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A HIGH-INPUT IMPEDANCE DIFFERENTIAL MILLIVOLT METER FOR USE WITH SOLID CERAMIC OXYGEN ELECTROLYTE CELLS

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Design factors are given for a high-input impedance differential millivolt meter designed, built, and tested as an inexpensive solid-state electronic system for use in measuring the electromotive force from solid ceramic oxygen electrolyte cells. A schematic diagram is included.

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Richard J. Williams
Lyndon B. Johnson Space Center
Houston, Texas 77058

and

O. Mullins and E. Quin
Lockheed Electronics Company, Inc.
Houston, Texas 77058

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By Richard J. Williams, O. Mullins,* and E. Quin*
Lyndon B. Johnson Space Center

SUMMARY

Electromotive force output from solid ceramic oxygen electrolyte cells is usually measured with expensive special electronic devices. An inexpensive solid-state electronic system that accurately measures cell output has been designed, built, and tested at the NASA Lyndon B. Johnson Space Center. The device has functioned successfully for investigators at the Lyndon B. Johnson Space Center.

INTRODUCTION

The solid ceramic oxygen electrolyte cells used for measuring oxygen fugacities in the NASA Lyndon B. Johnson Space Center (JSC) gas-mixing furnaces require a high-input impedance device for accurate measurement of the cells output over their full temperature-response range. The ideal device must respond over the range of 0 to 2000 millivolts and should resolve ±1 millivolt. Usually, special devices (electrometers or pH meters) are used in these measurements; however, these devices are expensive and incorporate features not necessary in the measurement of cell output.

A high-input impedance differential millivolt meter has been designed, built, and tested for use with solid ceramic oxygen electrolyte cells. This device should enable experimenters to reduce costs in building systems similar to that designed at the JSC.

OPERATION AND ADJUSTMENT

The circuit design is rather straightforward (fig. 1). The power supply provides stabilized direct current to the device and also provides controlled direct current to null cell output. Resistor R15 is used to set the span of

*Lockheed Electronics Company, Inc.

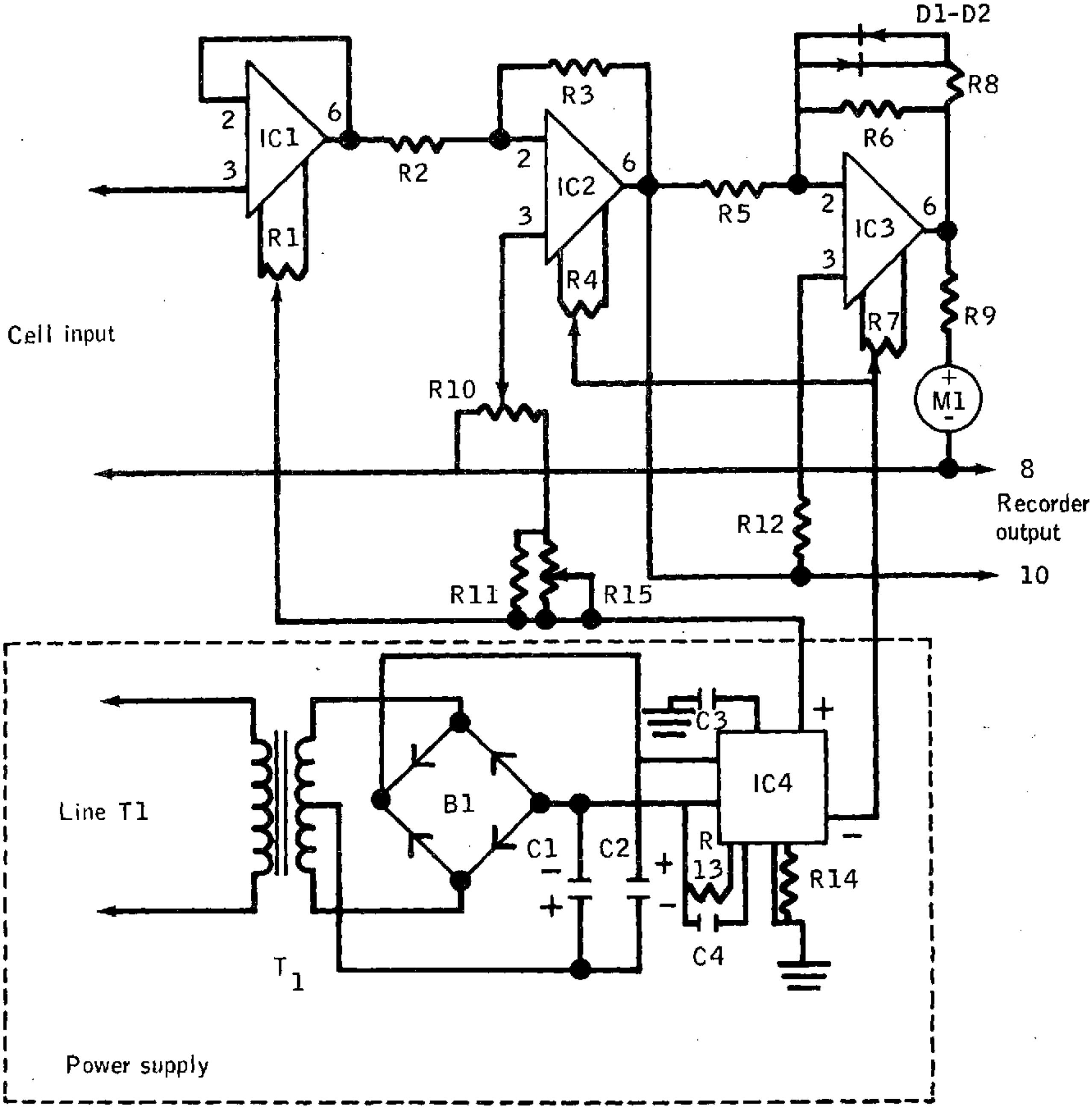

Figure 1.- Schematic diagram of a differential millivolt meter.

Key

Component	Description
R1, R4, R7	10-kΩ potentiometers
R2, R3, R6	5-kΩ, 1/8 W resistors
R5	1-kΩ, 1/8 W resistor
R8	100-kΩ, 1/8 W resistor
R9	Resistor set during calibration
R10	1-kΩ potentiometer
R11	25-kΩ, 1/8 W resistor
R12	2-kΩ, 1/8 W resistor
R13	71.5-kΩ, 1/8 W resistor
R14	33-kΩ, 1/8 W resistor
R15	100-kΩ potentiometer
C1, C2	100 μF capacitors
C3, C4	0.001 μF capacitors
D1, D2	RCA IN914 diodes*
IC1	Fairchild μA 740 integrated circuit*
IC2, IC3	Fairchild μA 741 integrated circuits*
IC4	RCA 194 integrated circuit*
B1	Motorola MDA 970-3 bridge*
T_1	Stancor P-8394 (for 110-V ac line) transformer* Stancor P-8320 (for 208-V ac line) transformer*
M1	50-0-50 microammeter

*Or equivalent.

Figure 1.- Concluded.

the power supply output. In the system designed at JSC, the power supply is set for 2000 millivolts full scale. Resistor R10 is a 10-turn potentiometer used to read the nulling voltage. Integrated circuit IC1 is a zero-gain amplifier that serves to isolate the cell from the measurement system. Resistors R1, R4, and R7 are used to balance the amplifiers. The 50-0-50 micrometer is a null indicator; resistor R9 is set by trial and error to adjust the span of the meter to the desired sensitivity. Points 8 and 10 are an output to a recorder; the signal is proportional to the offset from the null position of the device. Transformer T_1 supplies 6 V ac to the power supply from the line voltage.

After the device has been built and prepared for span, sensitivity, and balance, it should be allowed to operate for approximately 24 hours with the input from the cell shunted. Then, a final check of sensitivity and balance should be performed. Finally, a calibrated millivoltage source should be used as an input to adjust the span precisely. Once the device is activated, ideally, it should never be deactivated.

In the operation of a high-input impedance device, standard precautions must be taken: shielded lead wires, clean and dry contacts, physically stable configuration, and good grounds. Because the meter has not been designed to reject alternating-current signals, the sensors must be shielded.

CONCLUDING REMARKS

The high-input impedance differential millivolt meter designed and built at the NASA Lyndon B. Johnson Space Center has proved to be less expensive than other systems for use in measuring the output of solid ceramic oxygen electrolyte cells. Tests indicate the device is highly stable, remains essentially drift free for as long as 2 months, and provides accurate and reproducible measurements.

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