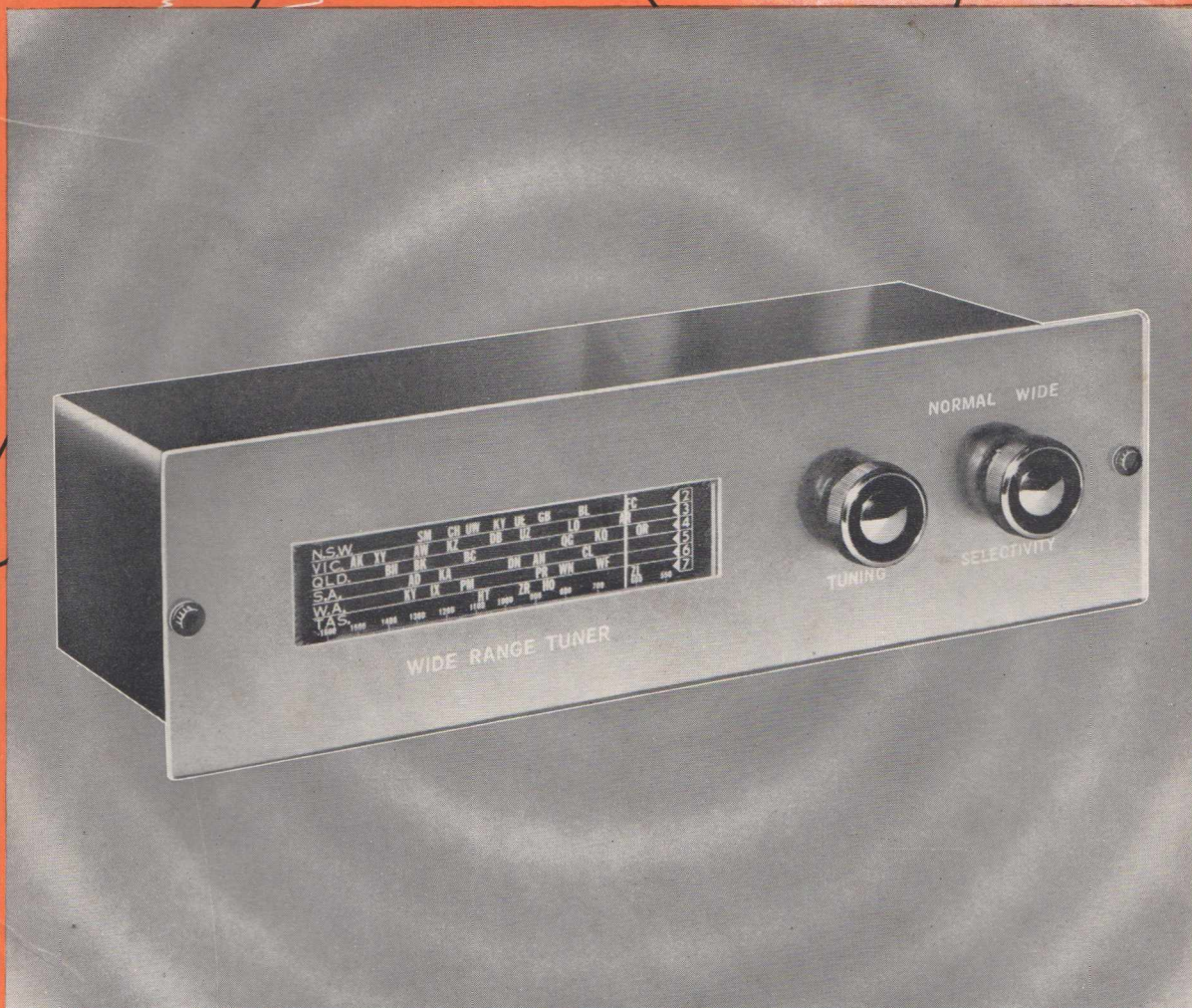


# Mullard

## Outlook

Australian Edition



VOL. 4, No. 1, JANUARY-FEBRUARY  
1961





MULLARD - AUSTRALIA PTY. LTD.



VOL. 4—No. 1 JANUARY-FEBRUARY, 1961

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Editor:  
**JOERN BORK**

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This is the new Mullard Wide Range Tuner which has been developed in response to numerous requests for a compatible tuner for use with existing high-quality amplifier designs.

A complete description may be found in this issue.

### MULLARD-AUSTRALIA PTY. LTD.

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VICTORIA

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Associated with  
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### — for knowing where to tap

Some television service charges have been criticized of late and this is more or less inevitable, although from the comments and counter-explanations it could be that full capital has not been made of the skill and training of a good technician.

To illustrate this we quote the classic case, true or untrue, where a large and well-equipped industrial concern was confronted with a technical problem with a piece of equipment that baffled their most capable engineers. Finally, after months of fruitless effort, a consultant was called in and, after a thirty-minute evaluation of the problem, a gentle tap with a hammer at a critical point put things right. Later, an account for £500 was rendered and, on querying how this was assessed, the consultant detailed the charge as follows:—

Time and general charges — £5

For knowing where to tap — £495

The skilled television technician is able to diagnose and repair a television receiver knowing, with confidence, that it is indeed the fault to be corrected, with no second call and the firm knowledge that in time another customer has been won. Fair argument for a reasonable remuneration and fair argument also for the skilled technician to select Mullard valves and Radiant Screen picture tubes for long-term reliability.

### CHANGE OF EDITOR

Amongst other duties and the running of the Technical Service Department, Mr. B. P. A. Beresford has been the Editor of Outlook since its inception three years ago, however, to cater for the ever-increasing need for technical service and the expansion of this Department, he has been obliged to relinquish the Editorship of this Journal. As from this issue, the first of Volume 4, we have as Editor Mr. J. Bork, who is by no means new, for he was previously Assistant-Editor and, as such, had the responsibility of Outlook's preparation.

M.A.B.

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# VIEWPOINT WITH MULLARD

## 1961—STEADY TV AND AM RECEIVER SALES

— For Knowing Where To Tap!

The crystal ball of market surveys and consumer facts and figures indicates a period of sober sales and creative selling with rewards to the salesmen who "know where to tap".

### OBSOLESCENCE

It can be shown this self-evident avenue for AM receiver sales has been neglected during the lush initial television years. A calculated examination of the durable goods in long-established homes will, in most cases, show a television receiver but few pop-up toasters, steam irons, electric frying pans and so on. As to refrigerators and AM radios, many are of pre-war vintage or early post-war, the radios cumbersome with dial lamps long given up the ghost and radiograms anchored with sentiment, dust and 78 r.p.m. records with most of the grooves torn out.

### A WORD ON REFRIGERATORS

A proud owner of a post-war eight cubic feet refrigerator told us recently that, on completing an annex for an elderly couple, he transferred the old eight cubic feet refrigerator and bought himself a new one. By circumstance and his sheer enthusiasm for what a present-day refrigerator means, he is the best "honest-to-goodness" refrigerator salesman we have met — no king size, fancy shelf, streamline approach here, but just the revelation of an efficient device, a revelation he had read about but never believed.

Recent personal experience whilst house-hunting has driven home these points and, in one group of suburbs, inspired some research. Asked when the last representative knocked on the door to suggest the householder should purchase one or other of these items, 95% could not recall any; in other areas 50% claimed they had the odd representative call, but were reluctant to make a move because the salesman had not identified himself with what they felt was a reliable firm.

### UNIQUE RESPONSIBILITY TO THE PUBLIC

Radio, television and appliance retailers have a peculiar responsibility

to the public, for you are selling, of all the goods in a home, the most complex technical items and, furthermore, you are selling these in the majority of cases to non-technical buyers — folk who, when given a hammer and nail, will invariably clout their thumb. The success of your business must, in the long run, depend on your customer's faith in your ability to maintain these products in good working condition.

### SALES AND SERVICE

Because customers know they are entirely in the hands of the retailers who supply them with their radio and television receivers, widely publicised criticism of service is bound to fall on fertile ground, and even though such criticism might be justified only in a small number of cases, the fact remains that the whole trade comes under suspicion. Here is a case where attack is the best method of defence. The attack based on a sales-service reputation built on reliable service, spreads and creates goodwill, and that will bring customers to your sales counter.

Apart from the goodwill which grows towards a retailer from good service, there is the practical consideration of being on the spot first when a customer's set is finally due for replacement. In a recent editorial in Outlook we read of the "Brief Encounter" and the "Eight Second Glance". Your window display must stop the customer and attract him into your store. When he is there, only courtesy and thoughtful salesmanship will keep him there. It is easier to make a sale than to make a customer and it is difficult enough to make a sale.

### NEW HOMES, NEW FACES, NEW FAMILIES

1961 and the years to follow will call for harder selling — but we are confident that the astute retailer who "knows where to tap" will assure the continued expansion and success of his business and its contribution to the radio and television industry.

## MULLARD-AUSTRALIA PERSONALITIES



This smiling fellow, Rick Gibson, hails from Scotland, is a graduate of Glasgow University and a keen exponent of business management and sales management procedure. For the past few years he has held an executive post in the Home Trade Sales Division of our Parent Company, Mullard Limited, London.

In making his future home and career in Australia, he has arrived at a time of expansion of our Company and now heads the Entertainment Valve Trade Sales Department of Mullard-Australia. He has already visited our Branches and Distributors in all States and brings with him the experience and enthusiasm of our valve colleagues overseas. No less, a breath of heather, a rich burr, the swish of the sporrán and, as the traditional canny Scot, has set aside his dirk and claymore and donned his hunting tartan for enhanced service to you from his Department.

A lover of the winter sports and fishing in fast mountain streams, he plans to continue these activities in the glens and lochs of the Snowy.

**Good Sets Fit Mullard Valves and Radiant Screen Picture Tubes**



# MULLARD WIDE BAND TUNER DESIGN

This AM broadcast tuner has been developed in response to numerous requests by home constructors for a compatible tuner for use with existing amplifier designs. Audio amplifier design by Mullard has long been accepted by professional and amateur alike where high quality sound reproduction has been of prime importance and emphasis to date in the Mullard range of circuits has been in the reproduction of sound from microphone, tape and disc. However, in each pre-amplifier design, provision has been made for a radio tuner input.

## CIRCUIT DESCRIPTION

In planning the tuner, as well as paying particular attention to the principles of good design, it was decided to incorporate the following desirable features:

- (i) Reasonable selectivity for the country user, including the facility for "opening up" the IF pass band to accept the full frequency range of local stations.
- (ii) A tuning indicator operative in the narrow band position to enable precise station tuning.
- (iii) A 10kc/s whistle filter to reduce to inaudibility the inter-station carrier beat, but of narrow "slot" frequency to minimise attenuation about the 10kc/s point.
- (iv) Finally, the tuner should match in form factor the Mullard range of pre-amplifiers. The layout of components and general method of construction should be such as to be easily followed by those possessing reasonable constructional ability, without the need for special tools.

The output from the tuner has been maintained at a low level to reduce the possibility of distortion due to damping of the detector by the input impedance of the following input stage.

The power supply uses an OA210 silicon power diode as a half-wave rectifier, and the maximum inverse voltage rating of 400V dictates that the unloaded RMS voltage of the power transformer secondary should not exceed 127V.

### IF Band Pass

Special IF inductors have been made available to enable the IF pass band characteristics to be varied. These inductors, housed in normal IF cans, consist of a single winding and a 100pF silvered mica capacitor. Two inductors are connected between the 6AN7/ECH80 mixer and the 6N8/EBF80 IF amplifier and choice of two values of bottom capacitive coupling allows for an IF pass band of 10kc/s or 18kc/s at the 6dB points. The transformer IFT3 is conventional and with normal circuit damping has adequate band width.

### Tuning Indicator

A 1M3/DM70 tuning indicator operative in the "normal" position of the selectivity switch assists in accurate tuning of the desired station.

### Whistle Filter

The 10kc/s whistle filter consists of a 250mH inductance tuned by a 0.001 $\mu$ F silvered mica capacitor and is variable over small limits by an adjustable core. The 250mH coil is wound in a Mullard

Vinkor pot core Type LA2303 resulting in an inductor of very high Q capable of providing 26dB attenuation at 10kc/s and less than 6dB attenuation at 200c/s either side of this frequency.

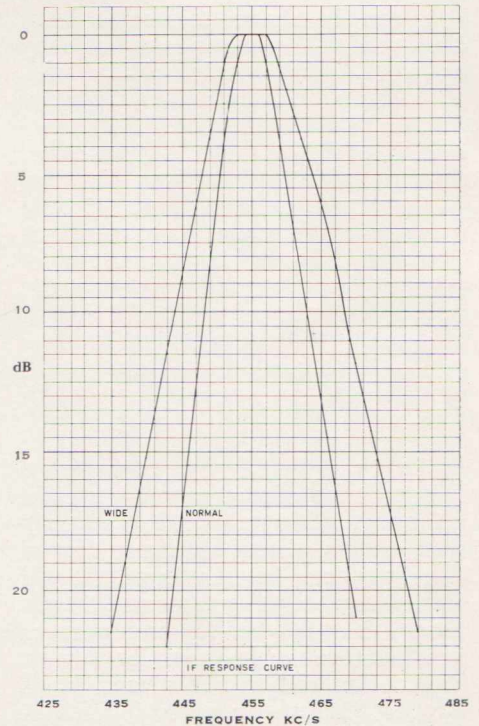


Fig. 2—IF response curve

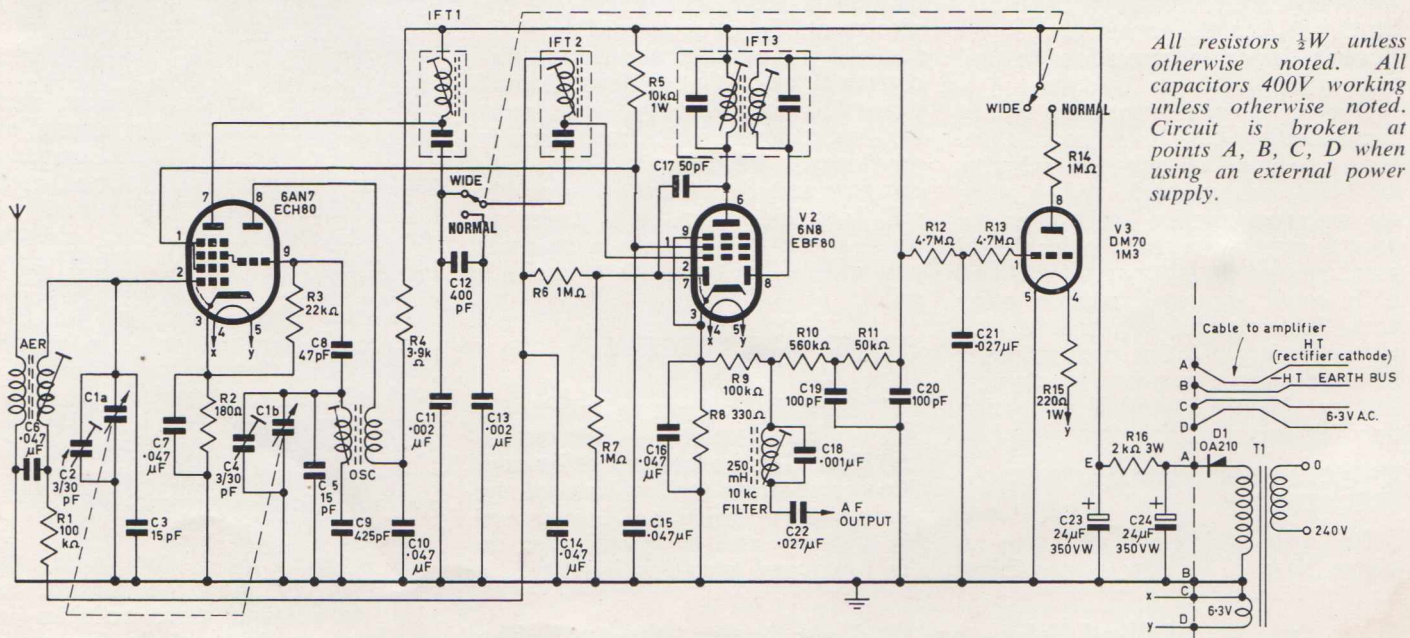


Fig. 1—Circuit diagram

All resistors  $\frac{1}{2}W$  unless otherwise noted. All capacitors 400V working unless otherwise noted. Circuit is broken at points A, B, C, D when using an external power supply.



## The Circuit

Apart from the features mentioned, the remainder of the circuit is conventional. Standard aerial and oscillator coils and a standard broadcast two-gang tuning capacitor are used. In order to preserve space, small bypass capacitors of the polyester type have been utilised throughout.

## CONSTRUCTION AND ASSEMBLY

### Major Parts Layout

Viewing chassis from the wiring side, with power supply end at left, the location of the components along the upper side from left to right is as follows:

Aerial coil, 6AN7/ECH80 socket, IFT1, whistle filter.

The location of the components along the lower side from left to right is as follows:

Oscillator coil, IFT2, 6N8/EBF80 socket, IFT3.

Location of tag strips: 8 tags across left-hand end of chassis, 10 tags along top edge right-hand end, 13 tags along bottom edge right-hand end.

**Note:** Valve sockets should be fitted with No. 1 pins to the left. The IF, aerial and oscillator coils mounting tags should be bent out and down, and fixed by soldering at the mounting holes.

### Resistors and Capacitors

The layout of these components should follow as closely as possible the positions shown in the underside chassis photograph (Fig. 3).

### The 1M3/DM70 Tuning Indicator

This valve is a "wire-in" type and the recommended method of mounting is by means of a "hook-over" clamp made from a 1" x ¼" piece of 18 gauge metal drilled for 6BA clearance at one end. A mounting hole is provided for this clamp above and to the left of the ⅝" diameter hole at the left-hand end of chassis part "C." The ⅝" diameter hole is for the 1M3/DM70 flying leads which may be passed through and terminated on a four-tag strip beneath the plate.

### Coupling Capacitors C11 and C13

The two .002µF coupling capacitors may be mounted above chassis part "C" and earthed by a solder lug mounted to the right of the selectivity switch shaft. The lead from each capacitor passes through a ⅜" diameter hole and grommet between the dial and switch shafts.

### Dial Assembly

The 6BA clearance hole slightly to the left of centre of chassis part "C" is to enable the dial drum to be temporarily attached to chassis part "C" to facilitate fitting of the dial cord. The

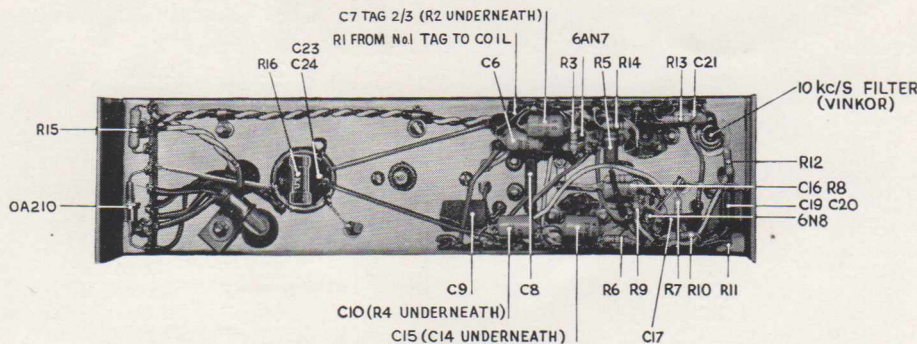


Fig. 3—Components lay-out

outer end of the tuning capacitor extension shaft should be drilled and tapped (6BA) for this purpose. During the final assembly of chassis part "C" into the main chassis part "D," the 6BA screw holding the extension shaft and dial drum should be removed. The tuning capacitor should be attached to chassis part "D" using ⅜" spacers so that all protruding parts of the gang assembly clear the chassis. Care should be taken to ensure that the length of the mounting screws is such that the capacitor plates are not fouled.

In the prototype, the dial lamp was mounted, using the 6BA countersunk hole to the right of the dial cut-out (chassis part "B") and four turns of 16 gauge tinned copper wire of the necessary diameter and pitch, to allow the dial lamp to be screwed in. The 6.3V line was directly soldered to the centre lamp contact.

To avoid damage to the perspex escutcheon, a thin sheet of cardboard should be sandwiched between chassis part "B" and the escutcheon.

Chassis part "C" should be painted black over the area visible through dial cut-out. All wiring around chassis part "C" should be completed prior to final assembly leaving sufficient ends of wire to attach to the points on the main chassis during assembly.

### Alignment

All IF coils should be peaked at 455kc/s with the selectivity switch in the "normal" position. The alignment of oscillator and, aerial coils follows normal procedure.

The 10kc/s filter may be adjusted by removing the perspex escutcheon. An insulated tool with a screw driver

shaped tip should be used. This adjustment is best made under actual operating conditions.

### Tuner Output

As mentioned earlier, the output of the tuner has been maintained at a low level. However, if more output is desired, the values of R9 and R10 may be changed; R9 being increased and R10 decreased to maintain a total value of approximately 680kΩ.

### USE OF EXTERNAL POWER SUPPLY

Current and voltage at reference point "E" (see Fig. 1) are 125V and 18mA respectively.

In order to supply power to tuner from existing amplifier or other power supplies, R16 should be calculated as follows:

$$R16 = \frac{V \text{ at Rectifier Cathode} - 125}{0.018}$$

### Example:

$$\text{Rectifier cathode voltage} = 300V$$

$$300 - 125$$

$$R16 = \frac{\quad}{0.018}$$

= 970Ω or 1000Ω approximately. The rating of 3W for this resistor should be observed.

A separate 6.3V filament winding is preferred; however, if this is not possible, ensure that the earthed side of the winding is connected to point "C" (see Fig. 1). If a 6.3V centre tapped winding is used, the centre tap should be earthed at the power supply and R15 (tuning indicator filament resistor) should be changed to 82Ω and the dial lamp will require to be insulated from the chassis.

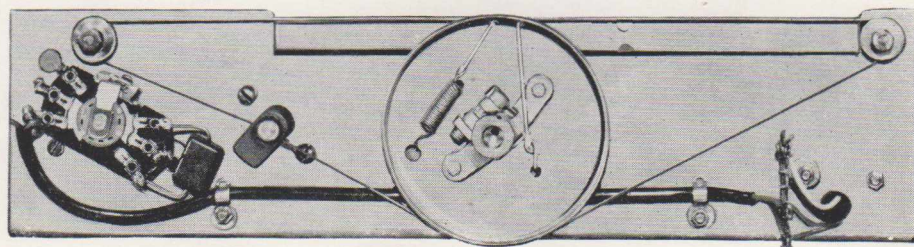


Fig. 4—Dial-drive mechanism



## LIST OF COMPONENTS

### Resistors

R1, R9	100 kΩ	½ W
R2	180 Ω	½ W
R3	22 kΩ	½ W
R4	3.9 kΩ	½ W
R5	10 kΩ	1 W
R6, R7, R14	1 MΩ	½ W
R8	330 Ω	½ W
R10	560 kΩ	½ W
R11	50 kΩ	½ W
R12, R13	4.7 MΩ	½ W
R15	220 Ω	1 W
R16	2000 Ω	3 W

**Valve** 2 Noval B9A

### Sockets

**Mullard** 6AN7/ECH80: 6N8/EBF80:

**Valves** 1M3/DM70

**Note:** The 1M3/DM70 is a "wire-in" type.

### Capacitors

C1a, C1b	RMG2	Roblan
C2, C4	3 to 30 pF	Concentric Trimmers
C3, C5	15 pF	Silvered Mica
C6, C7, C10, C14, C15, C16, C8	.047 μF	Polyester 400V W
C9	47 pF	Silvered Mica
C11, C13	0.002 μF	Silvered Mica
C12	400 pF	Silvered Mica
C17	50 pF	Ceramic N750
C18	0.001 μF	Silvered Mica
C19, C20	100 pF	Silvered Mica
C21, C22	0.027 μF	Polyester 400V W
C23, C24	24 x 24 μF	Electrolytic (chassis mounting)

**Note:** C2, C3, C4 and C5 may be replaced by 7 to 47 pF Ceramic Trimmers

*IFT1, IFT2	Special R.C.S. Type 118
*IFT3	Standard 455kc/s
*Aerial Coil	Standard
*Oscillator	Standard to suit
Coil	6AN7/ECH80
4	Grommets for ⅜" hole
1	Grommet for ⅜" hole
3 yards	Light duty 3-core flex
2 yards	Polythene-covered shielded cable
1	Plug for above to suit amplifier
2	Knobs
1	Dial lamp
	Hook-up wire, including tinned copper wire
1	2-pole, 2-position Oak switch
*1	Kit of dial parts
*1	Kit of chassis parts
*1	Escutcheon

### Miscellaneous Hardware

1	13 Tag Strip
1	10 Tag Strip
2	8 Tag Strip
1	4 Tag Strip
12	Solder lugs
18	Cheese-head or round-head ¼" x 6BA brass screws
12	Countersunk ¼" x 6BA brass screws
2	Cheese-head or round-head ½" x 6BA brass screws
36	Standard 6BA brass nuts
6	Round-head ¼" x 4BA brass screws
6	Standard 4BA brass nuts
6	Brass washers for 4BA screws (20 gauge)
2	⅜" spacers with 6BA clearance hole
1	¼" x ¼" x 1" gang-shaft-extension

### \*Whistle Filter

Mullard Vinkor No. LA2303  
 Bobbin No. DT2010 and DT2083  
 Alignment Plug No. DT2033  
 Bobbin wound with 672 turns of 38 s.w.g. enamelled copper wire. The core is assembled using alignment plug DT2034

**Power Supply**  
 Transformer — National Type No. U20/130  
 Diode Rectifier — Mullard OA210

\*The special non-standard components for this Tuner may be obtained through normal radio trade houses or direct from the manufacturers listed below.

**Effco Manufacturing Co. Pty. Ltd., 108 Princes Highway, Arncliffe, N.S.W.** — Kit of parts for dial drive assembly.

**A. E. Patrick Pty. Ltd., 4 Parramatta Road, Summer Hill, N.S.W.** — Perspex escutcheon, drilled and printed with dial scale and control knob positions.

**R.C.S. Radio Pty. Ltd., 651 Forest Road, Bexley, N.S.W.** — Special IF coils. Type 118.

**R. H. Oxford & Son Pty. Ltd., 97 Marriott Street, Redfern, N.S.W.** — All metal parts in dichromated steel, drilled and ready for assembly.

**National Transformers Pty. Ltd., 126 Sussex Street, Sydney** — Power transformer type U20/130.

**Special Transformers Pty. Ltd., 139 Sydenham Road, Marrickville, N.S.W.** — 10kc/s whistle filter.

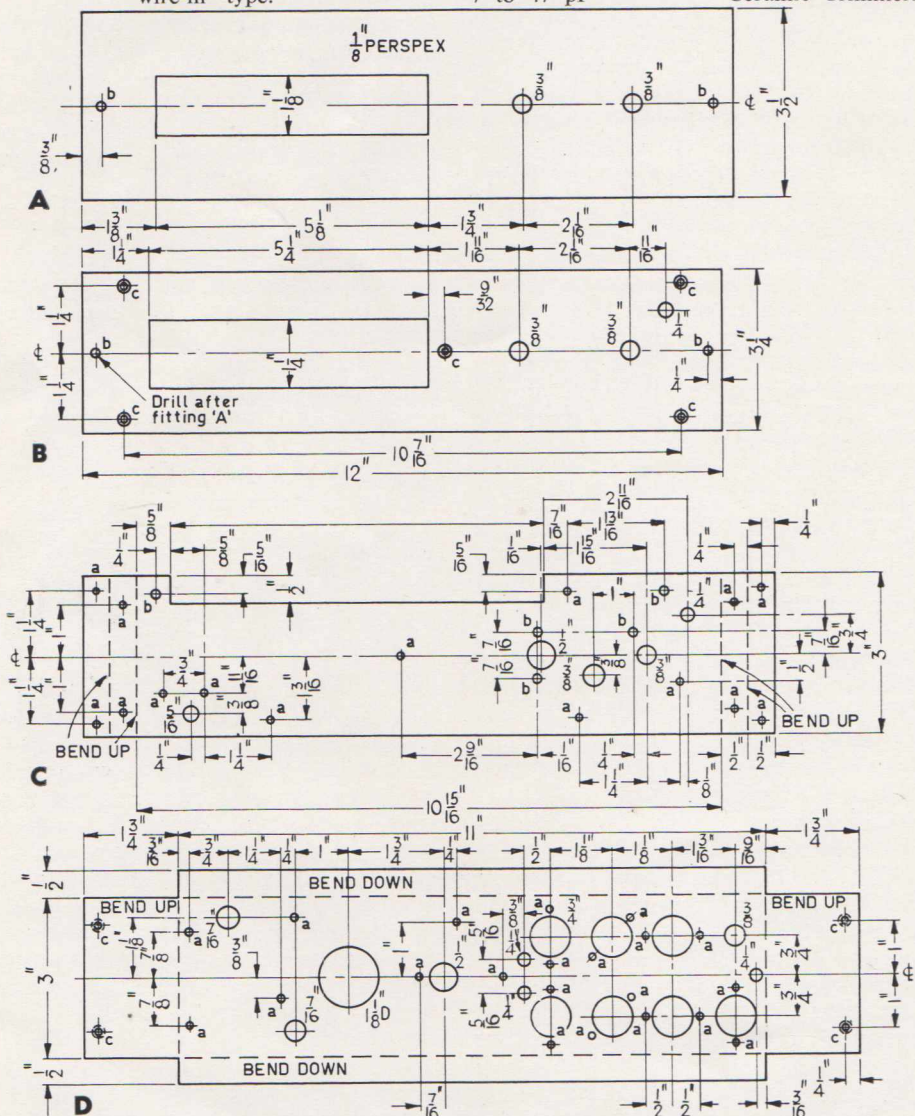


Fig. 5—Chassis outlines and dimensions

Components on top side of chassis part "D" — C1a, C1b, C2, C3, C4, C5. Tuning capacitors and trimmers. C18 and C22 mounted on a small tag strip located between 6N8/EBF80 and IFT3. The output cable is also connected to this tag strip.

Components attached to dial assembly chassis part "C" upper side — C11, C13, DM70 tuning indicator, dial lamp.

Material unless noted 18 gauge mild steel plate.

Holes marked "a" 6BA clearance.

Holes marked "b" 4BA clearance.

Holes marked "c" 6BA countersunk clearance.







# A FOUR-TRANSISTOR DC CONVERTER CIRCUIT FOR USE WITH RELATIVELY HIGH-VOLTAGE SUPPLIES

*The danger, in transistor circuits requiring high supply voltages, is that transients may exceed the maximum safe limits of the transistors used. The DC converter circuit described in this article is of the bridge type, using four power transistors, in which the peak voltage does not exceed the supply voltage.*

In push-pull DC converters, the peak voltage applied to the transistors, in the cut-off state, is twice the supply voltage. This, in turn, means that the supply voltage chosen must not be more than about half the maximum allowable peak collector voltage for the transistors.

It is often desirable to operate DC converters from supply rails of higher potential than the transistor ratings will allow. With a bridge circuit of four transistors, higher voltage supplies can be used. The peak voltage across any one of the transistors, in the circuit described, does not exceed the supply voltage.

## BASIC CIRCUIT

Fig. 1 shows the form of circuit described. It is essentially a bridge circuit, the transistors conducting in pairs through the primary winding of the transformer. The conduction period depends on the saturation characteristics of the transformer core. The peak current through the transformer core is the lesser of the peak currents available from the conducting transistors. As one transistor fails to supply the increasing current required to maintain the voltage across the transformer, it comes out of bottoming and regeneration causes the circuit to switch over.

## STARTING CIRCUIT

The circuit of Fig. 1 will not always oscillate on application of the supply voltage, because all four transistors are nearly in the cut-off state. The loop gain of the circuit will be less than one. Tr1 and Tr2, as shown in Fig. 2, can be biased-on under conditions of no oscillation by connecting a diode as shown. The base current, about 200mA, is sufficient to bias the diode in the forward direction, providing a low resistance path. The drive to the

affected transistors must be increased to compensate for the voltage drop across the diode, which is of the order of 0.5V. To ensure that the loop gain exceeds one, the bias current required must be calculated from

$$\frac{g_m R_L}{n} > 1$$

where  $R_L$  is the resistive load appearing across the primary winding and  $n$  is the feedback turns ratio. The  $g_m$  of the transistor stage is given by

$$\frac{1}{g_m} = r_e + \frac{R_b}{a'}$$

where  $R_b$  is the total base resistance, i.e., the sum of the internal and external resistances and  $r_e = 25\text{mV}/I_e\text{mA}$ . Thus the condition for starting is that the emitter current should be greater than

$$\frac{25na'}{a'R_L - nR_b} \text{ mA} \dots \dots \dots (1)$$

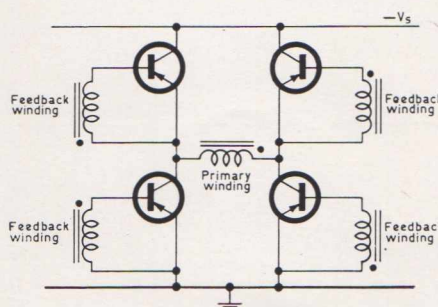


FIG. 1—BASIC CIRCUIT—All windings on one core

The values of  $R_1$  and  $R_2$ , see Fig. 2, can be chosen to fulfil this condition. They should also ensure, by choice of quiescent collector voltage, that if the output winding becomes short circuited and starting does not occur, the transistors should not dissipate excessive power.

## DESIGN DATA

The various transformer and circuit parameter relationships are given by

$$4fnAB_{sat} = V_s \times 10^8 \dots \dots \dots (2)$$

where  $f$  = frequency,  $A$  = area,  $V_s$  = secondary voltage,  $B_{sat}$  = saturation flux density,  $n$  = number of primary turns.

The four feedback windings can then be arranged to give sufficient drive such that, under the worst conditions, the collector current equals the maximum load current referred to the transformer primary winding. The drive to Tr1 and Tr2 should give a voltage 0.5V higher than this, to compensate for the drop across the starting diode.

Additionally it is desirable to put a small resistance in series with the bases, to reduce the effects of spread in the transistor input characteristics.

## PRACTICAL EXAMPLE

### The Transformer

Supply = 24V.  $f = 330\text{c/s}$ .

With a ½-in. stack of HCR laminations No. 227.

$A = 2\text{cm}^2$ ,  $B_{sat} = 15000$  gauss. From Eq. 2,

$$n = \frac{24 \cdot 10^8}{4.330 \cdot 15000 \cdot 2} = 60 \text{ turns.}$$

With  $4.7\Omega$  in series with the base a suitable drive voltage is 2.5V.

Allowing 0.5V across each bottomed transistor, the peak voltage across the primary winding is 23V. In order to provide 2.5V in the feedback winding to Tr3 and Tr4, 7 turns are required. However 8 turns are needed for Tr1 and Tr2 to provide 3V, allowing for the starting diode.

*This article is based on a report prepared by W. L. Stephenson of the Mullard Research Laboratories.*



### Starting circuit

On full load the reflected load resistance is  $8\Omega$  and the feedback turns ratio is 7.5.

If  $a' = 20$  and  $R_b = 10\Omega$ , from Eq. 1,

$$I_e > \frac{25.20.7.5}{8.20-7.5.10} = 44\text{mA.}$$

Allowing a total current of 100mA with 6V across the transistors,  $R_1 = 180\Omega$ ,  $R_2 = 1\text{k}\Omega$ . The exact values of  $R_1$  and  $R_2$  required depend on parasitic effects such as leakage inductance and stray capacitance, both of which will vary with the mechanical construction of the individual transformer.

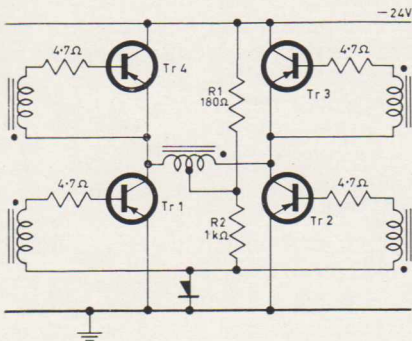


FIG. 2—PRACTICAL CIRCUIT

tance and stray capacitance, both of which will vary with the mechanical construction of the individual transformer.

### RESULTS

Constructed to the suggested design, the circuit operated successfully with a power output (across a load) in excess of 40W; the DC to AC efficiency was 90%.

It should be noted that the recurrent peak transient-voltage across the transistor depends very much on the actual transformer design (leakage inductance, capacity, etc.). Accordingly the circuit designer must still ensure that, in his particular case, the full published limits for the transistor used are never exceeded. DC converter circuits are becoming so important that special types of transistors have been developed to meet this particular application.

# TRANSMISSION LINES AS RESONANT CIRCUITS

## UHF CIRCUIT DESIGN

At UHF, transmission lines are used as resonant circuits because lumped circuits are difficult to achieve at these frequencies. When transmission lines are used in the anode or grid circuits of valves the parameters have to be taken into account to effectively determine the correct length of these lines. In push-pull circuits the anode and grid circuits are almost inevitably balanced lines consisting of a pair of rods tuned by a shorting bridge.

When the valve is oscillating the amplitude of oscillation is such that the negative conductance component of  $Y_t$ , the valve input admittance, equals the positive conductance presented by the transmission line section. Also  $B_t$ , the susceptance component of  $Y_t$  is of opposite polarity to the transmission line susceptance  $B$ . Thus for resonance the line length  $l$ , is related to  $B_t$  and line characteristic impedance  $Z_0$  as shown in the following formula:

$$l = \frac{\lambda}{2\pi} \text{arc cot } (B_t Z_0) \quad \text{Formula (1)}$$

The susceptance,  $B_t$ , is an extremely complex function of wave length. Certain equivalent circuits may be used to approximate this susceptance, but for best results the valve should be treated in an empirical manner.

It is conventional to represent the valve admittance by an additional open circuit length,  $l_t$ , which is chosen to present the same susceptance as the valve. The formula for this equivalent length is:

$$l_t = \frac{\lambda}{2\pi} \text{arc tan } (B_t Z_0)$$

Since resonance occurs at the electrical quarter wave length, the total line

$$\text{length is now } l + l_t = (2K-1) \frac{\lambda}{4}$$

(where  $K$  is any whole number). The transmission line length is therefore

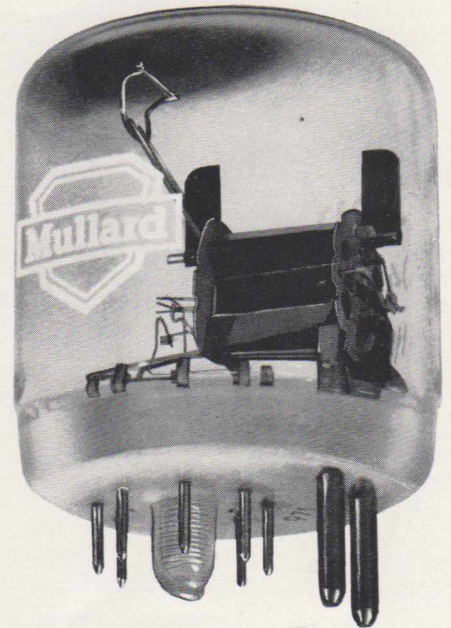
$$l = (2K-1) \frac{\lambda}{4} - l_t, \text{ which expands to:}$$

$$l = (2K-1) \frac{\lambda}{4} - \frac{\lambda}{2\pi} \text{arc tan } (B_t Z_0)$$

Formula (2).

This equation can be used to calculate line lengths.

It should be noted that a short circuit wire may not be sufficient to short circuit a parallel wire line successfully,



QQV04-16

especially if the line conductors extend beyond the short circuit. The current loop in the wire produces magnetic coupling with the extended conductors and results in a loss of power. A metal plate should be connected to the end of the transmission line so that it is in a perpendicular plane in relation to the line. This will eliminate the unwanted radiation by acting as a shield.

### TUNING THE ANODE CIRCUIT

The length of the anode transmission line is given by Formula (2) when  $K = 1$ . Therefore:

$$l (\text{Plate}) = \frac{\lambda}{4} - \frac{\lambda}{2\pi} \text{arc tan } (B_t Z_0)$$

At frequencies as high as 1000 Mc/s it is usual to tune by changing  $Z_0$  rather than using a shorting bridge. However, when the transmission lines are mounted near the chassis, parallel oscillations may take place. This can be counteracted by connecting a 50Ω resistor and 100pF capacitor in series with the anode circuit centre tap.

### TUNING THE GRID LINES

The length of the grid lines is given by Formula (2) when  $K = 2$ . Therefore:

$$l (\text{Grid}) = \frac{3}{4}\lambda - \frac{\lambda}{2\pi} \text{arc tan } (B_t Z_0)$$





Tuning of the grid lines is done by a simple shorting line which can be fixed on the line itself for a given frequency.

#### TYPICAL EXAMPLE

The following example illustrates the procedure for determining the physical length of a 2 conductor transmission line to act as a resonant tank in the anode circuit of a Mullard QQV04-16. The QQV04-16 is especially suited for this type of circuit because it is a twin tetrode with the anode pins accessible at the valve base, and the input and output circuits separated from each other to prevent radiated feedback. In addition the valve is internally neutralised to prevent any tendency to oscillate.

$$f = 960 \text{ Mc/s}$$

D (distance between transmission lines) = .375"

d (diameter of the line) = .195"

Length of the anode transmission line is given by the following formula:

$$l \text{ (anode)} = \frac{\lambda}{4} - \frac{\lambda}{2\pi} \text{ arc tan } (B_t Z_o)$$

$$\lambda \text{ (at 960 Mc/s)} = \frac{3000 \times 10^7}{960 \times 10^6} = 31.3 \text{ cm}$$

$$Z_o = 276 \log_{10} \frac{2D}{d} = 160 \Omega$$

At resonance  $B_t = 2\pi fC$  ( $C$  = total of anode to grid, anode to cathode capacitance = 1.5 pF)  
 $\therefore B_t = 0.009$

$$l \text{ (anode)} = \frac{31.3}{4} - \frac{31.3}{2\pi \text{ (Radians)}} \text{ arc tan } (0.009 \times 160)$$

$$= 7.83 - 31.3 \left( \frac{55^\circ}{360^\circ} \right)$$

$$= 7.83 - 4.78 = 3.05 \text{ cm}$$

It should be noted that this answer is an approximation based on an assumed value of  $B_t$ . Actual circuits using the QQV04-16 have indicated slightly higher values of  $B_t$  and consequently a shorter length of transmission line.

## TELEVISION TUBE WARRANTY—EXTENDED TO TWELVE MONTHS

As from 15th November, 1960, the guarantee on Mullard Radiant Screen Television Picture Tubes was extended to twelve months.

This applies to Mullard picture tubes already in the field as well as current sales. Now, more than ever, the need for ensuring that television picture tube sales are registered is emphasised so that customers may fully enjoy the privileges of this extended warranty period. Your co-operation will be appreciated.

## REFERENCE MANUAL OF TRANSISTOR CIRCUITS

Many readers will recall "Junction Transistors for the Home Constructor", released in 1955. This was followed by "Transistors for the Experimenter" in 1957 and "A Simple Explanation of Semiconductor Devices" last year. Although the first two publications have been out of print for quite some time, "A Simple Explanation of Semiconductor Devices" is still available at a cost of 5/3d. plus 8d. postage. An entirely new booklet entitled "Mullard Reference Manual of Transistor Circuits" is now due for release and an order form is enclosed with this issue of Outlook.

This publication will be found to contain a satisfying mixture of transistor theory for the "not-too-technical" and many practical circuits with constructional information for the keen amateur and hobbyist. The first nine chapters provide a general background ranging from the mechanical construction of semiconductor devices to the mathematical description of equivalent circuits. The remaining chapters give over sixty circuits, twenty-five of which are published for the first time, covering oscillators, converters, amplifiers, receivers and other devices.

The booklet consists of 308 pages carrying 241 illustrations and its purpose is to help those with some professional or spare-time interest in radio and electronics, to realise the possibilities of the semiconductor and to provide a guide in exploiting its possibilities.

## I.R.E. RADIO AND ELECTRONIC ENGINEERING CONVENTION

The Institution of Radio Engineers will hold its 1961 Convention at the Chevron-Hilton Hotel, Sydney, from March 20th to 25th.

The Mullard display will feature a selection of valves, electron tubes, semiconductors, microwave devices and specialised products from the comprehensive range already available for industrial, communications and research applications, together with a number of new developments from the Mullard Research Laboratories.

Working exhibits will demonstrate semiconductor applications ranging from domestic broadcast receivers, through test and measuring equipment, to DC-to-DC converters.

A 500W 1 Mc/s ultrasonic generator feeding a barium titanate transducer demonstrates the intense activity of water molecules under the influence of ultrasonic radiation.

Capable of evaluating valves such as transmitting triodes and tetrodes, gas filled rectifiers and thyratrons with peak anode ratings up to 7.5kV at 7.5A, a power valve tester will be shown under actual operating conditions.

Technical films from the Mullard Film Library, including two new films, "Principles of X-Rays" and "Manufacture of Frame Grid Valves," will be shown on the Mullard Stand.

Technical personnel will be in attendance at the display, and during the convention papers featuring semiconductor applications will be read by engineers from the Mullard Applications Laboratory.



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# TRANSISTOR RADIOS

## An Introductory Series PART 1

### Preliminary Survey

*The present article is the first of a series on transistor portable receivers and cordless radios and particular attention will be given to the problems of servicing these devices. The treatment will be as simple and straightforward as possible in order that maximum benefit may be derived by those who are required to maintain transistorised radio equipment.*

In order to set the scene for this series of articles, it will be useful to recall first of all, that the transistor radio now covers a wide range of types, from highly miniaturised portables, some with short wave-bands, battery operated cordless mantel receivers for home use, car radio receivers, and soon, transistorised television sets.

#### VARIETIES OF DESIGN

One of the most obvious trends in the design of transistor radios has been towards the production of smaller and smaller receivers, thus increasing the difficulty of access to components. Fault finding becomes more difficult and improved servicing techniques must be employed.

Fortunately many receivers, (e.g. cordless home receivers) are considerably larger and the technician may obtain experience on this type of receiver prior to dealing with the problems of miniaturisation. The larger receiver may be expected to provide an output of 1W or so and calls for the use of a battery of greater capacity.

The quality of reproduction is improved by a larger loudspeaker (e.g. 8 x 5 in.) and cabinet. Such receivers have all the advantages of the trans-portable and, due to the absence of mains leads, are cordless. They have a particular advantage, of course, for areas having no mains supply, because of the low battery consumption.

Some currently available models may have a socket which allows a car-radio aerial to be used instead of the internal ferrite aerial. In this way the performance of the receiver when used in the family car can be improved, thus increasing the general-purpose appeal of the set. A further development of the same idea has led to models which, when in normal use, appear to be a car-radio operating from the car battery; when withdrawn from the fittings this receiver becomes fully portable, and operates from its own internal battery.

#### THE TRANSISTOR

In the most general terms, it can be

said that the radio receiver requires amplifying and detecting devices which will operate at various frequencies. The circuit designer nowadays thinks in terms of two completely different types of device for providing amplification. Some general considerations remain the same, or almost the same, whether he intends to use thermionic valves or transistors. But in many respects the two approaches are completely different, and it is instructive to notice how often, if one can consider the valves in one way, it may be necessary to adopt an opposite viewpoint for the transistor.

One combination of characteristics — that of the valve — are thus being exchanged for a different combination — that of the transistor. The approach required for the transistor will be described in future articles as will its advantages and the way in which it should be handled. The ultimate aim is that those new to transistor techniques shall feel equally at home with transistors or valves.

#### PRINTED WIRING

Future articles will be devoted entirely to the question of printed wiring with particular reference to transistor receivers. The introduction of printed wiring at roughly the same time as the transistor has led to the production of highly compact personal portables. As many technicians will have had neither the time nor the opportunity to find out for themselves the best ways of repairing faults in this kind of wiring, the aim will be to pass on some of the techniques of those who have worked extensively on printed panels.

One point in favour of printed wiring is that, as all the connections are made in one plane, it is moderately easy to represent these connections diagrammatically in the service manual or service sheet. The maximum use should be made of this information when it is available.

#### THE CIRCUIT DIAGRAM

Fault finding will be less difficult for technicians having a good general

knowledge of basic transistor circuitry and in the articles to follow this will be emphasised.

#### FAULT FINDING

Fault-finding procedures will be described in later articles in the series.

The majority of set failures will result in complete break-down. These are the easiest to service because the fault can be traced to an open circuit or a short circuit. Intermittent faults present more difficulty, as do sets subject to low output or excessive distortion.

#### BATTERY REPLACEMENT

Of the transistor receivers brought in for service, the great majority will only need a battery replacement. This does not strictly speaking count as servicing, though checking the state of the batteries is an essential preliminary to starting any job which has been brought in for repair.

Whilst locally produced transistor receivers are designed specifically to use local standard type dry batteries and the dry battery manufacturers are producing the more common type used in imported receivers, some imported receivers will still not accommodate local batteries and the serviceman is confronted with a physical problem of endeavouring to accommodate the largest capacity battery as is practicable.

A rundown battery may be the cause of a variety of complaints of poor performance. To safeguard against this occurrence, the set should be allowed to operate for some time before checking the battery voltage. This simple precaution will soon weed out those cells which have been able to recover sufficiently to give a respectable reading when first switching on.

Although usually the rate of deterioration of each cell is consistent where individual dry cells are used and it is sensible to replace all cells.

Set Design policies on types of dry battery, measurement and anticipated battery life relative to receiver performance will be discussed in Part 2.

*(To be Continued)*



# SIMPLE OSCILLOSCOPE MEASUREMENTS

This is the first article of "Simple Oscilloscope Measurements" which is the second of the "Simple Measurements" series being published in Outlook and contains suggestions for a number of experiments which can be carried out in the laboratory with the aid of a cathode ray oscilloscope and auxiliary equipment.

A simple oscilloscope comprises four main circuits deriving power from a single source. It will be realised by reference to Fig. 1 that these circuits — namely the vertical amplifier, synchronising amplifier, time base and horizontal amplifier and the display unit itself — are all interdependent and, in order that the student may make the best use of such an instrument, it is essential that he understands the function of each stage.

The display unit contains the cathode ray tube, focus and brilliance controls. These controls should be set for the minimum spot intensity which is still visible and for minimum spot size. It should be noted that in this unit the student will find voltages in excess of 500V and extra care should therefore be taken.

The vertical (Y) amplifier comprises a multi-stage high gain amplifier system and two main controls. One of these, the Y shift, is capable of deflecting the spot vertically over the face of the cathode ray tube, the second control, namely the Y sensitivity, controls the degree of amplification of signals being fed to the Y deflection plates of the tube.

Very often the vertical amplifier is limited to accepting only alternating voltages, but in some instruments additional provision is made for the amplification of direct voltages — a factor which greatly increases the number of applications for which the oscilloscope can be used.

As already mentioned, this amplifier circuit is very sensitive and signals carried to it are liable to distortion due to induced hum. It is advisable, therefore, to make full use of screened leads.

Possibly one of the most useful circuits found in the cathode ray oscilloscope is the time-base generator and horizontal (X) amplifier. This produces a saw-tooth waveform which,

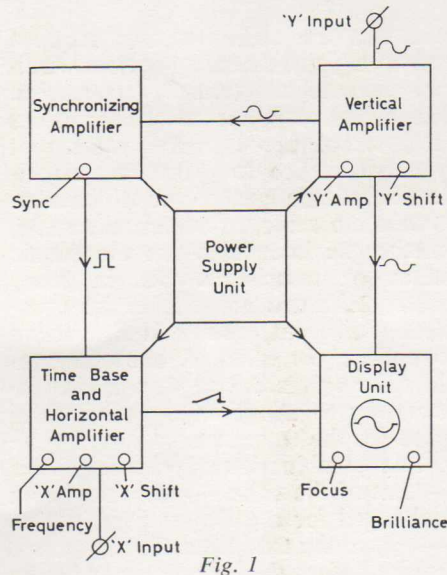


Fig. 1

when fed to the X deflection plates of the cathode ray tube, causes the spot to be swept across the screen at a constant speed. This sweep speed is governed by the frequency at which the saw-tooth waveform is repeated. The time-base therefore provides a variable time scale in the horizontal direction and it is this scale which is used when determining such quantities as the rate of charge of a capacitor or in the examination of various electrical waveforms which are time dependent. The frequency range of the time-base generator can vary from a few cycles up to many megacycles per second (Mc/s), but for most purposes the simple oscilloscope needs a frequency range of only 10c/s to 25kc/s.

Most oscilloscopes have provision made for external signals to be fed to the X deflection plates and, in some cases, an amplifier is built into the time-base chassis to amplify these externally derived signals. However, unless the input signals are of low magnitude, this amplifier is often unnecessary and the simple oscilloscope is not usually provided with this additional circuit.

to be continued

## AMATEUR EXPERIMENTERS COLUMN

### LIGHT SENSITIVE RELAY

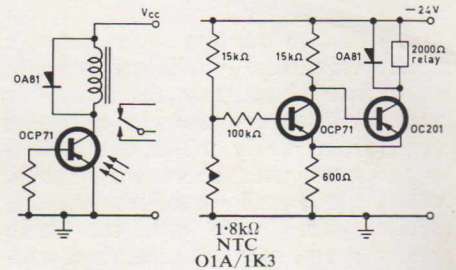


Fig. 1

Fig. 2

The circuits which may be employed are extremely straight forward and may amount to nothing more than the photo-transistor connected in series with a relay coil and a DC supply of 12V to 18V.

A resistor connected between base and emitter may be used to reduce the dark current and improve thermal stability (see Fig. 1). A suitable value may be of the order of 5kΩ.

If greater sensitivity is required, the circuit shown in Fig. 2 may be utilised. This includes an OC201 silicon transistor used as a simple DC amplifier.

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