RADIOTRONICS

AMALGAMATED WIRELESS VALVE COMPANY LIMITED

In this issue:–

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- Bases and Dimensions

Technical Bulletin No. 62

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Editor's Note:— The information on the use of Radiotron 1C4 as a single I.F. amplifier has had to be left over from this issue and will be given in Technical Bulletin No. 63, which will be available very shortly.

RADIOTRON 6L6

THE NEW BEAM POWER AMPLIFIER

(Tentative Data)

The Radiotron 6L6 is a power-amplifier valve of the all-metal type for use in the output stage of radio receivers, especially those designed to have ample reserve of power-delivering ability. This new valve provides high power output with high power sensitivity and high efficiency. The power output at all levels has low third and negligible higher-order harmonic distortion.

These distinctive features have been made possible by the application of fundamentally new design principles involving the use of directed electron beams. The beams of high electron density are produced by constraining the electrons with potential fields set up by the valve electrodes arranged to give the desired effects.

Primary features resulting from this arrangement are that the screen does not absorb appreciable power and that efficient suppressor action is supplied by space-charge effects produced between the screen and the plate. Secondary features are high power-handling ability, high efficiency, and high power sensitivity. Furthermore, large power output is obtainable without any grid current flowing in the input circuit.

In the design of the 6L6, the second-harmonic distortion is intentionally high in order to minimize third and higher-order harmonics. Experience has shown that second harmonics are far less objectionable in the audio-frequency output than harmonics of higher order. The second harmonics can easily be eliminated by the use of push-pull circuits, while in single-valve, resistance-coupled circuits, they can be made small by generating out-of-phase second harmonics in the pre-amplifier.

Because of the high power sensitivity of the 6L6, it is practical to use circuits which avoid the troublesome effects of loud-speaker resonance and variable impedance. In such circuits, the 6L6 not only maintains its high efficiency, but also provides power sensitivity and stability equal to or better than that of a triode.

BEAM POWER AMPLIFIER

(TENTATIVE DATA)

Heater Voltage (A.C. or D.C.)	6.3 Volts
Heater Current	0.9 Ampere
Maximum Overall Length	4-5/16"
Maximum Diameter	1-5/8"
Base	Small Octal 7-Pin

STATIC AND DYNAMIC CHARACTERISTICS.

Heater Voltage	6.3 Volts	Plate Resistance	22500 Ohms
Plate Voltage	250 Volts	Mutual Conductance	6000 Micromhos
Screen Voltage	250 Volts	Plate Current	72 Milliamperes
Grid Voltage	–14 Volts	Screen Current	5 Milliamperes
Amplification Factor	135		

SINGLE-VALVE CLASS A_1 AMPLIFIER

Subscript $_1$ indicates that grid current does not flow during any part of input cycle.

Plate Voltage	375 max. Volts
Screen Voltage	250 max. Volts
Plate and Screen Dissipation (Total)†	24 max. Volts

Typical Operation:—

Heater Voltage‡	6.3		6.3		6.3		6.3 Volts
Plate Voltage	375		250		300		375 Volts
Screen Voltage	125		250		200		250 Volts
	Fixed Bias.	Self Bias.*	Fixed Bias.	Self Bias.*	Fixed Bias.	Self Bias.*	Fixed Bias.
D-C Grid Voltage°	–9	–9	–14	–13.5	–12.5	–11.8	–17.5 Volts
Peak A-F Grid Voltage	8	8.5	14	14	12.5	12.5	17.5 Volts
Zero-Signal D-C Plate Current	24	24	72	75	48	51	57 Milliamperes
Max.-Signal D-C Plate Current	26	24.3	79	78	55	54.5	67 Milliamperes
Zero-Signal D.C. Screen Current	0.7	0.6	5	5.4	2.5	3	2.5 Milliamperes
Max.-Signal D-C Screen Current	1.8	2	7.3	7.2	4.7	4.6	6 Milliamperes
Load Resistance	1400		2500		4500		4000 Ohms
Distortion:							
Total Harmonic	9		10		11		14.5 per cent.
2nd Harmonic	8		9.7		10.7		11.5 per cent.
3rd Harmonic	4		2.5		2.5		4.2 per cent.
Max.-Signal Power Output	4.2	4	6.5		6.5		11.5 Watts

PUSH-PULL CLASS A_1 AMPLIFIER

Plate Voltage	375 max. Volts
Screen Voltage	250 max. Volts
Plate and Screen Dissipation (Total)†	24 max. Watts

Typical Operation—2 Valves:

Values are for 2 Valves.

	Fixed Bias.	Self Bias.
Heater Voltage‡	6.3	6.3 Volts
Plate Voltage	250	250 Volts
Screen Voltage	250	250 Volts
D-C Grid Voltage°	–16	–16* Volts
Peak A-F Grid-to-Grid Voltage	32	35.6 Volts
Zero-Signal D-C Plate Current	120	120 Milliamps.
Max.-Signal D-C Plate Current	140	130 Milliamps.
Zero-Signal D-C Screen Current	10	10 Milliamps.
Max.-Signal D.C. Screen Current	16	15 Milliamps.
Load Resistance (Plate to Plate)	5000	5000 Ohms
Distortion:		
Total Harmonic	2	2 per cent.
3rd Harmonic	2	2 per cent.
Max.-Signal Power Output	14.5	13.8 Watts

† Precautions should be taken to insure that dissipation rating is not exceeded with expected line-voltage variations, especially in the case of fixed-bias operation. Fixed-bias values up to 10% of each typical screen voltage can be used without increasing distortion.

‡ The heater should be operated at 6.3 volts. Under no condition should the heater voltage ever fluctuate so that it exceeds 7.0 volts. The potential difference between heater and cathode should be kept as low as possible.

* With no signal.

° The type of input coupling used should not introduce too much resistance in the grid-circuit. Transformer or impedance-coupling devices are recommended. When the grid circuit has a resistance not higher than 0.05 megohm, fixed bias may be used; for higher values, self-bias is required. With self-bias, the grid circuit may have a resistance as high as, but not greater than, 0.5 megohm, provided the heater voltage is not allowed to rise more than 10% above rated value under any condition of operation.

PUSH-PULL CLASS AB_1 AMPLIFIER.

Plate Voltage	400 max. Volts
Screen Voltage	300 max. Volts
Plate and Screen Dissipation (Total)†	24 max. Watts

Typical Operation—2 Valves. Values are for 2 Valves.

Heater Voltage‡	6.3	6.3		6.3		6.3	Volts
Plate Voltage	400	400		400		400	Volts
Screen Voltage	250	250		300		300	Volts
	Fixed Bias.	Fixed Bias.	Self Bias.*	Fixed Bias.	Self Bias.*	Fixed Bias.	
D-C Grid Voltage°	–20	–20	–19	–25	–23.5	–25	Volts
Peak A-F Grid-to-Grid Voltage	40	40	43.8	50	57	50	Volts
Zero-Signal D-C Plate Current	88	88	96	100	112	102	Milliamperes
Max.-Signal D-C Plate Current	126	124	110	152	128	156	Milliamperes
Zero-Signal D-C Screen Current	4	4	4.6	5	6	5	Milliamperes
Max.-Signal D-C Screen Current	9	12	10.8	17	16	12	Milliamperes
Load Resistance (Plate to Plate)	6000	8500		6600		3800	Ohms
Distortion:							
Total Harmonic	1	2		2		0.6	per cent.
3rd Harmonic	1	2		2		0.6	per cent.
Max.-Signal Power Output	20	26.5	24	34	30	23	Watts

†, ‡, °, *: See notes under Single-Valve Class A_1 Amplifier.

PUSH-PUSH CLASS AB_2 AMPLIFIER.

Subscript $_2$ indicates that grid current flows during some part of input cycle.

Plate Voltage	400 max. Volts
Screen Voltage	300 max. Volts
Plate and Screen Dissipation (Total)†	24 max. Watts

Typical Operation—2 Valves:

Values are for 2 Valves.

	Fixed Bias.	Fixed Bias.	
Heater Voltage‡	6.3	6.3	Volts
Plate Voltage	400	400	Volts
Screen Voltage	250	300	Volts
D-C Grid Voltage°	–20	–25	Volts
Peak A-F Grid-to-Grid Voltage	57	80	Volts
Zero-Signal D-C Plate Current	88	102	Milliamps.
Max.-Signal D-C Plate Current	168	230	Milliamps.
Zero-Signal D-C Screen Current	4	6	Milliamps.
Max.-Signal D-C Screen Current	13	20	Milliamps.
Load Resistance (Plate to Plate)	6000	3800	Ohms
Peak Grid-Input Power °°	180	350	Milliwatts
Distortion:			
Total Harmonic	**	**	per cent.
3rd Harmonic	**	**	per cent.
Max.-Signal Power Output	40	60	Watts

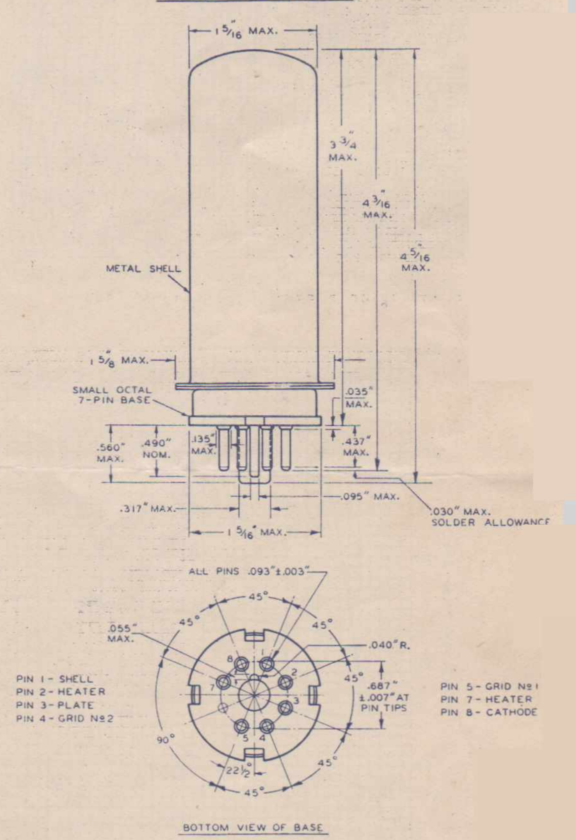
°° Driver stage should be capable of supplying the grids of the Class AB stage with the specified peak values at low distortion.

** With zero-impedance driver, plate-circuit distortion does not exceed 2%.

†, ‡, °, *: See notes under Single-Valve Class A_1 Amplifier.

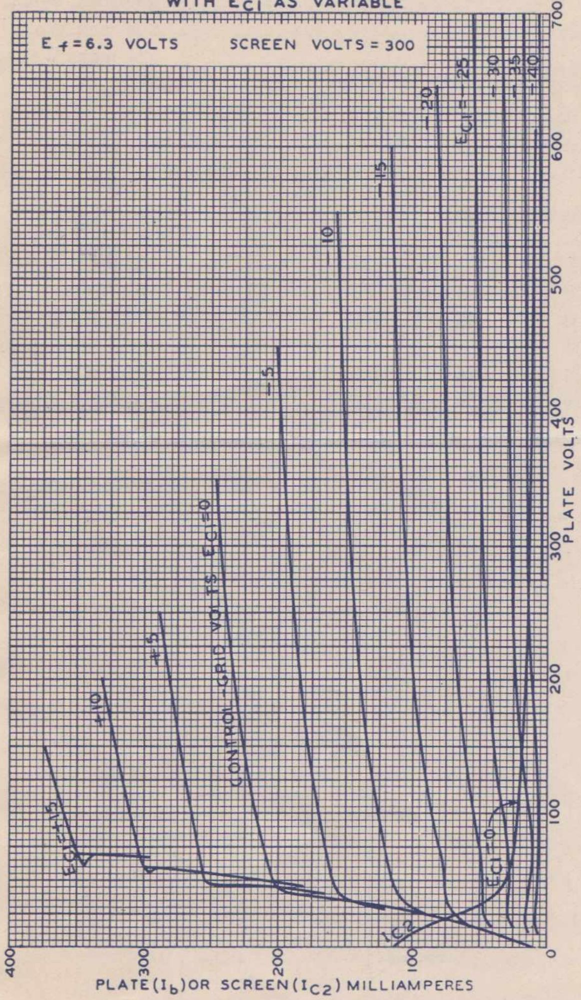
RADIOTRON 6L6

OUTLINE DRAWING



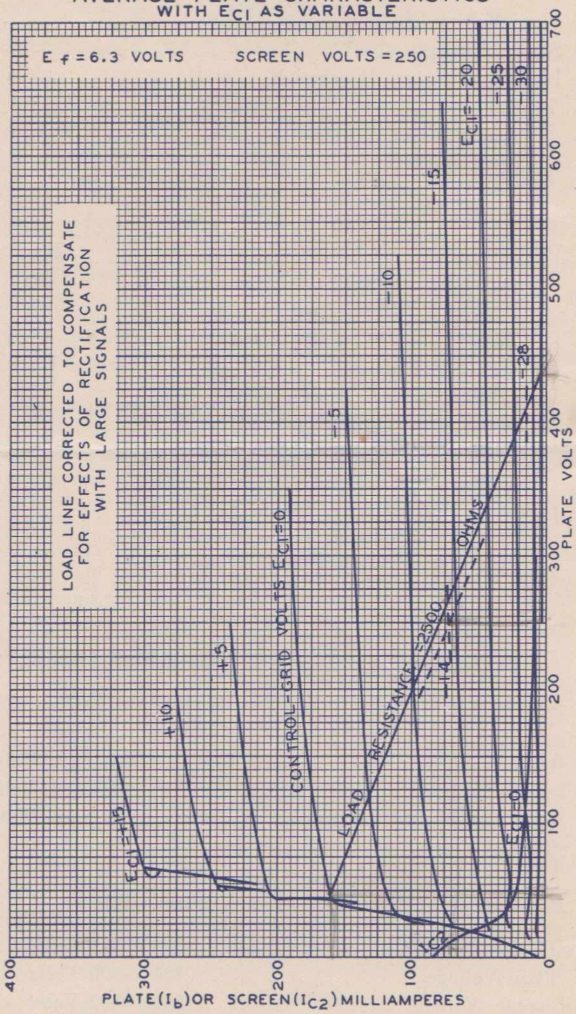
RADIOTRON 6L6

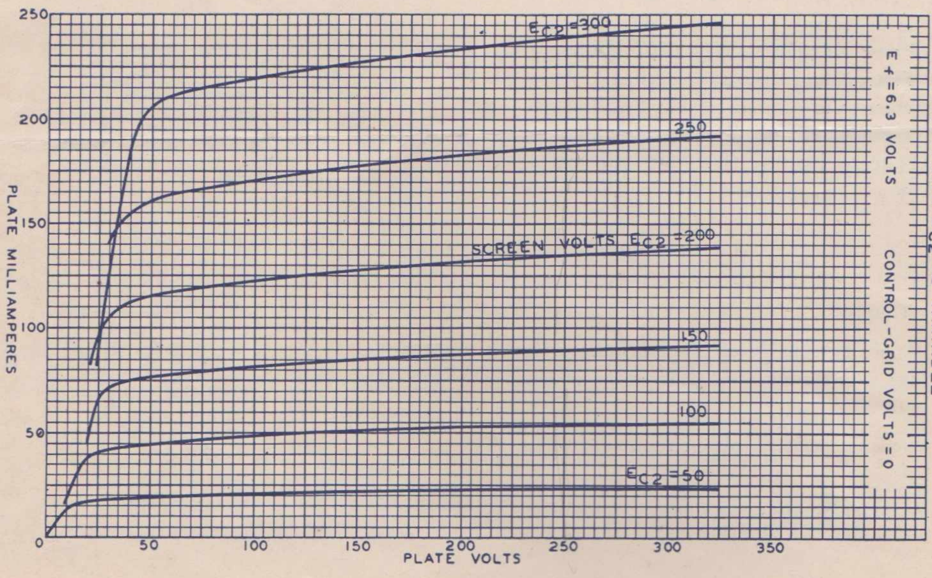
AVERAGE PLATE CHARACTERISTICS
WITH E_{C1} AS VARIABLE



RADIOTRON 6L6

AVERAGE PLATE CHARACTERISTICS
WITH E_{C1} AS VARIABLE





RADIOTRON 6L6

AVERAGE PLATE CHARACTERISTICS
WITH E_{C2} AS VARIABLE

RADIOTRON 6F5

(Information additional to that given in Technical Bulletin No. 56)

Many modern broadcast receivers require at least two stages of audio amplification in order to obtain rated power output. The gain necessary in the first stage depends upon the a-f voltage developed by the detector, which is usually a diode, and the input-voltage requirements of the second audio stage. When the number of valves in the audio amplifier is restricted to two, it may be necessary to use a high-gain first-stage valve in order to meet the input-voltage requirements of the output stage, especially when a low-percentage modulated carrier is to be received. The 6F5, the all-metal high-mu triode intended for use in high-gain resistance-coupled amplifier circuits, can be used to advantage in this case.

DIODE CHARACTERISTICS SHOWING DIODE DISTORTION OF A HIGH-PERCENTAGE MODULATED CARRIER

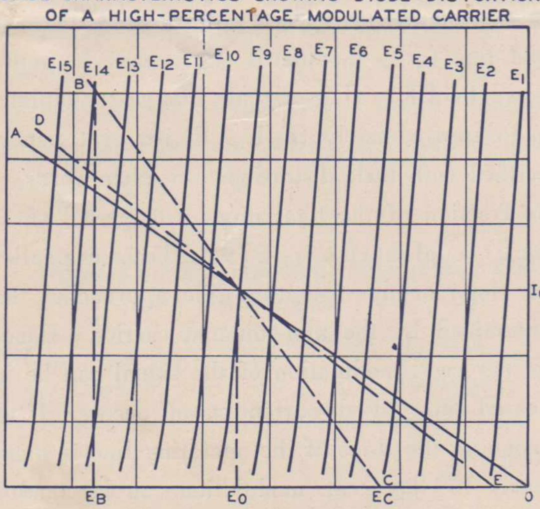


FIG. 1

The 6F5 may also also be used to advantage in receivers having more than two a-f amplifier stages. For example, the high gain obtainable through the use of a 6F5 in the first stage of a three-stage amplifier makes it possible to feed to the first a-f valve only a part of the total audio voltage developed by the detector. The smaller the fraction of the total detector output voltage that is fed to the first a-f valve, the larger the per cent. modulation that can be handled with small distortion. The utilization of less than maximum a-f voltage is not serious in a high-gain amplifier.

To understand why utilizing a part of the diode voltage is desirable, let us consider that the characteristics of a certain diode are as shown in Fig. 1. For a given carrier voltage (E_1, or E_2, ---- E_{15}) at the detector, the ordinate and abscissa indicate, respectively, the d-c current through and the d-c voltage across a suitably by-passed resistance (R) connected in series with the diode; the ratio of the d-c voltage across R to the d-c current

LOW-DISTORTION CIRCUIT USING THE 6F5 IN A HIGH-GAIN AMPLIFIER

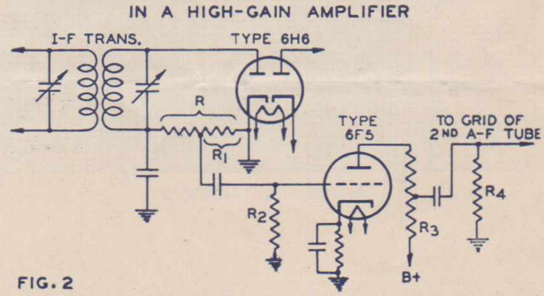
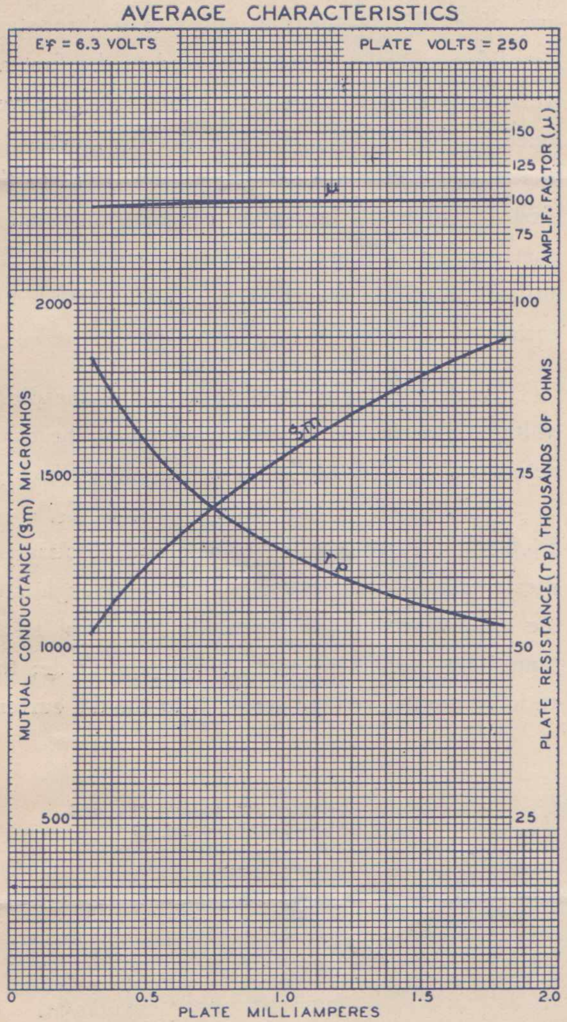


FIG. 2

through R equals the resistance of R. Hence, the intersection of a load line (whose cotangent is R) with any single carrier-voltage curve determines the value of the d-c current flowing in the circuit. Thus, if an unmodulated carrier voltage having a value E_9 is impressed across the input of the circuit consisting of R, suitably by-passed and the diode

RADIOTRON 6F5

AVERAGE CHARACTERISTICS



in series, a d-c voltage (E_o) will be developed across R and a d-c current (I_o) will flow in the circuit.

The audio voltage appearing across R is usually fed to the grid of the first a-f valve through a coupling condenser; the grid of this a-f valve is grounded through a high resistance (R_2). When the carrier is modulated, the diode load (R_d is then essentially $R_d = R \times R_2/(R + R_2)$. The reciprocal of the slope of the line (BC) equals R_d: BC passes through point (E_o, I_o). If the per cent. modulation is such that the minimum amplitude of the carrier is less than E_4, small carrier amplitudes will be cut off. Therefore, the maximum per cent. modulation that can be handled by this circuit is $(E_9\text{-}E_4)/E_9$. On the other hand, if R_2 is connected to only a portion of R, then the load line for a modulated signal may be represented by DE. Thus, signals that are modulated up to approximately $(E_9\text{-}E_1)/E_9$ per cent. can be rectified with little distortion. In other words, as the fraction of the total diode voltage (R_1/R in Fig. 2) coupled to the first a-f valve becomes smaller, the slope of the operating line approaches that determined by the unmodulated carrier. Hence, the per cent. modulation of the signal can be increased before diode-current cut-off occurs. If the change in the slope of the operating line is small, nearly 100 per cent. modulation can be handled without distortion, due to diode-current cut-off.

Diode biasing of the grid of the 6F5 does not produce this type of distortion, but is not generally suitable because of the probability of plate-current cut-off, even with relatively small signal voltages applied to the diode circuit. The use of a 6F5 in the first a-f stage of a high-gain amplifier, highly modulated signals with little distortion.

The design of a receiver may be such that, even though a part of the audio voltage developed by the diode is applied to the grid of the 6F5, the signal voltage at the grid of the second a-f valve may be more than necessary. Under these conditions, the plate resistor of the 6F5 may be tapped, so that only a fraction of the voltage developed across this resistor is applied to the grid of the second a-f valve. This circuit will tend to minimise plate-circuit distortion in the 6F5, caused by plate-current cut-off during the negative voltage excursions of the signal. Figure 2 shows a circuit that permits the rectification of highly modulated carriers with little distortion, and also tends to minimise any plate-curcuit distortion.

When the 6F5 is used in conjunction with a 6H6, the all-metal twin diode, the combination may be used as a detector, a.v.c. valve, and first a-f amplifier. A variety of circuits are possible with this combination, because each of the two diodes in the 6H6 has its own cathode and corresponding base pin.

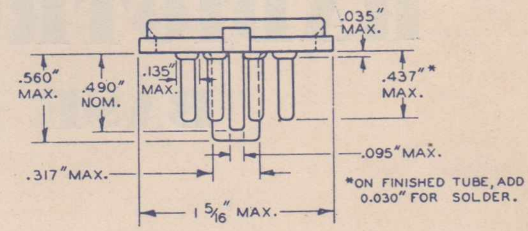
TENTATIVE CHARACTERISTICS OF THE 6F5.

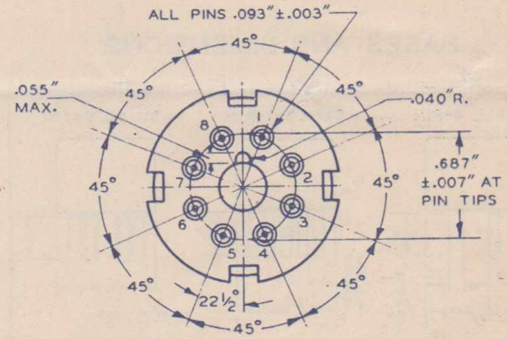
Heater Voltage (A.C. or D.C.)	6.3 Volts
Heater Current	0.3 Ampere
Plate Voltage	250 max. Volts
Grid Voltage	–2 Volts
Plate Current	0.9 Milliamperes
Plate Resistance (r_p)	66000 Ohms
Amplification Factor	100
Grid-Plate Transconductance	1500 Micromhos
Input Capacitance	6 $\mu\mu$F
Output Capacitance	12 $\mu\mu$F
Grid-Plate Capacitance	2 $\mu\mu$F

Note: The d-c resistance in the grid circuit of the 6F5 should not exceed 1.0 megohm.

BASES AND DIMENSIONS

SMALL OCTAL 8-PIN BASE





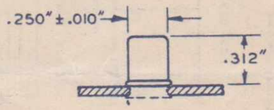
BOTTOM VIEW OF BASE

SMALL OCTAL 7-PIN BASE
AS ABOVE, OMITTING PIN № 6

SMALL OCTAL 6-PIN BASE
AS ABOVE, OMITTING PINS № 4 & 6

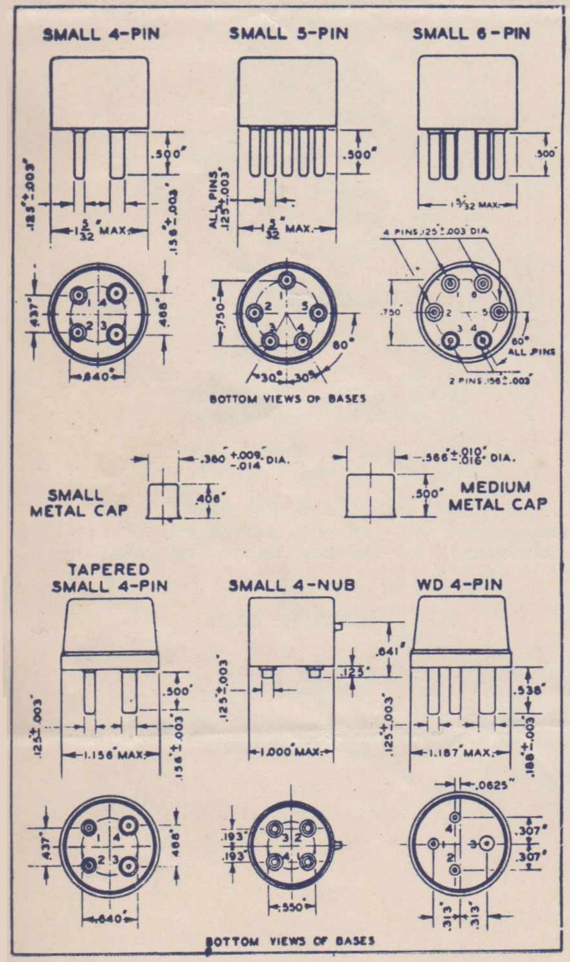
SMALL OCTAL 5-PIN BASES
ARRANGEMENT № 1 – AS ABOVE, OMITTING PINS № 3,5 & 7
ARRANGEMENT № 2 – AS ABOVE, OMITTING PINS № 3,5 & 6

MINIATURE CAP



RADIOTRON VALVES
BASE LAYOUTS

BASES AND DIMENSIONS



BASES AND DIMENSIONS