrated), adjustable to ±5 microvolts.
STD. CELL ADJ. RANGE	1.017 to 1.0200 volts (uncalibrated).

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8690
MILLIVOLT POTENTIOMETER

1. GENERAL INFORMATION

This instrument, shown in Fig. 1, is a single range, two-dial portable potentiometer. It is primarily used for general temperature measurements, by means of thermocouples, within the range of −11.0 to + 101.0 millivolts without reversing the input connections. It also can be used for checking thermocouple pyrometers, in laboratory and plant, and as a calibrated source of voltage (emf output). In addition, it can be used in conjunction with the L&N® 9912 Run Up Box to check millivolt meter type indicators or for the dynamic checking of low range Micromax® recorders or similar equipment.

The basic instrument consists of a millivolt selector switch, a slidewire, and a switch to select the function to be performed. Also included are a galvanometer, a standard cell, and a 1.5 volt battery.

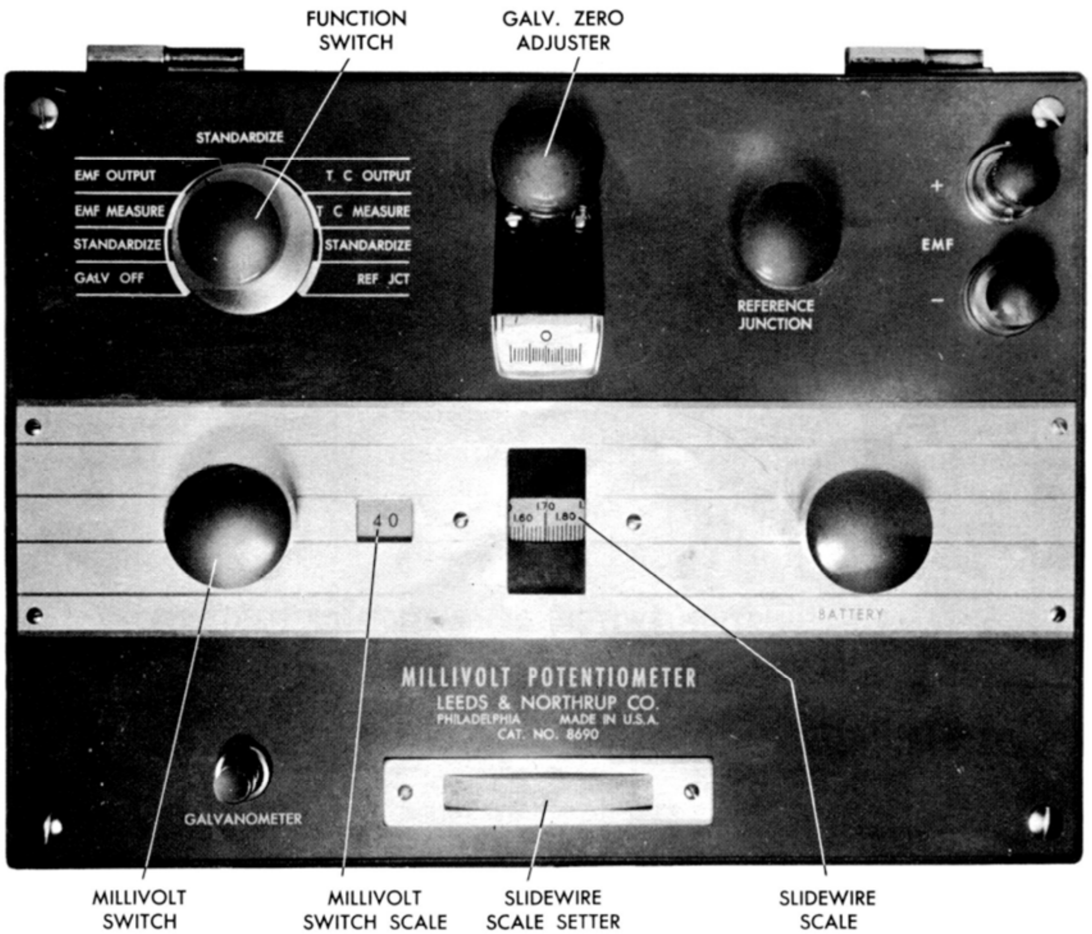

Fig. 1—Top view with lid removed.

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The millivolt value determined by the position of the selector switch appears at the window adjacent to the operating knob, while the value determined by the position of the slidewire appears at the center window. The sum of these two readings is the value of voltage set on the potentiometer. The 0 to −11 millivolts range is obtained by turning the millivolts selector switch to the minus (−) position. In this case, all measurements are made by adjusting only the slidewire and the values (negative) of voltage appear at the slidewire scale window.

2. DESCRIPTION OF COMPONENTS

2A. Function Switch

This switch is operated by the knob indicated in Fig. 1. The functions that can be performed for the various positions of the switch are shown in Table I.

This switch should be in the GALV OFF position, when storing or transporting the sintrument, to protect the galvanometer.

2B. BATTERY Rheostat

The BATTERY rheostat (3 turn) is used with the 1.5 volt battery, Fig. 2, to standardize the current in the potentiometer circuit.

2C. GALVANOMETER Key

The GALVANOMETER key is normally open so as to open the circuit to the galvanometer while making connections to the potentiometer and while making preliminary adjustments for a measurement. This prevents the galvanometer from receiving hard bumps which might be caused by a large unbalance in the potentiometer circuit while making preliminary adjustments.

This key must be closed to determine circuit balance. It is normally open and is closed when depressed. It will lock closed if it is turned in a clockwise direction as it is depressed.

2D. REFERENCE JUNCTION Compensator

This ten-turn slidewire is used to set the reference junction voltage to the value which corresponds to the temperature of the reference junction when using the instrument for measuring thermocouple voltages or when using it to supply similar calibrated voltages.

The reference junction is at the

TABLE I—FUNCTION SWITCH, DESCRIPTION OF POSITIONS

SWITCH POSITION	FUNCTION
GALV OFF	Galv. disconnected. No measurement can be made.
STANDARDIZE	Standardize potentiometer current
EMF MEASURE	Measure uncompensated voltage
EMF OUTPUT	Source of uncompensated voltage
TC MEASURE	Measure compensated thermocouple voltage
TC OUTPUT	Source of compensated voltage
REF JCT	REFERENCE JUNCTION compensator can be adjusted

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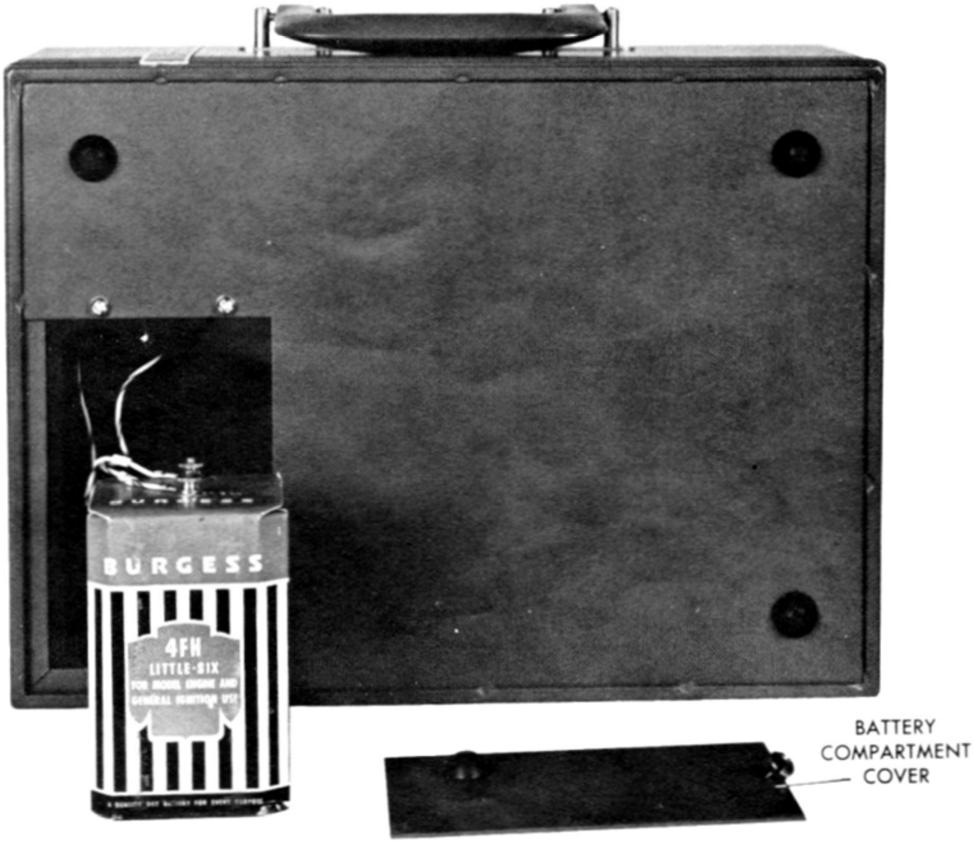

Fig. 2—Bottom view with cover removed to show battery.

EMF binding posts on the instrument when extension leadwires are used to connect the thermocouple to the instrument. However, the reference junction is at the thermocouple head when copper leadwires are used to connect the thermocouple to the instrument.

The required voltage can be obtained from conversion tables (temperature vs millivolts) for the type thermocouple being used. The temperature, in the tables, is that of the reference junction as measured by a mercury thermometer.

2E. Standard Cell Voltage Divider

This voltage divider, see Fig. 4, is used to compensate for any slight change in the voltage of the standard cell. Adjustment is outlined in Section 5E.

2F. Potentiometer Balancing Switch and Slidewire

This millivolt switch and slidewire (knurled wheel), Fig. 1, are used to obtain a circuit balance when measuring an unknown voltage or to set the value of the calibrated voltage when using the instrument as a voltage source.

Table II gives pertinent data on these components.

Each numbered division (step) on

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TABLE II—MILLIVOLTS SWITCH AND SLIDEWIRE, RANGES

	POSITIONS	SCALE MARKINGS	RANGE (Millivolts) *	RANGE (Millivolts) Δ
MILLIVOLT SWITCH	(11) 0 1-10	— 00-90	— ——	—— 0-90
SLIDEWIRE (Knurled Wheel)	2000 (approx.)	0-11	0-11	0-11
		TOTAL RANGE	(—) 11-0	0-101

*—This range used for negative voltages.
Δ—This range used for positive voltages.

the scale of the millivolts switch is equal to a change of 10 millivolts. Each numbered division on the scale of the slidewire is equal to a change of 0.1 millivolt. However, its scale is divided so that the smallest division is equal to 0.02 millivolt.

The setting of the millivolt switch appears at the window adjacent to the operating knob of this switch while the setting of the slidewire appears at the center window.

2G. Galvanometer

The galvanometer is a complete pointer type unit with the following nominal characteristics.

Sensitivity . . . . ±0.6 μa/mm (±75 μv/mm)

Coil Resistance . . . . . . 25 ohms

CDRX . . . . 100 ohms

Period . . . . 3 seconds

2H. Standard Cell

The standard cell is mounted on a bracket as shown in Fig. 4. It is an unsaturated cell and should be used

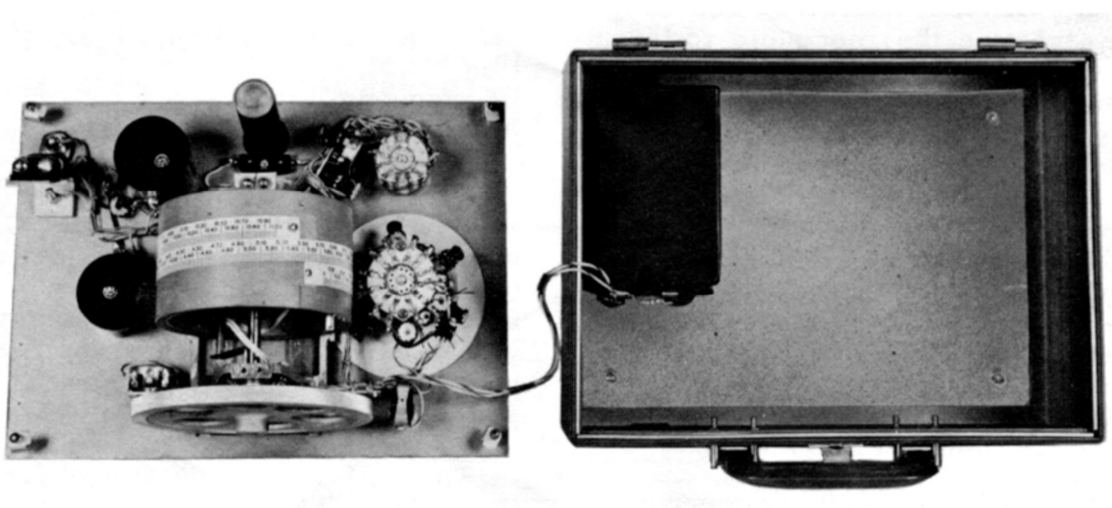

Fig. 3—View showing under side of instrument panel and inside of case.

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where the ambient temperature remains between 0C and 50C (32 F and 122 F).

The useful life of the cell, with periodic calibration, should be approximately five to seven years.

2I. Battery

A single 1.5 volt battery is used to furnish current to the potentiometer circuit and is mounted in a compartment in the bottom of the instrument case as shown in Fig. 2. The battery is made available by removing the screw from the edge of the cover plate and removing this cover as in Fig. 2.

2J. Trimmer

The trimmer, Fig. 3, is a locking type potentiometer which is used to calibrate the measuring slidewire. It has been factory set and requires no further adjustment.

3. PRINCIPLE OF OPERATION

This instrument is a double branch potentiometer. The complete wiring diagram is shown in Fig. 5.

One branch consists of the millivolt switch and measuring slidewire. The millivolt switch is a 10 step switch having 10 millivolts per step. Starting at zero step, its maximum range is therefore 90 millivolts. The measuring slidewire, having a range of 0 to 11 millivolts, is coupled to the switch in a Kelvin-Varley arrangement. In the minus millivolt switch position, the measuring slidewire is in reverse polarity to what it is in the other positions. Total millivolt range of the instrument is therefore −11 to 0 to + 101 mv.

The other branch includes the voltage divider and reference junction compensator. The reference junction compensator is connected in the circuit so that its emf can be set to the emf corresponding to the temperature at the reference junction. The compensator is a manually operated rheostat which is set as instructed in Section 4F.

The two branches are arranged so that they are of equal resistance and the circuit is designed for a 4 milliampere drain on the batteries. Since the branch resistances are equal, the current in each branch is 2 milliamperes.

4. OPERATING INSTRUCTIONS

CAUTION: Always turn function switch to GALV OFF position when not using instrument.

4A. Check Battery

The battery should require no attention until it needs to be replaced. See Section 5C for battery current adjustment and/or battery replacement.

4B. Check Standard Cell

This cell should require no attention, except for periodic calibration, until a check shows that it must be replaced. See Section 5E for standard cell voltage adjustment and/or standard cell replacement.

4C. Check Mechanical Zero of Galvanometer

The mechanical zero of the galvanometer should be checked and, if necessary, adjusted as follows:

See that the GALVANOMETER key is open (in the up position).

Turn the function switch to one of

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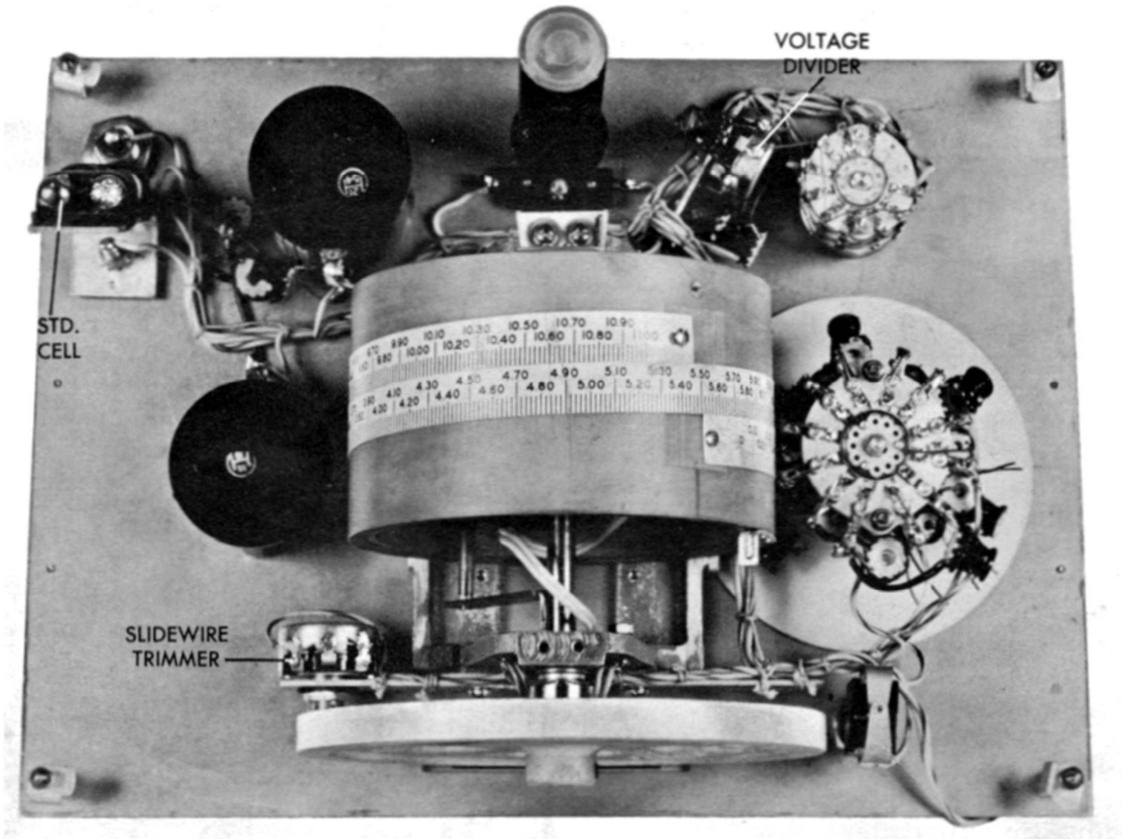

Fig. 4—Detailed view of underside of instrument panel.

the STANDARDIZE positions and observe the balance point of the galvanometer. If it does not balance at zero, turn the zero adjuster, Fig. 1, until this balance is obtained.

4D. Make Voltage Connections

If a voltage source is to be measured, connect it to the EMF terminals.

If the potentiometer is to be used as a source of calibrated voltage, connect the device to be supplied by this voltage to the EMF terminals.

4E. Standardize Potentiometer Circuit Current

Turn the function switch to one of the STANDARDIZE positions.

Depress the GALVANOMETER key and note the galvanometer pointer for any deflection. If the pointer does not balance at zero, adjust the BATTERY rheostat until the pointer remains at zero when the GALVANOMETER key is depressed or released.

4F. Adjust Reference Junction Compensator

This adjustment is necessary only under two conditions: (1) when measuring the voltages of a thermocouple when the reference junction temperature is other than 32 F (0 C), (2) when using the instrument to supply a similar voltage when the reference junction temperature is other than 32 F (0 C).

If, for either of the two conditions

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mentioned above, the reference junction temperature is exactly 32 F (0 C), as would be the case when using an ice bath, the reference junction compensator in the 8690 Potentiometer should be switched out of the circuit to obtain maximum accuracy. This is accomplished by placing the function switch in either the EMF MEASURE or EMF OUTPUT position and making an uncompensated measurement as indicated in Section 4G or 4H.

When using the reference junction compensator in the 8690 Potentiometer, adjust it as follows:

—Determine the temperature at the reference junction with a mercury thermometer or equivalent. Since any final temperature measurement, involving a thermocouple and potentiometer, is basically a difference measurement (i.e., the difference between the measured temperature and the reference junction temperature), the reference junction temperature must be determined to an accuracy in keeping with the desired accuracy of the final temperature measurement.

—Refer to Conversion Tables (temperature vs millivolts), for the type thermocouple being used, and obtain the millivolt value corresponding to the reference junction temperature.

—Set the millivolt switch at 00 and turn the knurled wheel so that the reading at the slidewire window equals the millivolt value corresponding to the reference junction temperature.

For example:

Thermocouple is iron-constantan

Reference junction temperature is 80 F

Millivolts at 80F = 1.36 (from Conversion Tables for iron-constantan thermocouples)

—Set the millivolt switch at 00 and turn the knurled wheel so that the reading at the slidewire window equals 1.36 millivolts.

—Turn the function switch to the REF JCT position.

—Depress the GALVANOMETER key and adjust the REFERENCE JUNCTION compensator until a galvanometer balance is obtained.

—Turn the function switch to either TC MEASURE or TC OUTPUT, as required.

4G. Measure Voltage

(1) Preliminary Adjustments

Be sure that all preliminary

TABLE III—MEASURE VOLTAGE, BASIC STEPS

TYPE OF VOLTAGE MEASUREMENT	RANGE (Millivolts)	POSITION OF FUNCTION SWITCH	ADJUST REF. JCT. COMP.	MAKE READING PER
UNCOMPENSATED	0-101	EMF MEASURE	No	Section 4G(2)
UNCOMPENSATED	(—) 11-0	EMF MEASURE	No	*Section 4G(2)
TC COMPENSATED	0-101	TC MEASURE	Yes	Section 4G(2)
TC COMPENSATED	(—) 11-0	TC MEASURE	Yes	*Section 4G(2)

*Except, turn the millivolts switch to the minus (—) position and use only the slidewire (knurled wheel) to obtain a balance.

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checks and adjustments have been made. Then, use Table III and operate the various components indicated for the voltage range which covers the voltage to be measured.

(2) Make a Reading

—Turn the millivolt switch to 00 and the slidewire to 0 on their respective scales.

—Depress the GALVANOMETER key and note the direction of deflection of the galvanometer pointer.

—Turn the millivolt switch clockwise, one position at a time, depressing the GALVANOMETER key momentarily at each position, until the direction of deflection of the galvanometer reverses.

—Turn the millivolt switch back one position.

—Rotate the knurled wheel slowly to the left, to adjust the slidewire, using the GALVANOMETER key to check for a galvanometer deflection, until the galvanometer balances at zero.

—Read the values at both windows. The sum of these two readings is the value of millivolts being measured. This may be either a positive or a negative value, depending upon the position of the millivolt switch.

4H. Supply Standard Voltage

(1) Preliminary Adjustments

CAUTION: This instrument can be used as a voltage source but is not designed to supply current. Therefore, it should be used only in null circuits. The internal resistance at the EMF terminals varies between 50 and 135 ohms depending on settings.

Be sure that all preliminary checks and adjustments have been made.

Close the GALVANOMETER key and lock it in this position to complete the circuit.

Use Table IV and operate the various components indicated for the voltage range which covers the voltage to be supplied.

(2) Obtain Voltage

Rotate the millivolt switch and the slidewire (knurled wheel) until the sum of the setting equals the desired voltage.

TABLE IV—SUPPLY VOLTAGE, BASIC STEPS

TYPE OF VOLTAGE TO BE SUPPLIED	RANGE (Millivolts)	POSITION OF FUNCTION SWITCH	ADJUST REF. JCT. COMP.	OBTAIN VOLTAGE PER
UNCOMPENSATED	0-101	EMF OUTPUT	No	Section 4H(2)
UNCOMPENSATED	(—) 11-0	EMF OUTPUT	No	*Section 4H(2)
TC COMPENSATED	0-101	TC OUTPUT	Yes	Section 4H(2)
TC COMPENSATED	(—) 11-0	TC OUTPUT	Yes	*Section 4H(2)

*Except, turn the millivolts switch to the minus (—) position and use only the slidewire (knurled wheel) to obtain a balance.

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5. MAINTENANCE

5A. Instrument Panel-Remove

Turn each mounting screw (one in each corner of the panel) two complete turns counterclockwise to release the clamping nut from the ledge inside the case. The mounting screws remain in place on the panel. Lift the panel from the case.

5B. Instrument Panel-Replace

Turn the clamping nut, on each mounting screw, so that it will clear the ledge inside the case when the panel is fitted into place on the case. After the panel is positioned on the case, turn each mounting screw counterclockwise until a click is heard and then turn each screw clockwise until it is tight.

5C. Battery

When the BATTERY rheostat reaches the limit of its adjustment because of a depleted battery, the 1.5 volt battery, Fig. 2, should be replaced.

To replace this battery, remove the screw, Fig. 2 and lift the cover off the compartment.

5D. Galvanometer

To replace the complete galvanometer unit, remove the two screws from the top of the galvanometer housing and lift the unit from the instrument panel.

5E. Standard Cell

(1) Replace

This cell should give satisfactory service for several years. However, if it is ever necessary to replace it, remove the instrument panel from the case, and note the connections to the cell. Then disconnect and remove it from the panel.

(2) Adjust for Standard Cell Voltage

The limit of error (accuracy) of the potentiometer includes the accuracy of the standard cell. Thus, a change in voltage of this cell will affect the accuracy of the readings. Therefore, it is recommended that the voltage of the standard cell be checked approximately once a year, using the following procedure:

—Apply 100 millivolts (±0.02%), from a precision potentiometer, to the EMF terminals of the instrument.

—Set the millivolt switch and the knurled wheel to obtain the value of the voltage, connected in the preceding paragraph, at the windows.

—Turn the function switch to EMF MEASURE.

—Adjust the BATTERY rheostat, depressing the GALVANOMETER key at intervals, to obtain a galvanometer balance.

—Turn the function switch to one of the STANDARDIZE positions.

—Lock the GALVANOMETER key closed. If the galvanometer balances at zero, no adjustment of the voltage divider is necessary.

—If the galvanometer does not balance at zero, remove the instrument panel from the case to make the voltage divider available. Stand the panel on the lower edge, as viewed in Fig. 3, with the face of the panel

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approximately vertical. Loosen the locknut on the slotted end of the shaft of the voltage divider. Insert a screwdriver in the slot and adjust the voltage divider until a galvanometer balance is obtained. Then tighten the locknut.

—Release the GALVANOMETER key and replace the panel in the case.

5F. Cleaning

(1) Measuring Circuit Slidewire

This slidewire may require occasional cleaning, over extended periods of time, depending upon the conditions under which the instrument is used. Remove the instrument panel from the case. Rub a clean cloth, moistened with Cramolin (L&N Part No. 090019, 2 oz. bottle of the solution), over the contact surface of the slidewire. Allow the Cramolin to remain for at least 30 seconds and then remove any excess with a clean section of cloth. Do not apply any lubricant to the slidewire and never use an abrasive material on it as this would destroy the uniformity of the slidewire.

(2) General

The finish on this instrument is a paint which has greater resistance to chipping and scratching than a baked enamel finish. If necessary, the top panel may be cleaned with a soft cloth dampened with a solution of water and a small amount of mild detergent.

Static charges on the galvanometer window may cause sporadic needle deflections. Hence it is suggested that an anti-static coating on the outside of the galvanometer window be prepared as follows:

—Dilute a small amount of "Joy" liquid soap approximately 50% by volume with tap water.

—Pour the solution over the window and allow it to drip dry.

—Lightly polish the window to remove any haze after the soap solution has dried.

The insulators of the EMF terminals are a plastic which is affected by some chemical solvents. Therefore, chemical solvents should not be used.

REPLACEMENT PARTS

Description	L&N Part No.
Battery, 1.5 volt (Burgess, 4FH, Little Six)	Std. 2233-1
Binding Post Head	002199
Feet	41-2-11-2
Galvanometer, complete unit	062112
Handle	046055
Key, GALVANOMETER	PI-123-L
Latch	71-1-0-1
Screw Assembly, panel mounting	------
Screw	4-4-1-24
Spring, upper	28-1-3-10
Spring, lower	28-1-3-9
Clamp nut	72-4-1-1
Retaining Ring	27-3-3-12
Standard Cell	130007
Window, lucite strip	066126

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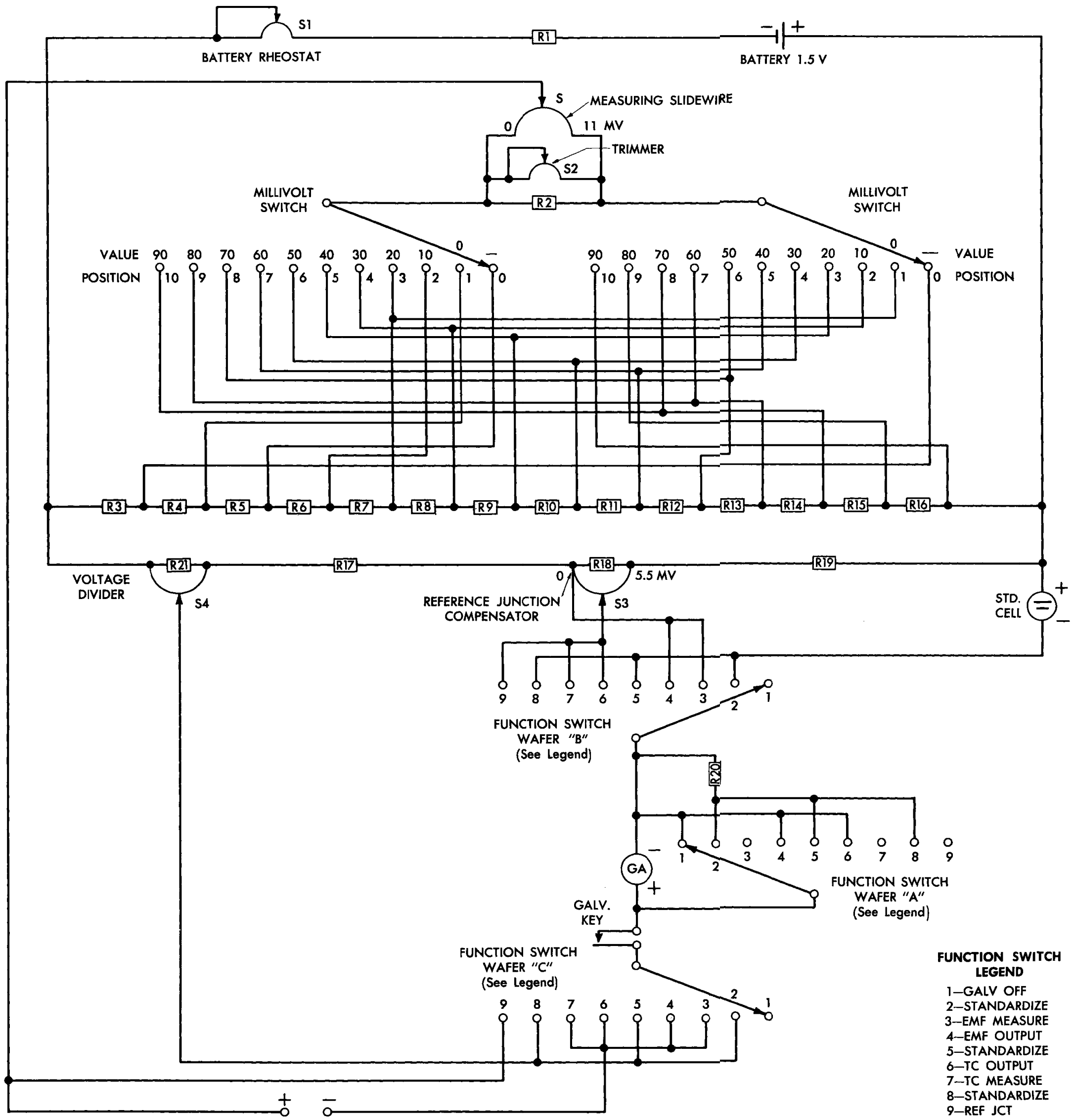


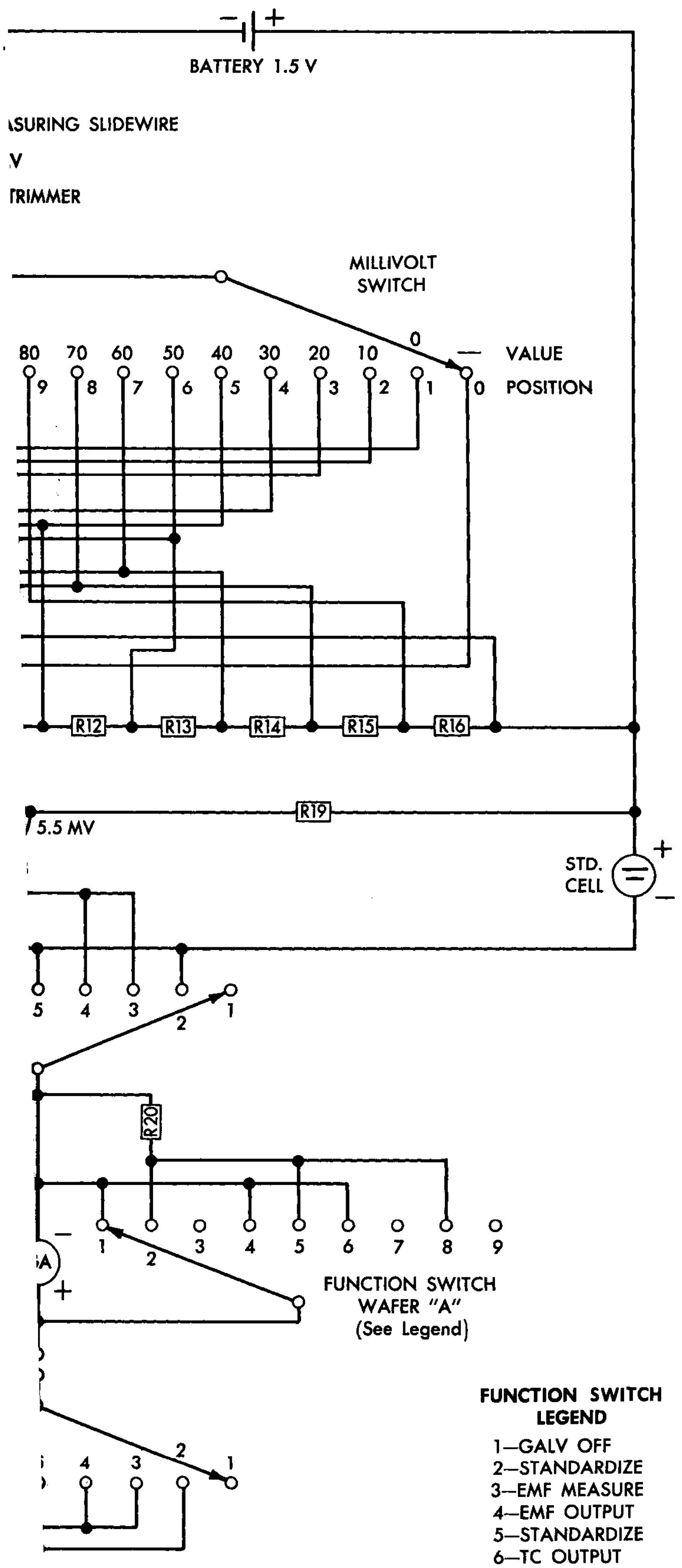
RESISTORS

Symbol	Value	Symbol	Value
R1	20.0 Ω	R12	5.000Ω
R2	14.651Ω	R13	
R3	454.640Ω	R14	
R4	5.500Ω	R15	
R5	4.500Ω	R16	5.000Ω
R6	0.500Ω	R17	458.195Ω
R7	5.000Ω	R18	2.828Ω
R8		R19	47.75 Ω
R9		R20	120.0 Ω
R10		R21	1.500Ω
R11	5.000Ω		

MISCELLANEOUS

Symbol	Value	Description	L&N Part No.
S	—	Measuring slidewire	012384
S1	140Ω	BATTERY rheostat	013204
S2	4000Ω	Trimmer potentiometer	013203
S3	100Ω	REFERENCE JUNCTION rheostat	013202
S4	4000Ω	SC calibration voltage divider	013203

Fig. 5—Schematic wiring diagram.



FUNCTION SWITCH LEGEND

1—GALV OFF
2—STANDARDIZE
3—EMF MEASURE
4—EMF OUTPUT
5—STANDARDIZE
6—TC OUTPUT
7—TC MEASURE
8—STANDARDIZE
9—REF JCT

RESISTORS

Symbol	Value	Symbol	Value
R1	20.0 Ω	R12	5.000Ω
R2	14.651Ω	R13	↓
R3	454.640Ω	R14	↓
R4	5.500Ω	R15	↓
R5	4.500Ω	R16	5.000Ω
R6	0.500Ω	R17	458.195Ω
R7	5.000Ω	R18	2.828Ω
R8	↓	R19	47.75 Ω
R9	↓	R20	120.0 Ω
R10	↓	R21	1.500Ω
R11	5.000Ω		

MISCELLANEOUS

Symbol	Value	Description	L&N Part No.
S	—	Measuring slidewire	012384
S1	140Ω	BATTERY rheostat	013204
S2	4000Ω	Trimmer potentiometer	013203
S3	100Ω	REFERENCE JUNCTION rheostat	013202
S4	4000Ω	SC calibration voltage divider	013203

Fig. 5—Schematic wiring diagram.

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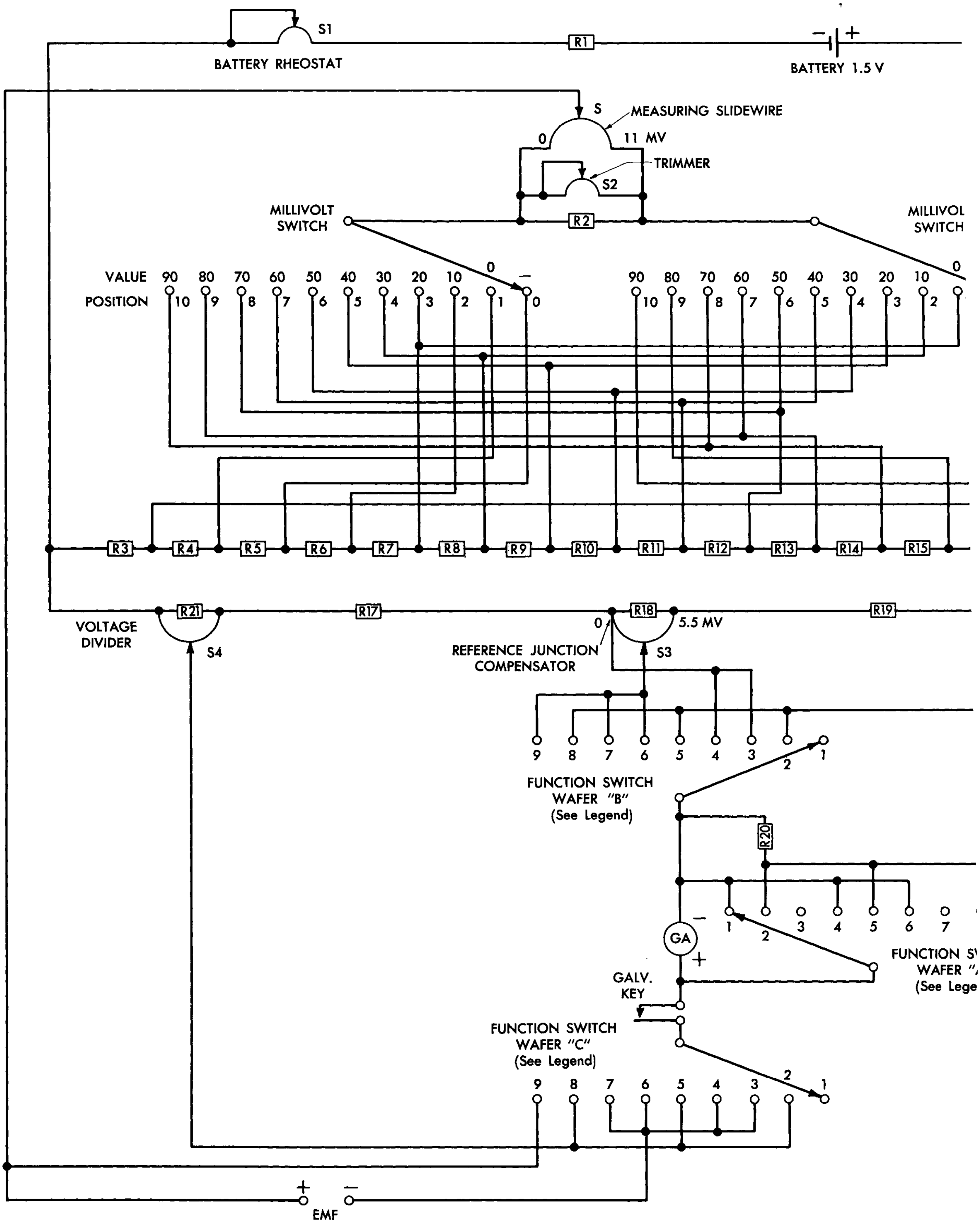

Fig. 5—Schematic wiring diagram.

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INSERT FOR DIRECTIONS 177124, 177125, AND 177165

MILLIVOLT POTENTIOMETERS 8690, 8686, AND 8696

In order to measure temperature with a thermocouple and a millivolt potentiometer, the temperature of the reference junction must be known and held reasonably constant. Under normal conditions the reference junction temperature is the ambient temperature at the junction of the thermocouple wire and the copper wire leading to the potentiometer (or the ambient temperature at the binding posts of the potentiometer). This temperature is relatively constant and short-term fluctuations can be ignored. However, where the effects of these fluctuations become significant, such as in an air conditioned room, or where the highest degree of accuracy is required, one of the following methods can be used to maintain a relatively constant reference junction temperature, independent of ambient temperature fluctuations.

A. Ice Bath Method

The ice bath maintains the reference junction temperature at 32 F (0 C) in the circuit of Fig. A. Note that the reference junctions are now at the junction of the copper and the thermocouple extension wires, instead of at the EMF binding posts. Since the conversion tables are based upon a reference junction temperature of 32 F (0 C), the REFERENCE JUNCTION compensator is not required in this method.

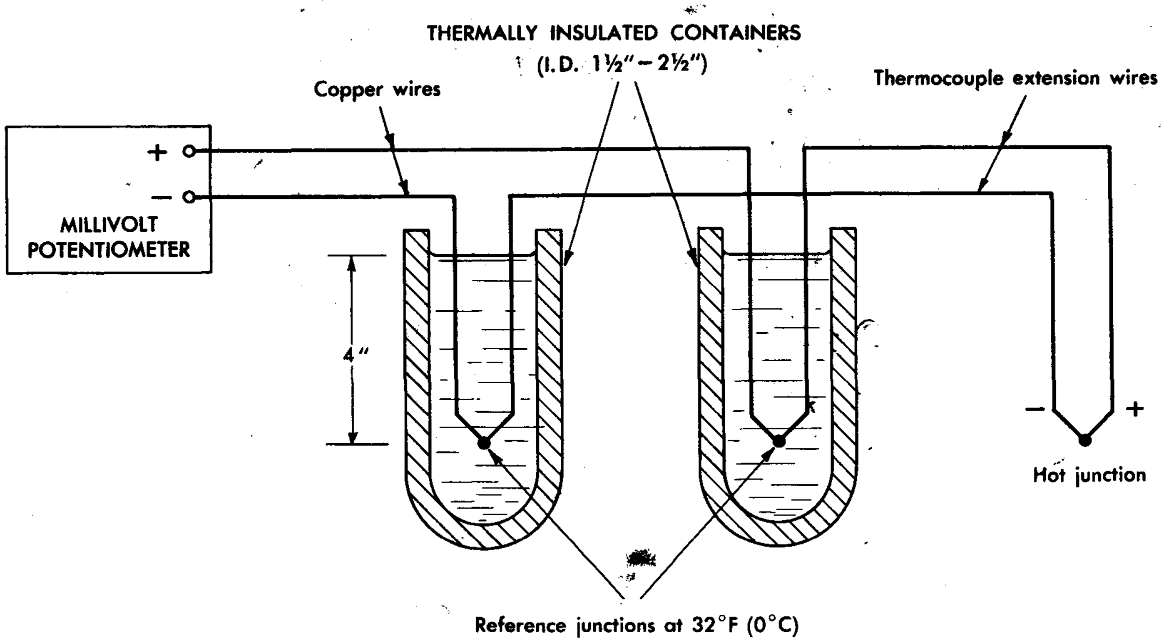

Fig. A

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The ice bath consists of two thermally insulated containers (I.D. 1-1/2" to 2-1/2") in which a mixture of compacted, distilled, crushed ice and distilled water surround the reference junctions. The quantity of water used should be limited to the amount necessary to ensure a water-ice mixture, which is the only means of maintaining a true 32 F (0 C) temperature. Care should be exercised when the reference junctions are inserted into the ice bath. At least a four-inch immersion is recommended. The crushed ice should be pressed firmly around the wires.

A single container can be used if the water is of sufficient purity to ensure electrical insulation between the reference junctions. The reference junction wires can also be dipped in melted paraffin to provide the required insulation.

B. Thermal Insulation Method

A less precise but satisfactory method of maintaining a stable reference junction temperature is to embed the junctions in a mass of thermal insulating material, such as foamed polystyrene. The reference junction temperature is determined by a mercury thermometer embedded with the junctions. In this method, the reference junction temperature is relatively constant in spite of room temperature fluctuations. However, the difference in temperature between the reference junction and 32 F (0 C) must be compensated for by the REFERENCE JUNCTION compensator.

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8690 Portable Millivolt Potentiometer

Designed for routine in-place checking of thermocouples, recorders and controllers, this 8690 Portable Millivolt Potentiometer also is of value in test and experimental work involving temperature measurements and calibration studies. Unique design features include:

Faster Reading—The measured values read directly in digits, plus a scale interpolation from a central reading window.

Wide Operating Range—This instrument has a range of −11.0 to +101.0 millivolts . . . eliminating the necessity of reversing input leads when measurements go below zero millivolts.

Accuracy—A potentiometer with a step dial plus a continuously adjustable two-turn slidewire, it has a limit of error of ± (0.05% of reading + 20 μv) without reference junction compensation, ± (0.05% of reading + 40 μv) *with* reference junction compensation.

Calibration Source—The instrument can be used as a millivolt calibration source for checking recorders, controllers and similar instruments.

Completely self-contained, the 8690 is provided with a manually-operated reference junction temperature compensator which permits measuring net emf directly . . . minimizes computation. A nine-position function switch facilitates rapid selection of the type of operation desired; with three "STANDARDIZE" positions, the user can switch from any previous function simply by turning the knob a single step.

The potentiometer is housed in a gray metal case with a durable vinyl finish. Operating instructions and a thermocouple conversion table are carried in the instrument lid.

Leeds and Northrup 8690 Millivolt Potentiometer.max

Designed for routine in-place checking of thermocouples, recorders and controllers, this 8690 Portable Millivolt Potentiometer also is of value in test and experimental work involving temperature measurements and calibration studies. Unique design features include:

Faster Reading—The measured values read directly in digits, plus a scale interpolation from a central reading window.

Wide Operating Range—This instrument has a range of −11.0 to +101.0 millivolts . . . eliminating the necessity of reversing input leads when measurements go below zero millivolts.

Accuracy—A potentiometer with a step dial plus a continuously adjustable two-turn slidewire, it has a limit of error of ± (0.05% of reading + 20 μv) without reference junction compensation, ± (0.05% of reading + 40 μv) *with* reference junction compensation.

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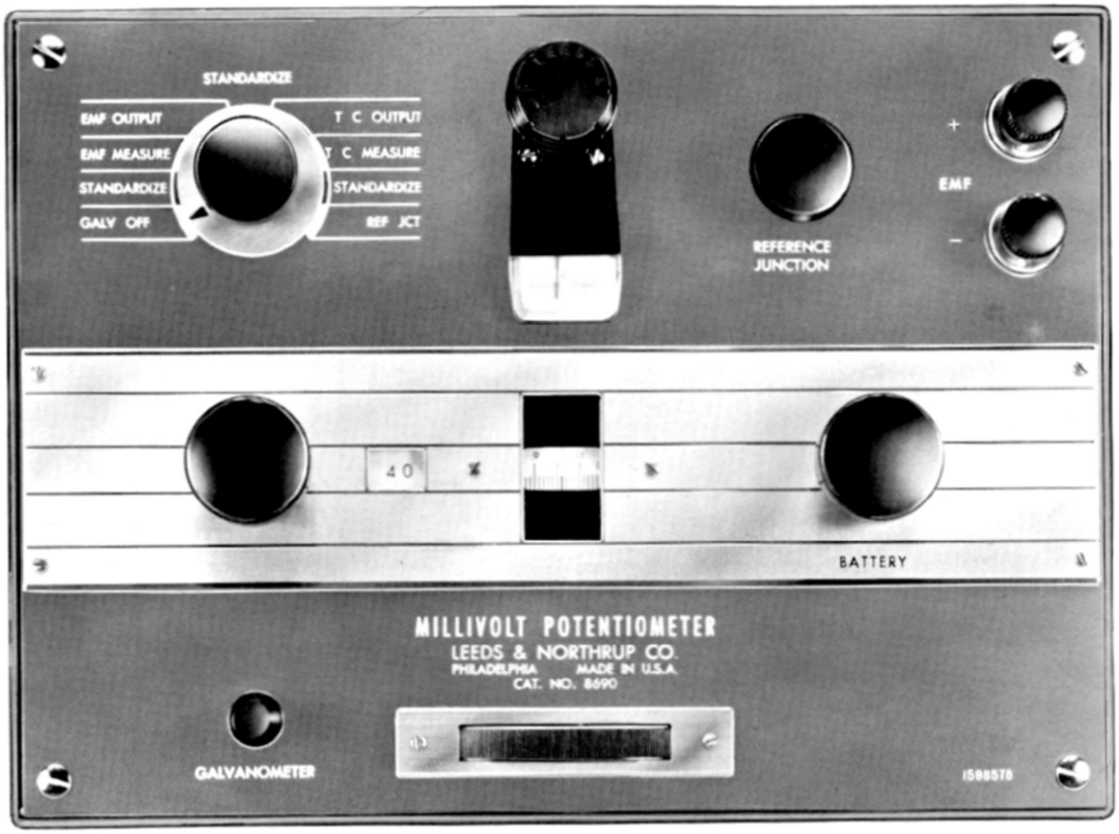

Specifications

List No.—8690 Portable Millivolt Potentiometer.

Range— −11.0 millivolts to +101.0 millivolts.

Limits of Error—Without reference junction compensation: ± (0.05% of reading + 20 μv). With reference junction compensation: ± (0.05% + 40 μv).

Maximum External Resistance — Approximately 50 ohms.

Measuring Dials—Millivolt Dial: 9 x 10 mv plus a "−" position. Slidewire: 0 to 11 mv, two-turn, 27.5″ long. Smallest scale division, 0.02 mv.

Reference Junction Compensator— Uncalibrated multi-turn slidewire, manually operated. Range 0 to 5 mv, adjustable to 5 μv.

Standard Cell Adjustment — An internal slidewire provides adjustment for any internal standard cell voltage from 1.0170 to 1.0200 volts.

Galvanometer*—Sensitivity: 0.6 μa per scale division (equivalent to 75 μv per scale division for a total circuit resistance of Rc + CDRX). Scale: 20 1-millimeter divisions, 10 on each side of a central zero. Coil Resistance (Rc): 25 ohms. CDRX: 100 ohms.

Rheostat—Three-turn rheostat for adjustment of battery current.

Function Switch—Nine-position switch to provide internal instrument connections as follows as switch is rotated clockwise:

(1) "GALV. OFF" (2) "STANDARDIZE" (3) "EMF MEASURE" (4) "EMF OUTPUT" (5) "STANDARDIZE" (6) "TC OUTPUT" (7) "TC MEASURE" (8) "STANDARDIZE" (9) "REF. JCT."

Key—One single-pole single-throw galvanometer key with lock-down position.

Battery—Self-contained, one 1½-volt for measuring circuit.

Case—Metal with vinyl finish, handle and removable lid, 12$\frac{11}{32}$″ x 8$\frac{29}{32}$″ x 7⅜″. Weight is 13 lb.

**Sensitivity at least as high as stated. Other electrical characteristics within ± 20%.*

Replacement Parts

List No.	Description
Std 2233-1	Battery (1½-volt Burgess 4 FH).
062112	Galvanometer System
130007	Standard Cell
002199	Binding Post
177124	Direction Book
077989	Conversion Tables

4907 Stenton Ave., Philadelphia 44, Pa.

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