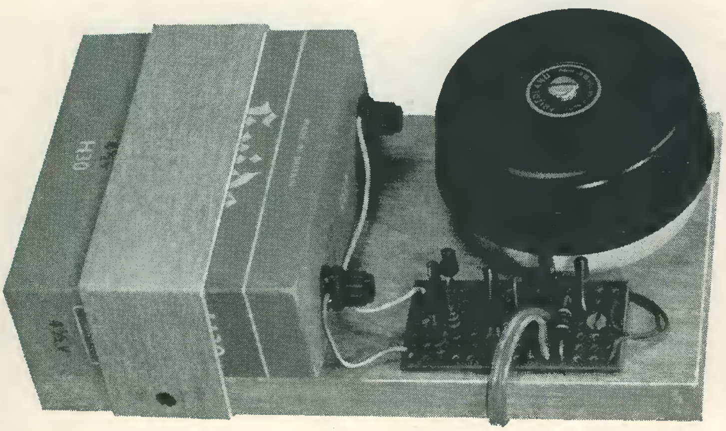
THE

RADIO CONSTRUCTOR

Vol. 22 No. 10 MAY 1969 THREE SHILLINGS

Water Operated Alarm



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2G374	5/-	AC187	12/-	BFW57	7/6	OC30	7/-
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2N388A	15/-	ACY19	4/4	BFX13	4/8	OC42	4/-
2N696	6/-	ACY20	3/8	BFX29	8/5	OC44	3/-
2N697	6/-	ACY21	4/-	BFY50	6/-	OC45	3/-
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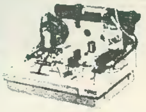

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U11	30 PNP Silicon Planar Transistors TO-5 sim. 2N1132	10/–
U12	12 Silicon Rectifiers EPOXY 500mA up to 800 PIV	10/–
U13	30 PNP-NPN Sil Transistors OC200 & 2S104	10/–
U14	150 Mixed Silicon and Germanium Diodes	10/–
U15	30 NPN Silicon Planar Transistors TO-5 sim 2N697	10/–
U16	10 3-Amp Silicon Rectifiers Stud Type up to 1000 PIV	10/–
U17	30 Germanium PNP AF Transistors TO-5 like ACY 17-22	10/–
U18	8 6-Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	10/–
U19	30 Silicon NPN Transistors like BC108	10/–
U20	12 1·5-amp Silicon Rectifiers Top-Hat up to 1,000 PIV	10/–
U21	30 A.F. Germanium alloy Transistors 2G300 Series & OC71	10/–
U22	10 1-amp Glass Min. Silicon Rectifiers High Volts	10/–
U23	30 Madt's like MAT Series PNP Transistors	10/–
U24	20 Germanium 1-amp Rectifiers GJM up to 300 PIV	10/–
U25	25 300Mc/s NPN Silicon Transistors 2N708, BSY27	10/–
U26	30 Fast Switching Silicon Diodes like IN914 Micro-min.	10/–
U28	Experimenters' Assortment of Integrated Circuits, untested. Gates, Flip-Flops, Registers, etc., 8 Assorted Pieces	20/–
U29	10 1 amp SCR's TO-5 can up to 600 PIV CRS1/25-600	20/–
U30	15 Plastic Silicon Planar trans. NPN 2N2924-2N2926	10/–
U31	20 Sil. Planar NPN trans. low noise Amp 2N3707	10/–
U32	25 Zener diodes 400mW Du7 case mixed Vlts. 3–18	10/–
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300	—	2/3	3/9	4/6	6/6	22/–
400	2/–	2/6	4/–	5/6	7/6	25/–
500	—	3/–	—	6/–	8/6	30/–
600	2/9	3/3	4/3	6/9	9/–	37/–
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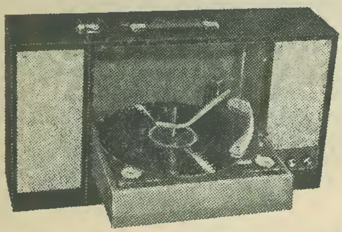

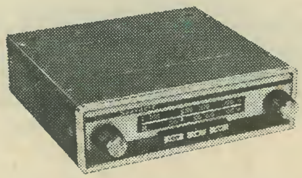

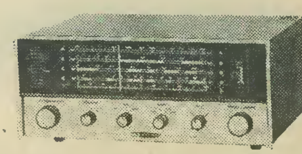

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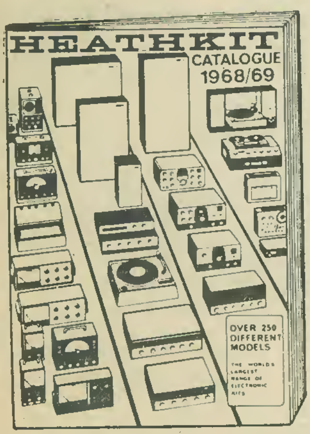

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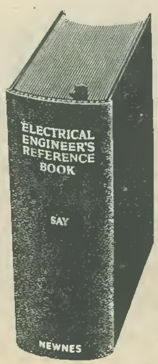

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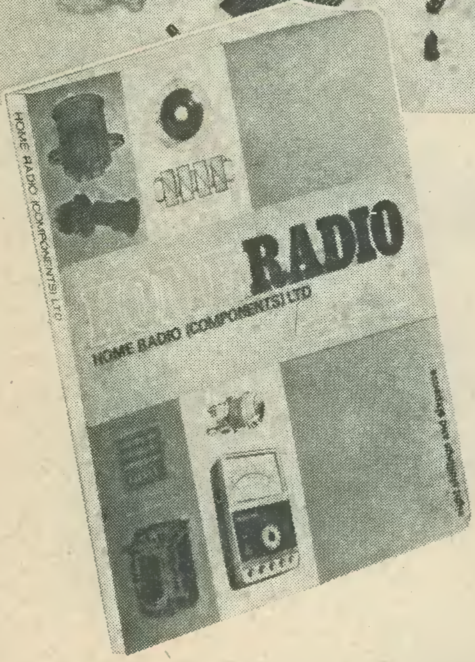

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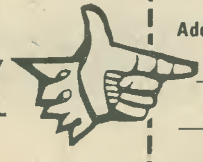

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CONTENTS

MAINS POWER FOR TRANSISTOR EQUIPMENT

by

G. W. SHORT

The provision of simple mains power supplies for transistor equipment tends to introduce more complications than are encountered in equivalent power supplies for valves. Our contributor examines the pitfalls which have to be avoided, illustrating his remarks with two practical supply circuits.

MAKING A SIMPLE UNSTABILISED MAINS POWER unit to supply low-voltage d.c. to transistor equipment is not quite as easy as it looks. True, the circuitry is not at all complicated: a step-down transformer, a rectifier, and an electrolytic capacitor are the only essential circuit elements. But there are snags. One of them is that unless care and knowledge are exercised, the power pack may deliver an output voltage which is much higher than the required value, with disastrous effects on the equipment supplied. There are also uncertainties about the amount of hum which will be produced as a result of the ripple on the d.c. output. Again, the constructor may wish to use the low-voltage heater windings on an old transformer from a piece of valve equipment. Will it give the right output? And last, but by no means least, how can the power pack be made safe? Not all these points can be answered precisely, but the two practical designs given here indicate the sort of performance which can be expected.

NOMINAL 9V, 100mA SUPPLY

Equipment designed for battery operation will usually work quite well from somewhat less than the full battery voltage. This enables the 6.3V winding of a valve "heater transformer" to be used for a nominal 9V d.c. output. Conventional transformers of this type will deliver at least 300mA r.m.s., and their secondary windings usually yield rather more than the nominal 6.3V when the current

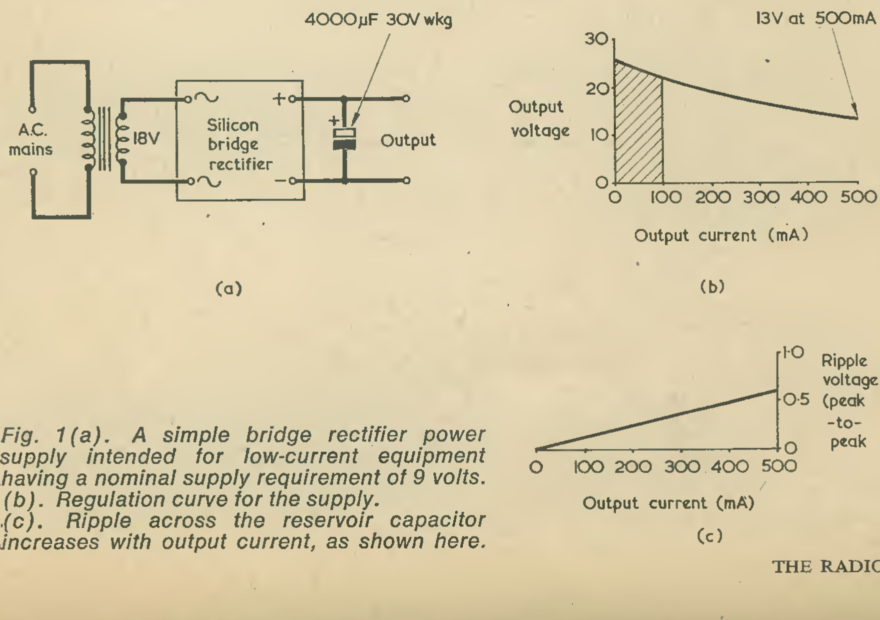

Fig. 1(a). A simple bridge rectifier power supply intended for low-current equipment having a nominal supply requirement of 9 volts. (b). Regulation curve for the supply. (c). Ripple across the reservoir capacitor increases with output current, as shown here.

drawn is much less than this. When a suitable rectifier is used, together with a large reservoir capacitor, the d.c. output is always well above 6.3V for small load currents. In theory, and assuming perfect rectifiers, etc., the output across the reservoir capacitor for zero load current would be equal to the peak transformer secondary voltage, and this is a little under 9V for a 6.3V r.m.s. input. In practice the direct voltage across the reservoir capacitor is always a little less than the peak value but the fact that the transformer secondary normally offers more than its nominal 6.3V at low current drains offsets this, and will leave you with something quite close to 9V — perhaps a little above, perhaps a little below — but within reasonable distance of that value.

The curve of Fig. 1(b) shows the performance of a particular combination of transformer, rectifier and capacitor, as checked by the writer using the circuit of Fig. 1(a). At zero load the output is 9.5V but as current is drawn it falls, and at 100mA output it is only about 6.5V. Thus, the circuit of Fig. 1(a) has its limitations so far as voltage regulation is concerned but is nevertheless of use provided these limitations are known and are acceptable for the equipment to be powered.

A selenium bridge rectifier was used. The forward voltage drop in a bridge is higher than with, say, a half-wave rectifier employing a single silicon or germanium junction diode. But the regulation with a bridge rectifier is better and the ripple voltage much lower. The curve of Fig. 1(c) shows that the ripple voltage increases as load current rises. This curve was taken using the writer's test circuit.

CHOICE OF RECTIFIER

Junction rectifiers are very suitable for low voltage supplies. Germanium types have a low voltage drop when conducting, and give a little more output voltage than silicon types, but they are no longer in large scale production. Silicon bridges are quite suitable also.

This leaves two other types to be considered, of which the first is the germanium point-contact diode. Rectifiers of this type are quite useless for power supplies which have to deliver more than a few milliamps, because their forward drop is high and they will not stand up to the large surge currents which flow during the short interval in which the capacitor is initially charged when switching on. Gold-bonded diodes are better, since they are really tiny junction diodes, but again they will not supply much current.

The second type of rectifier is the selenium component. The selenium rectifier diode has about the same forward voltage drop as a silicon rectifier at low currents, but may be worse at high ones. A qualifying point here is that a silicon bridge uses only four diodes (except for very high voltages) whereas selenium bridges may contain four, eight, twelve, and so on, according to the voltage rating. Since every diode produces a forward voltage drop, in the present case a selenium bridge with only four elements (four plates) must be used. Readers who are familiar with the old-fashioned grey-painted selenium bridges encountered in 'surplus' gear may have a poor opinion of selenium, but performance has now been greatly improved while at the same time size has been reduced. The selenium bridge used by the writer in the circuit of Fig. 1(a) is about the size of a little finger nail, yet it is rated at 30V, 150mA. These little selenium rectifiers are usually cheaper than silicon or germanium bridges. At higher voltages, silicon takes over.

25V SUPPLY FOR CLASS B AMPLIFIER

This is a much more critical requirement than the previous case. Designers of transistor power amplifiers nearly always operate the output transistors near the upper limit of permissible voltage. If more voltage is applied the transistors may be destroyed. Fuses give no protection since transistors can perish in microseconds, while a fuse takes much longer to respond.

The constructor is faced with an apparent dilemma. It would seem that, if he designs a simple unstabilised power unit so that the off-load voltage is not too high, then when a signal is applied and the amplifier draws more current, the voltage will fall, drastically reducing the amplifier output power. A fall in voltage of 30% halves the power, and a fall of 50% reduces it to one quarter of the design value. Furthermore, the actual measured performance of a power unit, as shown in Fig. 2(b), seems to bear out these forebodings to the full. (Fig. 2(b) shows the output voltage/output current curve for a second power supply assembled and checked by the writer, this employing the circuit of Fig. 2(a).)

In practice, however, a circuit like that of Fig. 2(a) gives results which are audibly almost indistinguishable from those given by a stabilised power unit with a constant 25V output. The reason is that although an amplifier with a nominal output of around 5W may draw 400mA at full output with sine-wave drive, it draws far less with speech or music drive, because speech and music waveforms are very spiky. If the input is adjusted so that the

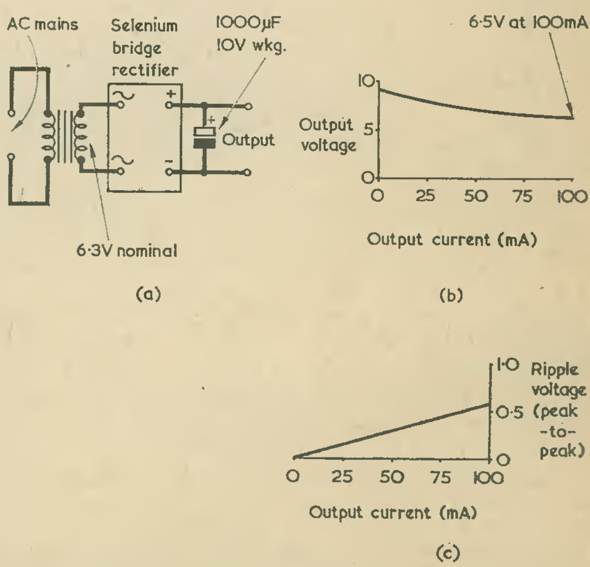

Fig. 2(a). A power supply intended primarily for 25 volt equipment.
(b). Voltage/current regulation curve for the second supply unit.
(c). Ripple amplitude against output current.

peaks just fail to overload the amplifier then the mean current drawn is quite small. The power unit operates for most of the time in the shaded area, where the voltage is still quite high. It is important that the supply can deliver short bursts of high current, and this can be ensured by using a high-value reservoir capacitor.

Having disposed of a 'paper tiger' we must now deal with a real one. If a simple unstabilised power supply is to provide a nominal output of 25V the mains transformer must *not* have a secondary voltage of that figure. The quoted secondary voltage of a transformer is in r.m.s. figures and, as we have already seen, the d.c. output of the power supply is well in excess of the r.m.s. figure at the lower currents, rising to around the peak value at zero load current. If a 25V secondary had been employed in the circuit of Fig. 2(a) the peak d.c. output could have risen to 35V, with consequent risk of damage to the powered equipment. Always use a transformer with a secondary voltage rated at 0.7 times the nominal d.c. output voltage of the power supply. (This is because the r.m.s. voltage of a sine wave is 0.7 times its peak value.) In our present example, 25 times 0.7 is equal to 17.5V, and the 18V secondary employed in practice is sufficiently close to this figure to obviate the risk of excessively high output voltages appearing at low load currents.

Another point to watch here occurs when buying low voltage mains transformers from local shops dealing in electrical goods. Low voltage transformers are frequently associated, by electrical tradesmen, with the function of battery charging and what is described as an '18V transformer' may, in practice, offer as much as 25V r.m.s. The purpose of the so-called '18V transformer' is to charge an 18V battery, whereupon it may have been designed to offer an actual voltage considerably higher than that figure. If your local supplier does think in terms of charger transformers, it is necessary to ask for a transformer which really gives 18V r.m.s., whatever the nominal voltage is. When confronted with this problem, the only certain way of ascertaining the secondary voltage is to measure it.

(This state of affairs does not arise with the well-known radio component mail-order houses, who state r.m.s. secondary voltages in their catalogues. —Editor.)

SAFETY PRECAUTIONS

It is absolutely essential, in the completed supply, that no conductor at mains voltage is capable of being touched, even by tiny fingers poked through small holes in the case. On the other hand ventilation is needed, or the power unit may get hotter and hotter and eventually break down. A generous area of perforated hardboard or metal is indicated, but if metal (e.g. expanded metal sheet) is employed remember to earth it reliably to the earth lead of the 3-core mains connector.

Make sure that the ventilation holes cannot be blocked if the unit is placed against a wall. One good system here is to provide the unit with feet which hold it ½in. off the surface on which it is placed, with ventilation holes positioned so that air is drawn in from below and passes out at the top of the side walls of the case. Ventilation holes in the top itself are dangerous, because liquids can get spilt into them.

The mains lead should be securely anchored. It is best to secure this with a reliable cable clip inside the cabinet, ensuring that it passes through a grommet if the cabinet is metal.

Fuses are advisable, and the mains should pass through them *before* it reaches the on-off switch. If only one leg is to be fused and/or switched, make it the 'live' one.

■

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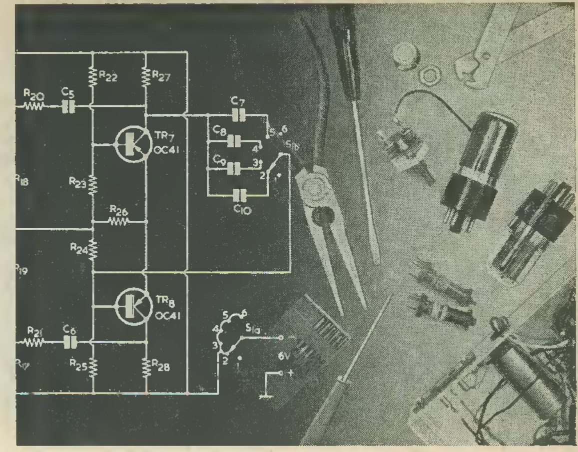


LIGHT OPERATED RADIO SWITCH

by G. A. FRENCH

MANY OF US LIKE TO HAVE a transistor portable radio in the bedroom in order to provide a late night programme before retiring. A slight irritation, however, is that it is necessary to switch off the receiver before finally settling down to sleep, and this may involve reaching over to an awkward position from the bed or, even, getting out of bed altogether.

This month's "Suggested Circuit" offers a novel solution to this minor domestic problem and it presents a design which automatically turns off a 9-volt portable transistor receiver when the bedroom light is switched off. As an added bonus, the photoconductive cell employed in the circuit can be so positioned that the receiver is also turned on again by the daylight of the following morning. The switching action of the circuit is carried out by transistors, and no relays are employed at all. The only disadvantage with the circuit is that it draws a continual current from the receiver battery when it is in the dark condition; but this current is, typically, less than one-tenth of a milliamp. The gradually increasing light of the following dawn will cause an increasing current flow in the receiver circuits until the latter commences to operate but, due to the high d.c. amplification provided in the circuit, this effect should be in evidence over a relatively short period of time only. The extra current drawn by the switching circuit in the illuminated state is slightly greater than in the dark condition, but it is still of the order of a third of a milliamp or less.

SWITCHING SECTION

To appreciate the operation of the overall circuit it will be of advantage to initially examine the semiconductor switching section, which incorporates two transistors in an arrangement similar to that illustrated in Fig. 1. The "load" shown in this diagram is actually a transistor receiver, but we shall assume for the moment that it is a resistor which draws a current of about 50mA at 9 volts.

TR1 is an ACY19, this being a small germanium p.n.p. transistor in a TO-5 can. It offers a reasonably high current gain (80 to 315 at an emitter current of 50mA), has a maximum dissipation rating of 260mW and a peak collector current rating of 2A. TR2 is a very small n.p.n. transistor type BC168C in the TO-92 encapsulation, and it offers the extremely high gain figure of 450 to 900 (The BC168C is available from Amatronix Ltd.).

When the switch in Fig. 1 is closed, a current flows in the base of TR2. An amplified current then flows in the collector circuit of TR2, this current being drawn via the emitter-base junction of TR1. TR1 functions as an emitter follower and a further-amplified current flows from its emitter to its collector. The two transistors function in much the same manner as occurs in the familiar Darlington pair with the exception that, since they are of opposite types, it is the collector of the first which is connected to the base of the second. The emitter-base current in TR1 and the collector-emitter current in TR2 are both drawn from the positive terminal of the battery via the load ("Conventional current"—positive to negative—is assumed here). If, in consequence, the two transistors are used as a switch between the battery and the load, the only extra current drawn from the battery, in addition to that flowing in the load, is the base current to TR2 which passes by way of its base resistor. The overall current gain for the two transistors is approximately equal to the product of their individual gains and something of the order of 40,000 times or more can be anticipated. When, during initial experiments, the author used a trial circuit similar to that of Fig. 1, both transistors were hard on for a current in the load of 50mA when the base resistor for TR2 was 8MΩ. This corresponds to a base current in TR2 of slightly more than 1μA!

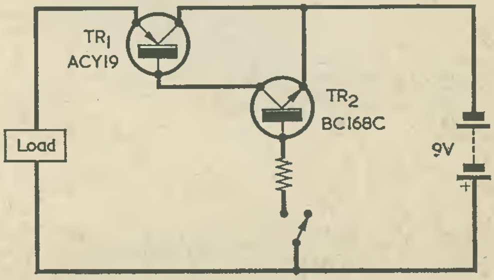


Fig. 1. The basic dual-transistor combination employed in the switching circuit

LIGHT OPERATED CIRCUIT

The full circuit of the light operated switching device appears in Fig. 2. Here, we have TR1 and TR2 connected as before, but the base of TR2 now couples, via R1, to the slider of the preset potentiometer, R2. R3 is a limiter resistor, whose function will be described later. It is intended that the circuit be interposed between the transistor receiver and its battery, the points at the left of the diagram designated "To Receiver" connecting to the receiver negative and positive supply rails via its on-off switch. The circuit is brought into operation by setting S1(a) (b) to the "In" position, whereupon S1(b) connects the lower terminal of the photoconductive cell, PC1, to the positive supply line. The cell is an ORP12 (also referred to as a "light dependent resistor"). Its resistance changes from some 75 to 300Ω in the fully illuminated condition to about 10MΩ in total darkness.

The functioning of the circuit is extremely simple. The slider of R2 is set up such that, when the cell is illuminated, sufficient current passes to the base of TR2 to bring both transistors hard on and supply power to the receiver. When the illumination is withdrawn the photoconductive cell offers increased resistance, the slider of R2 goes more negative, and both transistors become cut off. The receiver is thus turned off.

The prototype circuit was checked with the photoconductive cell directed in the general direction of a 100 watt lamp some eight feet away. A receiver was coupled to the circuit and this switched on reliably when the 100 watt lamp was lit and switched off again when the lamp was turned off. The setting required in R2 for this performance was not particularly critical. When the receiver was switched on the voltage drop across TR1 was about 0.3 volts. When the receiver was turned off, the only current drawn from the battery was that flowing in R2 and PC1, together with leakage current in TR1 plus amplified leakage current in TR2. The total of all these currents was found to be less than 100μA. The circuit was then checked for sensitivity by fully advancing R2 slider to the PC1 end of its track, whereupon it was found that the receiver could be turned on by striking a match six feet away from the photoconductive cell. All these tests were carried out during late evening, when ambient light was very low. No lens was used with the photoconductive cell but it was necessary for the burning match in the final test to be close to a line perpendicular to its photo-sensitive surface. With R2 slider adjusted to the PC1 end of its track, incidentally, the total current drawn from the battery in the dark condition was still less than 100μA.

When the light switching device is not required, S1(a) (b) is set to "Out". S1(a) then short-circuits TR1 and R3 whilst S1(b) breaks the positive connection to the photoconductive cell. The light switching components are thus taken completely out of circuit, and the receiver is switched on and off by its own on-off switch.

In use, the receiver will be tuned to the desired station at the required volume level. With the photoconductive cell illuminated by the bedroom light, S1 is then set to "In", whereupon the light-operated switching circuit takes over. The receiver on-off switch is, of course, maintained in the "On" position.

A final point in the circuit is concerned with R3. The function of this resistor is merely that of limiting surge current in TR2 to a safe value if the receiver should be turned off by its own switch, then turned on again whilst TR1 is in circuit and conductive. The voltage dropped across R3 is slightly less than a quarter of a volt at a current of 50mA.

RECEIVER AS LOAD

It is of interest next to examine the manner in which a transistor portable receiver functions as a load for the switching circuit, and to see how it may be switched by a relatively small transistor as is employed for TR1.

Typically, a 9-volt transistor radio draws some 10mA quiescent current, this increasing at high volume levels to about 50mA. When drawing 50mA it may be considered as a resistor having a value of 180Ω.

Maximum dissipation in TR1 occurs at half-voltage, when 4.5 volts appears across both the transistor and the load. If the load is a 180Ω resistor, this dissipation, from $\frac{V^2}{R}$, is 112.5mW, which is well within the maximum rating specified for an ACY19.

However, a transistor radio does not function in the same way as does a 180Ω resistor. To start off with, the radio only draws a current of the order of 50mA at a higher volume level than would normally be anticipated for bedside listening and, even then, only on audio programme peaks. Further, when its supply potential has dropped to around 6 volts it can be expected that its oscillator will stop running, whereupon the only supply current drawn is that associated with quiescent operation. From these last two points it may be seen that, so far as power dissipation is concerned, TR1 suffers even less dissipation than an initial assumption of a 180Ω load resistance would lead one to believe, whereupon there is a considerable degree of permissable dissipation "in hand".

CONSTRUCTION

Only a few small components are required for the switching circuit of Fig. 2 and it may in many instances

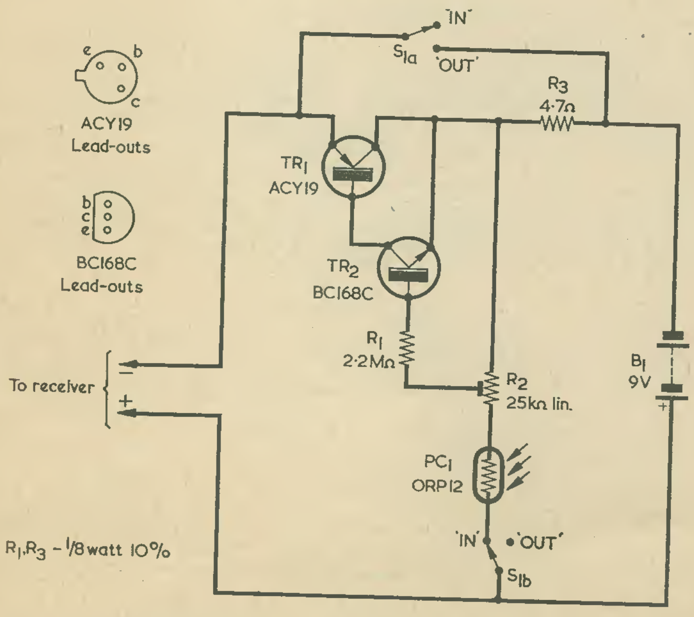


Fig. 2. The full circuit of the light-operated radio switch

be possible to instal these in the case of the receiver itself. S1(a) (b) can be a miniature 2-pole 2-way slide switch, whilst R2 may be a skeleton preset potentiometer.

Alternatively, the switching circuit could be external to the receiver, being fitted in a small case having its own 9-volt battery. It may then be coupled to the receiver by some convenient means which also enables the receiver internal battery to be isolated. It is left to the constructor to devise a suitable system applicable to the particular receiver to be controlled. Incidentally, a jack (on the receiver) and jack plug (from the switching unit) are not attractive here, because the jack plug contacts can be short-circuited on being inserted into the jack socket.

The light-sensitive surface of the photoconductive cell may be slightly recessed in the case in which it is fitted, but its positioning is not, in practice, of great importance.

After the circuit has been made up it may be tried out in conjunction with the bedroom light with which it is to be used. Daylight *must* be excluded if the setting-up is done during the daytime. Connect a voltmeter across the leads from the switch circuit to the receiver, set R2 slider to the negative end of its track and illuminate the photoconductive cell with the bedroom light. Then, slowly advance R2 slider towards the PC1 end of its track until it is a little past the point where the receiver is turned on with a full 9 volts (less the small voltage dropped in TR1 and R3) indicated in the meter. Switch off the bedroom light and ensure that the receiver is turned off, with a zero reading in the voltmeter. Remove the voltmeter and, as a final check, insert a current-reading meter in series with one of the leads from the battery. The current drawn under dark conditions should certainly be less than a third of a milliamp and, under low ambient lighting conditions, can be expected to be less than 100µA. If it is greater than a third of a milliamp, a slight readjustment of R2 is required.

If it is desired that the device be operated by early morning daylight, an optimum position in the bedroom for the switching device photoconductive cell may be found experimentally. A little experience soon enables the manner in which the circuit operates to be evaluated.

Fig. 3. If the switch is used to control a relay, a protective diode should be connected across the relay coil with the polarity shown here

OTHER APPLICATIONS

The switching circuit can be used as a light operated device for other applications. It can, for instance, turn on or off any other transistorised equipment drawing a maximum of 50mA at 9 volts. It may also be used to control a relay capable of energising at 9 volts and having a coil resistance of 180Ω or more. The relay coil should have a diode connected across it to prevent back-e.m.f. voltages being fed to the transistors when the relay de-energises, the diode being connected as shown in Fig. 3. The diode may be any silicon or germanium component having a p.i.v. greater than 9 volts, and it must be connected with correct polarity or excessive current will flow when initially switching on. Although not essential, it might be of advantage to fit TR1 with a small heat sink if the circuit is used with relay coils having coil resistances lower than, say, 250Ω. A small heat sink such as the Henry's Radio type H2 would be quite adequate. TR1 does not need a heat sink when the circuit is used with a transistor radio.

If it is required to have the circuit discriminate between two light levels of closely similar intensity, it may prove helpful to experimentally reduce the value of R1, the lower limit for this resistor being of the order of 200kΩ. However, this modification may require much more careful siting of PC1 in relation to the light sources than is necessary for the general applications for which the circuit was originally intended. As it stands, the switching circuit offers reliable and non-critical operation for the transition from light to dark, or vice versa, where the two states can be clearly differentiated. ■

KNIGHT KG.795 SOLID-STATE STEREO F.M. RECEIVER

Tuning the Knight KG-795 Solid State Stereo FM receiver tuner. This attractive set is one of many which can be easily assembled from the wide range of "Knight-Kit" construction kits now being marketed in the UK and Europe exclusively by Electroniques (prop STC Ltd.) Easily built in four hours by anyone, regardless of their technical knowledge, the KG-795 utilises the latest electronic devices and circuit techniques (including silicon semiconductors and a built-in automatic multiplex decoder) and is suitable for receiving the stereophonic broadcasting services of the BBC.

NEWS . . . AND . .

FOR TWO-METRE ENTHUSIASTS

The Hallicrafter CRX 102 in use

Now joining the Hallicrafter CRX 101 pocket-size solid-state aviation frequency receiver already available from Electroniques is the companion model CRX 102.

Hallicrafters' CRX 102 ranges from 144 to 174 Mc/s (the high-band). It tunes to the two-metre amateur band, business radio and utilities.

Like the CRX 101, it features a superheterodyne circuit with three I.F. stages and five tuned circuits. It receives both A.M. and F.M. An R.F. stage boosts sensitivity and push-pull class B amplification combines high efficiency and power with long battery life (standard 9 volt battery).

Automatic gain control, telescopic aerial, provision for external aerial and earphones are other features of this typically high quality Hallicrafters' product.

External dimensions of the CRX 101 and 102 are identical and either model slips easily into the pocket.

Price of the CRX 102, like the 101, is £17 9s. 6d., plus 7s. 6d. postage. From: Electroniques, Edinburgh Way, Harlow, Essex. (Harlow 26777).

INTERNATIONAL DX PARLIAMENT 1969

June 13th–15th, Halmstad, Sweden.

All Dx-ers and representatives from amateur radio stations throughout the radio world are invited to take part in the 1969 International Dx-Parliament.

The Dx-Parliament originally was the annual meeting of *Dx-Alliansen*, the organisation to which the Swedish Dx-Clubs are affiliated. Now this is only one organisation among many.

The idea behind the International Dx-Parliament is to make it possible for Dx-ers and radio amateurs to meet and to discuss common problems. This year there will, for example, be: an International Panel, a Technical Conference and an exhibition of equipment for Dx-ers.

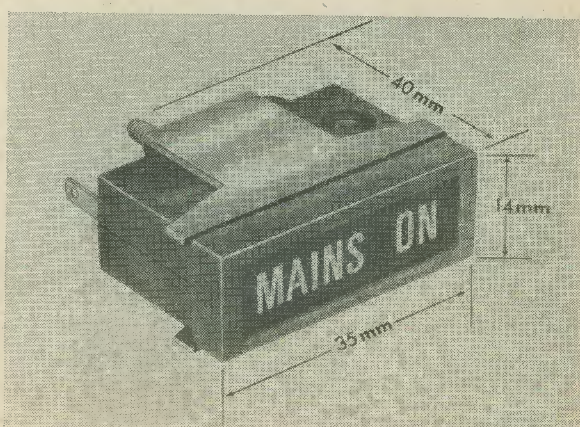
Halmstad Shortwave Club is this year responsible for the International Dx-Parliament.

For further information please write to: Halmstad Shortwave Club, Box 15, S-30102 Halmstad, Sweden.

BULGIN MINIATURE MAINS LEGENDED INDICATOR

Incorporating a brilliant glow neon lamp, this miniature indicator offers many original features:

Direct mains operation 200-250V, very low power consumption (1 watt approx.), negligible operating temperature rise, modern, attractive appearance. Instrinsically safe plastic construction, choice of colours, connections by 110 series push-on tags equally suitable for direct soldering. Clear, easy to read legends carried out to individual customers requirements. Two styles of legend, black characters on lit amber background, or lit amber characters on black background (secret until lit), even field illumination. Easy to fit simple rectangular panel cut-out (1.32in. x 0.512in.), efficient, positive, rear panel clamp, giving concealed fixing. Pilfer proof from front of panel. May be fitted to panel in groups (either horizontally or vertically) in a single rectangular panel cut-out, miniature size and weight. Panel area only $1\frac{3}{8}$in x 9/16in. Front of panel projection only 13/64in. Weight (17 grams approx.)



INTERNATIONAL LONDON ELECTRONIC COMPONENT SHOW

Significant technological and economic expansion is pin-pointed by the International London Electronic Component Show opening at Olympia on May 20th to 23rd, 1969.

It is the biggest show of its kind yet held and, the twenty-first of the series sponsored by the Radio and Electronic Component Manufacturers' Federation, it has "gone international" for the first time. The Component Show is held every two years, and there are 436 exhibitors—40% up on the previous exhibition.

The exhibition opens on a wave of production and export optimism.

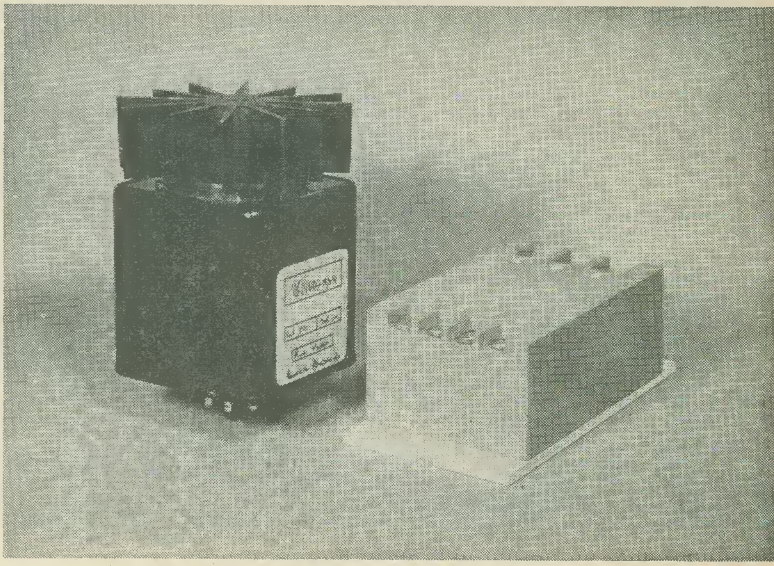
Although official figures are not yet available, estimates suggest that production, at around £225 million a year, has increased by more than 12% in the twelve months under review.

Exports are expected to reach the £75 million mark, some 20% greater than the 62.5 million of 1967. There has, however, been an upward swing in imports which is expected to reduce the favourable balance. Largest imports have been in the semiconductor and integrated circuit fields and will probably be reduced as British production expands.

The component manufacturers form the backbone of the electronics industry and the Olympia exhibition shows that significant progress has been made in all sectors. Passive and active components have been improved in performance and reliability while the precision required by modern standards has in general been achieved without comparable cost increases. Integrated circuits are becoming more realistic in price as production processes improve and give better yields.

On the instrument side, the greater accuracy and sensitivity to meet today's production and quality control standards have been achieved without undue operating complication and, again, without outstanding cost increases. Simplification is the general key-note of the instruments shown; much of the highly sophisticated test gear is completely automatic.

FULLY SOLID-STATE A.C. SWITCH



Left—Plug-in URY (on an International Octal base)
Right—Base-mounting URY

This *fully solid-state* a.c. switch (URY) has a sensitive and completely isolated gate circuit which will operate on *any* input potential from 100mV to 250V d.c. or r.m.s. a.c. at frequencies up to 1000c/s, regardless of polarity or phase angle relative to the load supply. The flexibility of the gate circuit gives complete freedom of choice of gating signals—from mains to micrologic.

There are four basic URY models, for load currents of 2A, 5A, 10A and 15A, and each is available in three load-supply ratings (25V to 60V, 40V to 120V, and 80V to 250V, all r.m.s. ac.). Also, each version is available as either a normally open switch or a normally closed switch.

All models have very high surge-current ratings (225A for the 15A device, for example) and are fitted with dv/dt suppression components for inductive loads. The use of triac output devices gives inherent protection against transients.

The URY is housed in a robust resin-filled case, with screw terminals, and incorporates an electrically isolated aluminium back-plate which serves as both mounting-plate and heat-sink for currents up to 5A.

All 2A and 5A models are also available in plug-in form (on an International Octal base).

The loads switched may be resistive, or inductive with power-factors down to 0.006, and the high peak-current ratings of the devices enable them to be used to switch full rated loads of tungsten lamps. The isolation between input and output is greater than 20MΩ at 500V d.c.

Descriptive leaflets are available from: New Products Department, Darpan Controls Limited, Bridge Mills, Derby Road, Long Eaton, Nottingham, NG10 4QA.

LOW-NOISE PRE-AMPLIFIER

by

S. P. NAREY

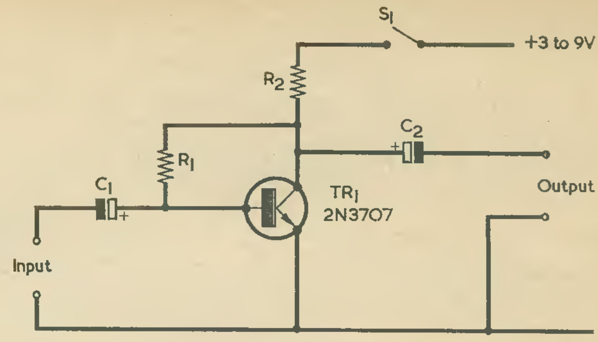


Fig. 1. The circuit of the low-noise pre-amplifier

It is always worthwhile returning to first principles from time to time, and the a.f. pre-amplifier described here could hardly be simpler in circuit design. Yet it can carry out a number of useful functions very successfully, as the author explains.

COMPONENTS

Resistors
(Both resistors are $\frac{1}{8}$ watt 10% hi-stab.)
R1 1.5MΩ
R2 18kΩ

Capacitors
C1 50μF electrolytic, 6V wkg.
C2 4μF electrolytic, 9V wkg.

Transistor
TR1 2N3707

Switch
S1 s.p.s.t. on-off switch

THE VERY SIMPLE A.F. PRE-AMPLIFIER DESCRIBED IN this article can be made small enough to fit inside the larger type of microphone, this being the author's initial reason for building it. In his case the pre-amplifier was fitted to a ribbon microphone amplifying the very low output available after its built-in transformer. The pre-amplifier, battery and on-off switch were all contained in the microphone housing.

Other applications for the pre-amplifier have consisted of amplifying the output from a 15Ω loudspeaker used as a microphone so that it could be fed to a main amplifier, amplifying the output of a crystal receiver used as a tuner, and amplifying the output from a "search coil" about 3ft. in diameter used for picking up atmospheric disturbances (as would be given, for instance, by distant thunderstorms).

The voltage gain of the prototype with 9 volts supply was about 80 times. Current consumption is very low, being much less than 0.5mA at 9 volts.

CIRCUIT AND CONSTRUCTION

The circuit is given in Fig. 1. The transistor specified is a 2N3707, this being employed in the prototype, but it is probable that most high gain low-noise silicon n.p.n. transistors would function equally well. The input impedance is suitable for low and medium impedance microphones. With the 4μF capacitor in the output circuit, the pre-amplifier should not be fed into an impedance of less than 1kΩ to avoid loss of bass. As is to be expected with a simple circuit configuration of this nature, the frequency response is flat from 40c/s to 18kc/s.

Construction may take up any form. Fig. 2 shows a layout in which all the components except the on-off switch are mounted on a small piece of Veroboard. If board with 0.15 in hole spacing is used, its outside dimensions are slightly less than $\frac{1}{2}$ by 1in.

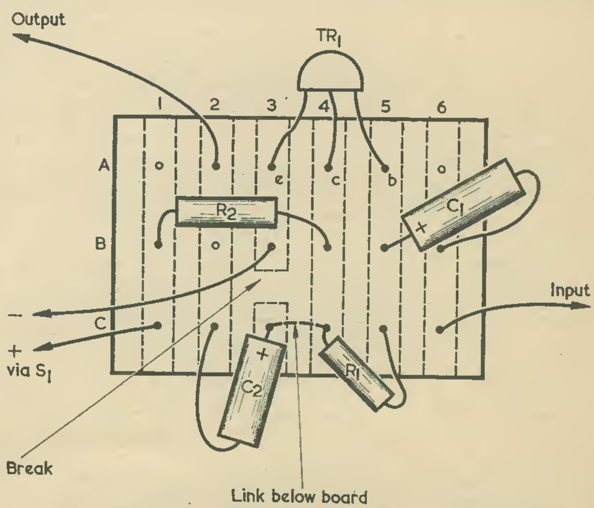


Fig. 2. The components mounted on a small piece of Veroboard. In this view the copper strips are underneath the board and the components above

Even small dimensions are given if Veroboard with an 0.1 in matrix is used. The capacitors should be sub-miniature types.

Fig. 2 shows the component side of the board with the copper strips underneath. For ease of presentation, C1, C2 and R1 are shown "splayed out"; these components should in practice be mounted vertically. Copper strip 3 is broken between holes B3 and C3. Also, the lower ends of strips 3 and 4 are joined together by a bare wire link under the board.

An alternative method of construction would consist of assembling the components on a small tagstrip. A tagstrip with one tag earthed and five tags insulated would take all the component connections required by the pre-amplifier circuit.

■

JOHN CLARRICOATS — G6CL

A PERSONAL APPRECIATION

Just as we went to press with our last issue, we heard the sad news of the death of John Clarricoats, G6CL, who was for over 30 years Secretary of The Radio Society of Great Britain.

It was then only possible to publish a brief obituary notice; we therefore take this opportunity to publish a personal appreciation by one who knew him well in his great work for Amateur Radio.

It seemed particularly appropriate that one should have heard of the death of John Clarricoats, G6CL, "over the air" as his name will surely go down in the history of Amateur Radio as one of its founders. Technically, Amateur Radio no doubt owes much to earlier enthusiasts than John Clarricoats, but no one can deny that the organisation of Amateur Radio in this country, indeed also in Europe, was almost entirely conceived and carried out by G6CL over a long period of time stretching back, as far as the writer is concerned, to the very beginnings of Amateur Radio. As far back as he can remember, 'Clarry and his little black book' were the focal point of any Amateur Radio gathering whether convened on a national basis or at an official local meeting, by the Radio Society of Great Britain.

Others will no doubt recall, whilst paying tribute to this great personality, the details of his activities in relation to the growth of the RSGB, his work during the war in spheres which his special knowledge of Amateur Radio particularly befitted him, and more recently his great work in building up Region 1 of the International Amateur Radio Union.

Amateur Radio came early in the writer's life, and it was as an enthusiastic youngster that he attended his first official regional meeting where 'Clarry and his little black book' enthralled a small but devoted assembly with news and views of the progress of Amateur Radio — then quite a 'rare' hobby. It was an impressive performance, as indeed were all Clarry's public appearances, we all went away inspired and full of confidence in the ability of Clarry to direct our affairs soundly for us.

John Clarricoats was probably at his best, and certainly enjoyed most, organising and running Region 1 of the IARU. The writer, having attended several of the Congresses he organised in various cities of Europe can, from personal experience, testify to the exceptionally high standard of administration and efficiency with which he conducted these, by no means easy, conferences. For his initiative and organising ability, Amateur Radio in Europe owes a great debt of gratitude to John Clarricoats for these conferences, as they cemented together into one powerful body most of the national radio societies in Region 1. Individually these societies could have done little to protect the interests of Amateur Radio in the scramble for frequency allocations by the professional and commercial interests at these top level, worldwide, telecommunications conferences.

John Clarricoats will be sadly missed, not only by his personal friends and relations, but by many who found his advice of value and his great experience a guide in difficult circumstances. At a time when judgement based on knowledge born of wide experience seems so sadly lacking in international affairs, be they for the well being and future success of a hobby such as Amateur Radio, or in the wider sphere of human relationships between nations as a whole, John Clarricoats will be missed as a great elder statesman of Amateur Radio.

For the writer, John Clarricoats will be remembered as one of those great personalities it was a rare experience to have known, an experience which unfortunately comes to one all to infrequently in life.

A. C. Gee, G2UK.

The funeral of John Clarricoats took place on Friday 14th March in Christ Church, the large and beautiful Southgate Parish Church. There were representatives of many organisations present, including the Radio Society of Great Britain, and every seat was occupied.

As we listened to the address given by the Bishop of Willesden, in which reference was made to the long years of service given by John Clarricoats to the community, we realised afresh how fortunate the Radio Society had been in having at the helm for so long one of such acumen, energy and organisional experience.

The funeral service was followed by private cremation.

■

MODIFYING THE "SPONTAFLEX" CIRCUIT FOR SILICON TRANSISTORS

by

SIR DOUGLAS HALL, K.C.M.G., M.A. (Oxon)

Regular readers will recall the first "Spontaflex" design, which we published in 1964. In this article our contributor discusses modifications which enable the original receiver to incorporate silicon transistors and thereby offer an improved performance. Readers who have not seen the earlier article can still make up the modified receiver, since this is described in full and represents a constructional project in its own right. Only three low-cost transistors are required, and the set covers both the medium and long wave bands.

THE AUTHOR INTRODUCED HIS "Spontaflex" circuit to home constructors in the issue of this magazine for June 1964. It was originally described as the "Autoflex" until it was discovered that this name was used by a commercial firm for apparatus of their own. There must still be many receivers in use, built to one or other of the three variations described in the original article, and particularly to the basic 3-transistor design shown in Fig. 2 of the June 1964 copy. Indeed, the author is still receiving correspondence about receivers built round that circuit.

At that time high frequency silicon transistors were not readily available to home constructors, but the position is very different now, when high amplification v.h.f. silicon transistors can be bought for a few shillings. It is well worth while modifying the original basic 3-transistor "Spontaflex" and gaining the improved results which will follow. Improvement will be most noticeable at the high frequency end of the medium wave band.

The modified design which will now be discussed may also be followed by readers who did not build the original "Spontaflex" receiver, or who do not have access to the earlier issue of 1964. The circuit and constructional diagrams which are given in this article are for a complete receiver which may be built up as illustrated and described.

REVERSAL OF POLARITY

The silicon transistors now specified are n.p.n. devices, so that connections to the battery, the electrolytic capacitors and the diode will all need reversing. It is also necessary to modify the biasing arrangements as silicon transistors need a larger voltage between base and emitter than do their germanium cousins. In the original circuit about one third of the voltage at the emitter of TR3 was taken back to the base of TR1. In the modified version virtually the whole of the voltage is passed back, though a second electrolytic capacitor and resistor are used for decoupling purposes. See Fig. 1.

TR1 is a special type which produces high amplification at a very low collector current. It is therefore ideal for the "Spontaflex" circuit, and for medium and long waves it allows R1 to be raised to the high figure of 220kΩ, thus enabling both TR1 and TR2 to give increased amplification. For short waves, the value of R1 may well have to be lowered.

The three transistors employed in the prototype were obtained from Amatronix, Ltd. No connection is made to the primary centre-tap of T1.

FRAME AERIAL

It may be found that the increased sensitivity will cause trouble with selectivity in some areas if the rather large frame aerials which have previously been described are used. The author has made up a receiver using a frame aerial with 5½in sides, made of four pieces of ¼in plywood, two pieces measuring 6in by 2in and two pieces 5in by 2in. The longer pieces are pinned to the ends of the shorter pieces such that there is an overlap of ¼in at each corner. This makes it possible for slots to be cut to keep the windings in position.

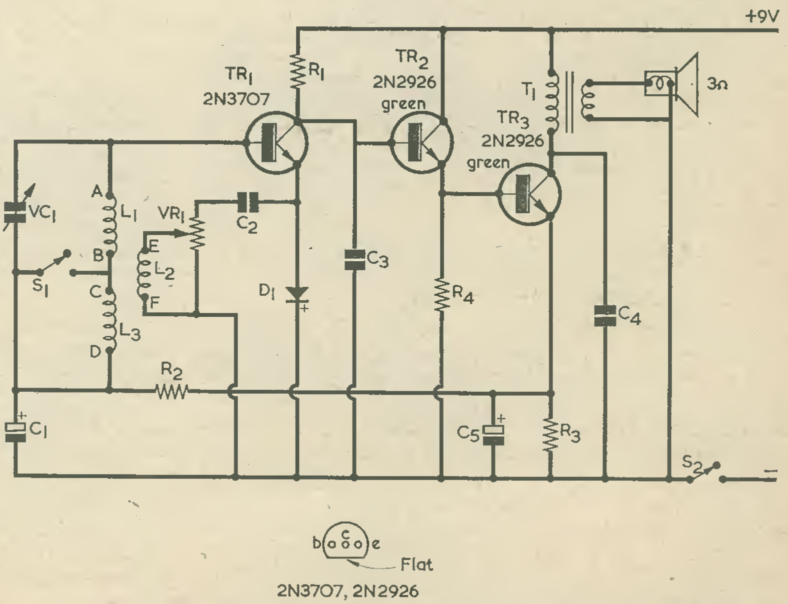


Fig. 1. Theoretical circuit of the modified Spontaflex receiver

The top of the frame aerial assembly is shown in Fig. 2. Fig. 3 illustrates the construction of a prototype receiver using the new transistors and it will be seen that the controls are fitted to the top piece of plywood in the frame aerial assembly, and that the remaining components are mounted on the inside of one of the sides of the assembly.

To make up the frame aerial, 6 slots are first cut in the plywood edges for L1, the first slot being 1/10in in from the edge, and each subsequent slot 1/10in from its neighbour. 5 turns of 32 s.w.g. enamelled wire are wound in each slot, making a continuous winding of 30 turns. L2 is in a single slot, 1/10in from L1 and consists of 5 turns of similar wire. There is then a gap of about ¾in after which 3 slots, also spaced at 1/10in intervals, are provided for L3, which consists of a total of 75 turns—25 turns per slot—of 36 or 38 s.w.g. enamelled wire. There is sufficient room between L2 and L3

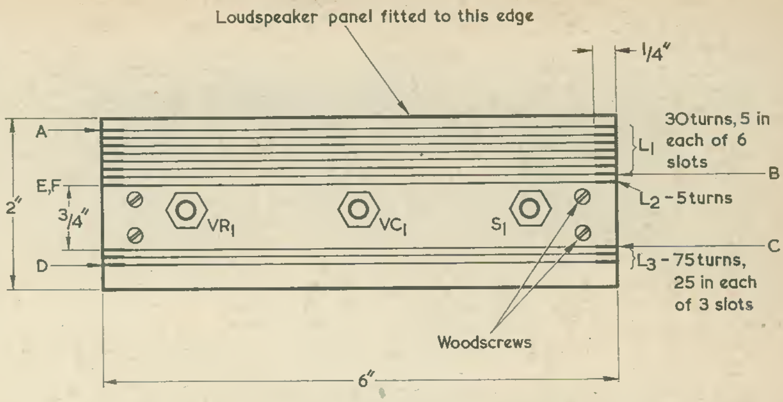


Fig. 2. Top view of the frame aerial assembly, giving details of the windings and control positioning

for the spindles and locking nuts of VR1, VC1 and S1 to be fitted so that these components take up the positions shown.

Required in the two side pieces of the frame aerial assembly are holes to allow wire ends A to F to pass through. The heights of these holes are indicated in Fig. 3 and they appear vertically below the points indicated as A to F in Fig. 2. All coils are wound in the same direction. It will be noted that L1 and L2 cannot have exactly the quantity of turns stipulated, as the holes for wire ends B and C are on the opposite side of the assembly to those for A and D. According to the direction of winding, L1 may have about a quarter-turn in excess and L3 a quarter-turn too little or vice-versa. This slight discrepancy is not important. The frame aerial wires passing through the holes may be held in position with small wedges of wood, or they may be secured with adhesive.

There is plenty of room for a

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)
- R1 220kΩ
- R2 2.2kΩ
- R3 68Ω
- R4 1kΩ
- VR1 5kΩ pot. linear, with S2

Capacitors
- C1 100μF electrolytic, 6V wkg.
- C2 0.01μF
- C3 1,000pF
- C4 0.1μF
- C5 100μF electrolytic, 6V wkg.
- VC1 500pF variable, solid dielectric

Inductors
- L1, L2, L3 See text
- T1 Output transformer type LT700 (Eagle)

Semiconductors
- TR1 2N3707
- TR2 2N2926 Green
- TR3 2N2926 Green
- D1 OA81

Switches
- S1 s.p.s.t. rotary
- S2 s.p.s.t., combined with VR1

Miscellaneous
- 3Ω speaker
- 9-volt battery
- 3 knobs
- Wire for frame aerial (see text)

Plywood, 7-way tagstrip, etc.

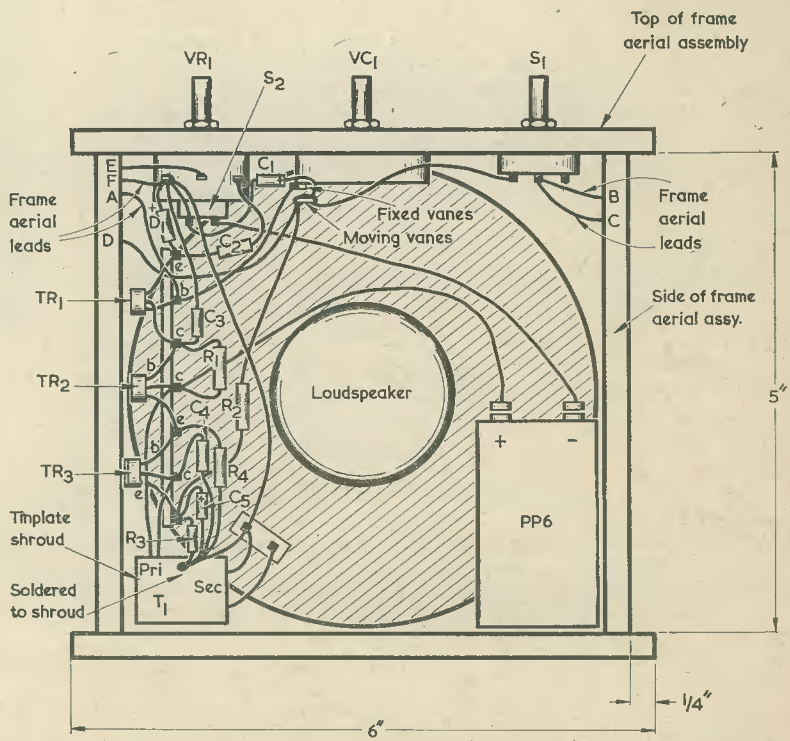


Fig. 3. Component layout and wiring of the prototype receiver

5in round loudspeaker, which is fitted to a panel affixed to one edge of the frame aerial assembly. This panel, requires, of course, a suitable aperture for the front of the speaker. Adequate space is available, also, for a PP6 battery. In fact the prototype uses two of these in parallel for economy during heavy use. If this is done it is important that both batteries should be fitted at the same time. It is not wise to connect an old and a new battery in parallel. As a final point, it is a good plan to fit the controls and other components before the windings are put on the frame as damage is then less likely to occur.

Since TR1 has lower internal capacitances than the MAT101 which it replaces it will be found that the minimum wavelength covered is lower than before. The lower the self-capacitance of the frame aerial used, the more noticeable will the effect be. If an earlier receiver is modified it may be necessary to add a few turns to L1 in order to cover the medium waveband. It will probably be unnecessary to modify the long wave band winding as its high self-capacitance will mask the effect of the lower internal capacitances of TR1.

As already stated, Figs. 2 and 3 show the frame arrangements and layout of the new prototype. There is a possibility of low frequency instability resulting from interaction between T1 and the frame aerial—particularly the long wave winding—and it is a wise precaution to cover T1 with a shroud of tin plate, soldering the edges and passing the leads, which should be covered with sleeving, through small holes. If instability or distortion persists, try removing C4 and replacing it with a smaller capacitor, of about 2,000pF, between TR3 collector and base. Reversing the connections to the primary of T1 may also help.

Apart from the possibility of instability just mentioned, the receiver is very fool-proof and reliable, and will be found surprisingly sensitive. ■

HOME RADIO (COMPONENTS) LTD. 1969 CATALOGUE

The 5th edition of the Home Radio (Components) Ltd. catalogue is now available to readers. Many sections of this well known and lavishly produced catalogue have been completely revised, brought up to date, many new items added and additional popular items illustrated. Amongst the new items listed are such components as heavy duty wirewound potentiometers, electric light switches, socket and plugs. Some other items have been added at customers' requests.

The price of the catalogue has been constant since 1965 (7/6d.) but with increasing present-day charges it has been raised to 8/6d. but still represents good value for money. To offset the additional charge, Home Radio have included one extra shilling bonus coupon. Additionally, cash customers with orders exceeding £10 will receive their goods carriage (or post) free — bringing them into line with credit customers. The new catalogue has been increased in size by a total of 72 pages, the catalogue now comprising a total of 330 pages, approximately $7\frac{1}{4}$ x $9\frac{3}{4}$in., printed on good quality paper and bound within a durable plastic-faced cover. A total of 8,000 items are listed and the catalogue features 1,500 illustrations. Also included within the covers is a separate 30 page price supplement and useful bookmark. The whole work is extensively indexed.

This latest edition of the Home Radio catalogue can be obtained from Home Radio (Components) Ltd., 234-240 London Road, Mitcham, CR4 2YQ and the cost, post paid, is 12/-.

ENGLISH ELECTRIC VALVE PUBLICATIONS

Currently available from English Electric Valve Company are two new publications, "Voltage Stabilisers and Reference Tubes" and "1969 Equivalents Index". The first of these is a 4-page leaflet which gives condensed data for the full range of stabilisers and reference tubes made by EEV. On the back cover is an equivalents list covering nearly 100 types. The "1969 Equivalents Index" is a reference booklet listing nearly 2,000 special electronic valves and tubes for which an equivalent EEV type is made. The Index includes Service type numbers, and will be particularly useful to buyers and service engineers who need to quickly determine equivalent valve types for replacement purposes.

A copy of either or both of these publications will be sent to any reader of *The Radio Constructor* who writes to English Electric Valve Company Ltd., Chelmsford, Essex.

CREATING A THREE-BAND TRAPPED DIPOLE

by

A. S. CARPENTER, G3TYJ

Our contributor gives details of a very successful trapped dipole which offers an excellent performance on the 15, 20 and 40 metre bands. Particular emphasis is placed on the procedure employed for setting up the traps and aerial section lengths.

ALTHOUGH INTENDED MAINLY for transmitting enthusiasts the information given in this article can also materially assist SWL's who like searching for Dx on the h.f. bands; and of course many SWL's will themselves have call-signs of their own one day!

For the benefit of the uninitiated, '40', '20' and '15' are three very popular amateur bands. These rather crude designations are more closely defined in terms of frequency as:

'40' = 7–7.1 Mc/s
'20' = 14–14.35 Mc/s
'15' = 21–21.45 Mc/s

The approximate length of a half-wave dipole for a particular band can be found from the simple formula:

$$\text{Length} = \frac{468}{f} \text{ feet}$$

where f is in Mc/s. A normal half-wave dipole for the 40 metre amateur band would thus be approximately 67ft in length.

MULTI-BAND AERIALS

Although the use of an aerial designed specifically for the frequency band in use may be an ideal, at most locations space for aerial erection is limited. The average operator is thus forced to make a single aerial work effectively on more than one band. The problem is by no means a new one and from time to time designs for multi-band aerials appear in print.

The familiar 'long wire' or 'end-fed' wire is a popular multi-band aerial both widely and effectively employed, for it is easy to bring into use. Dipole aerials are also extremely popular and a multi-band type can be designed for six-band working; the popular 'G5RV Dipole' is one example.[1]

Six-band dipoles however require something like 100ft minimum of garden space and when this is not available the smaller three-band dipole to be described may prove a more practical proposition.

It is well known that a half-wave

1. A description of the "G5RV Dipole" is given in "The Amateur Radio Handbook", third edition, published by the Radio Society of Great Britain.—Editor.

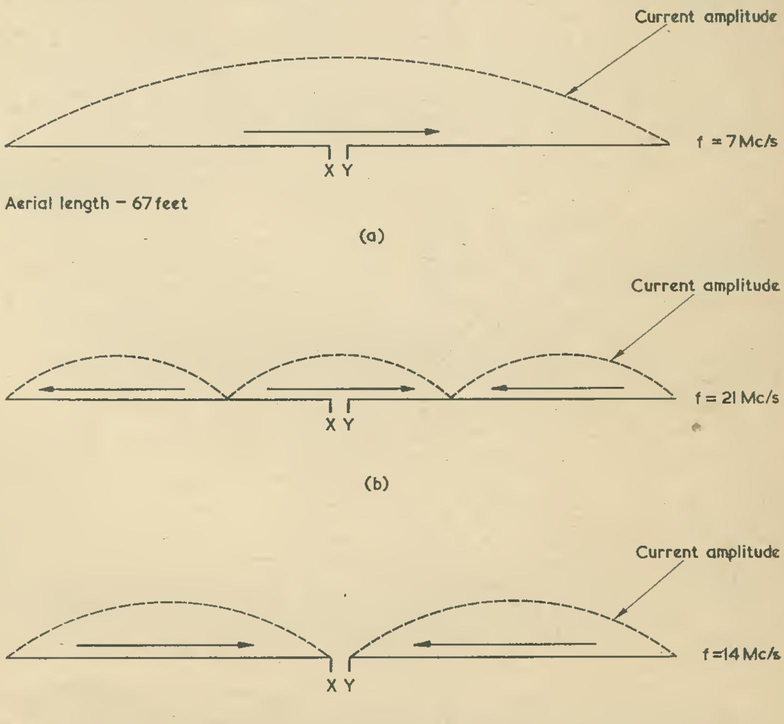


Fig. 1. Current distribution in a 67ft. aerial at (a) 7Mc/s, (b) 21Mc/s and (c) 14Mc/s. The horizontal arrows indicate instantaneous direction of current flow

dipole cut for the 40 metre band also works well on 15 when the top is cut centrally and connected to 75Ω coaxial cable. Such a dipole works as a half-wave element on '40' but in harmonic mode on '15' for, as is seen in Figs. 1(a) and (b), points 'x' and 'y' are low impedance on both bands. A 40 metre dipole is also harmonically related to the 20 metre band but, as we see in Fig. 1(c), the impedance at points 'x' and 'y' is very high and 75Ω coaxial cable becomes an unsatisfactory feeder. To get over the problem, spaced and tuned feeders could be used but the more elegant method of incorporating frequency 'traps' into the top is preferred by the writer. Coaxial cable can then be used on all the three bands just mentioned.

Provided that certain conditions are fulfilled there can be little doubt that a symmetrical dipole does possess advantages over a simple end-fed wire and not the least of these is a smaller TVI risk.

Trapped dipoles are of course no new thing and a great many are in use at amateur stations. Some trapped dipoles are perhaps beyond the constructional skill of the average amateur but simple — and very efficient — versions can be 'home-brewed' fairly easily. A considerable amount of time has been spent by the writer in this particular activity lately—and with very good results to boot!

INSERTING 'INSULATORS'

Reconsidering Fig. 1(c) it is soon seen that points 'x' and 'y' would be at low impedance for 20 metre working if two insulators were inserted in the 67ft top, each spaced some 16ft 6in from the centre as is shown in Fig. 2. Unfortunately such an aerial would immediately prove ineffective on the 15 and 40 metre bands for length 'L' would be no more than support wires for the central 20 metre dipole and would thus add nothing to the overall performance. Reasoning further we decide that what we *do* want is for the insulators to be 'in' when we are working on '20' but 'out' when we wish to operate on the other two bands. This could be done:

(1) *Physically*. By climbing up and down the pole as required or alternatively by raising and lowering the aerial.

(2) *Mechanically*. By fitting manually operated switches at points 'z'.

(3) *Electrically*. By fitting suitable trap assemblies (i.e. parallel tuned circuits resonant at about 14Mc/s) at points 'z'.

Obviously, the third alternative is the most attractive.

TRAP FREQUENCY

Since an L/C combination—and a trap assembly is just this—is a frequency-conscious item, use can be made of it as an automatic switch remotely tied to the transmitter. Traps tuned precisely to a desired portion of the 20 metre band and inserted in the 67ft top can be made to act effectively as insulators when this particular band is in use. In the test aerial—see Fig. 3—the traps T1 and T2 were each pre-resonated at 14.05Mc/s, the centre of the 20 metre c.w. segment (the writer's is a 95% c.w. station!) and the total wire length between the traps was also resonant at this frequency. Any signals fed to the aerial at 14.05Mc/s thus 'see' the opposition offered by the traps T1 and T2 as being great enough to virtually break up the top into a 20 metre dipole. The traps are also effective slightly to either side of their resonant frequency but may not be so over the complete bandwidth. Such traps can obviously be pre-tuned to any part of the band required in normal use.

When the transmitter is radiating on '40' the traps become ineffective, since the lower frequency signals 'see' little opposition from them; the 'L' sections can then contribute to the radiation and allow the total length of wire to perform as a dipole. On 15 metres, too, the whole top radiates in harmonic mode as a 1½ wave dipole.

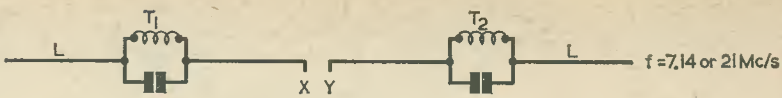


Fig. 3. Traps resonant at 14Mc/s can replace the insulators of Fig. 2

Clearly the inclusion of the traps cannot be ignored on '15'; and on '40' the familiar formula used to find the length of a half-wave dipole, viz:

$$\text{Length} = \frac{468}{7} \text{ ft.}$$

needs modification. It is thought simplest, however, to let '40' take 'pot luck' and to trim the top for '15' where dimensions may be more critical.

CONSTRUCTIONAL PROBLEMS

It can be said straight away that it is a waste of good operating time attempting either the construction of trap coils or trap dipoles without the requisite test equipment. This consists of a reliable grid-dip oscillator, together with a simple impedance bridge. An easily built impedance bridge will be described later.

Assuming that the required test gear is available the usual problem arises of where to obtain suitable materials for construction work. It must be remembered that the traps act as very high impedance points when the transmitter is radiating on '20' and the trap tuning capacitors will be subject to high r.f. voltages. What are described as 'high voltage tubular (pulse) ceramics' from the Radiospares range have been found quite suitable for use in trap assemblies, and a 68pF capacitor of this type is employed in each trap constructed by the writer. These capacitors are rated at 12kV, and are available from Home Radio (Components) Ltd., under Cat. No. C85. The capacitors are used as coarse tuning devices, final fine tuning being achieved by distorting an end turn of the coil.

Suitable coil 'formers' and containers that will protect the coils against the usual summer rains can be obtained from modern plastic drain piping which is available in a variety of diameters. Oddments of such pipings are not too difficult to obtain and two 6in lengths that will fit neatly within each other will be more than sufficient; the coils are of course wound on to the smaller diameter pieces.

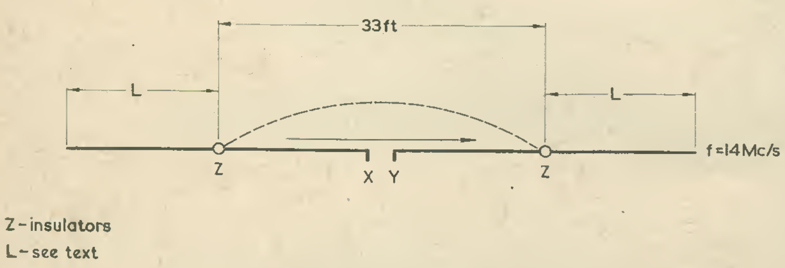


Fig. 2. If insulators are fitted at points 'z', a half-wave dipole for 14Mc/s is provided

However, better coil 'formers' can be made from rectangules of ⅛in thick Perspex with holes drilled equidistantly along the sides. The resulting two rows of holes can be made to take a pre-wound coil by 'spiralling' it along gently; the windings can then be locked with adhesive. The width of such a Perspex 'former' should be such that it fits firmly within the pipe securely at each end of the containers Perspex cheeks can be fastened securely at each end of the containers after allowing short lengths of wire to pass through for external connection purposes. Final strength and weatherproofing of the completed assemblies is afforded by the use of Bostik No. 2 adhesive. The constructional scheme is shown in Fig. 4, where the letter 'W' indicates the width of the Perspex. The tuning capacitors are located inside the coil, their lead-out wires being suitably sleeved.

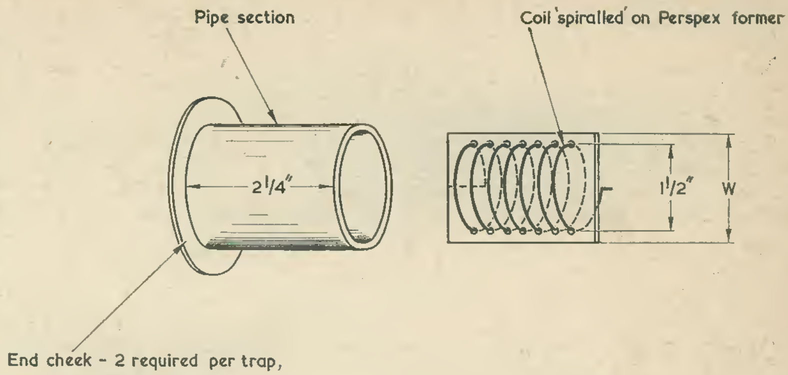


Fig. 4. Illustrating how a low-loss coil may be fitted to a Perspex 'former'

COIL WINDING

For 14Mc/s working, trap coils can be wound using 18 s.w.g. tinned copper wire. The number of turns required at a diameter of 1½in is about six, but since it is always easier to remove a turn than to add one, seven may be a better starting number. The turns should be spaced from each other by twice wire thickness and for each coil a 68pF capacitor of the type mentioned earlier is needed. The length/diameter ratio of each completed coil is such that it will confer a high 'Q' factor.

In the absence of sophisticated test equipment the 'goodness' of the coils can be assessed by noting the maximum distance away at which a g.d.o. can be situated and still give an indication. The two items will need to be quite close together for a poor coil but, say, approximately 12in apart in more favourable cases. This last figure depends upon the particular g.d.o., of course, and the constructor can judge results from his own experience with the instrument used.

The more finicky final tuning may be carried out by setting the station receiver to the required band frequency, adjusting the g.d.o. until its output is heard and then judiciously prodding each coil in turn until the required dip is observed in the g.d.o. Patience is required at this stage! If a coil insists on remaining 'low' in terms of frequency, removal of a turn may be required before peaking is possible.

THE BRIDGE

As was mentioned earlier, an impedance bridge and grid-dip oscillator are needed, and these simplify setting up considerably. The circuit of the 'home-brew' impedance bridge used by the writer is shown in Fig. 5, this being energised by the grid-dip oscillator. The bridge is built on a section of Paxolin sheet.

In constructing the device short wiring in conjunction with a careful layout must be aimed at, otherwise unwanted capacitances will be introduced. Carbon resistors are required and R2 and R3 should be closely matched. R1 equals the nominal line impedance, viz. 75Ω.

Inductor L1 is a two-turn 1in diameter pick-up coil, and this is mounted on an outside edge of the unit. In use the aerial lead-in is connected to socket SKT1 via a mating plug. When switch S1 is set to position '1' a full-scale deflection can be obtained in meter M1 when the associated grid-dip oscillator coil is brought close to L1. Moving the switch to position '2' connects the aerial, whereupon the bridge meter reading decreases by a certain amount. By tuning the g.d.o. greater changes can be observed on the bridge meter and when a zero reading is secured the bridge is balanced; inspection of the g.d.o. scale then reveals a resonance frequency.[2]

SETTING UP PROCEDURE

The finalised traps are each fitted with a 17ft 'tail' of copper wire at one end; these 'tails' are the outermost 'L' sections. A 2-terminal metal connector is then fitted to each remaining free 'inner' wire issuing from the traps, as illustrated in Fig. 6. Provision is also made for raising and lowering the aerial quickly and the usual rope and pulley arrangement at each end is most satisfactory. A reclaim rope at each end is also required since, otherwise, the lifting rope cannot be retrieved

2. R.F. chokes with a value of 1.1mH, as shown in Fig. 5, are not generally available, and the author states that a suitable alternative would be the tuned winding of a miniature iron-cored long wave coil. It is probable that a standard 1.5mH choke would also be suitable.—Editor.

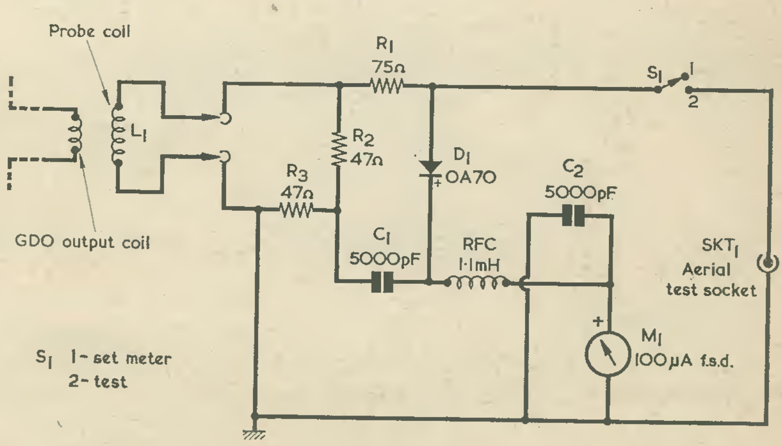


Fig. 5. Circuit of the home-constructed impedance bridge

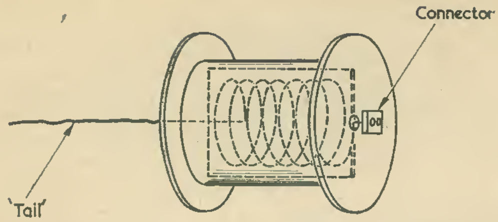


Fig. 6. How the 'tail' and inner connector are fitted to each trap

TRYING OUT THE TRAPPED DIPOLE

At this stage it is interesting to try out the aerial and it may be fed, as was the test model, via the usual low-pass filter, s.w.r. monitor and Z-match tuner, with the feeder leaving the aerial top at right angles to it for about 25ft before curving shack-wards.

A few preliminary QSO's soon pave the way for more extensive tests and give some indication of what to expect from what is after all a fairly simple system. With the writer's aerial, 'W' stations are QSO'd regularly on but 50W c.w.

Before the aerial is finally left to do its duty, short drip strings may be fitted on the 'L' sections close to the traps to carry off surplus water in bad weather. Thereafter it is but a case of seeking the comfort of the shack to relax knowing that 'out there' the traps are working for you—and they jolly well should do after all that hard work on your part!

from the pole top should the aerial wire break!

Initially the 20 metre section is prepared and this can be made 35ft overall, cut centrally and connected to 62ft of good quality air-spaced coaxial cable. A suitable method for connecting the coaxial cable to the feeder is shown in Fig. 7, this having the advantage that rainwater is less liable to enter the feeder. The feeder end is, of course, taped up after making the connections. The 20 metre section can be raised temporarily on its own—not necessarily to full height — and its resonant frequency found from the shack using the g.d.o. and impedance bridge arrangement just described. With the g.d.o. tuned around the 14Mc/s region it should be easy to obtain a 'zero'. If the frequency indicated is low—say 13Mc/s or so —all is well for it is then a simple enough matter to gradually prune back each end of the dipole until the desired frequency—14.05 Ms/c for example—is indicated.

The traps with their 'tails' are next fitted and the aerial again raised and checked from the shack. This time the g.d.o. should be tuned around the 21Mc/s region. If the system shows resonance lower than 21Mc/s all is in order for, leaving the central section untouched, the 'tails' may each be pruned back by a similar amount, an inch or so at a time, until the correct frequency is reached. It will be found that in this instance it is not possible to obtain an exact 'zero' reading in the bridge meter. This situation is correct, since the aerial is effectively $1\frac{1}{2}$ waves long on '15' and its feed-point impedance is slightly greater than 75Ω. The lowest possible reading should be sought, and will be fairly close to zero. The overall system should also be found to resonate around 7Mc/s although slight discrepancies here can be taken care of by use of a suitable aerial matching unit.

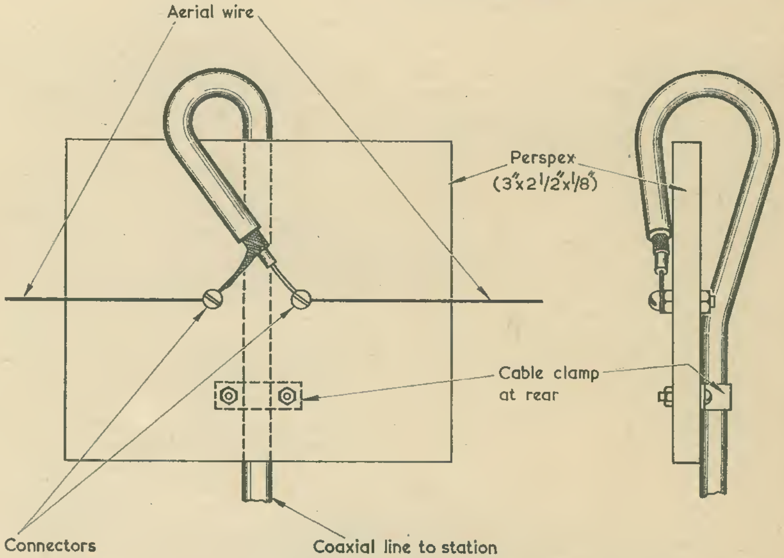


Fig. 7. A simple but effective method of coupling the coaxial cable to the aerial centre

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"DEVELOPING THE 'MINIFLEX' CIRCUIT"

We have recently been informed that the Colne Electric transformer specified for T2 in the receiver described under the above title in the July 1968 issue is not now available. A suitable alternative is the Repanco TT56. When the Repanco transformer is used, the negative terminal of C3 should be connected to the negative supply line instead of to the speaker, whereupon it appears directly across R1.

PRINCIPLES OF METAL DETECTION

PART 1

by F. L. THURSTON

This is the first of a 2-part series which deals with an application of electronics not normally encountered in the technical press. In the present article our contributor introduces the main types of metal locator then carries on to the beat-frequency metal detector

METAL DETECTORS, WHICH ARE BEST KNOWN IN the form of military mine detectors, come in a whole range of different shapes and sizes to suit all sorts of different applications. Some types are specially suited to finding small objects like coins at shallow depths, while others are intended for locating large objects, like pipes and cables, at depths of several feet. Most types can detect both ferrous and non-ferrous metals as well as 'magnetic' minerals (iron ores, etc.), and can be made to work on land or under water. Some types can even detect the presence of non-metalic objects like rock, bone, wood, plastic, etc.

Five different types of metal detector are in common use all of them working on slightly different principles and offering some particular advantage in terms of cost or performance.

BASIC PRINCIPLES

The basic principle of metal detection is very simple. All energised air-cored coils and antennas radiate a field pattern which, in normal circumstances, is stable and predictable. The field pattern is, however, inevitably changed when it interacts with any metallic or magnetic object, and may even be

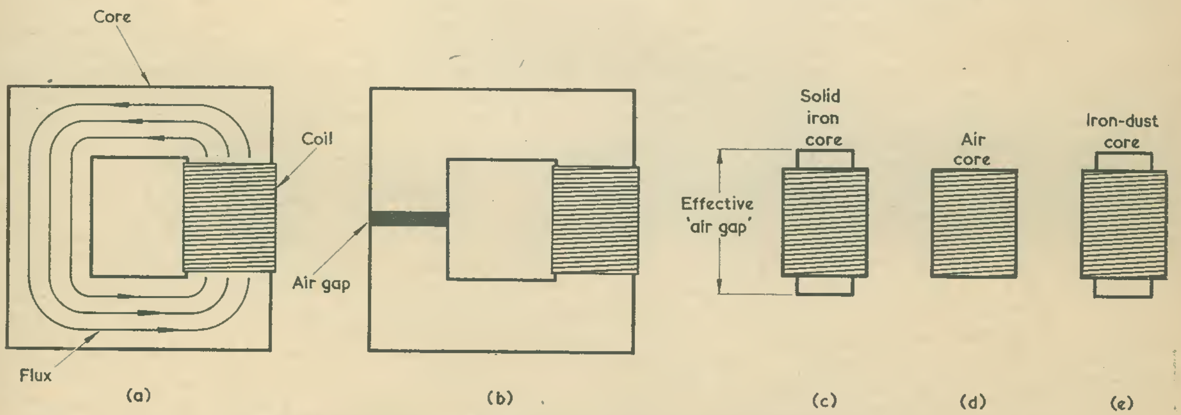


Fig. 1(a). If the continuous iron core shown here is laminated the coil exhibits a "very high" inductance, this falling to a "high" inductance if the core is solid iron
(b). An air gap reduces the inductance offered with either type of core
(c). The effective "air gap" with the solid iron core shown here is very large, and the inductance becomes "ultra-low"
(d). This air-cored coil has "very low" inductance
(e). Inserting an iron dust core raises the inductance to "low"

appreciably modified by non-metallic substances such as damp earth, large rocks, etc., if very high energising frequencies are used. Thus, the basic requirements for making a 'metal' detecting instrument are: (1), a field pattern generator or 'search head', and (2) a field pattern 'change' detector.

There are several different ways of detecting the change in field pattern, but all methods can be roughly broken down into three groups in the following manner.

Inductance Change. Any change in the field pattern of a coil due to the presence of a metallic object will almost inevitably result in a change in the inductance (and thus the impedance) of the coil, and this inductance change can be measured by direct or indirect methods.

Field Pattern Change. Any change in the field pattern of a coil or antenna inevitably results in a change in signal strength at different parts of the pattern. These changes in field strength can be detected by direct or indirect methods.

Reflected Energy. Any metal object placed in a field pattern absorbs energy from the field pattern generator and then re-radiates energy from itself. This re-radiated energy can be detected by direct means.

Of the three basic methods outlined above, the *Inductance Change* system calls for some additional explanation at this stage. When an air-cored coil is energised from a fixed-frequency alternating voltage source of low impedance and constant mean amplitude, a current flows in the coil and has a magnitude proportional to the coil's impedance or inductance. An alternating field is generated in the vicinity of the coil. If a piece of non-ferrous metal (i.e. brass, copper, silver, etc.) is placed within the coil's field an inductive coupling is set up between the metal 'target' and the coil, with the result that alternating currents are induced in the target and energy is absorbed by it. This energy is drawn from the coil, and must in turn be replaced by the coils a.c. energising source, so that a net increase results in the power fed to the coil. Now, since the frequency and mean voltage amplitude of the energising source are constant, this increase in power can only result from an increase in energising current, which in turn can only result from a fall in the inductance of the coil. Thus, the inductance of a coil falls when any non-ferrous conductor is placed within its field.

The case where ferrous (iron based) conductors appear in the field of the coil is slightly different. Here, currents are induced in the metal target and tend to result in a decrease in coil inductance, as with non-ferrous metals, but at the same time the high permeability of the ferrous target tends to intensify the flux density of the field and so increase the coil's inductance. Thus, two conflicting inductive reactions tend to take place. In practice, assuming that the target interacts with only *part* of the total field, the energy absorption factor predominates, with the net result that there is a decrease in coil inductance, as in the case of non-ferrous metals.

A newcomer to electronics, remembering that the iron core of a normal smoothing choke results in a considerable increase in the coil's inductance, may find the last paragraph rather puzzling. In this case, the situation may be made clearer by referring to Fig. 1. For convenience, we shall refer to the relative inductance offered by each of the coils of Fig. 1 in terms of 'high', 'medium', 'low', and so on.

Fig. 1(a) shows a normal iron-cored choke in which the core gives an uninterupted path for the flux; a laminated core is normally used to minimise eddy current losses, and choke inductance is 'very high.' If a *solid iron* core were used, losses will be large and the inductance will be merely 'high'. In Fig. 1(b) the path of the flux is broken by a small air gap, causing the inductance to fall to 'medium'; the larger the air gap, the lower the inductance. Fig. 1(c) shows the extreme case, where the effective air gap is of maximum dimensions and the core is made of solid iron. The core thus acts as a virtual short circuit to eddy currents and causes a decrease in inductance which outweighs any small increase that may tend to result from high flux density; coil inductance is 'ultra-low.' This inductance is even lower than in the case of an air cored coil (Fig. 1(d)), which can be described as being 'very low'. Finally, in Fig. 1(e) the core is of similar dimensions to that of Fig. 1(c), but is made of iron dust material so that only negligible currents can be induced in it. Thus there is an increase in inductance due to the resulting high flux density but no counteracting decrease due to power losses, the net result being that the inductance is 'low', but still slightly higher than in the case of an air-cored coil. Note that magnetic minerals such as iron ore have characteristics similar to iron dust, and also cause an increase in coil inductance.

Thus, the inductance of a coil inevitably decreases when a ferrous or non-ferrous metal conductor is moved into *part* of its field, but increases in the presence of a magnetic mineral. The magnitude of the inductance change depends on the size of the target and its position in the field.

BEAT-FREQUENCY LOCATORS

The simplest and best known type of metal detector is the *Beat-Frequency* type. Operation

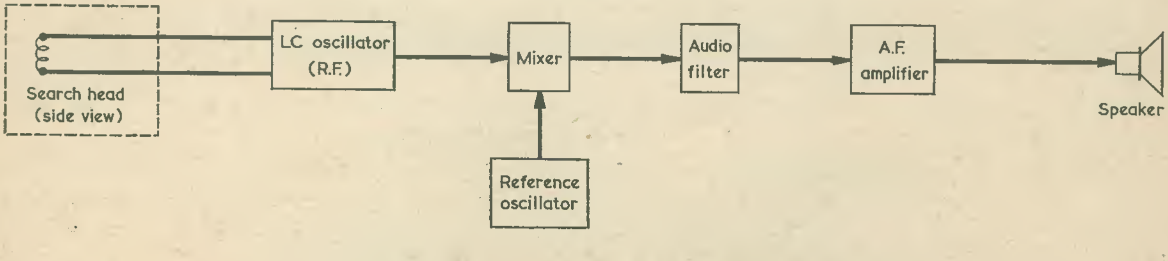


Fig. 2. Block diagram for the beat-frequency type of metal detector

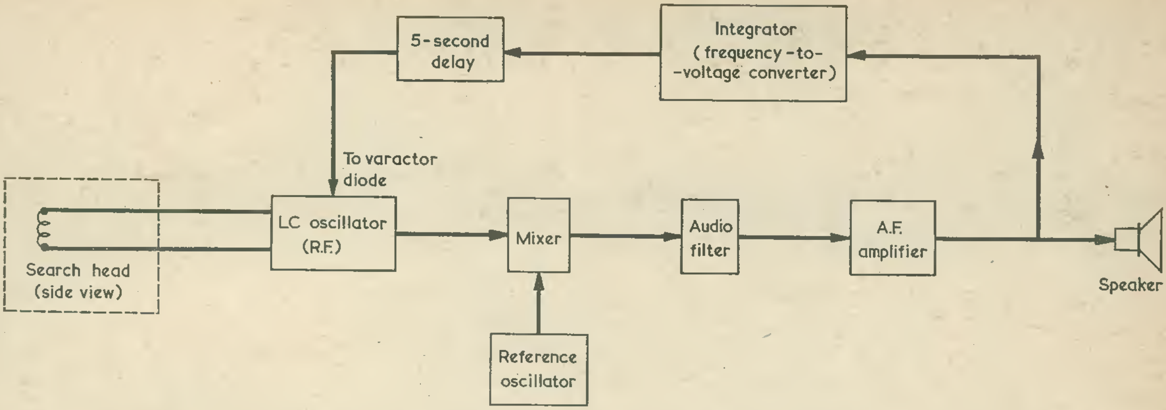


Fig. 3. A beat-frequency detector with automatic drift correction of the search frequency

depends on the inductance change caused in a search coil by the presence of a metal or mineral target. The block diagram of the locator is shown in Fig. 2. A large diameter air-cored coil is placed in a disc-shaped search head and forms part of the tuned circuit of an LC oscillator, so that changes in inductance are accompanied by changes in the search oscillator frequency. The output of this oscillator is mixed with that of a reference oscillator to produce an audio beat note that is fed to a speaker or earphones. Thus, a change in the search coil inductance causes a shift in search oscillator frequency, and a consequent change in the tone of the beat note.

In use, the frequency of one or other of the two oscillators is adjusted to give a low beat note in the speaker or earphones, and the search coil is then moved over the search area until a sudden change in beat tone is noted, indicating the presence of a target in the ground under the search head. In the presence of a metal target the beat note may either rise or fall, depending on which side of the search frequency the reference oscillator frequency appears. If frequency relationship is such that the beat note rises in the presence of a metal target, the beat note will fall in the presence of a magnetic mineral target. A reverse indication will be given for the opposite frequency relationship. Thus, this class of instrument can discriminate between metals and minerals.

The instrument can be built fairly easily and cheaply, is simple to use, and offers good target sensitivity (i.e., it can detect small objects, such as coins, at close range). On the other hand, its depth of penetration (maximum depth at which metal can be located) is usually limited to about 12in. It can be made to operate under water when suitably waterproofed.

DESIGN PROBLEMS

In spite of the apparent simplicity of the beat-frequency type of locator, a number of problems are involved in designing a unit to give really good results. Both oscillators must be very stable and free from drift, since a very small percentage drift in the operating frequency of either oscillator will give a very large change in the audio beat note.

The mixer stage must be carefully designed to ensure that the two oscillators do not pull and lock to each other, otherwise good low frequency beat notes will not be obtained and operation will become erratic. For the same reason, good supply line decoupling must be used between the two oscillators.

Another problem is that of overcoming the effects on operating frequency of the varying stray capacitance between the search coil and ground as the operator moves the search head around, possibly amongst long grass and under bushes. One way of minimising these effects is to use a very large value of fixed capacitance in the search oscillator tuned circuit. A better method is to screen the search coil with an electrostatic Faraday shield, which prevents external changes in capacitance having any effect on the actual capacitance of the tuned circuit (and thus on the operating frequency) but which still allows external objects to cause changes in coil inductance. The Faraday shield comprises a ring of copper tubing which encircles the coil windings and is earthed to the oscillator's supply line. It is split at one point so as not to completely screen the search coil. A practical example of the Faraday shield is given later in this article.

The metal detecting characteristics of the beat-frequency locator are primarily dictated by the physical dimensions of the search coil. The greater the coil diameter, the greater is the available depth of search field penetration, but the lower the unit's target sensitivity. It is possible to work to approximate relationships here with reasonable expectations of these being realised in practice; and it may be assumed that depth of penetration is about equal to the search coil diameter, whilst sensitivity (inductance change caused by a target) is roughly proportional to the cube of the target diameter (expressed as a function of search coil diameter) and inversely proportional to the 6th power of distance between the target and coil.

For example, using a 10in. diameter search coil and an operating frequency of 200kc/s, a 1in. diameter coin (i.e. one-tenth of search coil diameter) buried at a depth of 3in. may, hypothetically, produce a change in search coil inductance of one-thousandth part (= cube of relative target diameter).

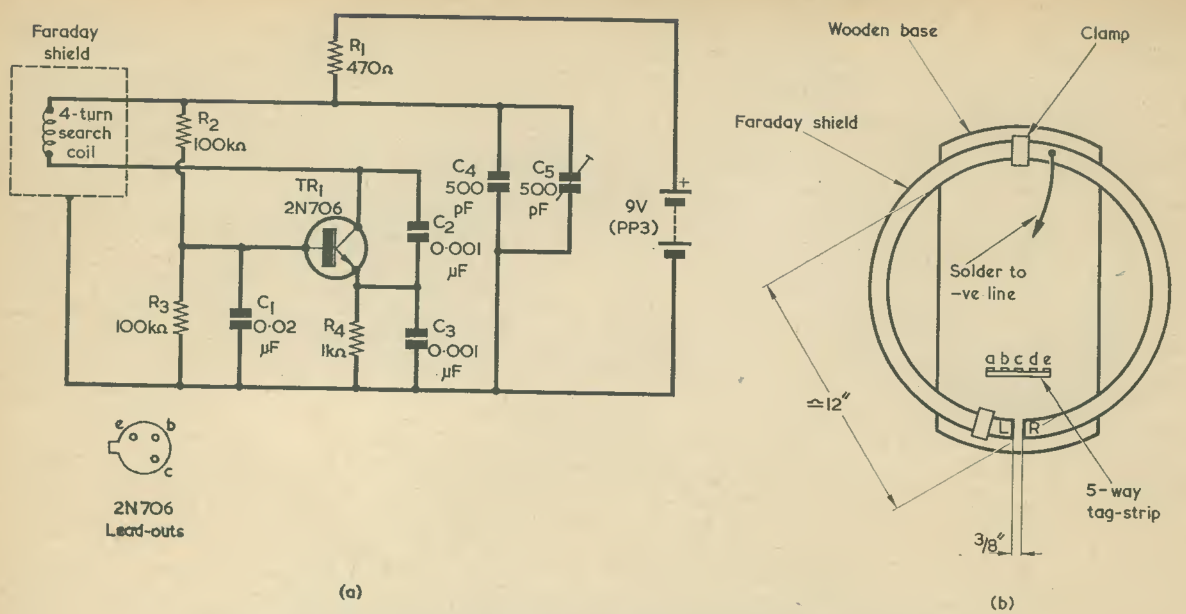


Fig. 4(a). An experimental metal locator which may be home-constructed. It works in conjunction with a medium and long wave portable radio receiver (b). How the search coil is made up

A ½in. diameter target at the same depth will produce an inductance change only ⅛ as great. If the 1in. coin were buried at a depth of 6in., rather than 3in., it would cause an inductance change only one-sixty-fourth as great as that of the 3in. deep coin, since the change is inversely proportional to the 6th power of object depth. A 4in. diameter target at a depth of 6in. will give the same inductance shift as a 1in. diameter target at 3in. depth. Objects buried deeper than about 10in. will be beyond the range of this instrument, and will produce no appreciable frequency change, irrespective of the target size.

If search coil diameter is doubled, to 20in., depth of penetration will increase accordingly, but target sensitivity will reduce to about ⅛ of that of the 10in. instrument.

This discussion assumes the use of a coil of circular form. In practice, a good deal of variation in coil shape is possible. An elliptical coil may, for example, result in a depth of penetration that approaches the maximum diameter of the coil, while at the same time giving a target sensitivity nearer that to be expected from the minimum diameter. Coil diameters of most practical instruments vary between about 6in. and 2ft. As may be gathered, there is field for experiment here, with experience on what may be achieved being obtained after practical observation with different coil sizes and shapes.

Target sensitivity is also affected by the choice of operating frequency used in the search head. Generally speaking, the higher the search frequency used the better will be the instrument's sensitivity, since (a) the effect on the search coil frequency due to a given metal target increases as the frequency increases, and (b) the higher the operating frequency used, the smaller becomes the percentage change in inductance needed to produce a given change in audio beat note. On the debit side, the higher the frequency used the more difficult it becomes to design the two oscillators with sufficient stability to keep beat note drift within acceptable limits, and also the greater becomes the effects of terrestrial attenuation or signal absorption.

Usually, the terrestrial absorption factor is not so significant as the other effects, so the general rule is to use the highest frequency possible, consistent with low beat frequency drift. The only main exception to this rule is given with locators designed to operate under salt water where, due to the highly conductive nature of the medium, the terrestrial absorption factor is important. Search frequencies here must be kept to a few tens of kc/s. Search frequencies of between 20kc/s and 2Mc/s are employed in most locators used on land or under fresh water.

A fairly common practice in low cost locators is to use a low search frequency (between 20kc/s and 200kc/s) but a high (500kc/s to 2Mc/s) reference oscillator frequency, a harmonic of the search oscillator then being mixed with that of the reference oscillator to produce the required beat note. If the 10th harmonic of a 50kc/s search oscillator is used to produce a beat note with a 500kc/s reference oscillator, a shift of 0.1% in search frequency (50c/s) will produce a change of 500c/s in the beat note, so good object sensitivity results and the system is of particular value when operating under salt water. The main advantage, however, is that, since a large number of fairly closed spaced search harmonics are available, the reference oscillator frequency can be very casually chosen, and search harmonics may even be picked up at several points on a medium-wave receiver fitted with a b.f.o.

A recent development in beat-frequency locator design is shown in block diagram form in Fig. 3. Here, the circuit of the metal detector is fairly conventional except that part of the output of the a.f. amplifier is fed to an integrator which produces a d.c. voltage that is proportional to the beat frequency. This voltage is then fed back via a 5 second delay circuit to a varactor diode in the search oscillator tuned circuit, so that any slow drift of this oscillator is automatically corrected, by delayed a.f.c. action, to produce a constant beat note. Slow changes in search coil inductance, due to remanent magnetism of different soils, are also balanced out by this system. Fairly rapid changes in inductance and frequency are not damped, however, due to the 5 second delay circuit, so that metal detection can take place in the normal way. The reference oscillator is crystal stabilised. This technique allows search frequencies of a few Mc/s to be used with excellent stability, enabling both good depth penetration and very high target sensitivity to be obtained with the aid of a large diameter search coil.

AN EXPERIMENTER'S METAL LOCATOR

Readers wishing to conduct simple experiments with the beat-frequency type of locator may find the practical circuit of Fig. 4(a) of interest. Only a 1-transistor search oscillator circuit is involved, a normal medium or long-wave portable receiver being used as a beat detector. A Faraday shield is used to minimise the effects of stray capacitance. Sensitivity is good enough to locate coins the size of a penny at depths of 4in., and the maximum depth of penetration is about 14in. The whole unit can be built at quite low cost and without any great expenditure in time.

Fig. 4(b) shows the essential constructional details of the search head and the Faraday shield. Construction should proceed as follows: Cut a section of ⅜in. outside diameter copper tubing to a length of 39in., and then thread four 50in. lengths of insulated household flex through the tube. The individual lengths of flex should be identifiable, either by colour coding or with the aid of an ohmmeter, and will be referred to by the numbers 1 to 4. With equal lengths of flex hanging from each end of the copper tubing, bend this into a neat ring of approximately 12in. inside diameter, and then make up a wooden base plate roughly to the shape shown in Fig. 4(b). Secure the copper ring (which forms the Faraday shield) to it with the aid of three clamps, taking care to leave a gap of ⅜in. between the ends of the ring.

Referring to the two ends of the rings as L (left) and R (right) respectively, mount a 5-way tag strip on the base plate and indentify the tags as "a" to "e" from left to right. Solder wire end 1L to tag "a", 1R and 2L to "b", 2R and 3L to "c", 3R and 4L to "d", and 4R to "e", trimming off excess wire in each case as necessary. This completes assembly of the 4-turn search coil.

Next, wire up the rest of the circuit on a small panel according to Fig 4(a), and then secure the panel and a 9 volt PP3 type battery to the base plate. Connect the junction of R1 and R2 to tag "a" and connect TR1 collector to tag "e". Solder a connection from the negative supply line to the centre of the Faraday shield. Finally, secure a wooden handle, mounted at an angle of about 45°, to the centre of the base plate, and this completes the assembly of the unit.

To use the metal detector, place a portable long or medium wave receiver within several feet of the search head and tune to a moderately strong broadcast station. Then adjust C5 of Fig. 4(a) until a strong beat note is obtained. The carrier of the received station acts in conjunction with the signal from the search oscillator as a b.f.o.; if the search signal is sufficiently strong, the broadcast station modulation will be almost completely suppressed by a.g.c. action, and the beat note will predominate in the speaker. Best results are obtained on long waves, where the search harmonics are strong, but performing on medium waves is still quite good. The metal detector is then used in the normal way, with the receiver held in one hand. Occasional drift correction can be made by re-tuning C5. Drift can, if required, be minimised by using a stabilised 9 volt supply in place of the PP3 battery. If a search coil beat cannot be observed with the first station tuned in on the receiver, try another station at a different part of the band.

(To be concluded)

RECENT PUBLICATION

AUDIO ANNUAL 1969. Edited by John Crabbe. 132 pages, 8½ x 11in. Published by Link House Publications, Ltd. Price 7s. 6d.

The "Audio Annual 1969" represents the fourth in the series and is produced by the staff of *Hi-Fi News* and *Tape Recorder*. A substantial part of the annual is devoted to reprints of equipment reviews which have appeared in these two journals, the items reviewed ranging from tape recorders and complete stereo systems to tuners and headphones. These are backed by six feature articles contributed by Gilbert Briggs, Raymond E. Cooke, Rex Baldock, B. J. Webb, James Moir and Stanley Kelly. In passing, tribute must be paid to Gilbert Briggs who, in surveying 50 years of progress in the field of sound reproduction, reveals the fact that he is now in his 78th year.

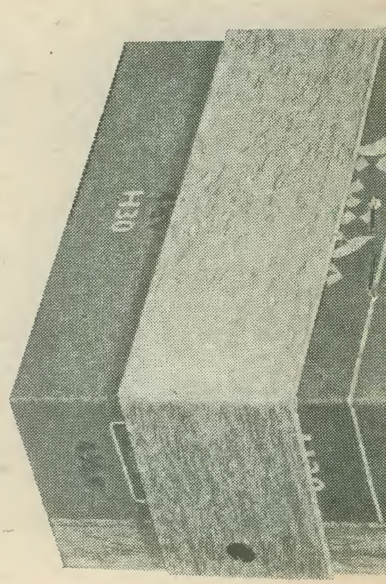
Of the 132 pages mentioned above, 82 are editorial whilst the remainder (which include inside and outside covers) are devoted to advertisements.

Cover Feature

WATER OPERATED ALARM

by

R. M. MARSTON



Using simple silicon semiconductor circuitry, this novel device sounds a bell to warn of excessive water level. No relays are incorporated and current consumption in the stand-by condition is negligibly low

THIS SIMPLE LITTLE UNIT AUTOMATICALLY SOUNDS an alarm bell when water or a similar liquid makes contact with a pair of probes. The alarm can be activated by bath water reaching a pre-set level, by an overflowing cistern, by flood water in cellars or basements, or by rain water, etc.

The device uses three silicon transistors in a relay-less circuit. One of these is a miniature power transistor, and gives direct operation of a domestic electric door bell. The circuit draws a typical standby current of less than 1μA at normal ambient temperatures, and can thus be permanently wired to a small battery without the need of an on-off switch. This feature enables the alarm to be used in permanently installed battery-powered applications.

CIRCUIT OPERATION

The circuit of the unit is shown in Fig. 1. Here, all three transistors are wired as simple common emitter amplifiers, using direct coupling between stages. The arrangement is such that the base of TR2 is effectively in series with the collector of TR1, and the base of TR3 is effectively in series with the collector of TR2, so TR2 and TR3 are cut off when TR1 is cut off, and are driven to saturation when TR1 is on. TR1 base bias is obtained from the positive supply line via the probe contacts, which are normally open circuit. In consequence negligible bias is normally applied to TR1, and all transistors are cut off. Under this condition, total current consumption is typically less than 1μA.

To bias TR1 on, a resistance of less than 100kΩ must be connected across the probe contacts. Under this condition, all three transistors are driven to saturation, and the bell, which forms the collector load of miniature power transistor TR3, operates. D1 prevents any back e.m.f. from the bell damaging the transistor circuitry. R2 prevents excessive base currents flowing in TR1 in the event of the probes being short-circuited.

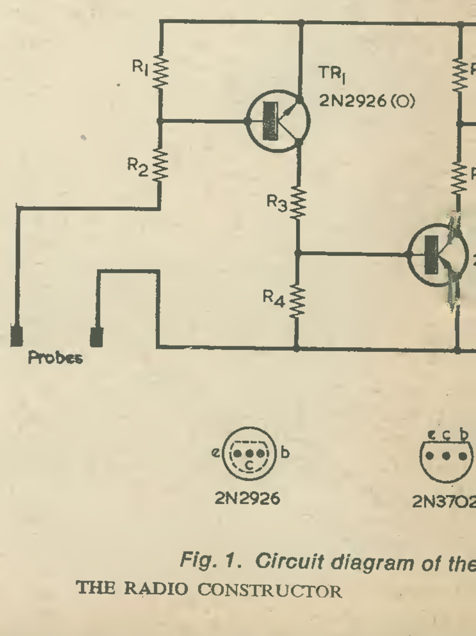
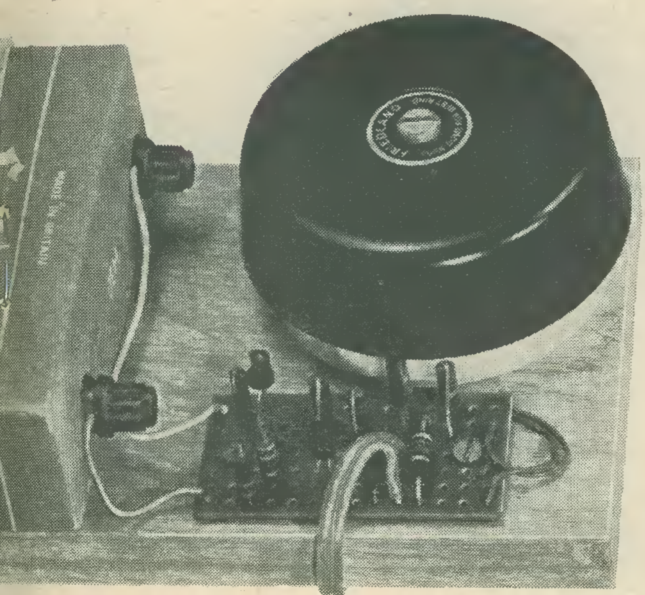


Fig. 1. Circuit diagram of the



COMPONENTS

(All resistors ½ watt 10%)

Resistors

R1	22kΩ
R2	12kΩ
R3	3.3kΩ
R4	10kΩ
R5	2.2kΩ
R6	150Ω
R7	470Ω

Transistors

TR1	2N2926 Orange
TR2	2N3702
TR3	MJE520
D1	0.5A silicon diode (see text)

Battery

B1 4.5V battery type H30 (Exide)

Miscellaneous

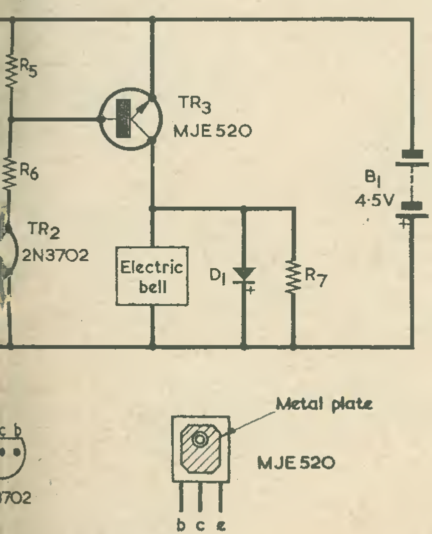
One 3 to 4.5V electric bell
Veroboard panel, 0.15in. matrix, $2\frac{1}{8}$ x $1\frac{1}{16}$in. (see Fig. 2)
Probes (home constructed)
Twin plastic covered flex, connecting wire, etc.

Now, although it is true that distilled water acts as a good insulator, it is also a fact that the impurities in tap water, or in rain water in industrial areas, cause normal water to exhibit a very low resistance, typically of the order of a few hundred ohms. Consequently, any water coming into contact with the pair of probes causes TR1 to be biased on, and the alarm bell to operate.

In Fig. 1, TR3 is a Motorola MJE520 power transistor (available from L.S.T. Components). Diode D1 may be any silicon rectifier rated at 0.5 amp or more. A suitable type is the Lucas DD000.

CONSTRUCTION

The major part of the electronic circuitry is wired up on a small piece of Veroboard panel with 0.15in. hole spacing, as shown in Fig. 2. This panel is secured directly to a block of wood which also holds the bell and battery, as shown in the photograph. The size of the board will depend upon the



the water-operated alarm

bell and battery employed. In the author's case the latter was an Exide batery type H30, and the board measured $6\frac{3}{4}$ by $3\frac{3}{4}$ by $\frac{1}{2}$in. thick.

Before mounting the components to the Veroboard, cut the copper strips at the points indicated in the upper view of Fig. 2. Also, drill two mounting holes to take thin wood screws at the points marked 'A'. After the components have been fitted to the board and soldered into circuit, the board assembly is checked.

Connect the 4.5 volt battery in place and check that the circuit draws a negligible stand-by current, typically less than 1μA. Next, short-circuit the twin flex probe leads and check that the bell operates; the circuit should then draw a current of roughly 0.5 amp, depending on the bell characteristics. Check that TR3 does not become excessively hot; if it does, fit it with a small heat sink.

The Veroboard may finally be secured to the wooden board by passing thin wood screws through the two mounting holes. Fit thin rubber or pvc grommets over the screws between the underside of the Veroboard and the surface of the wooden block. These act as spacers and prevent the Veroboard soldered connections being pressed against the surface of the wood.

USING THE UNIT

The probes consist of two conductors placed side by side, but insulated from one another, and connected to the Veroboard panel via twin plastic covered flex. A very simple probe can be made by baring and tinning a fraction of an inch of the free end of each of the twin flex leads, the tinned areas then acting as the actual probes. This type of probe can be used in a variety of ways. It can be fixed at the desired level to the side of a bath or other water container with adhesive tape, or it can be secured to a rubber sucker which is pressed into place. In permanent installations, the probe can be bonded directly to a suitable surface.

More complex probes can be made by soldering the ends of the twin flex to adjustable metal rods in a suitable holder, bracket, or stand.

A rain detecting probe can be made by connect-

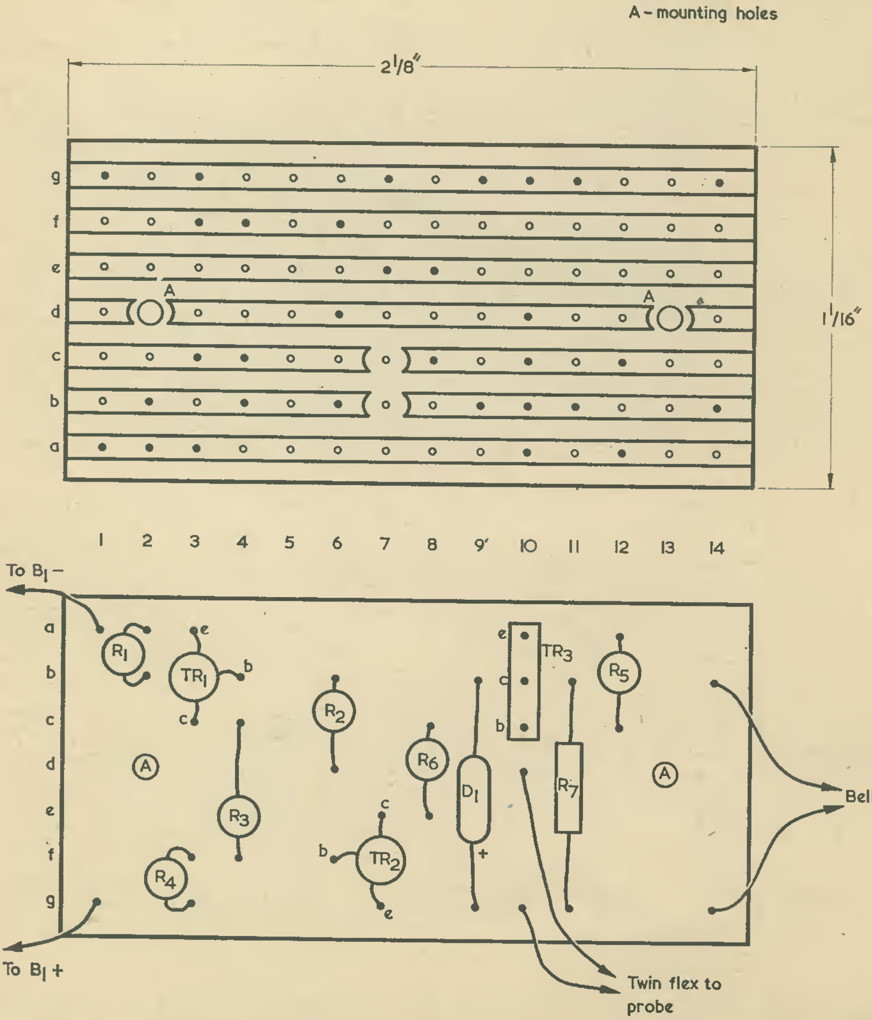


Fig. 2. The copper and component sides of the Veroboard on which the components are assembled

ing the twin flex to alternate copper strips on a piece of scrap Veroboard. Any rain that falls on the copper side of the Veroboard causes an effective short-circuit between adjacent copper strips, and so activates the alarm. The holes in the Veroboard enable the rain water to drain away fairly rapidly, and further larger holes could be drilled for this purpose, if so desired.

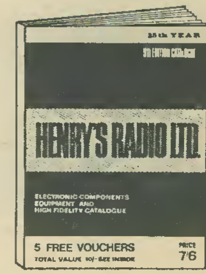
When the alarm is used to detect the presence of water in remote points, such as cellars, basements, boat bilges, etc., the main alarm unit is best installed in an 'inhabited' area such as a living room or cabin, and connected to the probe head via a long piece of twin flex. Several probes can be wired in parallel, if required, so that a single alarm unit can be used to monitor several different points simultaneously.

In some applications, the alarm may be inadvertently activated by condensation, steam, splash, or by remanent moisture between the probe heads, and in such cases special probe units may have to be designed. This problem can, however, be largely overcome by reducing the value of R1, by trial and error, to reduce the sensitivity of the unit.

EDITOR'S NOTE

The MJE520 has a maximum recommended collector current rating of 1.5 amps and an absolute maximum continuous collector current rating of 3 amps. The current drawn by good quality electric bells should be well below these figures, but avoid using the very inexpensive bells available at the popular stores. These normally have a single coil instead of the two coils (in a horse-shoe electromagnet arrangement) given in a more sensitive bell, and they can draw excessive values of current.—Editor.

HENRY'S RADIO CATALOGUE 9th EDITION (1969)



The 9th edition (1969) of the Henry's Radio Catalogue is now available and provides the most comprehensive listing of equipment and components yet to be presented by that company. It includes 32 pages devoted to semiconductor devices, valves and crystals, giving details of semiconductor lead layouts, suitable applications and operating data. There are, also, 210 pages covering other components and equipment, together with a further 70 pages listing high fidelity equipment ranging from microphones to complete amplifying systems.

The professional engineer is also catered for, and many of the items in the catalogue give details of equipment which will be found in the laboratory or employed for industrial control. Typical instances are provided by 10 turn precision potentiometers (with 360° vernier dial and 1–10 indicators, and offering 0.2% linearity) and a photomultiplier infra-red indicator.

The 9th edition (1969) Catalogue is complete with 10s. worth of discount vouchers, costs 7s. 6d. (plus 2s. post, etc.) and may be obtained from Henry's Radio Ltd., 303 Edgware Road, London W.2.

• *NEW PRODUCT* •

EEV FIBRE-OPTIC VIDICON

English Electric Valve Co. Ltd. has introduced a new vidicon camera tube with a fibre-optic faceplate.

Essentially the same as the EEV type P831 ruggedised vidicon, which has separate mesh construction, magnetic deflection and focusing; the P831F has a 1in diameter faceplate constructed from 9 micron diameter fibres. When used with a 7735B type photosurface and 1 ft-candle (10.8 lux) illumination on the faceplate, a signal current of at least 0.15μA is attainable with the target voltage set to produce 0.02μA dark current.

This new fibre-optic vidicon is ideal for applications involving coupling to other devices having fibre-optic window outputs, such as image intensifiers. By using fibre-optic windows on both devices and coupling them together in direct optical contact, the optical efficiency can be improved by as much as 50 times compared to a normal lens system.

INTERNATIONAL AMATEUR RADIO UNION REGION 1 CONFERENCE MAY 1969

The next I.A.R.U. Region 1, Conference, will be held in Brussels, at the Hotel Metropole, from the 5th to the 10th May. There are now thirty-three amateur radio societies in Region 1 of the International Amateur Radio Union, and it is of interest to record their names, as it is probably not appreciated just what an extensive area of the globe's surface is covered by Region 1. In alphabetical order they are as follows: Algeria, Austria, Belgium, Bulgaria, Cyprus, Czechoslovakia, Denmark, East Africa, Faroes, Finland, France, Germany, Ghana, Greece, Holland, Ireland, Italy, Ivory Coast, Lebanon, Luxembourg, Malta, Monaco, Nigeria, Norway, Poland, Portugal, Rhodesia, Soviet Union, Spain, Sweden, Switzerland, United Kingdom, Yugoslavia.

It is hoped that of these, 18 will send delegates, those not being able to do so will be able to participate by getting one of the other national amateur radio societies present to represent them. Eastern European countries to be represented include the USSR, Poland, Bulgaria and Czechoslovakia.

The "host society" will be the Belgian Amateur Radio Society, UBA.

The history of region 1 is interesting. It was in 1950, at the 25th Anniversary Meeting of the International Amateur Radio Union in Paris, when the proposal was made, that those member societies of the I.A.R.U. located in Europe should band together and establish what was to be called, an I.A.R.U. Region 1 Bureau. The idea met with the approval of the fifteen member societies present and under the guidance of the R.S.G.B., the Bureau was established. Conferences were subsequently held in Lausanne (1953); Stresa, Italy (1956); Bad Godesberg, Germany (1958); Folkestone (1960); Malmo (1963); and Opatija, Yugoslavia (1966).

The primary function of Region 1 was to provide the means whereby the Governments of countries having a say in such matters as frequency allocations in the radio spectrum, rules and regulations likely to effect amateur radio and so on, were kept informed by representatives from the radio societies in Region 1, of the consequences their deliberations might have on amateur radio. Delegates from Region 1 have attended meetings and conferences of these official bodies and have upheld the cause of amateur radio in no uncertain manner.

In addition, Region 1 Conferences have become the occasion for discussing much of interest and value to amateur radio itself. The discussions and talks which are organised at each conference now cover a very wide field of interest, as a perusal of some of the papers to be read at the coming Conference by R.S.G.B. Delegates alone will indicate. Amongst these are papers on "Television Transmission in the Amateur Bands", "Harmful Interference to the Amateur Service", "The Radio Amateur Emergency Network", "Amateur Radio Contests", Results from the ZB2VHF Beacon" and papers on VHF and SSB Topics. But, as is mentioned in the "IARU Region 1 Calling" feature in the February issue of the R.S.G.B.'s Journal "Radio Communication", "undoubtedly (there will be) considerable discussion on matters which are considered at every Conference and the most important of which is the question of maintenance and expansion of the Amateur Service. Basically this is the action and strategy necessary to ensure that the amateur bands are retained intact for our use. Action by one society on its own may be unrewarding but concerted action by the societies of the Region is vastly more effective."

Q S X

by L. SAXHAM

(All times GMT)

A report on the stations – both amateur and broadcast – that may be logged by the s.w.l. on the various short wave bands; compiled by a Dx'er whose QTH is located near the S. Suffolk coast.

● Topic

From time to time, the writer has received several requests from readers for hints and tips on the reception of Broadcast bands Dx stations. In the main, these requests are from relative beginners and, in one instance, from a former Amateur bands devotee.

When speaking of Broadcast bands Dx, for most operators there are two regions of the globe which represents the ultimate in Dx reception. These are, generally speaking, the Far East and South America.

Dealing with the Eastern stations first, these tend to be heard best in this country from around October to April. During this period, these stations may be heard, if conditions permit, from around 1400 to 1700 GMT. They begin their next day's transmission around 21–2200GMT.

The writer has found that a useful pointer to Eastern reception conditions, and one that will be easy for beginners to tune to the spot frequency – assuming their dial calibration is correct – is 4800kc/s around 15–1530GMT when All India Radio, Hyderabad, may often be heard. This station has a power of 10kW, and if conditions are such that it can be logged, then it may be taken that the reception of Eastern stations is possible in the conditions then prevailing.

This station is a good 'marker' for Asian transmissions. Having logged some of the Indian local transmitters, the next target area is that of Indonesia, Vietnam, Cambodia, Chinese local stations and others in the Antipodes. The successful reception and recognition of many of these Far Eastern stations represent, to the writer's mind, the ultimate in Broadcast Dx.

The South American stations also tend to be seasonal with respect to the best reception conditions in this country. The season for these stations is very approximately from April to October. Like the Asian stations, the signals at the start and end of each season are more difficult to receive than at the peak centre time period. All of this must only be taken as a very rough general guide – there are very few hard and fast rules with respect to s.w. reception.

A good 'marker' South American station is that of YVNK R. Juventud, Venezuala, on 4900kc/s with a power of 10kW. The frequency should be easy to read from a calibrated dial. Listen around 2230–2330 GMT. The South American stations are best heard during the small hours.

Some South American stations are relatively easy to log; whilst others, of low power, are quite difficult. To the latter category belong the Peruvian stations which, with few exceptions, are low powered (0.25 to 1kW). Their locations, on the far side of the high Andean mountain range, does not improve matters with regard to reception in this country.

In the last QSX, mention was made of 6250kc/s (Santa Isabel, Equatorial Guinea). This channel is also used by the Peruvian OAX7A Radio Cuzco. If the former station has been logged, and the dial reading noted, then with patience and the right conditions, it should be possible to hear R.Cuzco. Listen around 02–0300GMT – there is no other station on this channel during this period. Frequent references are made to "Radio Cuzco" and the interval signal consists of 2 chimes.

● Amateur Bands

Conditions have been quite good on these bands of late, particularly for c.w. working, although s.s.b. also produced a crop of Dx.

21Mc/s

CW: CO2KG, FG7XX, HZ4KO, JA1AYN, VP8KF, VU2VB, ZC4BX, ZL1AMO, ZL4BO, ZS1RA, ZS5LB, 5Z4LS, 9J2MX and 9J2VB. Other JA's logged were – JA1CMD, 1SKX, 1UV, 1WOE, 2EMP, 2FVJ, 2JFJ, 3CZH, 5BLF, 5GS, 7AGO, 8DLI and 8DTG.

14Mc/s

CW: CP1GN, FL8MB, FP8AB, 8AI, 8AP, HK5YC, HP1LE, HZ4KL, JA1KYV, 6HKC, 9BE, KL7GCK, PZ1AV, 1DD, VK2BKM, 2EO, VP8AD, ZL2BCW, 2BP, ZP5KA, 5Z4KO, 8P6BU, 9J2RQ and 9Y4KK.

SSB: CE6EZ, CP1BA, EL1G, EP3AM, HC1NM, 4RZ, 4WM, HK3UA, HS3RT, JA2BLA, KG4AA, KV4AB, MP4TCF, VP8KF, 8KO, XE1KV, YS1VST, 2RAR, ZL1IA, 3QN, ZS5D, 6FX and 9Y4VT.

7Mc/s

CW: CO2BB, JA1EUV, VK4HT, W4BVV, 9RQM and ØHPW.

3.5Mc/s

CW: K1LWI, 3UZE, W1ETU, 2KF and W3DQG.

1.8Mc/s

CW: DL9KRA, GI3OQR, GM3HLQ, 3KMR/A, 3OXX/A, 3YCB, GW3UUZ, 3WBU, 5TO, HB9CM, 9YL, OK1AIJ, 1ALZ, 1AES, 1AKG, 1AMA, 1AQO/P, 1ASG, 1AVN/P, 1AWQ, 1PWC, 1KYS, 1STU, 1WC, 1ZN, 2BMQ, 2BOL, 2BU, 2OP, 2PCN, 2GGA, 2TBN, 2QX, 2ZU, 3CHZ, 3KJJ, 3XU, 3ZAA and OK9AL.

● Broadcast Bands

3204kc/s 1900 Ibadan, Nigeria – with news in English.

3396kc/s 2150 Gwelo, Rhodesia – ezuala – with 1 chime and station identification.

3260kc/s 2105 Niamey, Niger – with African chants and songs.

3285kc/s 2100 Paradys, S. Africa – with light music, 6 'pips' and news in English.

3396kc/s 2150 Gwelo, Rhodesia – drama programme in dialect.

4695kc/s 2000 Unidentified Chinese speaking station. Opens at 2000 GMT with slogan, orchestra and choir. Harangues in Chinese dialect follow, suspected QTH Mongolia.

4680kc/s 0435 HCWE1 R. Nacional Espejo, Ecuador – with talk in Spanish.

4712kc/s 0200 Emisora Luz y Vida, Ecuador – announcing in Spanish. This station was first noted on this channel during December and listed, at that time, as unidentified.

4850kc/s 2040 Nouakchott, Mauritania – with talk in Arabic.

4907kc/s 1620 Radio Cambodia, Phnom-Penh – with Asian type songs by female trio, faded out rapidly after quoted time. Phnom-Penh, capital of Cambodia, is situated on the Mekong river. Exports are mainly rice and cotton, population 406,000.

6065kc/s 0350 PRL8 Brasilia, Brazil – with programme of 'pop' records in Latin American style. This is the new capital inaugurated on 21st April 1960. Designed for a population of 500,000, it is 600 miles N.W. of Rio de Janeiro.

6160kc/s 0355 HJKJ Bogata, Colombia – news in Spanish; bird song interval signal and identification.

9645kc/s 2035 ZYV4O Pocos de Caldas, Brazil – Latin American music; station identification at 2036 with echo effect.

9912kc/s 2015 VUD Delhi, India – with English programme. ■

FOR THE BEGINNER . . .

HOW TO START

by

E. SOHAM

The absolute beginner must start the hobby of radio construction and operation somewhere. To him, the bewildering array of circuits and inexplicable terminology which appear month by month in the radio press only makes life more difficult. In this article, the author deals with some basic knowledge and necessities which the beginner should obtain before any work is undertaken. Specially written for the absolute beginner, whose first interests are most likely to be centred on short-wave listening, it is hoped that this article will enable a clearer understanding of the hobby to be obtained.

When commencing the hobby of radio and electronics, the beginner should set himself a programme — this usually involving the building of a simple receiver. Such designs are often published in the radio press and are frequently of the 1, 2 or 3 valve type. Probably the best type of circuit to select is that for a 3-valve short wave receiver, the first valve being a detector, the second an audio amplifier and the third a rectifier (power supply) and having a loudspeaker output. Before construction of such a receiver can be undertaken, other considerations must be taken into account.

Generally speaking, the hobby may be divided into two separate compartments as far as the beginner is concerned — these being (a) constructional and (b) operational.

Constructional work is usually carried out at a workbench whilst the operational interest is catered for at a different bench — both benches often being in the same room. The operational bench carries the receiver and any other ancillary equipment which may be added at a later date — preselector, etc. Dealing with the constructional side of the hobby first, the workbench, whether in a room or garage, should be provided with access to an a.c. mains supply (points and plugs), the required tools and an aerial and earth for receiver testing purposes. If the workbench is in a garage having a concrete floor, the beginner should ensure that a substantial rubber mat is provided. Never stand on a concrete floor whilst working with electrical apparatus. It is assumed here that the mains installation has been carried out by fully qualified personnel and that it conforms to the required standards.

Ideally, the workbench should be fitted with a suitable vice (the writer prefers a carpenter's vice) and a tool rack. Provision should also be made for adequate lighting of the bench top.

TOOLS

The minimum number of tools required for radio construction work are as follows — a pencil bit electric soldering iron; a pair of thin round-nosed pliers with side-cutters; a centre punch; a selection of small screwdrivers having various shaft lengths; a Bib wire stripper and cutter; a small hacksaw; a small hand-drill; a set of twist drills, sizes 1/16, 3/32, 1/8, 5/32, 3/16, 7/32 and 1/4 inch; a set of chassis-cutters (for cutting valveholder holes in chassis) for B7G and B9A valveholders; a carpenter's brace; and a 7/16in. twist drill. The last two items are required for drilling chassis and front panels for the fitment of potentiometers and switches, etc.

Further items required are a supply of resin cored solder, a metal soldering iron stand (which may be easily made from a piece of waste aluminium, see Fig. 1), a piece of waste rag for wiping the hot iron clean, a small pair of tweezers (for holding nuts in awkward places) and a small sharp penknife. Additionally, a ruler and pencil for marking purposes will also be required.

These then are the basic requirements for constructional work and the beginner should obtain them before commencing any radio projects. As time progresses, other tools and equipment may be acquired, some of these being a pair of metal cutting shears; a 'Mole' wrench (this tool is self-gripping and virtually becomes a third hand); an Abrafile; a set of files of various types and sizes and perhaps even an electric drill with accessories!

Whilst waiting for a suitable receiver design to be

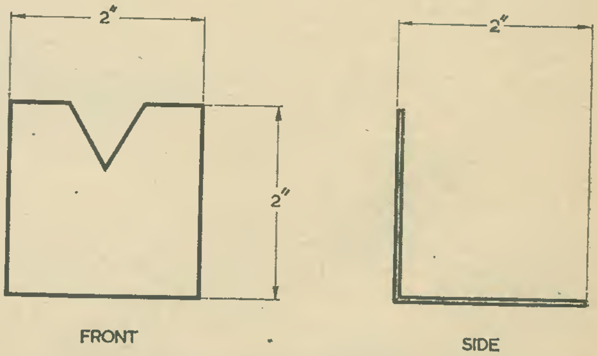


Fig. 1. A simple soldering iron stand made from a piece of L-shaped waste metal (aluminium is easy to bend). The stand may be secured to the workbench by suitably-sized woodscrews through two holes drilled through the base. In use, the hot iron is placed such that the bit rests in the cut-out V-shaped slot

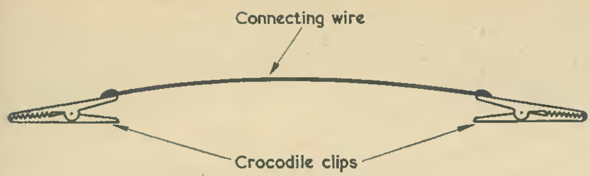


Fig. 2. For quick 'hookups' from one part of a circuit to another, two crocodile clips joined with a length of p.v.c. covered wire (lighting flex) are often of use on the workbench. Several sets should be made, each having differing lengths of connecting wire

published, two extremely simple projects will now be described, each of these being useful for testing or trying out various circuits at the workbench.

For quick 'hookups' from one part of a circuit to another, a number of crocodile clips—say 8—and 4 lengths of p.v.c. covered wire, should be made up as shown in Fig. 2. The best type of wire to employ is ordinary lighting flex. In use, one such set may be employed to complete a circuit from one point to another merely by bridging the break with the clips and wire. An example would be the completion of the chassis connection to one end of a detector grid resistor, as shown in Fig. 3. A word of warning is required here, however. This method of completing a circuit should *not* be undertaken by the beginner on those parts of a design which carry h.t. potential.

A simple continuity tester can also be made up, as shown in Fig. 4. A simple device of this nature is often of use when testing for breaks in coils and when wiring up a circuit to multi-contact switches such as are employed for wavechange, etc. So much for the simple construction items, and we now come to the operational part of the hobby and the preparation necessary prior to the installation of the receiver once this has been constructed and tested.

OPERATIONAL PREPARATION

The frequencies in which the beginner will probably be primarily interested are from 1.8 Mc/s to 30 Mc/s, this range of frequencies covering the various short wave bands.

Within this range are the Broadcast and Amateur bands and these are set out in the Table. The beginner is more likely to be accustomed to a station being referred to by its wavelength in metres and, whilst this is quite correct it is more usual on the short waves to state the frequency in kilocycles (kc/s) or megacycles (Mc/s) per second. A kilocycle equals 1,000 cycles and 1 megacycle equals 1,000 kilocycles.

To find the frequency of a station in terms of kilocycles per second, divide the wavelength into 300,000 thus:—

$$\text{Frequency in kc/s (approx.)} = \frac{300{,}000}{\text{wavelength in metres}}$$

For example, a station transmitting on a wavelength of 15 metres would have a frequency of 20,000 kc/s, thus:—

$$\text{Frequency in kc/s} = \frac{300{,}000}{15} = 20{,}000 \text{ kc/s or } 20 \text{ Mc/s}$$

AMATEUR BANDS

Frequency Mc/s	Known as
1.8 to 2.0	160 metres or 'Top Band'
3.5 to 3.8	80 metre Band
7.0 to 7.10	40 metre Band
14.0 to 14.35	20 metre Band
21.0 to 21.45	15 metre Band
28.0 to 29.7	10 metre Band

BROADCAST BANDS

Frequency Mc/s	Known as
4.75 to 5.06	60 metre Band
5.95 to 6.2	49 metre Band
7.1 to 7.3	41 metre Band
9.5 to 9.775	31 metre Band
11.7 to 11.975	25 metre Band
15.1 to 15.45	19 metre Band
17.7 to 17.9	16 metre Band
21.45 to 21.75	13 metre Band
25.6 to 26.1	11 metre Band

The terms kilohertz (kHz) and megahertz (MHz) are also used to define frequency. They mean the same as kilocycles per second and megacycles per second respectively.

On the operating bench one would ideally have the following items — a pad of notepaper and pen or pencil, for taking notes of announced frequencies, times, station call-signs, etc.; a clock working to Greenwich Mean Time (GMT*); a calendar; a copy

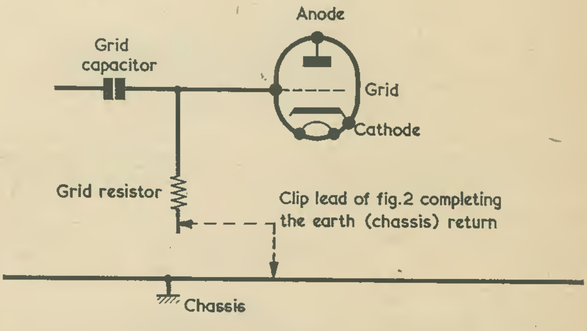


Fig. 3. A practical use for the clip lead of Fig. 2, consisting of completing the earth (chassis) return to the grid resistor in a triode (one grid) valve detector to determine the most suitable resistor value to obtain smooth reaction (positive feedback from anode to grid). Several resistors of differing values may be soldered to the grid prior to clipping the device to the individual free ends.

* All short wave stations, both Amateur and Broadcast, operate on a GMT basis—one hour earlier than BST, i.e. 11.00 GMT is 12.00 BST.

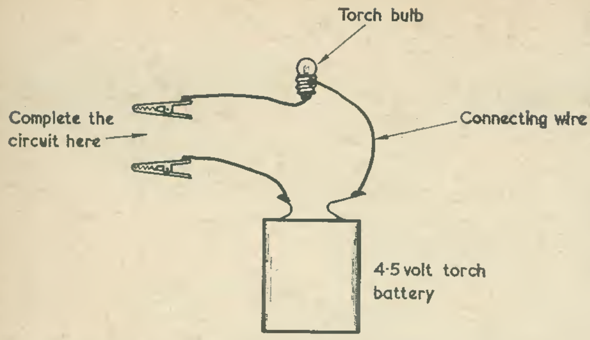


Fig. 4. Simple continuity tester. When the circuit is completed between the two crocodile clips the bulb will light up

of *Radio Amateur Operator's Handbook* and a copy of *World Radio–TV Handbook*. The first of these two books may be obtained direct from the publisher of this magazine — see advertisements — and the second from Modern Book Company, 19 Praed Street, London, W.2 at 42/- plus 2/- postage. The first publication, as its title implies, will provide all the information that the beginner interested in Amateur communications could possibly require, these including Amateur Prefixes, Radio Zone Boundaries, Call Areas, Local Time Conversions, Mileage Table, Amateur Abbreviations, etc. Additionally, there are seven maps which will prove of great interest to the beginner, a Frequency/Wavelength Conversion abac and lists of the various Amateur Codes. The second publication provides all the information that could possibly be required when operating over the Broadcast bands, and gives complete station lists with frequencies and wavelengths on the short, medium and longwave bands, station callsigns, interval signals, times of operating schedules, station addresses and a host of further information.

The above are the basic requirements. As time progresses in the hobby other, and more sophisticated items may be added, these consisting of a logbook (for a permanent record of stations heard, times, signal strengths etc.); a preselector unit (placed between the aerial input and the receiver to boost the radio frequency signals) and, last but not least, a tape recorder and a supply of tapes. This last item is rather a luxury feature for the operating bench, but it is one that is becoming more and more standard these days. It is directly coupled to the receiver (not via the microphone by the way) for the recording of rare and hard-to-receive stations — both Amateur and Broadcast — to enable the deciphering of weak signals to be carried out at a later date, to provide a permanent record of a station's transmission, and so on. The uses of a tape recorder in this respect are almost legion.

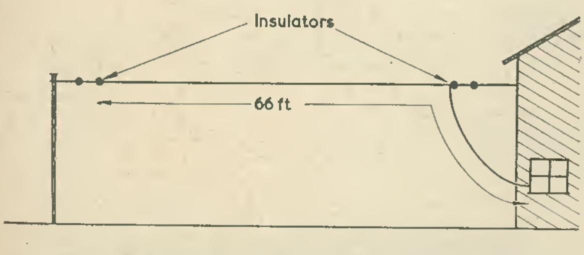


Fig. 5. An Inverted L long wire type aerial resonating at 7 Mc/s, which represents a good compromise for general operation over the short wave bands. The 66ft. dimension includes the length of lead-in wire

Other later additions at the operating bench would be a crystal frequency standard for accurate determination of receiver dial readings (done by pre-calibrating the receiver from the marker points provided by the unit); an aerial tuning unit which provides the maximum transference of signal from the aerial to the receiver; and probably a speaker unit containing two or more speakers, these being switchable and having differing audio response characteristics.

Much of the above will provide the beginner with thoughts for the future but it does give some idea of the ultimate to eventually aim for if the intention is to end up will a well-equipped listening station. Without the proverbial long pocket many of these items of equipment must await future acquisition, and this also applies to the eventual ownership of a high-performance communications receiver which is usually the ambition of most beginners. For the present, however, it is a very good idea to commence with a comparatively inexpensive simple-to-build receiver and in this way learn something of the constructional side of the hobby, using the end result to gain experience of short wave operating — the latter being, in itself, a very wide subject!

AERIAL AND EARTH SYSTEM

Having briefly considered the inside requirements, those apertaining to the outside must also be dealt with prior to receiver operating.

The subject of aerials for short wave reception is a very large one and obviously cannot be dealt with in any great detail here — this remark also applying to quite a lot of the foregoing! However, the best type of aerial for the beginner to erect is shown in Fig. 5, this being the Inverted L long wire end fed array. Cut to 66ft. (including lead-in), the aerial will resonate at 40 metres (7 Mc/s) and this is a compromise suitable for most general short wave reception. If the length shown is not possible in the circumstances prevailing, it may be reduced to half (33ft.), this resonating very approximately at 20 metres (14 Mc/s). Alternatively, the length of 66ft. may be gained by taking the wire around corners in the garden — it does not have to be in a straight line. If this is done, no angle should be sharper than 90° — the greater the angle the more efficient the system will become. The wire may consist of one lead of ordinary clear p.v.c. covered stranded wire of the type usually available from the local Woolworth store. Ideally, it should be of 14 gauge hard drawn copper wire (available from C. H. Young, Ltd., 170-172 Corporation Street, Birmingham 4.)

The earthing system should ideally be direct to ground and not to a water pipe, these often being of the plastic type in modern houses. *Never* make an earth connection to a gas pipe.

The earth system should consist of a metal rod or pipe, copper is the best material to use if available,

Continued on Page 658

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UNDERSTANDING RADIO

Tuning Meters and B.F.O.

$f = \frac{1}{2\pi\sqrt{LC}}$

by W. G. Morley

IN LAST MONTH'S ISSUE WE EXAMINED THE CIRCUITS employed for coupling an electron-ray tuning indicator to the a.g.c. or signal diode load of a valve superhet receiver in order that it may provide an indication of accuracy of tuning. We saw that the tuning indicator control grid can be coupled to the a.g.c. line when the a.g.c. diode is fed from the secondary of the last i.f. transformer instead of from the primary, and when there is no a.g.c. delay voltage. The tuning indicator grid should, on the other hand, be coupled to the signal diode load if the a.g.c. diode is fed from the primary of the last i.f. transformer or if the a.g.c. system has a voltage delay. We then went on to discuss electron-ray indicators other than the simple 6U5G "Magic Eye" (which we used to provide an introduction to the subject), these being the EM34, the EM84 and the DM70.

We now carry on to circuits in which moving-coil meters are employed as tuning indicators. After that, we shall turn our attention to the beat frequency oscillator.

TUNING METERS

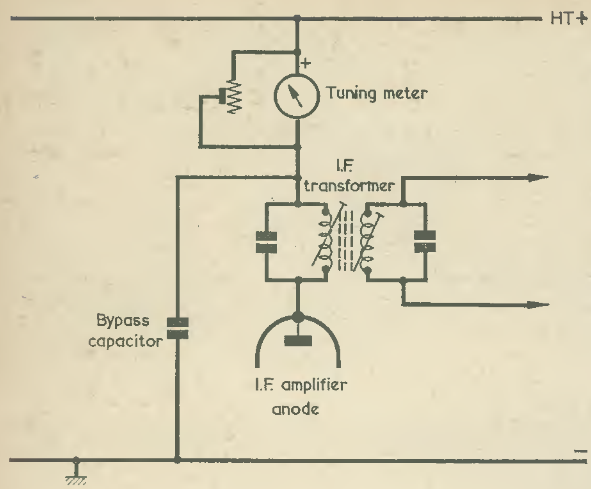
In the article which appeared in the last March issue we introduced the subject of tuning indicators (both meter and electron-ray) by means of the very simple circuit which is repeated here in Fig. 1(a). In this diagram, the meter is connected in series with the h.t. supply to the anode of an a.g.c. controlled i.f. amplifier valve, it being assumed that the a.g.c. voltage is obtained from a diode which is coupled to the last i.f. transformer secondary and that there is no a.g.c. voltage delay. The preset variable resistor in parallel with the meter is set up such that, in the absence of signal input to the receiver, the meter needle gives full-scale deflection.

Let us now briefly re-examine the manner in which the circuit of Fig. 1(a) functions. When the associated receiver is switched off there is no anode current and the meter gives a zero indication. If the receiver is then switched on without being tuned to a transmission, the meter needle indicates full-scale deflection. Should a signal next be tuned in, the a.g.c. voltage applied to the grid of the controlled valve goes negative and the anode current of the valve reduces. In consequence, the meter needle gives an indication lower than full-scale deflection, the reading decreasing as the transmission is more accurately tuned in. Correct tuning is thus indicated by a minimum reading in the meter. In practice, the meter could be a 0–1mA instrument, with the preset variable resistor having a value of 100Ω.

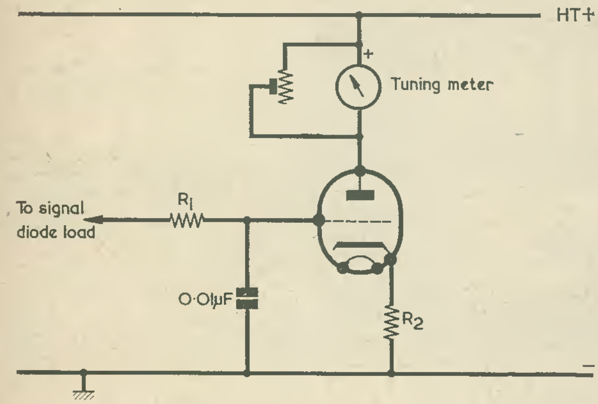
A number of minor variations to the basic circuit of Fig. 1(a) are possible. For instance, the meter could be connected in series with the h.t. anode supply to more than one a.g.c. controlled valve, thereby enabling a less sensitive meter to be used. Alternatively, the meter may be inserted in the anode supply to a separate triode of the a.f. voltage amplifier type whose grid is coupled to the signal detector diode load, as in Fig. 1(b). The series grid resistor, R1, should have a value of the order of 2MΩ or more to prevent excessive a.c. loading on the signal diode load, and the circuit has the advantage that, if the receiver is fitted with a switch which short-circuits the a.g.c. line to chassis when a.g.c. is not required, the tuning meter still functions. Also, the circuit may be used in receivers where the a.g.c. diode is fed from the last i.f. transformer primary, or where there is an a.g.c. voltage delay. A suitable triode would be one section of the double triode type ECC82, and the meter could be a 0–1mA component with a 100Ω preset resistor across it, as in Fig. 1(a). R2 may be 1kΩ.

A disadvantage resulting from having the tuning meter in series with an anode supply, as in Figs. 1(a) and (b), is that the needle of the meter (assuming a conventionally made instrument) moves to the *left* as the position of correct tuning is approached. Some receiver operators prefer to have the meter needle move to the right to indicate correctness of tuning, and meters intended specifically for tuning indicator purposes have been produced in which the movement operates in the opposite direction in order to satisfy this desire. A much simpler approach consists of employing a conventional meter and fitting it to the receiver panel upside-down!

It is not, however, a difficult matter to devise circuits which allow a conventional meter mounted in normal fashion to give a needle deflection to the right as correct tuning is approached. A typical example is illustrated in Fig. 2(a). Here, the positive terminal of the meter is connected to the lower end of a resistor, R1, in series with the h.t. anode supply to one or more a.g.c. controlled valves. The negative terminal of the meter couples to the slider



(a)



(b)

Fig. 1(a). A simple tuning meter circuit. The meter reading falls as the associated receiver approaches the position of correct tuning. (The preset variable resistor across the meter should be initially set to a low resistance during setting up, to ensure that excessive current does not flow in the meter)
(b). The same principle is employed in this circuit, where a separate triode is coupled to the signal diode load

of a preset potentiometer, R3, which is connected in series with R4 across the receiver h.t. supply. A preset variable resistor, R2, is connected across the meter.

The circuit of Fig. 2(a) is set up in the following way. Under no-signal conditions the anode current of the a.g.c. controlled valve or valves is at maximum, and greatest voltage is dropped across R1. R3 is adjusted such that, under these conditions the meter reads zero. If, now, a signal is tuned in, the anode current of the a.g.c. controlled valve or valves decreases, whereupon less voltage is dropped across R1, and the lower end of this resistor goes positive. The meter needle is, in consequence, deflected to the right. Variable resistor R2 is adjusted such that the meter gives full-scale deflection for the maximum signal input strength that is anticipated. If the meter has a full-scale deflection of 1mA and only one a.g.c. controlled valve is employed in the circuit, typical component values would be given by having R1 at about 500Ω, R4 at 50kΩ, R2 at 250Ω and R3 at 2kΩ. If the anode current of two a.g.c. controlled valves passes through R1 its value should be about 250Ω, reducing proportionally for further valves. R4 will require a wattage rating of 2 watts.

An alternative approach, which also enables the meter needle to move to the right as the position of correct tuning is approached, is shown in Fig. 2(b). In this diagram the meter is coupled to the cathode of an a.g.c. controlled valve. As a.g.c. voltage increases the cathode current reduces whereupon, because less voltage is dropped across the cathode bias resistor R1, the cathode goes negative. In consequence, the negative terminal of the meter is connected to this cathode. The circuit is set up by first adjusting R4 for a zero reading under no-signal conditions and then adjusting R2 for full-scale deflection when a signal having maximum anticipated amplitude is tuned in. If the a.g.c. controlled valve is a standard i.f. amplifier and the meter a 0–1mA component, typical resistor values would be given by R2 at 5kΩ, R3 at 50kΩ and R4 at 1kΩ. R1 would be the normal cathode bias resistor for the valve, and R3 would need to have a dissipation rating of 2 watts.

Both the circuits of Figs. 2(a) and (b) have the disadvantage that a fairly high current is continually drawn through the potentiometer (R3 and R4 in both diagrams) across the h.t. supply lines, and the circuit is, therefore, somewhat wasteful of h.t. power. If this point is considered of sufficient importance the circuits can be rearranged such that the potentiometer current flows through a valve drawing a steady anode and cathode current, such as the receiver a.f. output valve. An example of this approach is given in Fig. 2(c). This is a modification to the circuit of Fig. 2(b) and it ensures that no h.t. current is wasted. R5 and R6 of Fig. 2(c) should offer a total resistance equal to the cathode bias resistance normally required by the output valve, R6 having a value which allows about 5 volts to appear across its track. The usual electrolytic cathode bias bypass capacitor appears across R5 and R6.

In practical valve receivers, quite a number of variations on the basic tuning meter circuits we have just examined will be encountered, but they nearly all operate from the same principles.

Since a tuning meter also gives an indication of signal strength it is frequently employed for this purpose, particularly in receivers intended for amateur reception. In amateur communication, received signal strength is defined by the letter "S" followed by a number from 1 to 9, as shown in the accompanying Table. Thus, if an amateur reports that a certain signal is being received at "S7", this means that the signals are "moderately strong." It is a common practice for tuning meters of the type we have been discussing to be calibrated in divisions from "S1" to "S9" so that an operator can quote a signal strength direct from the meter reading. The meter is then referred to as an *S-meter*. Unfortunately it is rather difficult for a number of reasons to obtain a high level of accuracy with this technique. Firstly, interpretation of the S-code is itself a subjective matter, because different operators may well ascribe different "S" numbers to the same signal.

TABLE

The signal strength S-Code	
S1	Faint signals, barely perceptible
S2	Very weak signals
S3	Weak signals
S4	Fair signals
S5	Fairly good signals
S6	Good signals
S7	Moderately strong signals
S8	Strong signals
S9	Extremely strong signals

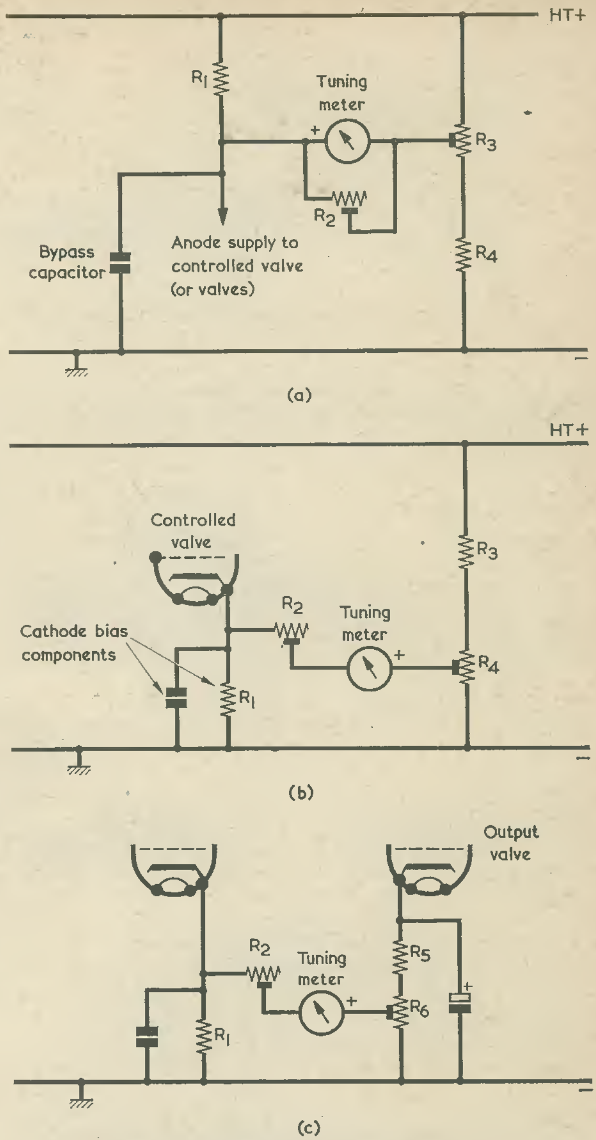


Fig. 2(a). A tuning indicator circuit in which meter current increases as a.g.c. voltage increases. (To ensure that excessive current is not passed through the meter, R2 should be adjusted to initially offer a low resistance when setting up)
(b). Another circuit in which meter current increases with increasing a.g.c. voltage. (R2 should be initially adjusted to insert maximum resistance during setting up)
(c). A modification to (b) which ensures that there is no waste of h.t. current

Secondly, it is necessary for the associated receiver to offer the same overall gain at all received frequencies, and this is rarely achieved in practice. Thirdly, it may be found that the successive "S" numbers are closely cramped together at one end of the meter scale and are difficult to evaluate. Despite these disadvantages, calibrated S-meters are very popular with amateur operators, and the calibration is certainly helpful for making a comparison between two or more signal strengths at fairly close frequencies even if the "S" units marked on the meter scale may not have any absolute accuracy.

As a final point, we have referred up to now to the setting up of the tuning meter circuit under "no-signal conditions". It should be mentioned that, with a sensitive receiver, "no-signal conditions" will probably not correspond to zero a.g.c. voltage but to a small a.g.c. voltage resulting from self-generated noise in the receiver itself. However, as a signal must have greater amplitude than receiver noise amplitude if it is to be reliably received, the tuning meter, with or without "S" calibration, still carries out the desired function.

THE B.F.O.

Before concluding this month's contribution we shall introduce a new subject which, like the S-meter, is encountered in superhet receivers intended for communication purposes but not in superhets employed for domestic entertainment.

The superhet receivers we have discussed so far have all been intended to provide reception of amplitude modulated signals. The amplitude modulated transmission is selected and amplified before detection, after which the detected signal is further amplified before being passed to the loudspeaker. The basic function of these receivers has, quite simply, been that of signal selection and amplification, together with reclamation of the original a.f. modulating signal.

There are, however, other methods of radio transmission in addition to the amplitude modulation mode, and particularly important amongst these is the *continuous wave* or *c.w.* type of transmission. C.W. transmission is employed for the sending of messages in morse code, in which the individual letters of words, and figures, etc., are transmitted in the familiar "dot" and "dash" fashion provided by that code. For c.w. morse operation the transmitter is not modulated in any way at all. Instead it is effectively switched on every time the transmitting operator presses his key and is effectively switched off when the key is raised. The term "continuous wave" applies, incidentally, to a radio signal which is constant both in amplitude and frequency, as is given in the present instance when the transmitting key is pressed.

The most convenient way of "reading" a morse signal (i.e. translating it back to the original message)

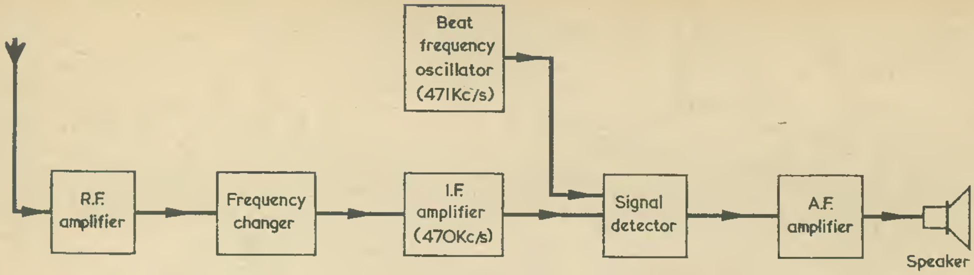


Fig. 3. Block diagram for a superhet incorporating a beat frequency oscillator

is given by causing an a.f. tone to be produced whenever the morse key is pressed. Morse training, for instance, is usually carried out by having the key actuate an a.f. oscillator coupled to headphones or a loudspeaker. Because it is not modulated in any way, a c.w. signal received by the superhets we have so far discussed will not produce this a.f. tone.

The provision of an a.f. tone is carried out by fitting to the receiver an additional stage which is described as the *beat frequency oscillator* or *b.f.o.* stage. The b.f.o. enables an audible output to be provided from a c.w. signal by applying to the signal detector a locally generated oscillation whose frequency is close to that at which the c.w. signal is fed to the detector.

In Fig. 3 we have, in block form, a simple superhet suitable for communications work which incorporates an r.f. amplifier, a frequency changer, an i.f. amplifier, a detector and an a.f. amplifier. For the present we shall ignore the other facilities, such as an a.g.c. system or tuning indicator, which normally appear in a receiver of this class. Also shown in the diagram is the beat frequency oscillator, its output feeding into the signal detector stage.

Let us say that the intermediate frequency of the superhet of Fig. 3 is 470kc/s. Then, when it is accurately tuned in to any c.w. transmission, that signal, after passing through the frequency changer stage, will always be applied to the signal detector at 470kc/s. This frequency is indicated in the diagram. The beat frequency oscillator is also assigned a frequency in the diagram, this being shown as 471kc/s. Now we know from previous discussions, including in particular those relating to the mixer valve, that when two signals at different frequencies are fed to an a.m. detector the output of the detector contains four signals. Two of these output signals are at the same frequency as the two input frequencies, the third is at a frequency equal to the sum of the input frequencies, and the fourth is at a frequency equal to the difference between the two input frequencies. In our present example the first three output signals would all be well above the audible range and are, in any case, prevented from passing to the a.f. amplifier by the filter circuit which is provided in the signal detector circuit. On the other hand, the fourth signal has a frequency of 1kc/s, which is well within the audible range, and this passes through the a.f. amplifier in Fig. 3 to be fed to the loudspeaker. It is obvious that the 1kc/s difference frequency can only be formed when both the b.f.o. signal *and* the 470kc/s c.w. signal from the i.f. amplifier are applied to the detector, whereupon it follows that an a.f. tone is produced at the receiver whenever the transmitter key is pressed. In consequence, the c.w. signal has, very conveniently, been changed to an a.f. tone, and the morse transmission can be "read" by the receiver operator without difficulty.

A 1kc/s tone will also be produced if the b.f.o. in Fig. 3 has an output frequency of 469kc/s because, once again, the difference frequency is 1kc/s. Should the receiver have an intermediate frequency other than the 470kc/s we have chosen for our example, it is only necessary for the b.f.o. frequency to be 1kc/s above or below it to produce the 1kc/s a.f. tone. In practice, it is usual to provide the b.f.o. with a panel control which enables its frequency to be varied over a small range on either side of the intermediate frequency of the associated receiver. The operator may then vary the frequency of the a.f. tone resulting from a c.w. transmission to suit his own requirements.

The term "beat frequency oscillator" derives from the fact that a "beat frequency" (the a.f. tone) is produced as the result of the two signals being fed to the detector. (To be precise, the term really applies to an instrument incorporating two oscillators and offering a difference frequency output — such an instrument being very commonly employed as an a.f. tone generator in the earlier days of radio.)

Next Month

In next month's issue we shall examine the beat frequency oscillator in greater detail, after which we shall turn to circuits which are intended to enhance the selectivity of superhet receivers.

■

FOR THE BEGINNER . . .

HOW TO START

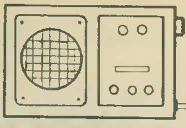
(continued from page 652)

driven as far into the ground as possible, the surrounding earth being made moist from time to time by the application of water. The lead from the copper rod to the equipment should have a large diameter, and is secured to the rod by either soldering or a Jubilee clip. This connection should then be weather-proofed by the application of bituminous paint.

If most of the foregoing is acted upon, the absolute beginner will be in a good position to commence the hobby once a suitable receiver design has been selected for construction.

■

In your work-shop



It cannot be denied that there are times when Smithy's able assistant, Dick, seems to require a larger size in headgear than do the rest of us. Smithy takes him up on one of his more boastful pronouncements and tests his knowledge over a wide range of technical subjects. Readers may care to match their wits against the pair as they travel through electronics from A to Z!

"NEVERTHELESS," BRAGGED Dick, "despite all its attempts to baffle me I finally managed to track the fault down."

"Where," asked Smithy, "was it?"

"Tucked away in the flywheel sync circuit,"replied Dick proudly. "It was a dirty little 150pF capacitor across one of the discriminator diodes, and it had developed enough leakiness for the circuit to be just short of working properly. The set would stay in lock for about a minute and then the line hold control would have to be adjusted again. As soon as I located that capacitor I whipped it out and popped in a replacement, with the result that that TV is now going like a bomb!"

Smithy threw an affectionate paternal glance towards Dick. Now was a good time, he decided, to foster his assistant's youthful keenness.

A TO Z

"You certainly," he remarked, assuming the expression of one who is considerably impressed, "did a jolly fine bit of trouble-shooting there."

"I'll say I did," boasted Dick. "The way I'm going these days it won't be long before I overtake you and start running this Workshop on my own, mate!"

Smithy's fondness for the exuberance of the young abruptly evaporated.

"If," he remarked acidly, "your technical ability was commensurate with the circumference of that immense head of yours, there might be some truth in your assertion. But you've got a long way to go yet, my boy."

"Oh, I don't know," exclaimed the unabashed Dick airily. "I don't suppose I'll ever become another Epstein, quite, but I reckon I'll still be jolly good so far as general electronic things are concerned."

"It's Einstein," growled Smithy irritably, "not Epstein. Epstein was the sculptor."

Dick dismissed this inaccuracy with a careless wave of his hand.

"A minor matter," he pronounced. "The important thing is that, at the rate I'm progressing, I should soon be able to get this whole electronics scene wrapped up, right from A to Z."

The Serviceman threw a quizzical glance at his assistant, then looked at the Workshop clock.

"You've given me an idea," he remarked thoughtfully. "There's still half an hour of lunch-break left before we get back to work, so I'll take you up on this A to Z business."

" How do you mean?"

"I'll ask you a question about something in electronics that starts with A, then carry on to something beginning with B, and then to something beginning with C, and so on. We should be able to get through the whole alphabet before we start work again. And it will be interesting to see just how good at electronics you actually are."

"Blimey," said Dick enthusiastically, "that *is* a good idea. All right, then, start off by choosing a subject in electronics beginning with A and I'll tell you all I know about it."

"Fair enough," replied Smithy equably. "Well, my first subject is 'A battery'."

"Corluvaduk," commented Dick rudely. "Didn't you ever go to school Smithy? That begins with B, not A!"

"I'm not," returned Smithy heatedly, "talking about *a* battery. I'm talking about *an* A battery."

"Oh, I see," replied Dick. "Well, 'A battery' is what the Americans call a battery which supplies the filament or the heater of a valve. At the same time, a B battery is the battery which provides h.t., and a C battery is the one which provides grid bias."

Smithy raised a mildly surprised eyebrow.

"You've certainly," he commented, "got that little lot off pat. Incidentally, the Americans also refer to the A supply, the B supply and the C supply as well, these being the heater or filament supply, the h.t. supply and the grid bias supply respectively."

"Right," said Dick briskly. "That

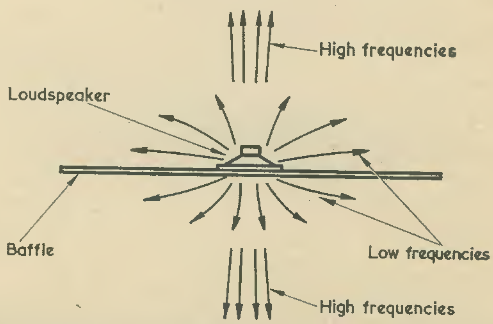


Fig. 1. Illustrating, in somewhat exaggerated form, the different manners in which the higher and lower audio frequencies are radiated by a loudspeaker. The baffle presents a physical obstacle to the passage of low frequencies from the back of the loudspeaker to the front

means we've now cleared up A, B and C. Let's get on to D."

"It's only A we've cleared up," retorted Smithy irately "*You* put in the B and C business. So the next letter is B and that stands for 'baffle'."

"Do you mean a loudspeaker baffle?"

"I do."

"Well," said Dick, "a loudspeaker baffle is used to increase the audible level of the lower frequency notes produced by a loudspeaker."

"Correct," confirmed Smithy. "But how does it work?"

"It prevents," replied Dick, "the low notes produced at the back of the speaker from coming round and cancelling out those produced at the front. If, for instance, the speaker cone is moving forwards whilst reproducing part of a low note cycle, its front surface is producing a compression in the air whilst its rear surface is producing a rarefaction. If you didn't do something to stop it, that rarefaction at the rear will come round the edge of the speaker and cancel out the compression at the front. One way of stopping it is to mount the speaker on a baffle made of wood or a similar material. (Fig. 1) The wood then simply gets in the way of the rarefaction at the rear and prevents it coming round to the front. The same applies, of course, if the cone is producing a rarefaction at the front and a compression at the rear."

"Why does the baffle only affect the low notes?"

"Because the higher frequency notes tend to travel directly forward and backward from the speaker cone, whilst the lower notes spread out more. Also, since the lower notes have a longer wavelength in air, the compressions and rarefactions produced at the rear of the cone can still be out of phase with those at the front even after they've travelled a relatively long distance. It follows from this that the bigger the area of the baffle the lower the audio frequency which is reproduced from the front of the cone without cancellation by the sound from the rear. Okay?"

VOLTAGE MULTIPLIER

"Definitely," said Smithy. "It looks as though I must concede that you've learned *something* during your years in the Workshop."

"I tell you," bragged Dick, "I'm a real gen kiddy, I am! Now ask me about something beginning with C."

"Right-ho," said Smithy obligingly. "Tell me what you know about the Cockcroft-Walton multiplier."

There was a moment of uneasy silence.

"Come again?"

"The Cockcroft-Walton multiplier."

Again there was a period of silence.

"*That* has to do with electronics?"

"It has," replied Smithy. "Apart from any other electrical or electronic applications it may have, the Cockcroft-Walton multiplier circuit has been standard equipment in quite a few domestic television receivers over recent years. It provides e.h.t. for the tube."

"Well, I must admit you've beaten me on this one," confessed Dick. "How does the circuit work?"

Smithy reached for his notepad.

"I'll sketch out some circuits to show you," he remarked, busying himself with his pencil. "As a matter of fact, the Cockcroft-Walton multiplier is quite simple to understand, and it consists of just a few rectifiers and capacitors. Here's a typical example, where it's used as a voltage doubler. (Fig. 2(a)). By the way, when examining this circuit remember that conventional current, from positive to negative, goes in the direction of the arrow in the rectifier diode symbol."

"Fair enough," said Dick, looking carefully at Smithy's diagram. "I see you've put an e.h.t. winding in your sketch."

"That's right," replied Smithy, "Lets assume for the moment that it's part of a line output transformer and that the upper end of the winding produces a positive pulse of 5kV with respect to chassis on each line flyback, and zero voltage in between. These 5kV positive pulses will first of all charge up C1 via D1 to 5kV. Between pulses C1 will, in its turn, charge up C2 via D2, to 5kV also. This means that, during succeeding pulses, the upper plate of C2 now goes up to 10kV, whereupon C3 becomes charged, via D3, so that *its* upper plate is 10kV above chassis. In consequence, you get an output of 10kV from the upper plate of C3 although the input pulse from the e.h.t. winding is only 5kV."

"Blow me, that's neat."

"It is, isn't it?" agreed Smithy. "Now, the main advantage of the multiplier is that you can continue to add capacitor and rectifier stages, whereupon you can get an output which is three times the input voltage, four times, five times or even more. I'll add another capacitor and rectifier stage to my original circuit to show you what I mean. (Fig. 2(b)). There are two new rectifiers, D4 and D5, and two new capacitors, C4 and C5. These work in just the same way as do D2, D3, C2 and C3, whereupon the output is now three times the input. In our example we'll get an output of 15kV."

"Is this the sort of circuit that's used in TV sets?"

"Not exactly," replied Smithy. "In TV sets, the approach is to omit C1 and have a final capacitor across the whole chain. Like this (Fig. 2(c)). The final capacitor is given by the inside and outside aquadag coatings of the c.r.t. to which the multiplied voltage is applied. You still get the same voltage multiplying effect, but the old C1 is now effectively provided by the c.r.t. capacitance in series with C5 and C3. In practical TV sets the e.h.t. coil supplying the rectifier normally gives 7kV pulses, and the output to the c.r.t. is 21kV off load, and is stated to be 20kV nominal. The rectifiers are special high voltage selenium types, and the circuit does not give off X-ray radiation, as would occur if you had a single e.h.t. rectifier valve working at a voltage as high as 20kV."

"Well," admitted Dick, "that *was* something I didn't know. Anyway, let me ask you one now."

"Fire away."

"D," announced Dick, "stands for Doppler effect. What's Doppler effect?"

"Doppler effect," replied Smithy promptly, "is the apparant change in frequency from a radiating source when it's moving with relation to the observation point. You get it with sound waves as well as with radio waves. If, for example, a railway locomotive passes you with its whistle sounding, the apparent frequency of the sound is greater than its actual frequency when the locomotive approaches you and is lower than its actual frequency when the locomotive is going away from you. The apparently higher frequency when the locomotive is approaching you is given because, so far as you're concerned, the cycles are compressed. And the reverse applies when the locomotive goes away from you. In radio applications, Doppler effect is employed in airborne navigation systems to determins ground speed and wind drift angle. It's also used in radar to distinguish between fixed and moving targets and to find the velocity of the latter. Again, it can also be used to determine the track of an earth satellite."

"Hell's teeth," said Dick, crestfallen. "All I knew about Doppler effect myself was the locomotive whistle business!"

"Don't let it worry you," replied Smithy soothingly. "To square things up, I'll give you a nice easy one for E. What's 'empire cloth'?"

"Is that the stuff they use for making Union Jacks?"

"Of course it isn't," retorted Smithy irritably. "It's a linen or cotton cloth which is first starched and then impregnated with an oil-based varnish. The usual type of empire cloth is bright yellow, but there's also a black version which is given if bitumen is incorporated in the varnish."

"What's empire cloth employed for?"

"To provide insulation," replied Smithy. "The cloth is cut into tape of different widths, as required, and the tape is then wound round whatever it is you want to insulate."

"Like ordinary black insulating tape?"

"Rather the same," agreed Smithy. "But empire tape isn't sticky and is much stiffer than black insulating tape. Also, it's waterproof and gives better insulation. Anyway, that's E done. F is next, so I'll ask you to tell me what Ferroxcube is."

"Ferroxcube," said Dick without hesitation, "is the Mullard trade-name for their ferrite materials. Like you get in ferrite aerial rods."

"Good," approved Smithy. "You also find Ferroxcube in many other applications, such as line output transformer and deflector yoke cores, computer memory cores, pot-cores, adjustable r.f. coil cores and a whole host of other things. G comes after F, so now tell me what 'grid base' is."

"It's the negative voltage," returned Dick promptly, "that you apply to the control grid of a valve."

"I didn't say grid *bias*, you steaming great twit," snorted Smithy, "I said grid *base*."

"Oh," said Dick, frowning. "Now, wait a jiffy. Ah yes, I remember. 'Grid base' is the negative voltage on the control grid, relative to cathode, which just takes the valve to cut-off."

UP THE CREEK

"That's more like it," replied Smithy, mollified. "Now let me think of something beginning with H."

"Hang on a minute," protested Dick. "How about another go for me?"

"All right, then," said Smithy. "Bash away."

"What," queried Dick, "is a hydrophone?"

"It's an underwater microphone," replied Smithy without hesitation. "It converts sound waves travelling through water into electrical signals. You have them, for instance, in Sonar-Buoys."

"What the heck," asked Dick despairingly, "are Sonar-Buoys?"

"They're light floating transmitters dropped in the sea by aircraft," explained Smithy, "and they're each fitted with a hydrophone. They transmit underwater sounds picked up by the hydrophones, and enable the aircraft to determine the position and track of a submarine. Anyway, let's get back at you now. What's 'infra-red'?"

"That's one of the easy ones," complained Dick, "which always catch me out. I can never remember whether infra red rays are higher in frequency than visible light rays, or lower."

"Red," put in Smithy helpfully, "is at the low frequency end of the visible spectrum."

"Is it?" replied Dick. "Then in that case infra-red rays are those which are a little lower in frequency than visible light rays."

"Hmm," grunted Smithy. "I'm afraid that's not entirely the right answer. Actually, the term 'infra-red'

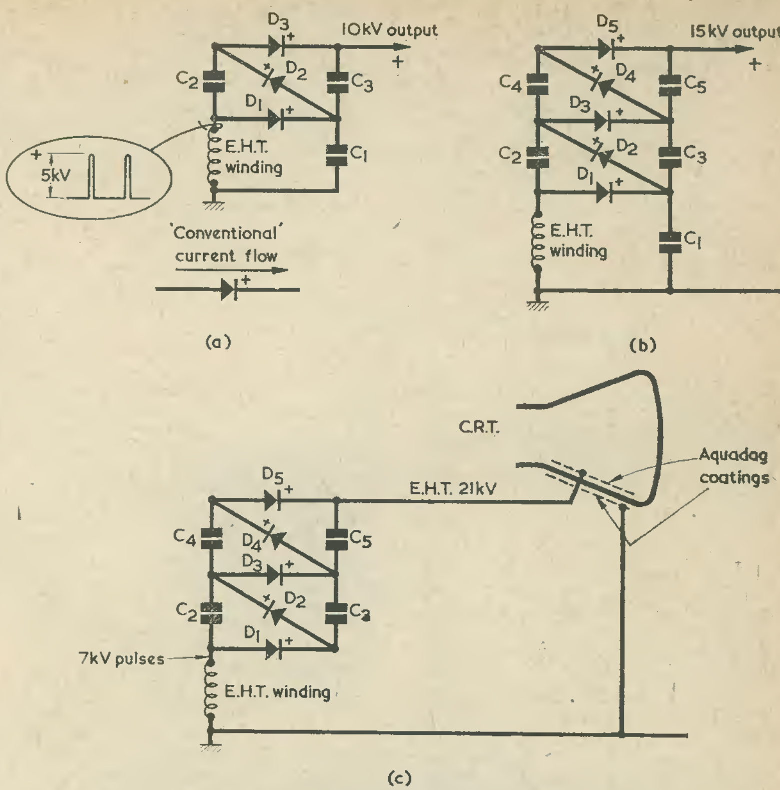


Fig. 2(a). A Cockcroft-Walton multiplier employed as a voltage doubler
(b). The addition of another stage of rectifiers and capacitors results in a voltage tripler
(c). Practical version of the voltage tripler, as employed in television e.h.t. systems

covers virtually *all* the electromagnetic waves whose frequencies fall between visible light waves and radio waves. For the record, electromagnetic rays *higher* in frequency than light rays are the ultra-violet rays, then X-rays and gamma rays. Right at the top of the scale are cosmic rays."

"That's interesting," remarked Dick. "Electronics seems to have a connection with *everything* scientific these days. What's the next letter?"

"It's J," replied Smithy. "Well now, the letter J stands for 'Jim Creek Transmitter'."

"It stands for *what*?"

" 'Jim Creek Transmitter'."

"What on *earth* is that?"

"It's reputed," replied Smithy, "to be the most powerful transmitter in the world, and it has a power of a megawatt. The transmitter is run by the American Navy and it's situated at a place called Jim Creek, Washington."

"Well, it certainly had *me* up the creek," retorted Dick, "and without a paddle, too!"

"Not to worry," grinned Smithy. "Try the next one. This is letter K and it stands for 'knee'."

" 'Knee'?" repeated Dick suspiciously. "The only knee I know about is the one you get in transistor collector current - collector voltage curves."

"Well?"

"It's the part where the curve is most bent."

"Very elegantly phrased," affirmed Smithy, "and correct as well. In actual fact, the term 'knee' applies to *any* curve which has marked curvature in one section, and refers to the part having maximum curvature."

"Good show," said Dick, pleased. "Let me try out the next letter on you. What's a lead-in groove?"

Smithy looked puzzled.

"Is this a gag or something?"

"I'm dead serious."

"All I seem able to think of," said Smithy, frowning, "are aerial lead-ins. Give me a clue."

"All right," replied Dick obligingly. "Just think of changers."

"Changers, eh?" repeated Smithy thoughtfully. "Frequency changers? No. Ah, I've got it now — record changers! You very nearly had me there, Dick, and I'm kicking myself for not having recognised such an obvious term when you first mentioned it. A lead-in groove is the

Fig. 3. Illustrating the essential difference between (a) a variable resistor and (b) a potentiometer

wide pitch groove on the outside of a gramophone record which guides the pick-up stylus on to the playing track."

"Exactly," grinned Dick. "Homer nodded a bit then, didn't he."

"He did indeed," confirmed Smithy ruefully. "It looks as though I'll have to pull my socks up if I'm going to maintain the image. Anyway, M is next, so what is a 'mho'? it's spelt m-h-o-."

"A mho," replied Dick quickly, "is the reciprocal of an ohm. It's the unit of conductance, which is dead opposite to resistance."

"That's correct," confirmed Smithy.

"In fact," continued Dick brightly, "two ohms are equal to half a mho!"

Smithy threw his arms despairingly to the ceiling.

"I *knew*," he lamented "I just *knew* that you'd come out with that hoary old gag. Let's get on quickly to N."

NANOFARAD

"Righty-ho," said Dick briskly. "I'll ask this one. What's a 'nanofarad'?"

"It's a unit of capacitance," replied Smithy, "and it's equal to 1,000 picafarads. Or, if you like, it's one-thousandth of a microfarad. Quite a few circuit diagrams these days have their capacitors marked up in nanofarads, but if you remember that nanofarads come between microfarads and picafarads you shouldn't get muddled. The abbreviated form is nF. Now, here's one for you. What's an 'ohmic connection'?"

"I'll take a guess at it," said Dick. "Is it a connection that obeys Ohm's Law?"

"Right first time!"

"Good show," chuckled Dick. "Now you explain to me what it is that I've just said!"

"You get references to ohmic connections," said Smithy, "in semiconductor devices and in integrated circuits. If you connect, say, an external lead-out to a section of the semiconductor material such as an emitter, a base or a collector, and the potential difference across the connection is proportional to the current flowing through it, then you've got an ohmic connection. In general, it's just another way of saying that the connection behaves like a piece of copper wire, as opposed to what goes on in the semiconductor material itself where potential difference may *not* be proportional to current flow. An ohmic connection to the semiconductor element may, in some cases, be made by a track of metallising over the surface of the semiconductor material, this technique being particularly common in integrated circuits. What's the next letter?"

"P."

"Then tell me what 'pinch-off' is."

"Is that," asked Dick warily, "something to do with f.e.t.'s?"

"Yes, it is," confirmed Smithy. "If you have a depletion f.e.t. the current flowing from source to drain is controlled by the reverse bias voltage applied to the gate. This bias voltage effectively controls the width of the channel along which the current flows and, at the pinch-off voltage, finally closes the channel altogether. It's roughly analagous to stopping the flow of fluid in a rubber tube by pinching it."

"In other words," commented Dick, "'pinch-off' is just the same thing as 'cut-off' in an ordinary transistor or in a valve."

"That's right."

"I think I'll have another go now," announced Dick. "After P we have Q and so I'll plump for 'quadrature'."

"If," said Smithy in reply, "you have two signals of the same frequency but with a phase difference of 90° between them, then you say that the two signals are in quadrature."

"Is *that* all there is to quadrature?"

"That's all," replied Smithy. 'I'll give you a simple one for R — 'rheostat'."

"A rheostat," replied Dick, "is a variable resistor designed to pass a relatively heavy current. You find them in battery chargers and things like that. In other words, it's a large pot."

"It looks," declared Smithy sadly, "as though I've got a lot of straightening-out to do here. To start off with, a rheostat is *any* variable resistor. It's a funny thing but, whenever you mention the word 'rheostat', most people seem to think of a dirty great component wound with resistance wire like a ship's hawser. In actual fact, however, 'rheostat' is just another word for 'variable resistor'. Now, to deal with your final comment, a variable resistor is *not*, if we're going to be pedantic about it, a pot. A variable resistor has two terminals and inserts an adjustable amount of resistance into circuit. (Fig. 3(a). A pot, or to give it its full name of 'potentionmeter', is a potential divider and it connects into circuit via *three* terminals (Fig. 3(b)). I know that in normal work we refer to both variable resistors and potentiometers as 'pots' because the same component is used for both functions, but it's still worthwhile knowing what the correct terms are. After that little excursion into etymology, let's carry on to S."

"I'm ready and waiting!"

"What," asked Smithy, "do you know about s.r.b.p.?"

"I've never even heard of it."

"You handle it every working day."

"Perhaps I do," replied Dick cheerfully, "but I still haven't got a clue what it is!"

"The letters s.r.b.p.," stated Smithy, "represent the correct engineering term to apply to the insulating material which we usually refer to as Paxolin. They stand for 'synthetic resin bonded paper'. So far as I know, 'Paxolin' is an old trade-name for the product, and it has now been discontinued. There's a similar material, incidentally, which goes under the initials s.r.b.f."

"I could make a guess what the b.f. bit stands for!"

"These letters," Smithy went on, firmly ignoring his assistant's comments, "stand for synthetic resin bonded fabric. However, it's the s.r.b.p. stuff that we employ normally in our work. Do you feel like asking me about leter T?"

TRANSDUCER

"Okey-doke," responded Dick equably. "What's a transducer?"

"The word 'transducer'," replied Smithy, "is a blanket term which covers any device that changes signal energy or power from one form to another. A gramophone pick-up is a transducer because it changes the mechanical energy which causes the stylus to move into corresponding electrical energy. So also is a loudspeaker, which converts electrical power into audible sound power. Right now, it's back to me. What are the ultra high frequencies?"

"Why, they're what we call u.h.f.," replied Dick. "That is, Bands IV and V in television."

"Bands IV and V," Smithy corrected him, "fall into the u.h.f. range. But what *is* the u.h.f. range?"

"All these ranges," said Dick, collecting his thoughts, "seem to start and end with 30 or 300 or figures like that. I'll make a guess that the u.h.f. range covers 300 to 3,000 Mc/s."

"You are bright today," replied Smithy approvingly. "That's just what it *does* cover."

The Serviceman opened a drawer in his bench and, after a little searching, produced a sheet of paper.

"Here we are," he remarked. "This is a table of all the frequency ranges which I made out a couple of years ago, just for reference."

Smithy showed the table to Dick, who looked at it with interest.

"You'll see," continued Smithy, "that above the u.h.f. range you have the s.h.f. and e.h.f. ranges, the latter extending up to 300,000 Mc/s. They'll have run out of superlatives if someone should happen to go on the air at a frequency higher than 300,000 Mc/s!"

"What has always puzzled me," put in Dick, "is why these ranges *do* go from 30 to 300 and so on. Why not have the ranges go in a 10 to 100, and 100 to 1,000 sequence?"

"Surprisingly enough, they do," replied Smithy. "As you can see if you look at them in terms of wavelength. For instance, v.h.f. is 30 to 300 Mc/s, or 10 metres to 1 metre. In consequence, the v.h.f. range is also known as 'metric waves'. For the same reason, the u.h.f. frequencies are also described as 'decimetric' waves'. See?"

"Well, I'm dashed," remarked Dick. 'Yes, I do see, now you've explained it to me. Anyway, let me put the next one to you, Smithy. What's a variometer?"

"A variometer," said Smithy, "is a variable inductor. It consists of two coils, one fixed and the other free to rotate inside it (Fig. 4). The two coils are connected in series. The inside coil usually has a lower inductance than the outside coil and you can get a very wide range of overall inductance change by rotating it."

Smithy glanced at the clock.

"Time's passing," he announced. 'We'll have to hurry the last few letters a bit if we're going to reach Z before the end of lunch-break. I'd better make the next letter a dead easy one. What's a watt?"

"When it's at ohm?"

"Dear, oh dear," sighed Smithy. "It is just impossible to achieve victory. Let's hurry on to X, which brings us to 'X-amplifier'."

"That's a dead easy one, too," responded Dick. It's the amplifier in an oscilloscope which feeds the X plates."

"And 'Y signal'?"

"That's the signal which goes into the Y amplifier of the 'scope."

"Well, it *could* be," replied Smithy dubiously, "but a better answer would have been that the Y signal is the luminance signal in a colour TV set."

"The only letter that's left is Z," Dick broke in. "And all I can think of here is zener voltage."

"Yes," agreed Smithy. "The Z's *are* a bit sparse on the ground. Well, zener voltage is, of course, the reverse voltage across a semiconductor junction at which the semiconductor material ceases to act as an insulator. The voltage remains fairly constant despite varying current, and the effect is, of course, put to good use in our old friend, the zener diode."

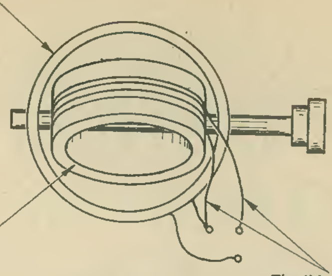


Fig. 4. The basic construction of a variometer

TABLE

Standard Frequency Ranges

Classification	Frequency Range
Very low frequencies (v.l.f.)	Below 30 kc/s
Low frequencies (l.f.)	30 to 300 kc/s
Medium frequencies (m.f.)	300 to 3,000 kc/s
High frequencies (h.f.)	3 to 30 Mc/s
Very high frequencies (v.h.f.)	30 to 300 Mc/s
Ultra high frequencies (u.h.f.)	300 to 3,000 Mc/s
Super high frequencies (s.h.f.)	3,000 to 30,000 Mc/s
Extremely high frequencies (e.h.f.)	30,000 to 300,00 Mc/s

BACK TO WORK

Smithy stood up and started to prepare for the afternoon's work. His assistant also rose, and stretched himself luxuriously.

"Do you know, Smithy," he remarked. "This A to Z business has been quite a bit of fun. We ought to do it again some time."

"As you like," said Smithy. "It certainly gives the brain a bit of exercise, if only because you have to hop about over such a wide range of subjects."

"I've just thought of something," commented Dick. "If I really *did* know all there was to know in electronics from A to Z, instead of pretending that I did, do you know what I'd have?"

"No, tell me."

"Not the big head you're always accusing me of," grinned Dick. "Instead, I'd have AYZ!"

■

PRESTON AMATEUR RADIO SOCIETY MOBILE RALLY

The Preston Amateur Radio Society are to hold their annual Mobile Rally this year on Sunday, 31st of August and are basing the event at Kimberley Barracks, Deepdale Road, Preston.

The Rally held last year, at the same location, was a great success and the organisers are hopeful that the forthcoming event will prove an even greater attraction to 'mobileers'.

Further details may be obtained from the Contests Secretary, G. Wright, Esq., 56 Queensway, Bamber Bridge, Near Preston, Lancs.

SOUTH BUCKINGHAMSHIRE V.H.F. CLUB

A South Buckinghamshire V.H.F. Club has now been formed in the High Wycombe area and meetings are held on the first Tuesday of each month at Bassetsbury Manor, Bassetsbury Lane, High Wycombe.

All who are interested would be welcome and should contact the Hon. Secretary, R. Barton, G3PQH, 25 Hillside Road, Marlow, Bucks.

RE-FORMING AND TESTING ELECTROLYTIC CAPACITORS

by

T. W. BENNETT

Electrolytic capacitors which have been in store for a long period, and particularly if they are in the "surplus" category or have been taken from surplus equipment, should really be re-formed before use. The instrument described in this article is capable of carrying out this process. It can also be used to restore capacitors which would otherwise be discarded due to excess leakage, and to test insulation.

EVEN UNDER IDEAL CONDITIONS, ELECTROLYTIC capacitors which lie idle will tend to de-form and, should the conditions be far from ideal such deterioration will take place much more quickly. A typical example of the latter instance often occurs with "surplus" components. The results of the deterioration are a reduction in capacitance, together with a lowering of internal resistance which gives rise to excessive leakage current. If a capacitor in this condition is put into service without first being re-formed, the excess current passed may be sufficient to overload and seriously damage the capacitor as well as the equipment with which it is associated.

LEAKAGE CURRENT

All electrolytic capacitors should allow a small leakage current to pass when in use to keep them functioning correctly. Normally, this leakage current is minute, being sufficient only to maintain a film of oxide on the capacitor's positive electrode. The object of re-forming is to restore the original capacitance and to reduce the leakage current to the permissible level in order to ensure that the capacitor will work safely at its rated voltage. The method of achieving this is to apply a safe initial low voltage to the capacitor; this voltage is controlled by the condition of the capacitor itself and gradually and automatically rises to the rated working voltage as the state of the capacitor improves. The unit to be described has been designed to produce this result with capacitors having a very wide range of working voltages, and to test, by visual means, the state of the capacitor while the re-forming operation is being carried out.

To understand the basic principle of operation, see Fig. 1. The capacitor undergoing treatment. CT, is connected to a d.c. supply through limiting resistor RL. The value of this resistor has to be carefully chosen to suit the voltage applied to the capacitor. The neon lamp and its associated components connected across RL may be ignored for the moment and they will be referred to later.

We know that there will be a potential difference across RL when current is flowing through it, and that the amount of this potential difference is dependent on the amount of current flowing. The greater the current the larger the voltage drop, and vice-versa.

As an example let RL have a resistance of 75kΩ and let the leakage current through CT be 5mA. Ohm's Law tells us that the resistor will drop 375V under these conditions. If CT has a rated working voltage of 500V and this potential is applied to the whole circuit, then we will have the full 500V between point "a" and the negative line "x", and there will be 500 minus 375=125V between points "b" and "x".

As the current continues to flow, CT will gradually re-form with a consequent reduction of leakage current, thus producing a rise in voltage at point "b" which is, of course, the same as that being applied to CT. The improvement will develop until such time as the leakage current becomes negligible, whereupon there will be hardly any voltage drop across RL and virtually the full working voltage will be applied to CT.

Attention can now be paid to the neon lamp with its series resistor RN. The voltage which is applied to these is that which exists at any given time across RL. When a high current is flowing through the main circuit the lamp will glow continuously, and as the current reduces so the voltage applied to the lamp will grow less until it is insufficient to sustain continuously alight. The neon lamp will then flash intermittently due to the charging and discharging of CN. The flashes will be produced quickly at first but will slow down as the voltage across RL becomes less. When CT is near normal, the period between each flash becomes much longer and finally the lamp will remain permanently extinguished, signifying that the capacitor leakage is now within the accepted limit.

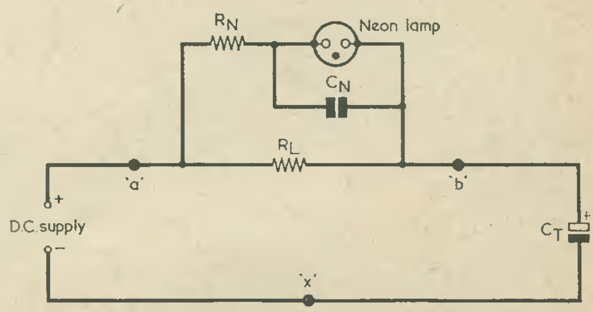


Fig. 1. As is explained in the text, this basic circuit provides both re-forming and test functions

The lamp thus gives a continual indication of the state of CT at any time during the re-forming process.

PRACTICAL CIRCUIT

The conditions needed to treat any particular electrolytic capacitor can be selected by switching in the rated working voltage in combination with a suitable resistor to function as RL. Fig. 2 gives the circuit employed in the unit.

In this diagram S1(b)—over positions 1 to 10—selects a d.c. voltage from the resistor chain given by R1 to R10, the voltage on its arm being passed to R11, R12, R13 and R14. The last three resistors take the place of RL of Fig. 1, whilst R11 is the series neon resistor referred to previously as RN. Position 11 of the switch accomodates capacitors having working voltages of less than 50V. Here the instrument uses a different principle, which is described later. Position 12 is intended for the discharge of capacitors before they are removed from the test terminals.

It will be noted that the values specified for R12, R13 and R14 increase as the test voltage selected by S1(b) decreases. These three resistors are selected to allow approximately the right amount of permissable leakage current to pass when the voltage across each is just below that needed to maintain the neon lamp alight. Thus, the neon lamp can be expected to extinguish when the re-forming process is complete. In general, the permissable leakage current for lower voltage electrolytic capacitors is less than that allowed for capacitors of higher voltage ratings. Therefore, the values of R12, R13 and R14 must increase as the working voltages decrease. The values specified for these resistors have been calculated by the writer, working from general capacitor specifications.

TABLE
SWITCH POSITIONS

Switch Setting	Function
1	For capacitors of over 500V wkg.
2	For capacitors from 450 to 500V wkg.
3	For capacitors from 400 to 450V wkg.
4	For capacitors from 350-to 400V wkg.
5	For capacitors from 300 to 350V wkg.
6	For capacitors from 250 to 300V wkg.
7	For capacitors from 200 to 250V wkg.
8	For capacitors from 150 to 200V wkg.
9	For capacitors from 100 to 150V wkg.
10	For capacitors from 50 to 100V wkg.
11	For capacitors below 50V wkg.
12	Discharge capacitor

The mains transformer, T1, has a 250V secondary winding capable of supplying a current of 35mA. A suitable type, if a component with a 35mA secondary cannot be obtained, is the R.S.C. midget clamped mains transformer which offers 250V at 60mA and 6.3V at 2A. The 6.3V winding is ignored, or can be used to light a pilot lamp. (The R.S.C. transformer may be obtained from R.S.C. Hi-Fi Centres Ltd., 102 Henconner Lane, Bramley, Leeds 13). The recti-

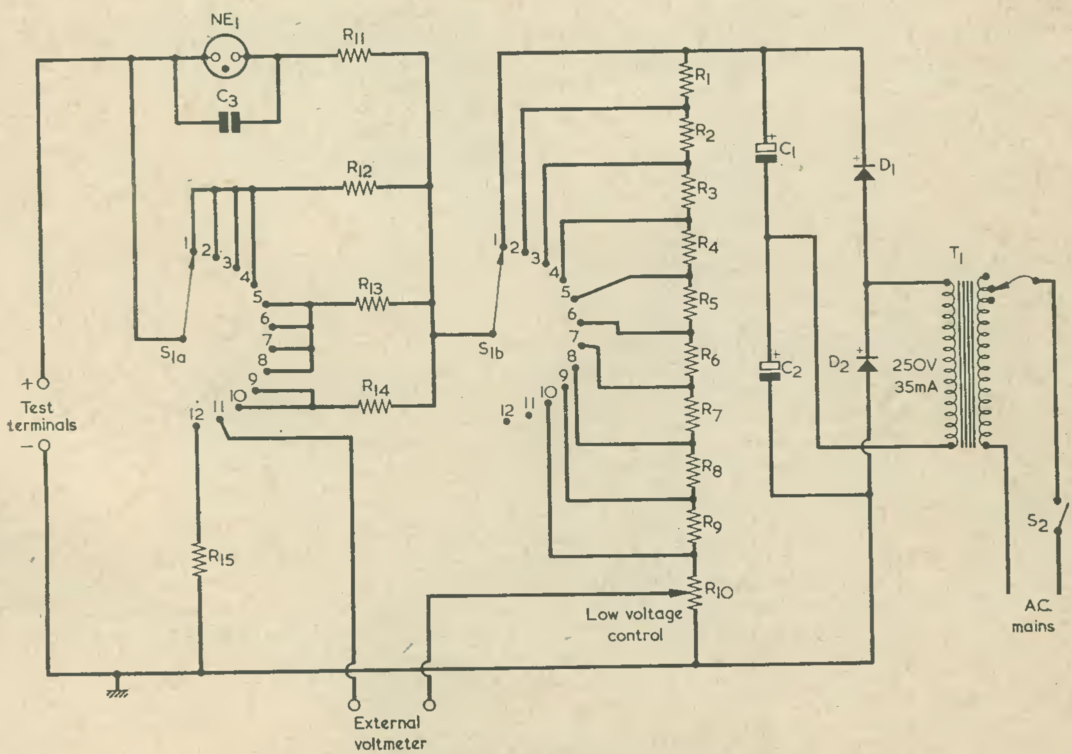


Fig. 2. Circuit diagram of the complete re-forming and testing unit

COMPONENTS

Resistors
(All fixed wirewound resistors 5%. All carbon resistors 10%)

R1	2kΩ, wirewound, 3 watt
R2	2kΩ, wirewound, 3 watt
R3	2kΩ, wirewound, 3 watt
R4	2kΩ, wirewound, 3 watt
R5	2kΩ, wirewound, 3 watt
R6	2kΩ, wirewound, 3 watt
R7	2kΩ, wirewound, 3 watt
R8	2kΩ, wirewound, 3 watt
R9	1.5kΩ, wirewound, 3 watt
R10	2.5kΩ, potentiometer, wirewound, 3 watt
R11	250kΩ, carbon, 1 watt
R12	75kΩ, wirewound, 3 watt
R13	100kΩ, carbon, 2 watt
R14	250kΩ, carbon, 1 watt
R15	1.5kΩ, carbon, 1 watt

Capacitors

C1	16μF electrolytic, 350V wkg.
C2	16μF electrolytic, 350V wkg.
C3	0.2μF, paper or plastic foil, 350V wkg.

Transformer

T1 Mains transformer, secondary 250V at 35mA (see text)

Rectifiers

D1, D2 Selenium rectifiers, half-wave, 250V 35mA or greater

Switches

S1(a)(b) 2 pole 12 way, wafer
S2 s.p.s.t. on-off, toggle

Neon lamp

NE1 Hivac neon type 16L (Henry's Radio Ltd.)

Miscellaneous

2 pointer knobs
Terminals and test leads, etc. (see text)
Cabinet

fiers D1 and D2 are half-wave selenium types rated at 250V 35mA or more, and may be finned or contact-cooled.

Voltage doubling rectification is employed. C1 and C2 are the reservoir capacitors and the rectified voltage is developed across the chain of resistors R1 to R10 which serves the double purpose of rectifier load and voltage divider.

To operate the unit with capacitors having working voltages of 50V or more, the selector switch S1(a) (b) should be initially set for the working voltage of the capacitor to be re-formed (see Table of Switch Positions). Ensure that S2 is off, then connect the electrolytic capacitor to the test terminals, observing the correct polarity. Switch on the mains supply with S2. Should the capacitor not be up to standard this will be indicated by the neon lamp glowing or flashing, according to the condition of the capacitor. Leave the unit switched on until such time as the lamp remains extinguished for at least 30 seconds, and the capacitor will then be suitably re-formed. The selector switch should then be turned to position 12 to discharge the capacitor before removal.

The unit can also be used for general insulation testing and for leakage checks on paper capacitors. Use a high voltage range for these tests. It should be remembered that paper capacitors cannot, of course, be re-formed. Neither, incidentally, can electrolytic capacitors which have suffered mechanical damage or which have become faulty in use.

A word of warning would not be out of place, and is worthy of a paragraph on its own. *Keep the fingers clear of the capacitor when the higher voltage ranges are in use. An unpleasant or even dangerous shock can be the reward for any carelessness or absent-mindedness.*

LOW VOLTAGE CAPACITORS

Since it is difficult to use the neon lamp technique with capacitors having working voltages of less than 50V, a different approach is employed here.

With the mains supply off the selector switch is set to position 11 and a voltmeter (preferably with an f.s.d. of at least 1mA, i.e. 1,000Ω per volt or better) is connected to the External Voltmeter terminals. The test terminals should then be temporarily short-circuited, the mains supply switched on, and R10 adjusted so that the meter reads the rated working voltage of the capacitor to be tested. The voltmeter is then left in circuit, the mains switched off and the short-circuit removed from the test terminals. The capacitor can now be connected and the mains supply switched on again. If any leakage is present in the capacitor this will be indicated by a deflection in the meter. When the meter reading has dropped to almost zero, the capacitor is re-formed.

It will be seen that, in this instance, the voltmeter is itself employed as the series resistance. A meter with a sensitivity of 100Ω per volt or better is preferable, as this will be more capable of indicating low leakage currents.

It is important to remember that the voltmeter must *not* be left connected to the unit when tests on switch position 1 to 10 are being carried out. This is because it is possible for a charged high-value capacitor to discharge into the meter as S1(a) passes position 11, and the discharge current through the meter may be sufficiently high to cause damage.

CONSTRUCTION

Construction is very simple, but there is a special point to observe regarding C1. The negative side of this capacitor is not connected to the negative supply line, and should it be of the canned variety then its case must be insulated either with sleeving or p.v.c. tape, or by mounting it on Paxolin or other insulating material. One other point to bear in mind is that it is advisable to allow adequate ventilation for the voltage divider network. The power rating for these resistors, as recommended, is more than generous. Some degree of warmth will be generated in view of the fact that some capacitors may take two or three hours to re-form.

The type of case in which the unit is housed can be left to the constructor's discretion, as he may have a suitable one to hand. The only panel controls required are the selector switch and the mains on-off switch. Also, the neon lamp must be fitted so that it is visible from the front. The test and External

Voltmeter terminals should be of the insulated type to reduce the risk of accidental shock. Alternatively, plugs and sockets may be used. The test leads may be terminated with shrouded crocodile clips. In this respect, Electroniques have available small crocodile clips under Code No. GE152C, with separate insulating sleeves under Code No. GE389/BK (black) or Code No. GE389/RD (red).

All the components listed are easily available. Should any difficulty be experienced in obtaining the ganged 12-way selector switch it is worth while mentioning that Radiospares "Maka-Switch" kit parts can be used to make up this component. These are available from Henry's Radio Ltd. or Home Radio Ltd.

The writer would like to state, in conclusion, that he has used one of these units for some years now, and that it has paid for its cost many times over both as an insurance against damage to other components and in restoring electrolytic capacitors which would otherwise have been discarded as being below standard. ■

Radio Topics

By Recorder

IT HAS OFTEN OCCURRED TO ME in the past that whilst humankind, when thinking of alien life species, for ever looks outwards towards the stars, such a species could well be comfortably ensconced already on our very own planet. I imagined an omnipresent all-permeating Alien Intelligence which was slowly and cynically controlling human actions until, eventually, its human victims had unknowingly set the stage for it to appear in physical form.

Evidence has since come to my hand which has convinced me that this is what is *actually* going to take place. I shall now recount to you what I have uncovered and I shall leave you to draw your own conclusions.

THE FACTS

It is, of course, possible to dismiss speculations concerning an Earth-based Alien Intelligence by simply drawing attention to the fact that our unwelcome visitor would require material tools and implements in order to take the world over on AI (Alien Intelligence) Day. It would also very definitely need a large and powerful computer if it were to successfully gain superiority over computer-oriented man. It could be said that, quite obviously, such a computer is not in existence.

Isn't it?

On my occasional trips to London I stay at one of those large and relatively inexpensive hotels which crowd a great many rooms in a single building and which are all characterised by plumbing that is, to say the least, mildly temperamental in nature.

Several years ago on a London visit, whilst getting ready to go out for the evening, I happened to turn on the hot water tap in my hotel bedroom. Nothing happened. Sounds from the next room indicated that the hot water tap there was running at the same time so, wise through experience, I waited until the next-door occupant turned his tap off. This occurred after a short while whereupon, with a little gurgle and splutter, my own tap came on. I thought nothing more about this incident until about ten minutes later when I once more turned on my own hot water tap. This time the water flowed immediately. However, several seconds later there was a loud curse from the next room, and it was obvious that my neighbour had just turned *his* tap on, to find that no water flowed. As soon as I turned my own tap off it was evident, from the sounds transmitted through the piping, that his had come on.

I still would have dismissed the whole business from my mind had it not been for the fact that my neighbour in the room on the *other* side chose to turn on his hot water tap, unwittingly setting it to a critical level which caused a loud periodic banging in the pipes. There was obviously a resonance in the system, and my mind turned for the moment to the subject of electronic resonance. It was at that exact instant, while what I can best describe as the "electronic section" of my mind was in control, that I suddenly perceived the significance in the behaviour of the original two hot water taps.

It was obvious! Those two taps had been purposely installed so as to form a flip-flop. Either one tap could be on or the other tap could be on, but both taps could not be on together.

Fortunately, my neighbours on either side were helpful people and, after I had knocked them up, had no objections to my carrying out some experiments with their taps. Apart from the flip-flop effect and the resonance I have already mentioned, I could detect no further phenomenon so far as the hot water system was concerned, and so I turned my attention to the cold water taps.

And it was here I made my most exciting discovery of the day. All three cold water taps worked correctly when turned on individually or in any combination except one. This combination was given when my two neighbours' cold water taps were on; if this occurred, my own cold water tap refused to emit even the vaguest suggestion of moisture. So far as I was concerned, this was the situation that clinched the whole matter. Call my tap A and the other taps B and C and you immediately have the case where A is not-on when B *and* C are on. A NAND gate—the most powerful gate used in a computer!

THE FUTURE

Thus were my suspicions aroused. Since that time I have stayed at a different hotel on every visit I make to London and in each instance I have checked on the plumbing.

Never have I failed to find some form of gate suitable for use in a computer. The most common are NAND gates of the type I've just described, but next in quantity are NOR gates, where tap A is not-on when either tap B *or* C *or* both together are on. Every WC I have checked has its own individual preset time delay between flushes, and I have encountered one-bit memories exemplified by the occasional washhand basins which refuse to drain away. After phone calls to the Reception desk, these latter are always cleared by large sinister men (doubtless in the pay of AI) who ascend from the basement armed with enormous rubber plungers.

I visualise the future with horror. On the day when there are sufficient London hotels in being, each fitted as are those I have visited with its own programmed plumbing, all the Plunger-men will come to the surface, whereupon they will quietly and unobtrusively couple together strategically positioned inlets and outlets with temporary piping until there is one vast complex of interconnected plumbing sprawling all over London.

It is then that the Alien Intelligence will finally materialise. And it will be backed by the very largest digital computer working on fluidic principles that has ever been assembled.

Don't say you haven't been warned.

POST OFFICE TRANSISTORS

It came as news to me to learn that the Post Office is a manufacturer of silicon transistors, and for this fascinating item of information I must thank the January issue of *The Post Office Electrical Engineers' Journal*. The transistors are special ultra long-life types intended for use in repeaters in undersea telephone cables, and are capable of amplifying 1,260 telephone conversations simultaneously. They are made to a guaranteed standard which specifies that not more than one transistor in 500 may fail in 25 years. The need for this exceptionally high reliability stems from the fact that a single repair in a deep sea cable can cost over £250,000 in lost revenue alone. The Post Office is among world leaders in this particular manufacturing field.

The transistors have been developed and are currently being made at the Post Office Dollis Hill research station, and extraordinarily stringent steps are taken to maintain the high standard required. Indeed, for every 500 transistors needed, up to 10,000 have to be made. The rest are used up or discarded in a series of rigorous checks and high temperature tests designed to isolate fault-free production batches. A failure in one transistor can mean the rejection of a complete batch.

To give an idea of the reliability achieved, some transistors are put through destruction tests simulating no less than 1,000 years of use. About half of the transistors survive even this.

The transistors are made in a special laboratory with temperature and humidity control. Filtered air is blown across the benches, and if an engineer wants to sneeze he goes to a special "sneeze hatch" coupled to the laboratory's air exhaust system.

The production of active amplifying devices is not a new activity for the Post Office, and it maintains the excellent tradition for reliability which was initially set up by Post Office long-life valves. Some 3,000 long-life valves have been made by the Post Office in the past and have been fitted in deep water repeaters. There has been only one failure in 145 million valve hours of service.

GROAN DEPT.

As I mentioned some months ago, a "jack" is a socket and there is no real need to refer to it as a "jack-socket". In other words, the term "jack" is sufficient to suggest a socket to me.

Get it? Socket to me?

Oh well, I've heard worse from Sam Costa.

F.E.T. VOLTMETER

Turning smartly to a completely different subject, I must record the fact that we are still receiving complimentary comments from readers concerning G. A. French's "Simple F.E.T. Voltmeter", which appeared, in the Suggested Circuit series, in our July 1968 issue.

You may recall that the 9-volt battery for the f.e.t. voltmeter had neither of its terminals connected to chassis (actually, the metal case of the instrument) and was in consequence "floating". A reader, Mr. R. O. Broome of Doncaster, warns of a peculiar effect which may occur if 9-volt batteries of the metal-clad type are used. He employed a PP7 metal-clad battery in his own version of the f.e.t. voltmeter, securing this to the voltmeter case by means of a metal strap. He next found that he was getting varying readings when trying to set up the instrument. Suspecting the battery, he removed it, wrapped it in p.v.c. tape, then refitted it under its metal strap. This time the voltmeter functioned correctly.

The reason for the trouble is that the insulation between the battery and its metal case is not sufficiently good to be effective at the high resistances encountered in the voltmeter circuit. So, if any other readers are contemplating the use of a metal-clad battery with the f.e.t. voltmeter, or with any similar device where both battery terminals have high circuit resistance to chassis, they are advised to insulate the battery case from the chassis.

We are indebted to Mr. Broome for passing on this information.

COLOUR TV AND TAPE

I suppose that the best of us tend to look for the unexpected when we deal with devices which take advantage of electronics coupled with magnetism. For instance, there's a rumour wandering around that colour TV receivers are liable to erase magnetic recording tape, because of their degaussing coils and their high-power horizontal deflection circuits.

However, I understand that there's no truth in this rumour and that it is quite in order to store tape close to a colour set without risk of erasure due to the varying magnetic fields generated inside the set.

This having been said let me scotch, before it starts, the reverse rumour that heavily recorded tape can upset the colour TV receiver's purity and convergence adjustments!

See you next month!

RSGB 1969 International Radio Engineering and Communications Exhibition

This annual event, of great interest to many radio amateurs, constructors, s.w.l.'s and electronic students, will be held again this year at the Royal Horticultural Society's New Hall, Greycoat Street, London, S.W.1. 10 a.m. to 9 p.m. 1st to 4th October inclusive.

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"MEDIUM WAVE NEWS" Monthly during DX season —Details from: K. Brownless, 7 The Avenue, Clifton, York.

FOR SALE: 88mH toroid coils, 5/- each. Cover for Siemens Teleprinter, 50/-. Ink rollers for Creed type 3 teleprinter, 5/- per bottle. EMI Fisk Solariscope, 7/6d. Prices include p. & p. Box No. F356.

FOR SALE: Brand new Heathkit RA-1 ham receiver Factory aligned, unused since. Best offer secures (Cost £40). Gowers, 6 Common Lane, Sawston, Cambs. (Telephone: 3093).

CRYSTAL SET—COMPLETE KIT. Includes all components, earphone, case, full instructions. Guaranteed. 25/-. H.A.C. Radio, 29 Old Bond Street, London, W.1.

FOR SALE: *Practical Wireless*, Jan. 1967 to March 1969. 25/-. *Practical Television*, same, 25/-. *Practical Householder*—20 copies 10/-. 17in. Bush TV—81R, needs overhaul, £4 10s. 80 valves—various, £1. Ancient typewriter, usable, £2. Please collect or add for postage. Wanted: Cheap 2 or 4 metre tuner/receiver. King, Point Cottage, Dale Hill, Ticehurst, Sussex. Telephone: 522.

JOIN THE INTERNATIONAL S.W. LEAGUE. Free Services to members including Q.S.L. Bureau, Amateur and Broadcast Translation, Technical and Identification Dept.—both Broadcast and Fixed Stations, DX Certificates, contests and activities for the SWL and transmitting members. Monthly magazine, *Monitor*, containing articles of general interest to Broadcast and Amateur SWLs, Transmitter Section and League affairs, etc. League supplies such as badges, headed notepaper and envelopes, QSL cards, etc., are available at reasonable cost. Send for League particulars, Membership including monthly magazine, etc., 35s. per annum. Secretary ISWL, 60 White Street, Derby.

SMALL ADVERTISEMENTS

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TECHNICAL DRAWINGS, Artwork, etc. Electronic and Radio Circuits a speciality. Moderate charges. B. P. Meaney, 43 Forest Road, Worthing, Sussex.

EXCHANGE: Year old Eddystone EC10 for EB35 of similar vintage. Cash adjustment. Box No. F363.

OUR PORTABLE ELECTRIC SOLDERING IRON is a sensational line. 40W, 220/240 volt. Plastic covered extension wire. Handle unscrews when not in use. Completely safe. 14/11d. plus 1/6d. p. & p. F. Hollows (R.C.1), 36 Henley Avenue, Pelton Fell, Chester-le-Street, Co. Durham.

WORLD DX CLUB covers all aspects of SWLing on Amateur and Broadcast Bands through its monthly bulletin *"Contact"*. Membership costs 25s. a year. Enquiries to Secretary, WDXC, 17 Taunton Road, Bridgwater, Somerset.

BOOKS FOR SALE: *Radio Astronomy*, Bernard Lovell & J. Clegg 12/6d. *Earth's Envelope*, Theo Lobsack 10/-, *Space Research & Exploration*, D. R. Bates 15/-, *Practical Yacht Racing*, Schiottz 15/-, *Yacht Racing*, Sturgess £1, *Faster Sailing*, Bavier 10/-, *The Story of Atomic Energy*, Soddy 7/6d., *Radioisotope Laboratory Techniques*, Faires 7/6d., *Atomic Medecine*, Behrens 15/-, *Medical Radiation Biology*, Ellinger £1, *Sunday Times & Life World Library Volumes: Brazil, S.E. Asia, Israel, Italy, Russia, Mexico, Greece, Africa, Germany, France, India, Britain, Japan, Scandinavia*, 12/6d. each, *Life Science Library: Wheels, Mathematics, Man & Space, Planets, Energy*, 12/6d. each, *The Colour of Canada*, £1, *Science Survey 3*, Vista Books £1, *Science Today & Tomorrow* 10/-. Box No. F364.

POSTAL ADVERTISING? This is the Holborn Service. Mailing lists, addressing, enclosing, wrappering, facsimile letters, automatic typing, copy service campaign planning, design and artwork, printing and stationery. Please ask for price list.—The Holborn Direct Mail Company, Capacity House. 2–6 Rothsay Street, Tower Bridge Road, London, S.E.1. Telephone: 01–407–1495.

WANTED. Glass paperweights. Please send details and price to Box No. F365.

GREEN ELECTRONICS FOR COILS & TRANSFORMERS wound to your specification, assembly and wiring of circuits. S.A.E. for details. "Templecombe", Cleveland Road, Worcester Park, Surrey.

FOR SALE: Headphone sets. S.G. Brown type F. High impedance, 12,000 ohms. Used but excellent condition. £1 post paid. Box No. F366.

FOR SALE: Solartron Oscilloscope CD568, £15 o.n.o. Marconi valve voltmeter T5428B, £4 o.n.o. Both robust construction. Box No. F367.

FOR SALE: Newnes *Radio & TV Servicing* Volumes 1 to 5. £7 10s. Marchant, 27 Long Street, Tetbury, Glos.

FOR SALE: *The Radio Constructor*, June 1960 to August 1968 inclusive. March 1961 only missing. What offers? Box No. F368.

FOR SALE: Codar CR.45 mains t.r.f., 150kc/s–30Mc/s. New in January. Still perfect. £8. Write: "Invararey", Queen's Road, Tipton, Staffs.

FOR SALE: Disposing of small collection of 78 r.p.m. records. Classical, semi-classical and light music (some musicals). Many collector's items. S.A.E. for list. Box No. F369.

ESSEX GARDENERS. Buy your bedding and rock plants, shrubs, etc., also cacti from May's Nurseries, 608 Rayleigh Road, Hutton, Brentwood, Essex. Callers only. Monday to Saturday.

SMALL ADVERTISEMENTS

Continued from page 673

MAGAZINES FOR SALE: *Wireless World* July to November 1965 inc., January to September 1966 inc., 1967–January & February and May to September inc. *Radio Constructor* January 1966 to March 1968 inclusive. *Practical Electronics* November 1964 (No. 1 issue) to December 1966 inclusive. *Practical Wireless* 1964 February to April inc., June, November & December; 1965–March to December inc.; 1966–January to December inclusive. *Practical Television* 1965–January, April to December inc.; 1966–January to July inc., plus September & October. *Short Wave Magazine* 1965–March, July, September to December inc.; 1966–January to November inc.; *R.S.G.B. Bulletin* 1965–January, March, June, August, September, November & December; 1966–January to September inc., plus November. *Hi-Fi News* 1965–May, August to October inc., November & December; 1966–January to October inc. *Amateur Tape Recording* 1965–May, August, September, October & December; 1966–January to April inc., June to August inc.; 1967–April, May, June to September inc. What offers? Will sell in lots or separately. Can be collected in London. Box No. F370.

LINEAR AMPLIFIER FOR SALE. G2DAF circuit. Plug-in coils for 40, 20 and 15 metre bands. Pair QY 3-125's. Nicely home built in Phillpotts cabinet 11in. wide x 12in. deep x 12in. high. Solid state power supply to suit as per description in *The Radio Constructor*, August 1966 issue. In cabinet 8in. wide x 11in. deep x 9½in. high. Matsunaga Variac and 0-3000V d.c. meter. £50 o.n.o. Box No. F371.

FOR SALE: Radio Control model M.T.B. Aerokit Patrol Torpedo Boat, 40in. x 11in. Good detail. Taplin Twin engine. Twin rudders. Steering and speed control on throttle fitted. Raven Flight Electronics new R/C equipment, needs installing. £50 o.n.o. Box No. F372.

FOR SALE: Two re-entrant type loudspeakers, fitted back to back on common base. Suitable public address or pop group. Powerful. 15 ohm input. Spare diaphragms. £5. Box No. F373.

PROPERTIES for sale and to let in London and suburbs. Apply to Maggs & Stephens, Estate Agents, 229 Maida Vale, London, W.9. MAIda Vale 8123.

FOR SALE: Back numbers of *The Radio Constructor*, Vol. 15, No. 12 to Vol. 22 No. 1 inclusive at 2/- each, or offers. Also *Wireless World* 1963 to 1968. Evans, 29 Tycehurst Hill, Loughton, Essex.

LARGEST SUPPLIERS OF SERVICE SHEETS: TV, Radio, Tape Recorders, Record Players, Transistors, Stereograms, Radiograms. Only 5/- each, plus s.a.e. Uncrossed P.O.'s please, returned if service sheets not available. We have the largest supplies of service sheets (strictly by return of post). Please state make and model number alternative. Mail order only. Please mention *The Radio Constructor* when answering this advert. Mr. C. Caranna, 71 Beaufort Park, London N.W.11.

INNOVATION IN DX CLUBS ANNOUNCED! Formed in October, 1965, the Radio New York Worldwide Listeners Club now has 3,600 members in 86 countries! A unique club offering shortwave listeners monthly magazines containing listening tips and technical features, numbered wallet-sized membership cards and gold 8½in. by 11in. membership certificates. Multilingual report forms available for cost of postage. "We must be doing something right!" Find out . . . join now!" Send 7s. 2d. (crossed domestic money order) for one year's membership to: The Radio New York Worldwide Listeners Club, 485 Madison Avenue, New York 10022, U.S.A.

RADIO CONSTRUCTORS DATA SHEET 26

625-LINE COLOUR AND MONOCHROME TELEVISION

The Table lists extracts from the current (February 1969) specification for transmitted 625-line colour and monochrome television signals in the U.K.

General (colour and monochrome)

Channel width	8 Mc/s
Spacing between unmodulated sound and vision carriers	6 Mc/s
Vision modulation (a.m. negative):	
Upper sideband	5.5 Mc/s
Lower sideband	1.25 Mc/s
Synchronising level[1]	100%
Blanking level[1]	76%
White level[1]	20%
Sound modulation (f.m.):	
Peak deviation	50 kc/s
Pre-emphasis	50μS
Ratio of vision power during synchronising pulses to sound power	5 :1
Lines per picture	625
Interlace	2 :1
Field frequency	50 c/s[2]
Line frequency	15,625 c/s[2]
Approximate gamma of picture signal	0.36
Aspect ratio	4 : 3

1 As percentage of maximum vision carrier amplitude.

2 The transmissions are asynchronous; i.e., the synchronising signals are derived from a stable oscillator and are not locked to the mains.

Colour (PAL system)

Relationship between colour, line and field synchronising signals:

Colour sub-carrier frequency

$$(f_{sc}) = (284-\tfrac{1}{4})\, f_{line} + \tfrac{1}{2} f_{field}$$
$$= 4.43361875 \text{Mc/s} \pm 1 \text{c/s}$$

Complete colour picture signal

General specification:

The colour picture signal corresponds to a luminance (brightness) component transmitted as amplitude modulation of the picture carrier and a simultaneous pair of chrominance (colouring) components transmitted as the amplitude-modulation sidebands of a pair of suppressed sub-carriers in quadrature having a common frequency as defined above.

Delay specification:

The group-delay characteristic of the transmitter is nominally flat; there is no precorection for receiver performance.

Luminance component:

The *attenuation versus frequency* characteristic of the luminance signal is substantially uniform from d.c. to 5.5 Mc/s, except where it may be modified in a region embracing the colour sub-carrier frequency, e.g. by use of a notch filter.