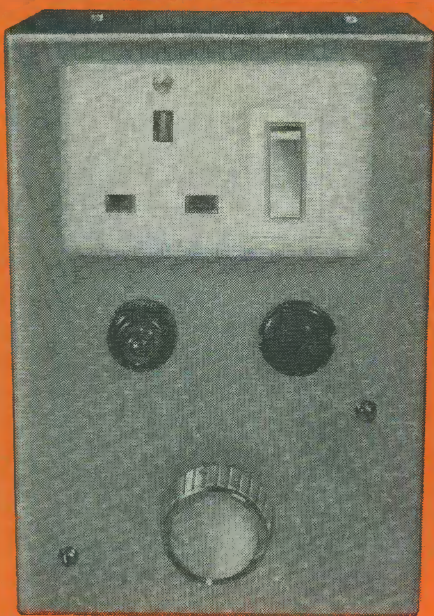
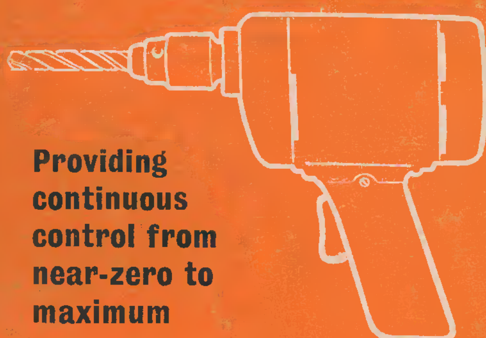
THE
RADIO CONSTRUCTOR

Vol. 23 No. 7 FEBRUARY 1970 THREE SHILLINGS



Electric Drill Speed Controller



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AAZ12	17/6	BC142	15/-	BYY25	31/9	NKT221	5/6	OC26	12/-	1N4007	5/6	2N2369A	6/-
AC107	14/6	BC143	15/-	BYY142	3/9	NKT222	4/-	OC28	12/-	1S44	1/6	2N2432	58/4
AC126	6/6	BC147	4/7	BYZ10	9/-	NKT223	6/-	OC29	15/-	2G302	3/9	2N2477	18/-
AC127	6/-	BC148	3/3	BYZ12	6/-	NKT223A	3/6	OC35	9/6	2G339A	5/-	2N2484	14/-
AC127Z	8/6	BC149	4/7	BYZ13	5/-	NKT224	4/6	OC36	13/-	2G374	5/-	2N2613	8/3
AC128	4/-	BC154	12/-	C106FI	9/-	NKT225	3/6	OC41	3/6	2G381	5/-	2N2614	7/6
AC151	8/8	BCY10	7/6	C111	18/-	NKT226	10/-	OC42	4/-	2G371	4/-	2N2646	10/-
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AC188	12/-	BCY31	9/2	C426	8/3	NKT261	4/3	OC45	3/-	2N301	8/-	2N2924	5/-
ACY17	5/9	BCY32	20/5	CG6E	4/-	NKT270	3/6	OC70	3/-	2N109	13/6	2N2925	5/6
ACY18	3/6	BCY33	4/11	CG63	2/-	NKT271	5/-	OC71	3/-	2N217	7/6	2N3036	39/2
ACY19	4/5	BCY34	6/6	D13TI	10/-	NKT272	5/-	OC72	4/6	2N386	12/-	2N3053	8/-
ACY20	3/7	BCY38	8/-	EA403	3/6	NKT273	4/-	OC73	3/-	2N384	17/-	2N3054	15/-
ACY21	4/-	BCY39	28/-	EC401	5/-	NKT274	5/-	OC75	5/-	2N385A	15/-	2N3055	15/-
ACY22	2/11	BCY40	16/-	EC402	4/8	NKT275	5/-	OC76	2/6	2N388A	15/-	2N3394	6/-
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AF116	4/4	BD123	23/6	K8/30	9/-	NKT403	16/-	OC169	6/-	2N697	5/3	2N3711	3/3
AF117	4/4	BD124	15/-	K3/50	8/3	NKT404	13/8	OC170	4/-	2N698	4/6	2N3819	8/-
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AF121	4/-	BF154	9/-	MAT101	5/6	NKT451	13/8	OC200	6/3	2N706A	3/-	2N3826	6/-
AF124	6/-	BF159	15/-	MAT120	5/-	NKT452	13/4	OC201	10/-	2N708	4/-	2N3906	7/6
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BC107	2/9	BTX40/		NKT152	3/4	OA85	1/6	XA702	15/-	2N1308	8/-	2S302	6/-
BC108	2/9	600R	120/-	NKT161	5/8	OA90	1/6	ZT22	19/-	2N1309	8/-	2S304	15/-
BC109	2/9	BTY87/		NKT162	5/8	OA91	1/6	ZT86	27/6	2N1507	4/8	2S320	12/6
BC113	5/-	150R	31/-	NKT163	5/4	OA95	1/6	ZT2270	19/6	2N1613	6/6	2S322	8/-
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16V	2.5	10	20	40	80	125
25V	1.6	6.4	12.5	25	50	80
40V	1	4	8	16	32	50
64V	0.64	2.5	5	10	20	32
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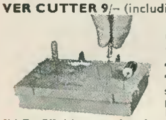

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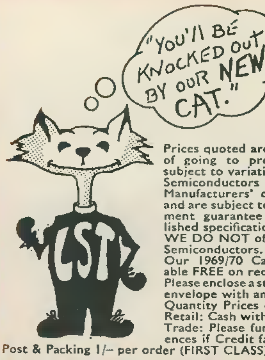

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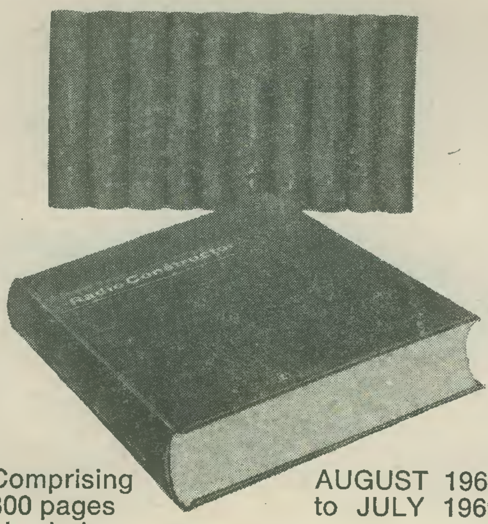

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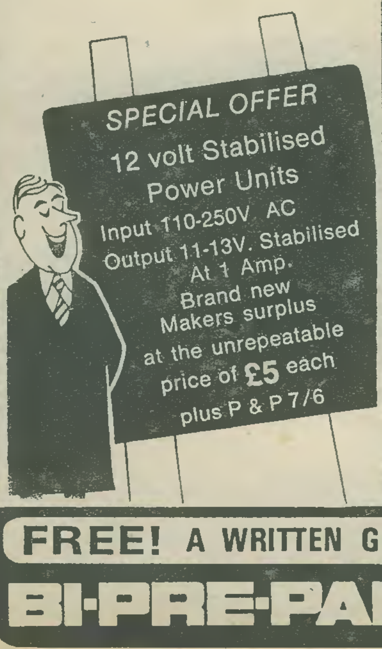

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MARCH ISSUE WILL BE PUBLISHED ON MARCH 2nd

Experimenter's Power Supply

by

C. CROSBIE

Employing simple basic principles, this power unit offers a continuously variable output voltage ranging from zero to 25 volts. An overload protection circuit enables output current to be limited to any desired level up to 1 amp. A further feature is the provision of an optional trigger circuit which gives a visual indication when the overload circuit commences to operate

THE SIMPLEST TYPE OF CONSTANT-VOLTAGE POWER supply is composed of a resistor in series with a zener diode, as in Fig. 1(a). This arrangement wastes both current and voltage although, for a mains power unit, a small power loss can be tolerated. Also, the power 'wasted' by the zener diode generates heat in this component whereupon, for large power supplies, the zener diode needs to be a high-power component. The power supply has an output impedance equal to the parallel combination of the series resistance and the slope resistance of the zener diode. The latter is usually very much smaller than the former but will still, nevertheless, be several ohms or more.

Adding an emitter-follower amplifier as in Fig. 1(b) facilitates the use of a low power zener diode, and the output impedance becomes equal to the emitter resistance of the transistor plus the sum of the zener diode slope resistance and transistor base resistance divided by the transistor current gain. All the transistor parameters here refer to its use in common emitter. Since the emitter resistance is of the order of 0.05Ω only for power transistors, and since the base resistance will be much lower than the zener diode slope resistance, the output impedance is approximately equal to zener diode slope resistance divided by transistor current gain.

The power supply circuit to be described in this article takes advantage of the reduced output impedance offered by inserting a transistor between the control voltage (provided in Fig. 1(b) by the zener diode) and the output terminals. It is intended, however, to function purely as a variable voltage power supply offering voltages up to 25 volts and currents up to 1 amp *without* stabilisation. As such, it will be particularly useful for the experimenter and amateur constructor. An overload protection circuit is included.

The basis of the variable voltage part of the circuit is shown in Fig. 2(a). The principle is the same as for the zener-controlled circuit of Fig. 1(b), except that it is the variable voltage from the potential divider VR1 which is now applied to the transistor base. The transformer and rectifiers provide a nearly constant d.c. supply (subject to mains variations) which is smoothed by C1. C2 provides further smoothing to the base of the transistor (except when the slider of RV1 is at maximum) so that the output from the emitter is very smooth. If we say that R_b is approximately the combined parallel resistance of the two parts of RV1 (divided by the slider) plus the supply resistance, the output resistance is approximately equal to R_b divided by the transistor current gain. The output capacitance is approximately equal to C2 multiplied by transistor current gain (over the frequency range at which this gain is exhibited).

We require the power supply to offer currents of up to 1 amp and, if we use the circuit of Fig. 2(a), it will be necessary for RV1 to provide current to the base of the transistor which is equal to this figure divided by the transistor gain. This makes it necessary for RV1 to have a relatively very low value, whereupon it has to be a high-power component. This difficulty is overcome by changing the transistor for a 'super-alpha' pair, as shown in Fig. 2(b). The overall gain is now very much higher, being approximately equal to the product of the current gains of the individual transistors. If RV1 is given a fairly low resistance the current drawn from its slider for high output currents is negligibly low compared with the standing current flowing through it, with the result that the output from the emitter of TR2 is the voltage at the slider of RV1 less about 0.4 volt due to the base-emitter drop in both transistors. (This assumes germanium

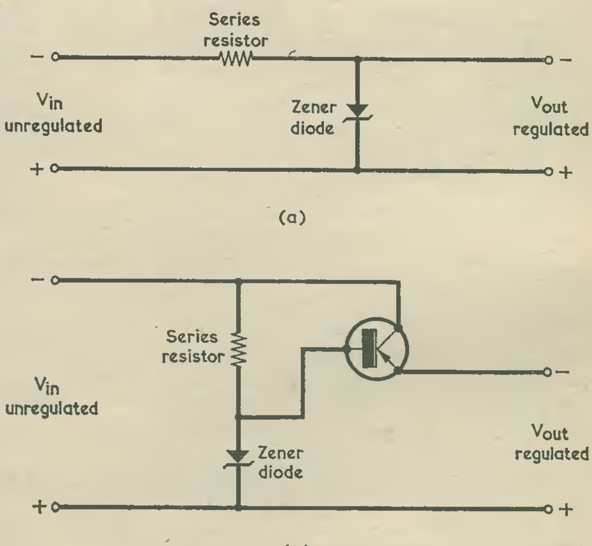


Fig. 1(a). A simple means of obtaining power supply regulation

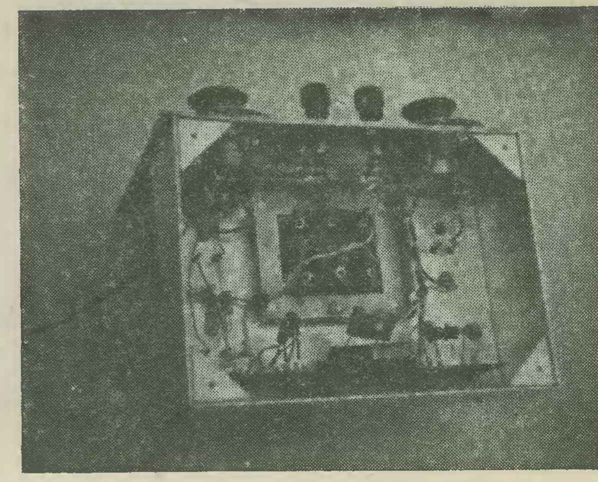
(b). Adding an emitter follower results in reduced output impedance, together with lower dissipation in the zener diode

transistors.) RV1 could be fitted with a scale calibrated directly in terms of output voltage.

PROTECTION

The circuit of Fig. 2(b) offers no protection against overload, and a very heay current could flow in TR2 if the output were accidentally short-circuited. A 1-amp fuse in series with TR1 emitter would provide some protection, but could not be relied upon to act rapidly enough to protect TR2 in the worst cases.

For protection, a circuit element having a constant current characteristic is required, and a transistor may be employed as a constant current device by taking advantage of its collector voltage/current characteristic. Fig. 3(a) illustrates a typical characteristic for a transistor with a fixed bias current. Below the 'knee' of the curve, which corresponds on the current axis to I_b multiplied by the transistor gain, the transistor exhibits very low resistance whilst, above the 'knee', any increase in current can only be achieved by large increases in applied voltage. For a power transistor the slope resistance beyond the 'knee' may be about 100Ω, while the actual resistance may fall to about 30Ω. Thus in practice, while a power transistor is not a true constant-current device, it is close enough to one to provide adequate protection for a power supply unit.



A view underneath the chassis of the power supply

The method of protection is shown in Fig. 3(b).

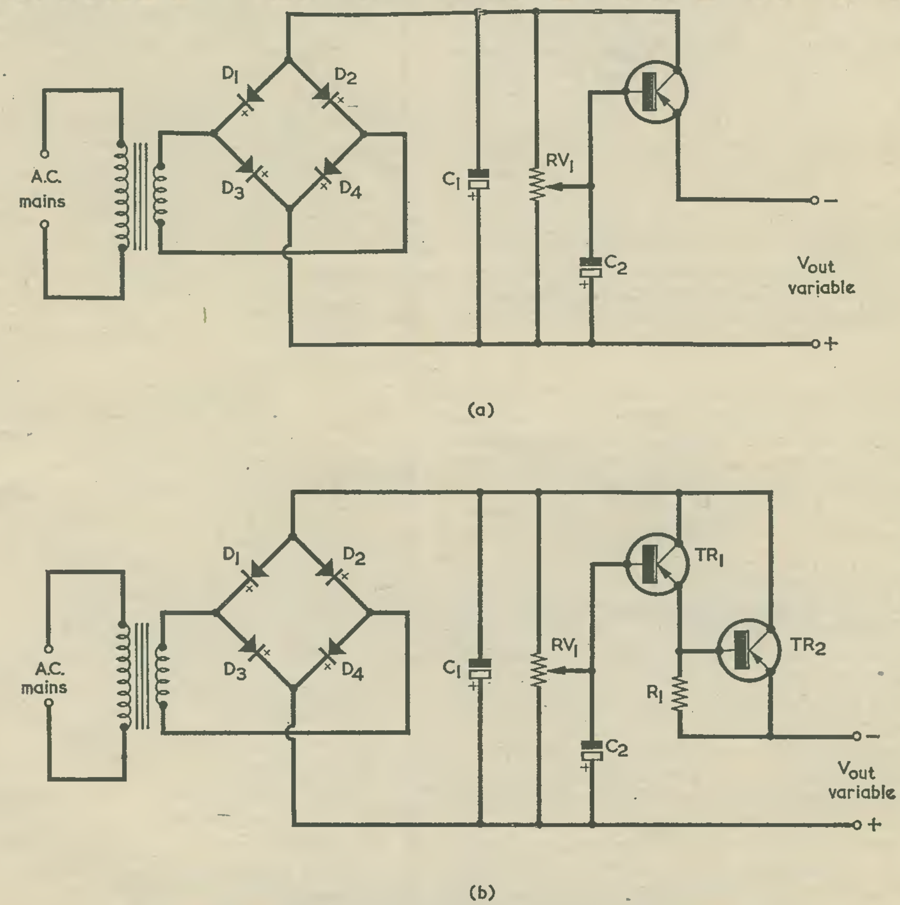
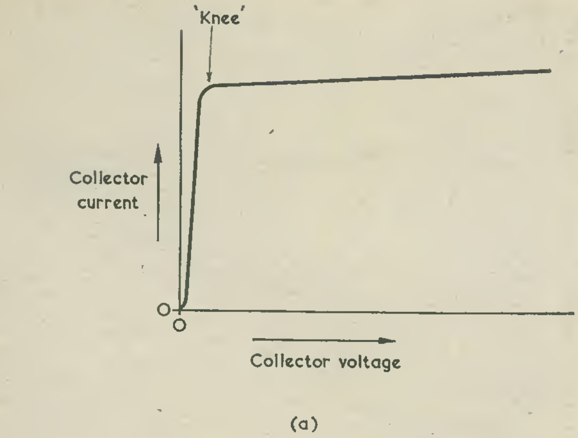


Fig. 2(a). Adapting the circuit of Fig. 1(b) to provide a variable output voltage

(b). Employing a 'super-alpha pair' in place of a single transistor further improves performance



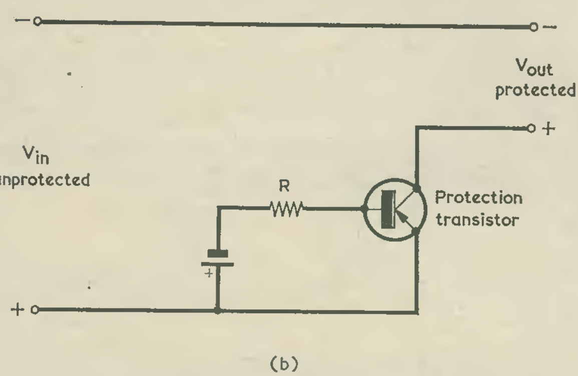


Fig. 3(a). Typical collector characteristic for a transistor with fixed base current

(b). The characteristic enables a transistor to be employed in the basic protection circuit shown here

The protection transistor is connected in series with the output from the power supply and its base is coupled via the fixed resistor, R, to a constant direct voltage, shown as a battery for convenience. In this way the transistor will behave as the characteristic of Fig. 3(a), and will only have a significant voltage across it when the 'knee' current is reached.

This approach ensures protection of the power supply, but what of the circuit being supplied? The latter will often be in the nature of an experimental prototype, and it may be very desirable to protect it from currents which would damage it but not the power supply. The need now arises for a protection circuit whose protection current can be varied. Since the protection current is proportional to Ib the obvious approach is to vary the I_b in Fig. 3(a). To enable the protection transistor to be run from a small potentiometer across the main d.c. supply, the transistor of Fig. 3(b) is replaced by a 'super-alpha' pair, and Fig. 4 shows the power supply of Fig. 2(b) modified to incorporate protection. In Fig. 4 the mains transformer, diodes D1 to D4, capacitors C1 and C2, R1, RV1, and transistors TR1 and TR2 are the same as in Fig. 2(b).

RV2 and R2 provide the adjustable bias current whence the protection current is set. TR3, TR4 and R3 take the place of the protection transistor in Fig. 3(b). Suitable component values and types are given in the Components List. R2 is found in the following manner. First set RV2 to maximum and RV1 to mid-range. Connect an ammeter across the output terminals and try different resistors in the R2 position until one is found which causes 2 amps to pass through the ammeter. Start with about 100kΩ and reduce the value carefully.

A particular characteristic of power transistor behaviour, not so far taken into account, is leakage current (i.e. the collector-emitter current which is passed when no base current is present). The disadvantage resulting from leakage current in the circuit as so far discussed is that the voltage at the emitter of TR2 can rise above the voltage at the slider of RV1. This is due to leakage current and occurs when the required output is at a low voltage and current. The effect is nullified by the inclusion of the 680Ω resistor, R6, across the output terminals. If the leakage effect remains serious, resistor R1 may be reduced to about 36Ω.

As a final point, the mains on-off switch is ganged with RV2. This potentiometer is wired such that the unit is switched off when RV2 slider is at the positive

COMPONENTS

(Fig. 4)

Resistors:

(N.B. RV1 and RV2 should be standard components, *not* miniature).

R1	100Ω ½ watt 10%
R2	See text, ½ watt
R3	100Ω ½ watt 10%
R4	1kΩ 1 watt 10%
R5	220Ω ½ watt 10%
R6	680Ω 2 watt 20%
RV1	3kΩ wirewound
RV2	5kΩ carbon, linear, with switch S1

Capacitors:

C1	2,000μF electrolytic, 30V wkg.
C2	100μF electrolytic, 30V wkg.
C3	2μF electrolytic, 30V wkg.

Transformer:

T1	Douglas type MT3AT (Henry's Radio)

Semiconductors:

TR1	OC36
TR2	OC36
TR3	ACY17
TR4	OC36
D1-D4	Silicon rectifiers, minimum rating 2 amps, 35 p.i.v. (e.g. RS50AF)

Switch:

S1	d.p.s.t., part of RV2

Pilot Lamp:

PL1	6V 100mA, LES (Henry's Radio—see text)

Miscellaneous:

Mica washers and insulating bushes (for TR1, TR2 and TR4)
LES lamp holder, insulated—see text.
2 knobs
2 terminals
Chassis, panel, etc.

end of its track, where it selects lowest protection current.

Fig. 5(a) indicates the overload performance of the unit when RV1 is set to 5 volts and RV2 is set to 100mA. The dashed line indicates ideal overload protection, whilst the solid line shows the performance obtained in practice. Fig. 5(b) shows the results given for settings of 10 volts and 300mA.

INDICATION OF PROTECTION

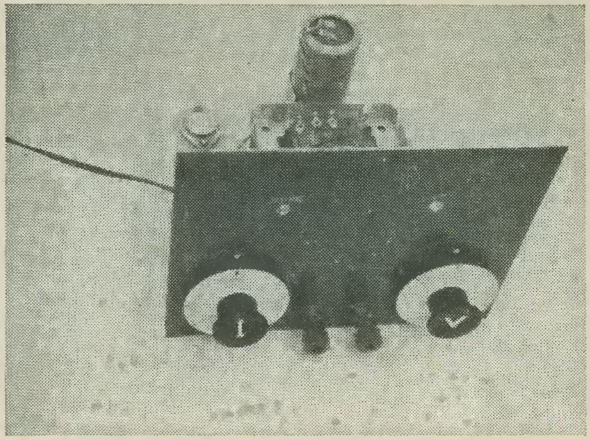
There remains one thing missing from the unit. The output voltage is adjustable and both the unit and its load are protected against excess current — but no indication is provided in the unit as to whether the protection circuit has gone into operation.

One method of providing an indication would be to insert an ammeter in the output circuit with a range switch to select different current ranges. A second method would be to connect a voltmeter across the output terminals. A third method, and that which was adopted in the prototype, is to sense the voltage across TR4. If there is more than a fraction of a volt across this transistor the protection circuit is beginning to operate. Whatever method of indication is employed the unit should be switched off when protection commences to come into effect.

A circuit which senses the voltage across TR4 will now be described and this can be added as an optional extra to the unit if so desired.

The sensing circuit is the Schmitt trigger shown in Fig. 6, where the voltage across TR4 is applied via R7 to TR5. It can be seen that if this voltage is less than that across R10, TR5 is held off and TR6 conducts, causing the bulb, PL2, to light up. In this condition, TR6 is held on by the potential divider given by R8-plus-R9 and R11. When the base of TR5 is taken above the voltage across R10 (plus the small V_{be} in TR5), TR5 begins to conduct. The voltage at its collector falls, causing TR6 to be switched off and the bulb to be extinguished. R8 and the bulb (when lit) both have about the same resistance so that the trigger circuit takes the same current in either of its two states. The single series resistor, R12, may in consequence be used to provide a suitable voltage for the trigger from the main rectified supply in the power unit.

Thus, the protection circuit indicating lamp remains illuminated until the current drawn from the unit starts to exceed the protection current selected by RV2. It then extinguishes, whereupon the unit should



Front view of the prototype supply unit. The component behind the mains transformer is capacitor C1. RV1 and RV2 are marked 'V' and 'I' respectively

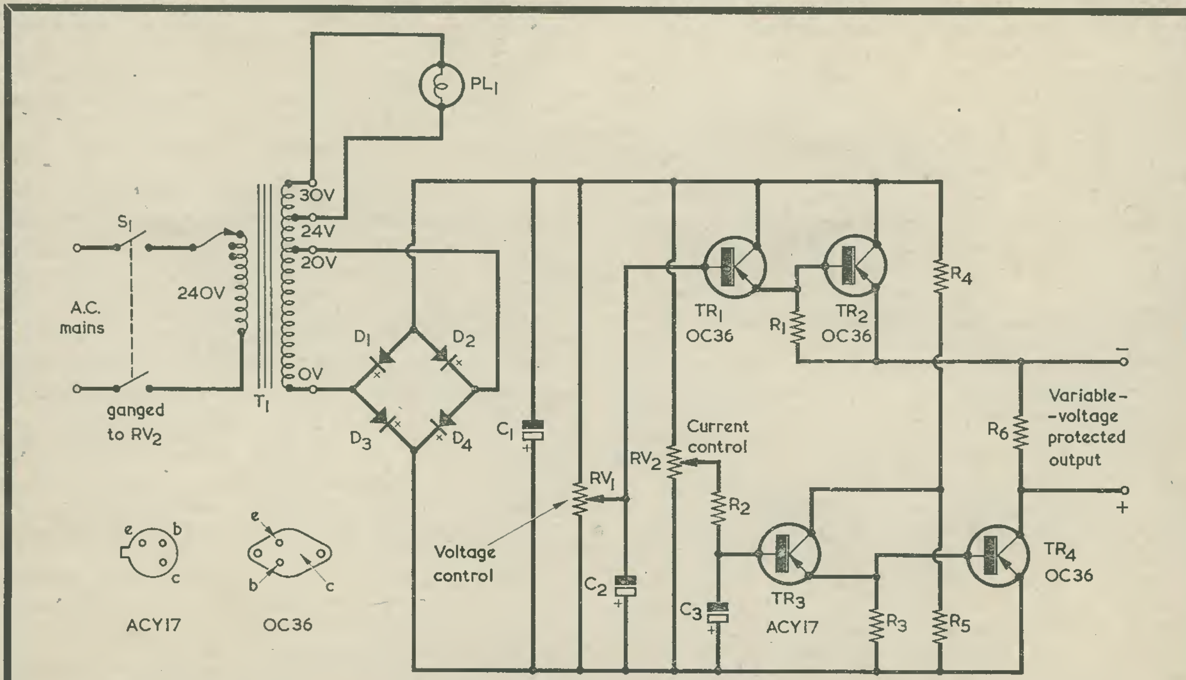


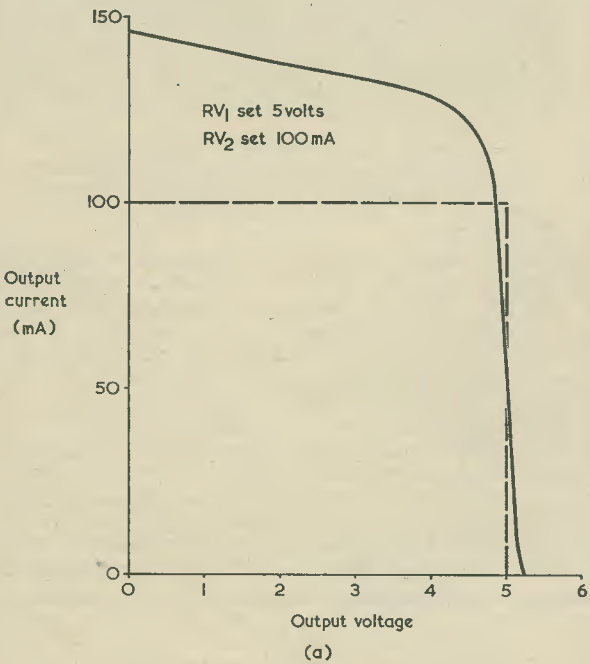
Fig. 4. Complete circuit diagram for the power supply, with variable voltage and variable maximum current controls

be switched off. The cause of the overload should be removed before the unit is switched on again.

PERFORMANCE

The performance of the power supply should be adequate for the requirements of experimenters. The output impedance varies with the setting of RV1, and is typically around 3Ω. Output voltages extend up to 25 volts.

The output power is limited by TR2. Low voltage high current outputs (e.g. 3 volts at 1 amp) cause



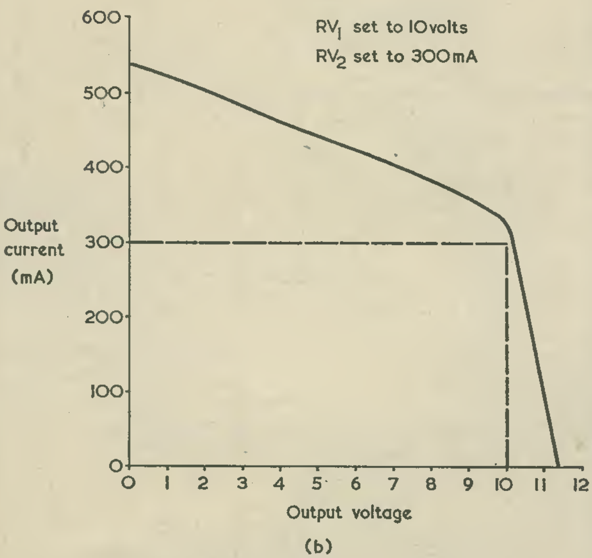


Fig. 5(a). Output characteristic for the supply when RV2 is set to 100mA

(b). The output characteristic for a setting of 300mA

COMPONENTS

(Fig. 6)

Resistors:

(All resistors are ½ watt 10% unless otherwise stated)

R7	1.5kΩ
R8	68Ω
R9	680Ω
R10	10Ω
R11	180Ω
R12	220Ω 3 watt

Transistors:

TR5	OC81
TR6	OC81

Pilot Lamp and Holder:

PL2 6V 100mA, LES (Henry's Radio)

LES lamp holder, insulated—see text

TR2 to be run fairly close to maximum power dissipation. At high voltage outputs, the output current may safely exceed the nominal 1 amp maximum figure for the unit, a typical example being given by an output of 20 volts at 2 amps.

CONSTRUCTION

The prototype was assembled on an 18 s.w.g. aluminium chassis measuring 7½ by 5½ by 2¼ in., this being fitted with an 18 s.w.g. aluminium front panel measuring 6 by 8in. The chassis forms a heat sink for TR1, TR2 and TR4, and these are secured to its surface with mica washers and insulating bushes. Care must be taken to ensure that there are no burrs on the chassis holes or any other surface irregularities which may reduce the efficiency of the thermal coupling between the transistors and the chassis. This point applies, in particular, to TR2, and it would be a good plan to apply a thin film of silicone grease to both sides of the mica washer before fitting this transistor. Silicone grease may also be employed for TR1 and TR4.

A cut-out in the chassis takes the mains transformer specified, and the remainder of the components were assembled on a sheet of perforated Paxolin with turret tags tapped in.

Both potentiometers should be wired such that their sliders are at minimum (the positive end of the track) when their spindles are fully anti-clockwise. It should be noted, incidentally, that potentiometers with large diameters permit smoother adjustment. Voltage and current scales may be marked out on 2 in. diameter discs screwed or glued to the bottoms of the two control knobs. (The current scale is calibrated with the aid of an external ammeter connected across the output terminals.) The exterior parts of the chassis may be painted matt black to assist heat radiation.

The mains transformer has a multi-tap secondary, the OV and 20V taps being employed for the power supply. A 6 volt supply (from the 24V and 30V taps) is taken from the secondary to supply a 6 volt panel light. It should be noted here that the Components List for Fig. 4 specifies a 6 volt 100mA LES lamp for PL1, in order that it may match the similar lamp, PL2, employed in the protection indicator circuit. If,

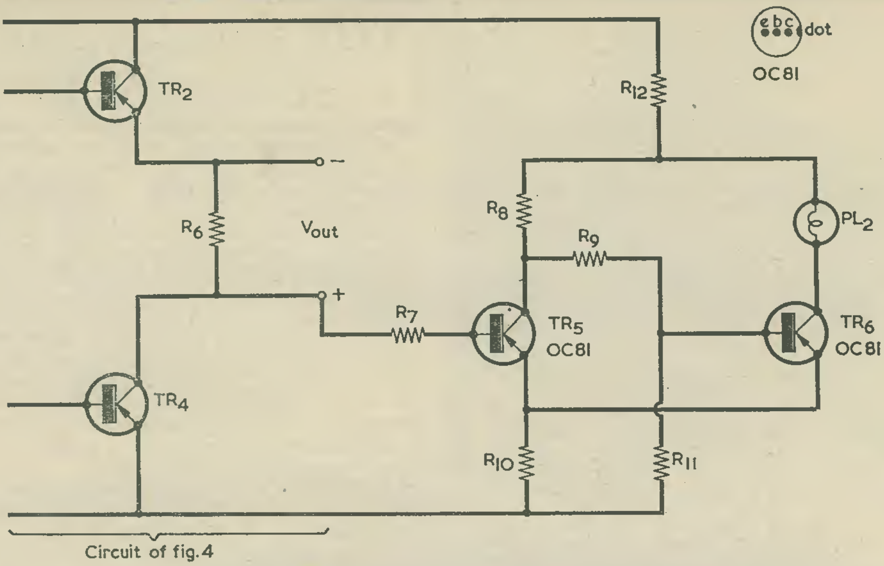


Fig. 6. An optional trigger circuit. This causes PL2 to extinguish when the protection circuit commences to operate

however, the latter is not incorporated in the power unit, PL1 can be any 6 volt pilot light.

There is no connection between any part of the power supply circuit and the chassis. So far as the power transistors are concerned, this point is catered for by the insulated mounting. Care should be taken to see that the bulb holders used for the lamps are of the type which have both contacts isolated from the mounting bracket.

■

EARTH STATION TECHNOLOGY CONFERENCE

The conference on earth station technology which is to be held at the Institution of Electrical Engineers, Savoy Place, London W.C.2., from the 14th to 16th October 1970, will consider the international operational experience that has been acquired with the present generation of earth stations and the existing systems of communication satellites.

Planning for the Intelsat IV systems and the various military, regional and domestic satellite systems is well advanced, and considerable developments are taking place in earth station technology. The conference programme will include: the interaction between satellite parameters and earth station characteristics; earth station configuration; electrical, mechanical and structural aspects of earth station aerials; aerial feed systems; high-power transmitters; low-noise amplifiers; modems, frequency conversion equipment, monitoring and control and operational and reliability aspects.

The conference is being organised by the IEE in association with the Institution of Electronic & Radio Engineers and the Institute of Electrical & Electronics Engineers. Further details and registration forms will be available in due course from the Manager, Conference Department, IEE, Savoy Place, London, W.C.2.

MANAGEMENT AND ECONOMICS IN ELECTRONICS

An account of the research and development policies in the Japanese electronics industry is to be given at the international symposium on management and economics in the electronics industry to be held in Edinburgh from the 17th to 20th March 1970. S. Shima, managing director of the Sony Corporation, will give the keynote address in the session on the management of innovation, making particular reference to research and development. Technological innovation in electronics in recent years has taken Japan to second place in the world production league for electronic equipment and components.

Keynote addresses will be given in the other sessions at the symposium on: marketing, A. L. Humphreys, managing director, International Computers Ltd.; management services, A. Chargueraud, president, Diebold Europe SA, France; manpower and training, F. Metcalfe, chief education and training officer, EITB; the role of governments, Lord Beeching; economics and scale of manufacture, C. H. Villiers, managing director, Industrial Reorganisation Corporation.

The symposium is being organised by the Institution of Electrical Engineers, in association with the Institution of Electronic & Radio Engineers, the Institute of Physics & the Physical Society and the Institute of Mathematics and its Applications, together with the support of thirteen other professional and government organisations and learned societies.

Further details of the symposium and registration forms are now available from the Manager, Conference Department, IEE, Savoy Place, London, W.C.2.

THE GOOD, THE BAD AND THE UGLY

THE GOOD side of Amateur radio is undoubtedly the all-pervading spirit of comradeship that exists and the consequent co-operation between individuals that invariably results.

Comradeship has existed within the Amateur radio movement since its inception some 50 or so years ago and is still, to this very day, one of its main driving forces. This apparently self-generating spirit is endemic and spontaneous, showing itself in many differing ways.

At the local Club the warmth of welcome, the bonhomie, the friendships and the sometimes intense feeling of belonging are all direct evidence of the cameraderie that is part and parcel of the Amateur scene. Personal contacts with fellow enthusiasts, many of them leading to life-long friendships, are a common result of Club membership. It was always thus.

On the air, comradeship shows itself in the many nets that may be heard and joined, resulting in enjoyable QSO's – often leading to social meetings with other participants. Personal friendships are often maintained by regular transmitting schedules, some of which have been kept for many, many, years. Listening around over the various bands will soon provide evidence of this facet of Amateur radio.

Co-operation is forthcoming from most Amateurs not only on a personal level but also from the combined membership of a Club or Group. Helping each other with advice, giving or swapping components and even supplying free labour for that aerial erecting party. All of this is to **THE GOOD.**

THE BAD exists unfortunately in all walks of life. If we did not have the bad, how would we recognise the good?

Sheer bad operating is one of their hallmarks. The ill-mannered bores can often be heard pushing their unwanted presence smack on top of an existing Dx contact in an effort to work-it-at-any-price – and devil take the hindmost! The work - it - at - all - costs - brigade charge up and down the band listening for choice Dx and, regardless of an existing QSO, usually put out a painfully long call right on frequency. The inevitable result is a splurge of QRM. Other baddies soon add to the cacophony and we have the beginning of that well-known phenomena – the Dx pile-up. Like little Topsy it just grows, the result being a maelstrom of frantic calls upon frantic calls amid an amorphous mass of QRM. In sheer desperation the Dx call holder either goes QRT or shifts rapidly to another frequency.

Then we have that charming (sic) fellow who absolutely insists on sweeping his carrier up and down the band prior to finally tuning up right band on top of a QSO. It apparently never occurs to this character to indulge in the good practice of listening on a channel before occupying it. We could well do without **THE BAD.**

THE UGLY also exists. It abounds in many home-built equipments, the front panels of which sprout a veritable galaxy of differing types of knobs, dials and switches – usually with complete lack of symmetry. A covert peek under some of the chassis would astound even the famed Heath Robinson. The lash-up maze of criss-cross wiring festooned with various components presents a wind-swept bird nest horror to even the most casual glance.

Ugliness is also personified in the Club back-row lawyer. This character invariably knows a better method of doing this or that – the Club Committee being, naturally, a gaggle of fools. Why doesn't he offer to do the job? Simply because he prefers to pontificate rather than perform! We just have to forbear **THE UGLY.**

C.W.

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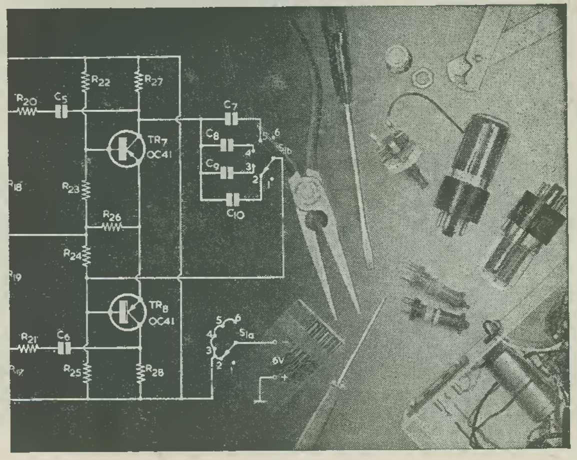
DECIMAL COINAGE CALCULATOR



by G. A. FRENCH

As is evident from the new coins filtering out from the banks into our pockets, the day when Britain changes over to decimal coinage creeps inexorably nearer. The relationship between the present shillings and the future New Pence is quite easy to grasp, but the mental conversion from current *pennies* to New Pence is considerably more difficult, this being due to the 12 : 5 ratio which exists between them. The awkwardness of this ratio is demonstrated when one considers that the quantity of New Pence equal to one current penny is 0.4166 . . . recurring!

This article describes a simple calculating device which enables present currency to be converted to New Pence by way of a simple potentiometer circuit and a meter. Shillings are initially converted to New Pence from a table, and current pennies are next set up on the calculator controls. The meter of the calculator then indicates the quantity of New Pence corresponding to the current pennies. Exactly the same function can, of course, be carried out by a printed conversion chart, with the obvious result that a calculator doing the same job should not be an expensive device. The present circuit has, in consequence, been designed around a very small number of standard components, and it is anticipated that many, if not all, of these will already be available in the average constructor's spares box. The calculator possesses the considerable advantages over a printed conversion chart that it is very easy to consult, that it offers an output indication in a manner that non-technical people will find attractive, and that it is easy to judge the New Pence equivalent to the nearest half New Penny.

The calculator operates from the mains supply and, to keep constructional costs to a minimum, does not incorporate a voltage stabilising circuit. It should not, in consequence, be employed in locations where mains voltage fluctuations are high. An adjustment is available to cater for long-term changes in mains voltage.

CIRCUIT OPERATION

To appreciate how the circuit operates, it is first of all necessary to consider the processes involved when converting from shillings to New Pence. 1 shilling is equal to 5 New Pence, 2 shillings are equal to 10 New Pence, 3 shillings are equal to 15 New Pence, 4 shillings are equal to 20 New Pence, and so on. As may be seen, when the number of shillings is even the corresponding quantity of New Pence runs in the series 10, 20, 30 and so on. At the same time, when the quantity of shillings is odd the corresponding quantity of New Pence runs in the series 5, 15, 25, 35 and so on. If we add current pennies to an even number of shillings, the corresponding quantity of additional New Pence falls between zero and 5. Similarly, if we add current pennies to an odd number of shillings, the corresponding quantity of additional New Pence falls between 5 and 10.

We may now turn to Fig. 1 which shows the circuitry employed in the calculator. For the purpose of explanation, we shall assume that R1, R2 and R3 are all *exactly* equal to 10Ω, and that the current drawn by meter M1 is negligibly low when compared with the current flowing in R3. The mains supply is applied to T1, whose 6.3 volt secondary feeds the circuit comprising R1, R2 and R3 via

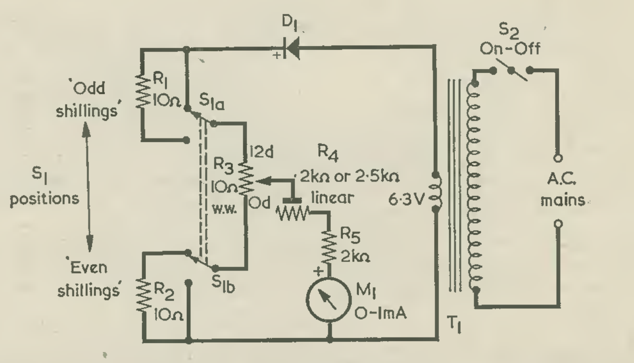


Fig. 1. The circuit employed by the coinage calculator. The text gives important details on the relative values of R1, R2 and R3

rectifier D1. Alternate rectified positive half-cycles become available on the cathode (the left-hand electrode in Fig. 1) of D1. Due to the mechanical inertia in the movement of meter M1 there is no necessity for these half-cycles to be smoothed, and circuit operation is just the same as would be given if a steady direct voltage were applied to R1, R2 and R3.

Meter M1 is a 0-1mA meter having a scale calibrated from 0 to 10. (With many 0-1mA meters such a calibration merely necessitates the addition of a nought after the "1" at f.s.d. to make "10", the decimal points preceding the previous figures on the scale being sufficiently small in size to be ignored.) After switching on, the circuit can, if necessary, be initially set up by putting S1 to "odd shillings", turning R3 slider fully to the "12d" end of its track, and adjusting R4 for f.s.d. indication in the meter. If, subsequently, S1 is put to the "Even Shillings" position, the bottom end of R3 track connects direct to the lower supply line whilst the top end of the track connects to the upper supply line via R1. Adjusting R3 will then cause the meter to give indications between zero and 5. R3 can, therefore, be calibrated in terms of current pennies from zero to 12. Putting S1 to "Odd Shillings" results in the bottom end of R3 track connecting to the lower supply line via R2 and the top end connecting direct to the upper supply line.

TABLE I

Shillings	New Pence
0,1	0+
2,3	10+
4,5	20+
6,7	30+
8,9	40+
10,11	50+
12,13	60+
14,15	70+
16,17	80+
18,19	90+
20	100

Adjusting R3 results, this time, in corresponding indications in the meter between 5 and 10. The previous calibration of R3 will still hold good, however, and the meter indications will be equal to the previous ones plus 5.

Fig. 2 shows a suggested panel layout for the calculator. On the left is a Table, this being a reproduction of Table I accompanying this article. The Table is consulted to find the quantity of New Pence corresponding to the whole number of shillings in the sum to be converted. S1 is next set to "Even" or "Odd" according to whether the qantity of shillings is even or odd. Finally, R3 is adjusted to the quantity of current pennies in the sum, whereupon the additional New Pence are indicated by the meter. To take an example, let us convert 12s. 7d. to New Pence. Since the quantity of shillings is 12, we set S1 to "Even", after which we adjust R3 to 7. The Table indicates "60+" for 12s, and the meter will show 2.9. The corresponding New Pence value is therefore 63 to the nearest New Penny. Should the sum we wish to convert be 5s. 10d., switch S1 is set to "Odd" and R3 adjusted to 10. The meter will indicate 9.2, whereupon the result is 29 to the nearest New Penny.

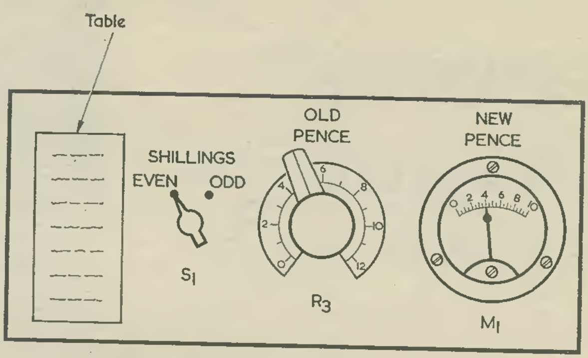


Fig. 2. A suitable panel layout for the calculator

PRACTICAL POINTS

Some practical points have next to be considered. Transformer T1 is a small 6.3 volt heater transformer. D1 is any silicon rectifier capable of passing a forward current of 500mA or more; in the prototype the writer employed a Lucas DD000. Due to the forward voltage drop in D1 the average rectified voltage available for R1, R2 and R3 is somewhat lower than the calculated figure of 4 volts which would be provided by an "ideal" rectifier. In practice, an average voltage of about 3 volts can be expected. The meter reading is proportional to average voltage, and R4 and R5 are given values which provide an f.s.d. reading at 3 volts when R4 slider is fairly near the centre of its track.

Heat dissipation in R1, R2 and R3 is due to the r.m.s. values of the rectified a.c. and not the average values. It will be seen that R3 is always in circuit, with either R1 or R2 in series according to the setting of S1. Thus, D1 is always presented with a 20Ω load, and the r.m.s. current which flows (assuming an "ideal" rectifier) is 220mA. The consequent dissipation in either R1, R2 or R3 is slightly less than 0.5 watt, and all three components should be rated at 1 watt or more. Wirewound potentiometers with a value of 10Ω are, incidentally, available from Home Radio under Cat. No. VR25 for 1 watt and Cat. No. VR22A for 3 watts. (The writer used a Cat. No. VR22A potentiometer for checking the prototype circuit.)

At an average rectified voltage of 3, the average current flow in R3 is 150mA, whereupon the current drawn by meter M1 is relatively quite low in comparison. In any event, R3 is directly calibrated against meter readings on the "Even Shillings" range, whereupon the current drawn by the meter cannot effect the accuracy of the calibration on this range at all. The process adopted for setting up R1 and R2 (to be described later) ensures that the effect of meter current on R3 calibration when S1 is set to "Odd Shillings" is very small indeed.

It will probably be advisable to have R4 adjustable from outside the housing of the calculator, so that it may be slightly reset, if necessary, after any long period of time. Both this component and the on-off switch, S2, may be mounted on the side of the housing, away from the front panel shown in Fig. 2. S1, also shown in Fig. 2, should be a rotary component.

SETTING-UP AND CALIBRATION

In the explanation of circuit operation given earier it was assumed that R1, R2 and R3 were all exactly 10Ω. In practice this cannot occur, and the process of setting up the instrument consists of adjusting the values of R1 and R2 so that they become equal to R3.

There are two possible approaches here. One consists of using preset variable resistors for R1 and R2 and of adjusting these as required for the desired values. This method will probably be considered by the average constructor as being too expensive in components, and he will prefer to use the second, alternative, approach. This consists of initally fitting, in the R1 and R2 positions, fixed resistors whose values are slightly higher than that of R3 and of then bringing these values down by connecting higher value fixed resistors, as required, across the initial resistors. Such a technique will be familiar to the constructor who had to provide very close tolerance resistance values for meter shunts and the like, and is quite quick and easy to carry out. The basic 10Ω resistors in the R1 and R2 position must be wirewound types with a dissipation rating of 1 watt or more. Any higher value resistors connected across them to reduce the overall resistance may be carbon types. If sufficient nominal 10Ω resistors are available to allow selection, two of these having values slightly greater than R3 should be chosen with the aid of an ohmmeter. Should no suitable 10Ω resistors be to hand, it is quite in order to slightly reduce the value of R3 by connecting a fixed resistor of the order of, say, 150Ω to 200Ω across its track and commencing the selection procedure once more.

In the instructions which follow next, the process described as "adjusting" R1 or R2 refers to either the setting-up of a preset variable resistor, or the addition of higher value resistors across an existing fixed resistor.

After wiring up the instrument with resistance values in the R1 and R2 positions which are slightly greater than the value of R3, switch on and set S1 to "Odd Shillings". Set R3 slider fully to the top end of its track and adjust R4 for exactly full-scale deflection. Switch S1 to "Even Shillings" and set R3 fully to the bottom end of its track. The meter should now indicate zero. If the potentiometer construction does not allow its slider to go completely to the bottom end of its track, the meter will give a small forward indication. Should this happen, set the meter to zero by means of its *own zero-adjust screw*. The fact that the meter needle will subsequently give an indication to the left of zero on the scale when the unit is switched off is of no consequence. Repeat these two adjustments.

Next, set S1 to "Odd Shillings" and adjust R3 slider fully to the bottom end of its track. Adjust the value of R2 until the meter reads exactly 5. Then, set S1 to "Even Shillings", turn R3 slider fully to the top end of its track, and adjust R1 until the meter again reads exactly 5. If R1 and R2 were close to 10Ω in the first place, the adjustments of their values will not upset the earlier adjustments for meter readings at 10 and zero. With S1 set to "Even Shillings" the range offered by R3 should now be from exactly zero to 5 on the meter, and with S1 set to "Odd Shillings", it should now be from exactly 5 to 10. If all is satisfactory here, the setting-up procedure is complete. Any subsequent adjustments due to change in mains voltage may be made with the aid of R4.

TABLE II

Old Pence	Meter Indication	
	"Even Shillings"	"Odd Shillings"
0	0	5
1	0.42	5.42
2	0.83	5.83
3	1.25	6.25
4	1.67	6.67
5	2.08	7.08
6	2.5	7.5
7	2.92	7.92
8	3.33	8.33
9	3.75	8.75
10	4.17	9.17
11	4.58	9.58
12	5	10

The next process consists of calibrating the scale of R3. This is carried out with S1 in the "Even Shillings" position against meter readings. Calibration is in discrete steps of single current pennies ("Old Pence") from 0 to 12, R3 being adjusted to give the meter indications shown in Table II. The indications given in this Table are calculated to 2 decimal places but it will not be possible in practice to resolve meter readings to quite as high an accuracy as this. When calibration is complete, S1 is switched to "Odd Shillings", whereupon it should be found that the calibration holds good for the corresponding column of figures in Table II.

The calculator is then complete and ready for use. ■

NEWS . . . AND .

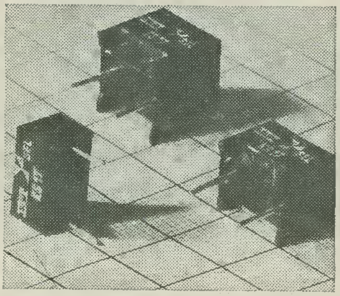
NEW ITT POLYSTYRENE FOIL CAPACITORS

Recently exhibited by ITT Components Group Europe are new polystyrene foil capacitors type KS 17.

Welding of the connecting leads to the layers over the whole front edge permits the following outstanding characteristics: highly reliable connection even at low voltage operation; low attenuation; low inductance wound construction.

Further advantages include uniform temperature coefficient over the whole capacitance range and low dissipation factor even at high frequencies.

These high-grade capacitors are therefore especially suitable for use in frequency-determining networks and filter networks.



ITT polystyrene capacitors type KS 17 – high grade components especially suitable for frequency determining and filter networks

All KS 17 capacitors have a uniform overall length of 12.5 mm. Remaining dimensions have been chosen so as to allow particularly high packing density on printed circuit boards with standard grid. In order to facilitate mounting on circuit boards, the leads of the larger capacitors are tapered off.

KS 17 capacitors are available over the range 350 to 24,000pF with nominal d.c. voltage ratings of 63 and 160V. The capacitance values are graded on the E192 series; they can be supplied in tolerances of ±1%, ±2.5% or ±5% as desired.

From: ITT Components Group Europe, Capacitor Product Division, Brixham Road, Paignton, Devon, Tel. Paignton 50762, telex 42951.

ITV 1970

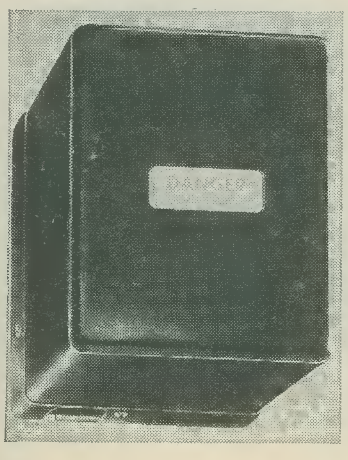
ITV colour programmes can already be seen in many parts of the country. *ITV 1970*, the annual handbook of Independent Television (on sale at bookstalls and bookshops, 240 pages, price 10s. 6d.) reflects the opening of this new and exciting phase. The pages are larger and there are more of them. There are more than 200 illustrations, and there's colour from page 1 to page 240. Many completely new features are included. *ITV 1970* is more informative and attractive even than its predecessors in the series of ITV annual handbooks.

Thinking about a colour set? The coverage maps in *ITV 1970* show the range of the existing colour transmitters, of those coming on the air in 1970, and the prospects for the mid-1970's. Advice is given on the correct siting of aerials to obtain the best reception of UHF and colour.

Sir Robert Fraser, Director-General of the Independent Television Authority, says in the Introduction: "For most television viewers, it is what they see on the screen that matters. And it matters a great deal to them, for everyone knows that watching television is much the largest of all leisure activities. Television viewers are intensely critical. It is not really very sensible to suggest that they do not know what they want, and cannot tell whether they are being pleased or not pleased. They are filling in their millions of ballot papers every viewing evening, and they vote in millions of little clicks. Television also has its landslides, and its close finishes. But some viewers are also interested in the kind of organisation through which their programmes reach them. How does it all work, who decides things, who gives them the power to decide, who does what, what makes it tick? For these readers the guide provides the answers. It describes a national television service which may or may not be the best of all television services, but is certainly, in its organisation and arrangement, the only one of its kind in the world."

ITV 1970 continues its established tradition as a standard library work of reference on the organisation of ITV, the programmes, the programme companies, technical developments and the control of advertising. For those in any way connected with communications it is invaluable – fully indexed too!

IMPROVED POWER SUPPLY UNIT FOR LOW VOLTAGE EQUIPMENT

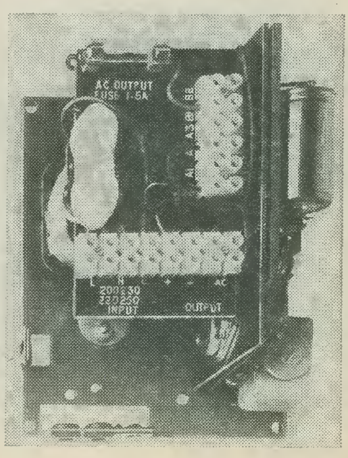


A new power supply unit – Type 1662 – is now available to provide ringing and speech power for intercom telephones, door telephones and other types of low voltage equipment.

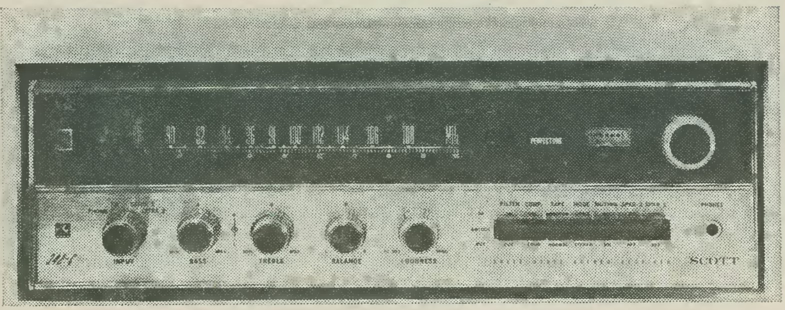
The features of the unit are said to add up to an attractive package for the designed applications. These features include solid state smoothing giving very low ripple, low regulation and adjustment in steps. The 1662 Power Supply Unit, which complies with G.P.O. Lines Branch requirements, has the a.c. and d.c. outputs fully isolated from each other.

The case, size 6 x 5 x 4in., is similar to P.O. 53A and can be delivered ex stock. Price per 100: £4 12s. 0d. each.

Full technical details are available on application to the sole manufacturer and distributor – Ashbee Research and Production, 172 Ifield Road, London, S.W.10. Telephone: 01-373 8573.



. . . . COMMENT



SCOTT INTRODUCE 342–C 100 WATT FM STEREO RECEIVER

Following the recent appointment of A. C. Farnell Ltd. as the new UK distributor for the full range of American Scott audio equipment, a new 100 watt FM stereo receiver has been introduced which includes many new design features. This receiver is the Scott 342-C and is the very latest model in the Scott range of high fidelity FM receivers to be launched throughout Europe by the European distributors, Syma International of Brussels.

Six new technical developments are included in the 342–C, and these are: (i) automatic tuning indicator; more accurate than normal meters, this device senses the FM signal and indicates tuning for lowest distortion and best reception. (ii) Scott Quartz crystal lattice filter now eliminates all i.f. realignment problems. (iii) Wire-wrap technique – a permanent terminal connection that eliminates all solder joints, giving maximum reliability up to military and aerospace standards. (iv) New IC complex gives improved stereo separation over normal printed circuit construction. (v) New full complementary output circuiting gives virtual distortion-free listening at low volume levels. (vi) Printed circuit modules snap into main chassis for fast and inexpensive servicing and elimination of solder connections.

Other interesting design features include the use of a line cord aerial to eliminate an outside aerial, except in areas of unusually poor reception. A new three-dimensional back-lit dial has been designed to improve visibility. The 342-C muting circuit eliminates noise between FM stations with plug-in speaker connectors eliminating phasing problems. Silver-plated f.e.t. front end and integrated circuit i.f. strip are also included to receive more stations more clearly and remove all outside inteference. Basic design features include IC preamplifier, f.e.t. tone control, all-silicon output circuiting and automatic stereo switching.

A technical leaflet describing the Scott 342–C can be obtained from A. C. Farnell (London) Ltd., 25a Hermitage Road, London N.4, tel: 01–802 4181.

WELLER H/D GUN KIT

With the range of soldering tools from Weller Electric Ltd. becoming more and more evident in Britain, the packs in which the tools are sold are also attracting attention.

The Weller Heavy Duty (275 watt) Soldering Gun Kit is one of these packs. The red polypropylene carrying case contains a fully fitted moulded foam interior in which is housed the Gun, a supply of resin-core solder, a plastics cutting Wellertip, a plastics smoothing Wellertip, a tip nut spanner and a double ended soldering tool — one end for holding wire during soldering, the other for separating wire when desoldering.

Inside the lid there is a panel giving specifications of the tool in the case, together with pictures showing four applications of the Gun.

BBC TAPES FOR THE WORLD

The BBC records many programmes, in a variety of languages, for other radio organisations, especially in the developing countries. The most important of these services is in English and is called the BBC Topical Tapes Service. Victor Price reported on it in a BBC broadcast.

In November 1962, three tapes were sent from Britain to nineteen broadcasting organisations overseas. Two were on political subjects, and one was a general magazine. They were the first venture of the BBC Topical Tapes Service. Today, some eight years later, sixty-seven broadcasting organisations subscribe to the service, and they have a choice of fourteen regular programmes.

What are the programmes about? Well, in addition to current affairs, there is also entertainment, the arts, sport, religion.

Why should the BBC bother to put all this on tape? And why should other broadcasting organisations want to use it? From the BBC's point of view, it is an attempt to solve the problem of poor short-wave reception. As far as the customers are concerned, not all capital cities are world communications centres on the scale of London. At any rate, the customers keep on subscribing in increasing numbers, and subscribing does mean paying.

COMPREHENSIVE TIMING UNIT

by

R. W. COLES

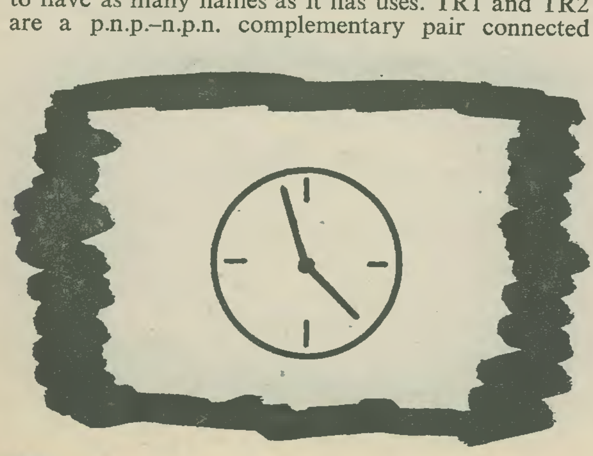
The author initially intended this design to function as an "electronic egg-timer", but it is capable of many more applications than are represented by such a simple domestic chore. Of particular interest is the manner in which theoretical semiconductor circuits are successfully put to practical use

THIS ARTICLE DESCRIBES THE CONSTRUCTION OF A very interesting timing circuit which, although it was originally intended for the simple job of timing boiled eggs, gives a useful insight into pulse circuit techniques and can be easily adapted to time almost anything. In its egg-timer form the circuit forms a small battery powered unit which gives an audible warning on the completion of the timing period. It is very simple to operate, the only control being a toggle switch, and even this could be dispensed with !

CIRCUIT OPERATION

The circuit, shown in Fig. 1, is divisible into four separate parts, each with a separate function. It may at first sight appear to be rather complicated and potentially expensive but, in these days of cheaply available silicon transistors, it is often easier to design a circuit using transistors and resistors liberally than to employ the "cheese-paring" techniques which were essential in the heyday of the germanium transistor. Those earlier transistors were expensive to buy and required more discrete components for their successful operation.

The main timing element consists of what is known to the writer as a "Hook circuit", but which seems to have as many names as it has uses. TR1 and TR2 are a p.n.p.–n.p.n. complementary pair connected base to collector and forming in effect a four-layer diode, as shown in Fig. 2. This combination acts in the same manner as a thyristor, the firing potential being set by the potential divider R3, R4.



When the unit is switched on, C1 begins to charge slowly through R1. At this time both TR1 and TR2 are cut off, the only current through them being leakage current, which will be very small for silicon transistors. When C1 has charged to a voltage that makes the emitter of TR1 more positive than its base, TR1 turns on and forward-biases the base-emitter junction of TR2, which also turns on. This action is regenerative, driving both devices hard on and at the same time discharging C1 and short-circuiting R4. However, when C1 has discharged the base-emitter junction of TR1 is no longer forward-biased, and both devices turn off abruptly. The overall effect is to produce a fast square negative pulse at the output, which is taken from the junction of R3 and R4 and used to turn off the normally "on" side (TR4) of the bistable given by TR3 and TR4.

The actual time taken for the circuit to reach its "firing" potential is determined by both the CR time of R1 and C1, and the aiming potential set by R3 and R4. The CR time (microfarads times megohms) of R1 and C1 is in practice 150 seconds, but to time an egg we need in the region of 240 seconds. The firing potential is therefore set so that the circuit switches on at 1.5 to 1.75 times CR. As can be seen from the voltage-time curve of Fig. 3, the capacitor charges exponentially, and therefore for the highest accuracy the trigger point should be set at less than 1 x CR time. Nevertheless, the accuracy required for egg timing is easily realised with the present arrangement, which is always within 5 seconds after a 4-minute timing period. Should any constructor require a higher repeat accuracy, this is easily arranged by increasing the value of C1 and decreasing the aiming potential by adjustment of the values of R3 and R4.

When the TR1, TR2 combination turns on, the negative pulse produced is passed to the base of TR4 which then cuts off and, by means of the usual bistable d.c. cross-coupling, turns on TR3 thus reversing the state of the bistable. When TR3 turns on, the lower end of R2 falls to slightly above the

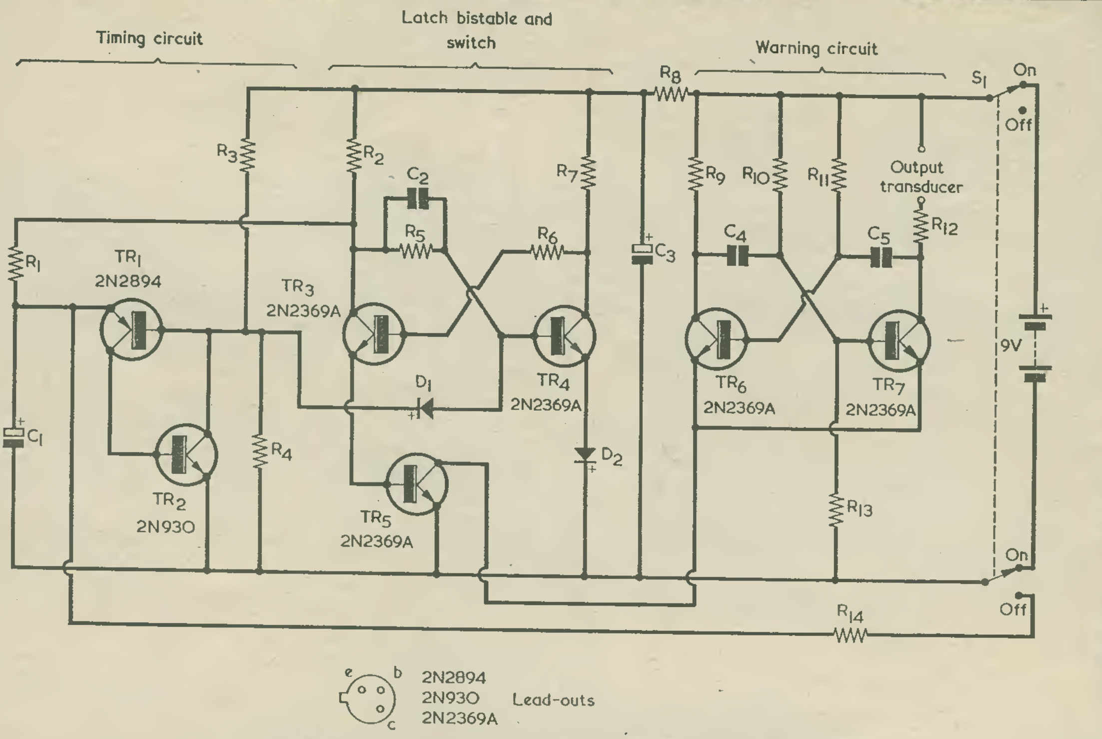


Fig. 1. The circuit of the comprehensive timing device. The output transducer may be an ear-piece or speaker

potential of the negative supply line, thereby preventing the timing circuit from initiating another period.

The emitter circuit of TR3 is made up of the base-emitter junction of TR5, which becomes forward-biased and switches hard on, and in its turn provides a d.c. path to the negative supply line for the astable multivibrator (TR6 and TR7). This begins to oscillate at about 250Hz, giving an audible warning note which is transmitted by the earpiece or speaker in the collector circuit of TR7. The bistable circuit itself is quite normal except that it has a "speed-up" capacitor, C2, across only one of the cross-coupling resistors. This capacitor simply ensures that, when the unit is switched on, TR4 always turns on first, thereby cutting off TR3. The forward-biased silicon diode, D2, in the emitter circuit of TR4 compensates for the base-emitter junction of TR5 and keeps the bistable symmetrical.

When the multivibrator begins to oscillate it could conceivably trigger the bistable and switch itself off due to feedback via the supply rail. To prevent this, R8 and C3 are included as a decoupling network for the bistable supply line. An unforeseen snag was encountered with the writer's prototype and consisted

COMPONENTS

Resistors

(All fixed values 10% ¼ watt unless otherwise stated)

R1	1MΩ 5%
R2	560Ω
R3	18kΩ 5%
R4	27kΩ 5% (see text)
R5	4.7kΩ
R6	4.7kΩ
R7	560Ω
R8	47Ω
R9	330Ω
R10	4.7kΩ
R11	4.7kΩ
R12	See text
R13	22kΩ
R14	100Ω

Capacitors

C1	150μF electrolytic, 10V wkg. (see text)
C2	0.04μF, paper or plastic foil
C3	100μF electrolytic, 10V wkg.
C4	0.47μF, paper or plastic foil
C5	0.47μF, paper or plastic foil

Semiconductors

TR1	2N2894
TR2	2N930
TR3 – TR7	2N2369a
D1	1N3065
D2	1N3065

Switch

S1 d.p.d.t., type as required

Miscellaneous

9 volt battery

Ear-piece or speaker (see text)

of the production of a very quiet high frequency whistle when the multivibrator was supposedly switched off. This was found to be due to the leakage current of TR5 allowing the circuit to oscillate at a very low voltage. The inclusion of R13 cured the fault by keeping the base of TR7 at a negative potential with respect to its emitter when TR5 is turned off.

S1 is used to switch on the 9 volt supply to initiate the timing period. When set to the "Off" position it connects C1 to the negative supply line via R15, enabling C1 to discharge. If for any reason the unit is switched off before the end of a timing period, the possibility of a stored charge shortening a subsequent period is thus removed.

COMPONENTS

The transistors used by the writer were silicon planar types, all being of the n.p.n. variety except TR1, which is a p.n.p. 2N2894. TR2, 2N930, is a very low leakage type. TR3 to TR7 are 2N2369a's. The transistors are available from advertisers in this magazine (such as Bi-Pre-Pak, Ltd., who also list the diodes used for D1 and D2). There is no reason why other types of silicon transistor should not be used, and substitutes will no doubt suggest themselves to the experienced constructor. Miniature silicon switching diodes type 1N3065 were employed for D1 and D2, though here again almost any type could be substituted directly. C1 should be the best type of capacitor available, preferably tantalum if the required value can be obtained, to preserve timing accuracy. (Readers may have difficulty in obtaining a 150μF tantalum capacitor through usual mail-order retail channels. A suitable alternative would be given by the use of a 100μF 12 volt tantalum capacitor and a 47μF 35 volt tantalum capacitor in parallel, both being available from Henry's Radio, Ltd. The working voltage of the component or components used can be higher than the 10 volt figure quoted in the Components List.—Editor.)

The timer should provide a period of about four minutes with the values stated, but if this is not realised the value of R4 should be increased or reduced accordingly. Replacing R4 with a skeleton preset potentiometer of some 50kΩ will provide a very convenient method of setting up the timer, though the writer found it possible to adjust the prototype to the accuracy required in its present application by using fixed resistors on a trial and error basis.

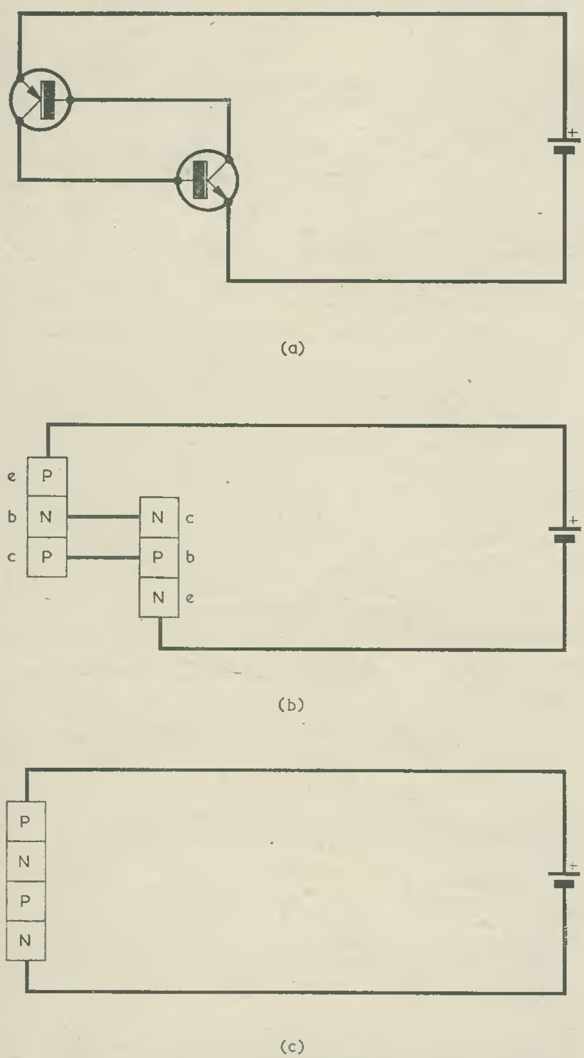


Fig. 2. Two transistors connected as in (a) can be shown, by way of the intermediate step in (b), to be equivalent to the 4-layer diode in (c). This diode has the characteristics of a thyristor

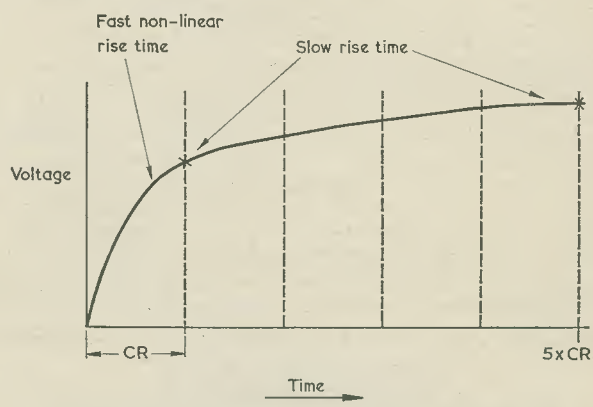


Fig. 3. The exponential charging curve of a capacitor when charging by way of a series resistor

The audio transducer employed by the writer was an old magnetic ear-piece of 120Ω impedance. When suitably mounted, this provides a loud enough warning for one room. A 40Ω miniature speaker was also tried with good results, but the power available from the multivibrator is insufficient to drive a load of less than about 250Ω so a series resistor to make the load up to at least this value must always be used. With the 120Ω ear-piece, R12 was 180Ω.

The on-off switch can be any d.p.d.t. type, and the writer is at present thinking of replacing it with a mercury switch, which would allow an even closer approach to the conventional egg-timer. To start the timer would merely entail inverting it, and vice-versa.

The 9 volt supply can be provided by a small dry battery, and its life will be extensive, current drain being roughly 15mA during the timing period and 50mA when producing a warning note.

CONSTRUCTION

An old transistor radio case measuring about 5 by 3 by 1½in. was used as a container for the complete timer and its battery. This has proved to be a good choice as the compact size makes it popular in the kitchen where space is always at a premium! The switch was mounted in the hole left by the tuning control, and the ear-piece was glued to the loudspeaker grille with Evo-Stik adhesive.

All the timer components except C1 and R14 were assembled on a piece of Veroboard measuring 2½ by 1in. C1 and R14 were mounted near the switch. Squeezing all the components onto such a small board means that miniature capacitors must be used. Inexperienced constructors, or those with normal size capacitors, would be well advised to allow themselves more room.

PERFORMANCE

The writer's prototype has braved kitchen heatwaves and Ice Ages together with the attentions of a critical band of egg eaters, and has met with approval from all. The period accuracy is within plus or minus 5 seconds always, and it has been found that a double period produces excellent hard-boiled eggs! ■

COMPUTERS

The most important and potentially far-reaching computer meeting ever held will take place in Llandudno, Wales, in July 1970.

At Llandudno will gather together the original computer pioneers, many of whom have never met before.

The purpose of the meeting is to pool together the experience and ideas of important men from several countries, and, by listening to an exchange of viewpoints, seek to forecast what is likely to happen in the future as a result of using computers even more widely.

The speaker from IBM in particular will show how he is aware of the tremendous responsibility his company (the largest computer manufacturer in the world) has, and its effect on the lives and well-being of millions of humans.

The School has been arranged by the longest established independent computer consultant company in Europe, and which company is still family owned.

The two-day school will be held at Llandudno, N. Wales, on Wednesday and Thursday, 8th and 9th July 1970. Applications for enrolment should be made to – Computer Consultants (International) Ltd., G.P.O. Box 8, Llandudno. Cables "Computers, Llandudno". Telephone Enfield 7185 or Llandudno 75171.

KALEIDOSCOPE

For many years from the inception of radio, the *amateur wireless* hobbyists have simply been lumped together under that term; but in recent times, notably with the advent of semiconductor and solid-state devices, has has now been elevated to the rather more lofty height of *electronics enthusiast*. This latter term is now deemed, by general usage, to include such varied interests as amateur radio – both transmitting and receiving, hi-fi audio reproduction, television, tape recording, construction-for-its-own-sake – and known just simply as "that dotty chap up the road who messes about with valves and wireless". The generic term *electronics enthusiast*, fairly recently coined, is in trend with the modern practice of re-labelling more mundane pursuits – whether at work or play. We now have, for instance, rodent operatives in lieu of rat catcher; garbage disposal operative instead of dustman; turf accountant in place of bookie and, no doubt, even the sagger maker's bottom knocker has by this time a new appellation!

Being more "with it" than hitherto, the electronics enthusiast has a much more varied, interesting and satisfying life than was apparent in pre-war days. The average hobbyist today has additional interests far removed from electronics – this often tending to be a winter pursuit. Most of us these days, with the rise in the standard of living, are home owners with the responsibilities that this implies – family, garden, decorating and improving the home. Add to these the ownership of a car with the consequent maintenance, running repairs, the planning of family tours, trips and picnics, etc. – it is probably true that the present-day enthusiast has more demands upon his time than ever was the case in the past.

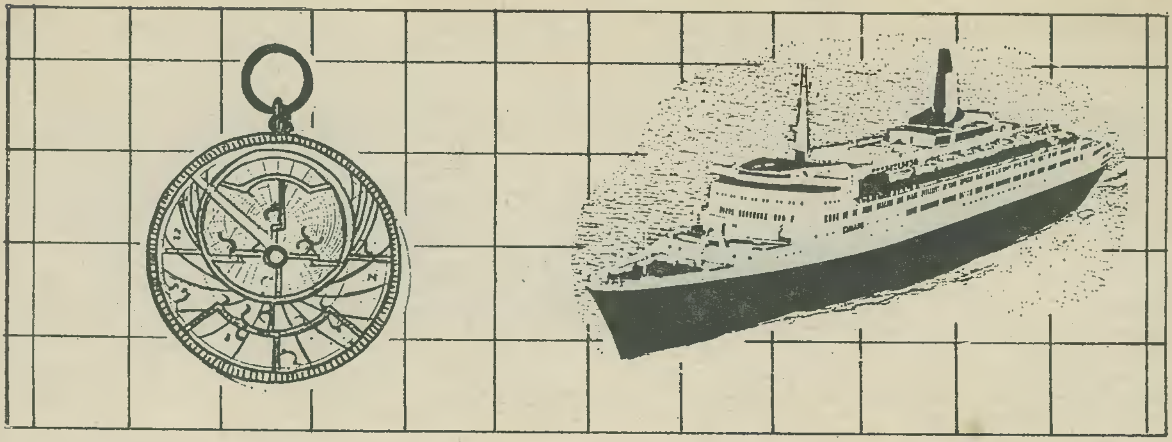
Electronic enthusiasts being intelligent people – they would hardly be engaged in the hobby if they were not – their interests are known to include many other subjects. To satisfy his intellectual appetite, such pursuits as bird watching, natural history, photography, astronomy, politics and local government, history and many others are often engaged in. Add to these the interest in one's employment and the keeping up to date with current affairs via the medium of newspapers, television and radio, etc., it becomes a fact that few of us have sufficient hours in the day to encompass all those interests in which we aspire to participate.

This veritable kaleidoscope of human beings, gathered together under the electronics enthusiast banner, also exhibit interest in their kaleidoscopic other hobbies and time-consuming subjects – so much so, it is a wonder that sufficient relaxation time is ever found for radio and electronics at all! Perhaps none of us ever will have sufficient time!

As an illustration of this kaleidoscope of enthusiasm for other pursuits, our office staff are an object lesson. In addition to some of the aforementioned interests, we can add – amateur theatricals, both dramatic and operatic, stage direction and producing; medical electronics; yacht and boat sailing; philately; Egyptology; archaeology; ornithology; microscopy; home-movies; local church affairs; and last, but not least, local community associations.

With that lot to contend with – the interests, not the staff – we hardly find time to go to bed!

C.W.



FROM DEAD RECKONING TO PINPOINT NAVIGATION

When men first embarked on the trackless oceans in their search for new lands and new treasures, they guided their crude vessels with the oldest navigational aid of all—dead reckoning.

Since then, the sailor's navigational abililty has undergone many improvements. No longer does he rely on dead reckoning.

The master on the bridge of a modern ship has an electronically controlled wheel, and close at hand are meticulously detailed charts, radar scopes, magnetic and electronic compasses, a gyro-compass, and a short-wave radio. Also within reach is the dependable sextant, invented in 1730, with which he can scan the night sky for constellations to guide him over the waters.

The latest advance is a highly accurate navigation system developed by the U.S. Navy and called Omega. It is a low-frequency radio system—efficient, swift and virtually errorproof—which should eventually benefit all seafaring nations.

The Omega system consists of eight transmitters strategically located around the world. Four of these are already in operation and the remainder will be completed by 1972.

The Omega system could mean considerable savings to the maritime industry. Time at sea will be reduced, insurance premiums lowered and port arrival times more accurately determined. Stevedores and dock facilities will be more effectively used.

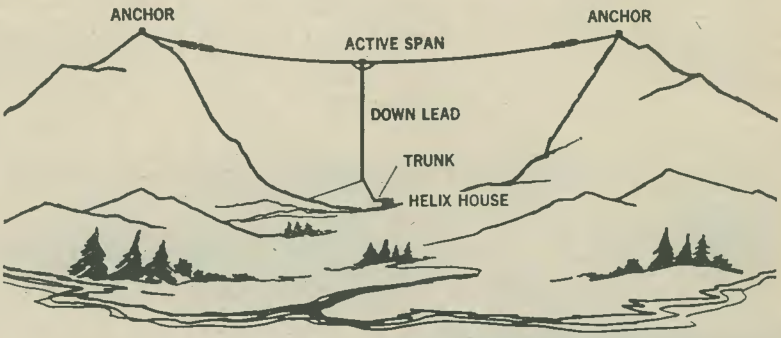
By sailing off course due to navigational errors and the vagaries of ocean currents, a typical merchant ship often loses one to three days at sea. Omega will give these lost days back to the shippers.

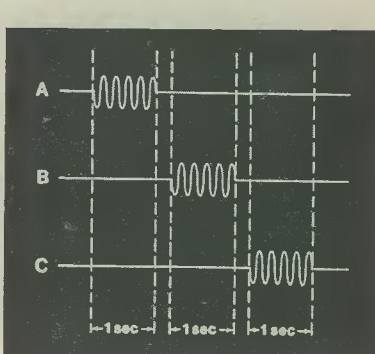
It will also give sea and air travellers a greater measure of safety. Omega will swiftly pinpoint the location of a crippled ship or downed airliner, and hasten the arrival of rescuers.

ALREADY INSTALLED

Omega solid-state radio receivers are already aboard two of the world's newest commercial ocean-going ships—Cunard's *Queen Elizabeth 2,* and the Manchester Line's *Challenge.*

Some day all 16,000 large ocean-going ships of the Free World's





Above: The chief elements of a typical Omega transmitting station with a four-wire antenna spanning a valley or fiord. Each of the eight stations in the global system sends out a continuous pulsed signal (right) for one second out of every 10 seconds. Signals from all stations are synchronised and picked up by planes and ships to establish their precise locations. Signals can be picked up 40 feet under the sea merchant fleet and 8,000 smaller ships and boats may be using the system. In the next 20 years, about 60,000 Omega receivers are expected to be in use throughout the world.

Omega had its origins 18 years ago when the U.S. Naval Research Laboratory started using long range, very low-frequency radio waves to achieve navigational performance over greater distances.

A three-station transmitter network was initially established to cover about a quarter of the globe. When two years of tests with the network proved its efficiency and accuracy, the U.S. Navy ordered Omega receiver sets to equip surface and underwater craft.

When the world-wide network is in full operation there will be transmitters in Minnesota, Hawaii, Norway, Trinidad, Japan, either New Zealand or Australia, Chile or Argentina, and La Reunion Island off the coast of Madagascar. Each station will cost less than $1 million.

Omega will complement the present leading navigational system, Loran, which covers part of the northern hemisphere. Loran uses high-frequency radio waves which unfortunately are absorbed by the ionosphere, and so are lost for navigational purposes to ships more than a few hundred miles from the source of the signals. Bad weather also can block the signals.

In contrast, Omega transmitters produce very low-frequency radio waves—operating on a band between 10 and 14 kilohertz as compared to Loran's 100 kilohertz and a home radio set which receives signals in a 550-1,500 kilohertz range. These very low-frequency signals radiate outward from the Omega transmitter and bounce back and forth between the ionosphere and the earth. They can be picked up by position-seeking ships as far as 8,000 miles from the transmitters. This enables ships equipped with Omega receivers to fix their positions easily, quickly and very accurately by calculations based on intersecting signals from any two stations.

Each of the eight transmitters will have a four-wire antenna span stretched across a huge valley or fiord. The antenna at Bratland, Norway, for example, spans 11,000 feet and has a mid-span height of 1,435 feet. The antenna at Trinidad measures 4,800 feet and is 800 feet high at mid-span.

HOW IT WORKS

All transmitters in the Omega network will radiate about one kilowatt of power and will send a continuous pulsed signal on a given frequency for about one out of every 10 seconds.

Only one station transmits a given frequency at a given time. The pulses from each station differ slightly in length to aid in recognition at the receiver set aboard the ship, submarine or aircraft.

The signals from all stations are synchronised precisely by the use of highly accurate atomic clocks. Thus, the phase of the signals at various stations will not drift from each other by more than one microsecond per day.

Although the transmitter stations are geographically independent of each other, synchronisation is maintained by daily corrections supplied by a "lead" station. Present plans call for this station to be the one at Haiku, Hawaii.

Each Omega receiver—models weighing 50 to 100 pounds and about 20 inches in height, width and depth—measures the phase difference of signals received from any two stations. Two of the three intersecting lines of position establish the receiver's position.

These selected lines of position are automatically displayed on the front panel of the receiver. Skywave corrections, taken from U.S. Naval Oceanographic Office tables, are applied, then corrected lines of position are plotted for the position fix on an appropriate Omega chart. Typical time to obtain a fix is about one minute.

■

LISTENERS' CLUB

Radio Australia runs a Listener's Club for those who send in a series of regular reception reports. To qualify for membership, short wave listeners should provide 12 reception reports at a rate of two per month over a period of six months. When the 12 reports have been received, the club lapel badge and membership certificate, illustrated here, will be forwarded to the reporter.

Each reception report should be numbered consecutively from 1 to 12 by the reporter to assist R. Australia staff in the keeping of records. The essential details of the reception report required by the engineers are: type of receiver, name of programme, frequency, date and time (GMT) and also some comments on reception quality. To standardise and simplify reports, R. Australia will issue a special reception card upon application.

Reception reports should be addressed to: "Listeners' Club", Radio Australia, Melbourne, 3000, Australia, or, in the case of U.K. listeners to R. Australia, 54 Portland Place, London, W.1. Verification QSL cards will be issued for each correct report.

The best listening times for the U.K. are: 0645 to 0745 GMT on 9.56MHz (31.38 metres) or 11.71MHz (25.62 metres); 1500 to 1730 GMT on 9.54MHz (31.45 metres) or 11.74MHz (25.55 metres).

■

TAPE RECORDING BIRDSONG

NOW THAT SPRING IS UPON US, WHY NOT RECORD some birds – the feathered variety – and their songs? As a complete change from taping music of various kinds, family gatherings and personal interviews, or Dx broadcast interval signals, etc., such a pursuit will be found most rewarding.

Even the complete newcomer to tape recording may preserve on tape the colourful songs and "language" of our feathered friends freezing, as it were, an enjoyable moment of time, to be unfrozen later in the comfort of one's own home. Contrary to some beliefs it does not require expensive equipment nor is a portable (battery operated) machine strictly necessary. For the average tape recording beginner, it is only necessary to acquire an extended mains lead, properly and safely connected to the recorder, with the garden as the hunting ground. Choose a dry sunny period and place the recorder on a wooden table or chair.

Birdsong has always fascinated man and the recording of such tuneful songs will be found to be one of the most enjoyable of tape recording enterprises. Most of us have no doubt heard over the BBC many of the birdsong recordings of the famous Ludwig Koch – the German musician who specialised in this field. However, birdsong recording is not all that new – it was going on during the early part of this century, the sounds being recorded on the old wax cylinders of the day. It remains a fact that only a few bird vocabularies, as distinct from song only, have been completely recorded – and there are something like 200 or so British bird species. This leaves the field of birdsong recording wide open for the amateur enthusiast.

WHY SING?

Before one can enjoy the taped results, it is necessary to know why birds sing and call.

Among the interests of many readers may be that of ornithology – the science and study of birds – and this is one the writer shares with them. Personal observation, together with the reading of published material, has led to agreement with the generally accepted conclusion that birds sing and use their limited vocabulary for a number of reasons.

Birdsong, especially during our Springtime or at the commencement of a particular breeding season, has the twin functions of laying a claim to nesting territory and of attracting a mating partner – this of course being the song of the male of the species.

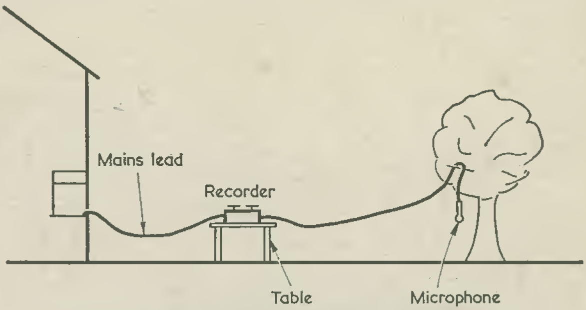


Fig. 1. The simplest method of obtaining birdsong on tape with a mains-operated machine. In some cases the mains or microphone lead will require lengthening. The microphone is hung in a convenient bush or tree

In consequence, we enter into the realm of "language". Song as a language imparts information from one bird to another. But it is only one part of the vocabulary, and birds have a number of differing calls apart from song, each with its special meaning and carrying its own message. Probably the most important of these is a "statement" of identity in terms of species and sex – this call in nearly all instances being produced by the male. It has been found that even variations in rhythm and pitch of song are used to identify the singer's "name". The

"DISCOVERY" BEGINNER'S RECEIVER

The insignia shown alongside is that of the "Discovery" Beginner's Receiver to be featured NEXT MONTH.

The MARCH issue will include easy-to-read enlarged Workshop Plans (see page 410 for details) which may be detached for ease of reference and use on the workbench.

Written especially for the beginner, this 2-valve, 4-stage design – ECC83, ECL82 – has an integral power supply (BY100 silicon rectifier) and features a grounded-grid input stage. An efficient reaction circuit with absence of "dead spots" is a feature of the design. Coverage is from 30 to 1.7MHz (approx.) and the medium wave-band.

The project is one with which the beginner could well commence constructional activities – each step being numbered throughout the entire building of the receiver from the panel/chassis drilling instructions (even the drill sizes are quoted) to the final testing of the circuit. If you are a beginner then this will be your chance to begin!

writer has on tape a singularly individual song of a blackbird which has resided in his garden for the past three years. Highly original, unmistakably distinctive and tuneful, it is the bird's own rendering of a human tune; and it is often followed by a good imitation of a man whistling his dog!

The successful taping of territorial claimant song is one of the most rewarding of any recording activity. It also happens to be the easiest to record by virtue of the fact that the song is repeated again and again, often from dawn to dusk, and may therefore be recorded many times, enabling the enthusiast to select any passage that he prefers.

Taping the dawn chorus is a very simple operation. It is common knowledge that more birds break into song for the half-hour or so around break of day in the Spring than at any other time. The writer has found from experience that the first to command the opening introduction to the chorus is the blackbird, this bird usually commencing some time prior to actual daybreak. In the writer's locality, this is followed by the song thrush and the robin, with the male pheasant delivering his "kronk, kronk" as the rhythm percussion section!

Alarm or warning calls of birds are more probably the province of the specialist equipped with a portable recorder who can position himself in a vantage point along a hedge or in woodland. There is however one common alarm call which the beginner can easily record in his garden, this being the blackbird's well-known "tik, tik tik".

There is, of course, much more to be said about birds and their songs and calls, but space does not permit further discussion here. Those interested are advised to join and enlist the aid of the local ornithological group.

PREPARATION

Most readers of this article will already have a tape recorder but where a new machine is to be purchased the points to consider, apart from cost, are quality of reproduction, tape speeds, spool running time and, where a portable unit is desired, the weight and battery life.

Recording tape speed is important as it provides a rough measure of the quality with which the birdsongs and calls will be recorded. Tape speeds begin at $\frac{15}{16}$in. per second, with successive speeds being twice as fast as the previous rate, these being $1\frac{7}{8}$, $3\frac{3}{4}$, $7\frac{1}{2}$, 15 and 30in. per second. The more expensive machines exhibit the faster recording tape speeds, these resulting in recordings of higher fidelity but, also, higher running costs. The speed most favoured by birdsong recording experts is 15in. per second, but the non-specialist will do quite well with a speed of $3\frac{3}{4}$ or $7\frac{1}{2}$ i.p.s. Many excellent recordings have been made at these latter two speeds.

The microphone used with the recorder has also a great bearing on the quality of the recording. Some birdsong recording specialists have found a sensitive moving-coil microphone to be the best for this type of work, as it is less affected by wind noise.

Fig. 1 shows the simplest method of recording birdsong, using a mains-operated recorder connected to the household mains supply and the microphone hung in a bush or tree. The major shortcoming with this method of working is that it is not always possible to select a particular song or call.

Fig. 2. A better method of obtaining birdsong recordings using a parabolic reflector. Note that the microphone is turned away from the sound source and towards the reflector dish

PARABOLIC REFLECTOR

Fig. 2 shows the microphone used in conjunction with a parabolic reflector. The reflector acts as a directional "sound-collector", reflecting the sound reaching it from its front towards the microphone mounted at its focal point. The use of a parabolic reflector enables birdsong to be recorded at many times the distance possible with an ordinary microphone simply suspended from a bush or tree. With a well designed reflector it is possible to record songs and calls up to thirty or forty times the distance obtainable with an open microphone. Particular note

CAN ANYONE HELP?

Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received and to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time.

Solartron 'Scope CT316 10S/16605.—J. A. Lee, Radio & TV, High Street, Southminster, Essex — circuit or manual required, any reasonable price paid.

BC221 Frequency Meter. — E. J. Sanby, 53 Prieska Road, Sybrand Park, Cape Town, Republic of S. Africa — has a calibration book for serial No. 4855 and requires, in exchange, calibration book for serial No. 6572.

Cossor 'Scope type 1042. — P. Dorrington, 383 Spen Lane, Leeds 16 — loan of circuit diagram or handbook.

R220 Receiver. — K. R. Diamond, 209 Allerton Road, Liverpool 18 — loan of circuit diagram for this receiver and also for the 58 Set transmitter/receiver.

EMI Oscilloscope Type QD101 or WM1. — N. B. Miller, 29 Chadacre Road, Stoneleigh, Surrey — short term loan of operating manual.

should be taken of the fact that the microphone is positioned to face into the reflector and *not* towards the sound source. Many experiments may be carried out with simple parabolic reflectors by the home hobbyist. The first reflector used by the writer some years ago was an ordinary colander lined with tinfoil – both being purloined from the kitchen! Other reflectors tried have been an old megaphone – highly directive but short ranged – a discarded electric fire bowl and a large metal mixing bowl or pan. Many constructors will no doubt be able to produce the metalwork required in their workshops. A commercially made parabolic reflector, designed with birdsong recordists in mind, is also available, this being manufactured by Grampian Reproducers Ltd., Hanworth Trading Estate, Feltham, Middlesex.

FUN AND GAMES

Much fun can be had with the tape recorder once several birdsong and call tapes have been made. Where a variable speed recorder is used, replaying the tape at a reduced speed can be quite instructive. The warblings of a wren, for instance, oscillate at around 4,000 cycles per second and are too fast for each *note* to be differentiated by the human ear. If one has been fortunate enough to record this sound the notes become intelligible when the recording is slowed down. It has been found that the wren can deliver approximately ten different *notes* per second! Another game is that of playing back the recording to the bird in its own habitat, this often resulting in the bird assuming the sound to come from a territorial intruder. It has been noted that most birds will break into an excited aggressive song to repel the imagined boarder! An adaptation of this game is to quickly switch from playback to record, at suitable points in the battle of song; the end result being some highly instructive "crosstalk".

MOONLIGHT SONATA

Not all birdsong or bird call recordings need be made at dawn or early morning. Many of course can be made during the day, bearing in mind possible extraneous and unwanted sounds. Again, some of the most interesting recordings can be made at eventide and early night.

One may not be able to tape the Moonlight Sonata at the far end of the lawn but excellent recordings can be obtained, by those who live in rural or semi-rural areas, by recording Nature's own version of the sonata. This can include the settling-down-to-roost calls of the male pheasant, owl hoots and screeches, and even that most beautiful sound of all – the song of the nightingale.

■

R.T.R.A. 1970 LONDON EXHIBITION

The Radio and Television Retailers Association is to hold a trade show in conjunction with its annual conference next year. The conference is to be held at the Grosvenor House Hotel from 31st March to 2nd April. Previous conferences have been held in the provinces.

NOW HEAR THESE

All times GMT. Information correct at time of preparation.

N. VIETNAM

15018kHz Voice of Vietnam, Hanoi. Broadcasts in English are at 0500, 1000, 1300, 1530, 2000 and 2300 on **7360kHz, 7416kHz, 9840kHz, 10224kHz, 11840kHz** and **15018kHz** – this last channel provides the best reception for U.K. listeners.

MEXICO

9535kHz XERMX Radio Mexico. This station has been reported being heard after Berne, Switzerland, closes. XERMX closes down between 0430 to 0545 when Berne opens transmission. Reports are requested and the address is: Apartado 20, 100 Mexico City. Reporters will receive souvenirs.

PANAMA

6030kHz HP5B Radio Miramar, Panama. This is a newcomer to the short waves (November last) and operates a schedule from 1030 to 0330. The address is: Apartado 4402, Panama 7.

VENEZUALA

9720kHz YVTR Radio Merida, Merida. This one is another newcomer and has a power of 1kW. Schedule 1000 to 2200. Address: Radio Merida, Avenida Principal, Merida, Venezuala.

4990kHz YVMQ Radio Barquisimeto. For those who want to record on tape a Venezualan station, they could not do better than tune to this frequency between 0100 to 0400. Reception is good and will be improving in the next few weeks as the S. American 'season' approaches.

BOLIVIA

5025kHz La Cruz del Sur, La Paz. This is a new channel, the station having moved from **4985kHz** during late October last year. Reports are requested and will be verified by QSL card. Postal address is: Cajon 1408, La Paz, Bolivia.

KUWAIT

4967.5kHz Kuwait. The English programme is radiated from 1630 to 21.00 GMT. In November use of a new frequency of **15185kHz** commenced, being heard with English programme from 0400 to 0600 GMT. English to Europe on **15385kHz** from 1600 to 1900 GMT.

TOGO

5047kHz Radio Togo, Lome. Weekdays, this station is on the air at 0530 – 0900, 1200 – 1400 and 1630 – 2300 GMT, Saturdays at 0530 – 0900 and 1200 – 2300 GMT. Sundays from 0530 – 2300 GMT. Languages used are French, English and several African dialects. Other outlets are: **6155kHz** (4kW) and **7265kHz** (100kW). The **5047kHz** transmitter has a power of 100kW.

KOREA

15115kHz Voice of Free Korea, Seoul. Broadcasts in English beamed to Europe are from 0600 to 0700 GMT on this channel and on **15430kHz** from 0300 to 0400 beamed to N. America.

Acknowledgements to ISWL, Swedish Dx'ers, and our own listening post.

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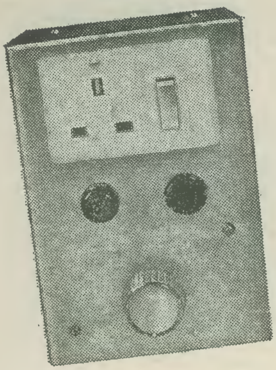


ELECTRIC DRILL SPEED CONTROLLER

by

R. M. MARSTON

Taking advantage of the facilities offered by a currently available triac, this unit provides continuous control, from near-zero to maximum, of the speed of electric drills

THIS DEVICE ENABLES THE SPEED OF AN ELECTRIC drill to be smoothly varied from near-zero to full, and to be set at any intermediate value. The unit is of particular value when using an electric drill in sanding, buffing, polishing, or sawing operations, or when drilling large-sized holes.

CIRCUIT OPERATION

The circuit of the drill speed-controller is shown in Fig. 1. The heart of the unit is the device marked Q1; this device is known under a variety of names, but that used by its manufacturer is "triac". The basic

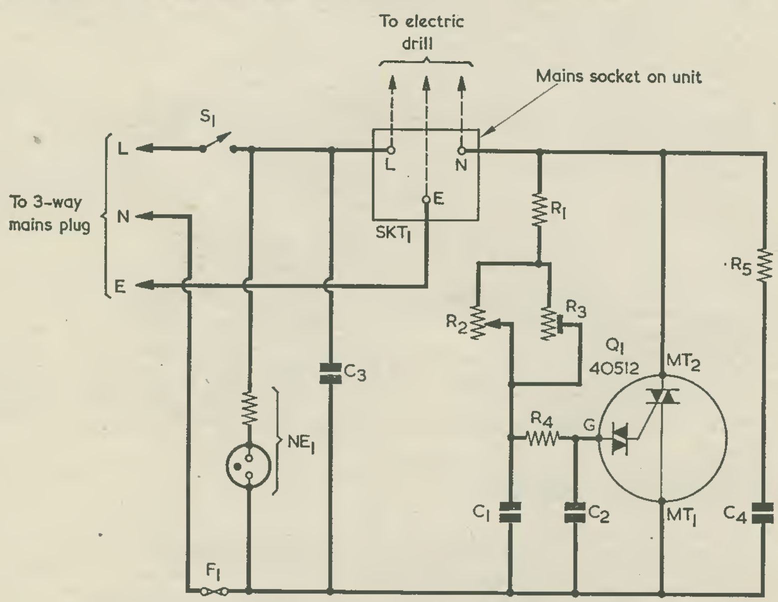


Fig. 1. The circuit of the electric drill speed controller

characteristics of the triac are as follows.

The triac is a solid-state high voltage power switch which is either open circuit or short circuit between main terminal 1 (MT1) and main terminal 2 (MT2). These terminals can be connected to any polarity of supply voltage, so the device can act as a switch for both d.c. and a.c. loads.

The triac is normally open circuit between its two main terminals, thus acting as an open circuit switch, but it can be made to act as a short circuit switch by applying a suitable trigger voltage or pulse to its gate terminal. This gate signal can be of either polarity, and must have an amplitude of about 35 volts; it only needs to be applied for a few microseconds, however, to ensure full turn-on of the triac. Once the triac has been turned on the gate loses control, and the device stays on so long as its main current (between MT1 and MT2) exceeds a fairly low "holding" value. When the main current falls below this value the device automatically turns off again, and remains off until it is triggered back on by a further gate pulse.

Thus, when the triac is used with an a.c. supply, and is triggered on via the gate during the early part of a half-cycle, it remains on until the end of that half-cycle, even though the gate signal may be removed in the meantime. At the end of the half-cycle the triac switches off automatically as its MT1 to MT2 voltage (and thus current) falls momentarily to zero.

Having examined the basic action of the triac, we can now look at the circuit of Fig. 1 to see how the device is used. Here, the electric drill is connected in series with the triac via 3-way mains socket SKT1, the combination being wired across the mains supply line via S1 and F1. R1, R2, R3, R4, C1 and C2 function together as a variable phase shift network, and enable the a.c. voltage on Q1 gate to be effectively delayed, relative to that on MT2, by any amount between about 5° and 170°, depending on the setting of R2.

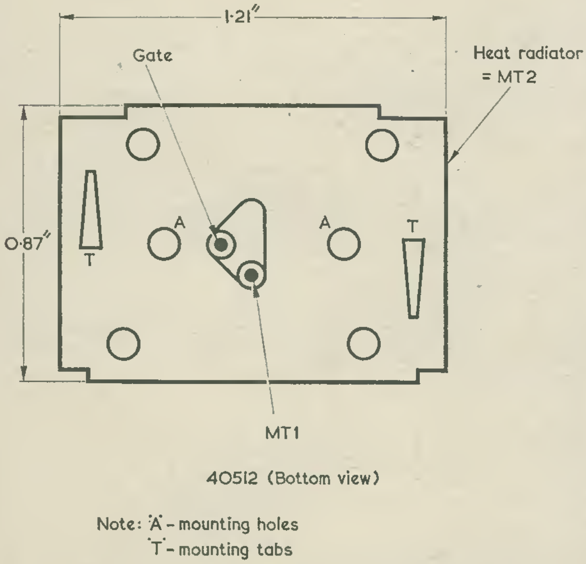


Fig. 2. The underside of the 40512 triac, showing connections and mounting tabs

Cover Feature

Suppose, then, that R2 is set for minimum phase delay. In this case Q1 is open circuit at the start of each half-cycle, and the full mains voltage is applied to the phase delay network. 5° after the start of each half-cycle, however, Q1 gate voltage rises to about 35 volts, and Q1 is triggered on and self-latches, thus remaining in the short circuit condition for the remaining 175° of the half-cycle. The triac is thus on (acting like a short circuit switch) for almost the full duration of each half cycle, enabling the drill to operate at maximum power.

COMPONENTS

Resistors
(All fixed values 10% ½ watt)
- R1 3.3kΩ
- R2 250kΩ potentiometer, linear, 1 watt
- R3 500kΩ potentiometer, preset, skeleton, vertical mounting
- R4 15kΩ
- R5 100Ω

Capacitors
- C1 0.1μ, 250V a.c. wkg., paper or plastic foil
- C2 0.1μF, 200V wkg., paper or plastic foil
- C3 0.1μF, 250V a.c. wkg., paper or plastic foil
- C4 0.22μF, 250V a.c. wkg., paper or plastic foil

Triac
- Q1 Triac type 40512 (R.C.A.)

Switch
- S1 5 amp s.p.s.t. switch

Fuse
- F1 5 amp cartridge fuse

Neon Lamp
- NE1 240 volt neon lamp in panel-mounting holder complete with series resistor

Socket
- SKT1 3-way mains socket

Miscellaneous
- Veroboard, 0.15in. matrix, 3½in. by 2⅛in. (see Fig. 3)
- Panel-mounting fuse holder
- Knob
- 3-core mains lead

Suppose, on the other hand, that R2 is set for maximum phase delay. Q1 is again open circuit at the start of each half-cycle, but in thise case the gate potential does not rise to 35 volts until 170° after the half-cycle has started. Q1 is, in consequence, only turned on for the final 10° of each 180° half-cycle, and very little of the available mains power is applied to the drill, which therefore operates at a low speed.

Thus, the drill power can be varied all the way from full to near-zero by varying the phase delay by means of R2. In the circuit, R5 and C4 prevent incorrect triggering of the triac due to an effect known as "commutating", whilst C3 helps to keep high frequency switching transients (from the triac) out of the mains power lines. Neon lamp NE1 gives a visual indication when the unit is connected to the mains line with S1 closed.

CONSTRUCTION AND USE

The unit can be used with the 50Hz 240 volt mains power supply. The specified triac is supplied with an integral heat radiator, and can handle r.m.s. currents up to a maximum of 2 amps at 25°C without extra heat sinking. Thus, the unit can control drill powers up to 480 watts on 240 volt supplies.

Fig. 2 gives a bottom view of the 40512 triac. The gate and MT1 are brought out at the two leads identified in the diagram. The heat radiator and case provide the connection to MT2. Note that, since it is common to MT2, the heat radiator is "live" and

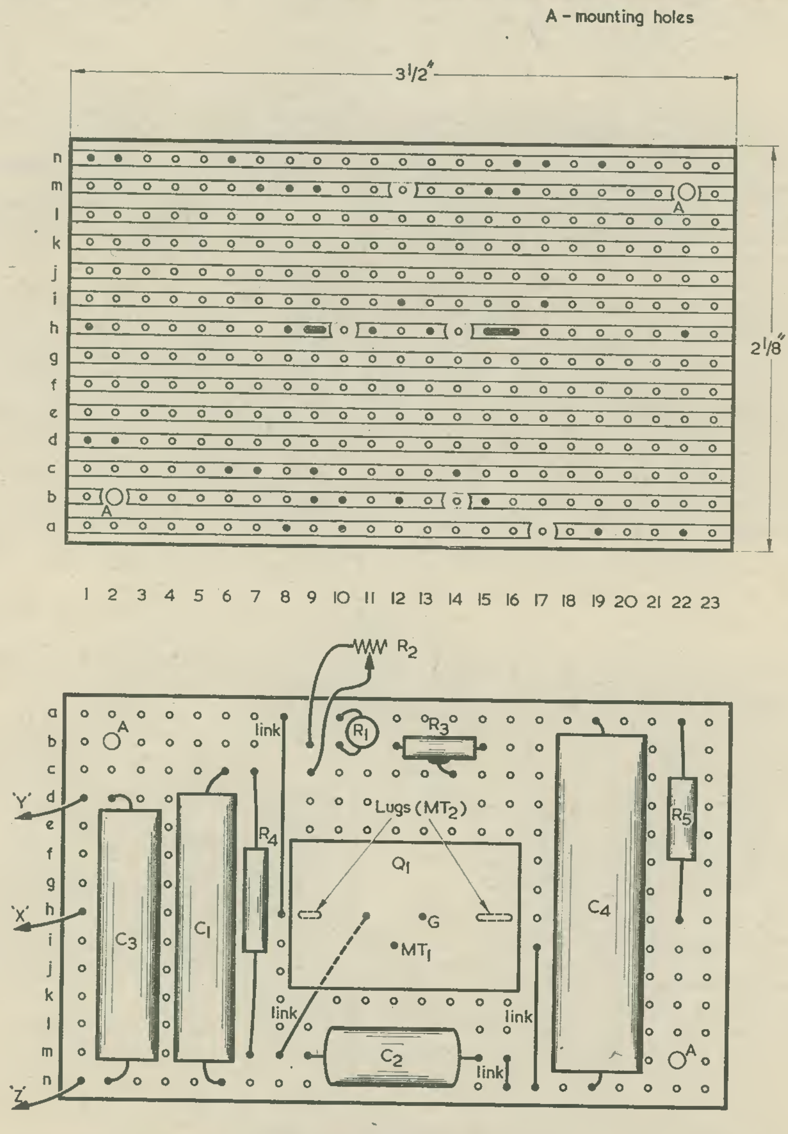


Fig. 3. Copper and component sides of the Veroboard assembly used in the prototype

must not be touched when the unit is connected to the mains.

Constructional details of the unit are in no way critical, and can be varied to satisfy individual tastes. The prototype unit uses Q1 without additional heat sinking, and the components are assembled in a metal case measuring 6in. by 4in. by 2½in., as shown in the photographs. Q1, R1, R3, R4, R5 and C1 to C4 are all mounted on a 3½in. by 2⅛in. piece of Veroboard with 0.15in. hole spacing, as illustrated in Fig. 3. The copper strips are cut at the points indicated. This panel is mounted over R2, and is secured above it by two ¾in. long insulated spacing pillars. These pillars ensure that the mounting metalwork at the holes marked "A" is reliably insulated from the metal case in which the Veroboard assembly is fitted. The copper strips adjacent to the mounting holes carry voltages at mains potential, whereupon it is essential that the method of mounting provides reliable insulation between these points and the metal case. The case is earthed to the earth lead from the 3-way mains plug. In the prototype, the function of S1 is carried out by the switch in the switched socket mounted on the front panel, this being wired into circuit in the required manner.

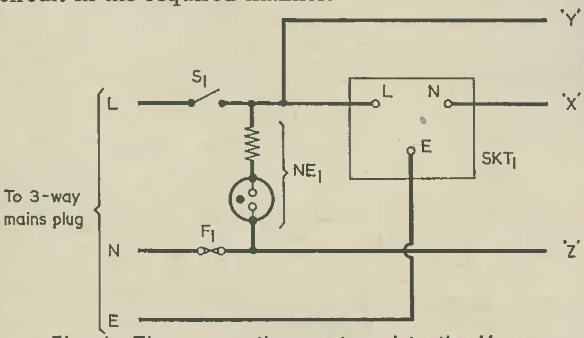
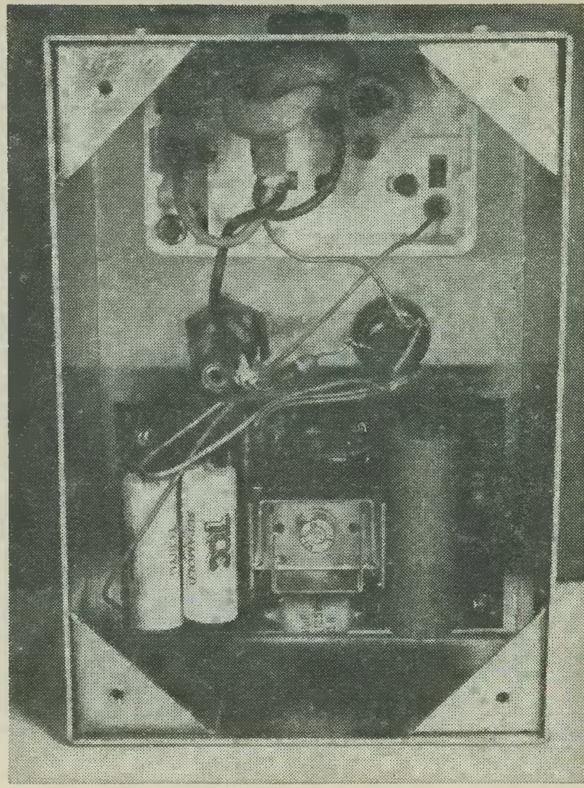


Fig. 4. The connections external to the Veroboard assembly

The case is fitted with a perforated rear cover and has four rubber feet to assist in providing ventilation for the triac. The connections external to the Veroboard assembly are shown in Fig. 4.

When construction of the unit is complete, set R3 at mid-value, connect the electric drill via SKT1, connect the unit to the mains, and switch on by means of S1. Check that the neon lamp lights up, then with R2 set to maximum value (for minimum speed), adjust R3 to give a near-zero drill speed. Now check that the drill speed can be smoothly varied from near-zero to maximum by means of R2. Check also that Q1 does not overheat, but remember that Q1 is "live", so disconnect from the mains before touching this component. If overheating does


The components mounted inside the unit case

occur it will be necessary to fix Q1 to an additional heat sink and provide more ventilation.

The unit is then complete and ready for use.

EDITOR'S NOTE

The maximum r.m.s. on-state current rating quoted by R.C.A. for the 40512 in free air is 2 amps at 25°C, the current being linearly derated to zero at 100°C. Most electric drills are rated well below 2 amps; if the unit is used with drills whose current requirements approach this figure, the triac should be provided with adequate ventilation. The 40512 triac specified is available from Electrovalue, 32a St. Judes Road, Englefield Green, Egham, Surrey.

It will be noted that R2 is specified as a 1 watt potentiometer. Suitable types here are standard (as opposed to miniature) potentiometers with "moulded" carbon tracks, these being available from Home Radio and other suppliers.

A final point is that it is important to ensure that the earth connection from the mains supply is reliably carried through to the earth socket on SKT1. ■

THE "AIRLANE" RECEIVER

The Ministry of Posts and Telecommunications has drawn our attention to Section 5(b) of the Wireless Telegraphy Act, 1949.

The Section reads as follows:–

Any person who, otherwise than under the authority of the Minister or in the course of his duty as a servant of the Crown, either –

(i) uses any wireless telegraphy apparatus with intent to obtain information as to the contents, sender or addressee of any message (whether sent by wireless telegraphy or not) which neither the person using the apparatus nor any person on whose behalf he is acting is authorised by the Minister to receive; or

(ii) except in the course of legal proceedings or for the purpose of any report thereof, discloses any information as to the contents, sender or addressee of any message, being information which would not have come to his knowledge but for the use of wireless telegraphy apparatus by him or by another person, shall be guilty of an offence under this Act.

DEVELOPING THE "SPONTAFLEX" SHORT WAVE RECEIVER

by

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

The "Spontaflex" DRC2 short wave receiver, published in an earlier issue, has proved to be very popular with readers. This article describes modifications which enable more modern transistors to be incorporated, whereupon performance and frequency range are further improved

CONSIDERABLE INTEREST HAS been taken in the author's DRC2 receiver described in an earlier issue[1], so that it seems worth while passing on to readers developments which have taken place since. These developments double the frequency coverage, taking it up to 35MHz, and enable signals to be heard through a small speaker incorporated with the set which still, however, remains essentially a headphone receiver so far as DX reception is concerned. If powerful speaker reproduction of weaker stations is required, an external amplifier can always be plugged in to the phone socket.

This article is primarily intended for those who have already built the original receiver, or who have the relevant issue of the magazine.

To avoid confusion it should be stated that the 5 switched positions in the new version of the receiver are referred to as Bands 1 to 5, Band 5 being the lowest in frequency. Later, when Denco coils are mentioned, they will be referred to as Range 2 to Range 5, Range 2 being the lowest in frequency. This complies with the manufacturer's nomenclature.

EXTRA BAND

In order to enable an extra high frequency Band to be incorporated (Band 1) it is necessary to change over to n.p.n. silicon transistors, and two 2N3707's will be needed. Also required are two resistors, each 1.2kΩ, and a small preset potentiometer of 50kΩ. The coil used for this Band is a Denco, valve type, Miniature Dual Purpose, Range 5, Blue or White. These components appear in the Components List for this article as TR1, TR2, R2, R3, VR1 and L3.

First, the five components bearing these numbers which appear in the original receiver should be removed and put in the spares box. Next C4, C5, D1 and the battery connectors should be removed and replaced in the same circuit positions, but with polarity reversed in each case. The new components TR1, TR2, R2, R3, VR1 and L3 should now be soldered into position. Fig. 1 shows the relevant part of the original layout, and Fig. 2 shows how the altered components should now be connected. Note that the new TR1 and TR2 have crossed lead-outs so the collector lead, in each case, should be covered with a small piece of insulated sleeving.

Disconnect the L2 starting lead from the fixed vanes tag of VC3 and solder pin 1 of the Denco coil (L3) direct to the VC3 tag instead. Then solder the L2 lead just disconnected to pin 6 of L3, and add a short lead from L3 pin 6 to the vacant tag of S1(a), as illustrated in Fig. 2. L3 should take up the position shown in Fig. 2. It is necessary, too, to join two tags of S1(b), as also shown in Fig. 2. Whereas, previously, there were two "off" positions on the switch, there is now only one, next to Band 5. All other components remain without alteration. The core of L3 should be adjusted so that about ¼in. of the threaded brass rod protrudes.

CHECKING THE CIRCUIT

The receiver, as so far modified, may next be checked. It is important that VR1 should not be adjusted so that less than about a quarter of the track is left between the slider and the end connected to the positive supply rail, or there is a danger that excessive current will flow later, particularly when TR3 is added. In the first place the slider of VR1 should be set to the half-way position and the receiver tried out on, say, Band 2. Oscillation should be easily available. If not, something is wrong and connections should be checked. Then switch to Band 1, open the vanes of VC3 completely and adjust VR1, if necessary, so that oscillation is easy and smooth. Next check on Band 4 with the vanes of VC3 closed and make sure that oscillation is satisfactory. If necessary, find a compromise position for the slider of VR1 which suits both Band 1 with the vanes of VC3 open, and Band 4 with the vanes of VC3 closed. These two tuning points will probably be found to be the most critical for satisfactory reaction, and the best position for the one is not always the best position for the other. Ensure also that reaction on Band 5 is satisfactory.

It will be seen from the circuit of Fig. 4 that adjustment is now made to the resistance in the collector load of TR2 (common to the base of TR1) rather than to the resistance in the emitter circuit of TR1 as was done in the original

1 Sir Douglas Hall, "The 'Spontaflex' Transistor Short Wave Receiver", *The Radio Constructor*, January, 1968. The receiver was also referred to as "DRC2", this standing for "Double Reflex Colpitts 2".—Editor.

design. The modified form of control has a larger effective range and causes less alteration to the collector current of TR1, which is an advantage if TR3 is added.

WAVE TRAP

A second modification which is useful in areas where a strong medium wave signal tends to break through—especially on Band 5—is the incorporation of a wave trap. This is given by L4 and VC4 connected in parallel and positioned as shown in Fig. 3. (Fig. 3 also shows a further modification incorporating VR2, this being described later.) If the interfering station has a wavelength of 300 metres or more, L4 should have 50 turns of 32 s.w.g. enamelled wire close-wound on a paper sleeve fitted over a piece of ⅜in. ferrite rod about 1½in. long. If the wavelength of the offending station is less than 300 metres, L4 should have 35 turns. In each case VC4 should be a preset capacitor with a maximum value of about 500pF. It is important that capacitance in the wave trap circuit should not be too low or the injection of short wave signals into the circuit will be impeded.

OUTPUT STAGE

For the speaker output stage some further components are required. These are a 2½ or 3in. round 3Ω speaker, output transformer T1, a 2N2926G transistor (available from Amatronix, Ltd.), capacitors C6 and C7, resistor R4, toggle switch S2 and a 3-way tagstrip. These components are mounted as shown in Fig. 3. T1 is fixed by soldering one of the feet of its clamp to a solder tag held under one of the mounting screws for the existing tagboard. Do not attempt to save the cost of T1 by using an 80Ω speaker. With a 9-volt supply and a small current flowing, this would offer a very bad match for TR3, and there would be a considerable loss of efficiency.

Switch S2 is included to switch the output stage in or out as desired, and a hole is required in the panel for its bush. As may be seen from Fig. 4, when S2 is open TR3 has no bias for its base and will not conduct. With S2 closed, base bias becomes available, and TR3 conducts and amplifies. If the receiver is critically tuned to a weak station when the speaker is switched in or out, slight readjustment of tuning and reaction may be needed owing to a small consequent change in bias for TR1 and TR2. In most cases this effect will not be noticed.

If a 2½in. speaker is used, it can be mounted on the plywood "foot" already in position to enable the receiver to be used without a case. It will, of course, be necessary to remove this piece of plywood and cut a hole in it for the speaker. The prototype uses a 3in. speaker with a square frame, obtained from Henry's Radio. This now takes the place of the plywood "foot", the panel being cut away for about ¼in. to make room for the speaker, which is attached to the panel by two thin wood screws. It is clear that in either instance a suitable hole will have to be cut in the case and covered, on the inside, with a piece of expanded metal to protect the speaker.

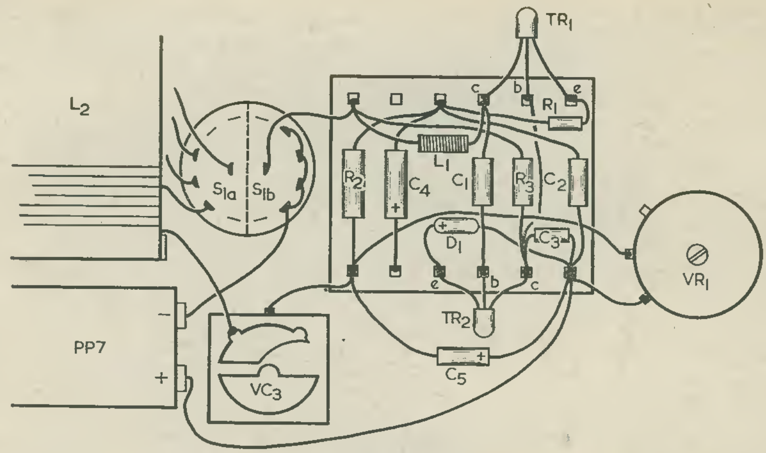


Fig. 1. Original layout, showing components affected by the modifications

PLUG-IN COILS

Some readers have asked about the possibility of using plug-in coils in place of the special home-made coil and switching circuit specified. Experiments have shown that, provided VC3 is replaced with a 160pF component, it is possible to obtain coverage from about 35MHz to about 1.2MHz using Ranges 5 to 2 inclusive of Denco valve type Miniature Dual Purpose coils, White. These White coils are intended as oscillator coils for an i.f. of 1.6MHz, but have just the right inductance for this receiver. Only the tuned winding is used. No connections are made to S1(a). A B9A valveholder is required, with pin 1 joined to the fixed vanes of VC3 and pins 2, 3, 4 and 6 to the moving vanes. This multi-pin connection is necessary as different Range coils have different pin connections. The coils may then be plugged in as required.

Some readers have said that they are only interested in the 80 and 160 metre bands. Both these bands can be covered by a Denco Range 2 White coil with the core suitably adjusted.

A disadvantage with the plug-in coils is that a 160pF tuning capacitor must be used and this results in some loss of efficiency at the low

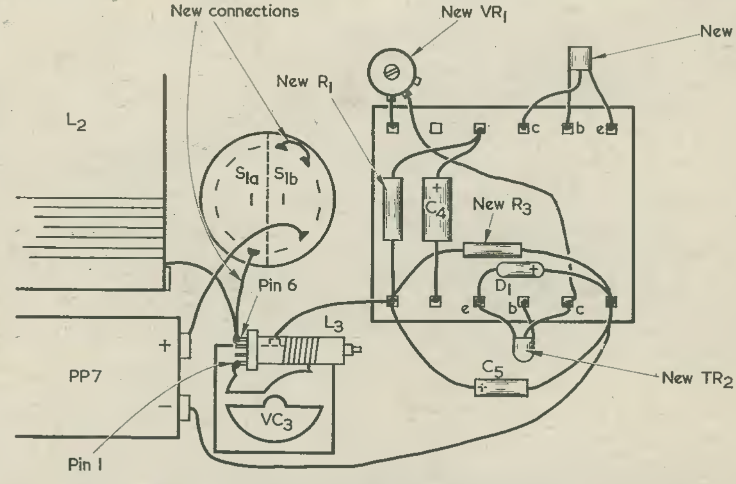


Fig. 2. The modifications in layout and wiring resulting from fitting new transistors in the TR1 and TR2 positions and extending the frequency range

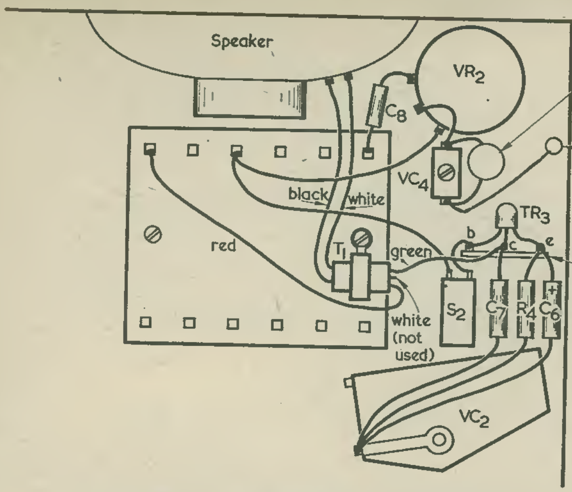


Fig. 3. Adding an output stage for a speaker, together with an adjustable aerial loading circuit and a wave trap

frequency end of each Range, as compared with the 100pF capacitor used with the home-made coil. It is useful to remember that 100pF across 1μH will tune to the same frequency as 10pF across 10μH. Other things being equal, the voltage of the signal received will be 100 times greater with the 10pF capacitor than with the 100pF capacitor – the equivalent of quite a useful r.f. amplifying stage.

NEW TRANSISTORS

Constructors who are not interested in frequencies higher than about 15MHz will gain less advantage by changing over to the new transistors. But the 10, 11, 13 and 15 metre bands cannot be received with the original design and the new transistors also ensure excellent reception of the 16 metre band, which was not too reliable with the previous transistors. There may, incidentally, well be disappointment if a small earphone is employed. The DLR5 headphones, as originally specified, are strongly recommended and will prove vastly more sensitive.

AERIAL-EARTH LOADING

As was described in the earlier article, the greater the aerial-to-earth loading, the greater will be the amplification. Increasing the aerial coupling, by closing the vanes of VC1, will generally require the reaction control, VC2, to be moved back.[2] In fact, at the low frequency end of Band 5 it may be found that the receiver will oscillate even with VC2 fully open if aerial coupling is too tight. But here the position is complicated by the fact that L1, with stray capacitances, forms a tuned circuit not far removed from that of the incoming signal. One reader has reported an improvement by using a 5mH choke for L1. This, however, may introduce some losses at 10 metres, due to larger stray capacitance.

Although the receiver is very free from hand capacitance effects on all the original Bands, whether an earth connection is used or not, this nuisance can begin to be noticeable on the 10 metre band, particularly if headphones are used, so that it is an advantage to use long necked knobs for the slow motion drive on VC3, and on VC2. Alternatively, an inch or so of insulated tubing can be added as extension rods. On the 10 metre band the length of the aerial has a considerable effect and it is worth experimenting to find a length which gives freedom from hand capacitance troubles. Excellent, hand capacitance-free results on 10 metres are obtained with the prototype using a fairly long outside inverted L aerial, although for most other bands this aerial causes selectivity problems even when VC1 is adjusted to the minimum position. For general use, about four yards of wire slung across the room is satisfactory. An earth, which may be the earthed socket of a mains plug, provides far greater sensitivity on Bands 4 and 5, has a useful effect on Band 3, very little advantage on Band 2, and none whatsoever on Band 1.

It may be found that VC1, the series aerial capacitor originally fitted, will not provide sufficient selectivity on the new Band 1, even when fully open. The minimum capacitance may still be too great to allow, say, powerful stations on the 13 metre band to be separated. In this event, a modification to potentiometer coupling, as shown in Figs. 3 and 4, will prove a considerable help. VC1 is replaced by a fixed capacitor, C8, and variable

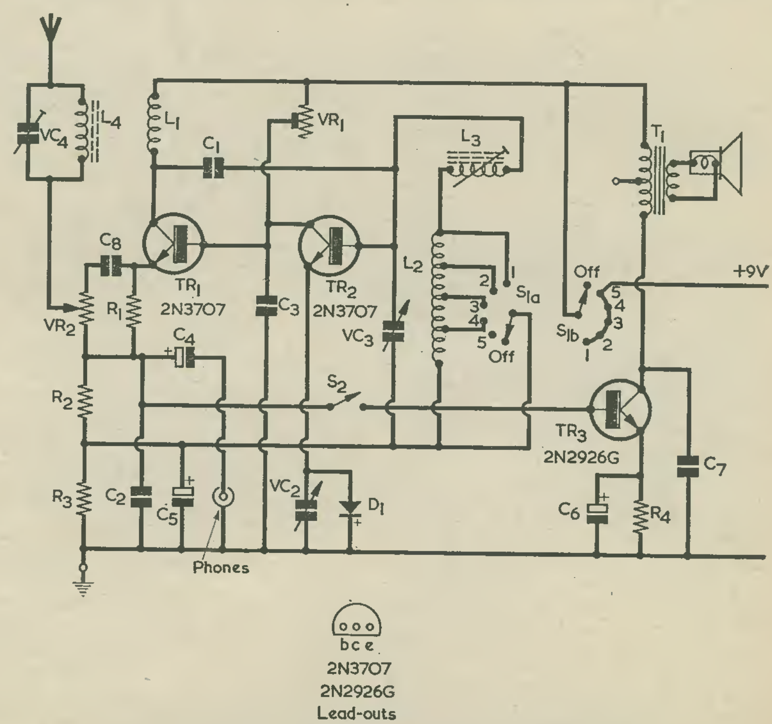


Fig. 4. The circuit of the receiver with all modifications incorporated

2 VC1 was a 100pF solid dielectric variable capacitor fitted in series between the aerial and the emitter of TR1 in the previous design.—Editor.

COMPONENTS

Components Retained From Previous Design

Resistor
R1 330Ω ¼ watt 10%

Capacitors
C1 22pF
C2 0.1μF
C3 0.0015pF
C4 100μF electrolytic, 9V wkg.
C5 100μF electrolytic, 3V wkg.
VC2 100pF variable, solid dielectric
VC3 100pF variable, air-spaced

Inductors
L1 2.5mH choke (Repanco)
L2 See text of January 1968 article

Diode
D1 OA81

Switch
S1 2-pole 6-way miniature rotary

Phones
Headset type DLR5 (Henry's Radio, Ltd.)

Dial Drive
Vernier Drive type T501 (Eagle)

Plugs, Sockets
Phone jack and plug
Aerial socket
Earth socket
Battery connector clips

Battery
9 volt battery type PP7 (Ever Ready)

Miscellaneous
6-way tagboard, 2½ x 2¼in.

New Components for Modified Receiver

Resistors
(All fixed values ¼ watt 10%)
R2 1.2kΩ
R3 1.2kΩ
R4 120Ω
VR1 50kΩ miniature potentiometer, preset, linear
VR2 2kΩ potentiometer, linear (see text)

Capacitors
C6 100μF electrolytic, 3V wkg.
C7 0.05μF
C8 100pF
VC4 500pF preset

Inductors
L3 Denco Miniature Dual Purpose Coil, valve type, Blue or White, Range 5.
L4 See text
T1 Output transformer type LT700 (Eagle) or similar

Transistors
TR1 2N3707
TR2 2N3707
TR3 2N2926G

Switch
S2 s.p.s.t., toggle

Speaker
3Ω, 2½ or 3in. round

Miscellaneous
3-way tagstrip
1½in. of ⅜in. dia. ferrite rod

coupling is provided by VR2. The value of this component is not very critical, but 2kΩ will be found to give smooth, progressive coupling on all Bands. With the prototype VR2 was also found a great help in removing hand capacitance on 10 metres when the length of the aerial was introducing this effect. It will be noted that at the zero coupling position the aerial is coupled to earth through C2, though powerful stations will still be received with critical reaction, being picked up direct on the wiring and coil. In Fig. 3, VR2 is mounted in the position previously occupied by VC1.

PROTOTYPE OPERATION

In the prototype of the modified receiver, TR1 draws 700μA, TR2 250μA and TR3 7mA. Thus, when headphones are used and the speaker is switched out, less than 1mA is drawn from the battery.

TABLE

Frequency ranges with the modified receiver.

Band	Frequency range (MHz)
1	35 – 16
2	18.5 – 8.8
3	10.4 – 4.72
4	5.2 – 2.38
5	2.75 – 1.21

The ranges covered by the 5 Bands with the prototype, using the original home-made coil for Bands 2 to 5, and the Blue Denco coil added for Band 1, are shown in the accompanying table.

It is not proposed to repeat all the detailed instructions given in the earlier article, nor to describe, again, the passage of a signal through the receiver. But Fig. 4, which shows all the modifications mentioned in this article, together with the Components List, should enable experienced constructors to make the receiver even if they do not have the earlier article by them. But they will have to design their own coil unit, or use plug-in coils as described.

Editor's Note. Copies of the January 1968 issue, containing the article describing the original "Spontaflex" receiver, are available for 3/6 post paid from Data Publications, Ltd. ■

LOW LIGHT LEVEL TV CAMERA TUBE

The latest addition to the range of TV camera tubes manufactured by English Electric Valve Co. Ltd., combines the low-noise read-out of a 3in. image isocon tube with the additional light amplification of a single stage image intensifier. The resultant type P8012 tube will give good pictures under overcast starlight conditions.

The intensifier stage, a P899B, has a curved faceplate for use with a mirror optical system, though with a corrector lens fitted it can also be used with a refractive optical system. The intensifier output screen and the 3in. image isocon (type P887) photocathode are both fitted with fused fibre optic faceplates, which coupled together provide an efficient transfer of the intensifier output image onto the photocathode of the isocon.

Both the P899B and P887 can be supplied separately if required.

NEW MICROELECTRONIC INTERCONNECTION SYSTEM

Hawker Siddeley Dynamics, Hatfield, Herts., has introduced a new microelectronic interconnection system for integrated circuits – Mynapak. It is a development of an earlier system, Micropak, with applications in the data transmission and handling and control engineering fields.

In a package measuring 5 cm by 2.5 cm by 0.4 cm thick, Mynapak can contain up to 25 integrated circuits and 25 other thick film and chip components to customer's specification.

The package has 40 leads in 'dual in-line' format (20 leads on each of the 5 cm sides) on 0.25 cm centres. Mynapak can dissipate up to six watts without a heat sink.

SIMPLE FREQUENCY METER

by

J. B. DANCE, M.Sc.

This article describes a neat and reliable circuit design for a direct-reading frequency meter capable of working up to 1MHz. It may be made up as a single-range instrument, or it may incorporate a switch offering up to five different ranges

FREQUENCY MAY BE MEASURED AND INDICATED BY either analogue or digital techniques. If digital techniques are employed, each of the input pulses is counted over a certain period (for example, 1 second) and the total number of counts is displayed in the form of digits (possibly by cold cathode numerical indicator tubes).

In the case of analogue circuits, however, a voltage or a current proportional to the input frequency is generated. As the input frequency changes, analogus changes occur in the amplitude of the voltage or current generated by the circuit. This voltage or current is displayed on a meter which is calibrated to indicate frequency. Such a frequency meter is known as a ratemeter when it is used for nucleonic instrumentation.

In general, analogue instruments tend to be more economical to construct than digital instruments, but the latter can provide greater accuracy. If an analogue display of a current is to have an accuracy of

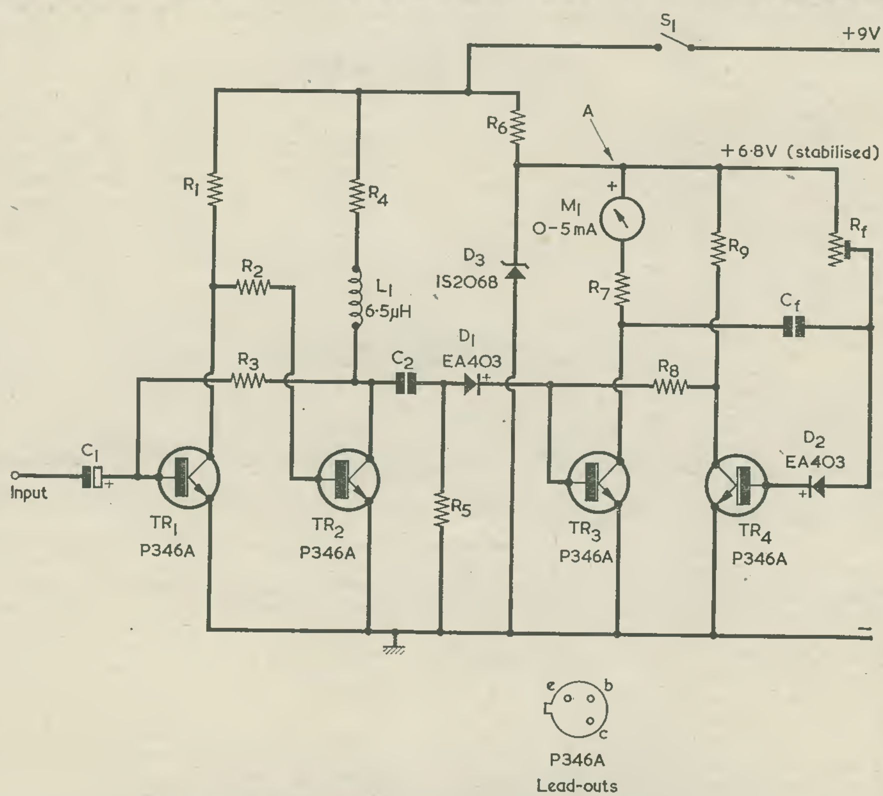


Fig. 1. A simple frequency meter with a single range. The values of capacitor Cf are as shown in the Table

±1%, a good meter is required. On the other hand, if a digital instrument is used to count each cycle of a 10MHz waveform for 1 second, it is possible to arrange that the error in the display of the frequency is little more than 1 part in 10^7. However, such instruments can be very complex.

THE CIRCUIT

The circuit to be described is a simple analogue frequency meter employing only four economically priced transistors. It can be constructed to provide a single range or, with an additional switch and components, five switched ranges covering 10Hz to 1MHz. (The lowest frequency which may be reliably measured is 10Hz.)

The input signal, the frequency of which is to be measured, should exceed 2 volts peak to peak and should be supplied from a source resistance less than 5kΩ. The power supply required is 9 volts at about 50mA.

PRINCIPLE OF OPERATION

The first two transistors in the circuit of Fig. 1 form a trigger circuit which switches over rapidly each time the input voltage rises and falls. The output pulses from this part of the circuit pass through the 100pF capacitor C2 which, in conjunction with R5 differentiates the pulses. The negative parts of the differentiated pulses cannot pass through D1. On the other hand, the positive parts do pass through this diode, and they are used to switch transistor TR3 to conduction.

The transistors TR3 and TR4 form a monostable circuit in which TR4 is normally conducting. When TR3 is switched to conduction, TR4 is switched off, but the circuit returns to its quiescent state after a time determined by the product of the values of Rf and Cf.

When TR3 conducts, a current passes through the meter and R7 to TR3 collector. The magnitude of this current is dependent on the potential of point A and on the collector voltage of TR3. The potential of point A is kept constant by the use of the 6.8 volt zener diode, D3, whilst the collector voltage is also constant ($=V_{sat}$) during conduction. Thus the magnitude of the current passing through the meter is constant.

TABLE

Full-Scale Deflection (Hz)	Value of Cf (μF)
100	1
1,000	0.1
10,000	0.01
100,000	0.001
1,000,000	0.0001

If the current passing during the pulses is kept constant, the deflection of the meter is proportional to the pulse duration and the number of pulses per second. For a given value of Rf and Cf, the deflection is therefore proportional to the input frequency.

The first two transistors are used to provide sharply rising pulses for the operation of the monostable circuit. Even if the input voltage changes rather slowly (e.g. if it is a sine wave), the first two transistors still switch rapidly.

COMPONENTS

(N.B. This list applies to Fig. 1. See text for additional components required for circuit of Fig. 2).

Resistors
(All fixed values 5% ½ watt)

R1	1kΩ
R2	4.7kΩ
R3	10kΩ
R4	330Ω
R5	1kΩ
R6	100Ω
R7	510Ω
R8	4.7kΩ
R9	510Ω
Rf	10kΩ preset potentiometer

Capacitors

C1	10μF electrolytic, 12V wkg.
C2	100pF ceramic
Cf	See Table

Inductor
L1 6.5μH coil (see text)

Semiconductors
TR1–TR4 P346A
D1, D2 EA403
D3 6.8 volt zener diode type 1S2068

Meter
M1 moving-coil meter, 0–5mA

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

Battery
9-volt battery

CALIBRATION

If the value of Rf or Cf is altered, the duration of the current pulses through the meter will be changed and this will affect the meter deflection for a certain input frequency. Thus the desired value of the full-scale deflection may be obtained by a suitable choice of Rf and Cf.

The value of Cf may be selected from the Table to cover the desired frequency range. The instrument is calibrated by feeding a signal from a generator to the input of the circuit, this signal having a frequency equal to the desired full-scale deflection. The value of Rf is then adjusted so that a full-scale deflection is obtained.

The value of Cf for various values of full scale deflection is shown in the Table.

The lowest frequency range may, of course, be calibrated using the 50Hz mains supply to give a half-scale deflection. The mains supply should be connected to a transformer and a low voltage output from the latter connected to the input of the frequency meter. A valve heater transformer supplying 6.3 volt r.m.s. can be used for this purpose.

MULTI-RANGE INSTRUMENT

If a multi-range instrument is required, alternative values of the capacitor Cf may be switched into the circuit as shown in Fig. 2. These capacitors have the values shown in the diagram.

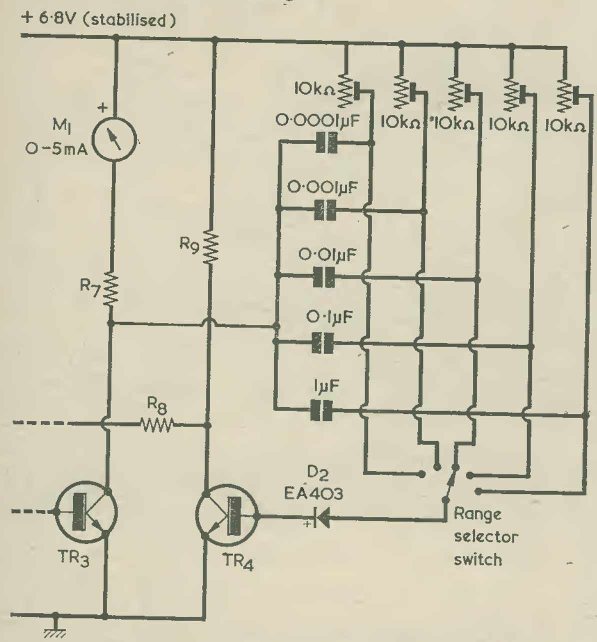


Fig. 2. Modifications to the circuit of Fig. 1 when a multi-range instrument is required. The remainder of the circuit is exactly as shown in Fig. 1

Each range should be calibrated separately and the full-scale deflection of each should be adjusted by the associated potentiometer shown in Fig. 2. If precision capacitors are used for the five capacitors, it may be possible to achieve satisfactory results with only one variable resistor, but it is normally both economical and more convenient to use readily available standard components in the circuit given.

COMPONENTS

The value of Cf may be selected from the Table 10 turns of enamelled copper wire wound on a 0.4 inch diameter former to produce a coil about half an inch in length is suitable. The wire may be about 26 s.w.g.

The trimming potentiometers should, for long-term accuracy, be high grade types. The transistors and diodes are readily available devices, obtainable from LST Electronic Components Ltd.

CONSTRUCTION

The circuit may be conveniently constructed on the normal type of Lektrokit insulated board which has holes spaced at 0.1 inch intervals to take tapered solder pins. Only about a third of one of these boards is required and this may be cut from a complete board by means of a small saw either before or after the components have been soldered in position. The board measures 4 by $4\frac{3}{4}$ inches and is Lektrokit Part No. LK-141, whilst the solder pins are Lektrokit Part No. LK-3011. Both are available from Home Radio (Components) Ltd.

A 9 volt battery of the type used in transistor radios is generally the most convenient source of power, since the instrument is then independent of a mains supply. However, the mains can be used as a source of power if a transformer providing an output of about 7 volts r.m.s. is employed; the output from this transformer is half-wave rectified by a single diode and smoothed with a capacitor of about $250\mu F$, 12V wkg.

The completed circuit board may be fixed in a small diecast box into one face of which the meter has been fitted. The size of the box required will depend on whether a range switch is to be used, on the size of meter used and possibly on the size of the battery to be employed. A range of suitable diecast boxes is available from Home Radio (Components) Ltd. Some constructors will, of course, doubtless prefer to make their own box for the unit.

ACKNOWLEDGEMENT

The circuit described in this article is a design published by SGS (United Kingdom) Ltd., to whom due acknowledgements are made. ■

CURRENT SCHEDULES

★ RADIO SWEDEN

This English language schedule for Europe is current until March 1st.

9625, 15315kHz (31.17, 19.59 metres) 1100 to 1130 GMT (12.00 to 12.30 BST).

6065, 9625kHz (49.46, 31.17 metres) 2045 to 2115 GMT (2145 to 2215 BST).

11705, 15155kHz (25.63, 19.80 metres) 2245 to 2315 GMT (2345 to 0015 BST).

★ SWITZERLAND

Current until May 2nd, the English language schedule is as follows:

9665kHz (31.04 metres), 1130 to 1230 GMT (1230 to 1330 BST), also radiated at the same times on **11865kHz** (25.28 metres).

6055kHz (49.55 metres), 1930 to 2030 GMT (2030 to 2130 BST), also on **9665kHz** (31.04 metres).

★ U.S.A.

Radio New York Worldwide schedule for Europe is as follows:

17845kHz (16.81 metres), 1700 to 2130 GMT (1800 to 2230 BST) and on **21530kHz** (13.93 metres), 1700 to 2015 GMT (1800 to 2115 BST). On Sundays only, transmissions end at 1600 GMT (1700 BST).

Later transmissions for Europe are on **11805kHz** (25.41 metres), 2200 to 2330 GMT (2300 to 0030 BST) and **15440kHz** (19.43 metres), 2025 to 2145 GMT (2125 to 2245 BST).

For the SWL and electronics hobbyist, Dx-ing Worldwide is radiated at 1735 GMT (1835 BST) on Saturdays and at 1905 GMT (2005 BST) on Sundays.

UNDERSTANDING RADIO

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

VOLTMETERS AND OHMMETERS

by W. G. Morley

IN LAST MONTH'S ISSUE WE CONtinued our examination of the moving-coil meter and discussed the manner in which it is used for measuring current. We saw that the current at which the meter offers full-scale deflection (or. f.s.d.) may be increased by connecting a shunt across its terminals, and we dealt with the simple equation employed for calculating the value of that shunt. We next examined the moving-coil meter as used in a multitestmeter having a number of switched current ranges and saw how the "universal shunt" circuit operates.

We now turn to the techniques involved when the moving-coil meter is employed for the measurement of voltage.

MOVING COIL VOLTMETERS

A voltmeter is an instrument which, as its name implies, is intended to indicate the voltage existing between two circuit points. The voltmeter is simply connected across these two points and there is no necessity to make any physical alterations to the circuit to which it is applied. This is a different state of affairs to that which occurs when a current indicating meter is used, since the latter has to be inserted *in series* with the circuit whose current flow is to be measured. For this reason, the voltmeter is normally a much more useful tool when servicing or fault-finding work is being carried out, since it is in most cases a much quicker operation to measure voltages in a piece of equipment than it is to measure currents. The measurement of current requires that a circuit be broken before the current indicating meter can be inserted. A skilled service engineer who is searching for an obviously incorrect current flow in a faulty item of equipment will often carry out the two-step procedure of first checking the voltage across, say, a resistor and then measuring the value of that resistor when the appropriate equipment has been switched off. The current which flows in the resistor may then be rapidly calculated, the overall process being considerably quicker than is given by physically disconnecting one end of the resistor and inserting a current indicating meter in series. In laboratory design and development work, on the other hand, meters are used to provide precise measurements rather than to merely locate the presence of obviously incorrect voltages and currents, whereupon the current reading meter has the same usefulness as the voltmeter.

A moving-coil meter is capable of indicating voltage on its own, in so far that the current flowing through its coil is directly proportional to the voltage across its terminals. Thus, a 0-1mA meter having a resistance of 100Ω will give an f.s.d. indication when the voltage across its terminals is 0.1 volt since (from the Ohm's Law equation, E=IR) that is the voltage required to cause 1mA to flow in a resistance of 100Ω. Other commonly encountered moving-coil meters will also give f.s.d. readings

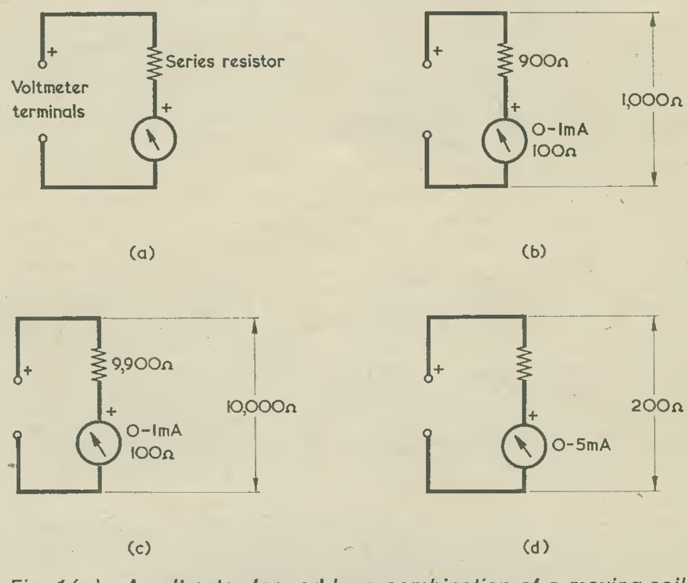


Fig. 1(a). A voltmeter formed by a combination of a moving-coil meter and series resistor
(b). A voltmeter with a full-scale deflection of 1 volt
(c). A voltmeter having a full-scale deflection of 10 volts
(d). This voltmeter has a full-scale deflection of 1 volt, but draws a higher current than that of (b)

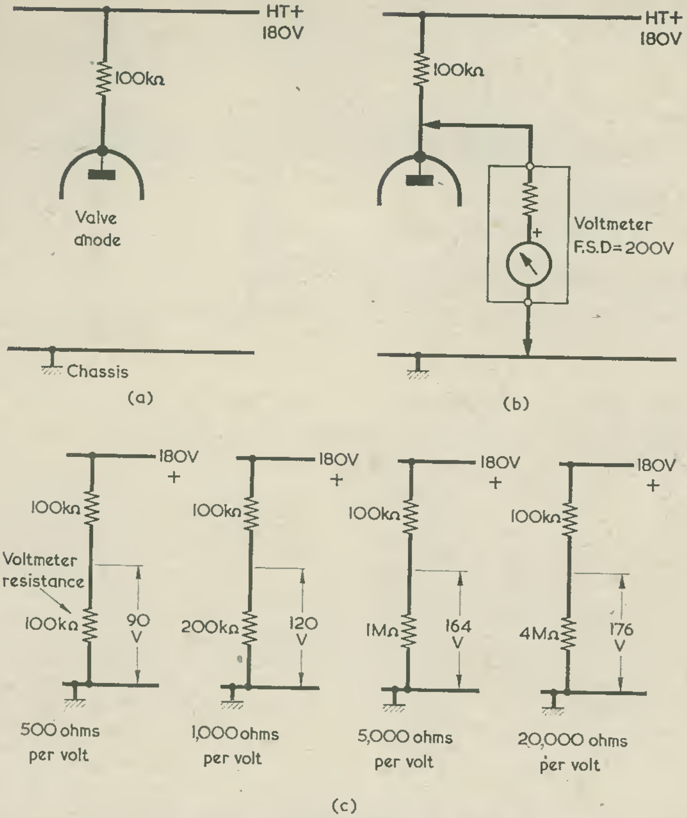


Fig. 2(a). A typical equipment circuit, in which a valve has an anode load resistor of 100kΩ

(b). Measuring anode voltage with a voltmeter having an f.s.d. of 200 volts

(c). If, due to a fault condition, the valve draws zero anode current, the only current in the 100kΩ load resistor is that drawn by the voltmeter. The lower resistors in the four examples given here represent the resistance presented by voltmeters having different ohms per volt figures. The voltages across the lower resistors are those indicated by the voltmeters they represent

when similarly low voltages are applied across their terminals.

Voltage indicating instruments which are incapable of giving readings higher than a fraction of a volt are obviously not of much use in practice, and it is only for occasional specialised applications that a moving-coil meter is employed on its own to show voltage in this manner. Voltages higher than that appearing across the meter coil are measured by connecting an external fixed resistor in series with the moving-coil meter, as in Fig. 1(a), the combination then being described as a *voltmeter*. Fig. 1(b) shows the 0-1mA meter with 100Ω resistance we chose as an example just now, this being connected in series with a 900Ω resistor to form a voltmeter. Since the total resistance between the terminals of this voltmeter is 1,000Ω (900Ω + 100Ω), and since a current of 1mA flows when a voltage of 1 volt is applied to a resistance of this value, it follows that the voltmeter of Fig. 1(b) has an f.s.d. figure of 1 volt. Fig. 1(c) shows the same basic meter with a series resistor of 9,900Ω, whereupon the total resistance between the voltmeter terminals is 10,000Ω. In consequence, the voltmeter of Fig. 1(c) gives a full-scale deflection at 10 volts.

These examples are helpful in introducing the fact that, if we want to find the value required in the series resistor of a voltmeter, it is first of all necessary to calculate the total resistance which causes the meter f.s.d. current to flow at the desired f.s.d. voltage, and to then subtract from this total resistance the resistance of the meter. The procedure may be summed up in the general equation:

$$R_{series} = \frac{E}{I} - R_m$$

Where R_{series} is the series resistor in ohms, E is the f.s.d. voltage in volts, I is the meter f.s.d. current in amps and R_m is the resistance of the meter in ohms.

OHMS PER VOLT

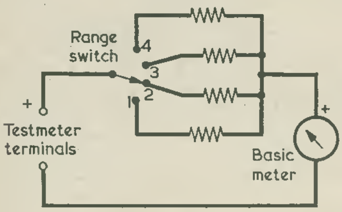
A convenient method of easing voltmeter series resistance calculations is to employ the concept of "ohms per volt". In Fig. 1(b) a total resistance of 1,000Ω resulted in a f.s.d. voltage reading of 1 volt. At the same time, an overall resistance in Fig. 1(c) of 10,000Ω resulted in an f.s.d. voltage reading of 10 volts. Both these examples demonstrate that a voltmeter incorporating a 0-1mA basic meter can be described as being a 1,000 ohms per volt instrument. If we wanted to find the value of series resistance for a voltmeter giving an f.s.d. reading at 5 volts and having a 0-1mA basic meter, we may commence by saying that the 1,000 ohms per volt figure associated with the 0-1mA meter tells us that the total resistance required will be 5 times 1,000 or 5,000Ω, with the result that the series resistor should be this value minus the resistance of the meter.

Fig. 1(d) illustrates a voltmeter incorporating a 0-5mA basic meter together with a series resistor which allows an f.s.d. reading to be given at an applied voltage of 1 volt. From the Ohm's Law equation we can calculate the total resistance as being 200Ω, whereupon the series resistor requires a value of 200Ω minus the resistance of the meter. The ohms per volt figure when a 0-5mA basic meter is employed is 200.

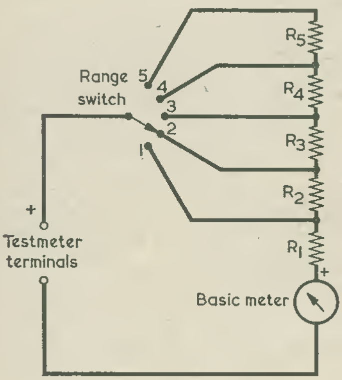
It will be apparent that the ohms per volt figure is directly dependent upon the current which the voltmeter draws at full-scale deflection. We have already seen that when the basic meter in the voltmeter has an f.s.d. rating of 1mA the voltmeter is a 1,000 ohms per volt instrument, and that when the f.s.d. rating is 5mA the voltmeter is a 200 ohms per volt instrument. If we take some further examples we will find that if the basic meter has an f.s.d. value of 100μA (equal to 0.1mA) the voltmeter has an ohms per volt figure of 10,000, that a 0-200μA basic meter provides a 5,000 ohms per volt instrument, and so on. As the current required to produce f.s.d. in the basic meter reduces, the ohms per volt figure increases. It is usual practice to refer to voltmeter "sensitivity" in terms of its ohms per volt figure, the sensitivity increasing as the figure becomes greater.

A very useful result of thinking

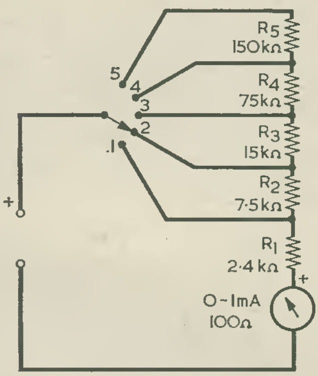
of voltmeter sensitivity in terms of ohms per volt is that this concept enables the resistance between the terminals of any voltmeter to be rapidly assessed. If we encounter a 0-50 volt instrument which is stated to have a sensitivity of 2,000 ohms per volt, we know at once that the internal resistance between its two terminals is 50 times 2,000, or 100,000Ω.



(a)



(b)



Range	F.S.D.
1	2·5V
2	10V
3	25V
4	100V
5	250V

(c)

Fig. 3(a). A simple switching circuit for a multi-range voltmeter
(b). A better switching circuit, which reduces heat dissipation in the series resistors for the higher voltage ranges
(c). A practical version of the circuit of (b) with component values

Like all pointer instruments, the moving-coil voltmeter absorbs power from the circuit to which it is connected. This point has always to be borne in mind when using the voltmeter, as it is otherwise possible to place incorrect interpretations on the readings it provides.

A typical instance of what can occur in practice is illustrated in Fig. 2. In Fig. 2(a) we have a valve with an anode load resistor of 100kΩ connecting to a 180 volt h.t. line. Let us assume that, due to a fault condition, the valve is passing zero anode current. Since there is no current flow in the resistor, the anode of the valve is 180 volts positive of chassis. In Fig. 2(b) we check the anode voltage by connecting a voltmeter with a full-scale deflection of 200 volts between the anode and chassis. Fig. 2(c) shows the actual readings which would be given by a number of voltmeters having different ohms per volt figures. A 500 ohms per volt meter will present a resistance of 100kΩ, whereupon exactly half the h.t. voltage appears across the voltmeter, and the reading it gives is 90 volts. A 1,000 ohms per volt meter gives a reading of 120 volts, a 5,000 ohms per volt meter gives an indication of 164 volts, and a 20,000 ohms per volt meter gives a reading of 176 volts. All these voltmeters draw current through the 100kΩ anode load resistor, with the result that none of them gives a *true* indication of the actual anode voltage. However, the readings provided by the voltmeters approach the true voltage more closely as the ohms per volt figure increases.

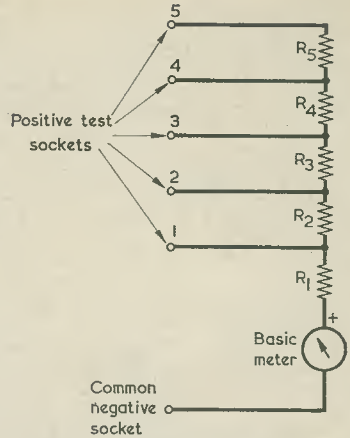
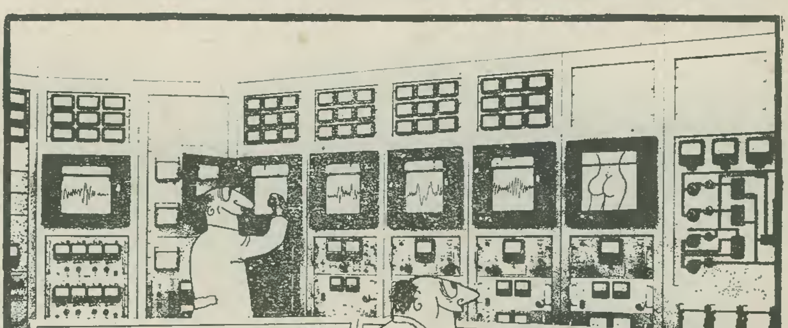


Fig. 4. The switch in the circuit of Fig. 3(b) may be omitted, if desired. The required voltage ranges are then selected by plugging test leads into the appropriate sockets

This example demonstrates that care must always be observed when taking voltage readings at circuit points where there is a high value of series resistance. It also shows that the indications obtained under these conditions become more accurate as the ohms per volt rating of the meter increases.

MULTI-RANGE VOLTMETERS

A multi-testmeter, or testmeter, incorporates a number of voltage ranges, these being based on the single moving-coil meter fitted in the instrument. Also employed is a switching circuit, or other means of selection, to enable specific voltage ranges to be brought into use. The switching arrangements required are very simple, and do not



have the complications inherent in switched current ranges.

A possible switching circuit for selecting one of a series of voltage ranges is shown in Fig. 3(a). The switch in this diagram simply selects different series resistors for the ranges, each resistor being equal to the total resistance required for the range minus the resistance of the basic meter.* A circuit of this type is quite practicable and its use would be justified in a voltmeter having only a few ranges at fairly low voltage.

A better circuit, particularly where a large number of ranges extending to high voltages are to be switched, is illustrated in Fig. 3(b). In this diagram, R1 is the series resistor for the lowest voltage range and has the requisite value of total resistance minus meter resistance. The succeeding resistors are then added in series, each having a value which causes the total resistance to be increased to the value required. Fig. 3(b) shows five ranges but the scheme can, of course, be adapted for a smaller or greater number of ranges.

Fig. 3(c) gives a practical example of the circuit of Fig. 3(b) with resistor values indicated. The basic meter has a full-scale deflection of 1mA and a resistance of 100Ω. Only R1 has a value which allows for the resistance of the meter. All the remaining resistors have round number values which provide the incremental resistance required. It will be noted that these values correspond to the ohms per volt concept. With a 0-1mA basic meter the ohms per volt figure is 1,000, whereupon R2, which provides the "step" between the 2.5 volt and 10 volt ranges, has a value of 7.5 times 1,000, or 7.5kΩ.

The circuit of Fig. 3(b) has two important advantages when compared with that of Fig. 3(a). First, the wattage dissipation in the resistors for the higher voltage ranges is considerably lower. Second, the voltage appearing across these resistors is also considerably lower. This last point is of importance because the design of some classes of resistor becomes modified for voltages across the resistor above some 500 volts.

The circuit of Fig. 3(b) lends itself readily to the use of sockets instead of a range selector switch. The appropriate circuit is given in Fig. 4.

As we saw in last month's issue, it is normal practice to insert a swamp resistor in series with the basic meter in a testmeter in order to maintain accuracy on the current ranges despite variations in coil resistance due to changes in coil temperature. To simplify the overall testmeter switching circuits it is often helpful to retain the swamp resistor in series with the meter when voltage ranges are selected. Should this be done, the lowest range series resistor (R1 in Fig. 3(b)) is given a value which takes into account the presence of the swamp resistor. Apart from this, the swamp resistor has no effect on the voltage ranges. Also, since variations in coil resistance due to temperature changes are negligibly low compared with the voltmeter series resistor values, these variations also have no effect in the voltage ranges.

In some testmeters with switched voltage range selection, the highest voltage range is provided by means of a separate terminal, or socket, as shown in the example given in Fig. 5 (a). Measurements on this range are then obtained by connecting the appropriate test lead to this terminal. The use of a separate high voltage range terminal ensures that the highest voltage which the testmeter can measure is not applied to the range switch, with the result that the insulation requirements for this switch are eased.

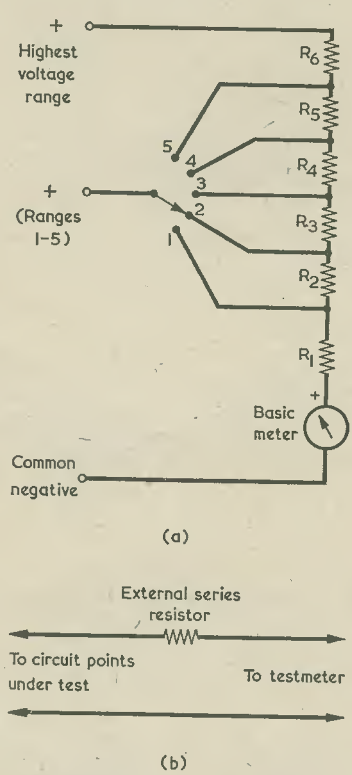


Fig. 5(a). In some testmeters the highest voltage range connection is brought out to a separate test socket or terminal. This eases insulation requirements in the range selector switch

(b). For measuring very high voltages an external series resistor is available for some testmeters. Connections are made to the testmeter in accordance with the manufacturer's instructions

Where very high voltages are to be measured it is common practice for the manufacturer of the testmeter to provide an external series resistor, this being connected to the meter as shown in Fig. 5(b). The external series resistor is provided with insulation appropriate to the voltage being measured.

The series resistors employed in testmeters are types offering a very high level of long term stability in value, and are operated well within maximum power ratings. They are close-tolerance components of the order of ± 1% or better. Voltmeter series resistors are normally referred to as *multiplier resistors*, or just as *multipliers*, this name arising from the fact that they effectively "multiply" the f.s.d. voltage figures. The term "multiplier resistor" may also be applied to the series resistor in a single-range voltmeter, such as that in Fig. 1(a).

OHMMETERS

A moving-coil meter may be made to measure resistance by connecting it into a suitable circuit with a number of other components. The resultant combination is then referred to as an *ohmmeter*.

A simple ohmmeter circuit is shown in Fig. 6(a). In this diagram the meter is connected in series with a battery. (or a single cell), a fixed resistor, R1, and a variable resistor, R2. The function of R2 is to take up changes in battery voltage and internal resistance as the battery ages, and it is adjusted to cause the meter to indicate full-scale deflection when the test terminals are short-circuited together. R1 provides current limiting and ensures that an excessive current cannot flow through the meter if R2 should be accidentally set to insert too low a resistance into circuit. Also, the values of the two resistors are such that full-scale deflection cannot be achieved by adjustment of R2 when the battery voltage is too low and/or its internal resistance is too high for accurate circuit operation. Thus, the user of the ohmmeter is automatically warned when battery replacement is due.

After R2 has been set up to provide full-scale deflection with the test terminals short-circuited, the ohmmeter is available for the measurement of resistance. If the test

*At the higher voltage ranges the internal resistance of the meter will tend to become negligibly low compared with the series resistance, whereupon it may be ignored.

terminals are connected to a resistor, or to a component having significant resistance, the pointer of the meter will be deflected to an indication lower than full-scale deflection, the actual indication depending upon the value of the resistor. The ohmmeter scale is calibrated in terms of resistance in order that the resistance being measured may be read directly. This calibration is not linear, being "opened out" at the right-hand low resistance end of the scale and becoming progressively more cramped at the left-hand high resistance end. Assuming negligible resistance in the battery and the meter, half-scale deflection is given when the resistance being measured is equal to the resistance inserted by R1 and R2 in series.

An alternative ohmmeter circuit is shown in Fig. 6 (b). In this diagram R1 provides current limiting as before, and prevents excessive current flow in the meter if the variable resistor is accidentally set incorrectly. The variable resistor is once more designated as R2, but in the present case it is connected across the meter in series with R3. As in the circuit of Fig. 6(a), R2 is set up to provide full-scale deflection in the meter when the test terminals are short-circuited, R3 being included to ensure that R2 cannot be set to a value much lower than that needed when a new battery is fitted. Without R3, R2 would have a needlessly wide range of adjustment, with only a small proportion of its slider rotation being useful for the purpose of setting up the ohmmeter. The ohmmeter offers resistance indications in the same manner as does that of Fig. 6(a), with low resistance graduations "opened out" at the right-hand end of the scale and high resistance graduations becoming progressively more cramped at the left-hand end. If it is assumed that the meter and battery have negligible resistance, half-scale deflection is given when the resistance being measured is equal to R1.

The circuit of Fig. 6(b) provides more accurate results than does that of Fig. 6(a) because there is no variable resistance in series with the resistance being measured. However, it is important that the battery should be replaced before its internal resistance rises to too high a level, and it is desirable to give values to R2 and R3 which ensure that an f.s.d. reading cannot be obtained with the test terminals short-circuited when battery internal resistance becomes excessive. This is fairly easy to arrange since increasing internal resistance in the battery is usually accompanied by noticeably decreasing voltage, and the two effects combine in restricting meter current.

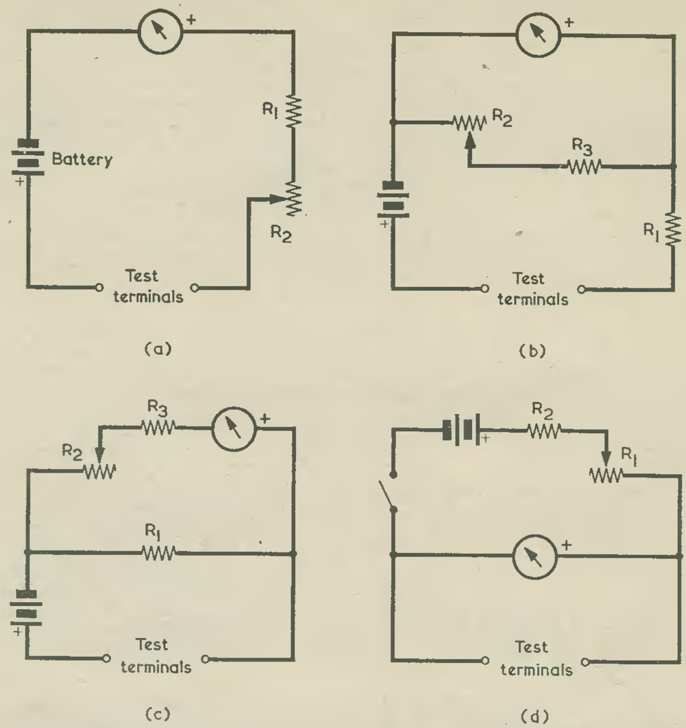


Fig. 6(a). A simple ohmmeter circuit incorporating a moving-coil meter

(b). An alternative circuit which offers somewhat greater accuracy

(c). A basic ohmmeter circuit which is particularly useful in multi-range instruments

(d). The "shunt ohmmeter" circuit. This is capable of indicating small values of resistance with low battery current

A third circuit, and one which can be particularly useful in testmeters having more than one resistance range, is shown in Fig. 6(c). Here, the battery is connected in series with R1 and the test terminals, the basic meter of the testmeter being coupled to R1 via variable resistor R2 and current limiter resistor R3. R2 is set up for f.s.d. when the test terminals are short-circuited. R1 is in parallel with the total resistance offered by R2, R3 and the meter and, assuming negligible internal resistance in the battery, the ohmmeter gives half-scale deflection when the resistance being measured has a value equal to the combined resistance offered by these components. If R1 is changed (by a range selector switch) so that the combined resistance it offers in parallel with R2, R3 and the meter is, say, one-hundredth of the previous value, all indications on the ohmmeter scale become divided by 100. Thus, it becomes possible to provide the associated testmeter with a single resistance scale, the resistance values marked on this being divided (or multiplied) by 100 (or by any other convenient number) by merely switching in different values of R1. For low resistance ranges having half-scale deflections of some 50Ω or less the internal resistance of the battery becomes significant and has to be considered as being in series with the combined resistance offered by R1, R2, R3 and the meter. The value of R1 is then chosen to cater for an average battery internal resistance, this being typically 0.5Ω for a single small 1.5 volt cell. It is necessary to replace the battery as soon as its internal resistance rises with age, or the accuracy of low resistance readings will be seriously impaired.

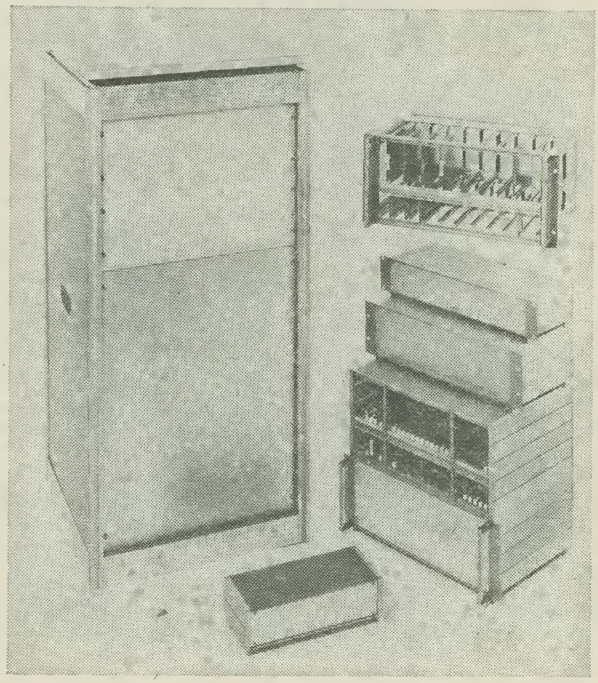
In this description, reference has been made to the combined resistance of R1, R2, R3 and the meter. The resistance inserted by R2 is that corresponding to its setting when the battery voltage is at the average level it will provide during its working life.

Fig. 6(d) shows a "shunt ohmmeter" circuit. When the switch is closed the battery is applied to the meter via variable resistor R1 and current limiter resistor R2. R1 is adjusted to give full-scale deflection with the test terminals open-circuited When the test terminals are connected to a resistor, the latter acts as a meter shunt, whereupon the meter indication falls below f.s.d. This type of ohmmeter is capable of reading very low values of resistance without drawing large currents from the battery. If battery voltage is high enough to allow the resistance offered by R1 and R2 to be many times greater than meter resistance, half-scale deflection is given when the resistance being measured is equal to the resistance of the meter. Low resistance readings appear at the left-hand end of the meter scale and high resistance readings at the right-hand end, the low resistance graduations being "opened out" and the high resistance graduations cramped. The circuit has the advantage that accuracy is not affected by variations in battery voltage and internal resistance during its useful life. The same resistance scale may be employed for a number of different ranges. If, for instance, a shunt is connected across the meter which causes its f.s.d. current to be increased, say, 100 times, and if the values of R1 and R2 are changed to allow the consequently increased current to flow, all scale indications become divided by 100.

NEXT MONTH

In next month's issue we shall turn our attention to circuits which allow moving-coil meters to read alternating voltages and alternating currents. ■

CURRENT TRENDS



NEW RANGE OF INSTRUMENT CASES

Radiatron announce an entirely new range of instrument cases; card frames and industrial cabinets. The product, known as Elmaset, is a complete system designed to cater for all types of electrical and electronic "packaging". The Elmaset system ranges from miniature card frames and instrument cases (3½in. to 4in.) to robust industrial 19in. cabinets, and includes over 1,000 different standard types and sizes.

The range is believed to be the first fully metric design of its type available within the U.K., but also includes the existing 19in. standard. Anodised extruded aluminium sections are used throughout, and these are pre-punched, drilled and tapped to allow simple and rapid assembly, whilst ensuring maximum rigidity and light weight. P.V.C. clad aluminium panels give the range an attractive, modern styling.

Units are normally supplied in kit form, although pre-assembled units can also be supplied. The aluminium sections can also be obtained in long lengths allowing construction by the user of special units.

The Elmaset range includes all components and accessories likely to be required with the frames and cases – such as printed circuit boards; modules; handles; forced draught units; guide rails and a wide variety of metric units, bolts and fasteners.

The system has also been designed to allow the use of virtually all known types and sizes of printed circuit cards and edge connectors or combinations of different types.

A 54 page, six colour catalogue is available explaining the range in detail, and can be obtained from: Radiatron Limited, 76 Crown Road, Twickenham, Middlesex. Telephone 01–892 1008. ■

In your workshop

This month Smithy the Serviceman discusses some aspects of constructional work which are frequently ignored by the amateur. He also demonstrates that even the humble chassis solder tag, if used incorrectly, can have a considerable effect on the overall performance of an item of home-constructed equipment

"DID YOU," ASKED DICK, "hear about the chap who runs the pet shop in the High Street?"

With a grunt of satisfaction, Smithy filled in another answer in his post-lunch crossword puzzle.

"No I didn't," he remarked abstractedly, "What about him?"

"He's now started," said Dick brightly, "selling birds on hire-purchase!"

Smithy concentrated on the next clue and ran his pen along the squares of the puzzle to see whether the answer he had just thought of would fit. Obviously, it didn't.

"Blast" he snorted.

"I said," repeated Dick, raising his voice, "that the chap at the pet shop in the High Street is now selling birds on hire-purchase."

"Is he?" replied the Serviceman absently. "Still, I suppose it's only to be expected, with everybody so short of money these days."

HOME CONSTRUCTION

Dick turned a furious scowl on the Serviceman. The latter, still engrossed in his crossword puzzle, appeared to be completely unaware of the glare in his assistant's eye.

"Do you," asked Dick after a few moments, "do much constructional work at home these days?"

Smithy's concentration was shaken by this abrupt and unexpected change of subject.

"Constructional work?" he repeated, startled. "What on earth has constuctional work got to do with the local pet shop?"

"Nothing really," admitted Dick.

"Then why mention it?"

"I'm trying," said Dick plaintively, "to relieve the crushing lunch-hour tedium to which I'm subjected whenever you indulge in one of these crossword puzzle sessions of yours."

Resignedly, Smithy threw his newspaper onto his bench.

"I *knew* I'd never get enough peace to enable me to finish it," he grumbled. "What do you want to do, then?"

"Have a bit of a natter!"

"What about?"

"Oh, any old thing. Like, for instance, the constructional work I mentioned just now."

"As it happens," said Smithy guardedly, "I *have* been doing a spot of construction at home recently. In a rash moment I promised a nephew of mine I'd knock up a little short-wave set for him, and this has kept me rather pleasantly occupied for the last few evenings. It's intriguing, incidentally, to find how much interest there is in short-wave listening these days. It's a hobby which seems to be attracting a continually increasing number of followers all the time."

"Are you doing the metal-bashing for this set at home?"

"I am," confirmed Smithy. "As a matter of fact, there isn't a great deal of bother involved in radio metal-work these days, since you can get ready-made chassis and panels of pretty well any size you want direct from the home-constructor suppliers. And, of course, valveholder holes and things like that are a piece of cake because all you need to do is to use standard chassis-cutters. In this respect it's helpful to remember that a B7G valveholder requires a $\frac{5}{8}$ inch chassis-cutter, a B9A valveholder requires a $\frac{3}{4}$ inch chassis-cutter, and an octal valveholder requires a $1\frac{1}{8}$ inch chassis-cutter."

"Octal valveholders?" queried Dick, raising his eyebrows. "Octal valves are a bit old-fashioned, aren't they?"

"They certainly are so far as commercial equipment manufacture is concerned." replied Smithy. "But, on the other hand, there's no reason why the home-constructor shouldn't use them if he wants to. As a matter of fact, octal valves can offer one or two small but quite distinct advantages, one of these being that they're readily available at very low prices. Another advantage, and one which will be appreciated by the real beginner, is that the tags of octal valveholders are well spaced out and are easier to solder to than the tags of B7G and B9A valveholders. I appreciate that most home-constructors these days are mainly interested in transistors and similar semiconductor devices, but that doesn't mean to say that valve circuits should be ignored, even if these incorporate the earlier octal types. I hardly need to remind you

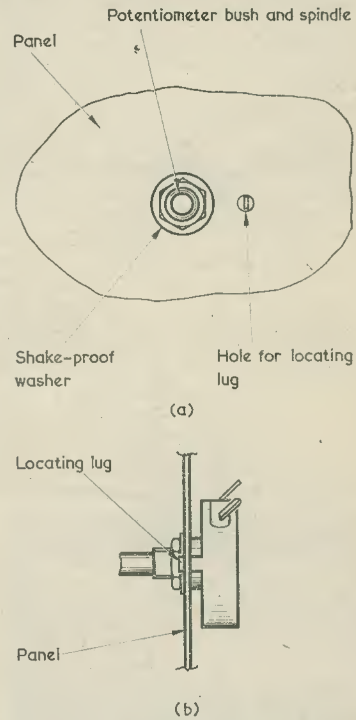


Fig. 1(a). The correct method of fitting a potentiometer to a panel includes the provision of a hole for its locating lug (b). Side view, showing how the lug passes through its hole in the panel that circuits employing octal valves are capable of giving excellent performances."

"That's true enough," conceded Dick. "I suppose that, in a way, the making up of sets using octal valves can have rather the same sort of fascination as is given by getting vintage cars into working order."

"Blimey," chuckled Smithy. "Octal valves aren't quite as old as all *that*! Anyway, I don't want to keep nattering on about valves, because the normal processes involved in chassis-bashing are equally applicable to equipment using transistors as well."

"Are there," asked Dick, "any points you pay particular attention to when you're preparing a chassis?"

"There are one or two," admitted Smithy. "Perhaps it's because I have what could be described as a professional background, but I *do* tend to be a little more fastidious about some practical matters than many amateurs are."

"In what way?"

"Well," said Smithy in reply, "take, for instance, the little matter of the locating lugs which are provided on panel-mounted potentiometers. These lugs are, of course, intended to fit into an appropriately positioned hole in the panel. (Fig. 1). However, quite a few amateurs merely drill out the main bush-mounting hole for the pot and then completely ignore the hole that's needed in the panel for its locating lug. Instead, they purposely cut off or bend out the locating lug to enable the control to be fitted square when the bush-mounting nut is tightened."

"And you, I suppose, drill out the locating lug holes instead."

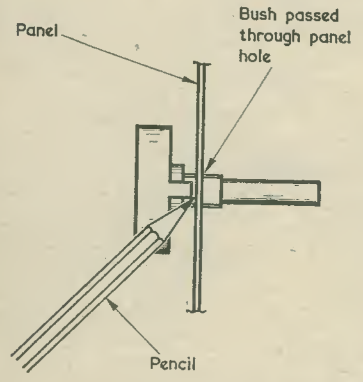


Fig. 2. To find the position required for a potentiometer locating lug hole, first drill the main bush-mounting hole, pass the bush through this and mark off the position required for the locating lug hole with a pencil

"I do," confirmed Smithy. "My view is that if the pot manufacturer has gone to the trouble of providing the locating lug then it's only sensible to use it in the manner for which it was intended. In any event, the process of marking out and drilling the hole only takes a minute or so. After cutting out the main panel hole for the bush of the pot, the component can then be used to find the position needed for the locating lug hole. (Fig.2). Most locating lugs will fit quite happily in a hole cut out with a ⅛ inch drill, and it doesn't matter if the lug is a loose fit in this hole."

"Why not?"

"Because the main function of the lug is simply that of preventing the whole pot being rotated bodily if, when the bush mounting nut is a little loose, some ham-handed geyser tries to turn the knob too far. Even if the panel hole for the locating lug is a little too large, it will still only allow the body of the pot to be rotated by a couple of degrees or so. Don't forget that if the body of a pot is forced round by a considerable amount terrible things can happen to the wiring and components that are soldered to its tags!"

CHASSIS TAGS

"Good point," grinned Dick. "I'll remember to drill pot locating lug holes in future."

Smithy frowned as his mind momentarily returned to an earlier remark made by his assistant.

"Why," he asked, "were you talking just now about the chap who runs the pet shop in the High Street? It so happens that I know him fairly well, and I haven't heard that he's changed his methods of doing business."

"He hasn't" replied Dick patiently. "When I said he was selling birds on hire-purchase, the words 'hire purchase' were intended to be a pun."

Smithy considered this information gravely.

"I take it," he said eventually, "that there was a second, hidden, meaning in your statement. Could one infer that the birds in question might also have been sold on 'higher perches'? That is to say, on perches having a greater height?"

"One could."

Smithy pondered.

"And so," he continued slowly, "your allegation was *really* intended to be a joke."

"Normal people," replied Dick, a note of desperation entering his voice, "would have treated it as such."

"And it had no actual foundation in truth?"

"None whatsoever."

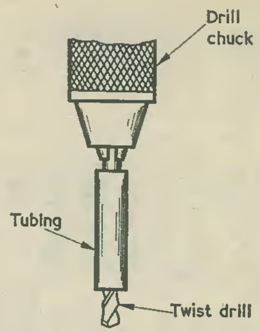


Fig. 3. A simple precaution which ensures that a twist drill does not pass too far through a chassis on completion of a hole

"I see."

The Serviceman appeared satisfied that the matter had now been adequately explained.

"Very well, then," he resumed. "Let's get back to our conversation about chassis-bashing."

"So far as I'm concerned," said Dick with obvious relief, "the sooner we do that the happier I'll be."

"Good," said Smithy, briskly. "Well now, apart from the locating lug business, there's little else I really need to say about chassis work. I suppose I ought to mention the obvious point that you should always endeavour to mark out and drill every hole in a chassis before you start mounting the parts on it. If you *have* to drill a chassis hole after the components have been fitted, it's a good plan to fit a length of metal or hard plastic tubing over the drill as soon as the hole has been started. (Fig. 3). The tubing should be a little shorter than the length of drill projecting from the chuck in which it's fitted, and it prevents the drill crashing through to its full length as sometimes happpens when it finally breaks through the metal on completion of the hole. Any well-stocked junk box should yield a suitable bit of tubing for this little job. Another thing worth mentioning is that, if there are any air-spaced variable capacitors already mounted on the chassis you intend to drill, you should always ensure that their vanes are completely enmeshed. This obviates the risk of the moving vanes getting bent if anything should accidentally come into contact with them."

"A very good precaution," commented Dick approvingly. "Is that the lot so far as chassis-work is concerned?"

"There's nothing else I can think of," responded Smithy thoughtfully, "which doesn't fall into the common-sense category. For instance, a hole should always be centre-punched before you apply the drill, or the latter will wander all over the surface of the metal. And you can often clean up the swarf left on a hole which has just been drilled by lightly countersinking with a larger drill."

Smithy paused for a moment.

"Let's next carry on to the process of mounting the components themselves," he resumed. "Now, so far as this procedure is concerned I always believe in paying particular attention to what are probably the smallest parts to be fitted."

"What are they?"

"The chassis solder tags," replied Smithy, "and the earthed tags of tagstrips. The reason I raise this matter is that home-constructor chassis are normally made of aluminium because this is a nice soft metal and is easy to handle."

"Another advantage of aluminium," interrupted Dick, "is that it doesn't rust or corrode."

"Exactly," agreed Smithy. "And you've conveniently introduced the next point I want to make. Do you know *why* aluminium offers such a high resistance to corrosion?"

"Not really," replied Dick. "I've just accepted this property of aluminium as being one of the facts of life!"

"Then I'll tell you," said Smithy. "Aluminium has a high corrosion resistance because a very thin but highly tenacious film of oxide always forms on its exposed surfaces, and this film provides protection. In consequence, you should always make certain that chassis tags fastened to an aluminium chassis are screwed down good and tight since, otherwise, the aluminium surface under the tag can become sufficiently oxidised with time to result in a poor connection. Personally, I fit a shake-proof washer under the nut securing a chassis tag to an aluminium chassis. It's good engineering practice to do this in any case, and the washer helps to maintain a high pressure between the tag and chassis as times goes by." (Fig. 4(a)).

"Fair enough," commented Dick. "Incidentally, whilst on the subject of chassis tags, some of the smaller 6BA ones can prove quite troublesome."

"How come?"

"Once they're bolted to the chassis," explained Dick, "the latter acts like a dirty great heat sink, with the result that it's difficult to make reliable solder connections to them if you're using a small low-power soldering iron."

"That *can* happen," agreed Smithy. "If you haven't got a larger iron available, the solution here is to make the soldered connections to the tag with its mounting screw and nut loosened. (Fig. 4(b)). This approach keeps the tag in position, and also ensures that there is virtually no thermal coupling at all to the chassis, whereupon the tag solders without difficulty. You tighten up the nut and bolt after you've completed the soldering operation."

COMMON IMPEDANCE

"Blow me," said Dick. "Now why didn't *I* think of that?"

"You pick up these little dodges as you go along," commented Smithy. "Anyway, I want to turn away now from the mechanical details of chassis tag mounting, and carry on to the equipment circuits which are connected to these tags. It is always advisable to ensure that the connections to a chassis tag are so chosen that, if a very small resistance *should* appear between the tag and chassis, this resistance doesn't provide a common impedance between two circuits which is capable of seriously affecting the performance of the gear in which the tag is fitted."

"Common impedance?" queried Dick, puzzled. "I don't follow you."

"I'll give you an example," replied Smithy. "Let's assume that we have, say, a transistor i. f. amplifier in which the emitter bypass

(a)

(b)

Fig. 4(a). It is desirable to fit a shake-proof washer under the nut securing a solder tag to an aluminium chassis (b). If only a low-power iron is available, it is sometimes helpful to secure a tag to the chassis loosely only whilst wires are being soldered to it capacitor of one transistor connects to the same chassis tag as the collector load bypass capacitor of the succeeding transistor. (Fig. 5 (a)). Now, this circuit will function quite happily if the solder tag has zero resistance to chassis. If, however, even a very low resistance appears between the tag and chassis, a common impedance appears in both the emitter circuit and the succeeding collector circuit. (Fig. 5 (b)). In the present example the common impedance is the resistance between the solder tag and chassis, and it allows feedback to take place from the collector circuit back to the preceding emitter circuit. If, with the requisite phase conditions, the impedance is high enough, the circuit will probably break into oscillation. If the impedance is low the circuit will not oscillate, but the feedback could still cause the response of the i. f. amplifier to be seriously affected."

"Hell's teeth," said Dick, impressed by this new revelation of the conduct of the lowly chassis tag. "This is something I've never even thought about before! The 'common impedance' idea is new to me, too."

"Then," replied Smithy, "I've done you a favour by introducing it to you. The example I've shown you illustrates that, by using a common chassis tag for these two bypass capacitors, even very small values of resistance between the tag and chassis can affect performance. Note that, if the two bypass capacitors had gone to separate chassis tags, at different parts of the chassis, the functioning of the circuit would not have been seriously affected if either or both of these tags had exhibited the same low value of resistance to chassis. The trouble starts when the two bypass capacitors connect to the *same* tag. The golden rule which comes out of all this is that, where a considerable degree of amplification appears between two bypass capacitors, the capacitors should always connect to separate chassis tags. This rule applies, of course, only in equipment where chassis connections are made via solder tags bolted to the chassis, and is not applicable with such things as printed circuits where there is no risk of unwanted resistance appearing at a later date where previously there was none."

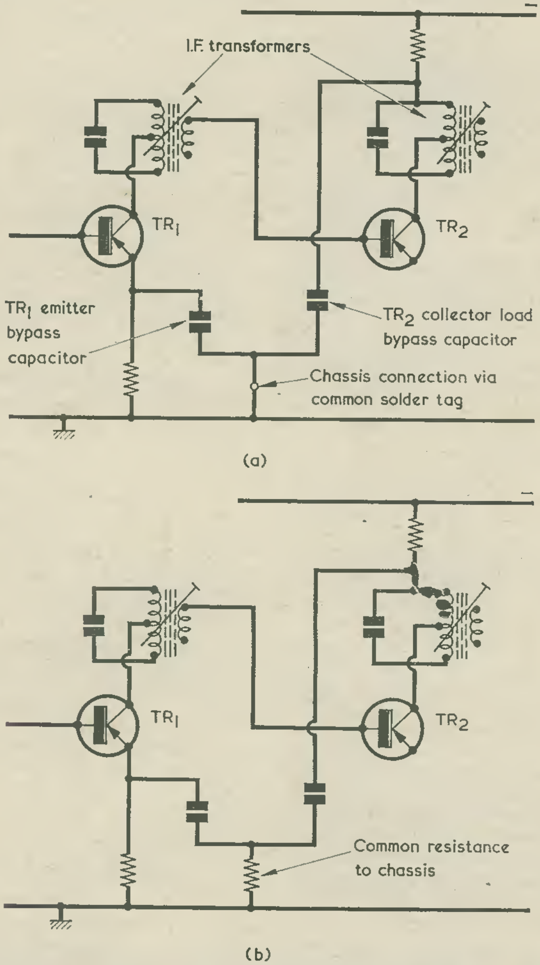


Fig. 5(a). Skeleton circuit illustrating the circuit conditions which exist when the emitter bypass capacitor of a transistor in an i.f. amplifier is returned to the same chassis tag as the collector load bypass capacitor of the following transistor
(b). Circuit operation changes dramatically if the common solder tag develops appreciable resistance to chassis

"I suppose," said Dick thoughtfully, "that the best approach here is to ensure that all the bypass capacitors for each stage in the equipment are returned to an individual chassis tag for that stage."

"That's normally adequate enough in practice," agreed Smithy. "Though, should the single stage provide a considerable amount of gain on its own, it would still be worthwhile using separate chassis tags for bypassing the input and output circuits. By the way, I used a transistor amplifier to provide an instance of what can happen when there is a common impedance to chassis between two stages. The same points apply if the equipment uses valves instead of transistors."

"Yes, I can see that," replied Dick a little impatiently. "Wait a minute, though! Your mentioning valves has reminded me of something else. As you know, it's a pretty common practice in valve equipment to use a common chassis tag at each valve stage, this providing the chassis connection for such things as grid leaks and cathode bias components as well as for one side of the heater. (Fig. 6). Since the heater current will be of the order of 0.15 to 0.3 amp, you could get quite appreciable a.c. voltages between the solder tag and chassis when a low value of resistance appears between them."

"True enough," confirmed Smithy. "The result could be that, even if the heater seems to be receiving its fair share of volts, a small hum signal can still be injected into the signal circuits of the stage. In practice you wouldn't get much trouble from this sort of thing in the stages of, say, the average domestic radio receiver, although the effect should still be borne in mind as a possible fault if the receiver develops a high hum level. On the other hand, it would be definitely unwise to use a common chassis tag for heater and signal circuits at the first stage or stages of a high gain a.f. amplifier. Incidentally, one good thing about faults caused by chassis tags developing resistance to chassis is that they're very easy to locate."

"How d'you do that?"

"You simply take up a screwdriver whose blade is nice and shiny and which hasn't rusted," replied Smithy, "and apply it to the tag and the chassis so that the flat end of the blade bridges the two. (Fig. 7.). If you apply a little pressure the screwdriver blade digs through any oxide which may have formed on the surfaces of the chassis and the tag, and it shorts out any resistance that may have developed between the two. Should the fault clear when the screwdriver is applied then its cause is obvious."

"What happened?"

"Well," said Smithy, returning to his bench, "he was driving down a motorway in his 15-cwt van and he kept stopping every few miles, getting out and banging on the sides of the van. After that he'd get back in again and drive on for the next few miles. Eventually, a police car stopped him and they asked him what he was up to."

"I should jolly well think so too," snorted Dick. "Did they run him in?"

"Of course they didn't."

"Why not?"

"He had a perfectly rational explanation," said Smithy. "What had happened was that he'd just been to the wholesaler's and taken delivery of a ton of budgies. The snag was that when they all settled down in the back of his 15-cwt van, their weight bent its poor old springs nearly double, and so he had to keep banging on the van sides every few miles to start them flying again."

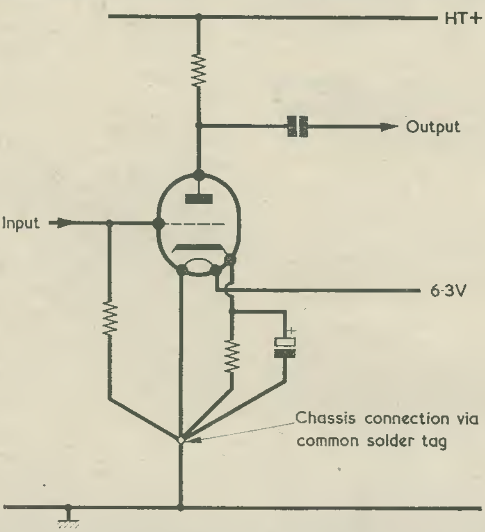


Fig. 6. Illustrating, with a triode a.f. amplifier stage as example, the practice of returning all chassis connections for a valve stage to a common chassis tag

SOLDERING

"You've certainly," remarked Dick, "given me a few things to ponder on during *this* lunch-hour."

"Good show," said Smithy cheerfully, as he glanced at the Workshop clock. "Dear me, we've used up nearly all our spare time, too. I must get ready to start the afternoon's work."

The Serviceman rose leisurely and made preparation for the forthcoming labours.

"It's funny," he remarked, as he picked up the newspaper from his bench and folded it neatly, "that you should have mentioned that chap who keeps the pet shop in the High Street. He was telling me only the other day how he very nearly got into serious trouble with the police."

"With the police?"

"With the police," repeated Smithy firmly.

The Serviceman walked over to his overcoat hanging behind the Workshop door, and put the folded newspaper into one of its pockets.

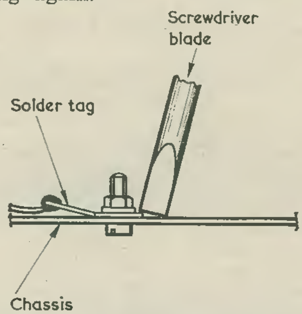


Fig. 7. The presence of resistance between a solder tag and chassis can easily be located with the aid of a screwdriver

Ignoring his assistant's expression of complete incredulity, Smithy tidied his bench and, with a purposeful gesture, switched on his soldering iron. Turning round, he once more glanced at the clock.

"Why," he remarked, "it's not quite as late as I'd thought. We've still got a couple of minutes of lunch hour left. In that case, I might as well conclude my remarks about constructional practice with a final little comment on the correct procedure to adopt when you're soldering a wire or wires to a tag with the aid of ordinary rosin-cored solder."

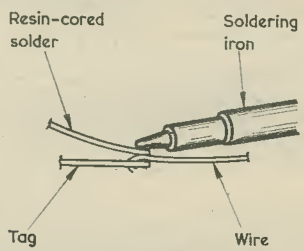


Fig. 8. The making of solder joints is hastened by applying the iron to the solder as shown here

With a visible effort Dick wrenched his mind away from the vision of a ton of budgerigars and concentrated once more on the subject in hand.

"Soldering a wire to a tag," he queried. "Well, surely, there's nothing to *that*! You just bung the iron on the tag and the wire, and then run the solder in."

"That's not the best way," reproved Smithy. "What you *should* do first is to rest the end of the solder on the tag and wire, and then apply the iron to the solder. (Fig. 8). When the solder melts the iron enters at once into good thermal contact with the tag and wire, after which the joint becomes completed in normal fashion."

"What's the advantage in making the joint that way?"

"The advantage," replied Smithy, "is that as soon as the solder melts it takes the heat from the iron to the tag and wire, and also releases hot flux. The flux is then able to break down the oxides on the tag and wire whereupon the flow of heat to the metal underneath is hastened, and the joint is made more quickly and with less cooking-up of components. If you initially apply the iron on its own, and without solder, to the tag and the wire, it merely causes these to heat up unnecessarily and form added oxides on their surfaces."

PROOF OF VERACITY

Smithy picked up his soldering iron and tested its temperature by applying a piece of solder to its tip.

"Right-ho," he remarked with satisfaction. "Let's get back to work, then."

Reluctantly, his assistant swung round on his stool towards his bench. After some moments he turned back again and presented an agonised face to the Serviceman.

"Tell me, Smithy," he pleaded. "Was what you said a few minutes ago about the pet shop owner and his van-load of budgies *really* true?"

"True?" queried Smithy, in an outraged tone of voice. "Why shouldn't it be?"

"Are you," persisted Dick, "*certain* it was true?"

"Let me tell you this, my lad," said Smithy weightily. "If your doubts about the non-veracity of that story are unfounded, then it's untrue that I'm not standing here wearing my bus conductor's cap and smoking this hookah I've borrowed for the moment from the Caliph of Bagdhad. Okay?"

It took Dick nearly five minutes to sort out this last statement on the part of the Serviceman. Even then, he'd had to work it out on a piece of paper. And even *then* he still wasn't completely sure he'd got it right!

TRUNK TELECOMMUNICATIONS BY GUIDED WAVES CONFERENCE

The conference on trunk telecommunications by guided waves, which was to have been held at the Institution of Electrical Engineers, Savoy Place, London WC2, in September 1969, and was postponed, will now be held from Tuesday, 29th September to Friday, 2nd October, 1970.

The aim of the conference is to survey and to assess current achievements, problems and prospects in the development of trunk telecommunications systems by guided waves at millimetric and optical frequencies. Special attention will be paid to:

systems aspects, modulation and multiplexing techniques, guiding structures, transmission imperfections, installation and fabrication, terminal and repeater equipment, measurement techniques, components.

Offers of contributions to the conference programme are invited. Full (2,000-word) manuscripts will be required by the 1st June, 1970.

Radio Topics

By Recorder

WE ALL OF US, FROM TIME TO time, tackle the odd bit of servicing work. The repairs required of us are usually to a domestic receiver belonging to the immediate family, to relatives or to friends. If one has plenty of time to spare, these servicing jobs can be very rewarding in terms of achievement, even if they're not very rewarding in terms of cash! There is quite a lot of pleasure to be obtained from bringing a radio or TV set to full working order after having traced and repaired an elusive fault. The best moment occurs when, after having soldered in the new part, one switches on the set again and finds that it has once more returned to full working order.

PROFESSIONAL SERVICING

Since we are inevitably committed to an occasional servicing job, it is worth our while to take a look at this subject from the point of view of the professional service engineer.

Really successful servicing, at professional level, represents a skill which is not possessed by everyone who dabbles or works in radio. Most of us have encountered or have heard about the clever design engineer who, when confronted with, say, a faulty transistor radio, arms himself with a meter and service manual then spends ages in locating and fixing the very simplest of faults. If the same set had been taken to the little shop on the corner the boy in the backroom, after having cleared the vacuum cleaner spares to one side to give himself a bit of bench space, would probably have cured the snag in a jiffy.

The professional service engineer must, of course, have a good solid foundation of technical knowledge if he isn't to spend most of his working life probing in the dark and indulging in guess-work. After that he acquires the *true* skill of servicing, which consists of this sound basic knowledge, plus experience, plus common-sense, plus a knowledge of the idiosyncracies of his fellow-men.

Experience is required by the engineer to enable him to gain confidence and to learn the short-cuts which are part of his stock-in-trade. He soon discovers what are the weak design points of a particular model, or of a particular run of models from a single manufacturer, and he frequently looks at these first before starting detailed fault-finding work on a set. With experience comes increased manual dexterity. Some service repairs are fiddling in the extreme, and it is only through practice that the service engineer is able to tackle these quickly and successfully.

Common-sense is one of the greatest assets of all. It is common-sense which guides the service engineer when he first looks inside a faulty receiver. Many faults are ridiculously simple, typical examples being given by wires which have come adrift from their tags, valves which are improperly seated in their holders, and broken-down insulation due to a wire being stressed against a sharp terminal or chassis part. A quick look for visually obvious faults of this nature can frequently be highly rewarding, allowing an otherwise obscure fault to be located in a matter of minutes without the need, even, for a test-meter.

A knowledge of peoples' foibles is also indispensable. This is especially necessary when the engineer is working from symptoms described by the set-owner. If insufficient attention is paid to this point the sort of situation that can arise occurs when, for instance, the engineer tackles a television receiver with a fairly loud hum, clears this successfully and sends the set back to the customer. It is only later that he discovers that the set-owner hadn't even noticed the hum and that the real fault was that the picture disappeared after the receiver had been switched on for an hour or two! Set-owners often attach little importance to the time factor involved with a fault, and will omit to state whether it occurs only after a period of time, or intermittently. And also, of course, some lay descriptions of receiver performance tend to be picturesque, to say the least. I recall one middle-aged man stating knowledgeably, as his radio produced an ear-splitting hum and nothing else: "There you are – that's the power coming through!"

HOME SERVICING

The professional service engineer learns to cope with all these points, and a good engineer is the one who takes greatest advantage of everything they offer.

Those of us who undertake an occasional servicing job at home can, to some extent, profitably follow the example of the professional. We may have the same basic technical knowledge that he has, but we do not, unfortunately, have his experience. On the other hand, if the faulty equipment is in our own house we are in the best position of all to evaluate the nature of the fault. If the receiver belongs to friends or relatives we are still in a good position to obtain the correct fault symptoms, because we obviously know the set-owner very well. The remaining attribute of the professional is common-sense, and it is here that the professional approach is really helpful.

The first thing to do, after taking the back off a receiver, is to look for the *obvious*. A visual examination taking a minute or two is definately worth-while. If the receiver is battery operated, *always* check the battery voltage with the set switched on. The 'fault' may, quite simply, be nothing other than a run-down battery. Even if the owner of the set states that the battery was bought 'only a week or so ago' it is still best to check its voltage. If the battery has run down in a short period of time the receiver may be drawing excessive current (a factor which can be readily checked) or someone has left the set switched on for a few days without noticing it. All these points fall into the 'common-sense' category so far as servicing is concerned.

If the visual examination and, where applicable, battery voltage check reveal nothing then the real fault-finding has to commence, whereupon the most useful tool is the voltmeter. A very useful series of tests is given by clipping one voltmeter lead to chassis and checking anode and cathode voltages with a valve set, or emitter and collector voltages with a transistor set. This procedure will very often show up a faulty stage in the minimum of time. Remember that it is nearly always quicker to check voltages than currents because the measurement of current very often necessitates the disconnection of a circuit to enable the meter to be inserted. If the trouble is instability, the best procedure is to bridge any suspect bypass capacitor with another of about the same value.

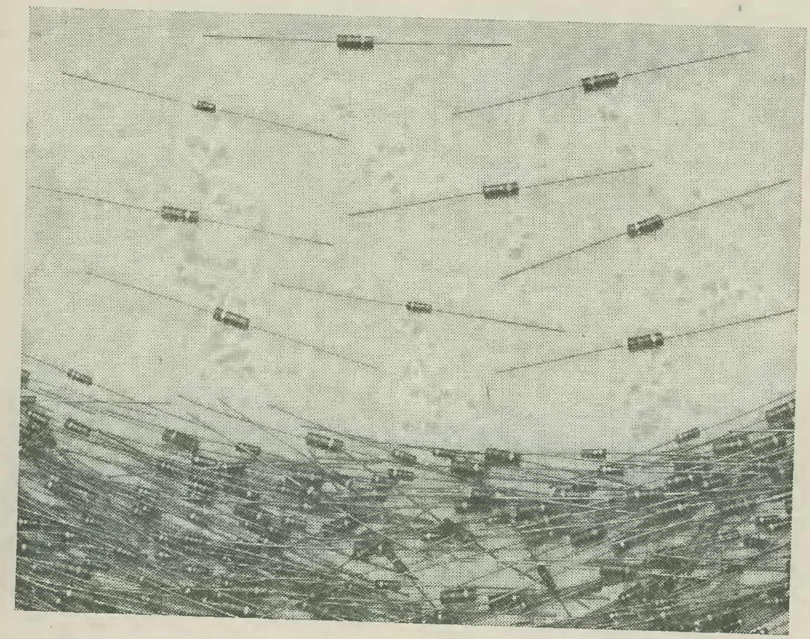
Finally, if at all possible, try to obtain the service manual or at least the circuit for the set. And don't be surprised if one or two of the components have slightly different values from those shown in the circuit, even though the components have been obviously fitted by the set-maker. Small changes of this nature are common in mass-produced domestic equipment, and are due to alterations introduced by the manufacturer whilst the model is in production, either to improve performance, to reduce cost, or to overcome the effects of temporary component shortages at the factory.

NEW MINIATURE RESISTORS

Whilst on the subject of components, the accompanying photograph illustrates a new range of miniature carbon resistors, obtainable from ITT Components Group Europe. Designated types RC025 and RC050, the resistors are available in $\frac{1}{4}$ watt and $\frac{1}{2}$ watt sizes respectively. These ratings apply to operation up to 70°C ambient.

Resistance values are from 2.2Ω to 1MΩ for the $\frac{1}{4}$ watt series and 2.2Ω to 4.7MΩ for the $\frac{1}{2}$ watt series. Both types are available with 5%, 10% and 20% tolerances. Advantages claimed for the new resistors include a very competitive price, high overload capacity, excellent h.f. characteristics and low temperature coefficient.

A new trilingual booklet (in English, French and German) gives full data and displays four pages of characteristic curves as well as describing stringent test specifications, including performance evaluated under an accelerated steam pressure test. The booklet may be obtained from ITT Components Group Europe, Trading Services, Edinburgh Way, Harlow Essex.



This cluster of resistors is from a new range introduced by ITT Components Group Europe. Ratings, applicable to operation up to 70°C ambient, are $\frac{1}{4}$ watt and $\frac{1}{2}$ watt

EMERGENCY GRAPH PAPER

Standard graph paper is very useful stuff, not only for its obvious application—that of drawing graphs—but for other purposes as well. Every now and again I have to make sketches of mechanical bits and pieces which are later drawn up properly by a competent draughtsman, and I find that I can save time and also make my rough diagrams convey the intended message much more readily if I sketch them out on graph paper. The graticule pattern on the paper not only ensures that straight lines *are* straight and that right angles *are* right angles but, in addition, enables rough scaling of dimensions to be achieved by the simple process of counting the squares. The graph paper is particularly helpful when drawing an angled view that involves the odd bit of perspective. I've even found that graph paper is of assistance with circuit diagrams when these are complicated.

Unfortunately, graph paper only seems to be carried by large stationers in big towns, whereupon, if it is used for projects carried out at home, one can quite easily run out of it during a week-end, with no possibility of immediate replenishment. This happened to me recently, whereupon I popped out urgently to the newsagent down the road. That gentleman, ensconced between his copies of *Woman's Own* and his stock of cigarettes, assumed an expression which was, to say the least, uncomprehending when I asked him if he had any graph paper in stock. But his wife, who probably turns out the occasional engineering drawing for Elliott-Automation in her spare time, sized up the situation immediately and, within seconds, flogged me a primary school exercise book with ruled squares. To assist readers whose memories of primary school exercise books are as hazy as mine, these cost only a few pence each and their pages, bound in with two easily removed staples, are ruled out faintly at four squares to the inch. Good enough for a rough graph and excellent for making mechanical sketches.

So, if you're out in the sticks and you urgently require graph paper for a tuning or meter calibration, or simply for sketching, do not despair. You can get one of these children's exercise books at pretty well any shop remotely connected with stationery, and it will certainly carry you over until you obtain further stocks of the real thing. With each exercise book, what's more, you can get all the multiplication tables from 2 to 12 printed on the back cover! ■

LATE NEWS

★ AMATEUR BANDS

The Top Band Trans-Atlantic Test held at 0500 GMT on 28th December produced by far the best results so far in the present series. Activity was apparent from switch-on at 0430 – half-an-hour prior to the official time of commencement.

The strongest signals heard were those from KV4FZ and W1HGT, both peaking to S7 on occasions. Activity rose to a peak between 0530 to 0600 after which the skip distance began to change with the consequent fading of signals, although K2ANR was heard at 0615 at S6.

The Test as a whole was marred by static bangs and crashes which, as usual, always seemed to occur when trying to resolve the weaker call signs! Despite this, however, the following calls from across the Atlantic were heard – K2ANR, K8DH, K8RNE, KV4FZ, W1HGT, W2IU, W4BRB, W8AH, W8ANO, W8GDQ, W9BKA/8 and WA4SGF.

The remaining Test is to be held on 15th February.

★ BROADCAST BANDS

● COLOMBIA

4765kHz HJDY R. Catatumbo, Ocana, Columbia. A newcomer since November, this station has a schedule from 11.00 to 0400 GMT. Power is 1kW.

6065kHz HJIQ La Voz del Llano, Villavicencio, Colombia. Has recently moved to this channel from the old 6115kHz. Power is 1kW.

6030kHz HJCT R. Nacional, Bogota, Colombia. Previously listed as inactive, this station has been reported with excellent signals at 0100 GMT. Schedule is from 11.00 to 0500 GMT. Power is 50kW.

5065kHz HJVN R. Horizonte, Bogota, Colombia. This station has been moving around of late. Listed on 5970kHz it has been heard on 5950kHz and was last reported on **5065kHz.** Schedule is from 0900 to 0500 GMT. Power 10kW.

● MONGOLIA

Ulan Bator Radio. According to the latest schedule, an English programme is broadcast daily from 1220 to 1250 on **15445** and **17785kHz** and from 2200 to 2230GMT on **7345** and **9545kHz.** Listeners reports, questions and musical requests are welcomed and should be sent to Foreign Broadcast Service, Box 365. Ulan Bator, Mongolia. IRC's are not required.

● SYRIA

Damascus. This station has been recently reported with an English programme from 2030 to 2200 GMT on various channels in the 31 metre band. Checked by our listening post, the frequency is actually **9670kHz** with news in English and station identification.

● MALAYSIA

R. Malaysia. The English programme is scheduled from 0625 to 0855 GMT on **6175, 11900** and **15280kHz** The address for reports is Federal House, P.O. Box 1074, Kuala Lumpur.

● CHINA

Tapei, Tiawan. The Voice of Free China radiates an International Service, in English, beamed to Europe from 1800 to 1900 GMT on **17890kHz.**

● PHILLIPPINES

Malolas. The Voice of the Philippines is now on the air at 0300 to 0400, 0900 to 1400 GMT on **9580** and **11950kHz.**

Acknowledgements to Swedish Dx'ers and our own listening post. ■

BOOK REVIEW

1970 WORLD RADIO–TV HANDBOOK. 400 pages, 6 x 9in. Published by World Radio–TV Handbook. Price 42s.

Published annually, the World Radio–TV Handbook is a virtual necessity for all who require a completely up-to-date source of information on current schedules, frequencies, directional bearings, newscasts in English and other languages, station personnel, interval signals and much other information of all stations on the TV, FM, Long, Medium and Short wave bands.

This publication, together with a Summer Supplement – published in June each year – represent the only complete reference guide to international radio and TV. It has long been recognised as the established authority and standard guide to world broadcasting stations, frequency and time standard transmissions.

The 1970 World Radio–TV Handbook can be obtained from the Modern Book Company, 19 Praed Street, London, W.2, at 43/9d. post paid. Immediate delivery from stock. ■

LAST LOOK ROUND

● TURKISH DELIGHT?

A. Sapciyan, our man in Instanbul, often contributes articles to this magazine. His simple transistor receiver designs have always proved of interest to readers. In the next issue we present a sweet little package entitled *Experimental Reflex Radio*. This article will be savoured with relish!

● GOT IT TAPED?

The vital statistics of Dx can be measured by recording those elusive signals. Taping sounds from those far away places with the strange sounding names can eventually provide the listener with an exciting sound library – see *Tape Recording for the SWL* in the March issue.

An aural record of Dx prowess can often be exciting and certainly more entertaining than the visual QSL card. Make a good job of it and you won't get your cards!

● 413, 414, 415

On these pages in this issue is featured an article dealing with one aspect of tape recording. We shall soon be introducing a short series entitled *Understanding Tape Recording* by our well-known contributor W. G. Morley. This series will be of great interest to all who own a tape recorder and aspire to know more about the technicalities of the subject. ■

TV

FAULT FINDING MANUAL for 405/625 LINES

8/6

POSTAGE 8d.

REVISED & ENLARGED

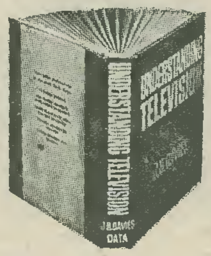
EDITED BY J. R. DAVIES

124 pages

Over 100 illustrations, including 60 photographs of a television screen after the appropriate faults have been deliberately introduced.

Comprehensive Fault Finding Guide cross-referenced to methods of fault rectification described at greater length in the text.

UNDERSTANDING TELEVISION



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Continued from page 445

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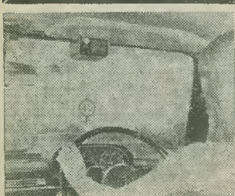

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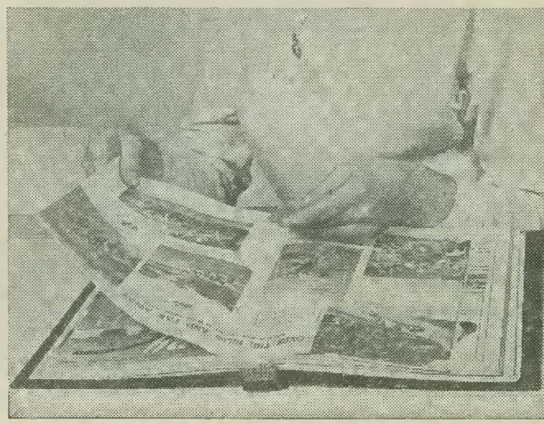

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Bias Resistance	EMITTER OR CATHODE CURRENT									
	0.5mA	1mA	2mA	4mA	6mA	10mA	20mA	40mA	60mA	80mA	100mA
1Ω											0.1
2.2Ω									0.13	0.18	0.22
4.7Ω								0.19	0.28	0.38	0.47
6.8Ω							0.14	0.27	0.41	0.54	0.68
10Ω						0.10	0.20	0.40	0.60	0.80	1.0
22Ω					0.13	0.22	0.44	0.88	1.3	1.8	2.2
47Ω				0.19	0.28	0.47	0.94	1.9	2.8	3.8	4.7
68Ω			0.14	0.27	0.41	0.68	1.4	2.7	4.1	5.4	6.8
100Ω		0.10	0.20	0.40	0.60	1.0	2.0	4.0	6.0	8.0	10
220Ω	0.11	0.22	0.44	0.88	1.3	2.2	4.4	8.8	13	18	22
270Ω	0.14	0.27	0.54	1.1	1.6	2.7	5.4	11	16	22	27
330Ω	0.17	0.33	0.66	1.3	2.0	3.3	6.6	13	20	26	33
470Ω	0.24	0.47	0.94	1.9	2.8	4.7	9.4	19	28	38	47
560Ω	0.28	0.56	1.1	2.2	3.4	5.6	11	22	34	45	
680Ω	0.34	0.68	1.4	2.7	4.1	6.8	14	27	41		
820Ω	0.41	0.82	1.6	3.3	4.9	8.2	16	33	49		
1kΩ	0.50	1.0	2.0	4.0	6.0	10	20	40			
1.5kΩ	0.75	1.5	3.0	6.0	9.0	15	30				
2.2kΩ	1.1	2.2	4.4	8.8	13	22	44				
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