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Note

An electronic safety system for high-voltage laboratory power supplies

High-voltage laboratory power supplies used in paper, acetate and starch electrophoresis deliver up to 50 mA of current over a 0–1000 V range. On contact with the human body, these values can produce conditions that are injurious or fatal[1]. As the standard U-ground and ground leak devices are designed to monitor faults in the equipment, they do not protect the external load circuit. In any event, a lethal current in the external circuit would be considered normal for an electrophoresis power supply.

With the trend towards routine electrophoresis analysis, a greater amount of safety control of the assembly is needed. The statement that the current may be on for several seconds after the chamber has been opened and the power shut off is insufficient[2]. Furthermore, some indication of safety malfunction must be made available to the operator.

This paper outlines a group of modifications and additions used in an electrophoresis assembly that decreases the shock hazard.

Circuit description

Fig. 1 outlines a diagram of an electrophoresis power supply. The arrows point to the places where the circuit is modified to receive safety additions. The power line is broken at (1) to insert the fail-safe latching circuit; (2) indicates the position at which the ground is lifted from the transformer and line in order that a reverse polarity switch may be installed. The position where additional circuit bleeding is installed is indicated by (3). The two output terminals (4) are replaced by a coaxial fitting.

The fail-safe modification applied to the power supply is shown in Fig. 2. The existing on-switch now becomes a main control. It sets up power for circuit actuation through a voltage dropping transformer. The main power is broken at (1) and therefore no output voltage appears at the terminals. Upon pressing the momentary con-

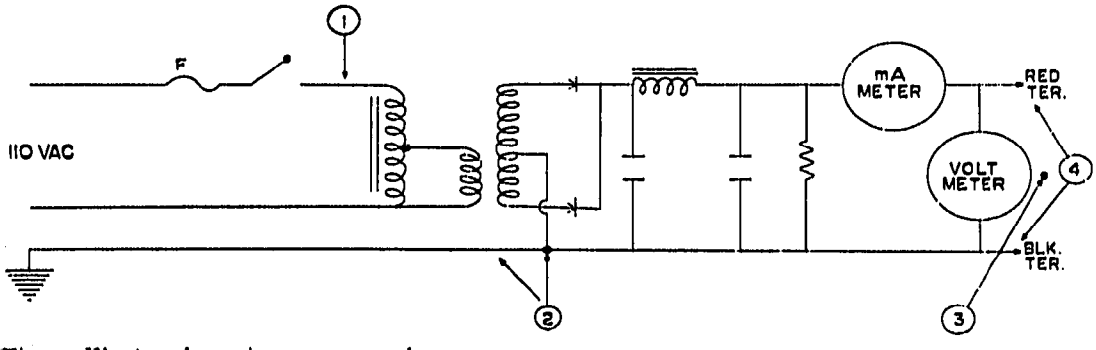

Fig. 1. Electrophoresis power supply.

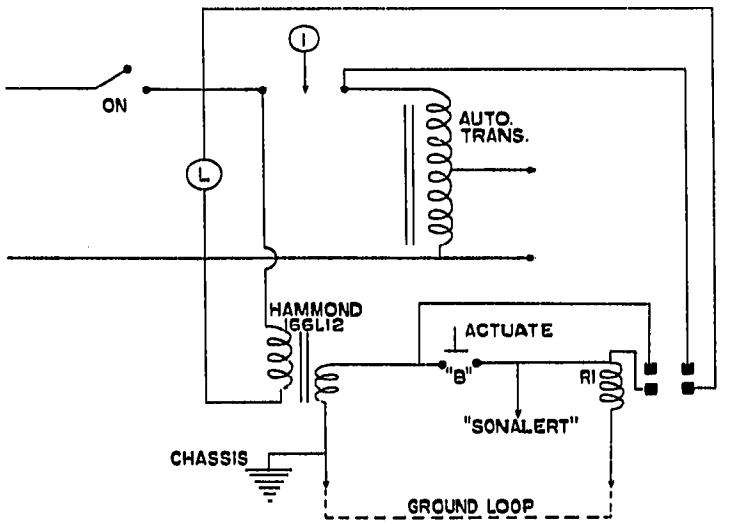

Fig. 2. Fail-safe circuit.

tact "B", relay I activates if the groundloop is intact. This relay latches itself and delivers power to the auto-transformer. This system is fail-safe with ground loop monitoring. The circuit will be de-energized should the main power be interrupted or the integrity of the ground violated.

Fig. 3 is a diagram of the external circuit used in conjuction with the power supply. A metal box containing a Mallory 628 "Sonalert" is bolted on to the back of the plastic electrophoresis chamber. The box is connected by coaxial cable to the output terminal of the power supply. Its metal supplies the ground contact to T_2, inside the plastic chamber. The power to T_1 is fed directly through the box. The lid of the electrophoresis chamber is equipped with a micro-switch. When the lid is closed it completes the ground loop circuit necessary for activation of the system. The PB-RI junction supplies, on circuit activation, current to charge the condenser C. If

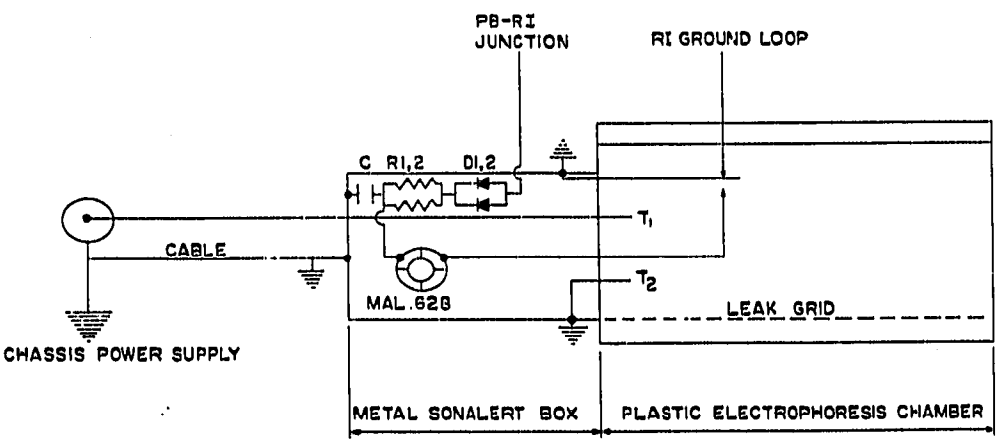

Fig. 3. External circuit.

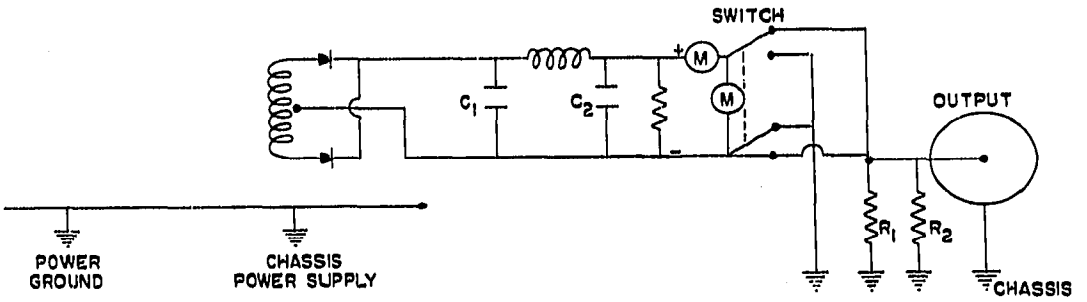

Fig. 4. Polarity switch modification.

the lid is opened, the charge on C will cause the Sonalert to sound for 1 sec. When it stops, the high voltage supply is off. The dying tone heard on opening the lid warns of danger and at the same time is a check on the working of the safety circuit. Of course, should the power not go off, the Sonalert will continue to sound. A metal grid is placed under the solvent containers in the electrophoresis chamber, and will short-out any leak current and prevent hot spills on the work bench. The diodes and resistors used in the charging circuit are duplicated for circuit security.

The polarity reversal switch circuit is outlined in Fig. 4. The transformer and negative lead are isolated from the ground. The switch simply selects the ground polarity. Included in this diagram are two bleeding resistors each 47K, 10W and wired separately. They supply added protection to discharge C_2.

Conclusion

This paper describes an electronic system designed to reduce the shock hazard associated with the use of laboratory power supplies. It is oriented to the routine operation of paper, acetate and starch electrophoresis. Fail-safe design is employed throughout, complete with an active ground monitoring system. Any malfunction in operation procedure results in an audible alert. The circuit of the audible alert is continually verified through a time decay tone on opening the electrophoresis chamber. A spill grid is incorporated to prevent hot liquids on the bench top. This apparatus is currently operating satisfactorily in routine electrophoresis analysis.

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1 G. DOWD, *Occup. Health Bull.*, 22, No. 9 (1967) 1.
2 *Gelman Model 38200 Electrophoresis Power Supply Manual*, Gelman Instrument Co., Ann Arbor, Mich., U.S.A.

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