Mullard

Outlook

Australian Edition
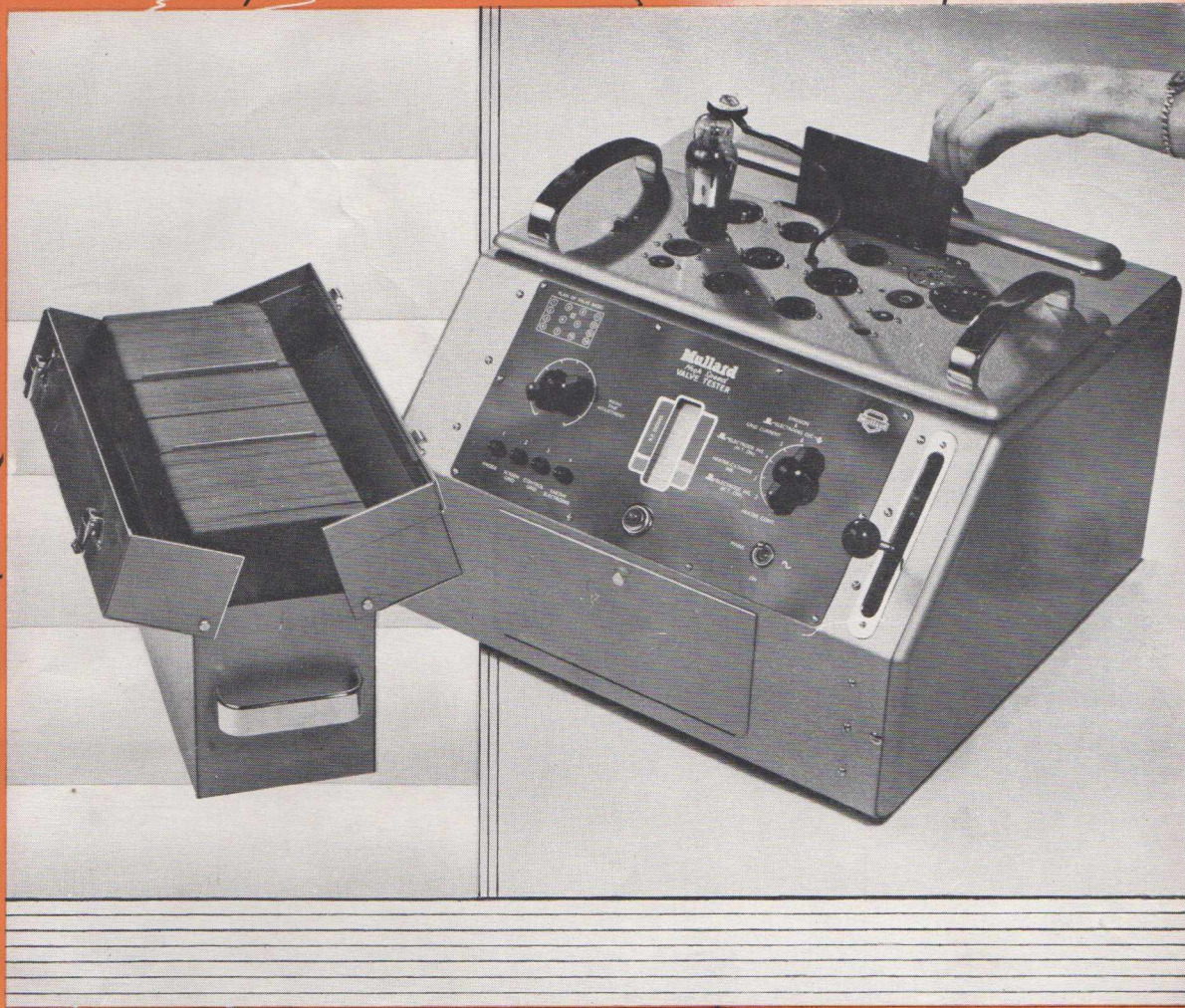
CONTENTS:

Speed, simplicity of operation, and accuracy of results— these are the factors that have led to many Australian set manufacturers, radio and television retailers acclaiming the new Mullard High Speed Valve Tester as an outstanding service aid. Using a unique control card system, this instrument will enable you to test any of the widest variety of international radio and television valves and tubes in less than a minute.

For more detailed information see also page 60 of this issue.

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Television brought to broadcasting the one element it always lacked—vision. Our adoption of C.C.I.R. standards, 625 lines, F.M. sound and the Australian Broadcasting Control Board pattern of Commonwealth-wide station development reflects vision of another kind, but vision indeed.

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A SIMPLE EXPLANATION OF SEMICONDUCTOR DEVICES

This is the title of still another new Mullard publication. Released by the Mullard Educational Service, this new booklet is intended to provide a non-mathematical treatment of semiconductors and some of the devices in which they are employed.

In dealing with this subject, emphasis has been given to explanation of the physical aspects of electron and hole conduction, mainly for the benefit of the less advanced student.

Chapter I deals with the properties of germanium, with the processing of the metal and with the controlled addition of impurities. The p-n junction is then described. This leads to a consideration of the junction diode and also of the point contact diode.

In Chapter II the principles and properties of both the point contact and junction transistor are described, and details are given of their characteristics and of some typical applications.

Chapter III briefly lists other types of semiconductor devices, some of which, at the time of going to press, are still in the development stage.

Available shortly at 5/3, plus 5d. postage per copy.

NEW MULLARD FILM

The latest addition to the Mullard Film Library "Photo-Emission" was made by Mullard Ltd., in conjunction with the Educational Foundation for Visual Aids.

The film, one of the E.F.V.A. Advanced Science Series, opens by showing the construction of a modern photo-electric cell. Experiments are then carried out to illustrate the first and second laws of photo-emission. Animated diagrams are used to show how the quantum theory of Planck and Einstein explains the two laws of photo-emission.

It has a running time of 18 minutes and ends by showing a number of applications of photo-emission, including the photo-electric cell used for colour printing, the photo-multiplier, image converter and high-speed camera.

Additional films available from the Advanced Science Series, are listed below:—

"Conquest of the Atom"—(Colour—22 mins.)—Introduction shows the opening of Calder Hall, Britain's first atom power station. It deals with the experiments of J. J. Thompson in 1897, Rutherford in 1919 and Sir John Cockcroft in 1932.

"Mirror in the Sky"—(22 mins.)—Story of research and development of radio wave propagation with particular emphasis on effects produced in and by the ionosphere.

"Principles of the Transistor"—(20 mins.)—Intended as an aid to teaching, the film reviews early use of crystals and subsequent replacement by thermionic valves. The larger portion of the film describes the working principles of the germanium diode and the transistor and summarises with details of application and advantages of these devices.

CIRCUITS FOR AUDIO AMPLIFIERS

This new Mullard publication was reviewed in the last issue of the "Outlook" and is now available through Mullard offices and distributors.

The price of 12/6, plus 1/5 postage per copy, includes an insert sheet which provides details of suggested loudspeakers and enclosures.

MULLARD-AUSTRALIA PERSONALITIES

We feel it is fitting in introducing this series of Mullard-Australia personalities to commence with the gentleman who controls the purse strings and we want you to meet our Accountant and Deputy to the General Manager, Mr. Keith Robertson, A.A.S.A.

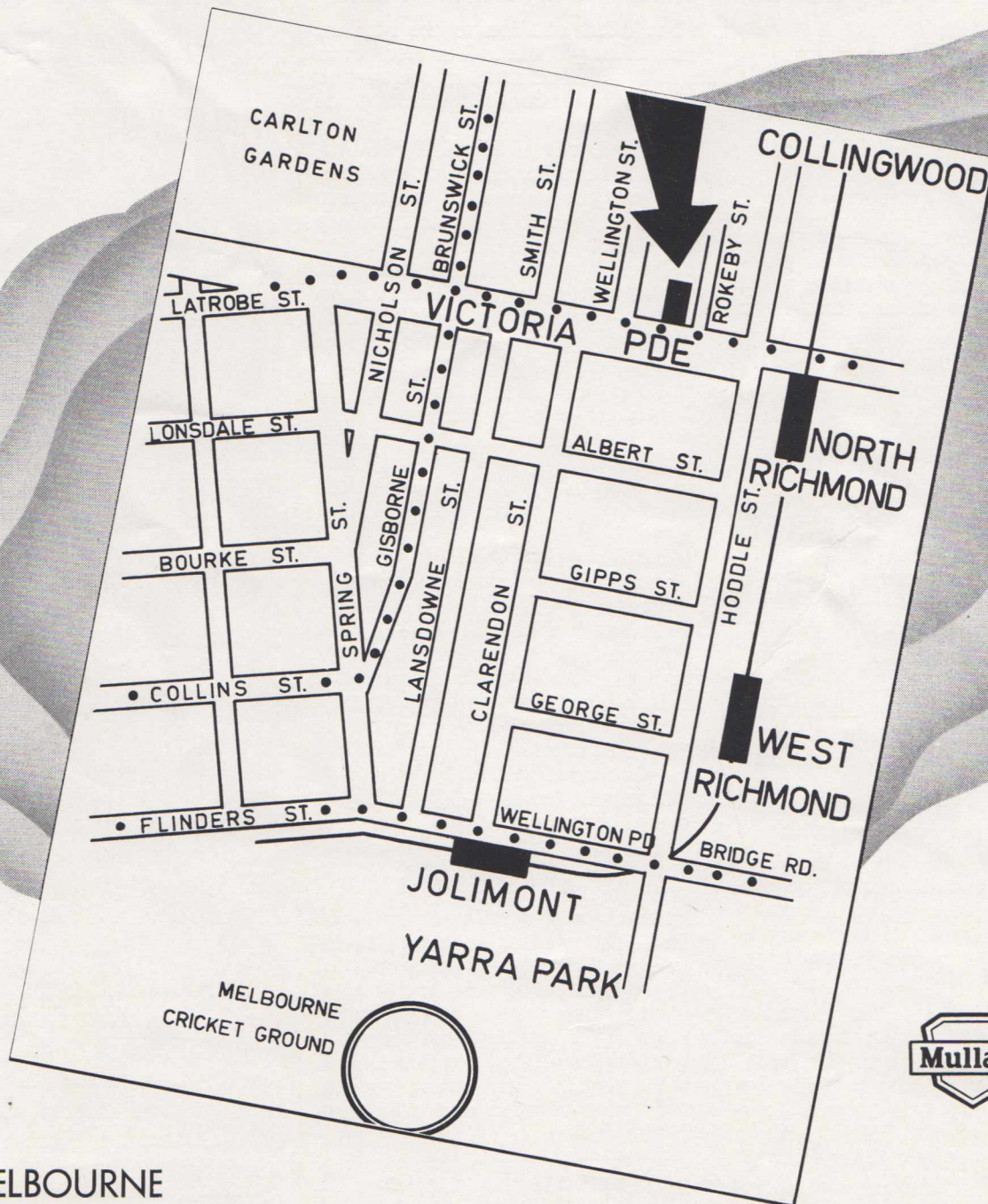Mr. Robertson has been with the Company for fourteen years, having joined it directly after his discharge from the R.A.A.F. He takes a keen interest in industry affairs, and is Honorary Treasurer and Member of the Board of Management of Sydney Breif Club.

He plays a fair game of cricket, golf and tennis, and from time to time has been known to catch a fish or two.

Why not look him up next time you are at our Head Office in Sydney!

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With the keynote on service we are glad to announce that our Melbourne Office and Valve and Tube Service Centre are now located at 123-129 Victoria Parade, Collingwood, N.5, Victoria. The new telephone number is 41 6644 (3 lines).

This new location — indicated on the attached street map — is conveniently situated in the centre of the metropolitan area, has ready access and adequate parking facilities.

Mullard VALVE AND TUBE SERVICE CENTRES
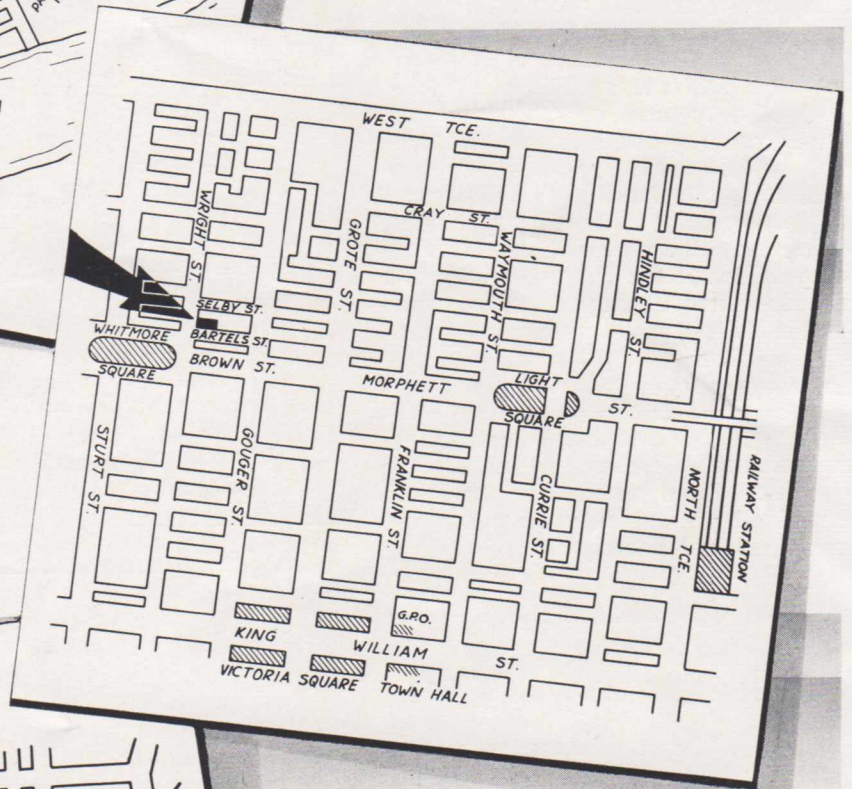## *FOR YOUR CONVENIENCE*
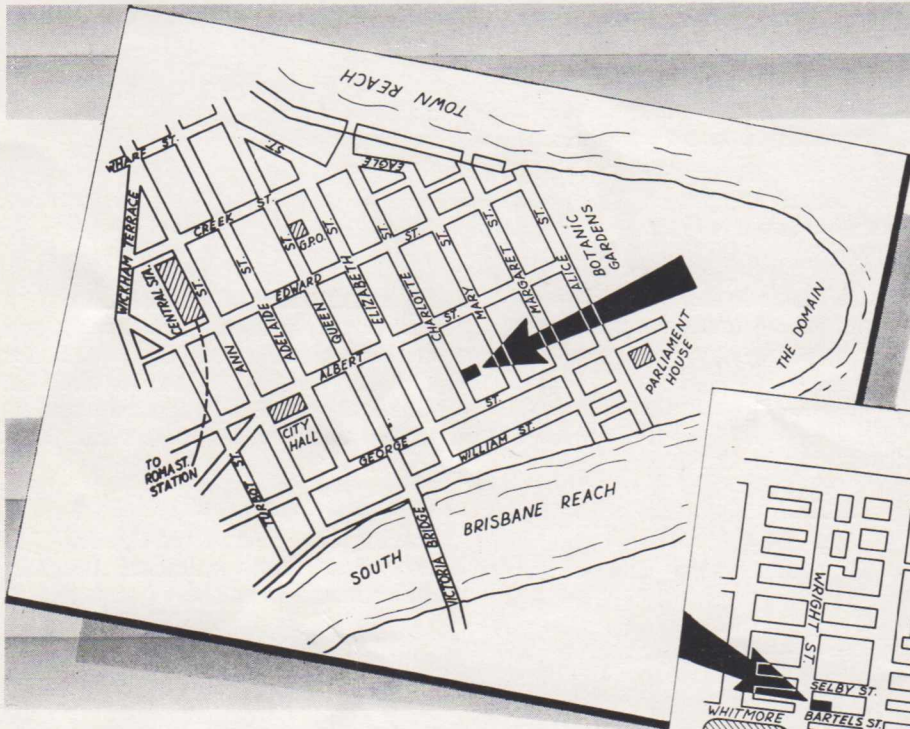
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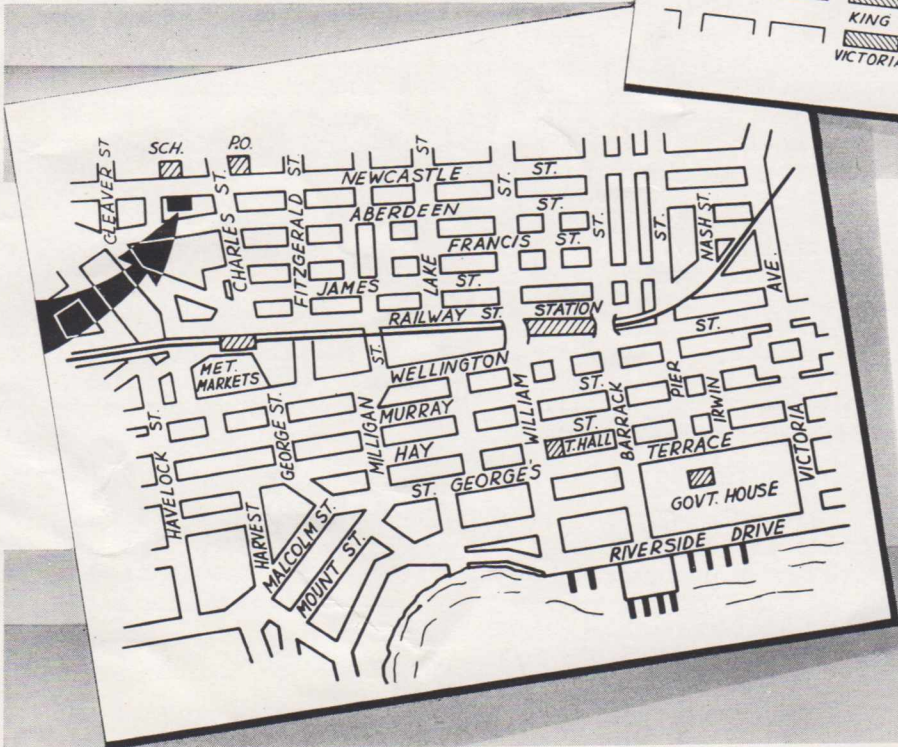
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DESIGN AND CONSTRUCTION OF A 40Mc/s HIGH-Q CAVITY OSCILLATOR

This article describes a self-oscillatory circuit, of high stability, which has a high degree of harmonic suppression under varying load conditions. Design considerations as well as constructional and operational details are included.

The stability and harmonic content of the high-Q cavity circuit satisfy the impending restrictions on the use of r.f. power. The anode-efficiency figures are acceptable and the high circuit-transfer efficiency justifies the adoption of this cavity design in practice.

INTRODUCTION

The internationally proposed industrial frequency allocations include three bands in the r.f. region:

$$13.56 Mc/s \pm 0.05\%$$
$$27.12 Mc/s \pm 0.6\%$$
$$40.68 Mc/s \pm 0.05\%$$

The narrowness of these well defined frequency-bands has drawn attention to the problem of designing self-oscillatory circuits of high stability and a high degree of harmonic suppression under varying load conditions. This article examines the factors which must be considered in the design, and then gives details of construction and operation of the circuit.

It should be noted that the results tabled in this report are based on measurements made in the laboratory; in practical applications, p_{in} should be slightly reduced, so that the maximum permitted industrial ratings for the valve are not exceeded.

DESIGN CONSIDERATIONS

Stability and the Loaded-Q

If the loaded-Q of a circuit is defined by

$$Q_L = \frac{2\pi \times \text{stored energy}}{\text{energy dissipated per sec.}}$$

the expression can be applied to a tuned circuit thus:

$$Q_L = \frac{I_o}{I_{r.m.s.}} \qquad (1)$$

where I_o = circulating current in the resonant circuit.

and $I_{r.m.s.}$ = current in the equivalent shunt resistance of the load, because $V_{r.m.s.}$ across both the resistive and the reactive components of the tuned circuit is the same value.

If initially a completely loss-free circuit (Fig. 1) is assumed, the circulating current is given by

$$I_o = \frac{V_{r.m.s.}}{X_C} \qquad (2)$$

or, substituting in Eq. 1,

$$Q_L = \frac{V_{r.m.s.}}{I_{r.m.s.} X_C}$$

But, as the alternating valve-current is also

$$I_{r.m.s.} = \frac{P_{out}}{V_{r.m.s.}},$$

$$Q_L = \frac{V^2_{r.m.s.}}{P_{out} . X_C} \qquad (3)$$

or, as at resonance $X_C = X_L$

$$Q_L = \frac{V^2_{r.m.s.}}{P_{out} . X_L} \qquad (3a)$$
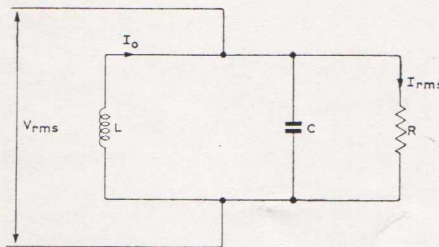

FIG. I—EQUIVALENT CIRCUIT

Eqs. 3 and 3a are useful for determining Q_L and the L/C ratio for a tank circuit, directly from valve data. If

$$X_C = \frac{1}{\omega C},$$

then, with a reactive load component $\triangle C$ reflected into the tank circuit,

$$X_C' = \frac{1}{\omega(C + \triangle C)}.$$

It becomes obvious, if $C > \triangle C$, that the change in frequency $\triangle f$ will be small.

$\triangle C$ being fixed by the load conditions, it remains to increase the tank capacity C in direct proportion to the desired increase of stability. If a conventional oscillator has $C = x$ and a stability of 1% with $Q_L = 15$, for a stability of 0.05% as required at 40.68Mc/s by the proposed regulations, C must be 20 x and therefore $Q_L = 300$.

Harmonic Suppression

Having determined the loaded-Q it is now possible to calculate the harmonic content from the expression:

$$\% \text{ nth harmonic} = \frac{67}{Q_L} . \frac{I_n/i_{(pk)}}{I_1/i_{(pk)}} \qquad (4)$$

I_n is the current amplitude of the nth harmonic, and I_1 that of the fundamental. Actual values for the above ratios may be found in the "Radio Engineers' Handbook"[*], and are dependent on the chosen angle of flow. This is, with the type of operation involved, usually between 120 and 150°. The value of the ratios for the 2nd harmonic is given by

$$\frac{I_2/i_{(pk)}}{I_1/i_{(pk)}} = 0.65 \text{ and, therefore,}$$

$$\% \text{ 2nd harmonic} = 0.65 . \frac{67}{Q_L}$$

$$= \frac{43.5}{Q_L}$$

or where $Q_L = 300$

$$\% \text{ 2nd harmonic} = 0.0145\%.$$

Circuit Losses

With $Q_L > 300$, some attention must be paid to circuit losses, which in practice would decrease the useful output. These losses can be derived from

$$P_{circuit} = I^2_o . R \qquad (5)$$

where R is the surface resistance of all parts of the tank circuit which carry r.f.

For these extremely high values of Q_L the tank capacitance becomes

*F. E. TERMAN, "Radio Engineers' Handbook", First edition, Sixth impression, 1943, p. 461, Fig. 86.

large and the tank inductance correspondingly small. For these reasons extra attention should be paid to the construction, finishing and fixing techniques of the tank capacitance as well as the inductance because, considering the complete circuit, each one forms an appreciable part of the other. From Eqs. 1 and 5 it can readily be seen that even a fraction of an ohm may cause circuit losses constituting a considerable part of the available output power.

Valve Conditions

An experimental cavity was designed around the TY3-250 with a target of a minimum load power of 0.5kW at $f_o = 40.68$Mc/s, using the conditions for telegraphy given in the published data:

$V_a = 2.5$kV	$P_{drive} = 24$W
$V_g = -200$V	$p_a = 250$W
$I_a = 400$mA	$P_{out} = 750$W
$I_g = 69$mA	

Tank Capacity

With a normal angle of flow $\phi = 140°$, the peak r.f. current for the above valve conditions will be:

$$i_{(pk)} = 4.5 \times I_a = 4.5 \times 400\text{mA} = 1.8\text{A}.$$

For this current the V_a/I_a characteristics give:

$$v_{min} = 250\text{V}$$
$$v_{(pk)} = 2250\text{V}$$

and $V_{r.m.s.} = 1600$V therefore, from Eq. 3,

$$X_C = \frac{1600^2}{750 \times 300} = 11.3\,\Omega,$$

and $C = 346$pF.

Tank Inductance

From the tank capacitance derived above, the tank inductance should be 0.045µH. Such a low inductance can be provided by a short, broad U-shaped strip of copper with the ends connected to opposite terminals of the capacitor. If the edges of the strip are considered to extend outwards and, at the same time, curved round to meet each other, the result is a closed canister surrounding the capacitor. This is called a cavity circuit, and it can be made self-screening to prevent radiation.

At the outset the physical size of the inductance L was arrived at experimentally with the aid of a sheet-aluminium model. It has been found since that a modified version of the straight-wire inductance formula could be applied to a cavity of similar proportions.

The usual expression is:

$L(\mu H) = 0.00508 \times l \times [2.303 \log_{10}(4l/d) - f]$ where d is the length of the wire and f for a straight wire = l.

Considering the inside surface of the cavity alone, $d = l$ and $f = 1.2$ where $l = a+b+c+d+e$ (see Figs. 2 and 3). The inductance becomes

$$L = 0.001016 \times l\ \mu H.$$

Circuit

The circuit employed (Fig. 4) is a parallel-fed Meissner oscillator chosen, in this instance, for its simplicity of drive adjustment under experimental conditions and minimum requirement of high-voltage decoupling components. All parts, except C and L should be available commercially.

Feedback is obtained using a coupling coil and a series capacitor. The resonant frequency of these two items
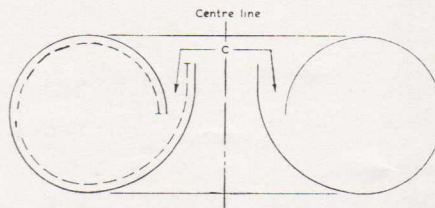
FIG. 2—CROSS-SECTIONAL DIAGRAM OF INDUCTANCE L (L × k = l)

should be at least 10% above the operating frequency.

In the experimental stages, an attempt was made to obtain feedback by means of a voltage probe. This was not successful, which supports the view that the cavity behaves as a lumped circuit rather than as a line circuit, despite its coaxial construction.

The load-coupling element also constitutes a series-tuned circuit in preference to a loop of feeder impedance, as this makes its positioning and mechanical size less critical for maximum power transfer.

CONSTRUCTION

From the requirements outlined above it appears that the required inductance must be obtained for a minimum length of conductor. Bearing in
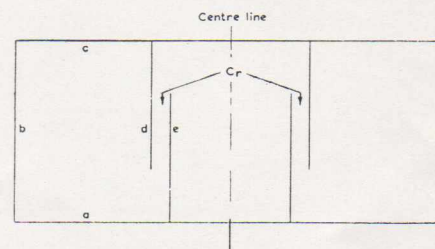
FIG. 3—SCHEMATIC DIAGRAM OF CAVITY RESONATOR

mind that the high capacity involved forms an appreciable part of the inductive path, a "doughnut" shaped cavity appears to give the electrically optimum solution. This shape must be rejected for mechanical and economic reasons.

The nearest approach is to make the cross-section of the cavity on both sides of the centre line a square with well-rounded and filleted corners.

The final shape of the cavity will therefore be a short cylinder of height b, containing a coaxially mounted assembly of three smaller diameter cylinders to form the tank capacitor.

The sizes of the inner cylinders are then so chosen that the valve can be inserted into the innermost one, leaving a 5mm gap all round to facilitate cooling with forced air.

These cylinders forming the tank capacity are mounted, the innermost and outermost to the bottom and the others to the top inner horizontal surfaces of the assembly (see cross-section Fig. 3 and dimensioned drawing Fig. 6). They have 5mm deep castellations at their fixed ends. These castellations are wider on the outermost cylinder and decrease in width from cylinder to cylinder, in proportion to the surface area of the remaining cylinders. This construction ensures an even current distribution in the tank capacitor and makes it as loss-free as possible. The construction is also applied to the innermost top cylinder (see Fig. 5) where the castellations allow the continuation of a loss-free r.f. carrying surface, by way of the spider arms bearing the anode blocking capacitor to the anode connector.

Feedback-coupling and load loops are inserted through appropriate holes in the cavity wall. Their position is not very critical because the loops are series tuned. Fig. 5 shows the arrangement.

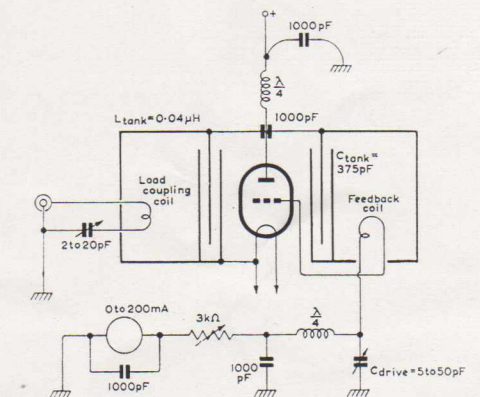A perforated metal skirt serves as a

FIG. 4—DIAGRAM OF CIRCUIT AND CAVITY

mounting for the cavity and effectively screens r.f. carrying leads exposed on the underside (see Fig. 6 for detailed measurements).

PERFORMANCE

Resonant Frequency of Cavity

After completion of the cavity, the tank capacity was measured and found to be 375pF. The resonant frequency (cold) was 40.7Mc/s, therefore, because $L = 1/\omega^2 C$ at resonance, $L = 0.041\mu H$.

R.F. Operation

In an attempt to reproduce published data as given above, the following readings were taken:

$V_a = 2.5kV$	$P_a = 250W$
$I_a = 384mA$	$\eta_a = 73.8\%$
$I_g = 70mA$	$P_{load} = 548W$
$R_g = 3k\Omega$	$\eta_{load} = 57\%$
$P_{in} = 960W$	

for $f_o = 40.68Mc/s$ and $Q_L = 342$.

Frequency Stability

Measurements made using a signal generator and a panoramic frequency display unit gave results which satisfy the restrictions listed above.
Warming up drift during the first hour $< 2k/cs$
Drift arising from drive variations such as occur with changing valve conditions $< 5kc/s$
Drift due to variation of load-coupling capacity (ratio 1 : 6), resulting in a variation of P_{load} from 548 to 70W $< 25kc/s$
Drift due to varying the input and thus varying r_a $< 10kc/s$

Fundamental and Harmonic Radiation

As the self-screening nature of the cavity suggests, no appreciable amount of r.f. was detected on its outside surface.

Checks for radiation of fundamental and second harmonic frequencies were made with a communications
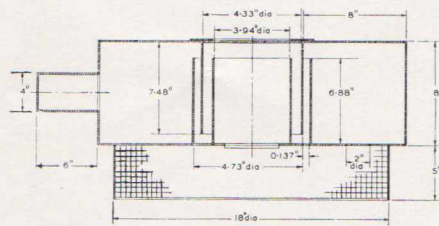

FIG. 6—DIMENSIONED DRAWING OF CAVITY—NOT TO SCALE
Material: Brass, Aluminium or Copper 14 s.w.g.

receiver fed from a 1m vertical aerial at a distance of 5m from the cavity. The sensitivity of the receiver being a nominal $6\mu V/m$ the readings were:
    at 40.68Mc/s, 16dB over S9
    at 81.36Mc/s, S3.5
giving a difference of 32.5dB between the two frequencies or a power ratio of 0.0005.

Even after allowance is made for inaccuracies in the equipment used, such as variation of sensitivity with frequency, the second harmonic frequency content is still of the right order for the Q_1 value adopted in the design.

TY3-250

V.H.F. POWER TRIODE

All-glass triode rated for a maximum anode dissipation of 250 W and suitable for use at frequencies up to 150 Mc/s.

ABRIDGED DATA

FILAMENT

Thoriated tungsten.

V_f	5.0	V
I_f	14	A

COOLING

Max. temperature of base pins	180	°C
Max. temperature of anode seal	220	°C

OPERATING CONDITIONS AS SINGLE VALVE R.F. POWER AMPLIFIER

(CLASS "C" TELEGRAPHY OR F.M. TELEPHONY)

Limiting Values

V_a max.	3.0	kV
P_a max.	250	W
P_g max.	30	W
I_k max.	480	mA
$i_{k(pk)}$ max.	3.0	A
R_{g-f} max.	100	kΩ

Typical Operating Conditions at $f \geqslant 100$ Mc/s

V_a	1.5	2.0	2.5	3.0	kV
V_g	−120	−150	−200	−250	V
I_a	400	400	400	365	mA
I_g	80	80	69	69	mA
$V_{in(pk)}$	295	320	380	430	V
P_{drive}	22	23	24	27	W
P_a	175	215	250	250	W
P_{out}	425	585	750	845	W
η	71	73	75	77	%
*P_{load}	340	470	600	670	W

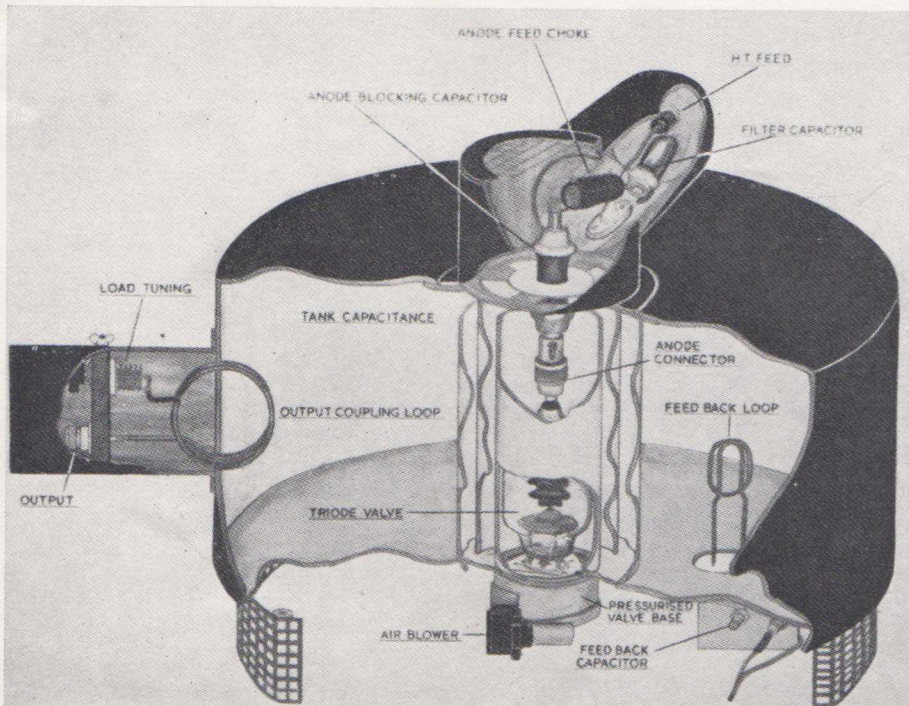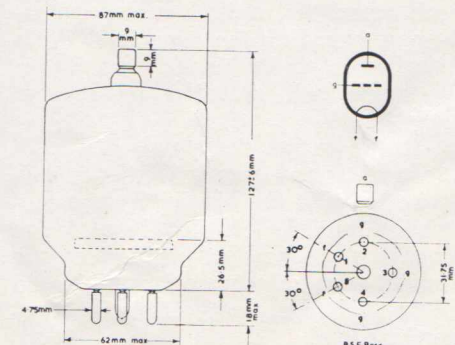*With a circuit transfer efficiency of 80%

FIG. 5—SECTIONED DRAWING OF A HIGH-Q CAVITY OSCILLATOR

15W PUBLIC ADDRESS AMPLIFIERS USING

OC16 TRANSISTORS

This article describes two amplifier circuits, suitable for public-address systems, giving an output of 15W, and working from 14 and 28V supplies. They have been designed to give maximum possible output, at these voltages, without exceeding the current ratings of the transistors.

The sensitivity is sufficient for the amplifiers to be fully driven by low impedance microphones, and the performance is more than adequate for the intended application.

INTRODUCTION

The basic amplifier, described in this article, operates directly from a 12V accumulator. The design is based on a supply voltage of 14V, which is the average voltage of a 12V accumulator under "charge" conditions.

The amplifier is suitable for operation at ambient temperatures, which normally do not exceed 45°C, but occasional excursions up to 55°C are permissible. Two OC16 power transistors in "common-emitter" operation in a symmetrical Class B push-pull circuit provide the output. The operating conditions are chosen so that the maximum possible output power is obtained from the OC16 transistors, at

14V, without exceeding their maximum peak current ratings.

The output stage is preceded by an OC16 driver stage and amplifier stages using OC72 and OC71 transistors. The amplifier is sufficiently sensitive to be driven fully by a low impedance microphone.

An alternative design, operating from a nominal 28V supply, is also given. In this case, a Class B single-ended push-pull output stage is used, instead of the symmetrical output stage of the 14V version.
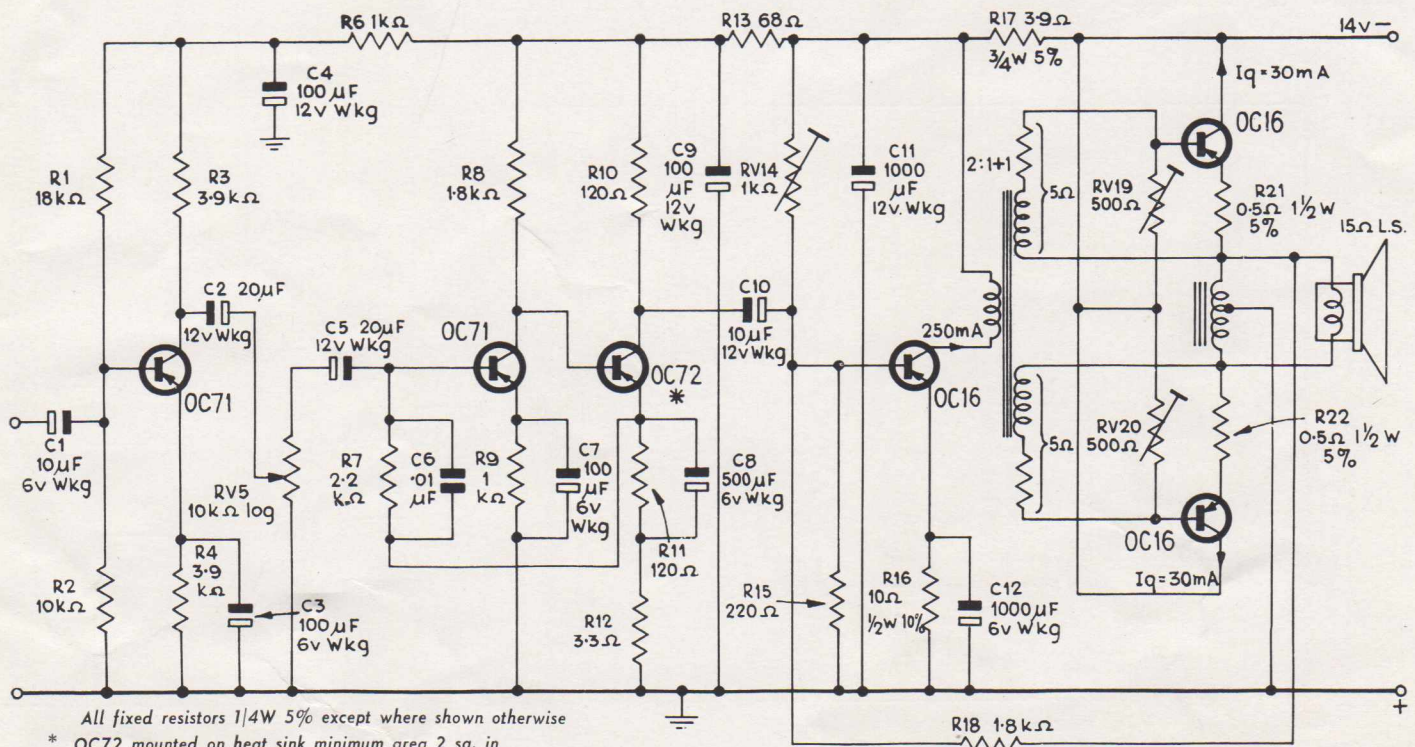
CIRCUIT

Output Stage

The output stage uses a matched pair of OC16 transistors in Class B

push-pull arrangement. Although, in the circuit of Fig. 1, the collectors are taken to the negative line, the transistors operate as common-emitter amplifiers. With this arrangement the transistors can be mounted directly on a common heat sink connected to the negative line.

Emitter resistors of 0.5Ω are necessary for thermal stability at the higher ambient temperatures. The quiescent currents, at normal ambient temperatures (25°C), are individually set to 30mA, to minimise cross-over distortion. The secondary resistance of the driver transformer, forms the lower

All fixed resistors 1/4W 5% except where shown otherwise

* *OC72 mounted on heat sink minimum area 2 sq. in For other heat sinks see text*

FIG. 1—14V AMPLIFIER CIRCUIT

part of the potential divider, and each half of the secondary winding should have a resistance of $5\Omega \pm 10\%$. If necessary additional resistances must be added to arrive at this value.

The optimum load per transistor is 3.75Ω. A centre-tapped choke can therefore be used to match a loud-speaker of 15Ω impedance, as shown in Fig. 1. This choke is cheaper and more efficient than a conventional transformer.

The peak current on full drive is 3.0A, and the maximum transistor dissipation is 5W at 55°C ambient temperature. With the transistors mounted on a heat sink, so that the total thermal resistance from junction to ambient temperature is 6°C/W, the maximum junction temperature is 85°C. The transistors are thermally stable at this junction temperature. Compact and cheap heat sinks, to give the required total thermal resistance, can easily be made.

Overall negative feedback is applied from the output to the base of the driver transistor, to minimise distortion. A curve of distortion against output is given in Fig. 2. With a 14V supply, the distortion is low (less than 4%), up to about 15W. The corresponding output at 12V is 11W. If the circuit is to be used only with a 12V supply, slight modifications to the loading, and to the driver stage, will enable the amplifier to deliver about 13W at 12V.
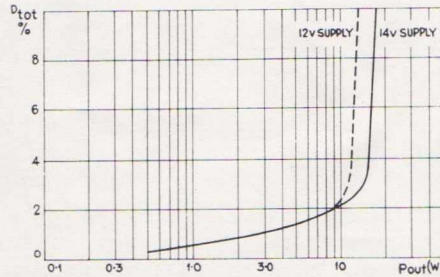

FIG. 2—DISTORTION CHARACTERISTIC

Driver Stage

The driver stage uses a single OC16 transistor in a conventional Class A circuit. The collector current should be adjusted to 250mA. The collector dissipation is less than in the output stage and the total thermal resistance, from junction to mounting base, has only to be less than 9°C/W. This can be achieved very easily by mounting the transistor, with mica insulator, on the chassis.

Amplifying Stages

The first stage uses an OC71 transistor and amplifies the signal from the microphone input. It is followed by OC71 and OC72 current amplifying stages. The circuit is conventional except that the second OC71 is directly coupled to the OC72, and has overall a.c. and d.c. negative feedback. This method of coupling uses fewer components, and provides better temperature stability than two conventional RC coupled stages.

Cross-over distortion of the output stage increases at higher frequencies. It is therefore preferable to limit the upper cut-off frequency of the amplifier to about 7kc/s. This is conveniently done by the capacitor, C6 (Fig. 1) in the feedback loop.

In public-address systems, reproduction of frequencies below 150c/s is not desirable. Using a smaller value for capacitor C10 (Fig. 1) provides a convenient method of limiting the low-frequency response.

28V Circuit

Fig. 3 shows this circuit. The output stage uses the transistors in a single-ended output arrangement, and a centre-tapped 28V supply is necessary for the circuit. The load required is 3.75Ω, and a speaker of this impedance can be connected directly into the circuit. Apart from these differences, it is similar to the 14V circuit.

If a centre-tapped 28V supply is not available, an artificial centre-tap can be used. A possible method of obtaining this centre-tap is to connect two 24Ω 10W resistors in series across the supply with the centre-tap decoupled by a 1000µF, 50V wkg, capacitor.
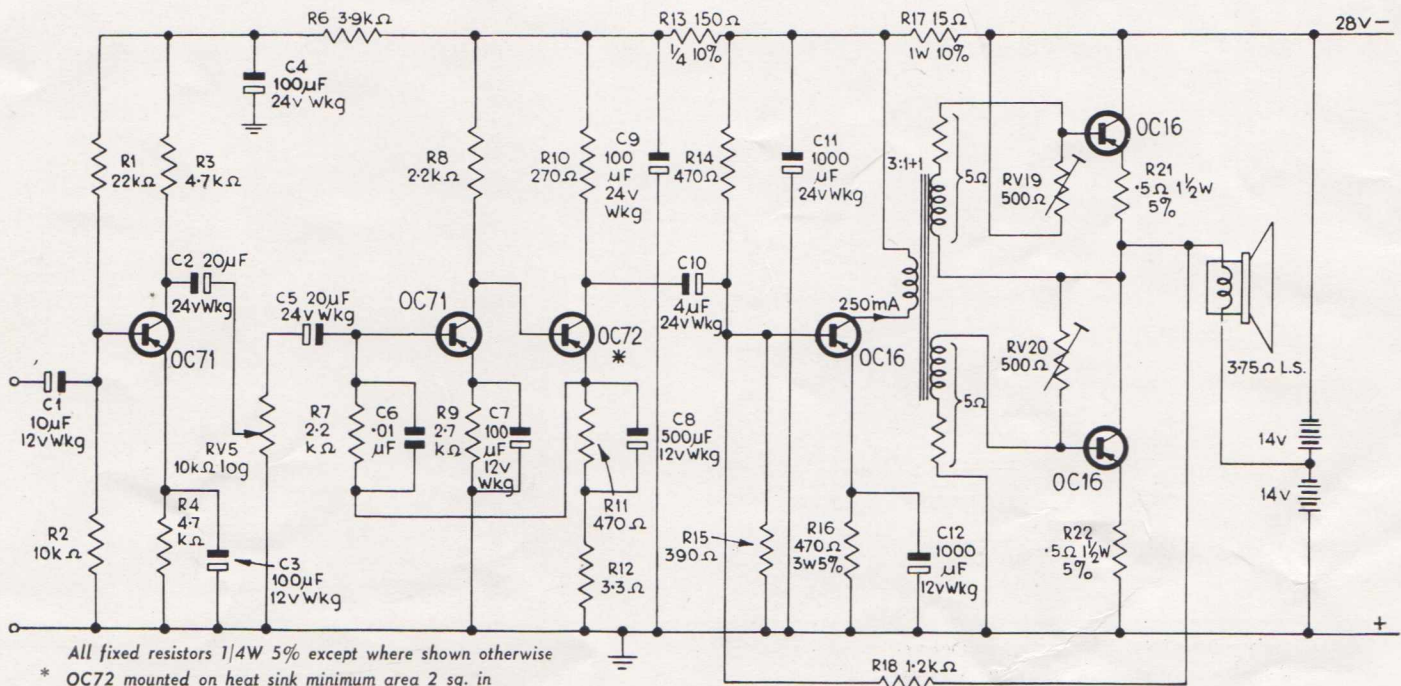

All fixed resistors 1/4W 5% except where shown otherwise

* OC72 mounted on heat sink minimum area 2 sq. in
  For other heat sinks see text

FIG. 3—28V AMPLIFIER CIRCUIT

TRANSFORMERS

14V Circuit

Driver Transformer

Turns ratio: 2 : 1+1 (secondary winding bifilar)

Primary inductance: > 150mH at 250mA d.c.

Primary d.c. resistance: < 2Ω

Secondary d.c. resistance: 5Ω+5Ω

The resistance of each half of the secondary winding should be 5Ω± 10%. If the resistance of the windings is less than this, external resistances must be added to meet the required value.

Output Transformer

For a 15Ω speaker a centre-tapped choke could be used.

Total d.c. resistance: < 0.2Ω

Total inductance: > 100mH

28V Circuit

Driver Transformer

Turns ratio: 3 : 1+1

Primary inductance: > 200mH at 200mA d.c.

Primary d.c. resistance: < 3Ω

Secondary d.c. resistance: 5Ω+5Ω

The resistance of each half winding of the secondary should be made up, if necessary, to 5Ω±10% as in the 14V circuit.

Output Transformer

A speaker of 3.75Ω can be connected directly into the circuit, a transformer then being unnecessary.

PERFORMANCE

Current Consumption

14V Version $I_q = 450mA$
Speech and music $\simeq 1A$

28V Version $I_{q(av)} = 300mA$
Speech and music $\simeq 550mA$

Sensitivity

For full output,

14V Version
0.5μA or 0.5mV (impedance 1kΩ)

28V Version
0.35μA or 0.35mV (impedance 1kΩ)

Frequency Response

This is flat within 3dB from 150c/s to 7kc/s.

Temperature Range

The maximum ambient temperature should normally be 45°C, but occasional rises to 55°C are permissible.
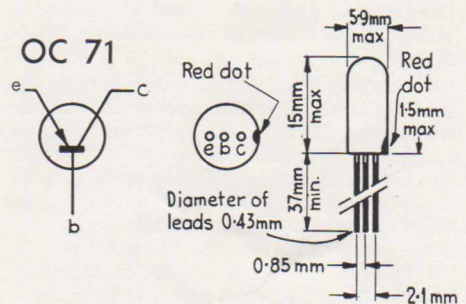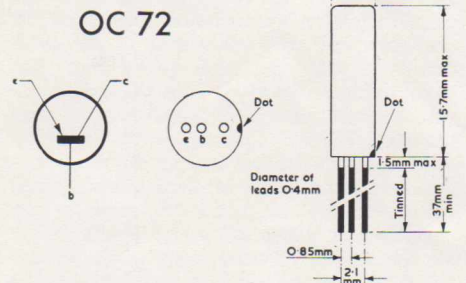
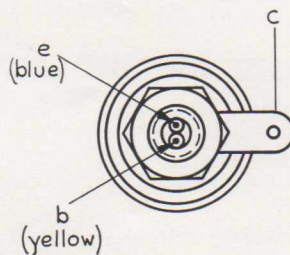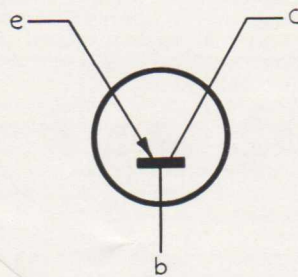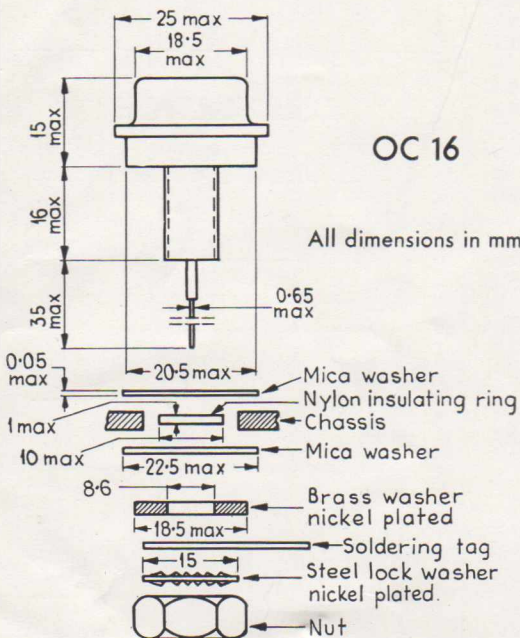### Distortion Characteristics

14V Amplifier

Curves are shown in Fig. 2.

For 14V supply—distortion at 15W output is <4%.

With a 12V supply—distortion at 11W output is <4%.

28V Amplifier

With 28V supply—distortion at 15W output is <4%.

OC 16

All dimensions in mm

OC 72

OC 71

HIGH SPEED VALVE TESTING

Valve Testing today means much more than it did a few years ago. The public has been made aware that receivers contain expendable components—valves and television tubes which need replacement as their efficiency declines with age. Before the advantages of regular valve testing were widely recognised, people kept their old sets going until they broke down, and they accustomed themselves to the gradually deteriorating performance which deprived them of much of the enjoyment their sets should have provided. One reason for their reluctance to do anything about this was their fear that repairs and overhauls would involve them in heavy outlays. Another reason was that their ears and eyes became attuned to indifferent reproduction. By making known the important part valves play in receivers, and the fact that they can be replaced at reasonable cost, Mullard helped to break down this initial resistance. The public were encouraged to consult their dealers more freely and the dealers, besides selling new valves and service, were presented with extra opportunities for demonstrating new sets.

These encouraging developments, welcome though they were, proved embarrassing to the countless dealers whose valve testing equipment was either inadequate or too complicated. Business was often turned away. because sufficient time could not be spared to test customers' valves and supply written reports; the situation was aggravated still further as television increased its demand on servicing facilities. Many of the dealers who found themselves in this position were only too well aware that they were losing business because they were unable to make enough personal contacts with potential buyers. Mullard, with their responsibilities to dealers and to the set manufacturers who fit Mullard valves and tubes, decided to tackle the problem by designing an instrument which would satisfy all the normal requirements of radio and television retailers and, in addition, operate at a speed which would make valve testing an economical and profitable activity. The result of the Company's work, which was carried out in their electronic research laboratories, their valve factories, and their service department, is the Mullard High-Speed Valve Tester.

In the Mullard factories and service departments, there are elaborate instruments which will measure every characteristic of a valve or television tube. Their functions are highly specialised because their purpose is to provide information essential to the valve designers and production engineers. Such information would be worthless to the retailer. He merely needs to ascertain, as quickly as possible, the condition of a valve in relation to the manufacturer's specified service limits. The following analysis of common valve defects covers all the contingencies likely to be encountered in retail servicing. To facilitate reference, the defects are classified under three headings.

1. **Defects which may cause complete failure to operate.**
   (i) Open circuit filament or heater.
   (ii) Faulty insulation between electrodes.
   (iii) Disconnected electrodes.
   (iv) Complete loss of emission.

2. **Defects resulting in noises, intermittent operation or instability.**
   (i) Faulty insulation between electrodes.
   (ii) Faulty insulation between cathode and heater.
   (iii) Intermittent short circuits between electrodes.
   (iv) Mechanical faults in electrode assembly.

3. **Defects causing poor amplification, distortion or inability to perform normal functions.**
   (i) Any of the defects mentioned in Group 2.
   (ii) Excessive grid current.
   (iii) Emission below manufacturer's limits.

THE OPERATING PRINCIPLES

A gate-switch consisting of 130 pairs of specially designed, self-cleaning silvered contacts provides the basic actuating mechanism for the instrument. By means of perforated paxolin cards, these contacts automatically arrange the test circuits, make all the necessary connections to the valve sockets, and select the correct voltages for the various electrodes. A test selection switch arranges the circuits for the various tests in correct sequence, and press buttons apply insulation and continuity tests to the electrodes. An adjustable control ensures that the correct mains voltages is supplied to the instrument. In districts where considerable mains fluctuation occurs, checks and adjustments taking only a few seconds can be made as required.

The instrument is provided with a cathode ray tube in place of the more conventional moving coil meter. This not only provides a more sensitive indicator, but also avoids the possibility of expensive repairs or replacements through overloading or mechanical damage.

Fifteen sockets accommodate all types of valves normally encountered in the work of a service department, and provision is made for the addition of new types as required. A simple method of checking cathode ray tubes, without removing them from the receivers, can be effected by means of extended leads.

ABRIDGED SPECIFICATION

Mains Supply
180 V — 260 V, 50c/s.

Mains Consumption
100 W (average).

Weight
50 lb. (approximately).

Dimensions
17 " wide.
11½ " high.
16 " deep.

Finish
High grade silver-grey dimenso case with black anodised control panel and chromium fittings.

AMATEUR EXPERIMENTERS COLUMN

PHASE SHIFT OSCILLATOR

This easily constructed transistor audio oscillator eliminates the need for an LC circuit and provides an output of 1,000 c/s with reasonable accuracy.

The output of 1V (RMS) into 25kΩ may prove useful for servicing audio amplifier stages and in numerous other applications such as alignment of SSB amateur transmitters.
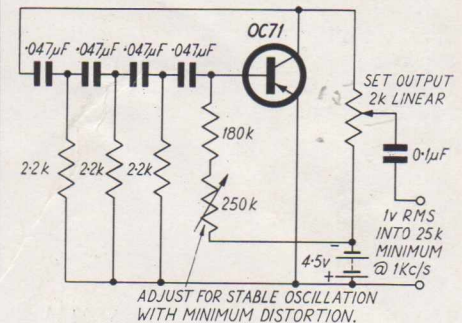
ADJUST FOR STABLE OSCILLATION WITH MINIMUM DISTORTION.

If you are on our mailing list and are changing your address or if you are a new reader wishing to be added to the mailing list, please let us know.