(Reprinted from the Italian magazine Audion. *Translation by Valeriano Tora)*

DUAL SINGLE 300B STEREO AMPLIFIER

BY FABRIZIO CAPPELLETI

This article describes a single-ended 300B, Class A output-stage stereo power amplifier, with no feedback and a rectifier tube and choke-type filter power supply. It features high-quality low-stray flux power and output transformers, the power one being tuned to the filter stage, and it includes traditional "in air" wiring and selected quality components. The balanced output stage allows bridging of the two channels for a double output power single-stage amp.

This 300B stereo amplifier (*Fig. 1*) is easy to build and is available as a kit at the extremely reasonable cost of 2,450,000 liras (approximately $1,500). The design of this amp is relatively simple (and inexpensive), since it uses only one driving pentode, chosen after careful consideration of both electrical and sonic properties.

It includes a "telephone" type tube, the TS49/PT49, which easily drives the 300B well over the high end of the audio range. Its good transconductance and rather low internal impedance allowed a circuit design with a sensitivity of only 800mV for 8W output, which

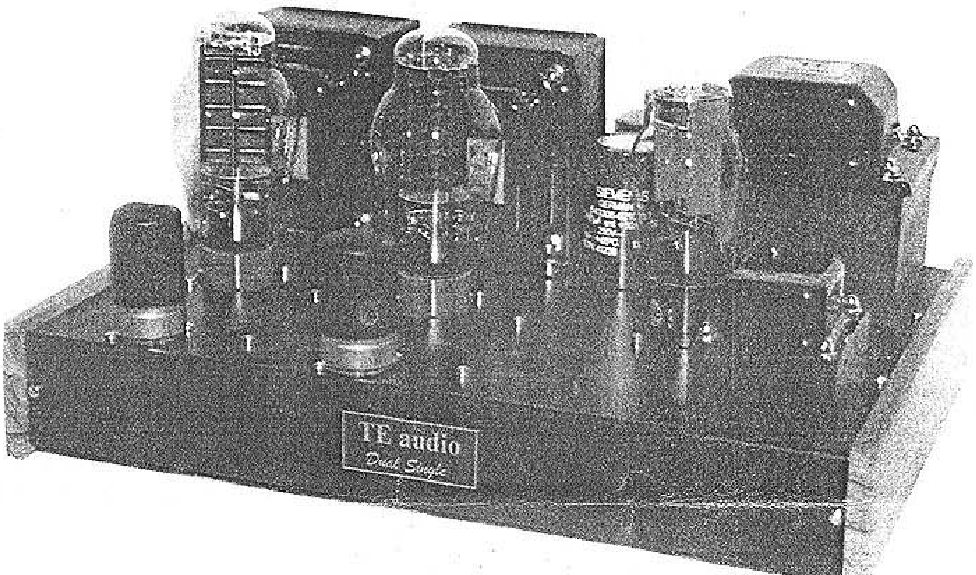


PHOTO 1: The finished amplifier.

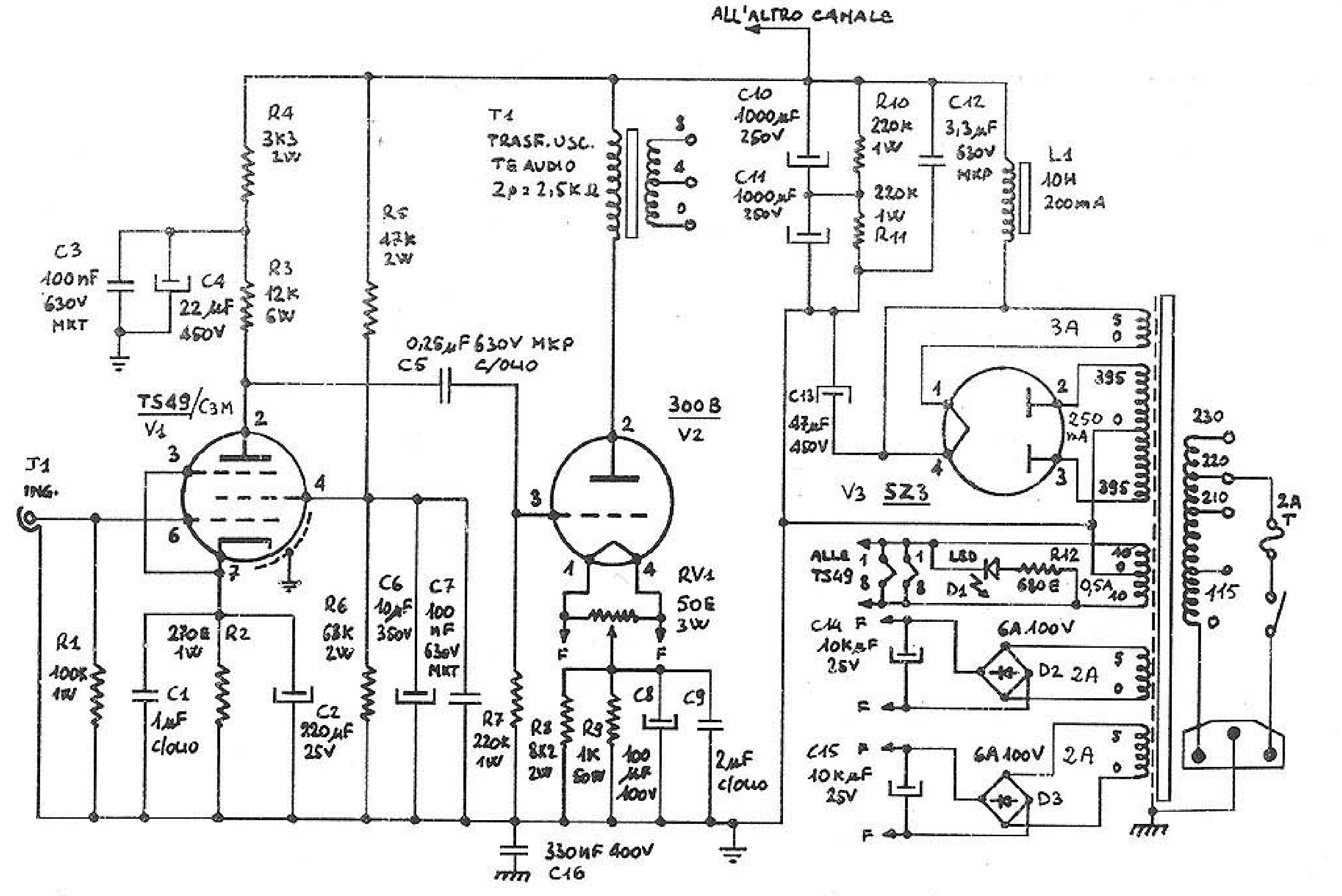


FIGURE 1: Schematic of the dual single 300B amp.

makes it suitable for direct connection to a CD player.

For all practical purposes, the TS49 turned out to be quite an exceptional tube, with very good electrical characteristics and excellent musicality in spite of its somewhat odd physical shape. Unfortunately, you will not have the pleasure of looking at a glowing glass tube, since this TS49 is enclosed in a black metal can for shielding purposes, but you will surely be rewarded by what this tube brings to your ears.

Electrical Circuit

The power-supply stage (*Fig. 2*) is common to both channels, which makes it both economical and easy to assemble–yet it is by no means of poor quality, being well oversized for the task. We are well aware of the influence this stage has on the performance of any amplifier, and particularly on that of an SE triode amp.

A single transformer supplies all voltages. A somewhat forgotten but still glorious old tube, the 5Z3, rectifies the plate voltage, while C13, L1, and the C10–C11 series form a classic pi filter to provide adequate leveling. C10 and C11 act like a single 500µF capacitor, and, together with C12, are largely responsible for the wide dynamic range. To eliminate hum problems, the 300B's filament is DC fed.

Power output is set at 8W, which does not overstress the output triode, but it is better not to pull the Chinese 300B "by the neck" if you don't want to replace them too often. We chose autopolarization essentially for two reasons: first, it's easily achieved and doesn't require any adjustment, and second, it ensures a wider stability margin against output-tube grid current than negative grid polarization. Although the 300B filament is DC fed, we still provided RV1 to further balance any residual hum, and actually found it quite useful.

Polarization of 300B is provided by R8/R9 parallel, bypassed by the parallel C8/C9. R9 is a 50W power resistor.

The driver stage, as already mentioned, makes use of a TS49/PT49 in a standard Class-A pentode configuration, optimized both electrically and musically. The same single driver stage is used to drive a single ended with 211 and 6C33 Class A.

TABLE 1

AMP SPECIFICATIONS

Stereo output power:	8W RMS per channel
Mono output power:	16W RMS
Frequency response:	16Hz–60kHz @ –2dB
Total gain:	10dB
Input sensitivity:	770mV
Output noise:	<0.5 mV

Transformers

Output and power-supply transformer quality, together with the choke-type filter, are mostly responsible for the character of this project. We thoroughly verified the winding specifications of these components for their electrical properties and sonic transparency, and we assembled many prototypes before arriving at the definitive choice. For the output, we wanted a low-resistance, electrically transparent component to achieve optimum interfacing of the output tube with the load; in fact, the total primary internal resistance is not more than 0.5Ω.

The secondaries are wound with a special technique that keeps their DC resistance below 0.2Ω. This results in a high

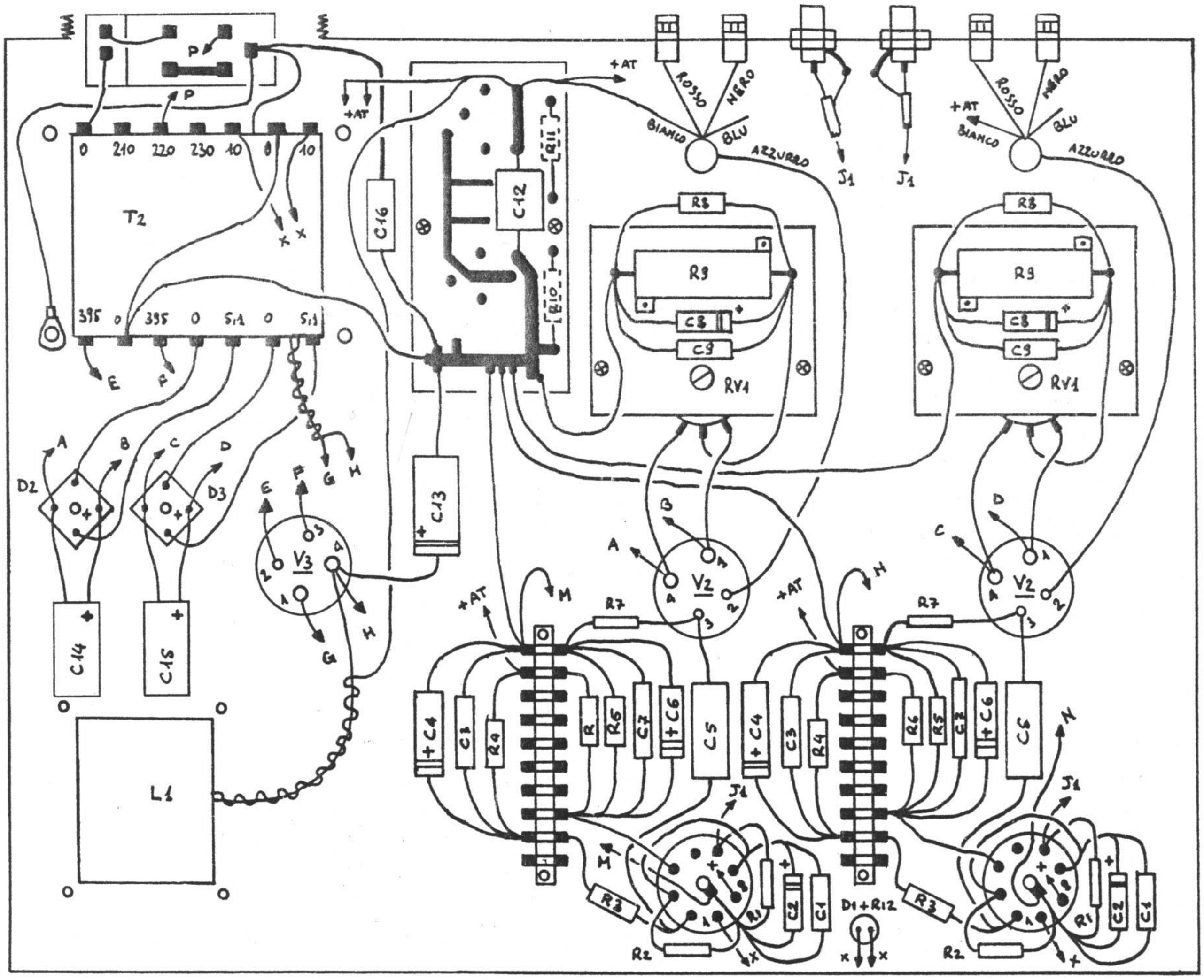


FIGURE 2: Component placement.

damping factor, which, being completely without negative feedback, relies heavily on the output transformer's specs for the load-damping characteristics.

Of course, for optimum low-frequency response, the output transformer is provided with an air gap in its iron core to prevent saturation due to DC flowing through the primary windings. The size of this gap isn't just the result of mathematical calculations; each transformer is optimized through observation of the sine wave at maximum output power and nominal polarization current.

Winding Geometry

Primary inductance was determined to reconcile the need for good high-frequency-response linearity with the number of turns used. The winding geometry and type of insulation used determine the component's capacitance value and resonance frequency.

The winding technique is complex, since it avoids use of modern digital-controlled automatic machines, relying instead on experienced winders who work on manual machines to optimize wire tension and turn spacing, filling each space with an even layer of wire without overlapping turns and with maximum precision.

Most of the winding concepts used for the output transformer also apply to construction of the power-supply transformer, with the addition of safety requirements according to standard European and international rules and regulations. For instance, due to the high voltages here, the requirements include a copper electrostatic shield between primary and secondary windings and proper separation between windings and terminal leads.

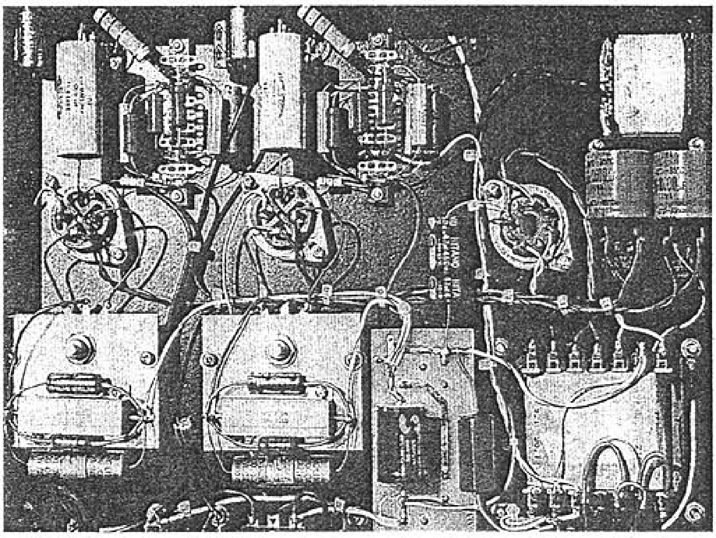


PHOTO 2: View of the amp's interior.

Testing is done on each unit, not on a sampling basis. The most significant tests are nondestructive insulation testing and measuring accurate voltage and no-load current. Inductance value must not resonate with the filter capacitor and the type of choke used. Transformers are the most critical and costly part of a tube amplifier because they greatly influence the good results of the finished product.

Building the Unit

This easy-to-assemble kit comes with a manual, complete with component layout. Also included is a black steel cabinet with all cut-outs and screw holes, as well as solid olive-wood side panels. The kit includes output transformers, power-supply transformer, filter choke, tubes, and all passive components (*Photos 1* and *2* show the finished product).

Performance and Conclusions

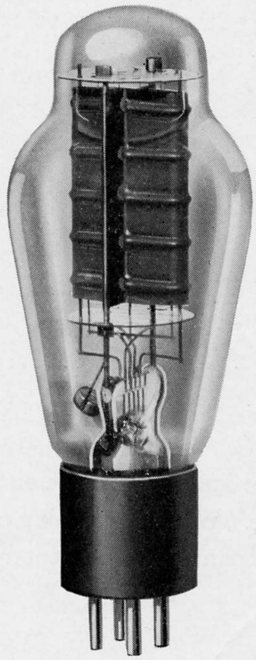
The unit achieves very good performance figures, validated through extensive listening tests, which we conducted to eliminate all those little sonic blemishes that come with every prototype. You can hear and appreciate the 8W of this amp even with somewhat inefficient speakers. All those we tested highlighted the remarkable transparency that, together with excellent musicality, make this a very high-level kit.

In conclusion, we must point out that building a high-level amplifier doesn't mean just jotting down a circuit and throwing a few good-quality components together. Rather, it involves thoroughly studying the project, then testing, listening, and trying again so as to avoid ending up with doubtful results. ❖

This kit is available from Audion, Giampiero Pagini, Casella postale 6599 Centro Settoriale Novoli, 50127 Florence, Italy, voice/FAX +39 55 293267. Price is 2,450,000 liras (about $1,500) plus shipping. A manual (in English) is also available. Contact Audion for more information.

Western Electric

300A and 300B Vacuum Tubes



Classification—Moderate power, filamentary triodes for Class A service

These tubes are identical except for the location of the bayonet pin in the base.

Application—Audio-frequency amplifier in positions where power outputs of approximately ten watts or less are required at relatively low plate voltages.

Dimensions—Dimensions, outline diagrams of the tubes and bases, and the arrangement of electrode connections to the base terminals are shown in Figures 1 and 2.

Base and Mounting—These vacuum tubes employ medium, four-pin thrust type bases suitable for use in Western Electric 143B or similar sockets. The 300B tube has the bayonet pin so located that it may also be mounted in a Western Electric 100M, 115B or similar socket.

The tubes may be mounted in either a vertical or horizontal position. If mounted in a horizontal position, the plane of the filament, which is indicated in Figure 2, should be vertical.

Average Direct Interelectrode Capacitances

Grid to plate	15 $\mu\mu$f.
Grid to filament	9 $\mu\mu$f.
Plate to filament	4.3$\mu\mu$f.

Filament Rating

Filament voltage	5.0 volts, a.c. or d.c.
Nominal filament current	1.2 amperes

The filaments of these tubes are designed to operate on a voltage basis and should be operated at as near the rated voltage as possible. When alternating current is used for heating the filament, the grid and plate returns should be connected to a center tap on the secondary of the filament transformer.

Characteristics—Average characteristics—($E_f = 5.0$ volts, a.c., $E_b = 300$ volts and $E_c = -61$ volts).

Plate current	60 milliamperes
Amplification factor	3.85
Plate resistance	700 ohms
Grid to plate transconductance	5500 micromhos

Plate-current characteristics for a typical tube are shown in Figure 3 as functions of grid bias, for alternating-current filament supply. The corresponding amplification-factor, plate-resistance, and transconductance characteristics are given in Figures 4, 5 and 6, respectively. When direct-current filament supply is used, and the grid and plate returns are connected to the negative end of the filament, the same characteristics are applicable if 3.5 is subtracted from the numerical value of each grid bias.

Limiting Operating Conditions for Safe Operation—not simultaneous ratings

Maximum plate voltage	450 volts
Maximum plate dissipation	40 watts
Maximum plate current of average tube for fixed grid bias	70 milliamperes
Maximum plate current for manually adjusted grid bias or self-biasing circuit	100 milliamperes

Recommended Operating Conditions

Recommended and maximum conditions for alternating-current filament supply are given in the table. Recommended conditions or others of no greater severity should be selected in preference to maximum conditions wherever possible. The life of the tube at maximum operating conditions will be shorter than at the recommended conditions.

Where it is necessary to operate the tube at or near the maximum plate current of 100 milliamperes, provision should be made for adjusting the grid bias of each tube independently, so that the maximum safe plate current will not be exceeded in any tube. Alternatively, a self-biasing circuit may be used, in which the grid bias for the tube is obtained from the voltage drop produced by the plate current of that tube flowing through a resistance.

Where it is necessary to use a fixed grid bias, the plate current of the average tube should be limited to a maximum value of 70 milliamperes, so that tubes having plate currents higher than the average will not exceed the maximum safe plate current.

Power Output and Distortion

Performance data including power output, second and third harmonic levels for a number of operating conditions are given in the table.

The variation of power output and harmonic levels with load resistance for several values of operating plate current are shown in Figures 7, 8 and 9, for a plate voltage of 350 volts.

The peak value of the sinusoidal input voltage, E_{gm}, which gives the indicated power output, P_m, and harmonic levels, F_{2m} and F_{3m}, for each point in both the curves and the table, is numerically equal to the grid biasing voltage at that point. For a smaller input voltage E_g, the approximate levels may be computed from the following relations.

$$P = P_m \left(\frac{E_g}{E_{gm}}\right)^2$$

$$F_2 = F_{2m} + 20 \log_{10} \frac{E_{gm}}{E_g}$$

$$F_3 = F_{3m} + 40 \log_{10} \frac{E_{gm}}{E_g}$$

TABLE

	Plate Voltage Volts	Grid Bias Volts	Plate Current Milliamperes	Load Resistance Ohms	Power Output Watts	Second Harmonic db	Third Harmonic db
Recommended	200	— 42	30	2000	3.0	20	31
Operating	200	— 39	40	2500	2.6	26	38
Conditions	200	— 37	50	2500	2.5	30	45
	250	— 55	30	2000	4.9	18	27
	250	— 55	30	4500	3.2	27	40
	250	— 52	40	3000	4.0	26	36
	250	— 50	50	2500	4.4	26	39
	250	— 48	60	2000	4.7	26	38
	250	— 48	60	2700	4.1	30	45
	250	— 45	80	1500	5.0	26	41
	300	— 65	40	2500	6.7	20	30
	300	— 63	50	2000	7.2	21	29
	300	— 63	50	3000	6.1	26	37
	300	— 61	60	2400	6.6	26	37
	300	— 61	60	3400	5.6	30	44
	300	— 58	80	1700	7.5	26	37
	350	— 76	50	3600	7.8	26	38
	350	— 76	50	5000	6.2	30	45
	350	— 74	60	2000	10.2	21	30
	350	— 74	60	3000	8.3	26	38
	350	— 74	60	4000	7.0	30	44
	350	— 71	80	2200	9.6	26	39
	400	— 91	40	5000	8.4	26	37
	400	— 89	50	3000	11.5	21	31
	400	— 89	50	4000	9.4	25	38
	400	— 87	60	3500	10.5	26	38
	400	— 87	60	5000	8.3	30	46
	400	— 84	80	2500	12.5	25	37
Maximum	450	—104	40	6000	9.5	26	38
Operating	450	—102	50	5000	10.7	27	39
Conditions	450	—102	50	6500	9.0	30	45
	450	—100	60	4000	12.5	26	38
	450	—100	60	5500	10.1	30	44
	450	— 97	80	2000	17.8	21	30
	450	— 97	80	3000	14.6	26	37
	450	— 97	80	4500	11.5	31	45

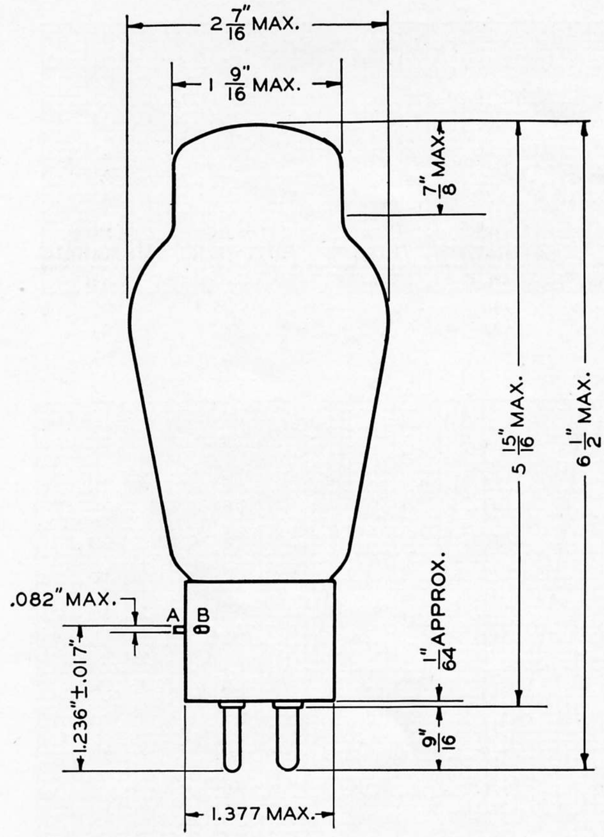


FIG. 1

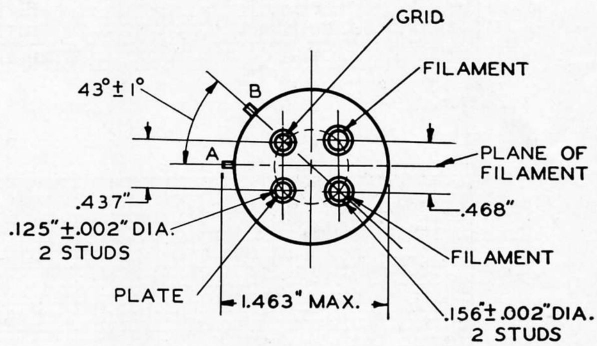


FIG. 2

A—LOCATION OF BAYONET PIN FOR 300A TUBE
B—LOCATION OF BAYONET PIN FOR 300B TUBE

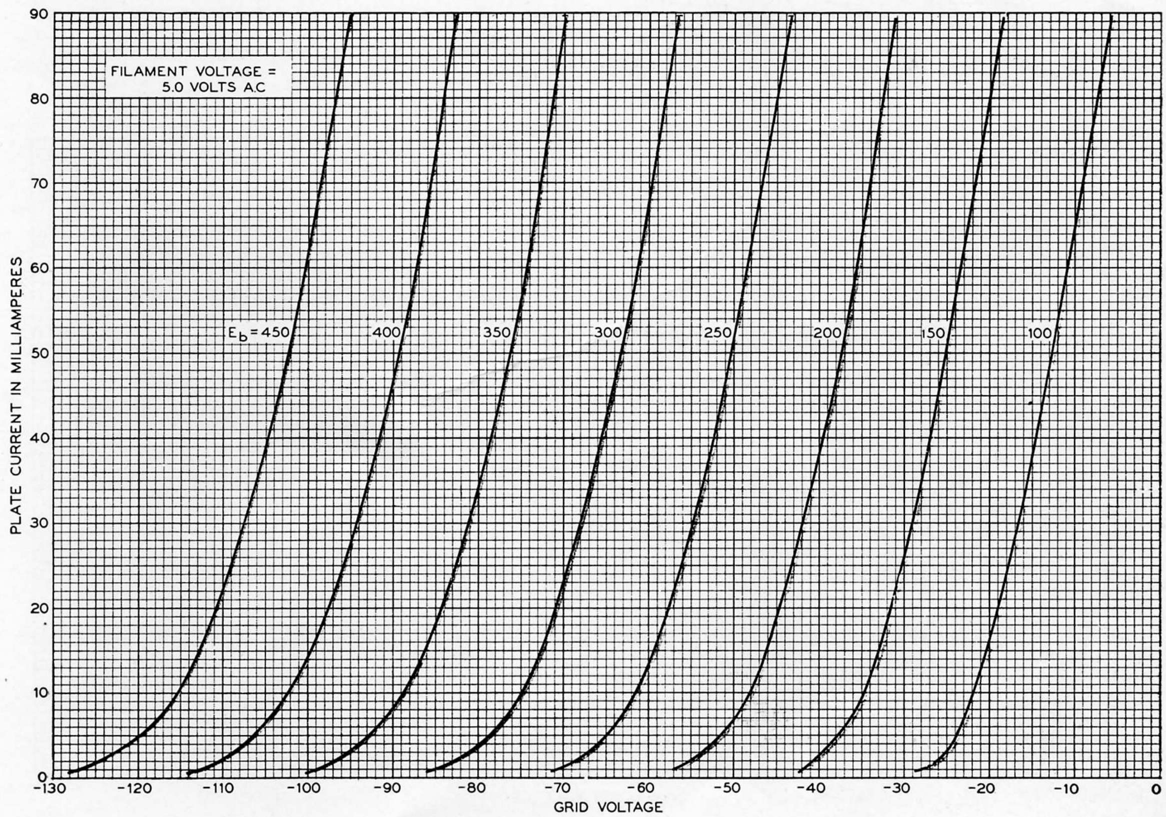


FIG. 3

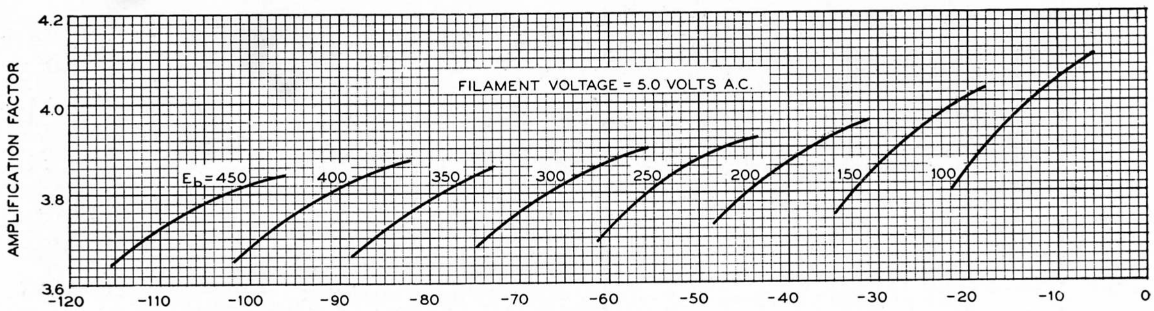


FIG. 4

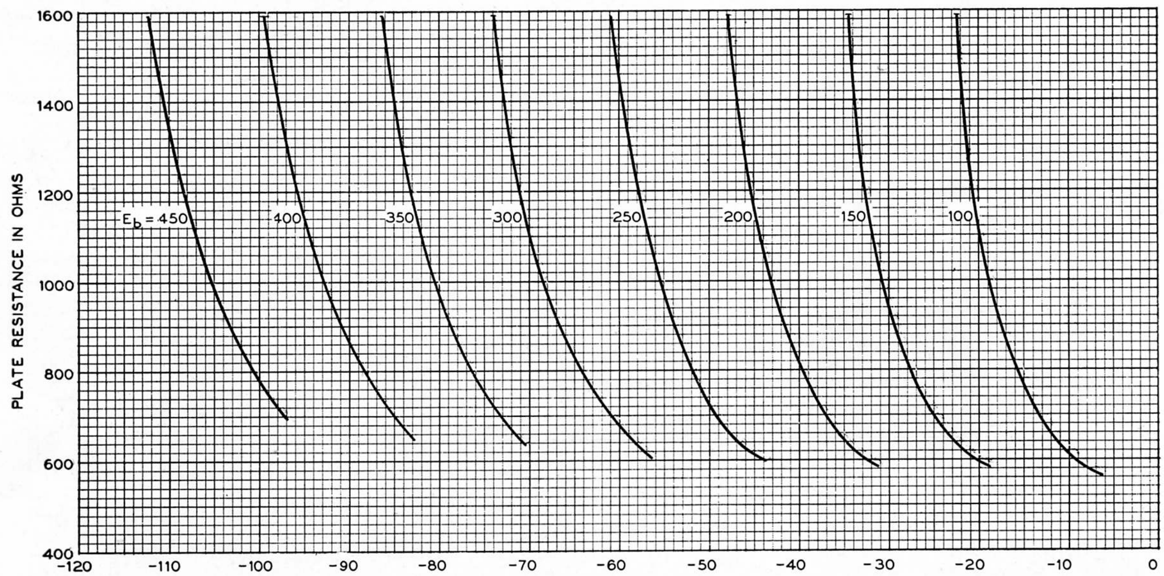


FIG. 5

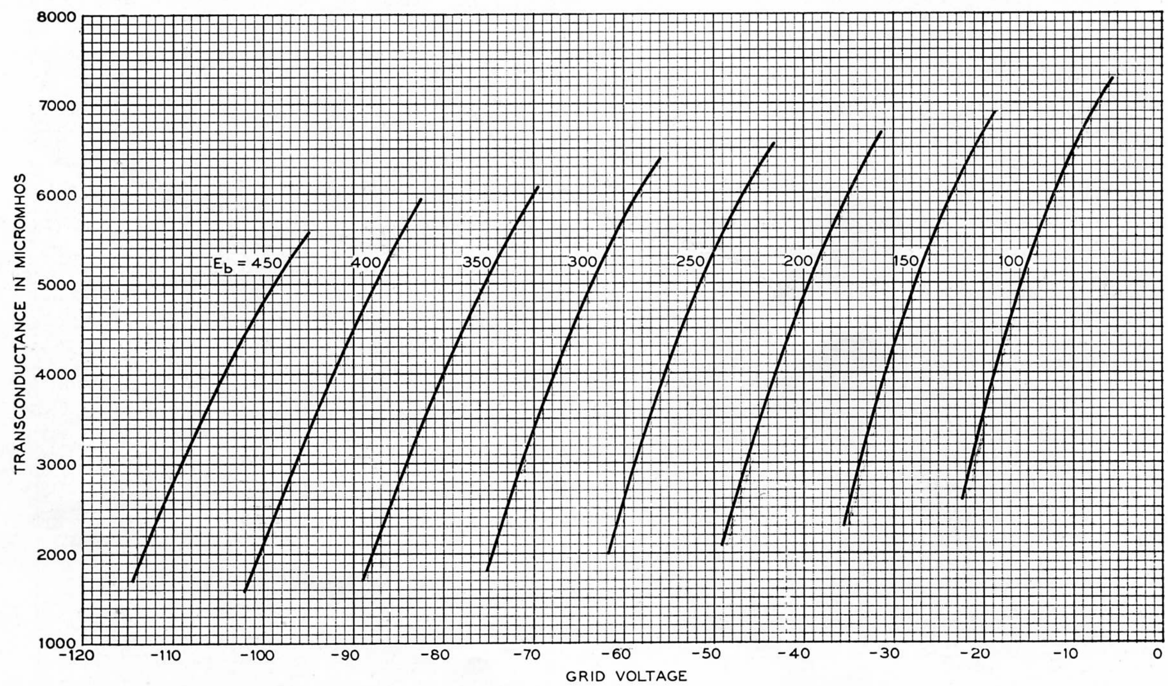


FIG. 6

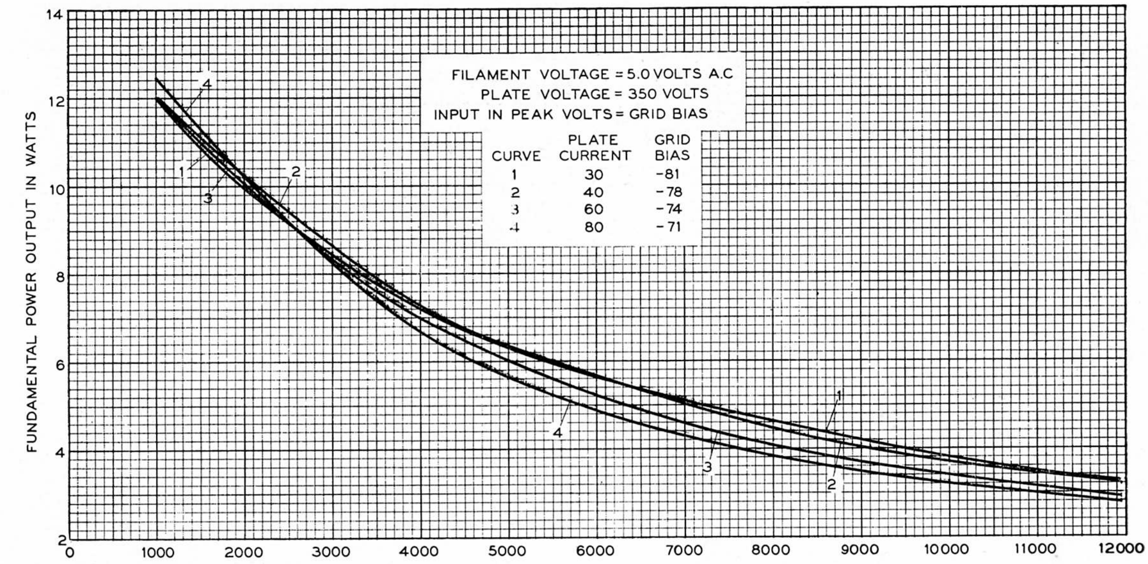


FIG. 7

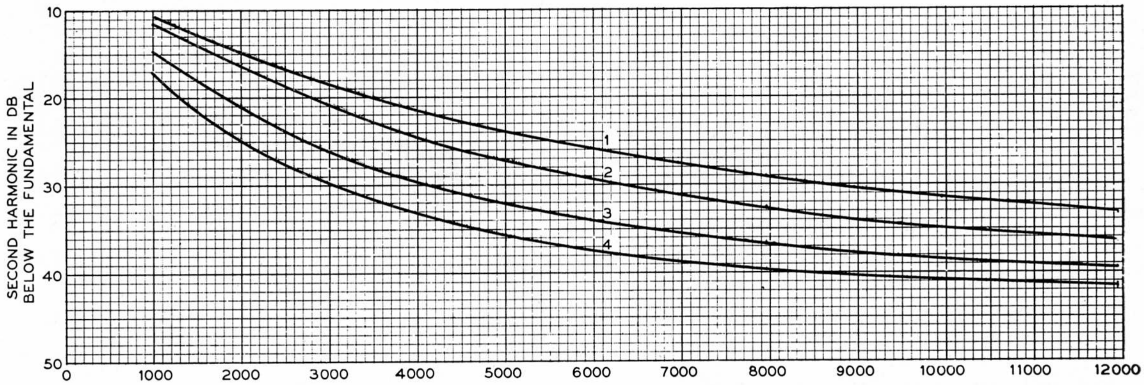


FIG. 8

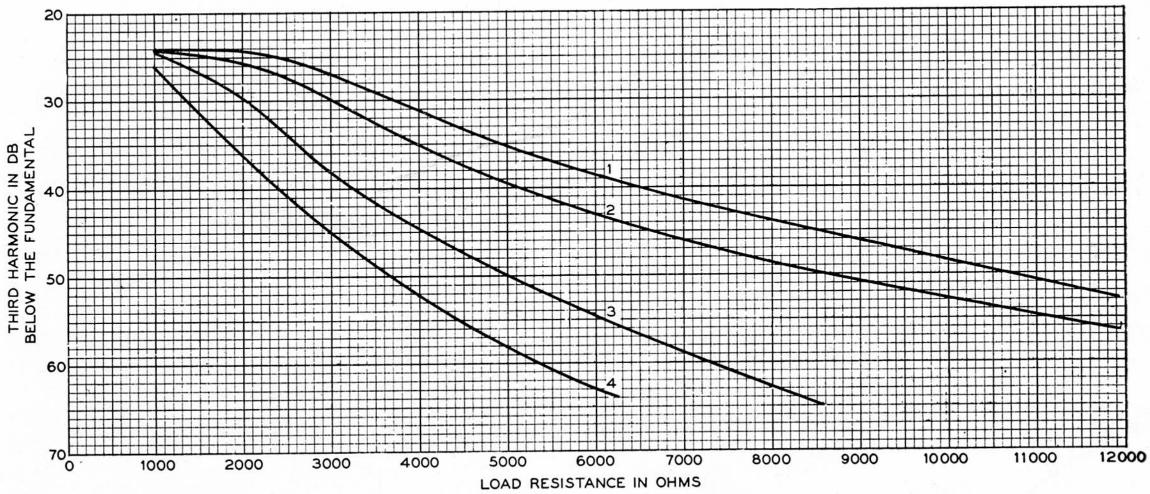


FIG. 9

1-H-39-6M
PRINTED IN U.S.A.

Developments of Bell Telephone Laboratories, Incorporated, research laboratories of the American Telephone and Telegraph Company and the Western Electric Company