
**Instruction Manual
AVTM 72-4302J**

For the
**Portable
Wheatstone Bridges**

Catalog Nos. 72-430 and 72-432

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Instruction Manual 72-4302J
for the use of
Biddle Portable Wheatstone Bridges
Catalog Numbers 72-430 and 72-432

Biddle Instruments
Blue Bell, PA. 19422

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SAFETY PRECAUTIONS

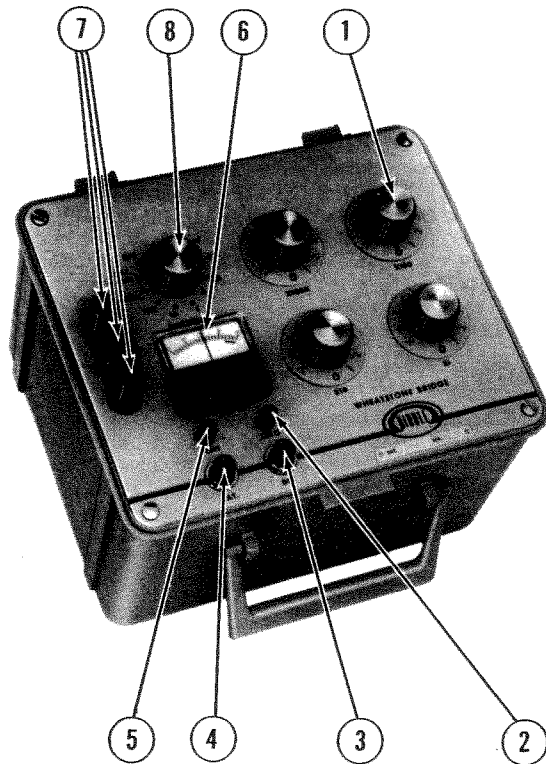
The Catalog Nos. 72-430 and 72-432 operate solely from dry batteries of low voltage and, therefore, meet the classification of "extra-low energy source" (ANSI C39.5-1974), "Safety Requirements for Electrical and Electronic Measuring and Controlling Instrumentation", Para. 3. They do not present a shock hazard in themselves, but as with all electrical equipment, safety rules must be observed. Particular care should be taken that wires carrying high voltages or power are not connected to the instrument binding posts. Such connections can cause shock hazard to the operator and damage the instrument.

RECEIVING INSTRUCTIONS

Your Wheatstone Bridge has been thoroughly tested and inspected to rigid inspection specifications before being shipped and is ready for use when received. Check the equipment received against the packing list. Notify Biddle Instruments, Blue Bell, PA 19422 of any shortage of materials. The instrument should be examined for damage received in transit. If any damage is found, file a claim with the carrier at once and notify Biddle Instruments or its nearest representative giving a detailed description of the damages observed.

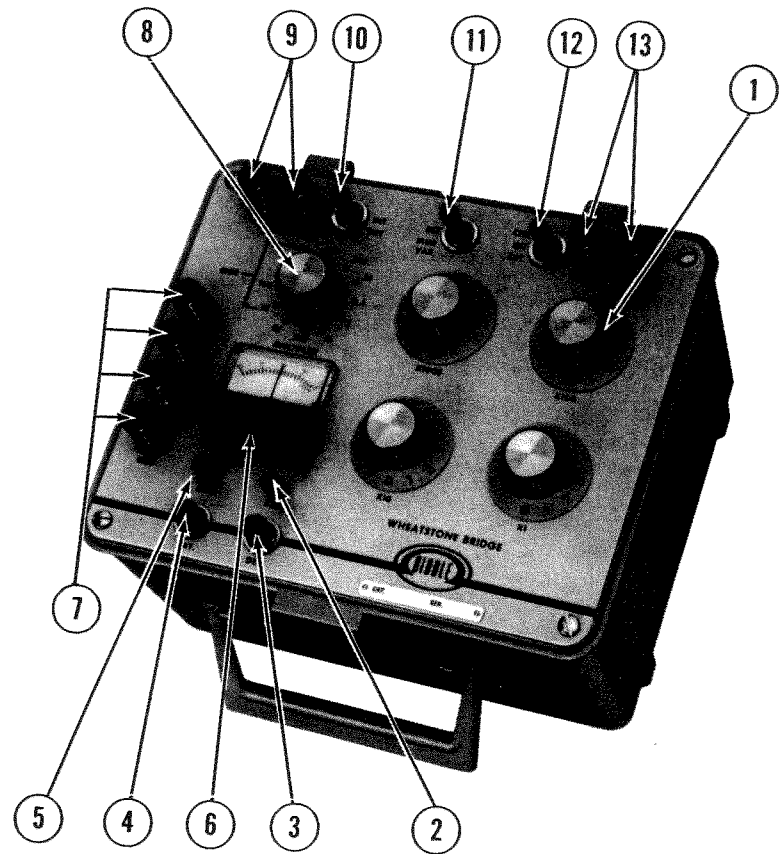
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|----------------------------------|----------------------------------|
| 1. Measuring (Rheostat) Dials. | 5. Detector Sensitivity Control. |
| 2. Meter Electrical Zero Adjust. | 6. Meter Mechanical Zero Adjust. |
| 3. Detector Key. | 7. Bridge/Resistance Box |
| 4. Battery Key. | Binding Posts. |
| | 8. Multiplier Selector Dial. |

Figure 1: Portable Wheatstone Bridge, Catalog No. 72-430.



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|----------------------------------|-------------------------------------|
| 1. Measuring (Rheostat) Dials. | 8. Multiplier Selector Dial. |
| 2. Meter Electrical Zero Adjust. | 9. External Detector Binding Posts. |
| 3. Detector Key. | 10. Detector Internal-External |
| 4. Battery Key. | Selector Key. |
| 5. Detector Sensitivity Control. | 11. Resistance-Murray-Varley |
| 6. Meter Mechanical Zero Adjust. | Test Mode Selector Key. |
| 7. Bridge/Resistance Box | 12. Battery Internal-External- |
| Binding Posts | Check Selector Key. |
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Figure 2: Portable Wheatstone Bridge, Catalog No. 72-432.

PORTABLE WHEATSTONE BRIDGES
 CATALOG NOS. 72-430 and 72-432

1. GENERAL:

The Catalog Nos. 72-430 and 72-432 are compact, rugged, portable Wheatstone Bridges designed for wide range resistance measurements in the laboratory, plant or field. The Cat. No. 72-432 Bridge consists of a complete 72-430 Bridge plus Murray and Varley loop circuitry for location of grounds, crosses and opens in multi-conductor communication and power cable. The self-heating in the unknown resistance is limited to less than 10 milliwatts for all resistance measurements above 10 ohms.

The bridges are fully self-contained being equipped with their own batteries and solid state null detector. The bridge rheostat arm may be used independently as a 4-dial resistance box.

2. SPECIFICATIONS for both INSTRUMENTS; exceptions noted.

A. Range:

As a Bridge: 0.1 ohm to 11.1 megohms in 7 ranges.
 As a Resistance Box: 0 to 11,110 ohms.

B. Limit of Error:

As a Bridge: $\pm(0.1\% \text{ of reading} + 0.01 \text{ ohm})$
 As a Resistance Box: $\pm(0.05\% \text{ of reading} + 0.02 \text{ ohm})$

C. Measuring Dials: (Rheostat Arm)

Consists of 4 decades giving steps of 10(1000 + 100 + 10 + 1) ohms. The Cat. No. 72-432 is equipped with an additional position for infinity.

D. Multiplier Dial: (Ratio Arm)

Seven positions for selecting resistance multiplier values of 0.001, 0.01, 0.1, 1, 10, 100 and 1000. These positions contain the ratio resistors of the bridge circuit and provide automatic current limiting for each setting of the multiplier dial. The BAT CHK position (Cat. No. 72-430 only) sets the instrument to indicate state of charge of the measuring circuit battery directly on the meter. The OFF position electromagnetically shorts the meter and disconnects the amplifier and batteries.

SPECIFICATIONS, Continued...

Cat. No. 72-432 is equipped with additional positions for MUR 1000, MUR 100, MUR 10 and MUR 1 Murray loop tests.

E. Current Rating:

Current rating of rheostat arm when used as a resistance box is determined by the highest rheostat decade in use. The rated and maximum permissible currents are as follows:

RHEOSTAT DECADE	CURRENT (RATED ACCURACY)	CURRENT (MAXIMUM)
1K ohms	7 milliamperes	16 milliamperes
100 ohms	23 "	50 "
10 ohms	70 "	160 "
1 ohm	230 "	500 "

F. Detector:

The null detector consists of a ruggedized zero center meter and a solid state high gain differential amplifier which drive the meter.

1. Sensitivity: 4 microvolts.
2. Input resistance: 5000 ohms.
3. Resolution: Sufficient to detect the following resistance changes:

1 ohm to 100K ohms	- at least 0.1%
@ 1 megohm	- 0.5%
@ 10 megohms	- 0.5%

4. Overload: 35V dc continuous without permanent damage.
5. Zero Control: Provides minimum adjustment of $\pm 200\mu\text{V}$ to compensate for thermal emf's and long-term drift voltages.
6. Sensitivity Control: Continuously adjustable from full sensitivity to 40:1 reduction of sensitivity.
7. Meter: 1-1/2" with rugged taut-band suspension. Scale is 10-0-10 divisions.

SPECIFICATIONS, Continued...

G. Keys:

Separate battery and detector keys are provided to permit choice of circuit closure sequence. Both keys can be locked down when desired.

In Cat. No. 72-432, additional lever keys are provided to select Resistance, Varley, or Murray test mode; Internal or External Detection; and Internal, External or Check Battery.

H. Binding Posts:

Three 5-way type binding posts with 3/4" spacing are provided for connection of unknown resistance and for using the rheostat arm as a 4-dial resistance box.

The Cat. No. 72-432 is provided with five additional binding posts: One pair to connect an External Battery, one pair to connect an External Detector, and one post for connecting to ground.

I. Battery Requirements:

1. Measuring circuit: Three 1-1/2 volt "D" size cells in series (4.5V). Normal battery life is in excess of 1000 hours.
2. Null detector: Two 9V Burgess 2U6 or Everady 216 (NEDA 1604); life exceeds 400 hours.

J. Enclosure:

Top panel is aluminum with off-white enamel finish. Case is an ABS plastic with gray textured finish and has a hinged removable cover.

Dimensions: 9" x 7-1/2" x 7-1/2" high, (23 x 19 x 19 cm).

Weight: 5-1/2 lbs., (2.5 kg).

3. OPERATING PROCEDURE:

A. Meter Zero Adjustment:

1. Rotate MULTIPLIER dial to OFF position, then adjust meter pointer to "0" by rotating screw in meter cover.
2. Rotate MULTIPLIER dial to desired setting, the SENS control to extreme clockwise position (maximum sensitivity), then adjust meter pointer to electrical "0" by rotating ZERO control.

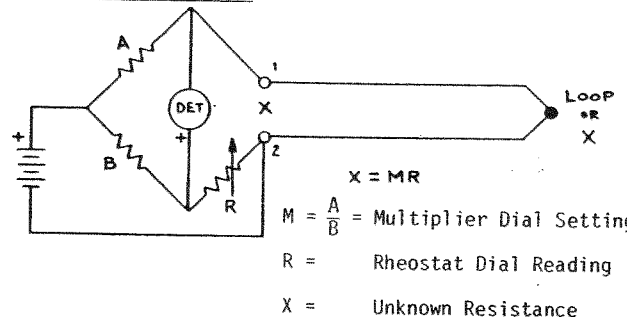
B. Battery Check:

1. Adjust meter pointer to "0" as described above.
2. Catalog No. 72-430: Rotate MULTIPLIER dial to BAT CHECK; depress BAT KEY and note meter deflection.

Catalog No. 72-432: Rotate MULTIPLIER selector dial to any Multiplier position; push Lever Key (Chk, Int, Ext.) to CHK position and note meter deflection.

3. A new battery (nominal 4.5V) will deflect meter pointer high in the green band. Replace measuring circuit battery if pointer deflects below the green band.

C. Resistance Measurements:



OPERATING PROCEDURE, Continued...

1. Connect unknown resistance to binding posts X_1 and X_2 .
2. Catalog No. 72-432 only:
 - a. Set test mode lever key at RES.
 - b. Set BAT and DET lever keys at INT (INTERNAL).
3. Set MULTIPLIER dial in accordance with the table below.

Unknown Resistance		Multiplier Dial Setting
Below	10 ohms	0.001
10 ohms to	100 ohms	0.01
100 ohms to	1K ohms	0.1
1K ohms to	10K ohms	1.
10K ohms to	100K ohms	10.
100K ohms to	1M ohms	100.
1M ohms to	11M ohms	1K.

4. Adjust meter to "0" as described in Section 3 "OPERATING PROCEDURE", Item A.
5. Depress BAT and DET keys and adjust rheostat dials (R) until meter pointer is nearest "0". If deflection is to the right, bridge dial settings are too high; if to the left, too low.
6. Lock down DET key and readjust last measuring dial, if necessary, for null meter deflection while depressing and releasing BAT key.

NOTE: Adjust SENS control to obtain optimum detector sensitivity or to reduce sensitivity during preliminary balancing. Clockwise rotation of SENS control increases sensitivity; counter-clockwise rotation decreases sensitivity.

7. Rotate MULTIPLIER dial to OFF position after completing measurements.
- D. Use as Resistance Box:

Set MULTIPLIER dial to OFF position and connect to the two binding posts marked R.

OPERATING PROCEDURE, Continued...

- E. External Battery (Cat. No. 72-432 Only):

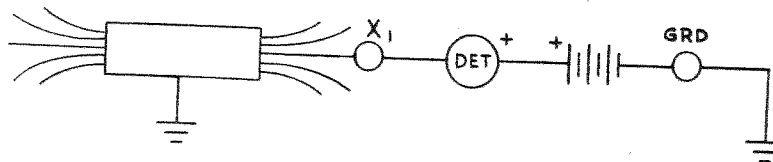
Connect external battery to BAT posts observing proper polarity. Set BAT lever key to EXT position. Maximum external voltage is 22-1/2 volts.

- F. External Detector (Cat. No. 72-432 Only):

Connect external detector to DET posts. Set DET lever key to EXT position.

4. FAULT MEASUREMENTS IN MULTI-CONDUCTOR CABLES (Cat. No. 72-432 Only):

- A. Picking Out Faulty Wires:



1. Grounded Wire:

Set Multiplier Dial at MUR 1K, lever switch at MUR and rheostat dials at the "0" setting. Connect the GRD post to ground or cable sheath and connect the cable wires, one after another, to post X_1 . The faulty wire will be detected by full scale meter deflection to the right when the BAT and DET keys are depressed. The detector is sufficiently sensitive to deflect one scale division for 4.5 volts through 1000 megohms, hence a very high resistance fault or ground can be detected.

2. Cross or Short Circuit:

Test procedure is the same as for a grounded wire except that the GRD post is connected to one of the suspected wires instead of to ground.

OPERATING PROCEDURE, Continued...

3. Open Circuited Wire:

Test procedure is similar to that for a grounded wire. Connect the GRD post to ground or cable sheath. Connect the suspected wires to ground or cable sheath at far end of cable. At the near end of cable connect the wires, one after another, to post X_1 . The meter pointer will not deflect if the wire has an open circuit.

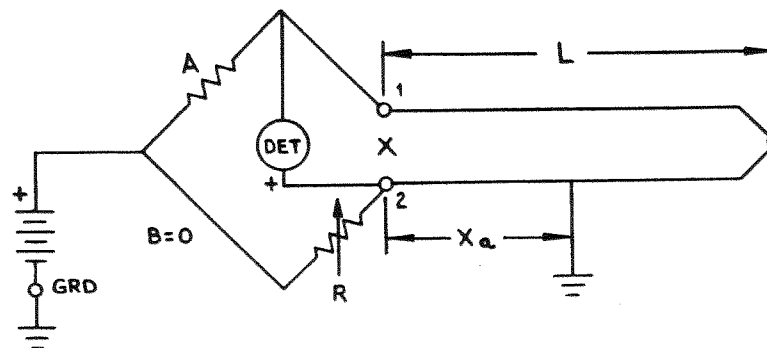
B. Locating a Ground or Cross:

Use the Murray loop test to locate a ground or cross in relatively low resistance loops, and Varley loop test for high resistance loops. Both tests involve the measurement of resistance. In each method join faulty and good wires at far end of cable. Connect faulty wire to X_2 and good wire to X_1 . Connect GRD post to ground, or if fault is a cross, connect second faulty wire to GRD post. Set lever switch at RES and measure total resistance (r) of the loop as described in "Resistance Measurements".

Continued...

OPERATING PROCEDURE, Continued...

1. Murray Loop Test:



$$X_a = \frac{Rr}{A+R} \quad \text{and} \quad D_a = \frac{2LR}{A+R}$$

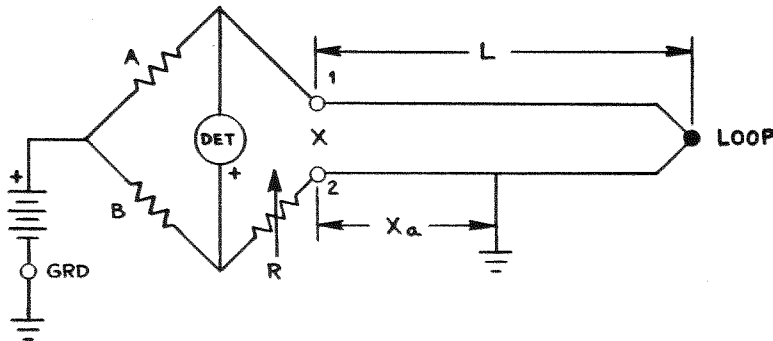
- X_a = resistance of faulty wire from bridge to fault.
- r = total resistance of loop.
- R = rheostat dial reading.
- A = multiplier dial setting.
- D_a = distance from bridge to fault.
- L = length of one wire.

NOTE: The above formula for distance applies only when wires are of the same gauge and of equal length.

Set lever switch at MUR. Set multiplier dial to MUR 1K which places 1000 ohms in bridge ratio arm (A in equation). Depress the BAT and DET keys and adjust the rheostat dials (R) for null meter deflection.

OPERATING PROCEDURE, Continued...

2. Varley Loop Test:



$$X_a = \frac{r - AR}{A + 1} \quad \text{and} \quad D_a = \frac{2L(r - AR)}{r(A + 1)}$$

Symbols have same significance as in the Murray Loop Test.

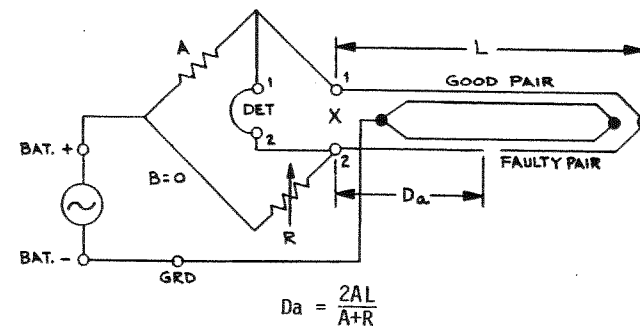
Set lever switch at VAR. Set multiplier dial (A) at 0.01 if r is less than 100 ohms, 0.1 if r is over 100 ohms, and 1 if r is over 1000 ohms. Depress the BAT and DET keys and adjust the rheostat dials (R) for null meter deflection.

OPERATING PROCEDURE, Continued...

C. Locating an Open:

The location of opens involves the intercomparison of capacities and requires the use of a telephone receiver or headset, and a source of alternating current such as produced by a buzzer or tone test set. Connect the telephone receiver or headset to the DET posts and the alternating current source to the BAT posts. Set the DET and BAT lever switches to the EXT (External) position.

1. Locating an Open in a Quadded Cable:



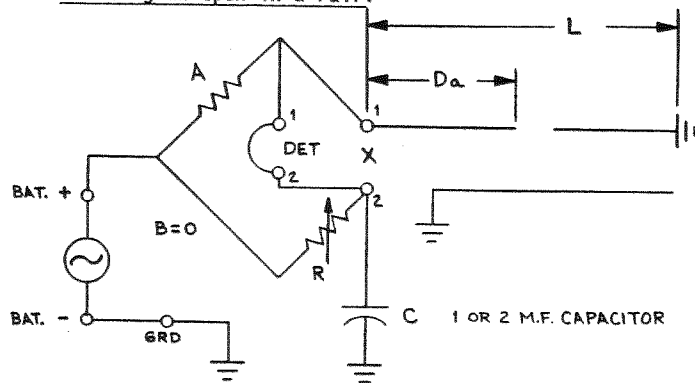
$$D_a = \frac{2AL}{A+R}$$

Symbols have the same significance as in Murray Loop Test.

Set lever switch at MUR. Set multiplier dial at MUR 1K which places 1000 ohms in bridge ratio arm (A in equation). Connect the open wire to post X₂ and a good wire of equal gauge and length in another pair to post X₁, then strap them together at the far end of the cable. Join the mates of these wires at both ends of the cable. Connect the near end of the joined mates to the GRD post. All four wires must be free from grounds and crosses. Depress the BAT and DET keys and adjust the rheostat dials (R) until a silence or minimum sound is heard in the telephone receiver. If a satisfactory balance cannot be obtained with multiplier dial at MUR 1K, set at MUR 100, MUR 10 or MUR 1.

OPERATING PROCEDURE, Continued...

2. Locating an Open in a Pair:



$$D_a = \frac{R_1 L}{R_2}$$

Symbols have the same significance as in Murray Loop Test.

Set lever switch at MUR. Set multiplier dial at MUR 1K. Connect the near end of the open wire to post X₁ and the far end to ground or cable sheath. Ground the near end of its mate and leave the far end open. Connect one terminal of the mica capacitor (C) to post X₂ and the other terminal to ground. Connect the GRD post to ground. Depress the BAT and DET keys and adjust the rheostat dials (R₁ value) until a silence or minimum sound is heard in the telephone receiver. Disconnect the near end of the open wire from post X₁ and connect it to ground. Disconnect the near end of the good wire from ground and connect it to post X₁. Balance the bridge and note rheostat dial reading as R₂.

5. MAINTENANCE

A. General:

1. Instruments having only periodic use should have the measuring dials rotated several times over their full travel previous to making a measurement.
2. To remove bridge from case, remove the four panel screws, then carefully lift panel assembly from case.

B. Battery Replacement:

Replace measuring circuit battery when the meter pointer deflects below the green band when checking the battery as described in Section 3B, Page 7. Replace null detector batteries when the meter pointer cannot be adjusted to "0" as described in Section 3A, Page 7. The battery requirements are described in Sections 2I, Page 6, and their connections are as noted in the schematic diagrams on Pages 21 and 22.

NOTE: Incorrect installation of null detector batteries, defective batteries, or failure to make contact with battery holders will cause meter pointer to deflect violently off scale or result in failure of pointer to move when ZERO control is rotated with MULTIPLIER dial set at any of the multiplier positions.

C. Compensating for Long Term Detector Drift:

It may be necessary to readjust the amplifier zero balance circuit to compensate for long-term drift changes beyond the range of the ZERO ADJ control. If the meter pointer cannot be adjusted to "0" and the batteries are known to be good, proceed as follows:

1. Remove panel assembly from case.
2. Rotate function selector switch to any MULTIPLIER setting, and SENS control to mid-position.

NOTE: Do not depress the DET key during this procedure.

MAINTENANCE, Continued...

3. Rotate ZERO ADJ control to the extreme clockwise position, then extreme counter-clockwise position while observing the meter pointer deflection. The pointer should normally deflect approximately the same amount in both directions.

If deflection of the meter pointer remains to the right side of "0" (or barely to the left side of "0") when the ZERO ADJ control is fully counter-clockwise, the total resistance of the amplifier resistors $R_x + R_x^1$ must be increased.

If the meter pointer remains to the left of "0" (or barely to the right side of "0") when the ZERO ADJ control is fully clockwise, the total resistance of $R_y + R_y^1$ must be increased or the total of $R_x + R_x^1$ must be decreased.

4. Remove the three screws which secure the amplifier assembly and carefully roll back assembly so that the circuit side of the printed circuit board is exposed. Locate resistors R_x , R_x^1 , R_y , and R_y^1 by the printed circuit board markings.
5. Increase or decrease the total value of $R_x + R_x^1$ or $R_y + R_y^1$ as required, using metal film resistors. (It is recommended that a decade resistance box be used to determine the exact value required before permanently installing resistors).
6. The correct resistance value will give approximately equal deflections on either side of "0".
7. Reassemble the instrument.

D. Meter:

Failure usually occurs by suspension breakage due to a severe shock. If broken, meter pointer will not deflect when an unbalance is known to exist. To replace, disconnect wires and remove control mounting panel from meter terminals, then remove ring nut, screws or snap bracket holding meter in place. Install new meter so that the shafts of the SENS and ZERO controls do not bind. Connect Gray and White/Gray wire (Cat. No. 72-430) or White/Gray wire (Cat. No. 72-432) to positive (+) terminal and White/Orange wire to Negative (-) terminal.

6. REPLACEMENT PARTS LIST:

A. PARTS COMMON TO CAT. NUMBERS 72-430 and 72-432:

Biddle Part No.	Quantity Per Instrument	Description
72-4302J	1	Instruction Manual
13005	1	Case, complete
10998	1	Case, bottom
10999-1	1	Case, lid
11859	1	Battery holder, case bottom
16643	1	Label, Battery check
11874	1	Meter
11166-2	3 or 8	Binding Posts (Superior #DF31BC)
11507-7	2	Potentiometer, ZERO and SENS controls
11945-1	1	Mounting plate, potentiometer
13357-3	2	Switch Pushbutton, BAT and DET
13353-3	1	Amplifier assembly
11444-8	3	Stand-off spacers, amplifier
11868	2	Knob, ZERO and SENS control. (Stockwell Rubber Co. #LC9250-1)
4690-8	1	Knob, multiplier dial, (Buckeye #PS-95PL-2)
11970	3	Knob, (X100,X10,X1)
11923-5	1	Resistor-Switch assembly (X100)
11923-3	1	Resistor-Switch assembly (X10)
11923-1	1	Resistor-Switch assembly (X1)
11933-1	3	Switch (X100,X10,X1)
11916	4	Resistor Mounting Plate (X1000,X100,X10,X1)
11998	1	Resistor Mounting Plate (MULTIPLIER)
1303-78	35	Screws, Resistor mounting
0397-2	6	Solder Lug, MULTIPLIER Resistor-Switch Assembly
10000-164	6	Resistor, 2000 ohms (R1 to R6)

REPLACEMENT PARTS LIST...Continued

A. PARTS COMMON TO CAT. NUMBERS 72-430 and 72-432:

Biddle Part No.	Quantity Per Instrument	Description
10000-162	6	Resistor, 200 ohms (R7 to R12)
10000-154	6	Resistor, 20 ohms (R13 to R18)
10000-38	6	Resistor, 2 ohms (R19 to R24)
10000-16	2	Resistor, 0.999 ohms (R25,R26)
10000-17	2	Resistor, 8.902 ohms (R27,R28)
10000-19	2	Resistor, 81.008 ohms (R29,R30)
10000-21	2	Resistor, 409.091 ohms (R31,R32)
8857	3	Battery, 1½ Volt "D" size cell
1482	2	Battery, 9 Volts, Burgess 2U6 or Eveready 216 (NEDA 1604)

B. PARTS FOR CAT. NUMBER 72-430 ONLY:

11939-2	1	Instrument Panel
11970	1	Knob, (X1000)
11923-7	1	Resistor-Switch assembly (X1000)
11933-1	1	Switch (X1000)
13010	1	Resistor-Switch assembly (MULTIPLIER)
11922-11	1	Switch (MULTIPLIER)
4501-148	3	Resistor, 51 ohm, ±5%, ½W, MIL R11 type, (R33-R35)
4501-149	2	Resistor, 510 ohms, ±5%, ½W, MIL R11 type, (R36, R37)
4501-171	1	Resistor, 4.7k ohms, ±5%, ½W, MIL R11 type, (R38)
4501-165	1	Resistor, 13k ohms, ±5%, ½W, MIL R11 type, (R39)
4501-146	1	Resistor, 5.6k ohms, ±5%, ½W, MIL R11 type, (R40)
4501-169	1	Resistor, 47k ohms, ±5%, ½W, MIL R11 type, (R41)

REPLACEMENT PARTS LIST...Continued

C. PARTS FOR CAT. NUMBER 72-432 ONLY:

Biddle Part No.	Quantity Per Instrument	Description
11962-2	1	Instrument Panel
11186-3	2	Switch, lever, DET-INT-EXT and RES-MUR-VAR
11186-5	1	Switch, lever, BAT CHK-INT-EXT
11970-1	1	Knob (X1000)
13007	1	Resistor-Switch assembly (X1000)
11922-10	1	Switch (X1000)
13229	1	Resistor-Switch assembly (MULTIPLIER)
11922-20	1	Switch (MULTIPLIER)
10000-23	1	Resistor, 1.001 ohms (R33)
10000-24	1	Resistor, 10.101 ohms (R34)
10000-25	1	Resistor, 111.11 ohms (R35)
4501-162	1	Resistor, 3k ohms, ±5%, ½W, MIL R11 type, (R36)
4501-148	3	Resistor, 51 ohms, ±5%, ½W, MIL R11 type, (R37,R43,R47)
4501-149	2	Resistor, 510 ohms, ±5%, ½W, MIL R11 type, (R38,R42)
4501-146	1	Resistor, 5.6k ohms, ±5%, ½W, MIL R11 type, (R39)
4501-171	1	Resistor, 4.7k ohms, ±5%, ½W, MIL R11 type, (R41)
4501-165	1	Resistor, 13k ohms, ±5%, ½W, MIL R11 type, (R40)
4501-168	1	Resistor, 15 ohms, ±5%, ½W, MIL R11 type, (R44)
4501-130	1	Resistor, 43 ohms, ±5%, ½W, MIL R11 type, (R45)
4501-150	1	Resistor, 300 ohms, ±5%, ½W, MIL R11 type, (R46)
4501-169	1	Resistor, 47k ohms, ±5%, ½W, MIL R11 type, (R49)
4501-147	1	Resistor, 1k ohms, ±5%, ½W, MIL R11 type, (R48)

7. WARRANTY and REPAIRS:

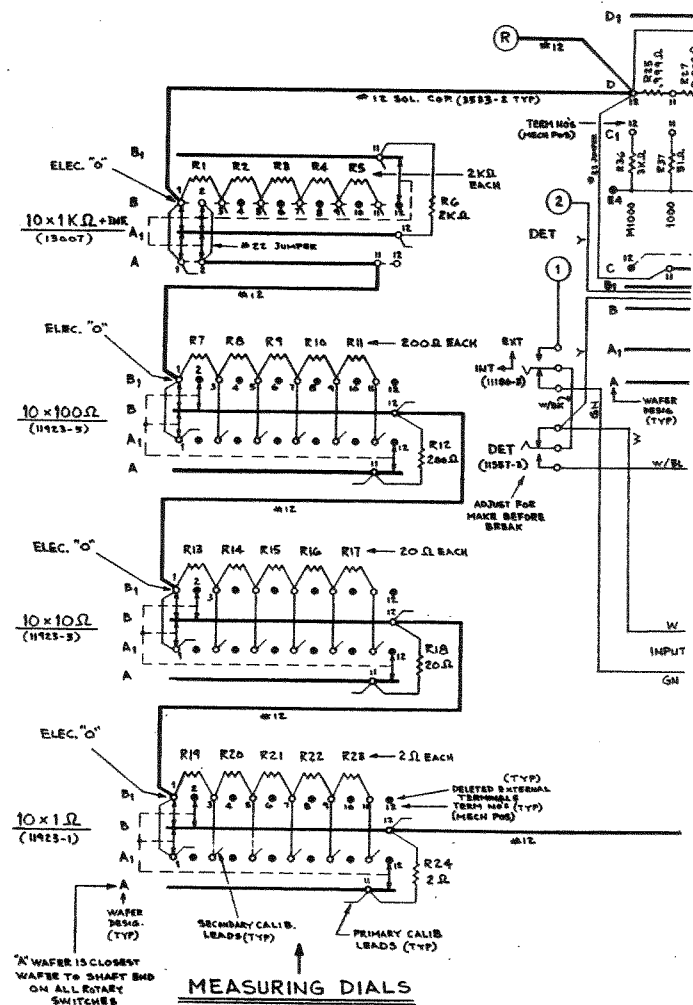
A. WARRANTY:

All products supplied by Biddle Instruments are warranted against all defects in material and workmanship for a period of one year following shipment. Our liability is specifically limited to replacing or repairing, at our option, defective equipment. Equipment returned to the factory for repair will be shipped Prepaid and Insured. The warranty does not include batteries, lamps or tubes, where the original manufacturer's warranty shall apply. WE MAKE NO OTHER WARRANTY.

The warranty is void in the event of abuse or failure by the customer to perform specified maintenance as indicated in the manual.

B. REPAIRS:

Biddle Instruments maintains a complete instrument repair service. Should this instrument ever require repairs, we recommend it be returned to the factory for repair by our instrument specialists. When returning instruments for repairs, either in or out of warranty, they should be shipped Prepaid and Insured and marked for the attention of the Instrument Service Manager.



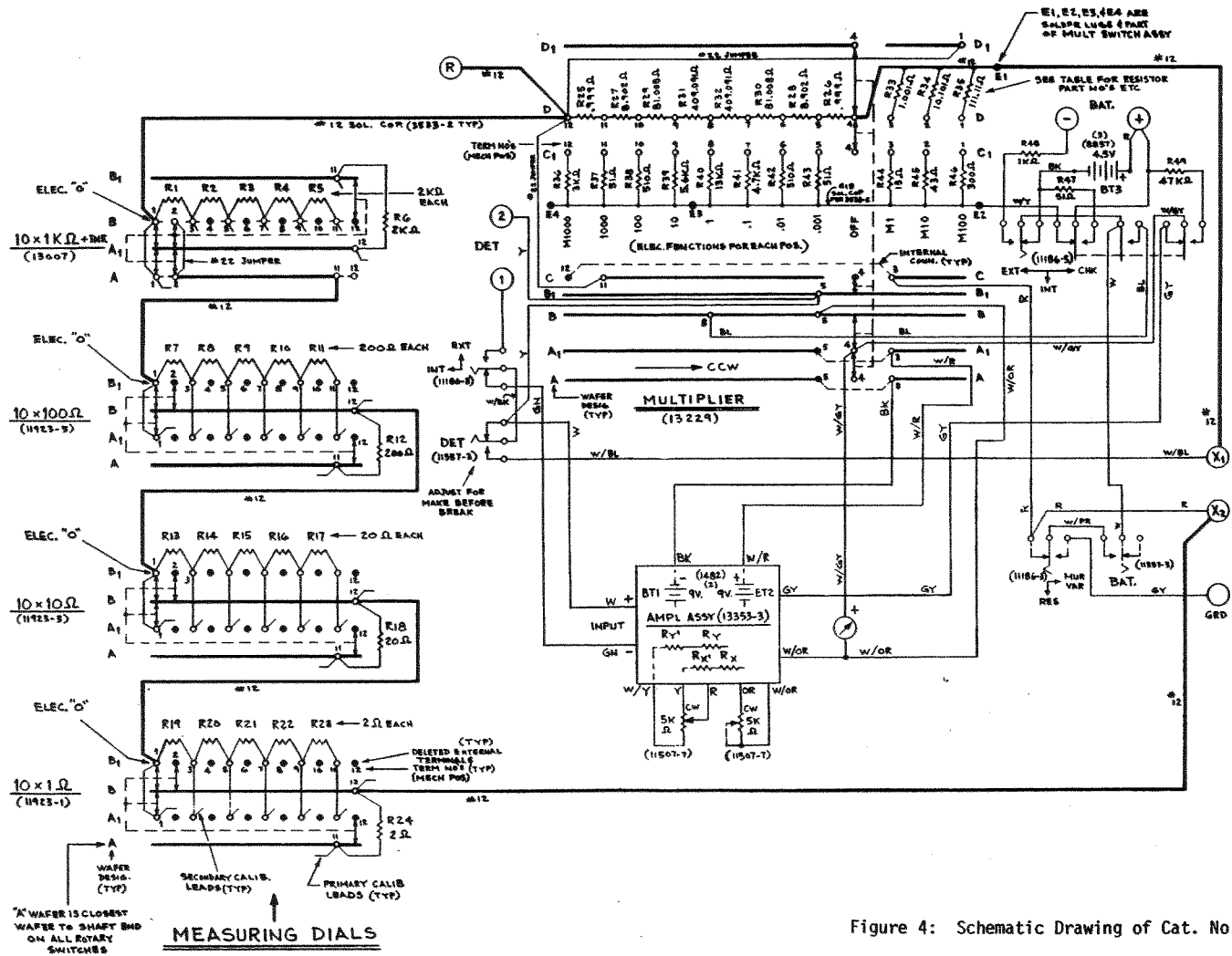


Figure 4: Schematic Drawing of Cat. No. 72-432