N73-20272

MSC-07684

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

APOLLO 16 MISSION

ANOMALY REPORT NO. 9

LUNAR ROVING VEHICLE ELECTRICAL SYSTEM METER ANOMALIES

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS
JANUARY 1973

MSC-07684

APOLLO 16 MISSION

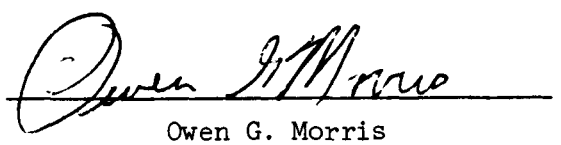
Anomaly Report No. 9

LUNAR ROVING VEHICLE ELECTRICAL SYSTEM METER ANOMALIES

PREPARED BY

Mission Evaluation Team

APPROVED BY



Owen G. Morris
Manager, Apollo Spacecraft Program

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS
January 1973

LUNAR ROVING VEHICLE ELECTRICAL SYSTEM METER ANOMALIES

STATEMENT OF ANOMALY

The following electrical system meter anomalies were present at initial powerup of the Apollo 16 lunar roving vehicle:

a. Battery 2 voltmeter indicated off-scale low.

b. Battery 2 ampere-hour meter indicated off-scale low.

c. Battery 1 and 2 temperature meters indicated off-scale low.

Other anomalous conditions were present during the second and third extravehicular activities. The battery 2 ampere-hour meter indicated an increase in ampere-hours and the battery 1 temperature meter again indicated off-scale low.

SYSTEM DESCRIPTION

The temperature of each battery is monitored by a thermister which operates in a bridge circuit (fig. 1). Bridge power is supplied when either the bus B or the bus D circuit breaker is closed. The two bridges then drive individual meter movements in a dual temperature meter.

The two battery voltages or currents are displayed on a dual display meter. The position of the VOLTS/AMPS switch (fig. 1) determines which parameter both meters will display.

The battery ampere-hour meter operates when either the bus B or the bus D circuit breaker is closed. The ampere-hour meter displays ampere-hours remaining in the batteries. This is accomplished as follows. A voltage, proportional to the battery current, is produced in the battery shunt (fig. 2). This voltage is applied through a resistor to an ampere-hour integrator. The resistor converts the shunt voltage into a current source.

The ampere-hour integrator (fig. 3) consists of a glass capillary tube which contains an electrode in each end and has an insulated external conductive coating. Between the two internal electrodes is a column of mercury with an electrolytic gap. When direct current flows between the internal electrodes, mercury is electroplated across the gap and the position of the gap moves. The position of the gap is then determined by the total coulomb charge which has been passed through the device.

The voltage is also applied across the internal electrodes. The two segments of the mercury column and the external conductive coating constitute a capacitor voltage divider; consequently, the voltage on the external conductive coating is determined by the position of the electrolytic gap. This voltage is then proportional to the total coulomb charge passed between the internal electrodes, and thus, the total charge removed from the battery. This voltage drives a meter which is calibrated to indicate ampere-hours remaining in the battery.

DISCUSSION

No single condition was found which would explain all anomalous meter indications. However, intermittent connections in some of the multiple wire crimp splices shown in figure 1 could explain the meter readings.

An intermittent connection in splice 1 could cause the battery 2 voltmeter to read off-scale low. Also, an intermittent connection in splice 3 or 4 would cause the battery 2 ampere-hour meter to read off-scale low. To cause both temperature meters to read off-scale low would require intermittents in either splice 2 or in both splices 5 and 6. An intermittent in splice 1 would cause the ampere-hour integrator 1 to indicate increasing rather than decreasing ampere-hours remaining, since the polarity on the current sense line would be reversed as shown in figure 2. Finally, an intermittent connection in splice 5 would cause the battery 1 temperature meter to indicate off-scale low.

Splice fabrication, tooling, and procedures were reviewed and are considered adequate. No cause for the intermittent conditions in the splices was found.

CONCLUSION

Intermittent conditions must have existed in several of the multiple wire splices shown in figure 1.

CORRECTIVE ACTION

No corrective action could be taken since the cause of the intermittents was not determined.

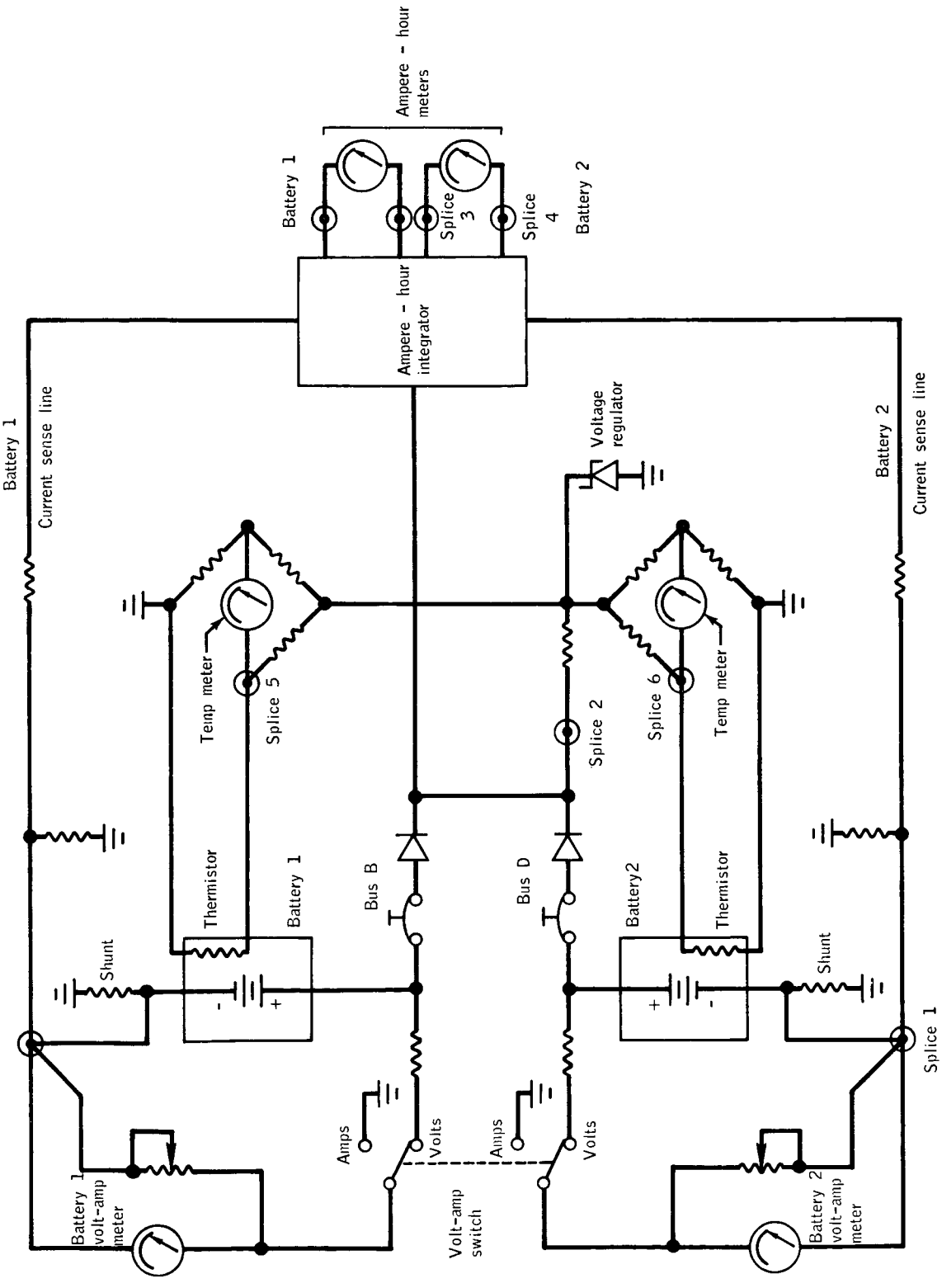


Figure 1.- Lunar roving vehicle electrical meters circuitry.

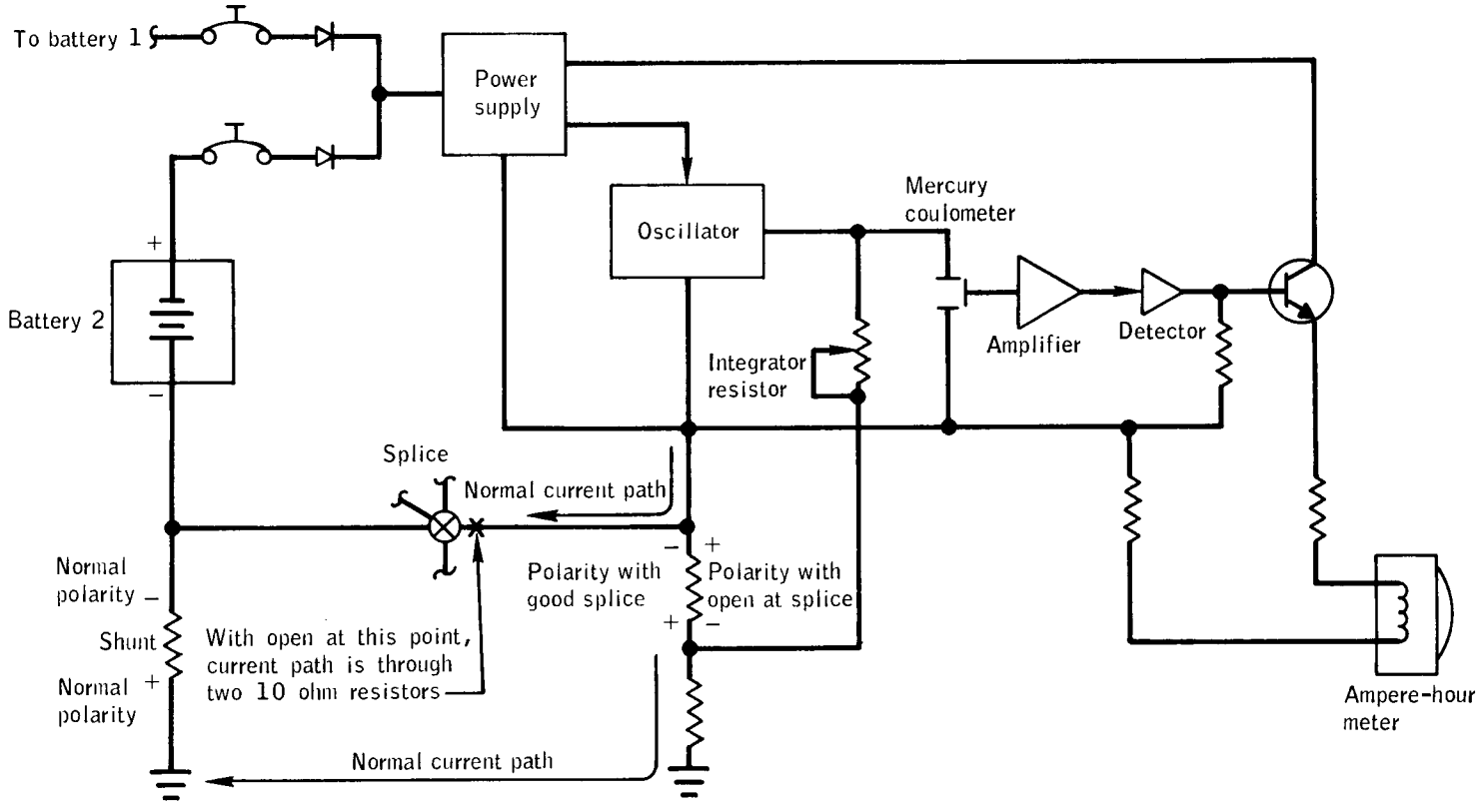


Figure 2.- Battery 2 amper-hour intergrator circuit.

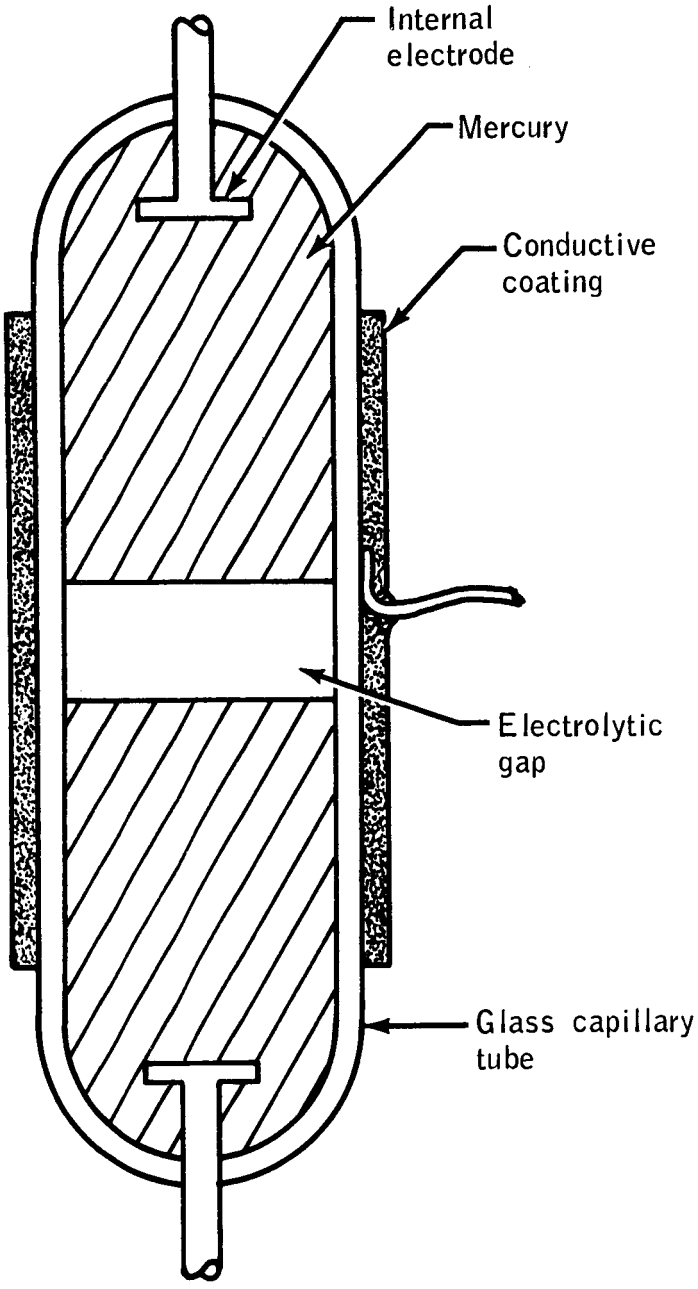


Figure 3.- Ampere - hour integrator.

NASA — MSC