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By the way—

The cover this month shows the exhausting and sealing of a batch of 2E26 power valves. This new valve has recently been placed in production at Ashfield to meet the Australian demand for a beam tetrode capable of working at 125 megacycles at full ratings. The 2E26 finds its chief application in the F-M field.

For those who were interested in the April article on an intermodulation analyser we would advise that E.M.I. have now produced in England a 78 r.p.m. record J.H. 138 which is similar to the RCA RL-420. This will be ideal for comparing and testing phonograph pickups.

We hope to feature regularly articles of interest to the audio fraternity. In this issue we are reprinting from the "Saturday Review of Literature" a gentle satire on the enthusiast who spends large sums of money without ever attaining his ideal.

By this time all applicants should have received the new Radiotron Valve Data Book. We regret the delay caused by power shortages to the production of this publication.

New RCA releases published in Radiotronics are intended for information only and present or future Australian availability is not implied.

All 1950 issues, together with February, March and April, 1951, are now out of print.

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Circuit Laboratory Report

Number 9

Improving the Short-wave Performance of Converters

The sensitivity of many commercial dual-wave receivers could be doubled at the high-frequency end of the short-wave band, merely by altering the relationship of the oscillator frequency to the signal frequency, that is, by operating the oscillator on the low-frequency side of the signal instead of on the high-frequency side.

The convention that the oscillator is usually operated at a higher frequency than the incoming signal probably arises from the fact that on the broadcast band, with an intermediate frequency of 455 Kc/s, this is the only possibility. Thus in a receiver tuning from 535 to 1620 Kc/s and using the standard intermediate frequency, the oscillator-frequency coverage, with the oscillator on the high-frequency side of the signal, is from 990 (535 + 455) to 2075 Kc/s, a frequency ratio of little more than 2 to 1. However with the oscillator at a lower frequency than the signal it would tune from 80 to 1165 Kc/s, a ratio of more than 14 to 1, needing a capacitance (or inductance) change of more than 200 to 1!

However on the 6 to 18 Mc/s short-wave band the difference in tuning ratio with the oscillator frequency higher or lower than the signal frequency is slight, whereas the advantages to be obtained from a correct choice of oscillator frequency are considerable.

The reason for this is that in all converter valves some oscillator-frequency voltage appears on the control grid at high frequencies, and this oscillator-frequency voltage modulates the electron stream in just the same way as does the signal. This additional modulation aids or opposes the original modulation by the oscillator grid, depending on the relationship between the oscillator and signal frequencies and on the type of converter valve.

So far as this effect is concerned there are only two types of converters used in commercial A-M receivers, inner-grid converters in which the oscillator voltage is applied to the grid closest to the cathode, and outer-grid converters in which the oscillator voltage is applied to a grid farther out in the electron stream. Thus inner-grid converters cover all types such as pentagrids and octodes, while outer-grid converters include all triode-hexodes and triode-heptodes with separate oscillator sections. Inner-grid converters have the oscillator section in the main electron stream whilst outer-grid converters have a separate oscillator section and an injector grid to modulate the electron stream of the mixer section of the valve.

With inner-grid injection converters the oscillator voltage on the control grid opposes the original oscillator modulation if the oscillator operates on the high-frequency side of the signal, but if the oscillator is on the low-frequency side the modulation, and thus the conversion gain of the valve, are increased. This is due to the change from capacitive to inductive reactance presented by the signal-frequency circuit to the oscillator-frequency voltage, and the consequent reversal of phase of the oscillator voltage.

With outer-grid injection converters maximum sensitivity is obtained when the oscillator is operated at a higher frequency than the incoming signal, although the coupling between oscillator and control grids is usually smaller in this type of valve so that the effect is not so important.

However, when an inner-grid converter is used it is not unusual for the 18 Mc/s sensitivity to be doubled as a result of changing the oscillator from the high-frequency side to the low-frequency side of the signal. At the same time the image ratio is greatly improved because the image, instead of being the stronger response, becomes the weaker one. In addition, frequency shift due to variation of voltages applied to mixer electrodes may be reduced. This is because some of the detuning resulting from say the application of a.v.c. voltage is due to a variation in the amount of pulling between oscillator and signal circuits, and this pulling is in the opposite direction when the oscillator frequency is changed from one side to the other of the signal frequency. As an example, the frequency shift of the 6BE6 for a given variation in control grid voltage at 18 Mc/s may be halved by operating the oscillator on the low-frequency side of the signal.

During the development of a receiver it is sometimes found that although an inner-grid converter is used, better sensitivity is obtained with the oscillator on the high-frequency side of the signal rather than on the low-frequency side. In such a case there is probably coupling between oscillator and signal circuits external to the converter and larger than its internal coupling. Unless the external coupling is known and can be controlled in production and produces no undesirable effects it should be removed. The benefits of operating the oscillator on the low-frequency side of the signal can then be obtained.

When a new receiver is being developed it is advisable in any case to check that the oscillator voltage on the control grid is not excessive. Whilst

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Contributed by the Circuit Design Laboratory, Valve Works, Ashfield.

a small amount of oscillator voltage may be beneficial a larger amount may cause the signal grid to draw current and thus damp the input circuit. The current may also increase the bias on the converter and any other valves connected to the same a.v.c. line and so reduce the sensitivity of the receiver.

Some changes in circuitry and alignment technique are brought about by low-side oscillator operation. For a signal-frequency coverage of 5.9 to 18.4 Mc/s a high-side oscillator covers, with a 455 Kc/s intermediate frequency, 6.355 (5.9 + 0.455) to 18.855 Mc/s. Thus the signal-frequency tuning ratio is 18.4/5.9 ≈ 3.1/1 and the oscillator frequency tuning ratio is 18.855/6.355 ≈ 2.9/1 so that the oscillator circuit, which covers the smaller tuning ratio, must be padded. However, a low-side oscillator covers a tuning ratio of 5.445 (5.9 – 0.455) to 17.945, i.e. 3.3/1, which is greater than the signal-circuit tuning ratio. For this reason the signal circuit is padded and the oscillator circuit is not. This introduces no great difficulties as can be seen from Fig. 1, the converter stage of a receiver using the 6BE6 with low-side oscillator operation.

at the high-frequency end of the band the response which was the image with high-side oscillator operation (i.e., the lower-frequency response) is the correct signal with low-side operation. This can be readily understood by considering the frequencies involved. With an intermediate frequency of 455 Kc/s a receiver with its oscillator on the high-frequency side has, when tuned to an 18 Mc/s signal, an oscillator frequency of 18.455 Mc/s. However, by tuning the oscillator to the *lower* frequency of 17.545 Mc/s the separation between signal and oscillator frequencies is once again 455 Kc/s and a second response, the image, is heard. With low-side operation and the receiver tuned to an 18 Mc/s signal the oscillator is at 17.545 Mc/s and has to be tuned *higher* in frequency to 18.455 Mc/s to receive the image.

If the signal generator is tuned and the receiver tuning is fixed, the correct signal is the lower-frequency one with a high-side oscillator and the higher-frequency one with a low-side oscillator. The reason for this is obvious if the various frequencies are worked out as for the previous case.

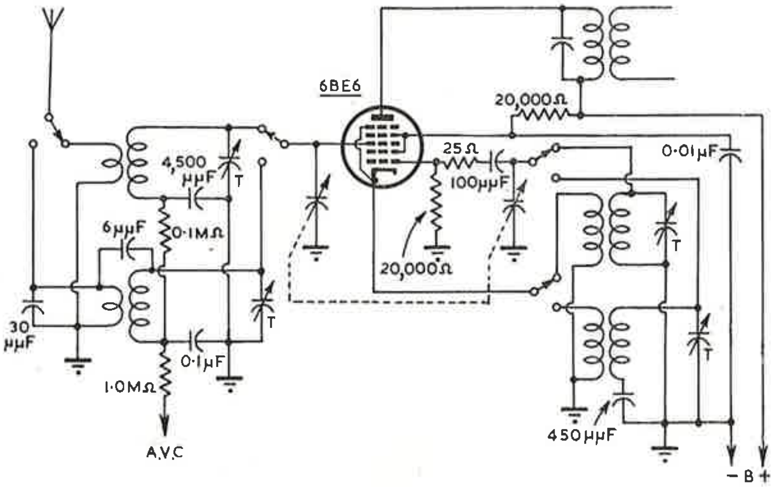

Fig. 1. Converter stage of receiver using 6BE6 with low-side oscillator operation.

One consequence of the increased tuning ratio required from the oscillator circuit is that stray capacitance in the oscillator circuit must be reduced for a given signal-frequency coverage. That this is not a difficult matter is demonstrated by battery receiver RA41 in Radiotronics for May, 1951. Normal short-wave coverage was obtained in the receiver using low-side oscillator operation with a 1.4 volt battery converter, in which oscillator mutual conductance is necessarily restricted. With a.c. converters the required reduction in capacitance will normally be obtained merely by trimmer adjustment.

The modification in alignment technique brought about by low-side oscillator operation is not a difficult one; briefly, when tuning the receiver for alignment

The interchanging of correct signal and image is a disadvantage where only high-side oscillator operation has been used previously. However, large manufacturers have used a mixture of high-side and low-side operation (depending on the type of converter) for many years without experiencing trouble due to incorrect alignment in the factory or in the field. A note in service manuals and factory alignment instructions as to which is the correct signal to use covers the needs of those who align receivers by rule of thumb, whilst to those who fully understand the significance of the various operations in short-wave alignment the reason for the slightly different technique is self-evident.

The Development of Radio Transmitting Valves

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Technical Manager, M.-O. Valve Co. Ltd., Hammersmith.

The article begins with a review of the limitations of the earlier types of transmitting valves and an indication of the directions in which improvements were required. New constructional and manufacturing techniques, which have enabled these improvements to be realised in practice, are described. Some of the new types of valves developed during the last thirteen years are illustrated, and tables are included showing their ratings and performance.

Introduction

It is some thirteen years since a paper[1] on transmitting valves last appeared in this Journal.

Then Le Rossignol and Hall described the history of transmitting valve development and dealt with the types produced, and with the techniques used in manufacture, up to about 1936. It is the purpose of the present paper to bring this story up to date, to describe some of the advances which have been made in the last thirteen years, and to indicate some of the reasons for the changes that have taken place.

The general trend of transmitting valve development during this period has been chiefly in the direction of producing higher power at higher frequencies, and at wider band-widths. Progress has been rapid, particularly during the war years when urgent military needs gave a stimulus to the development of new valves for special purposes. As in other fields, the truth of the old adage, "Necessity is the mother of invention," has been amply borne out and there is no doubt that, but for the war, the advance in techniques would not have been so rapid.

The early wartime valves were based on designs which had previously been developed for services such as television. Many of the valves developed during the war, however, were designed specially for operation under pulse conditions and, as a rule, were not suitable for use on c.w. Valves for pulse operation require to have very high cathode emission to supply the high peaks of anode current, but as the mean power is usually very low, the power handling capacity of the anode and the grid need not be large. The balance between cathode emission and anode and grid dissipation, therefore, is often quite different in the pulse valve. Nevertheless, the same principles of construction are applicable to both conditions of use and some of the more important wartime pulse valves have since been modified and rendered suitable for c.w. applications.

The various valves with which this paper deals are described under four headings:

(1) Glass valves.
(2) Silica valves.
(3) Air-cooled anode valves.
(4) Water-cooled anode valves.

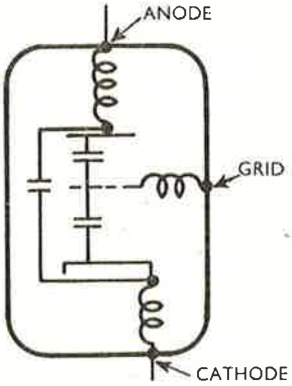

Fig. 1.—Inter-electrode capacitances and lead inductances of a triode.

Advances have been made in all four classes, but the most striking progress has been in the air-cooled and water-cooled valves. It is these valves which have enabled the power obtainable at high frequencies to be so greatly increased during the last ten years. The glass transmitting valve is limited

Reprinted from the G.E.C. Journal with acknowledgments to G.E.C., England.

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[1] **Le Rossignol and Hall. G.E.C. Journal, Vol. 7, No. 3, 1936.**

in power, maximum frequency of operation and mechanical ruggedness, but nevertheless, still finds new applications in compact mobile equipment where only a minimum of ancillary equipment can be tolerated. Silica valves have long been used by the Royal Navy, but it is only recently that they have found application in commercial equipment. The fact that the silica envelope may be used some four or five times offsets its high intrinsic cost.

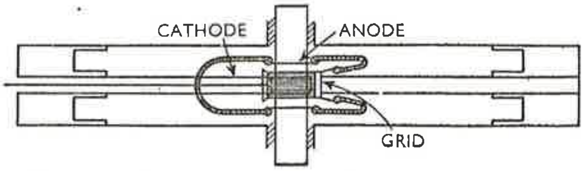


Fig. 2.—Common-anode earthed-anode co-axial line oscillator circuit.

Magnetrons[2], which were the subject of intensive development during the war, are not dealt with in this paper. Their operating frequency is much higher than that covered by the conventional triodes, and, apart from Marine Radar, they have not yet found a large commercial outlet.

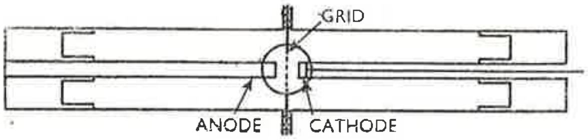


Fig. 3.—Common-grid earthed-grid co-axial line oscillator circuit.

Design considerations

It is mainly because of the higher frequencies at which triodes are now required to operate that the many new types of valves described in this paper have been developed. There are two reasons why the performance of a triode deteriorates as its operating frequency is increased: firstly, because of transit time, i.e. the time taken by electrons emitted from the cathode to reach the anode, and secondly, because of the disappearance of the external circuit. It can be shown that the drop in efficiency is already significant when the transit time is one twelfth of the period, and that oscillation ceases altogether when the transit time approaches half the period. Now the transit time may be decreased by reducing the clearance between electrodes, or by increasing the anode voltage. It can also be shown[3] that the transit time in the grid-cathode space is proportional to $\left(\frac{d}{i}\right)^{\frac{1}{3}}$ where d is the grid-cathode distance, and i is the current density. Hence, if the maximum frequency is to be increased, either d must be decreased or i must be increased. In the latter case, the cathode emission must be increased if space charge limitation is to be maintained.

Fig. 1 shows the interelectrode capacitances and the lead inductances of a triode. The maximum frequency of oscillation of this triode will be reached when the whole of the oscillating circuit resides inside the valve, and is formed by these interelectrode capacitances and inductances resonating together. To increase the maximum frequency, therefore, it is necessary to reduce the internal capacitances and inductances. The inductance of the leads to the active electrodes can be reduced by reducing their length and by increasing their diameter; the internal capacitances, however, can only be reduced either by increasing the spacing between electrodes or by reducing the area of the electrodes. In the former case, the transit time losses will be increased unless the anode voltage is raised to compensate, and in the latter case the power handling capacity will be reduced.

Fortunately, this difficulty can be overcome and a considerable improvement in performance can be effected by making the electrodes, and their leads, parts of transmission lines which are continued through the envelope of the valve to the external circuits. If the external circuit is a transmission line of characteristic impedance Z_0, which is continued without change right up to the valve electrodes, then some of the interelectrode capacitance is distributed in the circuit, and only a part of it appears as a loading capacitance at the end of the line. The length of the circuit for a given wavelength can be increased by decreasing either Z_0 or C, the loading capacitance, hence high power valves, in which the interelectrode capacitances cannot be reduced to very low values, without sacrificing performance in other directions, may be used at very short wavelengths by employing circuits of low characteristic impedance.

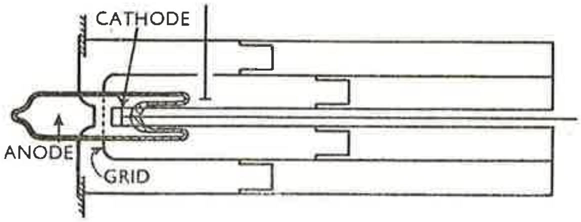


Fig. 4.—Common-grid earthed-anode co-axial line oscillator circuit.

Coaxial lines provide convenient circuits of low impedance, and many of the valve types developed in the last ten years have been specially designed for use in such circuits. One arrangement is shown in fig. 2. The grid lead is continued through the envelope at one end to form part of the inner conductor of a coaxial line, the anode forming part of the outer conductor. Likewise, the cathode and

[2] **Willshaw, Stainsby, Balls, Rushforth, Latham and King. Jour. I.E.E., Vol. 93, Part 3a, No. 5, 1946.**

[3] **Bell, Gavin, James and Warren. Jour. I.E.E., Vol. 93, Part 3a, No. 5, 1946.**

the anode form the inner and the outer conductors of a second coaxial line at the other end of the valve. These coaxial lines act as reactances, and, in conjunction with the interelectrode capacitances, provide the oscillatory circuit. In some cases the length of line having the required reactance may be so short that it does not project outside the valve envelope, but in such cases, normal operation may be restored by lengthening the line by one or more half-wavelengths.

It will be noticed in fig. 2 that one electrode of the valve is common to the two tuned circuits. In this illustration the anode is the common electrode, but other arrangements are possible, and it is usual to describe the circuit arrangement by reference to the common electrode, sometimes adding a reference to the electrode that is earthed, i.e., at r-f earth potential. For use in coaxial line circuits, it is necessary for the connection to the common electrode to be intermediate physically between the connections to the other two electrodes, and this is a major factor in determining valve design.

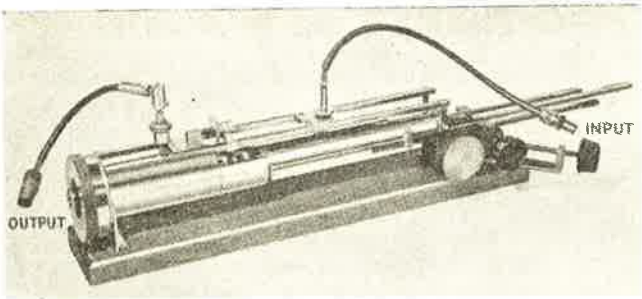


Fig. 5.—Common-grid earthed-anode amplifier circuit.

The three types of circuit in common use, for which most of the valves described in this paper have been specially designed, are:

(1) Common anode-earthed anode. Fig. 2, typical valve, ACT 24.
(2) Common grid-earthed grid. Fig. 3, typical valve ACT 23.
(3) Common grid-earthed anode. Fig. 4, typical valve, DET 24.

The common anode-earthed anode arrangement makes a simple and easily adjusted oscillator circuit for very high frequencies. The common grid arrangements may also be used as oscillators, in which case feed-back between the two circuits has to be provided, but their main use is as unneutralised amplifiers. Fig. 5 shows a photograph of a common grid-earthed anode amplifier circuit having a wavelength range of 10 to 50 cms., using a DET 24 valve.

Glass valves

Owing to the general trend over the last ten years or so towards the use of higher frequencies, the field of application of glass valves has become limited in the range of powers in which, hitherto, they held pride of place. Nevertheless, certain applications still exist, and no doubt others will arise, where, because of the limited facilities available for cooling, or, as in mobile transmitters, because the weight must be restricted, the glass valve still has a place in the low power field. Fig. 6 shows a group of small glass transmitting valves covering the frequency range up to 200 Mc/s and Table 1 gives their electrical characteristics. With the exception of the TT 15, this range of valves was a pre-war development, and although modifications to constructional details have been introduced from time to time, they are practically identical with the original designs of twelve years ago.

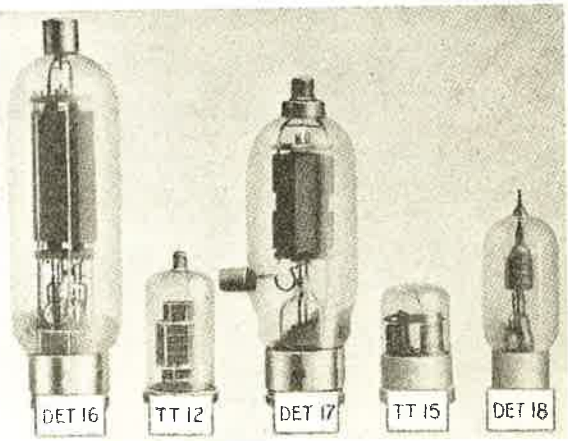


Fig. 6.—Small glass transmitting valves.

In the glass valve, most of the heat generated has to be dissipated by radiation, primarily from the anode, and any increase in power must be accompanied by an increase in the size of the anode to maintain an equivalent temperature. The grid size and filament rating must also increase in proportion. As a result of this, interelectrode capacitances increase, a feature militating against any improvement

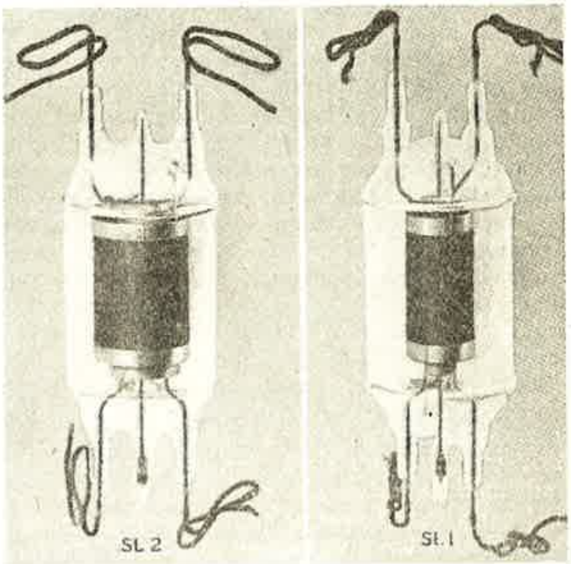


Fig. 7.—Silica valves.

TABLE 1.

SUMMARISED CHARACTERISTICS OF SMALL GLASS TRANSMITTING VALVES.

Type	Class	Type of Filament or Cathode	Filament or Heater Rating		Peak Space Current	Amplification Factor	Mutual Conductance	Max. Anode Voltage
			Volts	Amps.	Amps.		mA/V	Volts
DET 16	Triode	Thoriated Tungsten	10	5·5	1·8	60	6·5	1,000
DET 17	Triode	„	10	5·0	1·5	36	4·8	2,000
DET 18	Triode	„	5	4·0	0·9	32	4·4	2,000
TT 15	Double Tetrode	Oxide-coated	6·3	1·6	0·5	6·5	3·9	300
TT 12	Tetrode	„	19	0·42	0·5	10	6·0	600

Type	Max. Anode Dissipation	Max. Useful Frequency	Power Output Watts			Capacitances $\mu\mu F$		
	Watts	Mc/s	3 Mc/s	20 Mc/s	100 Mc/s	A-G	G-K	A-K
DET 16	125	3	120	—	—	18·25	10	10·3
DET 17	125	80	300	270	—	5·5	6·5	2·5
DET 18	50	150	70	60	50	1·7	4·6	0·17
TT 15	15	250	18	18	12	0·05	7·8 Input	5·1 Output
TT 12	25	150	40	38	24	0·14	11 Input	6·25 Output

in performance at the higher frequencies.

If this situation is to be avoided, the electrode temperature must be allowed to rise, hence the use of tantalum as the electrode material in some heavily loaded, high frequency valves.

As a result of wartime developments, however, some advances have been made in glass valve design. For example, the TT 15, a double tetrode of 15 watts anode dissipation, has indirectly heated oxide coated cathodes, mounted in such a way that the inductance between them is extremely low. The other electrodes follow the conventional design, but are mounted on a pressed glass base. The internal connection between the two screens is also arranged to have very low inductance. Due to the very short leads, this form of construction shows a worthwhile gain compared with earlier designs. A problem arises, however, in connection with the material employed for the seal through the glass base. Owing to the high resistance of the alloy pins which form the seal, it is necessary to plate them with copper, or silver, to reduce the high-frequency losses to a minimum.

While it is possible, by the use of techniques such as those just described, to effect some improvement in the performance of glass valves at high frequencies, it is evident that the limit for any appreciable power is reached at about 200 Mc/s.

Silica valves

The first silica valve seems to have appeared during the 1914-1918 war and was developed in its early stages by H.M. Signal School, Portsmouth. It has been used extensively in naval communications up to the present time. Owing to its high intrinsic cost, fragility, and relatively poor performance, it did not at first find favour in the general industrial and communications field.

Briefly, the valve consists of a fused quartz envelope with electrodes of conventional shape, supported on quartz insulators fused on the inside of the envelope at appropriate positions. The external connections to the electrodes are made via molybdenum rods which pass through quartz tubes fused on to the outside of the envelope. The seal is made with a lead plug and, to prevent the lead melting, it is necessary to place it some distance from the envelope. This results in a very long seal, in some cases as much as 8 inches, which adds to the fragility and limits the maximum frequency of operation.

Considerable development work, which was carried out on seals during the war, has resulted in the present improved form. This consists of a tungsten rod sealed to the envelope via a special hard glass, thus reducing the seal length to a small fraction of the original lead seal length. This new seal greatly improves the silica valve from the point of view of mechanical ruggedness. It has also greatly extended its field of application, by enabling it to operate at much higher frequencies.

With the growth of industrial heating equipments since the end of the war, the silica valve has found application in commercial sets operating at frequencies as high as 50 Mc/s.

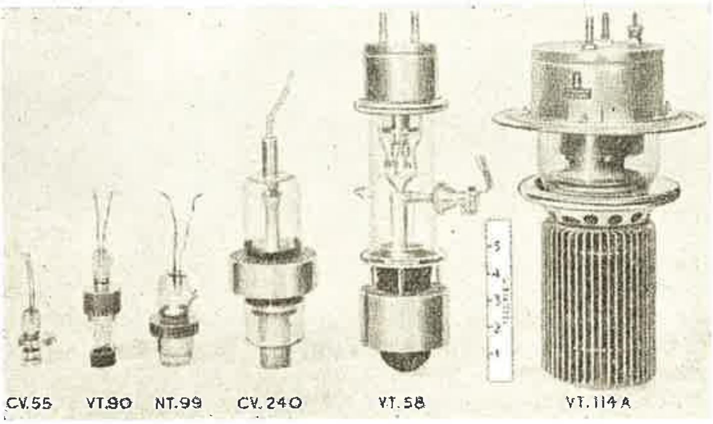


Fig. 8.—Some wartime air-cooled valves for radar.

Taking into account the repairability factor, which may be 4 or 5, or even higher depending on the state of the envelope, it appears that the economics of silica valves compare favourably with air-cooled and water-cooled valves for comparable power.

Fig. 7 illustrates two types and Table 2 gives their ratings.

Air-cooled anode valves

The range of air-cooled anode valves is divided naturally into two classes: (1) ratings up to about 1.5 kW, where the alternative (at low frequencies) is the glass valve, and (2) higher ratings up to tens of kilowatts, where the alternative is the water-cooled valve.

Low power air-cooled valves

Fig. 8 illustrates some of the types of air-cooled valves, developed during the war for use in radar equipments, working on wavelengths of several metres, in the case of the larger valves, and down to about 25 cms. for the smallest valve. Most of these valves in their wartime form were unsuitable for c.w. use, but a range of c.w. valves based on these designs was developed later, and it is with these that this paper is mainly concerned. The range of air-cooled valves with anode ratings up to 1.5 kW is illustrated in fig. 9. The summarised characteristics of these valves are given in Table 3, and nothing further need be said about their electrical properties. The constructional techniques employed are illustrated in figs. 10 and 11. Fig. 10 is typical of the construction of a common grid valve, and fig. 11 shows a typical common anode construction. Many of the features are common to both and the main difference lies in the arrangement of the electrodes.

Description of ACT 23

It will be seen from fig. 10 that the electrodes of the ACT 23 are short cylinders. The indirectly heated oxide coated cathode (6) has an emitting area of 6.5 cm.^{2} The distance between grid and cathode is 0.25 mm. and the grid-anode spacing 1.0 mm.

The main manufacturing operations are as follows. The envelope, comprising the various metal and glass

TABLE 2.

SUMMARISED CHARACTERISTICS OF SILICA VALVES.

Type	Class	Type of Filament or Cathode	Filament or Heater Rating		Peak Space Current	Amplification Factor	Mutual Conductance	Max. Anode Voltage
			Volts	Amps.	Amps.		mA/V	Volts
SL 1	Triode	Thoriated Tungsten	10	10	2·5	17	3·8	4,000
SL 2	Triode	„	10	20	4·0	33	5·1	6,000

Type	Max. Anode Dissipation	Max. Useful Frequency	Power Output Watts			Capacitances $\mu\mu F$		
	Watts	Mc/s	3 Mc/s	20 Mc/s	100 Mc/s	A-G	G-K	A-K
SL 1	500	50	1,200	1,200	—	11·7	9·6	3·3
SL 2	1,000	45	2,300	2,100	—	18	13	2·0

components, is made in one operation on a specially designed jig, which ensures the requisite accuracy in the disposition of the metal flanges (10, 12 and 13) on which the electrodes are later mounted. The precision required is much greater than could be obtained by normal glass working methods.

The anode (1) of the ACT 23, which is re-entrant, consists of a short length of thick-walled copper tube which is hard-soldered to a copper disc (2). The grid (3) is of the squirrel cage type and consists of 180 molybdenum wires, 0.15 mm. diameter, spot-welded to nickel rings, one at each end of the grid. The supported end of the grid is mounted on a copper tube (4) to conduct away as much heat as possible, and hence keep the grid cool. The cathode (6) consists of an annular nickel box enclosing the heater, and is mounted on a nickel tube (7), via a short length of nichrome tube (8) which provides thermal insulation. In assembling the valve, the whole cathode unit is introduced into the envelope through the open end (9) and bolted to the disc (10). The live end of the heater is then welded to the lead (11). Next, the grid is inserted over the cathode, and bolted to its flange (12), and lastly, the anode is assembled in the envelope by the gold wire process, by means of which a vacuum tight seal is made between flanges (2) and (13). The grid and anode coolers (5) and (14) are soft soldered on after exhaust.

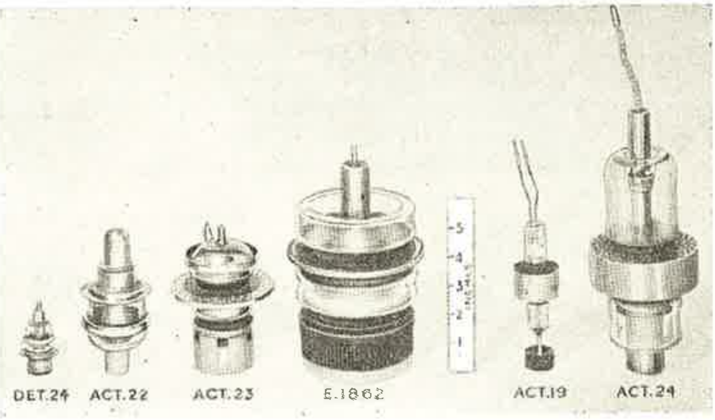


Fig. 9.—Low power air-cooled valves.

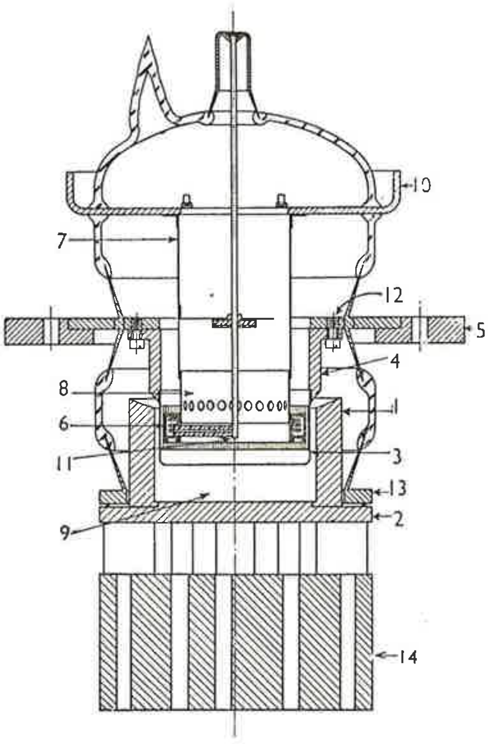


Fig. 10.—Typical construction of common-grid triode (ACT 23).

Description of ACT 24

Owing to the different electrode arrangement of the ACT 24 (fig. 11), the methods of construction employed are somewhat different from those used for the ACT 23. The electrodes of the ACT 24 are also cylindrical but considerably larger than in the case of the ACT 23. For example, the coated area of the cathode is 20 cm.², and the grid and anode are correspondingly larger. The interelectrode clearances are also greater; the grid-cathode distance being 1.3 mm. and the grid-anode distance 3.4 mm.

The main steps in the manufacture are as follows. The copper anode and grid seals (1 and 2) are prepared for glassing by flaring, and rolling the ends to a knife edge. The glassing is done in a small glass lathe to ensure accuracy in alignment. At this stage both glass tubes attached to the anode are open. Next, the flared glass tube (3), already attached to the grid seal, is sealed in to one of the glass tubes attached to the anode, during which operation the surface on which the grid is to be mounted is accurately located with respect to the

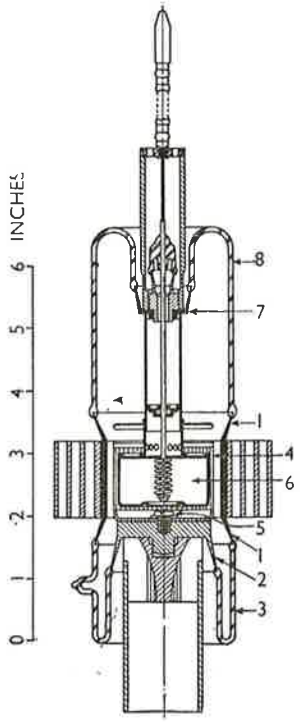


Fig. 11. Typical construction of common-anode triode (ACT 24).

TABLE 3.

SUMMARISED CHARACTERISTICS OF LOW POWER AIR-COOLED VALVES.

Type	Common Electrode in Coaxial Circuits	Type of Filament or Cathode	Filament or Heater Rating		Peak Space Current	Amplification Factor	Mutual Conductance	Max. Anode Voltage
			Volts	Amps.	Amps.		mA/V	Volts
DET 24	Grid	I.H. Oxide-coated	6·3	1·0	1·0	33	12	400
ACT 22	Grid	,,	6·3	4·0	1·5	22	20	600
ACT 23	Grid	,,	13·5	2·8	5·0	40	30	1,000
E 1862	Grid	,,	16	6·7	10·0	50	40	1,500
ACT 19	Anode	Thoriated Tungsten	8·25	7·0	2·0	15·5	3·1	2,500
ACT 24	Anode	I.H. Oxide-coated	6·0	17	6·0	35	20	1,500

Type	Max. Anode Dissipation	Max. Useful Frequency	Power Output Watts			Capacitances $\mu\mu F$			Air Flow
	Watts	Mc/s	100 Mc/s	300 Mc/s	1,000 Mc/s	A-G	G-K	A-K	cubic ft. per min.
DET 24	20	2,000	20	20	10	1·9	4·8	0·04	—
ACT 22	75	1,500	105	105	50	6·5	13·5	0·3	5
ACT 23	400	1,000	400	400	200	16·5	22	0·6	30
E 1862	1,500	500	1,500	1,500	—	27	31	0·5	100
ACT 19	200	300	250	150	—	3·7	2·2	1·0	11
ACT 24	1,500	200	1,500	—	—	15·4	17·4	3·5	60

anode by means of a jig. The grid (4) can then be introduced through the other end of the bulb and attached to its seal by means of a small bolt (5). Finally, the cathode (6), which has already been mounted on another glass-to-metal seal (7), is sealed into the glass tube (8) on the end of the anode remote from the grid seal. The two components being sealed together in this operation are held in accurate relationship by mounting on aligned Vee blocks.

High power air-cooled valves

To turn now to the air-cooled valves of higher power, fig. 12 shows the ACT 16, a valve of conventional construction, which is rated at 18 kW dissipation. Apart from the anode cooler, this valve is identical with the water-cooled valve CAT 9, which is illustrated in fig. 17. The ACT 16 requires an air flow of 600 cubic feet per minute at a pressure of 6 inches water gauge for anode cooling. The choice between the air-cooled and the water-cooled valve depends on many factors mostly concerned with the cooling systems rather than with the valves themselves. The advantages and disadvantages of the two arrangements, however, are fairly equally balanced and personal preference often decides.

A new 5 kW air-cooled valve of novel design (ACT 26) is shown in fig. 13, and its electrical characteristics are summarised in Table 4. The ACT 26 has a thoriated tungsten filament giving an emission of 15 amperes. One of the problems in design was how to incorporate such a large filament in a valve of this size, and the photograph of the mounted filament system, shown in fig. 14, indicates how this problem was solved. Among the advantages of this type of filament may be mentioned (1) the effects of the cold ends are minimised, (2) the emission per unit length is increased, and (3) a convenient rating in voltage and current can be achieved without the use of insulators.

The grid of the ACT 26 is a squirrel cage of molybdenum wires mounted on a copper tube, a design which ensures good thermal and electrical conductance between the active grid itself and the seal which is air-cooled. The anode cooler is of the

Fig. 12.—High power air-cooled valve (ACT 16).

high efficiency type, requiring an air flow of only 300 cubic feet per minute at a pressure of 4 inches water gauge. The valve is designed so that it may, if desired, be operated in coaxial line circuits.

Water-cooled valves

Le Rossignol and Hall, in their earlier paper, ended their account of water-cooled valves with a description of the CAT 14, which has an anode dissipation of 150 kW, and is still the largest valve manufactured. The next development was the making of the CAT 17 (fig. 15), a short wave version of the CAT 14. The electrode dimensions of these two valves are identical and they differ only in the grid seal, which, in the CAT 17, is a copper flange with a copper-to-glass seal on either side of it. These seals are $5\frac{1}{4}$ inches in diameter. The grid seal of the CAT 17 is therefore capable of carrying much greater r-f current and it has much lower inductance. Thus, the CAT 17 has enabled the medium wave performance of the CAT 14 to be obtained on the short wave bands, and it has been extensively used for short wave transmission on frequencies up to 25 Mc/s.

A more recent development is illustrated in fig. 16. This shows the E 1872, a new experimental valve, in which the r-f conductance of the grid system has been still further improved and, at the same time, the length and inductance of the filament leads have been greatly reduced. Otherwise this valve is identical with the CAT 14 and CAT 17, but the modifications enable better use to be made of the electrical characteristics at the highest frequencies.

TABLE 4.

SUMMARISED CHARACTERISTICS OF HIGH POWER AIR-COOLED VALVES.

Type	Common Electrode in Coaxial Circuits	Type of Filament or Cathode	Filament Rating		Peak Space Current	Amplification Factor	Mutual Conductance	Max. Anode Voltage
			Volts	Amps.	Amps.		mA/V	Volts
ACT 26	Grid	Thoriated Tungsten	6·5	105	15	22	45	5,000
ACT 16	—	Tungsten	20	100	12	45	10	15,000

Type	Max. Anode Dissipation	Max. Useful Frequency	Power Output Watts			Capacitances $\mu\mu F$			Air Flow
	Watts	Mc/s	20 Mc/s	50 Mc/s	100 Mc/s	A-G	G-K	A-K	cubic ft. per min.
ACT 26	5,000	300	7,500	7,500	7,500	18	22	0·26	300
ACT 16	18,000	50	15,000	7,500	—	21·5	30	2·3	600

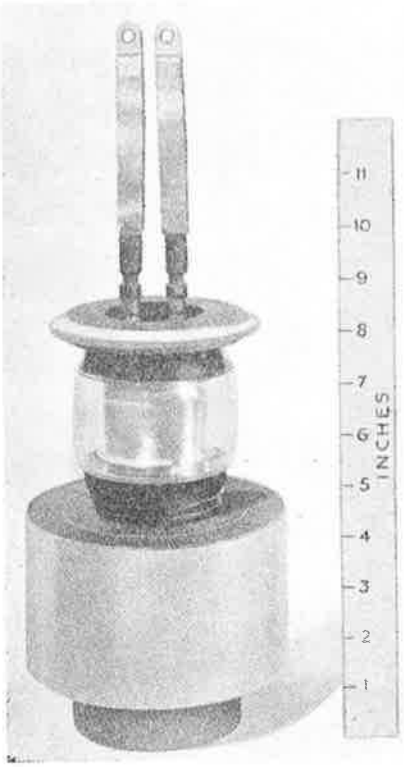


Fig. 13.—High power air-cooled valve for high-frequency operation ACT 26.

Another striking example of the constructional modifications necessary to improve the short wave performance of water-cooled valves can be seen in fig. 17, which shows the CAT 9, a 20-year-old "short wave" valve and the CAT 21, a modern design having the same anode dissipation. The greatly reduced dimensions and the improved grid and filament seals give the CAT 21 a great advantage at high frequencies. For example, the maximum useful frequency of the CAT 9 is 50 Mc/s, whereas the CAT 21 may be used at 100 Mc/s.

In order to reduce transit time effects, it has been necessary to use much smaller interelectrode spacings in the CAT 21 than in the CAT 9. An undesirable consequence of small spacings is high capacitance, but, by reducing the length of the electrodes in the CAT 21, the increase in capacitance has been restricted. For efficient wide band operation, the ratio of peak anode current to anode-grid capacitance should be high, and this figure of merit is much better for the CAT 21 than for the CAT 9 in spite of the higher capacitance of the CAT 21. Details of the electrical properties of the CAT 21 are given in Table 5.

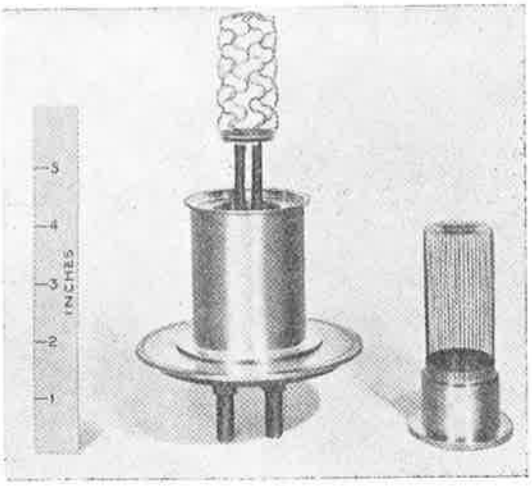


Fig. 14.—Filament and grid of ACT 26 valve.

Some experimental work was carried out before the war on multi-electrode water-cooled valves and two pentodes rated at 10 and 25 kW were developed. The 10 kW valve PCA 21 shown in fig. 18 has since been extensively used in broadcast transmitters where its higher gain, and freedom from the necessity to neutralise, give it advantages over triodes of similar dissipation. An air-cooled version of this valve has also been made.

Fig. 15.—High power short wave water-cooled valve CAT 17.

Due largely to the limitations imposed on the radiated power of broadcasting transmitters, there has not yet been the necessity to produce a valve of greater power handling capacity than the CAT 14. Most of the new developments have therefore taken place in the high - power short wave valves, as has just been described. Should the need for much greater power on medium wavelengths arise, it is not unlikely, however, that consideration of problems in transport and in handling would lead to the adoption of a number of 150 kW valves in parallel rather than to the use of a very large single unit.

Fig. 16 (left).—Latest model of the CAT 17 (E1872).

Fig. 17 (above).—Old and new water-cooled valves of 20 kW dissipation (CAT 9 and CAT 21).

Fig. 18 (right).—Water-cooled pentode PCA 21.

TABLE 5.

SUMMARISED CHARACTERISTICS OF WATER-COOLED VALVES CAT 9 AND CAT 21.

Valve Type.	Overall Length mm.	Type of Filament	Filament Rating		Peak Space Current	Amplification Factor	Mutual Conductance
			Volts	Amps.	Amps.		mA/V
CAT 9	803	Tungsten	20	100	12	45	10
CAT 21	380	Tungsten	12	320	25	20	25

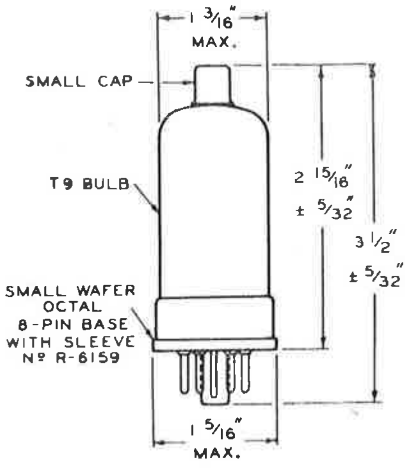
Valve Type	Max. Anode Voltage	Max. Anode Dissipation	Max. Output	Max. Useful Frequency	Capacitances $\mu\mu F$		
	kV	kW	kW	Mc/s.	A-G	G-K	A-K
CAT 9	15	18	15	50	21·5	30	2·3
CAT 21	10	20	30	100	32	42	1·1

These large water-cooled valves have established a high reputation for reliability and give upwards of 10,000 hours of trouble-free service before eventual failure, which is almost always due to the inevitable wastage of the hot tungsten filament by evaporation.

Acknowledgments

In conclusion, the authors desire to tender their acknowledgments to the M.-O. Valve Co. Ltd., on whose behalf the work described in this publication was carried out.

DIMENSIONAL OUTLINE



Radiotron

TYPE

2E26

This modern power valve is now in production at the Ashfield Works of Amalgamated Wireless Valve Company Pty. Ltd.

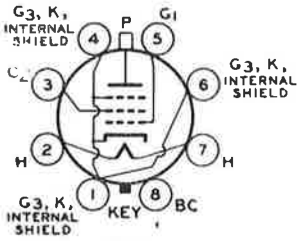
Radiotron 2E26 is a beam power amplifier intended primarily for use in F-M transmitters, either in low power driver stages, or in the output stage when only low power output is required. It is also useful in a-f power and modulator service.

Having high power sensitivity and high efficiency, the 2E26 can be operated at relatively low plate voltage to give large power output with small driving power. Furthermore, it can be operated with full input to 125 megacycles.

Small in size for its power-output capability, the 2E26 features rugged button-stem construction with short internal leads, and an octal base with short metal sleeve which shields the input to the tube so completely that no other external shielding is required. Separation of input and output circuits is accomplished by bringing the plate lead out of the bulb to a cap opposite the base.

GENERAL DATA

SOCKET CONNECTIONS
Bottom View



7CK

PIN 1: CATHODE, GRID NO.3, INTERNAL SHIELD
PIN 2: HEATER
PIN 3: GRID NO.2
PIN 4: SAME AS PIN 1
PIN 5: GRID NO. 1
PIN 6: SAME AS PIN 1
PIN 7: HEATER
PIN 8: BASE SLEEVE
CAP: PLATE

Electrical:

Heater: for Unipotential Cathode:		
Voltage (a.c. or d.c.)	6.3	Volts
Current	0.8	Ampere
Transconductance for plate current of 20 milliamperes	3500	Micromhos
Grid-screen Mu-factor	6.5	
Direct Interelectrode Capacitances:°		
Grid to Plate	0.20 max.	μμF
Input	13	μμF
Output	7	μμF

° With no external shielding and base sleeve connected to ground.

Mechanical:

Mounting Position	Any
Overall Length	$3\frac{1}{2}'' \pm \frac{5}{32}''$
Seated Length	$2\frac{15}{16}'' \pm \frac{5}{32}''$
Maximum Diameter	$1\frac{5}{16}''$
Bulb	T-9
Cap	Small
Base	Small Wafer Octal 8-Pin with Sleeve No. R-6159

See P.152 for characteristics curves.

A-F POWER AMPLIFIER & MODULATOR Class A_1

Maximum Ratings,

Absolute Values:

	CCS †	
D.C. Plate Voltage	300 max.	Volts
D.C. Grid—No. 2 (Screen) Voltage	200 max.	Volts
Plate Dissipation	10 max.	Watts
Grid—No. 2 Input	2.5 max.	Watts
Peak Heater—Cathode Voltage:		
Heater negative with respect to cathode	100 max.	Volts
Heater positive with respect to cathode	100 max.	Volts

Typical Operation:

D.C. Plate Voltage	250	Volts
D.C. Grid—No. 2 Voltage	160	Volts
D.C. Grid—No. 1 (Control Grid) Voltage	–14	Volts
Peak A-F Grid—No. 1 Voltage	14	Volts
Zero-Signal D.C. Plate Current	35	mA
Max.-Signal D.C. Plate Current	42	mA
Zero-Signal D.C. Grid—No. 2 Current	7	mA
Max.-Signal D.C. Grid—No. 2 Current	10	mA
Load Resistance	5500	Ohms
Total Harmonic Distortion	10	Per cent
Power Output	5.3	Watts

Maximum Circuit Values:

Grid—No. 1—Circuit Resistance	30000 max.	Ohms

PUSH-PULL A-F POWER AMPLIFIER & MODULATOR — Class AB_2*

Maximum Ratings,

Absolute Values:

	CCS †	*ICAS †*	
D.C. Plate Voltage	400 max.	500 max.	Volts
D.C. Grid—No. 2 (Screen) Voltage	200 max.	200 max.	Volts
Max.-Signal D.C. Plate Current**	75 max.	75 max.	mA
Max.-Signal Plate Input**	30 max.	37.5 max.	Watts
Max.-Signal Grid—No. 2 Input**	2.5 max.	2.5 max.	Watts
Plate Dissipation**	10 max.	12.5 max.	Watts
Peak Heater-Cathode Voltage:			
Heater negative with respect to cathode	100 max.	100 max.	Volts
Heater positive with respect to cathode	100 max.	100 max.	Volts

Typical Operation:

Values are for two valves.

D.C. Plate Voltage	400	500	Volts
D.C. Grid—No. 2 Voltage▲‡	125	125	Volts
D.C. Grid—No. 1 Voltage (Fixed Bias)	–15	–15	Volts
Peak A-F Grid-No. 1-to-Grid-No. 1 Voltage	60	60	Volts
Zero-Signal D.C. Plate Current	20	22	mA
Max.-Signal D.C. Plate Current	150	150	mA
Max.-Signal D.C. Grid-No. 2 Current	32	32	mA
Effective Load Resistance (Plate to plate)	6200	8000	Ohms
Max.-Signal Driving Power (Approx.)♦	0.36	0.36	Watt
Max.-Signal Power Output (Approx.)	42	54	Watts

PLATE-MODULATED R-F POWER AMPLIFIER — Class C Telephony

Carrier conditions per tube for use with a maximum modulation factor of 1.0.

Maximum Ratings,

Absolute Values:

	CCS †	*ICAS †*	
D.C. Plate Voltage	400 max.	500 max.	Volts
D.C. Grid-No. 2 (Screen) Voltage	200 max.	200 max.	Volts
D.C. Grid-No. 1 (Control Grid) Voltage	–175 max.	–175 max.	Volts
D.C. Plate Current	60 max.	60 max.	mA
D.C. Grid-No. 1 Current	3.5 max.	3.5 max.	mA
Plate Input	20 max.	27 max.	Watts
Grid-No. 2 Input	1.7 max.	2.3 max.	Watts
Plate Dissipation	6.7 max.	9 max.	Watts
Peak Heater-Cathode Voltage:			
Heater negative with respect to cathode	100 max.	100 max.	Volts
Heater positive with respect to cathode	100 max.	100 max.	Volts

Typical Operation:

D.C. Plate Voltage	400	500	Volts
D.C. Grid-No. 2 Voltage#	160	180	Volts
	32000	35500	Ohms
D.C. Grid-No. 1 Voltage●	–50	–50	Volts
	20000	20000	Ohms

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Peak R-F Grid-No. 1 Voltage	60	60	Volts
D.C. Plate Current	50	54	mA
D.C. Grid-No. 2 Current	7.5	9	mA
D.C. Grid-No. 1 Current (Approx.)	2.5	2.5	mA
Driving Power (Approx.)	0.15	0.15	Watt
Power Output (Approx.)	13.5	18	Watts

Maximum Circuit Values:

Grid-No. 1-Circuit Res.••	30000 max.	30000 max.	Ohms

R-F POWER AMPLIFIER & OSCILLATOR

Class C Telegraphy

Key-down conditions per tube without modulation##

Maximum Ratings, *Absolute Values:*

	CCS †	*ICAS* †	
D.C. Plate Voltage	500 max.	600 max.	Volts
D.C. Grid-No. 2 (Screen) Voltage	200 max.	200 max.	Volts
D.C. Grid-No. 1 (Control Grid) Voltage	–175 max.	–175 max.	Volts
D.C. Plate Current	75 max.	85 max.	mA
D.C. Grid-No. 1 Current	3.5 max.	3.5 max.	mA
Plate Input	30 max.	40 max.	Watts
Grid-No. 2 Input	2.5 max.	2.5 max.	Watts
Plate Dissipation	10 max.	13.5 max.	Watts
Peak Heater-Cathode Voltage:			
Heater negative with respect to cathode	100 max.	100 max.	Volts
Heater positive with respect to cathode	100 max.	100 max.	Volts

Typical Operation: Up to 125 Mc/s

D.C. Plate Voltage	400	500	600	Volts
D.C. Grid-No. 2 Voltage□	190	185	185	Volts
	19000	28500	41500	Ohms
D.C. Grid-No. 1 Voltage ó	–30	–40	–45	Volts
	10000	13500	15000	Ohms
Peak R-F Grid-No. 1 Volt	41	50	57	Volts
D.C. Plate Current	75	60	66	mA
D.C. Grid-No. 2 Current	11	11	10	mA
D.C. Grid-No. 1 Current (Approx.)	3	3	3	mA
Driving Power (Approx.)	0.12	0.15	0.17	Watt
Power Output (Approx.)	20	20	27	Watts

Typical Operation: At 160 Mc/s

D.C. Plate Voltage	300	350	Volts
D.C. Grid—No. 2 Voltage□	170	200	Volts
	21500	21500	Ohms
D.C. Grid—No. 1 Voltage ó	–75	–90	Volts
	30000	30000	Ohms
Peak R-F Grid—No. 1 Voltage	85	105	Volts
D.C. Plate Current	75	85	mA
D.C. Grid—No. 2 Current	6	7	mA
D.C. Grid—No. 1 Current (Approx.)	2.5	3	mA
Driving Power (Approx.)	1.5	2	Watts
Power Output (Approx.)	13	16.5	Watts

Maximum Circuit Values:

Grid-No. 1-Circuit Res.••	30000 max.	30000 max.	Ohms

FOOTNOTES

* Subscript 2 indicates that grid current flows during some part of input cycle.

** Averaged over any audio-frequency cycle of sine-wave form.

▲ Preferably obtained from a separate source, or from the plate-voltage supply with a voltage divider.

‡ In applications requiring the use of screen voltages above 135 volts, provision should be made for the adjustment of grid-No. 1 bias for each valve separately.
The necessity for this adjustment at the lower screen voltages depends on the distortion requirements and on whether the plate-dissipation rating is exceeded at zero-signal plate current.

♦ Driver stage should be capable of supplying the No. 1 grids of the class AB_2 stage with the specified driving power at low distortion. The effective resistance per No. 1 grid circuit of the class AB_2 stage should be kept below 500 ohms and the effective impedance at the highest desired response frequency should not exceed 700 ohms.

Obtained preferably from a separate source modulated with the plate supply, or from the modulated plate-supply through series resistor of the value shown.

• Obtained from grid resistor of value shown or by partial self-bias methods.

•• Any additional bias required must be supplied by a cathode resistor or a fixed supply.

Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

□ Obtained preferably from a separate source, or from the plate-voltage supply with a voltage divider, or through a series resistor of the value shown. The grid-No. 2 voltage must not exceed 600 volts under key-up conditions.

ó Obtained from fixed supply, or by grid-No. 1 resistor of value shown.

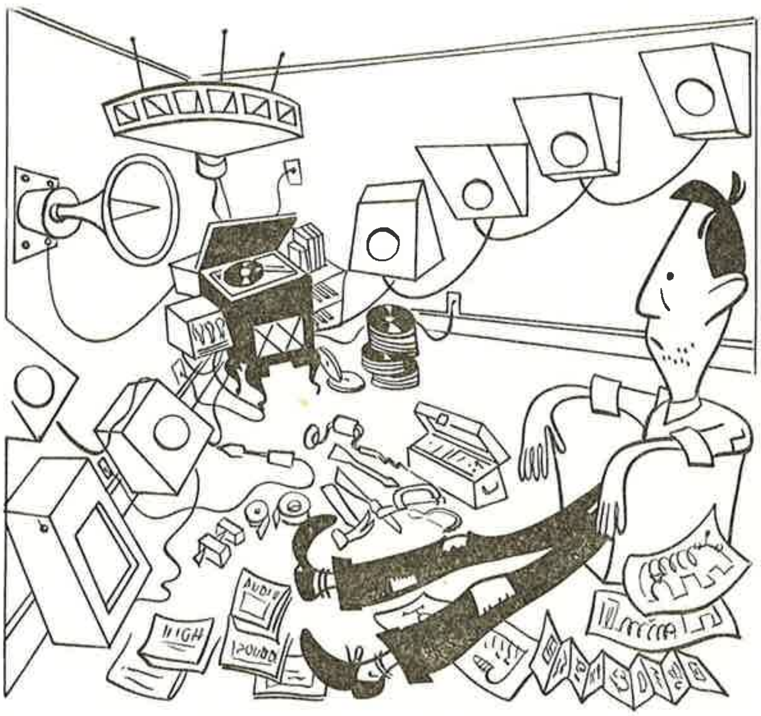
† CCS = Continuous Commercial Service.

ICAS = Intermittent Commercial and Amateur Service.

The Dethronement of Queen Anne

By C. G. BURKE

When two hearers disagree about the technical qualities of a recording familiar to both — and they do very often — the difference may be caused by unequal human perceptions, temperaments, or experiences, but it is more probably the result of the incompatability of two phonographs. If the disputants exchanged instruments it is quite likely that they would swap opinions too. Human perceptions vary but machines vary more, and both are also mutable. Only the record, before age or injury subdues it, is changeless and complete at its birth. A record is engraved with a complexity of sound and no phonograph available to us now can coax from the grooves all their latent complexities exactly as they were received there. The best records sound magnificent but they would sound better if we had better instruments on which to play them. A residue of silent sound lies in every disc. When the reproducing apparatus is of the best the residue is comparatively small; when the apparatus is poor the residue can exceed the output.



Many people care little for reproductive values if they can recognise a melodic contour. Others agonize at a trifling deviation from their concept of perfection. A listener was recently observed rapt at the "Moonlight" Sonata played on a Columbia portable "viva-tonal" (non-electric; half-pound soundbox; rusty steel needle entering its hundredth victim) phonograph of 1930 manufacture, which tinkled out a farcical sketch of the music as if on a dry-rotted xylophone. But it gave pleasure.

But only pain was given to a man whose impressive apparatus (magnetic pickup, fifty-watt amplifier with cut-offs every 2,000 cycles, handmade preamplifier, ten-circuit compensator, four $200 dual speakers) brought the new Ansermet "Petrouchka" to terrifying life in his living room. Cutting off the cycles above 10,000, his ear detected no difference in the sumptuous tumult from what it had heard with an unrestricted cyclic output. "Lousy recording," he declared with a bitter and outraged finality.

Between these extreme extremes the great majority of phonophiles take gratification from records. It is a majority with countless mobile gradations of taste and sensitivity. It steadily receives recruits from the portable stratum and constantly loses graduates to the cult of high-fidelity. The last, by the unwavering fanaticism of their demands and the influence a learned clamor can exert, affect imposingly the course of recording policy. They want exact realism. They want the continuous splendor of the Boston Symphony Orchestra audibly present in their living rooms, indistinguishable from the orchestra in Symphony Hall, without the loss of a single overtone from cymbal or triangle. The great improvements of the last few years — ffrr and microgroove — stimulate a fiercer hunger for glories newer still. They are inescapably and forever damned, a perfectionistic elite in sight of and approaching a culmination that can never quite be attained.

Once their zeal has infected others previously contented with the placid issuance of a gentle musi-

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cal entertainment from a comfy, reassuring phonograph incapable of parading the dazzle of the new records, the neophytes undergo the breathless excitement of discovery and revelation, renewed and renewed again as equipment is discarded and replaced by more elaborate or more accurate components. New values of reproduction are sought and eventually found, bit by bit, after disappointment, exasperation, and expense. The original germ of discontent, cultivated, will produce progressively improved blooms, each bearing fertile seeds of untoward dissatisfaction.

The typical convert to the dogma of perfectionism begins in discontent, with little valid information and dubious assistance. He has a box (not improbably mounted on Queen Anne legs) which, through the magic of an electric current, emits music. Once complacent about the quality of the issuing sound, he has despised it since hearing an enviably richer complexity burst forth from a box owned by a friend. The friend's box (bleached modern) cost $800, his own $250, so the audible return is honestly proportionate. But knowledge of this does not stifle dissatisfaction. At a phonograph shop he is told what he already knows, that equality with his friend can be had for $800.

Directed to a radio-supply store, he will eventually encounter a functionary knowing in the intricacies of sound reproduction in its most finicky aspect: accuracy (high-fidelity). He will hear for the first and not the last time a promising patter of decibels, cycles per second, the audible spectrum, response curves, etc. A pair of variable reluctance pickups will be installed in his changer, replacing a pair of crystals. This is his first revelation.

Magnetic pickups express a tingle, a vibrancy of sound, peculiar to themselves; and with a little preamplifier screwed to the back of his Queen Anne box the convert enjoys his records for weeks as he has not enjoyed them before. For weeks; then he notices the cutting shrillness of the violins on LP's. He cannot correct this properly by turning down his treble control, for with the disappearance of the shrillness vanishes also the characteristic quality of all the higher instruments. "An equalizer will take care of that," the serviceman says.

And so it does, for a while. The equalizer with four selective circuits, affixed to the side of the Queen Anne box, reduces treble scream and refines the bass. The LP's become playable, the sweep of ffrr unified and disciplined. The serviceman agrees that the improvement is remarkable, "even with a lousy speaker like that."

The neophyte has never seen his speaker, concealed deep in his sonic box, its aperture covered by a screen of metallic cloth. "What's the matter with it?" he demands. Practically everything, it seems.

Why, a good speaker would cost as much as the whole set; that is, a really good speaker. However, a pretty good speaker can be had for about $70.

Out comes the old contemptible ten-inch thing with its undersized magnet. After the shape and interior arrangement of the Queen Anne box have been altered to admit it, in goes a fifteen-inch coaxial job with a three-pound magnet and a solemn testimonial from the manufacturer to its excellence, with graphs to prove it.

The change from a poor speaker to a reasonably good one gives the most apocalyptic of immediately possible transformations. Queen Anne immediately discoursed with the flamboyant robustious disambiguity of the great Catherine, and our neophyte listened to cosmic intonations in a daze of wonderment for weeks.

Naturally he was the victim of his success. His remade box afforded some intimations of perfection; its new sensitivity betrayed crudities previously unheard. The thud and wow of a slightly uneven turntable came out of the speaker magnified. The remedy was a cast-aluminium turntable with a beautifully machined, oversized spindle so nicely fitted as to allow the turntable no deviation from the horizontal. The deterioration of styli became apparent in distortions the old speaker had not been able to express. He bought new pickups with diamond styli and then a counterbalanced tone-arm to hold them. Inevitably he bought an amplifier constructed on elaborate principles which the thrifty manufacturer of his Queen Anne had carefully ignored. This was magnificent but it showed the new speaker to be by no means the last word in speakers, and led to the purchase of one that nearly was: separate high- and low-frequency drivers, directional horn, six-pound magnet, infinite baffle, absorbent packing, etc. This was perforce stationed away from the Queen Anne since it was in every way larger. Inferior preamplifiers can be injurious to the quality of sound so he bought a superior one.

A single radius would not serve as point with satisfactory results for all records: he supplemented his .003 diamond with points of .0025 and .0027, then with .002 and .0022. These were mounted in cartridges of the variable-reluctance type, of improved response. He experimented with filters, condensers, and resistors; and in order to bring the various components of his sprawling assembly into harmonious adjustment bought an oscilloscope to study their characteristics. He installed a more sensitive, accurate, and versatile compensator in place of his old equalizer. He has discovered the subtle stereophonic possibilities of multiple speakers placed at different distances from the listening ears and at different heights from the floor. He has two speakers installed now and rearranges them periodically. He is about to buy a third.

He makes his own installations, solders, splices, strips, and tests efficiently. He knows Ohm's law better than the civil code and reads technical papers to study new developments in acoustics. He has become in a modest way an amateur audio engineer and a radio mechanic. He has a phonograph about as good as he could buy anywhere outside of professional laboratories. It has cost to date more than two thousand dollars. He gave Queen Anne to his janitor, who thinks it in every way superior to the magnificent, disorderly composite upstairs.

Expert guidance would have deprived the former neophyte of a succession of triumphs but would have saved for him nearly two-thirds of his expense. There are many audio experts and there are many audio quacks. Music lovers should entrust a high-fidelity project only to audio men with distinguished credentials.

A basic manual explaining the principles and functions of high-fidelity reproduction of sound, with the technical jargon thoroughly glossed and tabulated, would obviate the costly empiricism of retarded correction and personal discovery. It is curious that a fundamental manual, focused brightly and exclusively on the constructional aspects of the finest reproduction of music from records, does not exist. It would help.

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New RCA Releases

Radiotron 5946 is a very compact, forced-air-cooled power triode designed for u-h-f plate-pulsed oscillator and amplifier service. In such service, this new tube has a maximum rated plate dissipation of 250 watts, and can be operated with full plate voltage at frequencies up to 1300 megacycles per second. Operation at higher frequencies is permissible with reduced ratings.

Featured in the design of the 5946 is a coaxial-electrode structure for use with circuits of the coaxial-cylinder type. The design provides low-inductance, large-area, r-f electrode terminals for insertion into the cylinders, and permits effective isolation of the plate from the cathode. The latter feature makes the 5946 particularly suitable for grounded-grid circuits.

Radiotron 17GP4 is a new rectangular picture tube which requires no focusing coil or focusing magnet with resultant important savings in critical materials.

Featuring electrostatic focusing, the 17GP4 uses an electron gun of improved design to provide good uniformity of focus over the entire picture area. Furthermore, focus is maintained automatically with variation in line voltage and with adjustment of picture brightness. Need for alignment of a focusing magnet is eliminated and therefore tube installation and adjustment for optimum performance are simplified.

Because the electron gun is designed so that the focusing electrode takes negligible current, the voltage for the focusing electrode can be provided easily and economically.

In other respects, the 17GP4 is similar to the 17CP4. It is of the metal-shell type, has a maximum high-voltage rating of 16 kilovolts (design centre), and produces brilliant 14⅜″ × 11″ pictures on a relatively flat, high-quality face made of frosted Filterglass. Employing magnetic deflection, the 17GP4 has a diagonal deflection angle of 70° and a horizontal deflection angle of 66°.

Radiotron 20CP4 is a directly viewed rectangular picture tube having a picture area 17¼″ × 13¼″. The design of the 20CP4 incorporates a high-efficiency, white fluorescent screen on a face made of Filterglass to provide increased picture contrast; employs magnetic focus and magnetic deflection; and has an ion-trap gun requiring only a single-field, external magnet. The 20CP4 has a diagonal deflection angle of 70° and a horizontal deflection angle of 66°.

With its maximum high-voltage rating of 18 kilovolts (design centre), the 20CP4 provides pictures having high brightness and good uniformity of focus over the whole picture area.