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Fig. 1 Model ESP-9 Studio Monitor Stereophones with E-9 self-energizer.

ESP-9 Electrostatic Stereophones* are a new development employing the principle of a currentless, or electrostatic charge on push-pull condenser plates to cause movement of an intervening, light, conductive diaphragm. The diaphragm will move in conformance to the signal energy from an amplifier to produce wide frequency response range with low distortion.

The ESP-9 has a response range of 10 octaves, *the widest ever attained in a headset*. A new cup design promotes virtually linear response to below 20 Hz.

The ESP-9 has a signal handling capacity of 10 volts at 30 Hz with good wave form versus 6 volts for the ESP-6. This is made possible by increasing the size of the coupling transformers by a factor of 4, and mounting them externally to the cup in the E-9 Energizer.

The E-9 Energizer offers the option of self-energizing for the bias supply, or energizing through the ac line. Choice is made with a selector switch on the front panel. When energized through the ac line, very precise level measurements can be made. Thus the unit is ideal for audiometry and for evaluating the spectral character of very low level noise in equipment like tape mastering machines and recording consoles. In contrast to the ESP-6 and ESP-7, both cups are independently energized; a left cup signal is not required to supply bias to the right cup.

Electrical Description. The usual speaker impedance is lowest in the midrange of frequencies. At the extremes of the range, the impedance will increase 10 to 20 times or more. With electrostatic devices, the highest impedance is in the middle of the range, with the lowest impedances at the extremes. For these reasons it is appropriate to quote, not the internal impedance of the speaker or headphone, but the impedance of the source into which it is designed to operate. Therefore, in the specifications to follow, attention is called to the **source impedance**.

The self-energizing power source consists of a voltage tripler, the maximum voltage of which is controlled by a zener diode circuit across the internal high impedance circuitry. Because of the long time constants employed, the "wattless" drain of the power source has no perceivable effect on the signal.

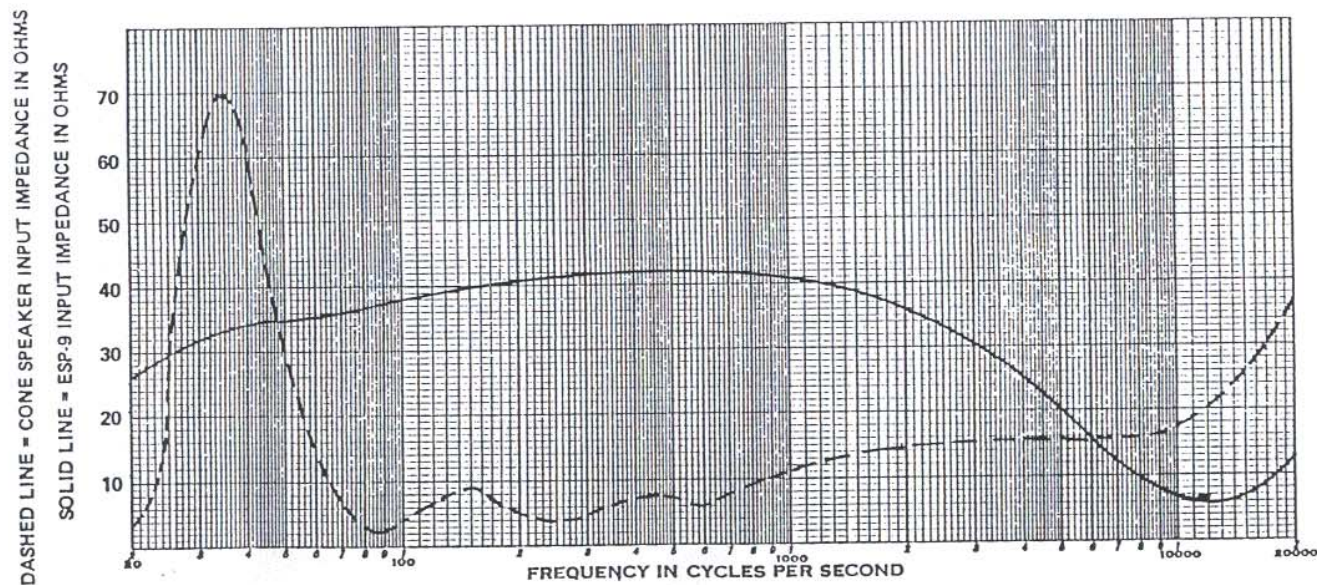


Fig. 2 Solid line represents impedance characteristic of ESP-9 Stereophones. Dashed line shows impedance characteristic of a high quality speaker for comparison. (Courtesy Klipsch and Associates.)

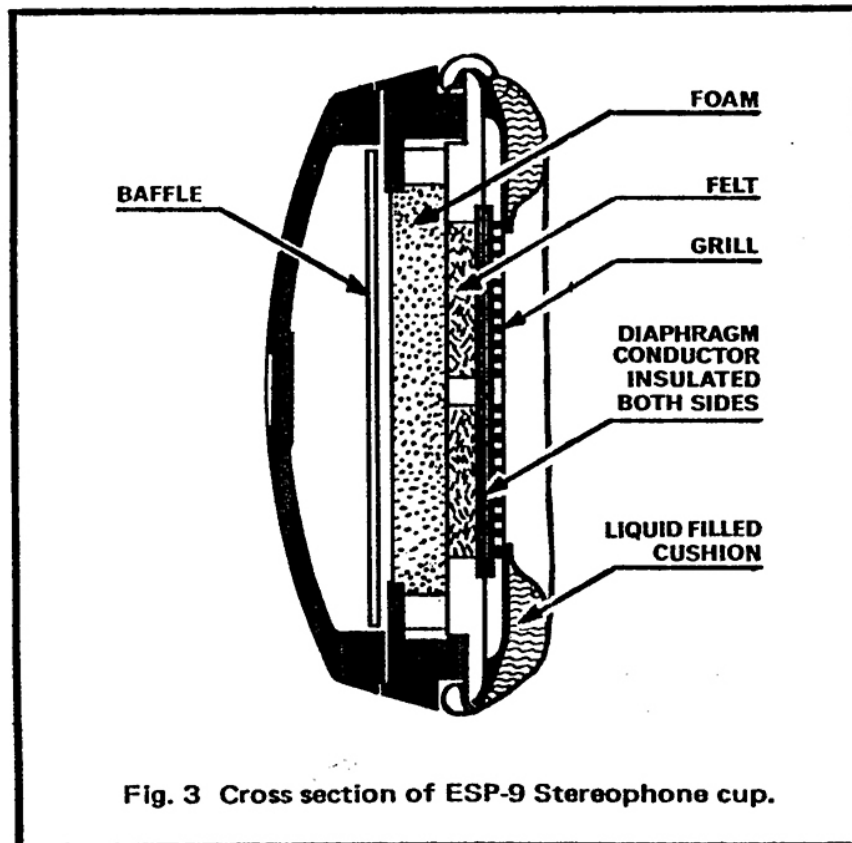
Physical Description. The ESP-9 is a comfortable, light weight design with a wide, fully adjustable stainless steel headband and molded plastic headband cover. This cover is fitted with a wide, foam cushion for added comfort. The large coupling transformers and speaker/headphone transfer switch are mounted in the E-9 energizer. The rotary switch on the front panel of the energizer selects ac operation for precision measurements of output, or self-energizing for maximum convenience. The headset itself weighs only 19 ounces. Fluid filled ear cushions conform to individual head contours, providing an excellent seal and unusual comfort.

The headset is connected to the E-9 energizer with a 5 conductor cable which terminates in a 5 pin plug. The E-9, in turn, is connected to a 6', 4 conductor input cable, which is terminated with 4 spade lugs for easy connection to amplifier output terminals.

The source for the currentless electrostatic charge on the element plates is located in the E-9 energizer. This isolates the high impedance electrostatic plates from the low impedance amplifier output.

A mount which accepts all standard boom microphones is installed on the left cup, in front of the phone cord. This mount is furnished for the convenience of conductors, sound engineers and technicians who require the facility of studio "talk-back".

The ESP-9 represents a true breakthrough in wide range frequency response and low distortion. It *exceeds* the performance of the best speaker systems now available. A new era in personal listening is beginning for the discriminating music lover. Spurious room resonances are banished by the controlled listening environment exactly tailored to the human ear.



Source Impedance: 4 to 16 ohms; at higher impedances response at the extremes of the range will progressively reduce, e.g., 50 ohms causes a 5 db loss at 30 and 10,000 Hz.

Sensitivity: 90 db SPL at 1kHz \pm 1 db referred to 0.0002 dynes/cm² with 1 volt at the input. Variations from calibration furnished are less than 1/2 db at 25° C.

Frequency Response Range, Typical:
 15-15,000 Hz \pm 2 db (10 octaves)
 10-19,000 Hz \pm 5 db

An individual, machine-run response curve is furnished with each headset, made as shown in Fig. 5.

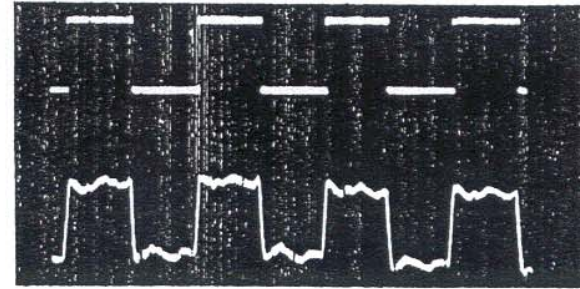


Fig. 4 Response to 400 Hz square wave. Upper trace is input; lower trace is ESP-9.

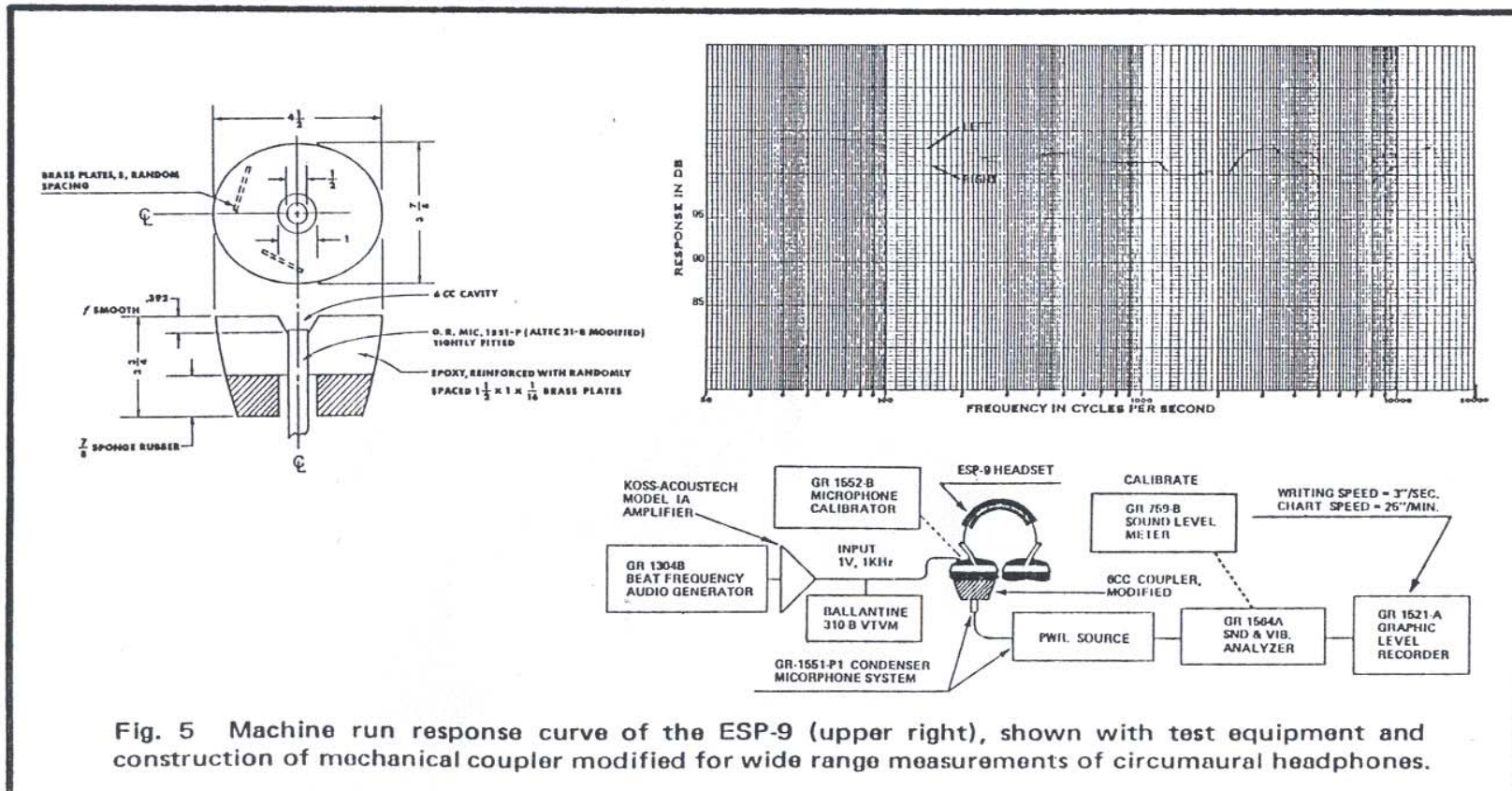


Fig. 5 Machine run response curve of the ESP-9 (upper right), shown with test equipment and construction of mechanical coupler modified for wide range measurements of circumaural headphones.

Isolation from External Noise: 40 db.

Total Harmonic Distortion: Less than .2% at 110 db SPL.

Power Handling Capability: Maximum continuous program material should not exceed 10 volts (12 watts) as read by an ac VTVM (Ballantine meter 310B or equal) with average indicating circuitry and rms calibrated scale; provides for transient peaks 14 db beyond the continuous level of 10 volts.

External Power Requirements: None, except when used for precise low level signal measurement, when external ac line can be selected by a front panel switch on the E-9 energizer (1/16 amp, 117 VAC, 50-60 Hz normally; 234 VAC with internal strap for foreign use).

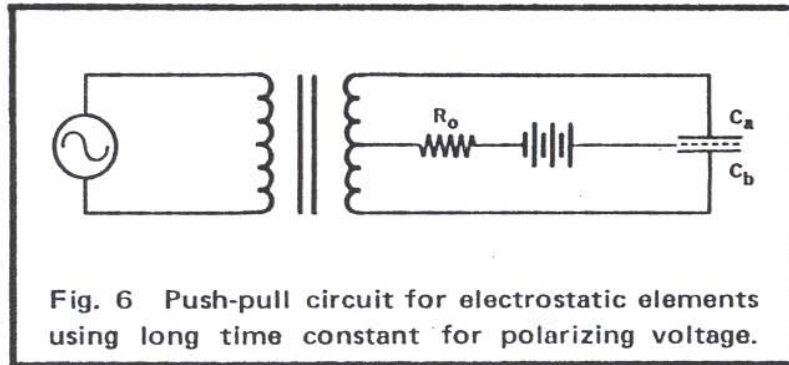


Fig. 6 Push-pull circuit for electrostatic elements using long time constant for polarizing voltage.

physical

Size of Cup: 4½" h x 3¾" w x 1¼" d.

Cushions: Fluid filled for high ambient noise isolation.

Headband: Extendable, stainless steel bands with self-adjusting, pivoting yokes. Conforms to any head size.

Headband Cover: Wide, molded polyvinyl with ½" thick polyethylene pad on underside.

Headset Cable: Flexible, polyvinyl, 5 conductor, shielded, 6' long. Black with 5 prong plug keyed to jack on E-9 energizer.

Boom Microphone Mount: Knurled, anodized aluminum knob on left cup with threaded shaft and 2 rubber washers. Accepts all standard boom microphones.

Weight of Headset only: 19 ounces.

E-9 Energizer: Contains 2 coupling transformers, self-energizing circuitry, speaker/headphone transfer key switch, energizing source selector switch and ac pilot light on black anodized front panel. Also contains ac power transformer, ac line fuse, and speaker terminals. Integral, 6', 4 conductor input cable is terminated with spade lugs for connection to amplifier output terminals.

Size: 4½" h x 3¾" w x 6¼" d.

Weight: 3 pounds.

Accessory Provided: 6' ac line cord (P/N 41-0235) for optional use for ac energizing.

theory of operation

The moving diaphragm of the ESP-9 is a conductively coated polyurethane film less than .5 mil thick, spaced 25 mils from 2 perforated, acoustically transparent metal plates. When a static charge is placed on the element, ac signals from the source, through the coupling transformer cause the diaphragm to be attracted from one plate to the other in conformance to the signal variations.

Dynamic and static stability of the diaphragm is sustained through the push-pull action and the tension of the mobile diaphragm. This stability is achieved because the static charge has a long time constant when fed to the stator plates through the very large resistor of 22 megohms.

This gives response which is flat below the 1500 Hz resonance of the system, and the output is entirely free from second harmonic distortion, except that resulting from the coupling transformer. Odd order harmonics are those due to small asymmetrical differences from one side of the diaphragm area to the other. High frequency response is smoothed through critical damping by means of felt, polyurethane foam, baffles, slots and grills.

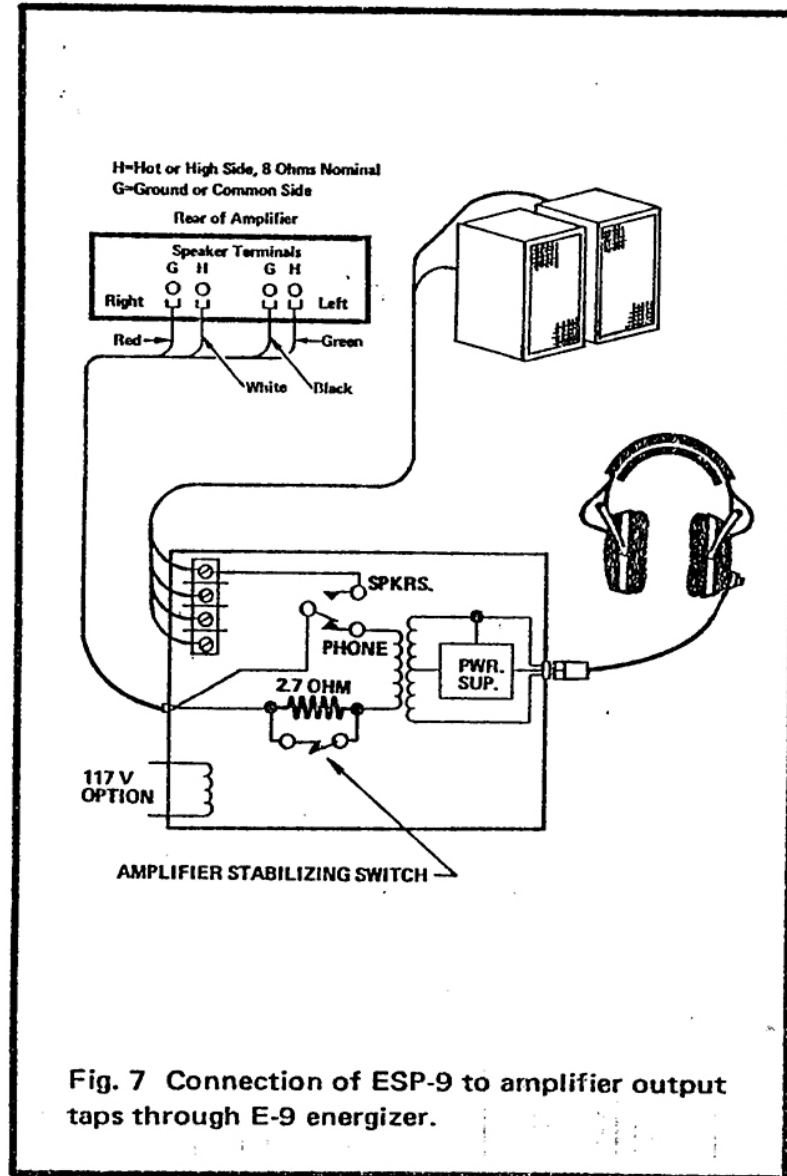
The ESP-9 must be connected directly to the output terminals of the amplifier or receiver through the E-9 energizer.

CAUTION NOTE: Make certain the amplifier is turned off before connecting the E-9. The BLACK and RED wires go to the COMMON, or GROUND of both channels. If these are connected to the hot, or high sides of the amplifier outputs, no stereo will result. In addition, the outer plates of the ESP-9 elements adjacent to the ear will be at signal potential instead of grounded. This will tend to attract dust to the diaphragm surface. The WHITE wire feeds the HOT of the right channel, and the GREEN wire feeds the HOT of the left channel.

While the ESP-9 is rated for an amplifier output impedance of 8 ohms, the frequency response range at the extremes is favored by the lowest impedance tap on the amplifier. However, some transistor amplifiers have a series resistor in the 4 ohm tap so a low speaker load will not draw higher power, nor cause the amplifier to approach an unstable operating condition where oscillation might occur. In the case of a series resistor in the 4 ohm tap, better operation will be achieved by the ESP-9 on the 8 ohm amplifier outputs. See Fig. 2.

A special slide switch is located on the rear of the E-9 which inserts series input resistors to stabilize amplifiers with very low damping factors.

With tube amplifiers, the 4 ohm tap will deliver best results. In any case, the ESP-9 will deliver response within specification at impedance taps of 4 to 16 ohms on both transistor and tube type amplifiers.



Monaural Connection - The inputs to the ESP-9 can be paralleled for monaural operation. The ground, or common lead wires (BLACK and RED) are both attached to the COMMON amplifier output terminal. The GREEN and WHITE lead wires are both attached to the HOT amplifier terminal.

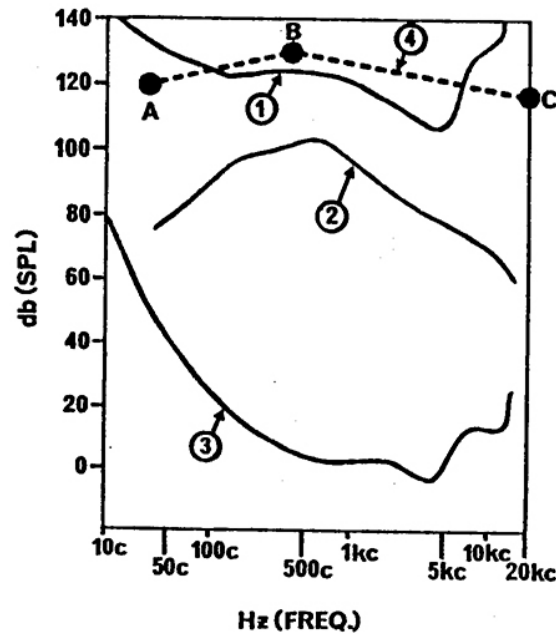
CAUTION NOTE: The outer element plates of the left and right ESP-9 assemblies (RED and BLACK wires) are connected together, and must go to the COMMON side of the respective amplifier output terminals. This grounds signal voltages on the element plates adjacent to the ear, and prevents the accumulation of dust on the diaphragms due to the electrostatic charge. If the RED and BLACK wires are transposed with the GREEN and WHITE wires, and go to the HOT amplifier output terminals, monaural sound will result, whether or not it is desired.

Next, attach the speaker leads to the speaker terminals on the back of the E-9 energizer. This will make the speaker/headphone transfer switch operational. Make certain the amplifier volume is turned down. Then plug the ESP-9 headset into the E-9 energizer. With the transfer switch in the Stereophones position, gradually increase the volume to a comfortable listening level.

Since speaker efficiencies vary considerably with make and model number, it is recommended that the amplifier volume be turned down before placing the transfer switch in the Speaker position for the first time. This is to insure against doing accidental damage to your speakers. If you

determine that the volume does not vary greatly between phones and speakers, this precaution will not be necessary.

When you seat the fluid-filled ear cushions, an almost perfect seal against outside noise is effected. Because of this near-perfect seal, a slight crinkling or "sucking" sound may be heard. This will stop as soon as the pressure on both sides of the diaphragms has equalized.



LEGEND

- ① Threshold of pain.
- ② Peak orchestral levels.
(Probable levels are typically 25db less)
- ③ Threshold of audibility.
- ④ ESP9 Sound Power Level capability
w/o failure.

NOTES

- ① 0db SPL represents either 0.0002 Baryes
(Sound Pressure Level) or 10^{-12} w/m²
(Sound Power Level).
- ② Points A & C represent 10 V rms. Point B
represents 20 V rms across ESP9 input.
- ③ Curves 1, 2, and 3 from Bell Tel. Lab's
"Record" issue of June, 1934.

Fig. 8 Maximum power handling of ESP-9 at various frequencies compared with peak energy distribution in music. The power at which failure will occur varies with frequency. Note that peak handling capabilities conform to the average energy distribution in music.

RESISTANCE and VOLTAGE - All readings taken with a 20,000 ohm/volt VOM

**LEFT CUP - element assembled to circuit board,
headset unplugged from E-9**

RESISTANCE	FAULT
K to M = greater than 20 megohms	If less than 10 megohms, element diaphragm is shorted
L to M = greater than 20 megohms	

E-9 CIRCUIT BOARD - board unplugged from socket

RESISTANCE	FAULT
D1, D2 and D3 = less than 1k ohms forward resistance, greater than 20 megohms reverse resistance	Defective diode
D4, D5, D6 and D7 = less than 1k ohms forward resistance, greater than 20 megohms reverse resistance	

VOLTAGES

With 3V rms at 1k Hz applied to the primary, red and blue, of each audio transformer

- green to yellow = 90V rms \pm 10%
- yellow to black = 90V rms \pm 10%
- green to black = 180V rms \pm 10%

With 117 VAC applied to the primary, black and black/red, of AC transformer

red to red/yellow = 200V rms \pm 10%

**RIGHT CUP - element assembled to circuit board,
headset unplugged from E-9**

RESISTANCE	FAULT
A to C = greater than 20 megohms	If less than 10 megohms, element diaphragm is shorted
B to C = greater than 20 megohms	

AUDIO TRANSFORMER

RESISTANCE BETWEEN TRANSFORMER LEADS - BOARD UNPLUGGED	FAULT
blue to red = 0.95 ohm green to yellow = 1.8k ohms yellow to black = 1.6k ohms green to black = 3.4k ohms	Defective transformer

AC POWER TRANSFORMER

RESISTANCE BETWEEN TRANSFORMER LEADS - BOARD UNPLUGGED	FAULT
red/white to blue/white = 1k to 1.7k ohms red/black to green/white = 400 to 750 ohms red/black to black/white = 500 to 850 ohms green/white to black/white = 900 to 1600 ohms	Defective transformer

**LEFT CUP - element assembled to circuit board,
headset unplugged from E-9**

RESISTANCE

FAULT

K to M = greater than
20 megohms

L to M = greater than
20 megohms

If less than 10 megohms,
element diaphragm
is shorted

**E-9 CIRCUIT BOARD - board unplugged
from socket**

RESISTANCE

FAULT

D1, D2 and D3 = less
than 1k ohms forward
resistance, greater than
20 megohms reverse
resistance

D4, D5, D6 and D7 =
less than 1k ohms
forward resistance,
greater than 20 megohms
reverse resistance

Defective diode

VOLTAGES

With 3V rms at 1k Hz applied to the primary,
red and blue, of each audio transformer

green to yellow = 90V rms \pm 10%
yellow to black = 90V rms \pm 10%
green to black = 180V rms \pm 10%

With 117 VAC applied to the primary, black and
black/red, of AC transformer

red to red/yellow = 200V rms \pm 10%
red to red = 400V rms \pm 10%

**RIGHT CUP - element assembled to circuit board,
headset unplugged from E-9**

RESISTANCE

FAULT

A to C = greater than
20 megohms

B to C = greater than
20 megohms

If less than 10 megohms,
element diaphragm
is shorted

AUDIO TRANSFORMER

**RESISTANCE BETWEEN
TRANSFORMER LEADS -
BOARD UNPLUGGED**

FAULT

blue to red = 0.95 ohm
green to yellow = 1.8k ohms
yellow to black = 1.6k ohms
green to black = 3.4k ohms

Defective transformer

AC POWER TRANSFORMER

**RESISTANCE BETWEEN
TRANSFORMER LEADS -
BOARD UNPLUGGED**

FAULT

red/white to blue/white =
1k to 1.7k ohms
red/black to green/white =
400 to 750 ohms
red/black to black/white =
500 to 850 ohms
green/white to black/white =
900 to 1600 ohms

Defective transformer

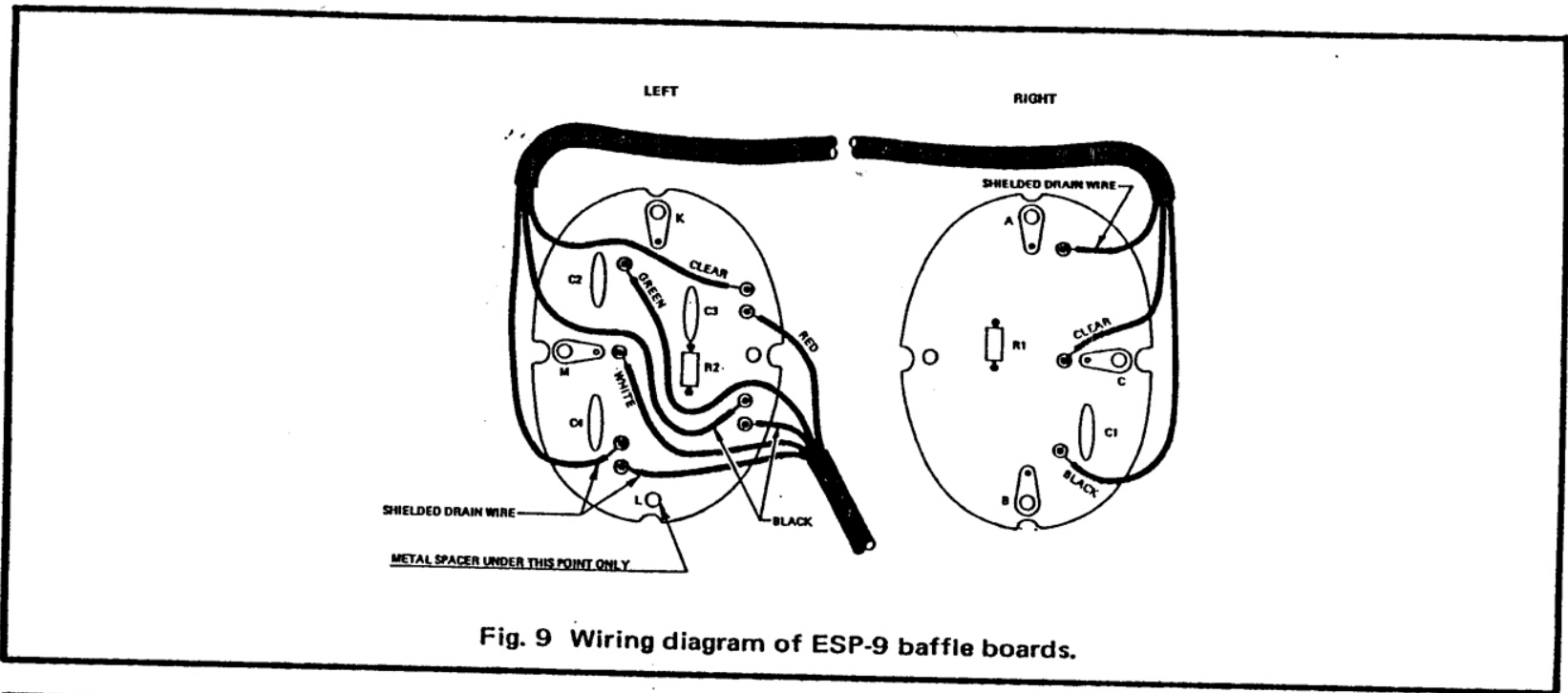


Fig. 9 Wiring diagram of ESP-9 baffle boards.

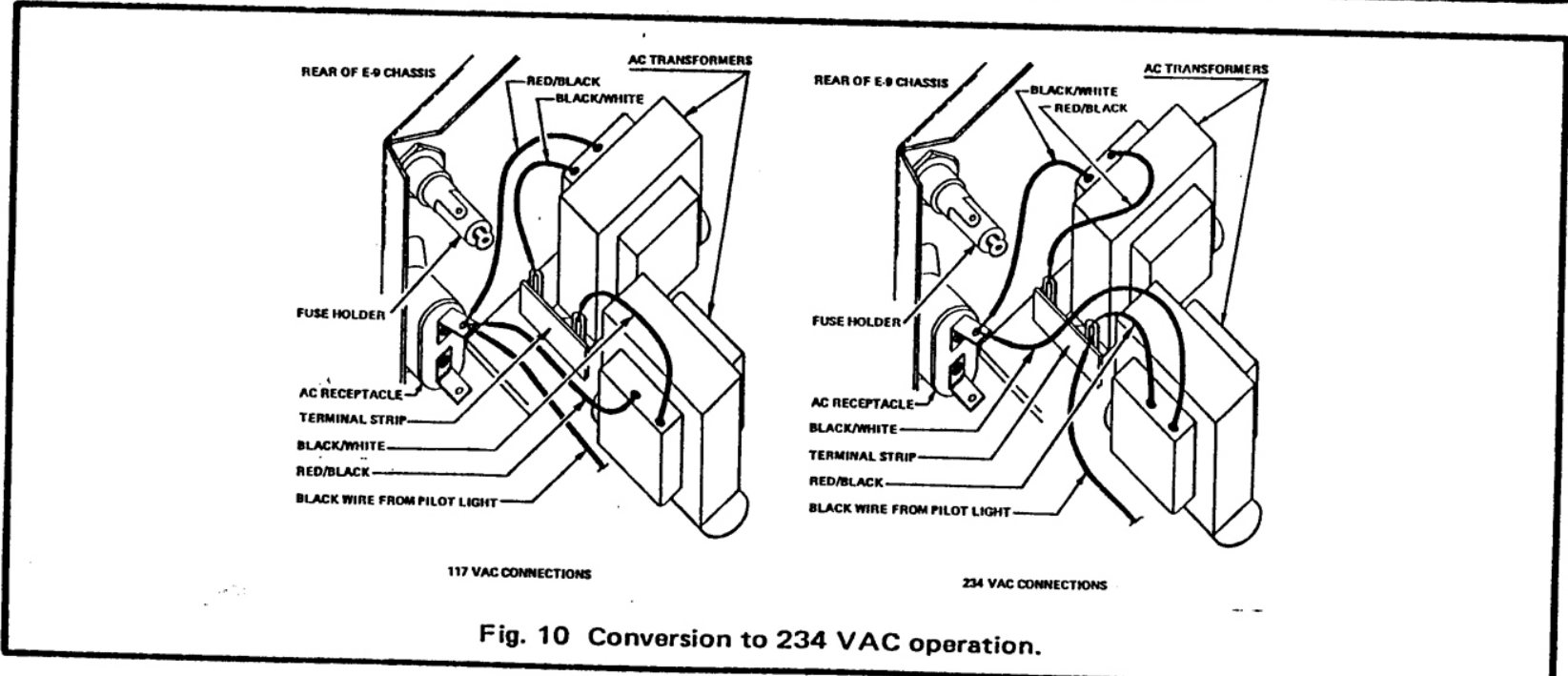


Fig. 10 Conversion to 234 VAC operation.

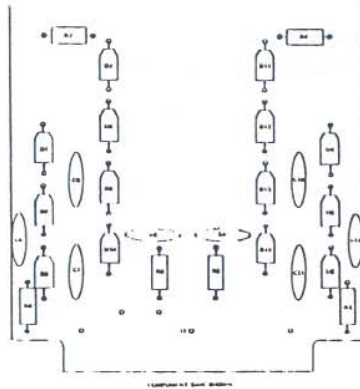


Fig. 11 E-9 Circuit Board.

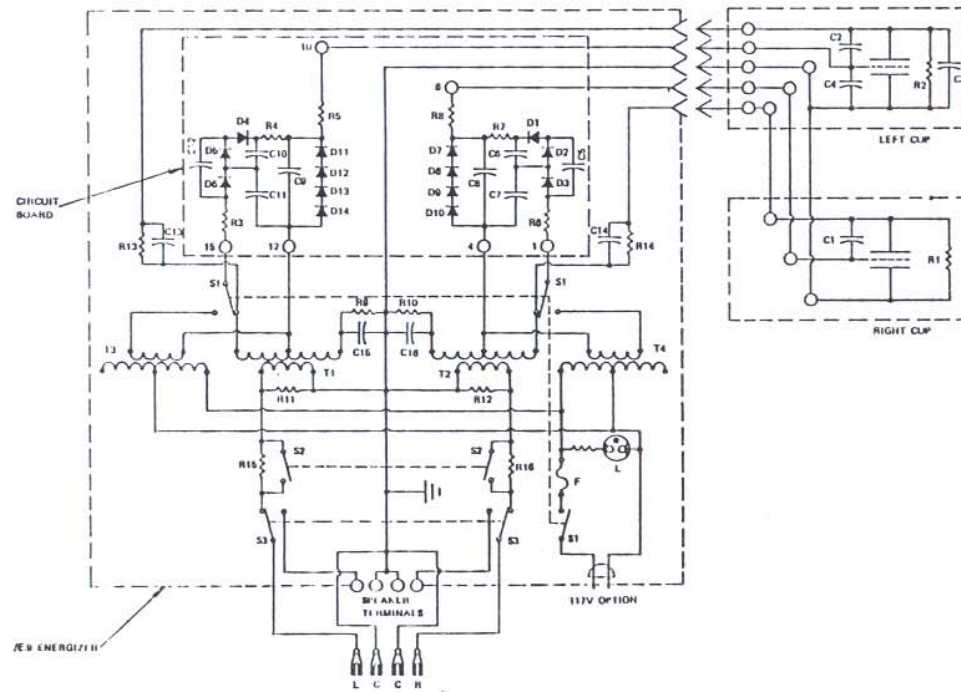


Fig. 12 ESP-9 Schematic Diagram.