SLAC-TN-77-4
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May 1977

PORTABLE HAD

This control unit is designed to power the General Monitors hydrocarbon gas detector which is presently used at SLAC by the LH_2 Target group as their standard Hazardous Atmosphere Detector (HAD). The sensor requires a heater current of 330 mA (5 V) to establish the necessary temperature for the device to perform as specified. The sensor has two elements connected in series, one being coated with a proprietary catalyst that causes the gas to burn on the surface of the element, thus increasing the temperature; and since the element is a platinum compound, also increasing the element resistance. See Figure 1.

Referring to SLAC drawing SD-140-701, Q1 is a series pass transistor and IC1 (723) is the current regulator. The voltage across R3 is forced to equal the reference voltage at pin 5 of IC1. Since the current through the sensor elements is basically the same as that through R3, it will be held at a constant value.

The control unit is powered by a 12 volt rechargeable GEL cell rated at 1.5 amp hours, which should supply sufficient power for continuous three-hour operation. Battery recharge is accomplished by plugging in 117V 60 ~ line voltage to the connector provided on the rear of the chassis. The battery will charge at a 150 mA charge current which drops down as battery voltage rises. The charging current stops when battery charges to $\approx$ 14.5 volts. If line voltage remains connected, charge current will trickle charge at $\simeq$ 15 mA. This charge function is accomplished utilizing IC7 (723) as the current limiting regulator, one-half of IC8 as the voltage monitor. K2 (relay) is used to reduce the battery drain to zero when the device is not in use or being charged. LED 2 is across the resistor R54 CR11 which senses battery charging current and indicates when the battery is actually being charged. Transformer T_1 is part of the charging circuit, reducing the line voltage to 20 volts. T_1 has a current rating of 250 mA when connected as shown.

When battery voltage drops below 11 volts, the need for recharging will be signalled by a loud warbling alarm from the speaker (when the device is turned on).

The instrument is turned on by pressing S1 (see Figure 3 schematic). This latches on relay K1 (which is also used to reduce the non-operating battery load to zero). K1 on battery voltage is supplied to the remainder of the circuitry. Half of IC5 (556) is used as a 20 minute (nominal) timer to insure that if the unit is not manually turned off (by pressing S2) within the 20 minute time span, the unit will shut itself off. Depressing S1 will cause the instrument to resume operation immediately. The purpose of this function is to eliminate the possibility of an operator forgetting to turn the device off and possibly destroying the batteries.

Under normal operation, S1 will be depressed and the instrument will come on with the meter running quickly up scale and an audio frequency following it. If the alarm level is set to 50% LEL, the alarm will be tripped during this warm up period. Within a minute or so, the meter and the audio should return to zero. The audio at zero meter deflection will be a "tick" at a frequency of approximately 1 per second. IC4 (XR2207) is a voltage controlled oscillator that will be adjusted by varying P5 with the meter at zero for a 1 cps tick. As a gas is sensed the meter will start to deflect up scale and the frequency of the ticking will increase in proportion until the previously established alarm level (normally set to 50% LEL) is reached, at which point one-half of IC3 will sense the alarm level has been reached and will force VCO (IC4) into a high frequency mode. When the level drops below the alarm level, the audio will return to a non-alarm mode. The alarm level is set by adjusting P4 and is adjustable over the range 0 to 100% LEL. The second half of IC3 is used to indicate a low battery voltage with the warbling being generated by using the other half of the 556 dual timer.

The two elements of the sensor are connected in a wheatstone bridge configuration along with R1 and R2. The output voltage is taken from the connection of R1 and R2 and the center arm of the span pot P2. Zeroing is accomplished by varying the d.c. voltage of the R1/R2 junction point and thus zeroing the output of the d.c. amplifier (half of IC2 (747)). P2 is the span adjust that will compensate for different sensitivities of the sensors. The output voltage of the sensor (when a 100% LEL gas level is experienced) is approximately a ten millivolt change. One-half of IC2 is used to d.c. amplify this signal to a 0 to 2 volt signal change. For this case, the amplifier

output is returned to a fixed 4.5 volt voltage regulator (reference supply IC6 (723)). The output voltage starts at 4.5 volts and decreases to 2.5 volts when the 100% LEL gas is experienced. R8 is a 2K resistor that converts this 0-2 volt signal to a 0 to 1 mA meter drive. During normal operation the meter must also be returned to the 4.5 volt reference supply. This output voltage is also directed to the VCO to cause the frequency to track the meter indication. S3, when depressed, switches the meter to indicate battery voltage. Full scale is 22 volts.

S4, when depressed, will indicate the heater current by reading the voltage across R3. Normal operation will result in a mid-scale deflection of the meter. Adjusting of the heater current is accomplished by changing P3.

The second half of IC2 is used to obtain an 0 to 10 volt analog output voltage corresponding to 0-100% LEL.

The second half of IC8 is used to monitor the sensor heater current. Should this drop below 300 mA, the malfunction alarm LED will indicate.

PORTABLE HAD FEATURES AND SPECIFICATIONS

1. Package size: 3.5 x 6 x 8.5 inches
   Weight: 6 lbs

2. Power source: 12 V rechargable Globe Cell No. GC 1215
   1.5 AMP hour rating

3. Power shut off automatically after 20 minutes

4. Typical number of (on) cycles before charge needed: 5

5. Maximum time required for full recharge: 10 hours

6. Audio alarm for battery low condition (frequency warbles) when power is switched on

7. Built-in charge circuit (rear panel plug 120 V 60 cycle)

8. Adjustable alarm level: range 0-100% L.E.L.

9. Adjustable audio alarm volume

10. Calibrated full scale for 100% L.E.L. of Hydrogen
    Can be calibrated for most all combustible gasses

11. Increased gas concentration results in increased audio frequency

12. Blinking LED on sensor gives additional visual indication of gas concentration. (Flashing rate increases with higher concentration)

13. Sensor attached to control unit by a coiled cable extendable to 6 feet

14. Front Panel

Controls:
1. On switch
2. Off switch
3. Battery voltage check switch (meter should read in the green)
4. Heater current check (adjust for mid-range) (330 mA)

Adjustments:
1. Meter zero adjustment
2. Span (range or calibration adjustment)
3. ALARM level adjustment
4. AUDIO volume adjustment
5. TICK adjustment (audio frequency)
   Set to 1 pps when meter is zero

Indicators:
1. Front panel meter (1 mA movement): visually displays percent of L.E.L. switched capabilities:
   (a) indicating battery voltage (Half scale = 11 volts)
   (b) and heater current (Half scale = 330 mA)
2. LED MALFUNCTION indicator (indicates open in heater circuit)
3. LED indicating battery is being charged
4. Speaker - gives audio indication of gas concentration
5. Front panel jack - allows use of earphones in high noise environment

FIGURE CAPTIONS

Figure 1	Schematic of sensor head
Figure 2	Control unit photos: 3 views, front, back and internal
Figure 3	Schematic SD-140-701

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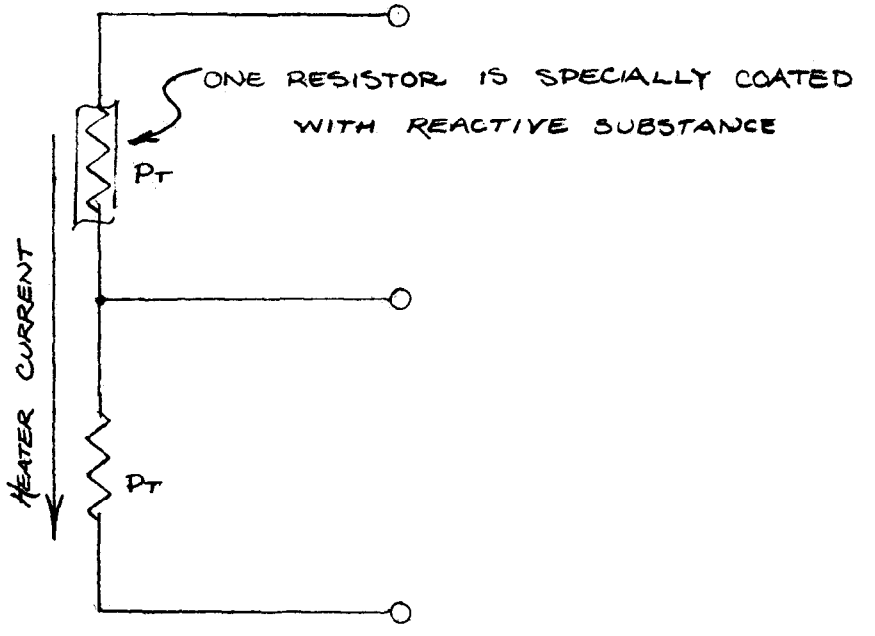

Fig 1 : Schematic of Sensor Head.

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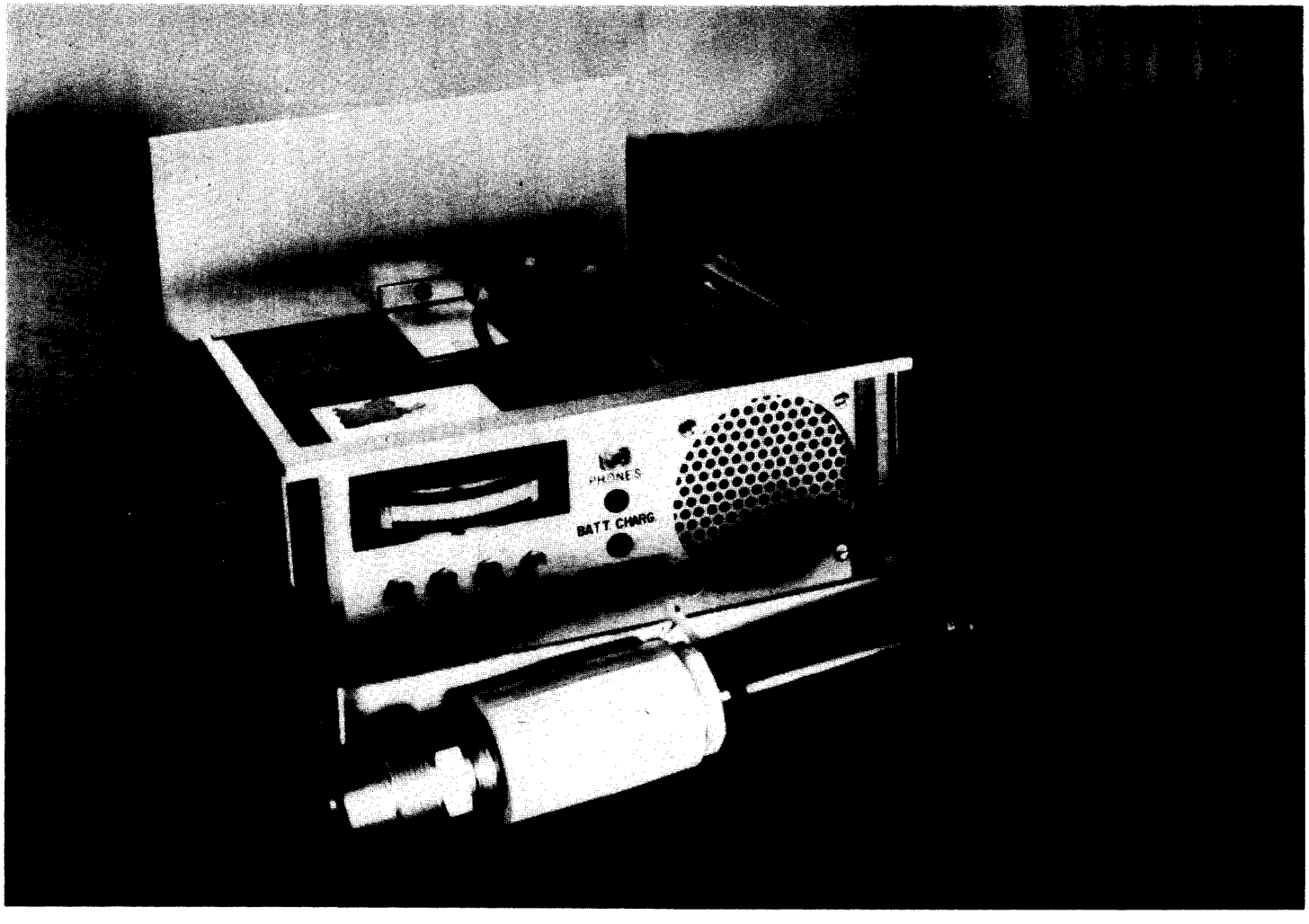

Fig. 2a

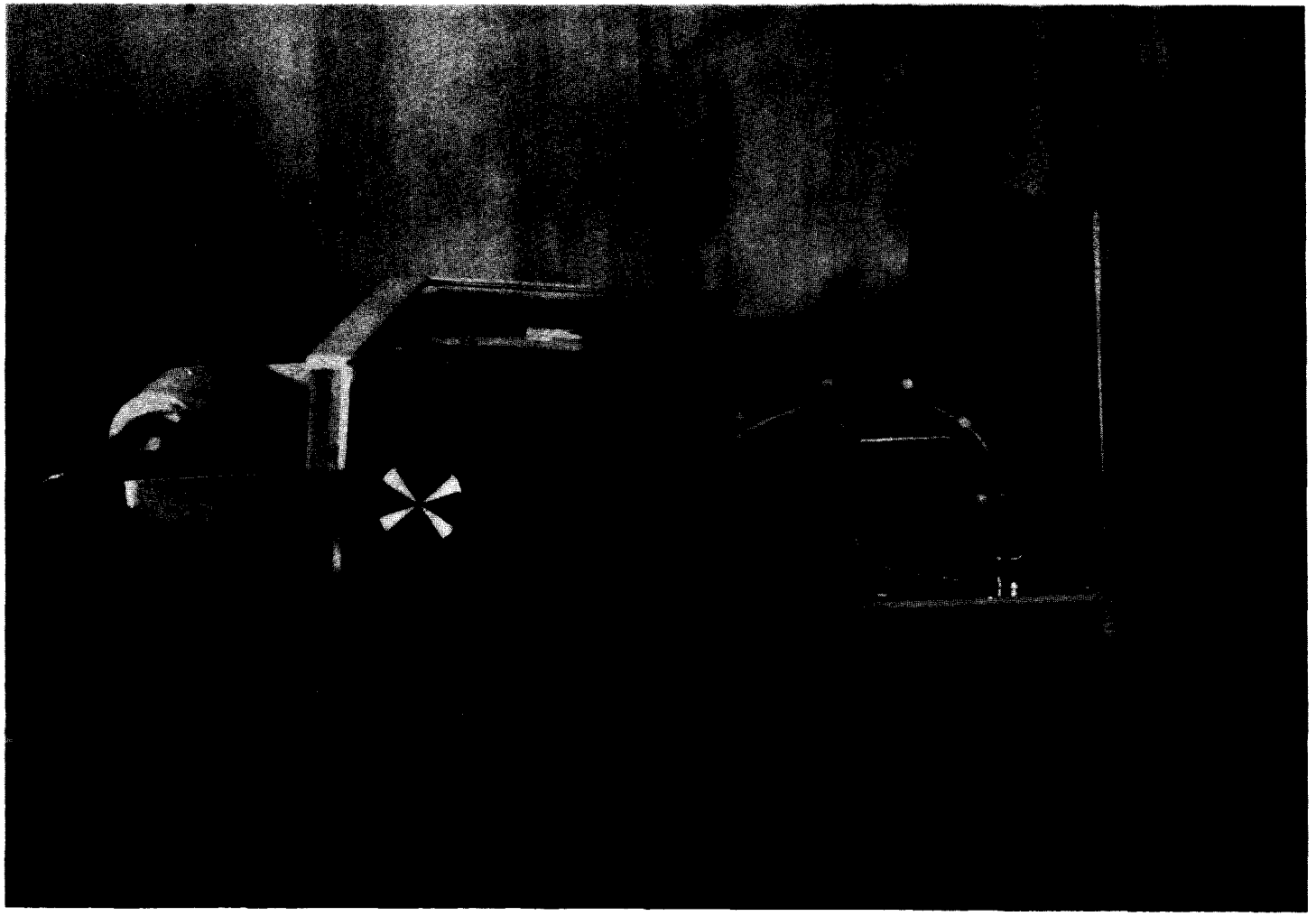

Fig. 2b

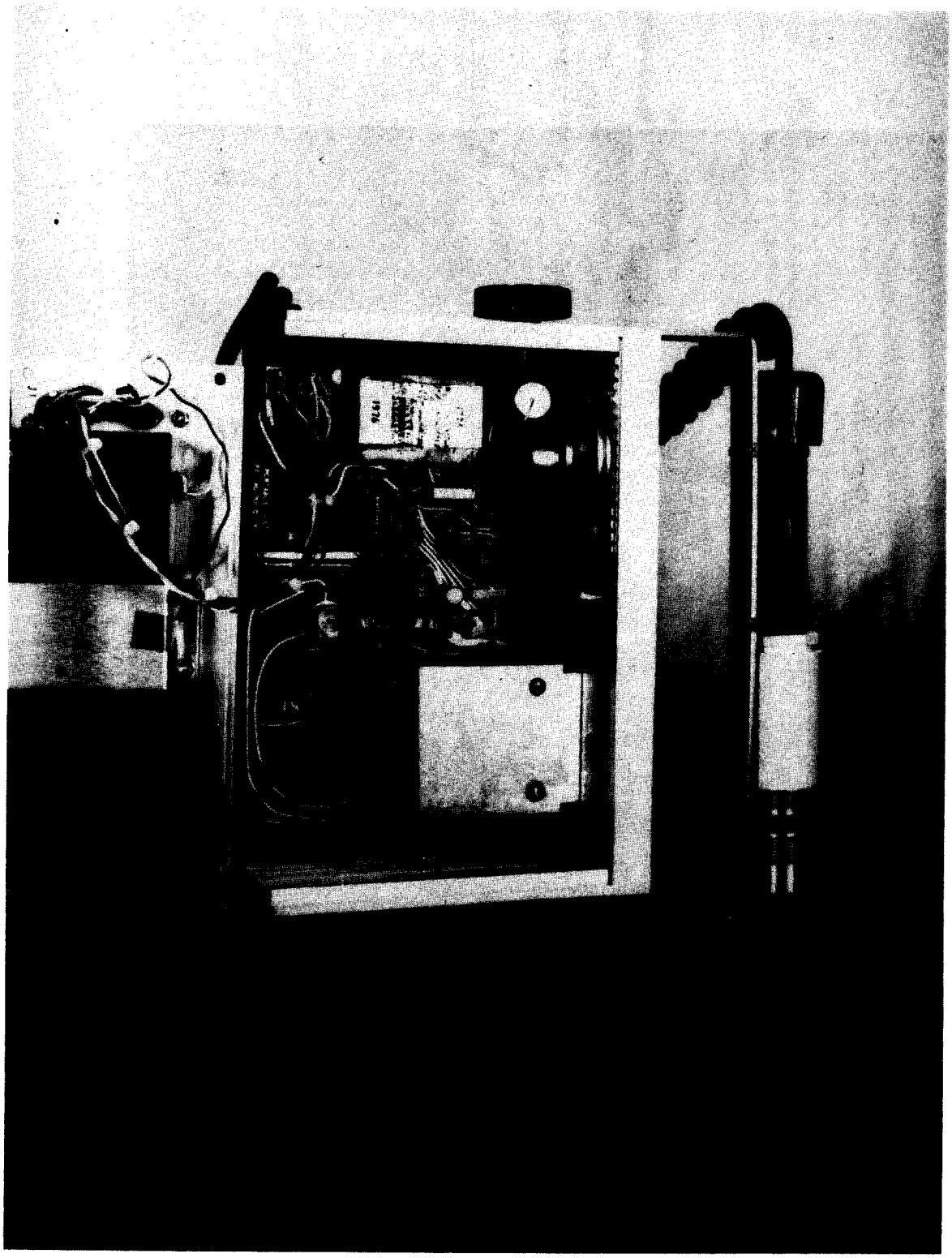

Fig. 2c

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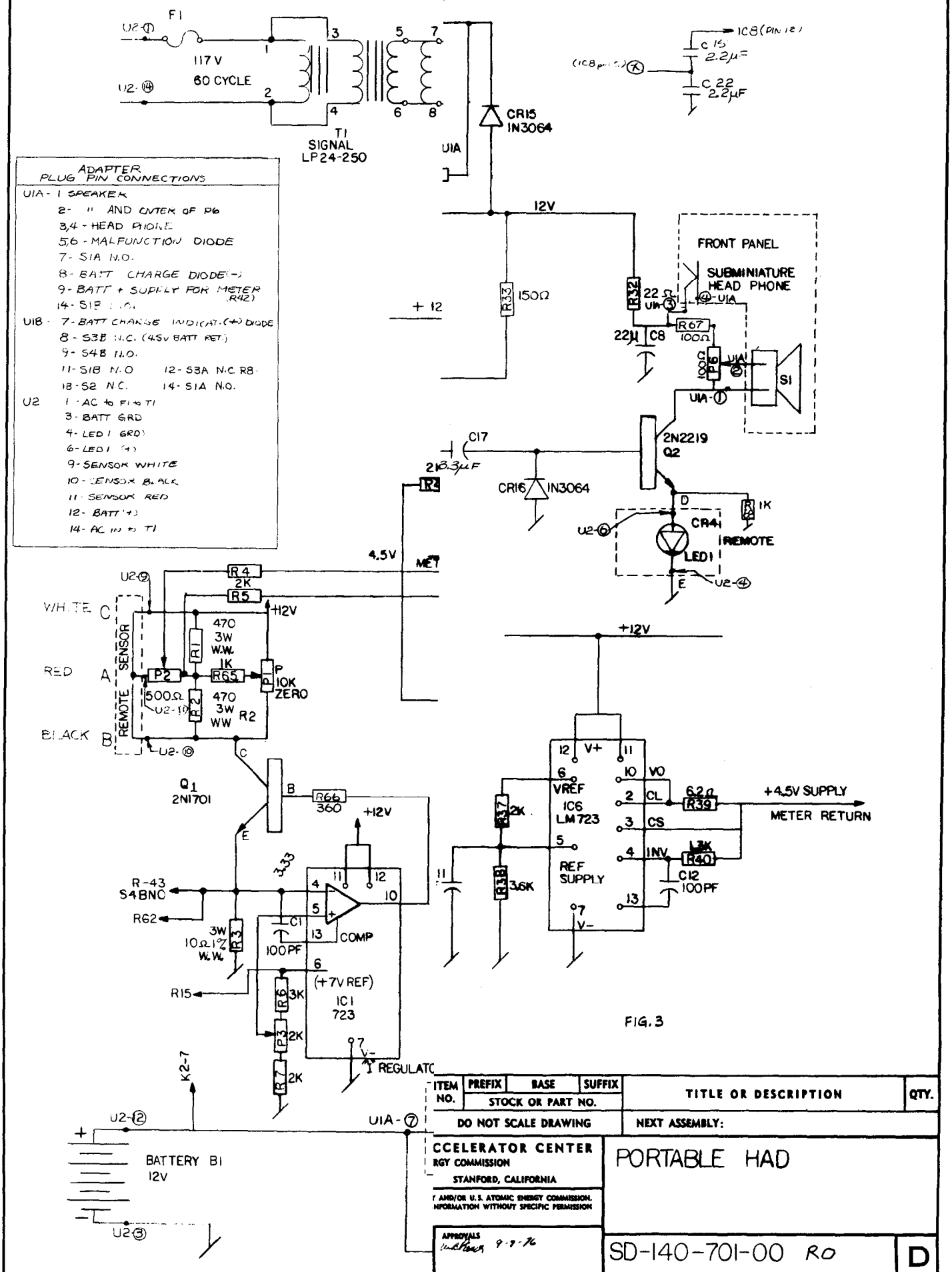

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