THE
RADIO CONSTRUCTOR

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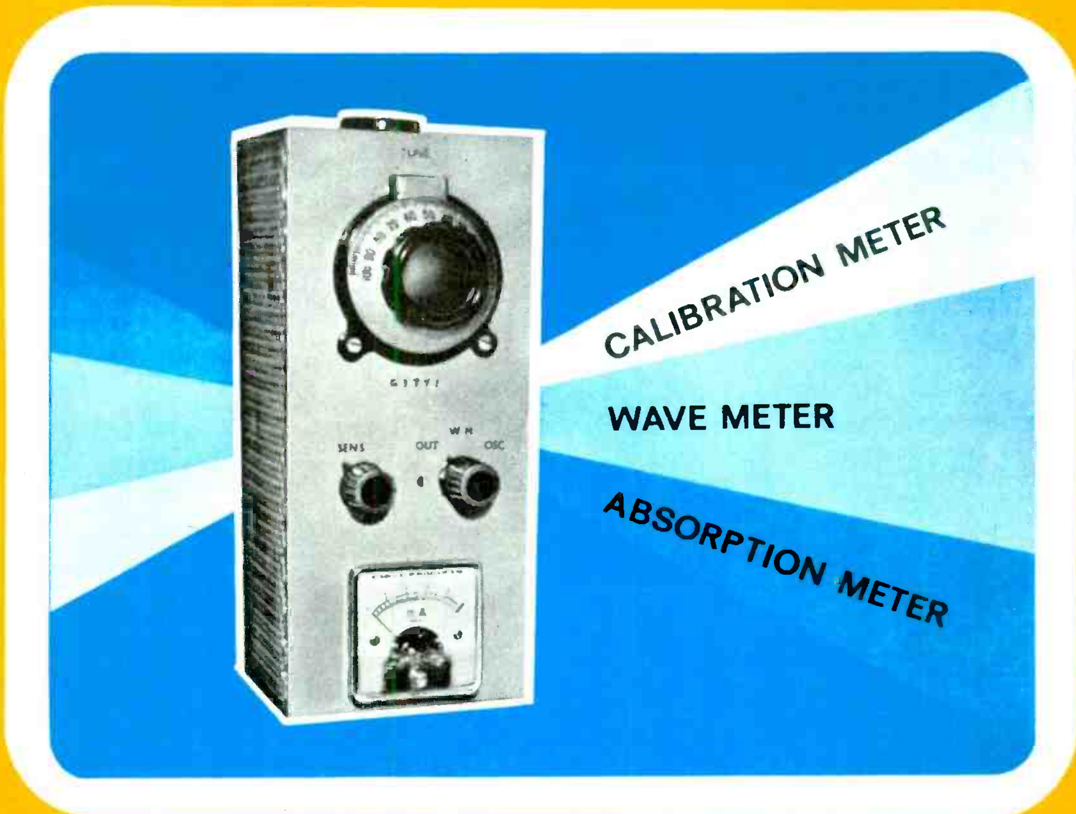

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BP01 – 7401	Quadruple 2-input positive NAND gate (with open collector output)	0.15	0.14	0.12
BP02 – 7402	Quadruple 2-input positive NOR gates	0.15	0.14	0.12
BP03 – 7403	Quadruple 2-input positive NAND gates (with open-collector output)	0.15	0.14	0.12
BP04 – 7404	Hex Inverters	0.15	0.14	0.12
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BP10 – 7410	Triple 3-input positive NAND gates	0.15	0.14	0.12
BP13 – 7413	Dual 4-input Schmitt trigger	0.29	0.26	0.24
BP20 – 7420	Dual 4-input positive NAND gates	0.15	0.14	0.12
BP30 – 7430	8-input positive NAND gates	0.15	0.14	0.12
BP40 – 7440	Dual 4-input positive NAND buffers	0.15	0.14	0.12
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BP42 – 7442	BCD to decimal decoder (4–10 lines, 1 of 10)	0.67	0.64	0.58
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BP48 – 7448	BCD-to-Seven-Segment decoder Driver	0.97	0.94	0.88
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BP51 – 7451	Dual 2-wide 2-input NAND-OR-INVERT gates	0.15	0.14	0.12
BP53 – 7453	Quad 2-input expandable NAND-OR-INVERT	0.15	0.14	0.12
BP54 – 7454	4-wide 2-input NAND-OR-INVERT gates	0.15	0.14	0.12
BP60 – 7460	Dual 4-input expander	0.15	0.14	0.12
BP70 – 7470	Single-phase J-K flip-flop	0.29	0.26	0.24
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BP74 – 7474	Dual D type flip-flop	0.37	0.35	0.32
BP75 – 7475	Quad latch	0.47	0.45	0.42
BP76 – 7476	Dual J-K with pre-set and clear	0.43	0.40	0.38
BP80 – 7480	Gated full adders	0.67	0.64	0.58
BP81 – 7481	16-bit read/write memory	0.97	0.94	0.88
BP82 – 7482	2-bit binary full adders	0.97	0.94	0.88
BP83 – 7483	Quad full adder	1.10	1.05	0.95
BP86 – 7486	Quad 2-input exclusive NOR gates	0.32	0.30	0.28
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BP91 – 7491	8-bit shift registers	0.87	0.84	0.78
BP92 – 7492	Divide-by-twelve counters	0.67	0.64	0.58
BP93 – 7493	4-bit binary counters	0.67	0.64	0.58
BP94 – 7494	Dual entry 4-bit shift register	0.77	0.74	0.68
BP95 – 7495	4-bit up-down shift register	0.77	0.74	0.68
BP96 – 7496	5-bit parallel in parallel out shift-register	0.77	0.74	0.68
BP100 – 74100	8-bit bistable latches	1.75	1.65	1.55
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BP154 – 74154	4 to 16 Line Decoder	1.80	1.70	1.60

Devices may be mixed to qualify for quantity prices. Larger quantities—prices on application. (TTL 74 Series only.)

Data is available for the above series of I.C's in booklet form, price. 13p.

TTL INTEGRATED CIRCUITS

Manufacturers' "Fall outs"—out of spec. devices including functional units and part function but classed as out of spec. from the manufacturers' very rigid specifications. Ideal for learning about I.C's and experimental work.

PAK No.		PAK No.	PAK No.
UIC00 – 12 × 7400N	50p	UIC42 – 5 × 7450N 50p	UIC80 – 5 × 7480N 50p
UIC01 – 12 × 7401N	50p	UIC50 – 12 × 7450N 50p	UIC82 – 5 × 7482N 50p
UIC02 – 12 × 7402N	50p	UIC51 – 12 × 7451N 50p	UIC83 – 5 × 7483N 50p
UIC03 – 12 × 7403N	50p	UIC60 – 12 × 7460N 50p	UIC86 – 5 × 7486N 50p
UIC04 – 12 × 7404N	50p	UIC70 – 8 × 7470N 50p	UIC90 – 5 × 7490N 50p
UIC05 – 12 × 7495N	50p	UIC72 – 8 × 7472N 50p	UIC92 – 5 × 7492N 50p
UIC10 – 12 × 7410N	50p	UIC73 – 8 × 7473N 50p	UIC93 – 5 × 7493N 50p
UIC20 – 12 × 7420N	50p	UIC74 – 8 × 7474N 50p	UIC94 – 5 × 7494N 50p
UIC40 – 12 × 7440N	50p	UIC75 – 8 × 7475N 50p	UIC95 – 5 × 7495N 50p
UIC41 – 5 × 7441AN	50p	UIC76 – 8 × 7476N 50p	UIC96 – 5 × 7496N 50p

UICX1 – 25 × Asst'd 74's £1.50

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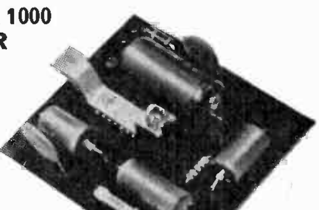

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BP930	Expandable duel 4-input NAND	12p	11p	10p
BP932	Expandable dual 4-input NAND buffer	13p	12p	11p
BP933	Dual 4-input expander	13p	12p	11p
BP935	Expandable Hex Inverter	13p	12p	11p
BP936	Hex Inverter	13p	12p	11p
BP944	Dual 4-input NAND expandable buffer without pull-up	13p	12p	11p
BP945	Master-slave JK or RS	25p	24p	22p
RP946	Quad, 2-input NAND	12p	11p	10p
BP948	Master-slave JK or RS	25p	24p	22p
BP951	Monostable	65p	60p	55p
BP962	Triple 3-input NAND	12p	11p	10p
BP9093	Dual Master-slave JK with separate clock	40p	38p	35p
BP9094	Dual Master-slave JK with separate clock	40p	38p	35p
BP9097	Dual Master-slave JK with Common Clock	40p	38p	35p
BP9099	Dual Master-slave JK Common Clock	40p	38p	35p

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BP 701C—SL701C	TO-5	8	OP Amp	63p	50p	45p
BP 702C—SL702C	TO-5	8	OP Amp Direct OP	63p	50p	45p
BP 702—72702	D.I.L.	14	G.P. OP Amp (Wide Band)	53p	45p	40p
BP 709—72709	D.I.L.	14	High OP Amp	53p	45p	40p
BP 709P—µA709C	TO-5	8	High Gain OP Amp	53p	45p	40p
BP 711—µA711	TO-5	10	Dual comparator	58p	50p	45p
BP 741—72741	D.I.L.	14	High Gain OP Amp (Protected)	75p	60p	50p
µA 703C—µA703C	TO-5	6	R.F.-I.F. Amp	43p	35p	27p
TAA 263—	TO-72	4	A.F. Amp	70p	60p	55p
TAA 293—	TO-74	10	G.P. Amp	90p	75p	70p

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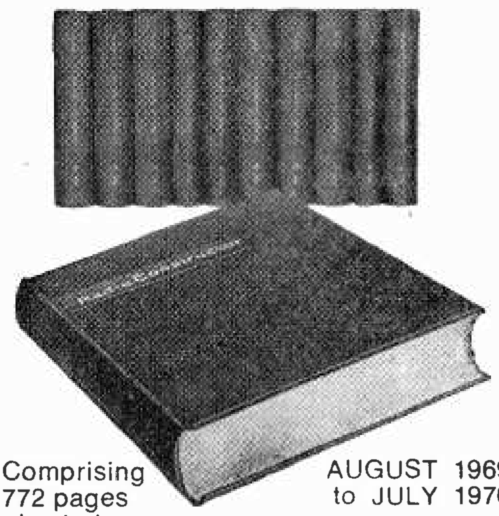

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AF139	.13	2G303	.13
AF186	.37	2N711	.50
AF239	.37	2N1302-3	.20
BC154	.25	2N1304-5	.25
BC171 = BC107	.13	2N1306-7	.30
		2N1308-9	.35
BC172 = BC108	.13	BC113	.10
		Power Transistors	
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BF274	.15	OC20	.50
BFY50	.20	OC23	.30
BSY25	.37	OC25	.25
BSY26	.13	OC26	.25
BSY27	.13	OC28	.30
BSY28	.13	OC35	.25
BSY29	.13	OC36	.37
BSY95A	.13	AD149	.30
OC41	.13	AUY10	1.25
OC44	.13	2N3055	.63
OC45	.13	2S034	.25
OC71	.13	Diodes	
OC72	.13	AAY42	.10
OC73	.17	OA95	.09
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OC139	.13	IN914	.09

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A.E.I. Fully marked and tested Flipflops	50p	40p	30p
OC71/72, Fully tested, unmarked	5p	5p	4p
Matched Sets, 1-OC44, 2-OC45. Per set	25p	20p	15p
Matched Sets, OC45, 1st and 2nd I.F. Per set	15p	12p	10p
TIC45 Thyristors .6A, 60V, Texas	15p	15p	12p
OA47 Gold bonded Diodes, marked and tested	3p	3p	2p
1W Zener Diodes 6.8, 7.5, 24, 27, 30 and 43 volts	5p	4p	3p
10W Zener Diodes 7.5, 11, 13, 20 and 100 volts	20p	17p	15p
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H18	10	OC71/75 uncoded black glass type PNP Germ.	50p
H19	10	OC81/81D uncoded white glass type PNP Germ.	50p
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CONTENTS

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Technical Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. We regret that such queries cannot be answered over the telephone; they must be submitted in writing and accompanied by a stamped addressed envelope for reply.

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OCTOBER ISSUE WILL BE PUBLISHED ON OCTOBER 1st

HIGH IMPEDANCE TRANSISTOR PRE-AMPLIFIER

by

G. W. SHORT

This versatile low-level audio pre-amplifier with an input impedance of 9MΩ is suitable for matching crystal microphones to transistor power amplifiers or for use with an oscilloscope or a.c. voltmeter. Constructors with the requisite test gear may set it up for a precise level of gain

NOWADAYS THE OBVIOUS DEVICE to use when a high input impedance amplifier is required is the field-effect transistor. However, if operation at audio frequencies is all that is needed it is possible to get acceptable results from ordinary transistors, which are cheaper and electrically more robust.

It is true, of course, that amplifiers made with ordinary p.n.p. or n.p.n. bipolar transistors don't usually have high input impedances. One reason is that such devices, as normally operated, naturally have a lowish input impedance. Another is that even if their input impedance is made high by emitter feedback or some other trick it is generally reduced again by the presence of a base bias resistor or resistance network.

REDUCED COLLECTOR CURRENT

There are various ways out of this problem, but by far the simplest is to reduce the collector current of the input transistor to a very low value – a few microamps. This kills two birds with one stone. Lowering the collector current automatically increases the input impedance – that is a property of bipolar transistors. Equally, lowering the collector current calls for a reduced base current and enables a high-value bias resistance to be used. The input impedance can if necessary – and it is necessary for our purposes – be further increased by applying the right kind of negative feedback. All these techniques are used in the circuit of Fig. 1, which has also been designed for low noise and insensitivity to supply voltage variations. But before going into details let us first discuss the amount of amplification we can make practical use of.

GAIN REQUIRED

Noise always imposes a limit on the amount of gain which can be usefully employed. Few constructors are aware of the magnitude of *inevitable* noise voltages in audio circuits. Let us forget about transistor noise for the time being and reflect on the fact that noise is generated by every resistance in a circuit, *including the resistance of the signal source itself*. There is such a thing as a low-noise resistor, but no such thing as a no-noise resistor, unless you are prepared to cool it to absolute zero, by which time it will probably have become a superconductor anyway instead of a resistor. At all normal temperatures, the thermal agitation of the molecules produces thermal noise, and we are stuck with it.

This thermal noise sets a limit to the signal-to-noise ratio at the amplifier input. Only when we have satisfied ourselves that this is adequate need we worry about amplifier noise. The amplifier does, inevitably, degrade the input signal-to-noise ratio. The amount by which it does so is called the 'noise factor' of the amplifier. For example, if the noise factor is 10dB then an input signal-to-noise ratio of 60dB gives an output signal-to-noise ratio of 50dB. A good audio amplifier will have a noise factor of 3dB or less.

In the present case we need an amplifier for signals from high impedance sources. If the source has a resistance of 1MΩ, then the thermal noise of the source itself, integrated over the whole audio band,

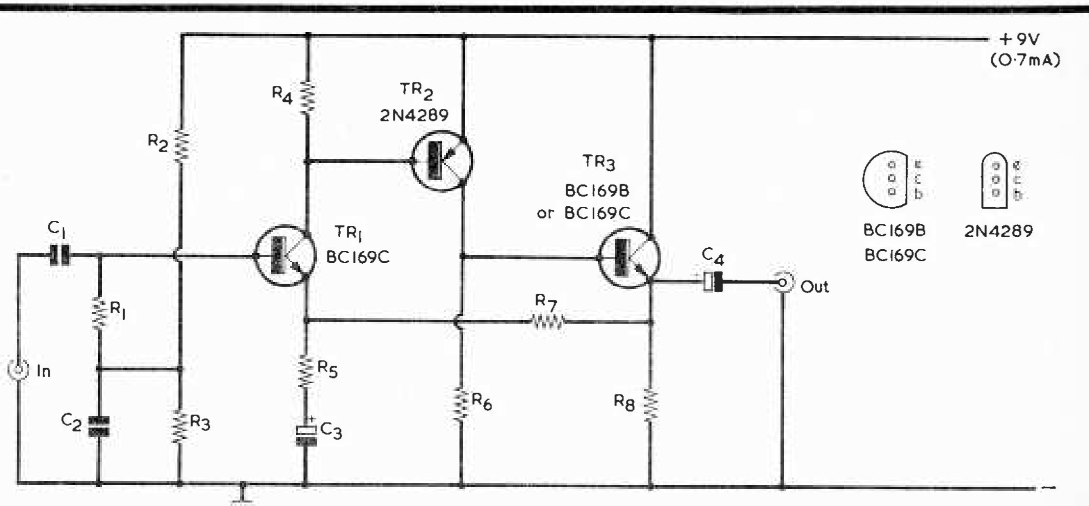


Fig. 1. High impedance pre-amplifier, giving low noise and stable gain over the entire audio range

is about 15μV. If the *input* signal-to-noise ratio is to be 60dB, then the input signal must be 60dB up on 15μV, which means a signal of 15mV. This is a comparatively large signal, so the amount of amplification which will be needed for most practical purposes will be small. Suppose our pre-amplifier is to drive a power amplifier with a drive requirement of 100mV. The gain needed is only 7.

The circuit of Fig. 1 gives a gain of 10 with an input impedance of 9mΩ. The output impedance is low. It is possible, as described later, to raise the gain to 100 at the price of reducing the input impedance to some 2MΩ. In this way the constructor can adapt the basic circuit to his particular needs.

CIRCUIT DESIGN

The input transistor is all-important. It must have low noise and high gain even at the very low collector current of 5μA. A silicon planar type is the obvious choice, and fortunately suitable transistors are not expensive. The type used here is BC169, in the high-gain selection known as BC169C. The makers' data sheet gives a typical current gain of 600 at Ic=2mA, and experiments show that, even at micro-amp collector currents, values of 100 or more are usual.

The BC169C (TR1) is directly coupled to a high-gain p.n.p. silicon type, 2N4289 (TR2), and this in turn is directly coupled to another BC169 (TR3), connected as an emitter-follower to provide the low output resistance of about 100Ω. TR1 provides only a small voltage gain, and TR3 none at all. Most of the gain comes from TR2. (The transistors specified are available from Amatronix Ltd., 396 Selsdon Road, South Croydon, Surrey.)

Without feedback, the overall gain would be 1,000 or more, and the input impedance about 500kΩ. Negative feedback via R7 and R5 reduces the gain to approximately 10 and raises the input impedance of TR1 to a very high value, in the region of 100MΩ. The input is still shunted by R1, however, so the net input impedance is a little less than R1.

COMPONENTS

Resistors
(All ¼ watt high stability 10%. See text for alternative values to give different amplifier performance.)

R1	10MΩ
R2	1MΩ
R3	2.7MΩ
R4	120kΩ
R5	10kΩ
R6	47kΩ
R7	100kΩ
R8	10kΩ

Capacitors
(All working voltages equal to or greater than supply voltage.)

C1	0.01μF
C2	0.1μF
C3	50μF electrolytic
C4	50μF electrolytic

Transistors

TR1	BC169C
TR2	2N4289
TR3	BC169B or BC169C

Sockets
Input and output phono sockets

PERFORMANCE

The frequency response is flat from 10Hz to 100kHz, with 10kΩ load at the output. At zero frequency (d.c.) the impedance of C3 is infinite and raises the negative feedback to virtually 100%. This stabilises the d.c. operating conditions very effectively. The voltage at TR3 emitter is about 6V d.c. This is the condition for maximum output (1.5V r.m.s. sine wave) to a 10kΩ load. However, the circuit can still deliver 300mV r.m.s. even if the supply voltage is reduced to 3V, so immunity to minor variations in battery voltage is guaranteed.

If R3 is reduced to 1MΩ, the circuit can be used at voltages above 9V. Indeed, it can still be used at 9V, with reduced output (1V r.m.s.) and drain (0.4mA) but this is not recommended since protection against tired batteries is then less good. With this modification, the supply voltage can be taken up to 30V. The supply current drain and circuit voltages vary as the supply voltage is changed but the gain and input impedance, being mainly set by feedback, do not vary appreciably. In a word, if you want to use the circuit at more than about 12V, change R3 to 1MΩ.

DIFFERENT LOADS

The circuit can be adapted for different loads.

If the pre-amplifier has to drive a load of much less than 10kΩ it may not be able to deliver enough output. In this case, reduce R8 so that it is equal to the load required. Values down to 1kΩ may be used provided that the supply voltage is 9V. Supply drain increases in consequence: R8 still has 6V across it so a value of 1kΩ calls for 6mA through TR3, and so on.

When used as an oscilloscope or meter pre-amplifier it may be that the load is very high in resistance. In this case, if desired, the maximum output can be raised to 2V r.m.s. into 100kΩ or more by changing R3 to 1.2MΩ.

GAIN ADJUSTMENT

For some purposes it may be useful to set the gain to a precise value, such as exactly 10 or exactly 100, while for others some general degree of gain adjustment may be needed. This can be carried out by changing R5 or R7. These resistances set the negative feedback. If the amplifier had infinite gain without feedback the gain would be set at exactly (R5+R7)/R5. In the practical case the gain is always less than this, but at low gains the approximation is good. To set the gain, first calculate the required value in R5 from the formula:

$$R5 = \frac{R7}{A - 1}$$

where A is the voltage gain wanted. Then install a pre-set variable resistor of this value in the R5 position, and adjust. The best method of adjusting for a definite A is to use an attenuator as a standard, as shown in Fig. 2. If the attenuator is put ahead of the amplifier and set to reduce the signal to 1/A of its input value, then the amplifier will restore the signal strength if its gain is A. In this case, Vx = Vy. These voltages should preferably be measured on the same (high impedance) meter, since any meter error does not then affect the accuracy of the result. The pre-set resistor used for R5 should preferably be wirewound; R5 is effectively in series with the signal as far as noise goes and some carbon pre-set resistors are noisy.

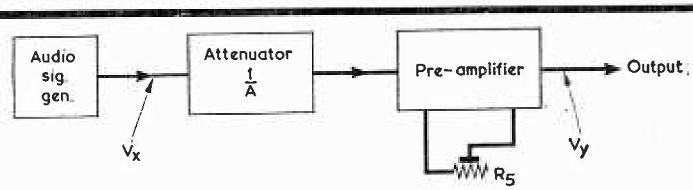


Fig. 2. Set-up for gain adjustment to a precise value. When the amplifier just compensates for the loss in the attenuator, Vx is equal to Vy

It should be remembered that as the gain is raised the input impedance, frequency response and gain stability against supply and component variations all suffer. At A = 100, probably the maximum for meter applications, input impedance is 2MΩ and response is −3dB at 8Hz and 30kHz.

HIGHER INPUT IMPEDANCE

If an input impedance of more than 9MΩ is required, increase R1, if necessary correcting the d.c. conditions by adjusting (raising) the value of R3 to give 6V at the emitter of TR3. (Or, in the case of supply voltages of other than 9V, or of the version with R3=1.2MΩ, to give just over half the supply voltage.) The conventional method of raising the input impedance, i.e. by 'boot-strapping' R1, is not recommended for this circuit.

NOISE FACTOR

The noise factor is not definable unless the signal-source resistance is specified. For this amplifier, the best performance (noise factor = 2dB approx.) is obtained with a signal source impedance of 100kΩ, but it remains very good for the range 10kΩ to 1MΩ. On the face of it, this seems not to be compatible with such sources as crystal microphones, which are associated with higher impedances. However, we must remember that a crystal transducer is electrically capacitive. It behaves as if it were a signal voltage in series with a rather lossy capacitor. This lossy capacitor can be represented at any one frequency as a loss-free pure capacitance in series with a resistance. It is the resistance alone that produces noise, and so long as it lies in the fairly wide range of 10kΩ to 1MΩ the noise factor remains low.

CONSTRUCTION

It is important to remember that a high input impedance invites hum, and that hum voltages are everywhere inside buildings wired with a.c. mains. Even though the preamp is battery-driven the input cable, etc., can pick up hum. So put the circuit in a metal box and screen the input cable. For the circuit itself any of the normal constructional methods may be used. ■

NEW ELECTROMETER DEVICE, MBH1

by

M. J. DARBY

A semiconductor device which outperforms the electrometer valve and the MOST

IF A DEVICE IS REQUIRED WHICH WILL AMPLIFY VERY high impedance signals, an electrometer valve is usually selected. Such valves can operate with input currents of about 10^{-15}A, but they have the disadvantages that they are physically large by modern standards and are not so robust as semiconductor devices when they are subjected to the forces associated with rocket launching, etc.

Vibrating capacitor electrometer instruments can operate at extremely small input currents, but their bandwidth is limited and they are relatively large.

Recently a new semiconductor electrometer device has been developed by D. W. J. Barker (Portsmouth Polytechnic) and B. L. Hart (North East London Polytechnic) in collaboration with Marconi Microelectronics (Witham). It is expected that this device (which is designated by the symbol MBH1) will be capable of operating at currents of about 10^{-16}A – which is lower than the grid current of good electrometer valves.

CHARGE LEAKAGE

The development of metal-oxide-silicon-transistor devices (MOST's) has produced semiconductor devices which are potentially useful in very high impedance circuits. However, leakage of charge from the input gate electrode through the bulk of the encapsulating material and also across the surface of this material increases the input current. The resulting leakage currents are dependent on the cleanliness of the outside surface of the device and on the humidity; such factors are not under the control of the device manufacturer.

The MBH1 employs a dual MOST device, but is used in circuits which keep the metal casing of the device at the same potential as that of the input gate electrode. It can also be arranged that the drain to gate voltage is zero. With no driving voltage across the material between the gate and its surroundings, virtually no leakage current flows. In addition, the gate current is virtually independent of the outer surface contamination and the humidity.

The MBH1 is expected to have important applications in certain types of nuclear instruments, in pH meters and in other instruments which must operate with very small input currents.

It is interesting to note that the charge of an electron is 1.602 x 10^{-19} coulomb. A current of 10^{-16}A therefore corresponds to a flow of less than 1,000 electrons per second. ■

"Excuse me young man, but could you turn that thing down a bit – I'm a musician."

RECENT PUBLICATIONS

MANUAL OF SOUND RECORDING. By John Aldred, M.B.K.S.T.S.
269 pages, 6 x 8½in. Published by Fountain Press Ltd. Price £3.50.

This is a second and enlarged edition of a work that originally appeared in 1963, and it is necessary to read only a few of its pages to realise that the author is patently an expert in the field of sound recording and that he is writing from a wide background of practical experience. Indeed, the book opens with a photograph of Mr. Aldred seated at a recording console whilst an orchestra plays the background music for a film.

The book commences with chapters on basic sound and electrical principles, magnetic recording and reproduction, disc recording and reproduction, microphones, amplifiers, filters and loudspeakers. Subsequent subjects are recording studios, the recording of music, stereophonic sound, motion picture sound and microphone techniques. There is also an Appendix listing reference books, test discs, test tapes (including azimuth and alignment tapes), test films, and standard tape and film dimensions.

The approach is essentially practical with little recourse to mathematics, and the book will be of value to the professional sound recordist. It will also make fascinating reading for the home recording enthusiast, since it opens the window on the professional world and offers much advice that will be of advantage to the amateur.

PRINCIPLES OF TELEVISION RECEPTION. By W. Wharton, C.Eng., F.I.E.E., and D. Howorth, B.Sc.Tech., C.Eng., M.I.E.E. 304 pages, 5½ x 8½in. Published by Pitman. Price £1.40.

This book, a title in the Pitman Paperbacks series, appears here in its first paperback edition. It was previously published in 1967.

In 'Principles of Television Reception' the authors set out to provide a brief explanation of the fundamentals of high-definition television, together with a concise account of the circuits, techniques and systems involved. As a result the volume tends somewhat to fall into the category of reference book in that the reader may consult it for facts and figures concerning specific aspects of television. This factor does not detract from the book's usefulness: virtually the whole gamut of television reception in both monochrome and colour is covered and every item is dealt with in a clear and crisp manner.

It may be added that the first of the two authors is a member of the B.B.C. Transmitter Planning and Installation Department, whilst the second is a member of the B.B.C. Research Department. This background is, of course, more than adequate to ensure that the book is both accurate and authoritative.

SOLID-STATE DEVICES AND APPLICATIONS. By Rhys Lewis, B.Sc.Tech., C.Eng., M.I.E.E.
264 pages, 5½ x 8½in. Published by Newnes-Butterworths. Cased price £3.00, limp price £2.00.

This book is intended primarily for technicians, students who are about to enter or who have already entered the final stages of courses such as the Higher National Certificate in Electronics, or for those who have completed these courses in recent years and wish to bring their knowledge up to date. However, it will also have a general interest for all those who are concerned with discrete semiconductor devices, integrated circuits and logic applications at fairly advanced level.

The book opens with a chapter on semiconductor fundamentals, then proceeds to diodes, bipolar and unipolar transistors, and to integrated circuits. We next see the devices at work in a.f. and r.f. amplifiers, and in d.c., wideband and operational amplifiers. After a chapter on sinusoidal oscillators, modulation and detector circuits, we proceed to logic circuits, these including RTL, DTL and TTL logic, emitter-coupled logic and metal-oxide semiconductor logic, together with the full family of flip-flops. The following chapter, on power applications, is mainly concerned with thyristor circuits. There are, finally, three chapters covering transistor parameters and equivalent circuits, and Boolean algebra fundamentals and applications. Three appendices, on the binary system, binary-coded decimal systems, and the efficiency of Class A and Class B amplifiers, complete the text. There is an extensive and helpful index.

TV TECHNICIAN'S BENCH MANUAL. By G. R. Wilding.
182 pages, 5½ x 8½in. Published by Fountain Press Ltd. Price £2.50.

This book is intended to meet the requirements of the TV service engineer in a form which presents the maximum amount of servicing information in the minimum of reading time. Written by an author who has had many years of practical experience in the servicing of television receivers, each chapter, which deals with a specific section of the television receiver, gives first of all a brief description of the circuits concerned and then carries on to describe the faults that are liable to occur and their causes in order of probability.

The text is liberally backed up by circuits taken from manufacturers' service manuals, and particular aspects of individual manufacturers' designs are fully discussed. Both valve and transistor circuits are dealt with. The first nine chapters in the book cover monochrome receivers, whilst the last three chapters are devoted to colour receivers.

'TV Technician's Bench Manual' is a practical book intended for practical engineers, and it has a down-to-earth and concise style which will particularly appeal to the busy serviceman for whom time spent in fault-finding represents the greatest economic hazard in his work.

BRAKE LIGHT FAILURE INDICATOR

by

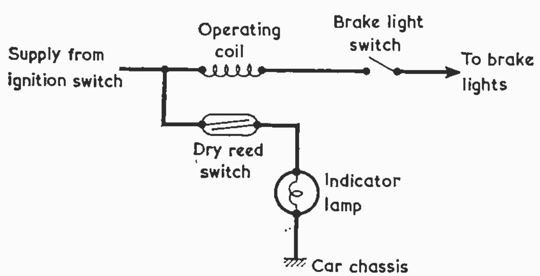
P. W. HAND

A simple answer to a problem that affects all car-owners

IT IS TRULY ESSENTIAL TO ENSURE THAT BOTH BRAKE lights of a vehicle are operating correctly. It is surprising the delay which can occur before drivers realise that a vehicle in front is slowing down when its brake lights are not functioning properly. Also, a single brake light may be, and often is, easily confused with a direction indicator.

DRY REED SWITCH

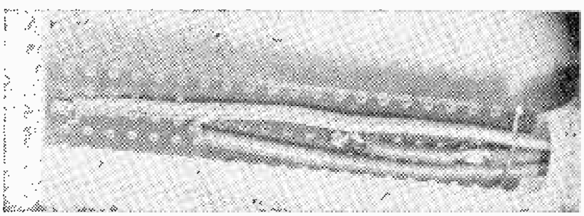
The unit to be described indicates to the driver of the car in which it is installed that both brake lights are functioning correctly. It consists basically of a dry reed switch fitted in a coil inserted in series with the brake light circuit, as shown in the accompanying diagram. The current in the coil is sufficient



The simple circuit employed for the brake light failure indicator

to close the dry reed switch contacts only when both brake lights are drawing current. Some experiment is required in finding the number of turns needed in the coil for the particular dry reed switch employed. The circuit is fail-safe, since open-circuit of the coil, or failure of the dry reed switch or brake switch contacts to close will cause the indicator lamp to remain extinguished, thereby indicating that something is wrong. Should the dry reed switch or brake switch contacts remain closed for any reason the lamp will light continuously, again indicating a fault.

The dry reed switch should be selected to carry the indicator lamp current, plus extra to allow for the cold switch-on resistance of its filament. For instance, a 12 volt 2.2 watt lamp draws about 0.18 amp when illuminated. A wide range of dry reed switches is available on the home constructor market including one (Home Radio Cat. No. WS240) which has contacts rated at 500mA. The dry reed switch employed by the author was an unmarked manufacturer's surplus type, and this has given no trouble in practice.

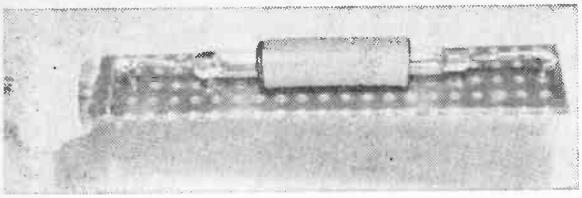


The dry reed switch and operating coil are mounted on a strip of plain Veroboard

COIL TURNS

Dry reed switches, even of the same type, vary in the ampere-turns required to operate; also the maximum voltage in different makes and models of vehicle will be slightly different. In consequence, the number of turns in the coil should be determined empirically in the following manner, which applies to 12 volt vehicles only. The design has not been checked with 6 volt cars, although it would seem reasonble to expect that a coil with thicker wire and fewer turns should be satisfactory.

A test coil of 18 s.w.g. enamelled copper wire is close-wound in a single layer with 25 turns, the internal diameter being sufficient to allow the dry reed switch to be inserted without binding, say with a clearance all round of 0.01in. The coil is self-supporting and should be positioned centrally along the length of the switch. It is next connected into the brake light circuit as shown in the diagram. *Discon-*



The dry reed switch and coil assembly. The coil shown here has been covered with tape

nect one brake lamp, then run the engine of the car at such a speed as to produce the maximum voltage. (In the author's case this was 14.7 volts.) If possible, monitor this voltage and also the current through the coil.

Next, the brake pedal is depressed. If the dry reed switch fails to operate, a coil with more turns, say 30, should be wound. Once the dry reed switch is operating, the turns should be reduced one at a time and the circuit tested each time until the dry reed switch closes momentarily and opens again whilst the coil is kept energised. The momentary closing of the contacts is due to the initial surge of current due to the cold resistance of the brake lamp. One more turn is now removed. It is important that with only one brake light connected and with the maximum voltage that the dry reed switch closes only momentarily. This condition was fulfilled in the author's case with a coil of 20 turns.

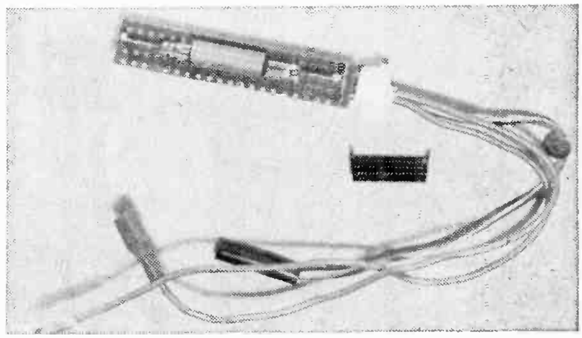
The current taken by two 12 volt 21 watt lamps is 3.5 amps, but at 14.7 volts the measured current was 4 amps. It is not unusual for the potential of a car battery to fall as low as 9 volts and at this voltage the current is about 3 amps. This current will still be sufficient to operate the dry reed switch.

CONSTRUCTION

The coil and dry reed switch are both mounted on a small piece of plain 0.15in. Veroboard without copper strips measuring 3.3 by 0.7in. This can be clearly seen in the photographs. A medicinal tablet or old solder tube is suitable to house the device. The width of the Veroboard depends on the internal diameter of the tube and should be a nice sliding fit. The tube should not have an internal diameter of less than 0.7in. Two wiring pins are used to solder the dry reed switch into position. Also shown is the complete device ready for insertion into the tube.

The indicator lamp was a 12 volt 2.2 watt bulb fitted in a dashboard lamp holder purchased at a branch of Halfords.

Since the 18 s.w.g. wire used in the coil may seem a little light for currents of the order of 4 amps a test was made to see that no appreciable rise in coil temperature occurred. The method used was to insert a mercury thermometer into the tube containing the unit, maintaining the thermometer in contact with the coil. A current of 4 amps was passed through the coil. After a period of three minutes the temperature increased by 1°F and remained steady for an additional period of five minutes. The test was repeated twice, with similar results each time.



The complete unit ready for fitting into its tube housing. Shown in the centre is an example of the operating coil. The relatively small size of the components may be judged from the drawing pin which secures one of the leads in position

The brake light indicator device has now been in constant use, without failure, since August 1968 in a 1966 1500 Ford Cortina. ■

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.

TX/RX Type CR1–43044 (TBY8). — D. Byrne, Kylemore, Endsleigh, Douglas Road, Cork, Eire – circuit or any information, borrow or purchase.

PCR2 Receiver. — M. V. Davidson, 13 Hartley Road, Southport, Lancs – circuit, power requirements or any other details.

Ex-U.S. Army v.h.f. converter type AM–913/TRC. – K. Dodd, 1 Nansen St., Bulwell, Nottingham – any information on this unit.

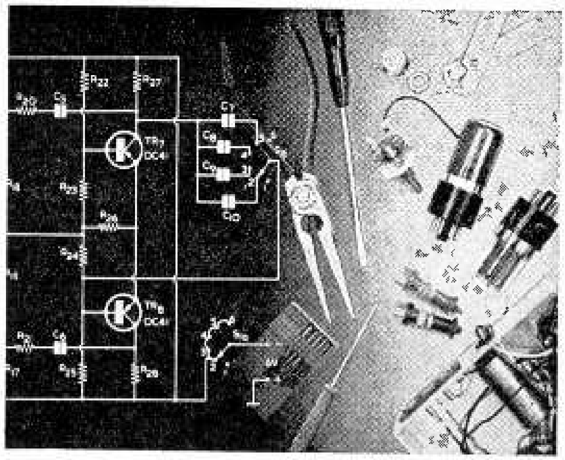
Homelab Signal Generator. — A. E. Walker, 32 Moseley Drive, Marston Green, Birmingham, 37 – circuit diagram and service sheet Type No. 10 Serial No. 10042.

Small 2-way intercom. – W. L. Brunsdon, 28 Meadfoot Road, Moreton, Wallasey, Cheshire – Simple wiring diagram to enable construction by bedfast invalid.

American Signal Generator. — A. E. Harvey, 39 Curlieu Road, Oakdale, Poole, Dorset, BH15 3RJ – Manual or circuit, Type No. 1–30–A, Serial No. 68.

Avometer Ex A. M. Model D. — R. E. Simms, 18 Osborne Drive, Sompting, Lancing, Sussex – Circuit diagram.

MAINS FAILURE INDICATOR



by G. A. FRENCH

IT IS OFTEN DESIRABLE TO HAVE available some form of warning device which provides an indication when the mains supply at any particular point ceases. Such a device can be coupled to the entire mains supply for a house or workshop, or to a single item of equipment under test, its function being to give warning that the supply has failed. Failure can result from such causes as the blowing of a fuse due to fault conditions or the unanticipated opening of a supply connection.

The warning device to be described in this article gives an audible indication when the mains supply ceases. Its basic mode of operation consists of having a large-value capacitor become charged by way of the mains supply when the supply is present, the capacitor then discharging into a neon oscillator coupled to a loudspeaker when the supply ceases. This idea, which obviates the necessity of incorporating a battery, is not new, and the writer encountered it first in an article by Frank H. Tooker which appeared in the Brazilian journal *Electronica Popular*.* The design in *Electronica Popular* incorporated an a.c. relay which de-energised when the mains supply failed, coupling the large-value capacitor to the neon oscillator into which it discharged. However, the unit to be described here does not use a relay. Instead, it employs an all-electronic means of coupling the large-value capacitor to the oscillator.

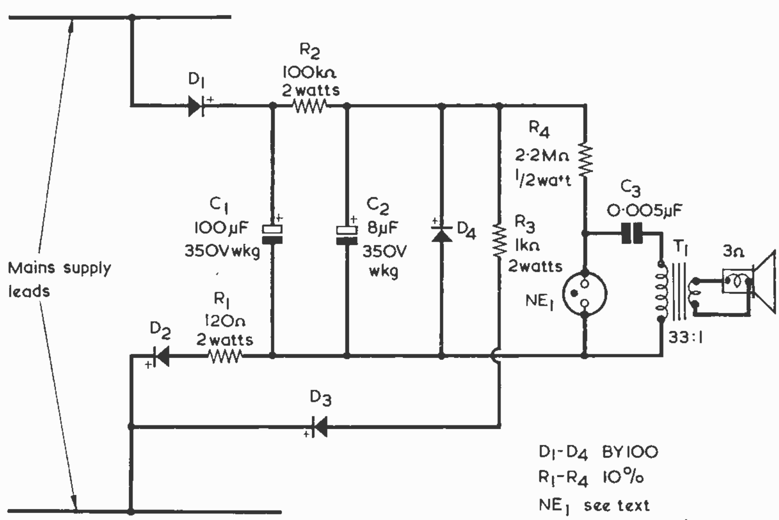
CIRCUIT OPERATION

The circuit of the warning unit appears in the accompanying diagram. The unit is capable of being connected to the live and neutral lines of a mains supply at any point.

When the mains supply is present, the 100μF capacitor C1 charges up by way of D1 and D2 until the voltage across its plates is a little lower than the peak voltage of the mains. Series resistor R1 is included merely to function as a surge limiting component. The voltage across C1 is applied to C2 via R2, whereupon C2 also charges. However, on half-cycles when the lower mains supply line in the diagram is negative, rectifier D3 conducts and discharges C2 via R3. The result is that C2 is subject both to charge and discharge currents, and a relatively low voltage appears across it.

If the mains voltage ceases, the resistance appearing between the two supply lines depends upon the equipment which is connected to them, and this resistance may vary from a low to an infinite value (the latter being given if the supplied equipment happens to be switched off). The failure warning unit must, in consequence, be capable of coping with all these conditions.

Let us first examine the situation which exists if, after cessation of the mains, an infinite resistance appears across the supply leads. In this instance C1 cannot discharge via D1 and D2, but it can discharge via R2 into C2. C2 is not now being discharged on alternate half-cycles by way of D3 and so the potential on its upper plate goes positive,



The circuit of the mains failure indicator. The loudspeaker sounds an audible tone when the mains supply ceases

* Frank H. Tooker, "Alarma Contra Falta De Energia", *Electronica Popular*, January/February, 1971.

approaching that on the upper plate of C1. There is no circuit between the plates of C2 capable of providing a discharge path: although D3 is connected in a manner which would allow it to pass forward current from the positive plate of C2, the path to the negative plate is blocked by the reverse-connected D2.

The other instance to consider is when, after failure of the mains, a low resistance is present across the supply leads. In this case D1 and D2 become effectively connected together, both being reverse biased so far as the flow of discharge current from C1 is concerned. Again, C2 becomes charged via R2. The only forward current which could, at first sight, flow from the upper plate of C2 is via D3 and D1 to the upper plate of C1. But it would be impossible for such a forward current to flow because the upper plate of C2 can never go positive of the upper plate of C1, from which capacitor it is receiving its charge. So, once more, C2 becomes charged until the voltage across its plates approaches that across the plates of C1.

It may be seen, therefore, that whatever resistance appears across the supply leads after cessation of the mains supply, C2 (which previously had a low voltage across its plates) acquires a high voltage, being charged from C1. As soon as the voltage across C2 passes the striking potential of neon bulb NE1, the neon oscillator commences to function, causing an audible note to be heard from the loudspeaker. The neon oscillator runs continually, its operating voltage being maintained by the charge originally stored in C1. This capacitor slowly discharges into C2 and, thence, into the neon oscillator until the voltage applied to the oscillator becomes too low to maintain illumination of the neon, whereupon the oscillator ceases working. As will be discussed shortly, the time taken for C1 to discharge to this level is surprisingly long.

A component not mentioned so far is rectifier D4. This rectifier is included because, without it, a small inverse voltage can momentarily appear across C2 if the device is connected across the mains supply with all its capacitors in the discharged condition. This inverse voltage could cause damage to C2.

COMPONENT DETAILS

In the prototype circuit checked out by the author all the rectifiers, D1 to D4, were type BY100. There are a number of low-cost near-equivalents to the BY100 available on the components market, and these could be employed instead, if desired. They should have a p.i.v. rating of 800. The inverse voltage appearing across D4 is only some 300 volts, and a slight economy could be effected by using a rectifier with a p.i.v. of 400 or more in this one particular position. A BY114 would be suitable. Whilst dealing with the rectifiers it may be mentioned, in passing, that the load remaining across the supply leads after cessation of the mains supply could, whilst presenting a low resistance, also be highly inductive. A typical instance would occur if the load were the primary of a large mains transformer, which might offer a high back–e.m.f. if it were not sufficiently well damped. To check that the circuit would work under such conditions, it was tested a number of times with the primary of a large valve receiver type mains transformer connected across the supply leads, and with no circuits connected to the transformer secondaries. There was no evidence of damage to the rectifiers after the tests were completed and the warning device functioned perfectly reliably on all occasions.

Both C1 and C2 must be good quality components having a working voltage rating of 350 volts or more. It may be found convenient to make up C1 from a number of individual capacitors in parallel. In the prototype circuit three 32μF capacitors were connected together in parallel to provide (approximately) the value of 100μF shown in the diagram.

The neon bulb, NE1, is a small wire-ended component. It is available from Henry's Radio as Hivac type 16L or 34L, or from Home Radio under Cat. No. PL32A.

Transformer T1 is a valve type speaker transformer having a ratio of about 33:1. The component employed in the prototype circuit was an Elstone type MO/T (Home Radio Cat. No. T012). This transformer offers three ratios, these being 90:1, 55:1 and 33:1. When the two higher ratios were tried, it was found that the oscillator did not operate reliably over the wide range of voltages applied to it from C2; but there was no trouble at all on this score when the 33:1 ratio was used. From this experience it would appear virtually essential to employ a low ratio transformer here. The value of C3 is a little critical, and it may need to be varied slightly to obtain the desired tone frequency.

CIRCUIT PERFORMANCE

The prototype circuit was checked a large number of times as already described, and it performed satisfactorily in all instances. The voltage appearing across C2 when the mains supply was present was 30 volts, this rising rapidly to 290 volts when the mains supply ceased. The 290 volt figure was given for all loads across the supply lines ranging from low to infinite resistance.

The frequency of the tone generated by the neon oscillator is dependent upon the voltage available from C2, and it increases as the voltage increases. As soon as the mains supply ceases, the tone from the loudspeaker is initially heard as a rising siren-like note which rapidly reaches a high piercing level. The volume available should be more than adequate for an ordinary room or small workshop. As the voltage across C2 gradually falls so also does the frequency of the tone, losing, with time, a little of its initial high volume level.

With the prototype the tone was at its loudest for some seven minutes after the cessation of the mains supply. It then continued to fall gradually in frequency and volume level but was still clearly audible after 15 minutes, at which point the test for length of audible tone emission was discontinued. If desired, the period during which tone is heard can be extended by the simple process of increasing the value of C1. If this capacitor were made 200μF, for instance, the time during which the warning was sounded would be approximately doubled.

It is immaterial which input lead of the warning device connects to the live side of the mains and which connects to the neutral side. An important point to bear in mind is that voltages with respect to earth which are in excess of the mains r.m.s. value appear in the circuit, this condition applying, in certain circumstances, even after the mains supply has ceased. In consequence, all the components should be completely enclosed in an insulated case to prevent the risk of accidental shock. The loudspeaker should also be mounted in an insulated case so that both its frame and mounting bolts cannot be touched. A good approach would consist of fitting the components and loudspeaker in a wooden case which acted also as a baffle, this being helpful for accentuating the lower frequency tone offered when the voltage across C2 has, after a period of time, dropped to a low level. The loudspeaker could be secured by short woodscrews inserted from the inside of the case. A final touch would consist of fitting the neon bulb behind a small aperture so that its glow would be visible when the warning was being sounded. This would have the secondary advantage of ensuring reliable ionising of the bulb, since the type specified may fail to ignite at its striking voltage if kept in total darkness. ■

NEWS . . . AND .

EDDYSTONE RADIO INTERFERENCE DETECTOR

A new portable transistorised v.h.f. interference measuring set, the Eddystone type 31A, will be one of the main weapons in the fight for cleaner and clearer reception in the crowded v.h.f. television, radio broadcast and communications bands. This receiver has been engineered by Eddystone Radio, from a design by the Post Office, to detect and home-in on interference sources so that action can be taken to suppress their nuisance value to acceptable levels. Eddystone Radio is a division of Marconi Communications Systems, Marconi House, Chelmsford.

Operating in the v.h.f. bands from 31 to 250MHz, the characteristics of the detector are tailored to international standards for radio frequency noise and field strength measuring equipment. The detector incorporates a double superheterodyne receiver having three separate and individually tuned r.f. sections covering 31 to 68MHz, 66 to 136MHz and 135 to 250MHz respectively.

A balanced aerial system, complete with balun transformers, feeder cable and coaxial connector is provided. The aerial is adjustable by means of telescopic rods, so that it can be made self-resonant at any frequency in the range 50 to 250MHz.

In the photograph the detector is measuring stray harmonic interference from an electric arc-welding source.

RADIO ASTRONOMY

To our readers who are interested in Radio Astronomy we commend *Radio Sky*, the Journal of the Society for Amateur Radio Astronomers. The Journal is published four times a year in a duplicated form and runs to approximately 30 pages. It is available to societies, institutions and libraries at a cost of £1.25 per year.

Educational and descriptive articles are published on various aspects of astronomy and space science. Practical details of radio telescope construction are covered in detail. Reports of amateur observations and suggestions for future observations are published from time to time.

Some back copies of the Journal are available as sample copies. Please apply to the Hon. Secretary, Society for Amateur Radio Astronomers, 17 St. Thomas' Square, Newport, Isle of Wight.

NOW – SUITS CUT BY LASER TAILOR

Laser tailoring, recently introduced in the United States, and claimed as the first major advance in apparel manufacturing since the invention of the sewing machine.

At one factory in America's largest garment company, a computer-controlled laser beam is now at work around the clock performing the basic operation of the business – cutting the cloth for garments.

The laser beam cuts out garments one at a time with amazing speed and accuracy, according to Genesco Inc., the company which has installed the system. This, they say, is a big advance on the system of cutting a dozen garments or more by other methods.

The company says that laser cutting will enable them to respond to the needs of the market and will mean the end of the system of accumulating large orders before starting the cutting. Now they can cut a man's sports jacket, a woman's skirt and a child's pair of shorts, consecutively, with scarcely a pause. If a customer wants one suit of a particular style, size and material it will be possible to do the job at no extra cost by pressing a computer button.

The laser cutting system has four main components: a computer programmed with cutting instruction, a positioning device, the laser and a conveyor.

A single layer of cloth is unrolled from a bolt and moved along the conveyor until it is under the positioning device. Turned on by the computer, the laser's beam is automatically manoeuvred above the cloth to follow the pattern stored on tape.

The beam cuts each garment according to the programmed instructions, which include directions on size and style. The cut material is quickly removed by the conveyor and another section of material moves into the cutting area.

PUBLICATION DATE

The Radio Constructor is published on the first of the month and copies should be obtainable on that day, except where it falls on a Sunday, then copies should be on sale the following day.

. . . COMMENT

IN BRIEF

- Mr. R. A. Allan has been appointed a Governor of the BBC, for five years, in succession to Sir Robert Bellinger.

- The Butterworth Publishing Group are awarding a Scientific Fellowship to be presented annually. The aim of the Fellowship is to provide the means by which a would-be author can take time off to write a book on some aspect of physical or biological science. Details can be obtained from The Scientific Publisher, Butterworth Group, 88 Kingsway, London, WC2 B6AB.

- The recent mini-budget, it is anticipated, will give a boost to sales of colour TV sets. The normal drop in summer sales was greater than anticipated, but it is now thought that sales this year will exceed 800,000 sets.

- The President of the Incorporated Society of British Advertisers speaking at a recent luncheon attended by the Minister of Posts and Telecommunications, called for longer hours on ITV.

- R. A. Lister & Co. Ltd. have printed a new brochure on their base load and standby diesel generating sets, which are suitable for automatic starting, mains failure and remote control. Readers may obtain the brochure free; the address of the company is Dursley, Gloucestershire, GL11 4HS.

- Mr. Ray Pyman has recently been appointed General Manager of B. H. Morris & Co. Ltd., the well known radio wholesalers who are the exclusive U.K. distributors of the Trio range.

- The International Instruments, Electronics and Automation Exhibition will be held at Olympia, London, next year (8th to 12th May, 1972).

- A 50-page booklet featuring sections on the basic theory of indicator tube operation, tube characteristics, supply voltages and methods of controlling the tubes is available free from the Publicity Department, ITT Components Group Europe, Edinburgh Way, Harlow, Essex.

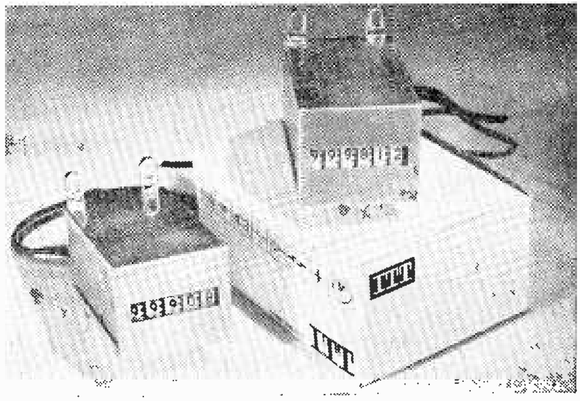
- J. Stuart Sansom has been elected Chairman of The Royal Television Society's Council for 1971–72. Mr. Sansom is Technical Countroller for Thames Television.

- Shorrock Security Systems Ltd. – the Hawker Siddeley subsidiary which develops, manufactures and markets electronic, sonic, infra-red and laser detection devices – has moved into a new purpose-built factory in Blackburn.

- Art Cushen, M.B.E., New Zealand's famous shortwave listener, recently received his 2,000th QSL card from a broadcast station, Radio Tahiti. Art Cushen's collection of cards dates back to 1937.

- The British Radio Corporation's colour TV, the Ferguson Colourstar, is one of the cheapest colour television receivers in the world. The recommended price is less than £200. The size of picture is 36cm wide by 29cm high.

ITT ADD 6-DIGIT VERSION TO COUNTER RANGE



Added to the wide range of ITT electromechanical counters is the Type E607. The six-digit E607 is identical to the five-digit E507 except for the extra decade. Overall dimensions and fixing centres are the same for both types.

The E607 is for base or panel mounting. It is non-reset and has a minimum life of one million counts. Maximum counting speed is 600 c.p.m. and operation is possible from pulses of 50ms or longer. Versions are available for a.c. or d.c. operation up to 240V. Ambient operating temperature range is from −20°C to +70°C.

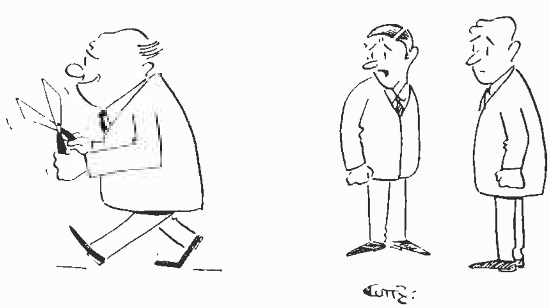
BROADCAST BANDS CONTEST

The International Short Wave League are holding a contest on Saturday and Sunday 11th and 12th of September.

The contest is open to all members and commences at 1300 hrs. local time and finishes at 0100 hrs local time.

The object of the contest is to hear as many countries as possible on each of the specified frequency ranges; only broadcast stations may be logged.

Enquiries should be addressed to the I.S.W.L. Contests Manager, G–1516, Mr. Clifford A. Tooke, 6 Chelmer Avenue, RAYLEIGH, Essex.



"Hullo – another power cut coming?"

AUTOMATIC MORSE PRACTICE KEYER

by

A. G. BLEWETT

A simple and reliable circuit which enables a.f. from a tape recorder to directly key a Morse practice oscillator

THE MOST DIFFICULT THING FOR an aspiring amateur to find whilst trying to learn the Morse code is not an oscillator or a key, but a willing hand to bash some characters out for him.

A tape recorder would seem to be the best way round this problem, with passages of characters on the tape at varying rates as the student progressed, but the snag here of course is that to cover, for example, from 5 to 20 w.p.m. in easy stages many passages would still have to be initially recorded by some obliging expert.

Many domestic tape recorders have three speeds, so this fact could be taken advantage of, perhaps, to multiply the ranges with a minimum amount of recorded material. Using this method, unfortunately, 3 w.p.m. at 3¾ i.p.s. using a 1kHz tone would end up as 2kHz at 6 w.p.m. and so on, an undesirable feature.

The author therefore developed the simple circuit described in this article to overcome these problems, and at the same time give additional facilities.

THE CIRCUIT

The circuit of the automatic keyer appears in Fig. 1. Here, R1 presents a suitable terminating impedance, simulating the speaker, to the output of the tape recorder amplifier. The voltage developed across this resistor is fed to the germanium bridge D1 to D4, where it is rectified and subsequently smoothed by C1. R2 couples C1 to the base of TR1, with the result that a forward bias current is fed to this base whenever a.f. appears at the output of the tape recorder. The collector-emitter circuit of TR1 provides a cathode earth return for the practice oscillator, which in the author's case is a pentode wired as a phase-shift oscillator. R3 and C2 are the normal cathode bias components, and R4 ensures that a high voltage does not appear at the cathode under 'key-up' conditions. The value of R4 is found by experiment, as is described later.

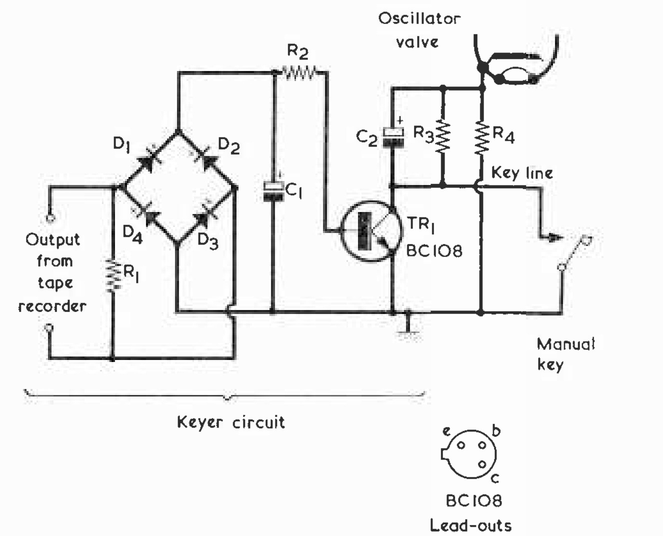


Fig. 1. The automatic Morse practice keyer coupled to an oscillator valve

R2 protects the base of TR1 from possible overloads. The value given for C1 gave a time constant in conjunction with the input circuit such that the resulting characters had a pleasant rate of 'attack', yet were not 'blurred'. In use, the tape recorder volume control is advanced from zero to just past the point where the characters from the Morse oscillator are perfectly formed.

RECORDING

If, for example, three passages of Morse are now recorded, one at say 4 w.p.m., one at 5 w.p.m. and one at 6 w.p.m.; using a 3 speed tape recorder the following Morse speeds are obtainable: 4, 5 and 6 w.p.m. at 3¾ i.p.s., 8, 10 and 12 w.p.m. at 7½ i.p.s. and 16, 20 and 24 w.p.m. at 15 i.p.s. Other combinations may be chosen, and all will be reproduced at a constant frequency from the oscillator.

The recording can take any form, even spoken 'dah dah dits' will operate the circuit very successfully.

By the same token, amateur transmissions may be recorded from a receiver and replayed into the circuit, slowed down if required, for training purposes. The circuit could also be operated direct from the receiver's output stage if required, though if a fading station is chosen disappointing results may be experienced. Judicious use of the tape recorder volume control to set the input threshold correctly as previously explained can completely eliminate the background noise content of the original signal, making the resulting Morse even more suitable for training purposes.

An important point concerns the coupling to the tape recorder. The author's recorder is a battery portable and the direct connection shown in Fig. 1 gives no trouble. But if a mains operated recorder in used in which one side of the speaker is connected to the same mains earth as is the chassis of the

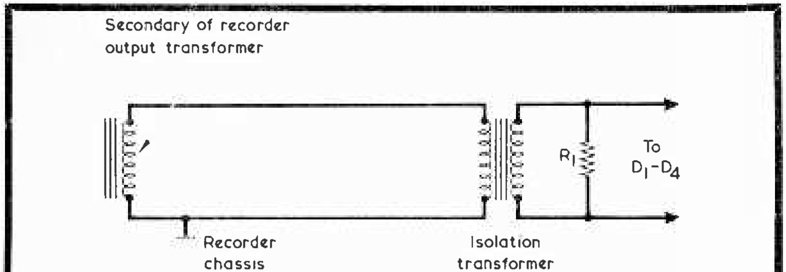


Fig. 2. An isolation transformer is required if one side of the tape recorder output is at chassis potential

COMPONENTS

Resistors
- R1 3Ω, 8Ω or 15Ω (to match recorder output impedance) 3 watts wirewound
- R2 2.2kΩ ¼ watt 10%
- R3 390Ω ¼ watt 10% (part of oscillator circuit)
- R4 see text

Capacitors
- C1 8μF electrolytic, 16V wkg.
- C2 25μF electrolytic, 12V wkg. (part of oscillator circuit)

Semiconductors
- D1–D4 OA81
- TR1 BC108

oscillator unit, then a small a.f. transformer must be used to isolate the input to the bridge, as shown in Fig. 2. A suitable transformer would be the Wharfedale WMT2 (Home Radio Cat. No. LS40B). Alternatively, a half-wave rectifier could be used in place of the bridge, but this has not been tried by the author.

Great care must be taken if the amplifier to be used as a feed has a chasssis which is connected to one side of the mains. The connection to the keyer *must*, in this case, be isolated by a suitable transformer.

No details of construction are given for the keyer, since it is so simple that is should be capable of being built on a suitable tagboard within the case of the oscillator.

THE OSCILLATOR

Provided that it incorporates a valve whose cathode circuit can be keyed, the practice Morse oscillator can be of any conventional type. However, for completeness the circuit employed by the author is given in Fig. 3. Here, the oscillator is a pentode phase-shift type, the frequency of which is controlled by the 2-gang 500kΩ potentiometer. This oscillator cannot feed directly into phones or a speaker and so it is followed by a 6V6 output valve. There is a possibility that keying 'thumps' may be noticeable if a speaker is connected to the amplifier, in which case the value of the intervalve coupling capacitor shown as 0.1μF should be reduced experimentally until the effect disappears. The 'thumps' are not troublesome in the author's installation, in which the amplifier feeds a number of ex-Govt. headsets having poor l.f. response.

The value of the key-up pentode bias resistor, R4, should be determined by experiment. Initially fit a 20kΩ variable resistor in the R4

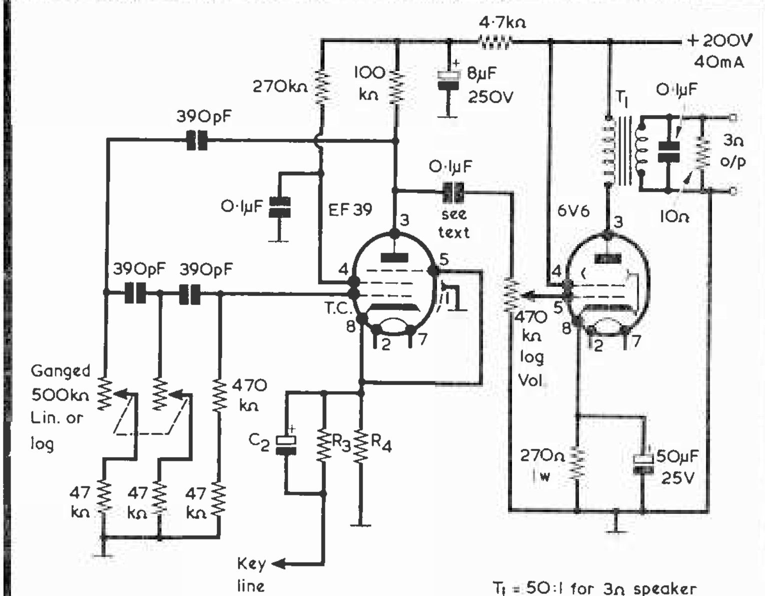


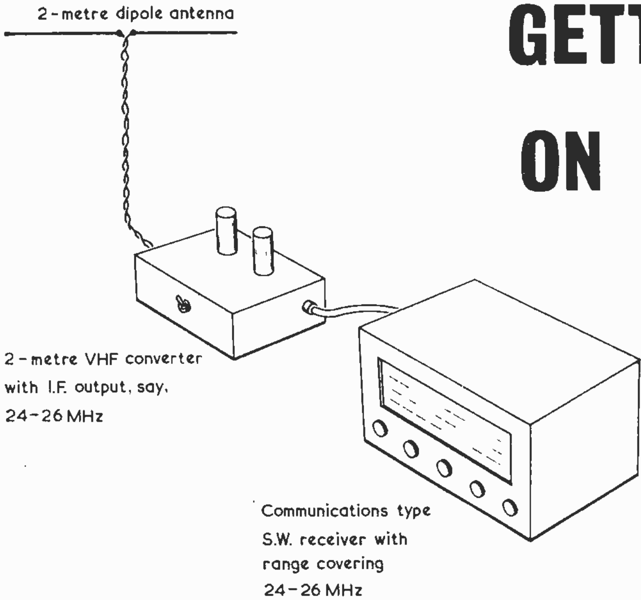
Fig. 3. Circuit of the oscillator and amplifier employed in the prototype installation

position and set it to insert zero resistance. Then, under key-up conditions, increase its value until it is just past the setting where oscillations cease. A fixed resistor of the appropriate value is then fitted in its place. In the author's oscillator the final value required for R4 was 4.7kΩ. This method of finding the key-up resistor value ensures that minimum voltage appears on the key line, which will be external to the equipment, hence giving maximum safety for the operator and ensuring that the collector-emitter voltage rating of the keyer transistor is not exceeded. A voltage of around 12 volts above the chassis line is the maximum that should normally be allowed to appear on the key line. The maximum collector-emitter voltage for a BC108, it may be added, is 20 volts. ■

RADIO AMATEUR EXAMINATION COURSES

Plymouth College of Further Education are starting a course on 13th September. It will continue each Monday and Wednesday evening, 6.30 to 9.00 p.m. Lecturer, Mr. D. M. Webber, G3ENX. For further details telephone 68000 (day) or 73238 (evenings).

A class for the R.A.E. wil be held at the Gascoigne Recreation Centre, Gascoigne School, Morley Road, Barking, on Tuesday evenings at 7.30 p.m., commencing 21st September, 1971.



GETTING STARTED ON TWO METRES

by

ARTHUR C. GEE, G2UK

Advice to the SWL on how to start receiving on the VHF amateur band

QUITE A NUMBER OF RADIO enthusiasts who might well do so hesitate to start short wave listening on the 2 metre band because they just do not know how best to go about getting equipped for this, the most popular of the VHF amateur bands. What, for instance, is the receiving equipment required; what aerial is needed? What results can be expected? Some may have visited a radio amateur station equipped for VHF working and seen the elaboráte rotatable beam antenna system frequently used, have heard talk of VHF converters and "IF frequencies", and so on, and have come away with the feeling that "it's all too complicated for me".

The writer hopes this article will show that worthwhile results are possible with quite simple equipment and aerial systems and thereby encourage some SWLs to have a go at what is a very interesting aspect of the amateur radio scene.

For many transmitting radio amateur enthusiasts, the VHFs have a number of advantages over other frequencies. In the first place, the antennas required are much, much smaller than those required for the "HF" frequencies. Size for size, they compare very favourably with TV aerials. This makes the 2 metre band a popular one with many transmitting radio amateurs who are restricted by "plot" size, planning restrictions and so on from putting up the bigger systems required for the lower frequencies. For much the same reason, the 2 metre band is a popular one for mobile work.

VHF PROPAGATION

Propagation of VHF signals differs markedly from that of lower frequency radio waves. Whereas the latter are propagated over long distances by reflection from ionised layers in the ionosphere, this type of propagation rarely takes place with VHF signals, which are propagated mainly by ground wave signals. These travel more or less by "line of sight" pathways and are much affected by intervening hills and buildings. Generally speaking therefore, the higher the transmitting aerial and the clearer of surrounding buildings it is the better. Occasionally however, quite long distance communication does take place on the VHF's. By "long distance" in this connection we can say up to a hundred miles or even more. Experience has shown that this type of propagation depends much on the weather between the transmitting and the receiving stations and it is referred to as "tropospheric propagation". Fairly powerful transmitters, sensitive receiving equipment and a high gain antenna system are – except in unusually good conditions – required for this type of VHF communication. Reception of tropospheric signals is the province of the more experienced VHF worker and we will not deal with it further in this article as it is outside the scope of the beginner to the VHF's. The great majority of radio amateurs who work the 2 metre band content themselves with much simpler equipment sufficient to enable them to have "across the town" nets for local communication purposes only, and this type of "local" communication is the subject of this article.

Almost any town large enough to have half a dozen or so transmitting radio amateurs will as likely as not have a 2 metre "local net". This may be part of the local RAYNET organisation, or it may be purely "amateur radio" for the convenience of the local amateurs wishing to keep in touch with one another. A number of these amateurs may also run mobile 2 metre stations installed in their cars. These local 2 metre transmissions provide an interesting source of activity for the SWL anxious to gain experience of 2 metre work, and quite a simple aerial and receiving equipment is all that is needed to receive most of this type of 2 metre signals.

For reception of these signals, the method which at present seems most popular is to use the normal station short wave receiver, preceeded by a unit called a "converter" which, as its name suggests, converts the 2 metre signals down in frequency to one which can be tuned in by the particular SW receiver being used. The converter is coupled between the VHF aerial and the aerial connection of the SW receiver. Tuning of the VHF band then takes place using the normal tuning dial on the receiver.

There is a good deal of theory applicable to the choice and design of suitable converters for the various VHF bands, but we do not need to concern ourselves with this at the present stage. Once some preliminary experience has been gained the finer points of converter design can be studied if the SWL so desires. All that is necessary here is to point out to the aspiring VHF SWL that suitable converter units can be quite easily – and not too expensively – purchased and to give him some guidance on what to buy.

IF FREQUENCIES

All up-to-date VHF converters have crystal controlled oscillators and they feed out into the main receiver at various IF frequencies, depending on their design. If you look at the advertisements featuring these converters in the radio magazines, you will see in the specification the "IF" into which the converter must work. For instance, an advertisement may quote the IF as 4 – 8, 14 – 18 or 28 – 30MHz. These figures indicate the various main receiver frequencies over which the particular VHF band, i.e. 2 metres, will appear when the converter is coupled into the main receiver. In other words, you must select a converter which will have an IF output within the tuning range of your SW receiver. A 28 – 30 MHz IF converter will need to be coupled into a SW receiver with a tuning band covering the 28 – 30 MHz range of frequencies. If the converter is one designed for the 2 metre band, then the whole of the 2 metre band will be spread over the frequencies 28 to 30 MHz on the main receiver. Not all SW receivers have a 28 to 30 MHz range, in fact unless the set is one specifically made to cover the amateur radio bands it is not likely to have this range.

So it is customary to design VHF converters to feed into receivers with other ranges. Some SW broadcast-type or general coverage receivers do go up to 24 to 26 MHz and so it is common to find this as one of the ranges for which converters are built. Similarly, converters with the ranges 14 to 18, 4 to 8 MHz and so on are designed to feed into receivers with these ranges. So the first point to notice, therefore, is that we must purchase a converter with an IF output suitable for the particular receiver we already have. It is no good obtaining a converter with an IF of 28 to 30 MHz if the SW receiver does not have this range on it. With a receiver of this type, we would have to get a converter with the IF in a lower range.

AVOIDING INTERFERENCE

Another point which is worth making at this stage is that it is advisable to select an IF output in a band of frequencies which is not likely to contain very high power SW broadcast or other signals because, if the screening of the main receiver is not too good, these signals may get into the receiver and break through into reception of the 2 metre band, a factor which can be irritating. The IF frequency range of 24 to 26MHz is a popular one for 2 metre converters as, generally speaking, there are not many very high power transmissions in this band – at least under normal ionospheric conditions. One of the photographs accompanying this article shows the author's present 2 metre receiving set-up. The converter shown has an output of 24 to 26MHz, and this is nicely covered and bandspread by the Lafayette Model HA-83A communications receiver which is also shown.

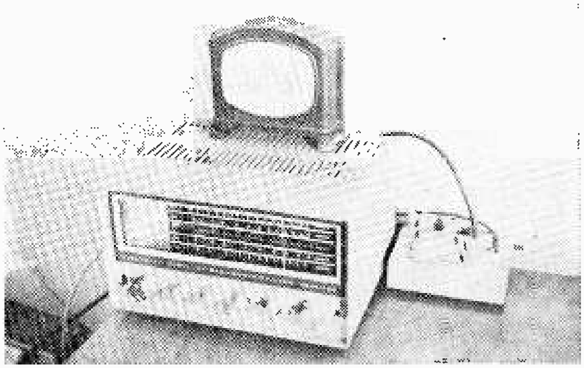
A further point to note about modern VHF converters is that most of these employ transistors and require very modest power supplies. In fact voltages in the 12 volt range, with low consumptions of 10 to 15mA or so, are the order of the day, so the operating power can quite easily be supplied by a small dry battery which can be contained within the converter housing itself. Alternatively a very small AC mains power pack may be provided, also housed within the unit itself, as is the case in the author's converter illustrated.

VHF converters can be comparatively easily built by the experienced radio constructor, and the radio magazines and handbooks give designs and constructional details from time to time for doing so. So, if you feel inclined, you might well try your hand at building one instead of purchasing a completed unit, though if the VHF field is completely new to you, you would probably be better advised to obtain experience with a professionally constructed unit to start with.

AERIAL SYSTEM

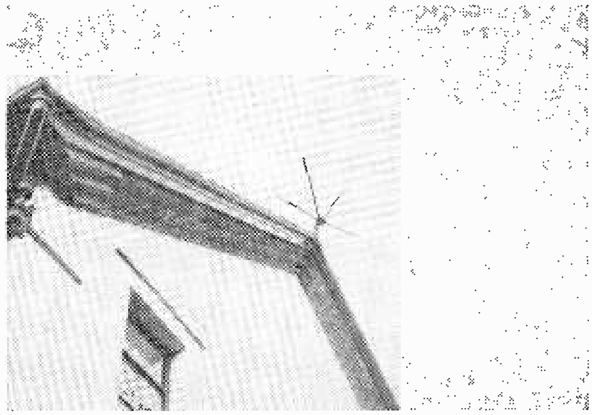
Finally, we must give some thought to the aerial system. If there happens to be a very strong 2 metre amateur radio transmitter near you, you will no doubt be able to receive him on the proverbial "odd length of wire" simply connected to the aerial input socket on the converter unit. But you'll do much better to put up a simple dipole antenna. This can be a length of 2-way flex, with 3ft. unravelled at one end, fixed out to form a half-wave dipole. It can be positioned in the roof space or beneath the eaves and may prove quite sufficient to receive the local amateurs. Or you can go a step further and make up a dipole of aluminium tubing and mount it on top of a pole outside. Again, you can use a ground plane antenna (consisting of a quarter-wave vertical rod with radial rods at the base) with quite good results. A typical example was described by the writer in a recent issue of this magazine.*

* A. C. Gee, G2UK, "A 2-Metre Ground Plane Antenna", *The Radio Constructor* October 1968.



The author's 2 metre receiving equipment

The purists will say that as the majority of 2 metre amateur radio transmissions take place using aerials horizontally polarised, the groundplane aerial, which is vertically polarised, is no good for receiving these transmissions. However, most 2 metre amateur radio signals, even though they be radiated from aerials with mainly horizontally polarised radiation characteristics, have quite enough vertically polarised characteristics by the time they arrive at a receiving aerial to make the question of polarisation of the signals a matter of more theoretical than practical importance; and the writer can say from personal experience that the groundplane aerial makes a very good receptor for all but the weakest 2 metre signals. The writer uses a very neat groundplane antenna, coupled by coaxial cable to the receiving equipment and mounted on the end of the house roof ridge, which has proved most successful for hearing most of the local amateurs in his district. This particular model is made by Mosley Electronics, 40 Valley Road, New Costessey, Norwich, Norfolk. If you get really keen on VHF working and particularly if you are interested in hearing the DX type of signals referred to earlier, you will want ultimately to go in for one of the rotatable beam antennas, details of which you can find in the handbooks specialising in VHF activities.



2 metre groundplane antenna used by the author

In conclusion, be it noted that you will not find the 2 metre band as full of signals as the other parts of the radio spectrum with which you are familiar. In fact, you may go days without hearing any signals at all! It is a good idea to find out from one of the local amateurs who transmits on 2 metres just when the local net comes on and try your hand at a 2 metre SWLing to begin with. You'll then be sure that there are signals on the band which you could be hearing. Otherwise you may think the lack of signals is due to a fault in your gear. Once you have found where to look for the local amateurs, you'll be able to check for activity, certain that when it is there you'll be able to receive it. Let's hope that you'll find the activity of such interest that you'll be encouraged to take the amateur radio transmitting examinations and in time join the "2 metre brigade" and help to stimulate activity on this very interesting band ■

THE SURFACE CHARGE TRANSISTOR

by

J. B. DANCE, M.Sc.

A new 3-electrode device capable of storing information at exceptionally high densities

THE SURFACE CHARGE TRANSISTOR IS A NEW DEVICE developed by W. Engeler, J. Tiemann and R. Baertsch at the General Electric Laboratories in the U.S.A. It shows great promise for use in compact fast memories, since it can store information at densities of over 1,500 bits per sq. mm of the silicon chip.

The surface charge transistor has three electrodes, the source electrode, the receiver electrode and a small input electrode which is known as the transfer gate. The latter overlaps the other two electrodes, but is insulated from them. The structure of the device is simple; it can therefore be made very small and this facilitates the development of complex circuitry.

The functioning of the transfer gate has been compared to that of a sluice gate which controls the flow of water between two levels. As in the water flow analogy, a small input (in the form of a charge on the transfer gate) can control the flow of a much larger current between the other two electrodes. The device will amplify charge and voltage and has the advantage that the output is electrically isolated from the input.

The most important initial applications are expected to be in shift registers (circuits which store numbers and permit the pattern of digits to be moved from one position to the next). A number of charge sensitive transistors can be easily linked together, the receiver electrode of one device being connected to the source electrode of the next.

It is hoped that the small size and high speed of this new device will produce a considerable increase in the storage capacity of future semiconductor memories. ■

DODGES WITH DIODES

by

P. T. EVANS

Silicon rectifiers can be used in applications other than that of merely producing an h.t. voltage

SILICON RECTIFIER DIODES OF THE BY100 CLASS ARE familiar nowadays in the power supply circuits of TV receivers. Their great advantage is that they drop a very low voltage (about 0.6 volt) when they conduct, with the result that the power dissipated inside them is very low. If, for instance, a BY100 continually passes a current of 0.5 amp, the consequent power dissipated is only 0.3 watt. The power dissipated when the diode is reverse-biased, as occurs on non-conducting half-cycles when it is used as a rectifier, its negligibly low since reverse leakage current is of the order of tens of microamps only.

Because of their low power dissipation, silicon rectifier diodes are very small components. They can readily be added to existing circuits in the manner to be described in this short article.

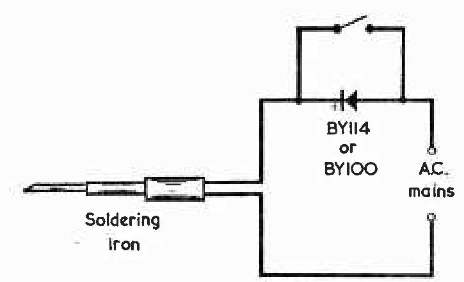


Fig. 1. A soldering iron economiser circuit. The switch is opened when the iron is out of use

SOLDERING IRON ECONOMISER

If a soldering iron is left switched on for long periods without being used it tends to overheat, and there is a consequent shortening of bit and element life.

A circuit which allows the soldering iron to be maintained just below operating temperature when not required is shown in Fig. 1. The switch in this diagram is left open when the iron is out of use, with the result that the silicon diode allows alternate half-cycles only to be passed to the element, which thus runs at reduced temperature. The switch is closed whenever the iron is to be used, whereupon the iron becomes connected to the mains supply in normal fashion, with both half-cycles of the a.c. mains current flowing in its element. The iron very soon heats up to full working temperature, the process being much quicker than if it had been switched on from cold.

In this circuit the rectifier diode need only have a peak inverse voltage of 400 minimum, and a suitable type would be the BY114. The circuit will also function well if the BY100, with its p.i.v. rating of 800, is used. Both diodes are capable of passing a maximum forward current of 1 amp.

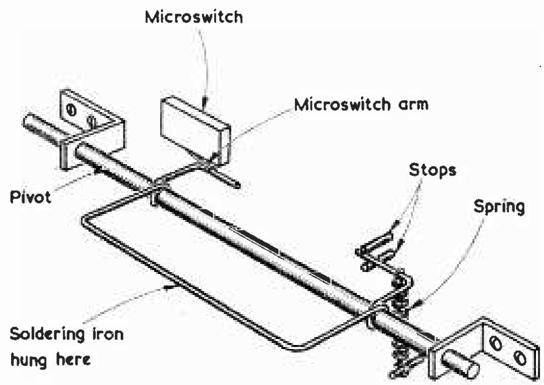


Fig. 2. A soldering iron rest which causes a microswitch to be operated when a soldering iron is hung where indicated. The main section consists of a length of stout galvanised wire bent to shape

If desired, a soldering iron rest could be devised in which the switch is incorporated. A suggested design is shown in Fig. 2, this being suitable for irons which have hooks on their handles by means of which they can be hung up when not in use. When the iron is hung on the bar of this rest, its weight causes the bar to descend slightly against the action of the spring at the rear, thereby operating the microswitch and bringing the series rectifier into circuit.

REDUCING WARM-UP TIME

Many domestic valve radio receivers are still capable of offering good service, but have the disadvantage of taking rather a long time to warm up after having been switched on.

If, as is usually the case, the receiver has a 'live' chassis with a half-wave h.t. rectifier and a series dropper resistor for the heaters, the addition of a silicon rectifier diode can reduce warm-up time considerably. The existing power supply circuit in the

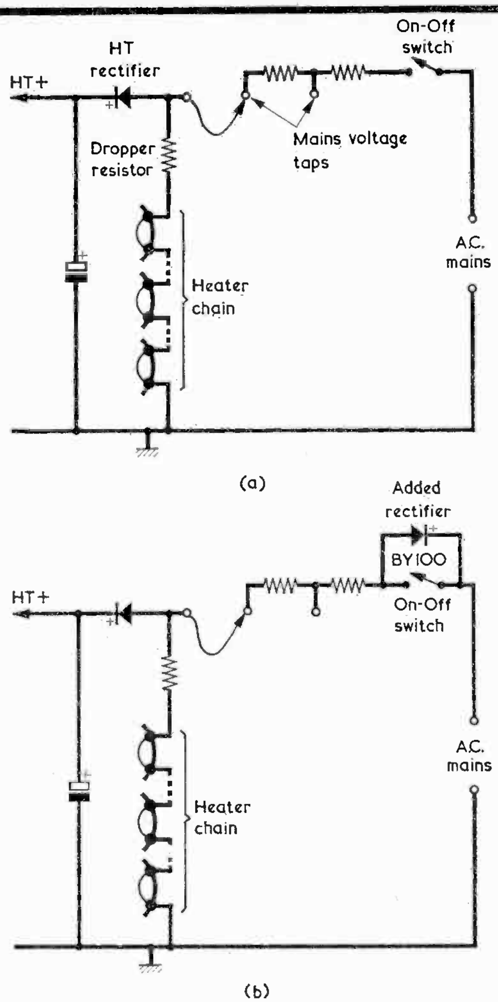


Fig. 3(a). Typical power supply arrangements in a domestic valve radio
(b). Warm-up time is greatly reduced by the addition of a silicon rectifier across the on-off switch, as shown here

receiver should be like that shown in Fig. 3(a). Fig. 3(b) shows the modification, which merely consists of connecting a silicon rectifier diode, with appropriate polarity, across the on-off switch. When the switch is open the added diode allows alternative half-cycles to flow in the heater circuit, maintaining the valve heaters just below working temperature. At the same time, the diode does not allow positive half-cycles to pass to the h.t. rectifier in the receiver, and no h.t. voltage is produced.

After modification, the receiver functions in the following manner. It may be turned *completely* off by the switch at the power supply socket from which it draws its mains current. If the switch at the supply socket is closed the receiver goes into a 'stand-by' condition, with valve heaters nearly fully warmed up but with no h.t. supply available. When the receiver on-off switch is closed, the set comes into complete operation.

The receiver circuit shown in Fig. 3(a) assumes a 'metal' or silicon h.t. rectifier. The modification will work satisfactorily with receivers having a valve h.t. rectifier, but its use with such sets is not generally recommended as the current surges which flow when the receiver on-off switch is closed may shorten the life of the rectifier. The modification must *not* be used if the receiver has a mains input transformer, since high transient voltages appearing across the primary on switching off may break down the rectifier diode. The circuit should not, also, be used with sets which include another silicon rectifier as heater 'dropper' because, according to the polarity of the diode used as 'dropper', the added diode will either cause the heaters to run at full operating temperature when the receiver switch is turned off, or not at all!

It would be better to use a silicon rectifier diode with a high p.i.v. in the circuit of Fig. 3(b), a suitable type being the BY100. This is because many receivers have an anti-mains-modulation capacitor (not shown in Figs. 3(a) and (b)) connected across the supply lines immediately after the on-off switch, and this could function as a reservoir capacitor in a half-wave circuit. If the receiver switch is a double-pole component, the pole in which the diode is not connected should be short-circuited.

EMI WINS MAJOR CONTRACT TO DEVELOP NEW AIRBORNE MARITIME RADAR

A new airborne maritime radar for detecting submarines and ships is to be developed by EMI under a contract placed by the Ministry of Defence (Aviation Supply). The order, won by the Radar & Equipment Division of EMI Electronics Ltd., Hayes, Middlesex, provides for a future replacement of the existing EMI ASV.21 radar.

Expected to be the most advanced of its type in the world, the radar will be designed to detect submarines as well as being used to carry out general surveillance duties on maritime surface traffic.

Compared with the present radar system, the new development will have a greater range and better detection performance in rough seas. It will significantly improve today's capabilities of long-range maritime aircraft. Other uses for the EMI radar will be to aid the navigation of the aircraft by detecting land masses at long range and for cloud and collision warning.

Development work has commenced and the equipment is expected to be ready for the Royal Air Force in about five years time. Due to the maritime radar's advanced performance, interest is likely to be shown by potential customers abroad – particularly countries already operating airborne surveillance patrols at sea.

EMI has had considerable experience in developing and producing airborne radar systems for maritime and other applications. For many years the company has manufactured the radar used in both RAF and Canadian Air Force maritime aircraft.

Q S X

by
FRANK A. BALDWIN
(All Times GMT)

In the world of short wave broadcast band listening there are always mysteries to be solved and puzzles to be unravelled. At almost any one time there are transmissions on various frequencies, none of them listed, which take all the skill and ingenuity of experienced operators – using sophisticated equipment – to identify. It is, perhaps, this aspect of the hobby which is often the most interesting and rewarding.

To illustrate this constant battle of wits, equipment and skill, recent events on the short waves concerning the Arabic-speaking world will be of interest.

As far back as last March, the writer logged a station on a measured frequency of **4988** at 1845 with Arabic music and songs, this being reported in 'Bandspread', the journal of the British Association of Dx'ers, dated 8th April and listed as 'Unidentified'. From information received from elsewhere, this station was identified as Abu Dhabi Broadcasting Service. A few days later this station was measured on **4987** from 1923 through to sign-off at 2002. At other times it signs off at 1950 after an anthem and one bar of an interval signal consisting of six single notes on a stringed instrument. Identification is "Idha'at el Abu Dhabu . . . Arabia".

Again in March, Martin A. Hall of BADX,* one of our most able and experienced operators, heard an Arabic transmission on a measured 5345 at 1740 to close down at 1931. The 'lead' Martin had established in this detective story was taken up by Alan B. Thompson of Neath, probably one of the best equipped SWL's in the world and most certainly in this country, Alex Moore of Stafford and Andrew Waddelow of Bungay – also superbly equipped and experienced operators. From their own observations and with assistance from the BBC Monitoring Service, the following emerged. (Acknowledgements to 'Bandspread', Vol. 1 No. 10.)

The station does not state its location but is believed to be in Saudi Arabia. Parallel frequency is **8405** and schedule is from 1130 to 1400 and from 1630 to 1930. Aim is to transmit propaganda against the present regime in Southern Yemen, and is believed to use the same facilities as the station which used to be Yemeni Royalist Radio.

The Voice of the Free South, Arabic identification "Sawt-al-Janub-al-Hurr" was first intercepted by the BBC Monitoring Serivce (to which acknowledgements are made) on 17th December 1970 on **8405** and "it broadcasts talks and slogans denouncing the 'communist regime in Aden' and exhorts the people of Hadramawt and South Arabia to revolt. It proclaims itself to be the mouthpiece of the Army of National Deliverance (Arabic: Jaysh al-Inqadha al-Watani) which leads the 18th Sha'ban (approximately 19th October) revolution". The station "is believed to use the same facilities as a station which formerly broadcast under the name 'Mutawakillite Kingdom of Yemen Radio' on behalf of the Royalist faction during the civil war in the (northern) Yemeni Republic".

This station was still on the air in June, when the writer heard Arabic chants until sign-off at 2003 with the sounding of Arabic war drums.

Still dealing with the Yemen area, the Sana'a transmitter has been reported by BADX to be on **5802.5** at 1918 after a sudden move from the **4938** channel. However, it had also been heard a few days earlier on a measured frequency of **5807** with a talk in Russian and music of the Slav type. The question now is – are programmes being broadcast for the benefit of the 'advisers' in the country?

MORE ARABIC MYSTERIES

To complete the saga of mysteries emanating from the Arabic-speaking world, consider the following.

South Yemen Broadcasting Service on **5060.** Identification is not as listed but is, in fact, "Huna Adan Idha'at el Gumhoriya't al Yemen al Demokratiya Ash-shahiya" Why?

EAJ203 Radio Sahara on **7230.** This station may be heard during the evenings up to around 2050 when the BBC Europe carrier wipes out the signal. EAJ203 can then be heard again after 2215 when the BBC transmission to Europe signs-off. The programme from Radio Sahara consists of a continuous series of Arabic songs and musical items without identification announcements. The question here is – what is the identification?

MYSTERIES SOLVED

A great many of the mysteries on the short waves are, of course, eventually solved as was the case with the following.

In February of this year, Dx'ers in this country reported an Arabic-type transmission on **4988** from around 1830 onwards. This remained a mystery for just one month, when information came to hand that this transmitter was located in Abu Dhabi.

For some weeks this summer, the writer was involved in identifying a station on **3320.** Unlisted at the time, it turned out to be Johannesburg on a new channel.

● NEWS ITEMS

COSTA RICA

Radio Capital, San Jose, has opened a short wave outlet on **4832** where it is reportedly best heard after 0400.

DOMINICAN REPUBLIC

Radio Cristal, Santa Domingo, is now back on **5010** after using **5071** for some weeks. The latter channel suffered interference from Radio Sutatenza on **5075.**

EL SALVADOR

Radio Nacional de El Salvador has a schedule from 1200 to 0500 on **5980** and **9555.** Announcements are in English and Spanish.

GUYANA

Radio Demerara, Georgetown, is currently operating on the new channel of **3290** after a move from the old **3265.**

ISRAEL

Kol Yisrael, Jerusalem, has added a new outlet for their broadcasts in English and French to Europe from 2045 to 2200. To the regular **9009** and **9625** channels, **6000** has now been added as an experiment. Previously, the experimental channel was **7225**, now abandoned. Reports are requested on the **6000** channel, although this may well have been changed to another frequency by the time this appears in print.

AUSTRIA

According to reports, the short wave transmissions from Vienna may be dropped at the end of this year owing to financial reasons.

UGANDA

It is believed that Radio Uganda is to have an external service in the near future.

● BEGINNERS' CORNER

15005 Hanoi with the English programme at 2000.

17780 HCJB Quito, Ecuador, programme in English directed to Europe at 1930.

* BADX, 16 Ena Avenue, Neath, Glam. An organisation of experienced and active broadcast band Dx'ers. 'Bandspread', their Journal, is published fortnightly throughout the year, except during July and August, when it is produced monthly.

METERLESS BETA TESTER

by

G. W. SHORT

The most expensive component in most transistor testers is the meter. It is also the most fragile. This article shows how to measure 'beta' (hfe) accurately without using a meter at all

FROM TIME TO TIME ARTICLES APPEAR IN POPULAR radio magazines which describe meterless transistor testers. There have also been one or two commercial instruments of the same general type. The basic principle is appealing in its simplicity: connect the transistor under test in some form of oscillator circuit with controllable regeneration, then the critical setting of the regeneration, at which oscillation just starts up, gives a measure of the gain of the transistor.

Unhappily, there are plenty of snags. Some of the published circuits, though they purport to measure hfe in fact come more closely to measuring the *voltage* gain, and as this is nearly a linear function of the collector current, and is the same for all transistors operated at that current, it doesn't have much bearing on what one wants to measure. This is, of course, what the books call the "small-signal short-circuit current amplification factor", alias hfe, beta, h21e, and, once upon a time, 'alpha dash'.

CALIBRATION PROBLEMS

Assuming that the transistor is set up in the right way for measuring hfe the problem is how to calibrate the tester. In most published designs there is no easy way of doing this. In fact, in one article I remember, constructors were advised to calibrate their instruments by inserting transistors of known hfe. In other words, to calibrate that tester you already had to have one, or at least access to one, or to a source of transistors whose hfe was accurately known. Not, one would think, much help to the average home-constructor.

The instrument described here has been designed to overcome this problem of calibration. Of course, you must have access to some sort of standard in order to calibrate anything at all. Here, you must be able to measure resistance. If you can calibrate an ordinary volume control with the aid of an ohmmeter or, better, a bridge, then you can calibrate this transistor tester and achieve quite good accuracy in your measurements of hfe.

The instrument tests at VCE = 6V and IC = 1mA, which are quite usual conditions for small transistors and capable of giving a rough indication of the gain of power transistors. The frequency at which hfe is measured is roughly 1kHz which, again, is quite normal. The instrument has one range from hfe = 11 to an upper limit which is under the control of the user but can usefully be chosen to be 1,000 which covers practically every transistor of interest.

The basic circuit is shown in Fig. 1, where TR1 is the transistor under test. The transistor is given a small load resistance, RC, and any output is fed back via a unity-gain phase-inverting amplifier which drives the base via a high resistance RB. Only a.c. signals are fed back, because we are measuring hfe, the a.c. current amplification factor, not hFE, the d.c. counterpart.

The theory behind Fig. 1 is given in detail in the Appendix. For the time being it is sufficient to say that, if all else is perfect,

$$hfe = RB/RC.$$

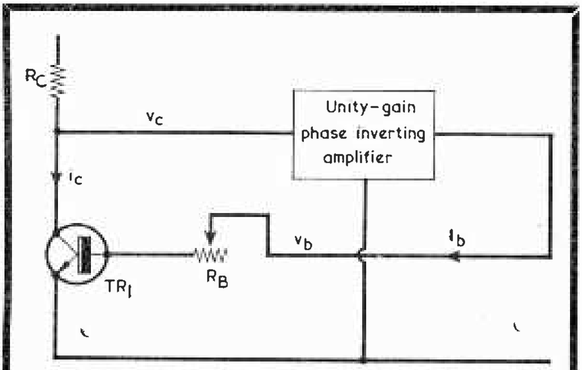


Fig. 1. Circuit for measurement of hfe. RB is set so that oscillation just begins. The current amplification factor, hfe, then depends on the ratio of RB to RC

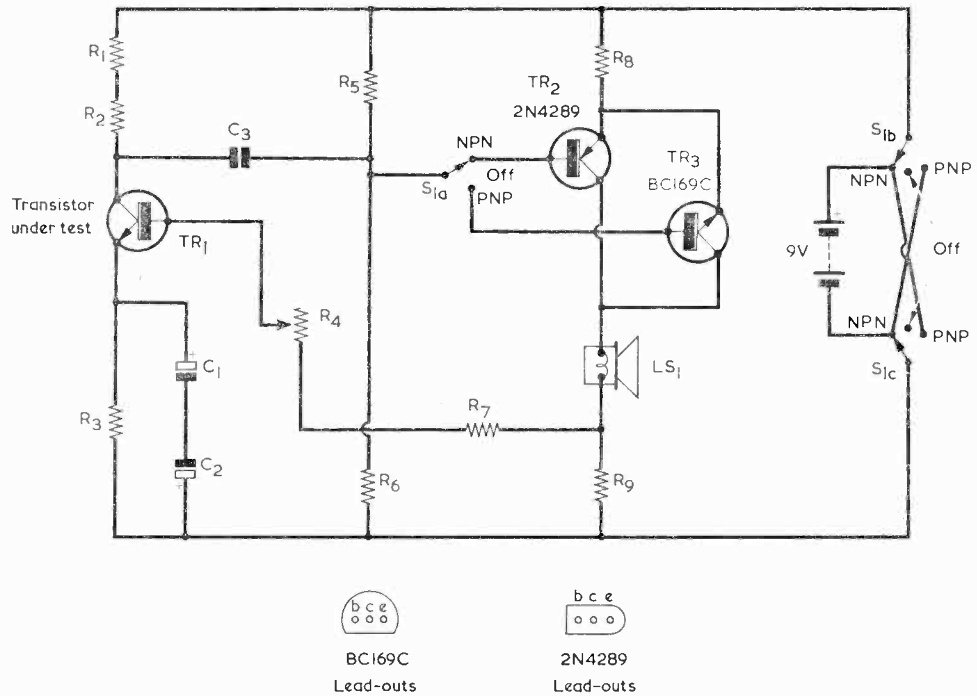


Fig. 2. Complete circuit of the practical hfe tester. TR1 is the transistor under test; TR2 is the unity-gain inverter. When polarity switch S1 is set to 'p.n.p.' TR3 takes over from TR2 as amplifier

COMPONENTS

Resistors
(All fixed values high stability, ¼ watt min., 5%, unless otherwise stated)

R1	56Ω
R2	1kΩ 2%
R3	1.5kΩ
R4	1MΩ potentiometer, log track
R5	100kΩ
R6	100kΩ
R7	10kΩ 2%
R8	1kΩ 2%
R9	1kΩ 2%

Capacitors

C1	125μF electrolytic, 10V wkg.
C2	125μF electrolytic, 10V wkg.
C3	0.1μF, paper or plastic foil

Transistors

TR1	Transistor under test (not part of tester)
TR2	2N4289
TR3	BC169C

Switch
S1(a) (b) (c) 3-pole 3-way, rotary

Speaker
LS1 moving-coil speaker, approx. 80Ω (see text)

Miscellaneous
Transistor sockets (see text)
9-volt battery and battery clips
2 pointer knobs

If RC is given a convenient value such as 1KΩ then RB is easily calibrated in hfe. To measure hfe you just set the circuit to the point of oscillation and read off hfe from the scale of RB.

COMPLETE CIRCUIT

The complete circuit is given in Fig. 2. Here TR1 is the test transistor as before. Since it is n.p.n. the polarity/on/off switch S1 is set to the 'n.p.n.' position. This brings TR2 into circuit as the unity-gain phase inverter. The regeneration control R4 corresponds to RB in Fig. 1, and RC of Fig. 1 appears here as R2, plus a bit added in the shape of R1, for reasons given in the Appendix. The circuit behaves as a relaxation oscillator or complementary multivibrator. The frequency is governed by the time constant of C3 and the associated circuit resistance. Transistors TR2 and TR3 are available, by post only, from Amatronix Ltd., 396 Selsdon Road, S. Croydon, Surrey, CR2 ODE. Amatronix Ltd. can also supply, again by post only, a kit of the components required.

In calibrating the instrument, allowance has to be made for R7 and R9, which are effectively in series with R4. The result is simply:

$$hfe = R4 + 11$$

where R4 is measured in *kilohms*. Thus a 500kΩ potentiometer would give a range of 11 to 511 in hfe. To give a reasonable scale shape, use a log. law component for R4; i.e. an ordinary carbon track volume control. This will give a scale rather like that on the ohms range of a multimeter. (A linear potentiometer would be much too cramped at the low end.)

Log. law volume controls are subject to large tolerances, usually $33\frac{1}{3}\%$, so to be sure of reaching hfe = 1,000 one would need a 1.3MΩ control. However, the precise upper limit is not very important and a standard 1MΩ log. volume control is good enough. Avoid miniature controls: the resistance variation of volume controls is never the smooth logarithmic curve which it should be, and in general the smaller the component the more violent the departures from what is desirable.

So far we have tested only an n.p.n. TR1. To test a p.n.p. type, S1 is turned to the 'p.n.p.' position. This substitutes TR3 for TR2 and changes the polarity of the supply. The polarity of the emitter bypass capacitor for TR1 should also in theory be changed. In practice it is easier to make it reversible, either by connecting two normal electrolytic capacitors back-to-back as shown (C1 and C2) or by using a genuine reversible or non-polarized 50μF, capacitor if you can find one!

Oscillation is made audible by the 80Ω loudspeaker. The precise impedance is not at all important, but the volume given by low impedance speakers may be inadequate. A miniature 75Ω Elac speaker of good efficiency was in fact used in the prototype tester, but impedances down to about 15Ω are probably usable, given high efficiency. It is also possible to use a telephone earpiece or headphones. These must be magnetic, not crystal, and to avoid throwing too much of a load into the collector of the phase-inverting amplifier it is advisable to connect a 330Ω resistor in parallel. This should be done even if the d.c. resistance of the phones is low, because some types have quite a high inductance. Surplus types CHR and CLR are both usable in this way.

ADJUSTMENT

There are no special constructional or operational points, except that R4 should be set carefully to the point at which oscillation just starts if accuracy is sought. To avoid subjecting the more delicate types of transistor to excessive oscillation amplitudes start off with R4 at maximum and work downwards cautiously. (The transistor under test is, however, protected against really huge base currents by R7, which is there for that purpose. Constructors who want to extend the lower limit of hfe may reduce R7 at the risk of applying larger base currents if the tester is not used carefully. I suggest a minimum of 3.3kΩ, which when R9 is added fixes hfe at a minimum of 4.3, which should be low enough for anybody.)

One thing which is much to be recommended is to equip the tester with a number of test sockets, wired to suit commonly used lead-out arrangements. Too many transistor testers have only one test position, often in the form of three wander-plug sockets too far apart to accommodate modern miniature short-lead transistors and with holes too wide to get a grip on thin transistor leads, long or short. A good arrangement is to bring out emitter, base, and collector to a 3-way screw terminal block, to which long test leads may be attached for in-situ work, plus a reasonable selection of test sockets. The Eagle TS10 4-way plastic sockets are a good bet; they are made for push-through panel mounting and will accept nearly all the usual small transistors. A problem sometimes encountered with transistor testers is h.f. oscillation, caused by stray couplings in the wiring. It can often be stopped by wiring low-value resistors, not more than 100Ω, close up to the base or collector tags on each of the test sockets.

It may have occurred to readers that a 1:1 transformer might be used in place of a phase-inverting amplifier. This is indeed the arrangement used in many testers of this type. I considered the idea but rejected it on the grounds that there seemed to be no simple way of allowing accurately for certain errors, notably the losses in the transformer itself. Of course, if you have access to a good selection of transistors whose hfe is known to within a few per cent. . . But this is where we came in!

APPENDIX

DETAILED ANALYSIS OF CIRCUIT

Referring to Fig. 1, assume that the amplifier has infinite input impedance. Then the load in the collector circuit of TR1 is just RC, and the a.c. collector voltage is:

$$vc = hfe.\ ib.\ RC \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

If the amplifier has zero output impedance, and TR1 zero input impedance, then ib = vb/RB. Since, for unity gain, vb is equal to vc, apart from the phase inversion, it follows that:

$$ib = vc/RB \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Substituting this value for ib in (1) and doing a bit of algebra gives:

$$hfe = RB/RC \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

In practice, of course, the idealistic assumptions we have made are not justifiable, so we must now make allowances for the imperfections of the real circuit. First, the input impedance of the amplifier is not infinite. It is made up of two known quantities, R5 and R6, each of which shunt the load of TR1, and the input impedance of the amplifier transistor itself, i.e., TR2 or TR3. This is made high by emitter feedback and is approximately hfe.R8, where hfe refers to TR2 or TR3. To make it so high as to be negligible, the amplifier transistor must have a high hfe. Of the types shown, the 2N4289 has the lower hfe, an average value being 250. Thus a further 250kΩ is placed across the circuit. This is comfortably high in comparison with the equivalent of R5 and R6 in parallel (50kΩ), and we can say with reasonable confidence that the net effect of all these components is to reduce the effective value of collector load of TR1 by a little over 2%. We shall allow for this later.

Another false assumption was that the input resistance of TR1 is zero. It could be as high as 25kΩ for a transistor with hfe = 1,000. The input resistance is in fact made up of two elements. One is the so-called 'extrinsic base resistance', a fixed resistance which appears in the base lead of the transistor and hardly changes with working conditions. If it is known for a particular transistor it can be added to RV4, otherwise we ignore it and tolerate the error. (With transistors with high cut-off frequencies it is low anyway.) The second part, the 'intrinsic base resistance' is calculable and for IC = 1mA it is 25.hfe ohms. Thus if hfe = 100, this internal resistance is 2.5kΩ. Now, the total base resistance at the point of oscillation is 100kΩ for hfe = 100, so the error due to the internal resistance is some 2.5% and the meter reads low. Fortunately, RV4 is set high when the internal resistance is high, and vice versa, and this error of 2.5% applies for all transistors. It can therefore be allowed for.

The method of allowing for all the calculable errors is to increase the collector load of TR1 from its nominal 1kΩ by adding R1. The percentage errors noted so far add up to 4.5%, which implies that R1 should be 45Ω. In practice, it needs to be a little more, because we have ignored factors such as the actual gain of the inverting amplifier, which must be slightly less than 1 if R8 is exactly equal to R9. My estimate suggests that 56Ω is the nearest standard value for R1 for correct compensation.

The only remaining built-in source of error is the output impedance of the amplifier. This is so high in relation to R9 that we can ignore it: R9 itself is allowed for in calibrating RV4, along with R7.

We have now reduced errors to the point at which resistor tolerances become dominant. Here R2, R8, and R9 can all cause errors of 2% if this is their tolerance. Add to this another 2% for errors in calibrating RV4 and a final 2% for errors not properly compensated by R1 and the grand total, if all go in the wrong direction, is 10%. If there is a law of averages and it works here, a more likely figure is 5%. This is small enough to ensure that the biggest error is likely to be the human one of not reading the scale of RV4 accurately enough. ■

THE 'STEREOSIM'

The two 10MΩ potentiometers listed as VR4A and VR4B in "The 'Stereosim'" (described in the July 1971 issue) are no longer available from the source quoted in the article. If readers have difficulty in obtaining this value in panel-mounting potentiometers elsewhere, a suitable alternative is the 10MΩ carbon skeleton pre-set vertical mounting potentiometer type PR, which is available from Electrovalue, 28 St. Judes Road, Englefield Green, Egham, Surrey. The Electrovalue potentiometers may be mounted on small tagstrips fitted close to TR3A and TR3B respectively.

THE RADIO AMATEUR OPERATOR'S HANDBOOK

The new edition, the twelfth, of this popular data book will be published early in October.

Comprising 80 pages, the cover price is 45p, by post 50p.

It would assist our administration if orders, where possible, are not sent in before 1st October.

NOW HEAR THESE

Times = GMT *Frequencies = kHz*

● **EQUATORIAL GUINEA**

Santa Isabel, Fernando Po, operates on **6250** (48.00m) 10kW with the Home Service from 0500 to 2300. Announcements are mostly in Spanish and the music of Spain is largely featured in their programmes. The address is – La Voz Guinea Ecuatorial, Apt. 195, Santa Isabel.

The other transmitter in this country is that of EAJ206, Bata, Rio Muni on **4926** (60.90 metres) 5kW. This station, like that of S. Isabel, can often be heard from around 1900 onwards. The address is – Radio Bata, Apt. 57, Bata, Rio Muni.

Readers locating **6250** on the receiver dial (listen for the nearby transmitter emitting the letter U in Morse continuously – two dots and one dash) should make a note of the dial reading. On the same frequency, from 0200 or so onwards, listen for OAX7A Radio Cuzco in Peru, usually heard best at this time of the year from 0200 through to 0330. OAX7A closes at 0500, the address is – Ca.Shapi 601, Cuzco.

● **DAHOMEY**

Cotonou can be heard on **4870** (61.60m) 30kW from around 1900 onwards. The programme language is mainly French, the station often featuring guitar music. Listen for the identification "Ici Cotonou . . ." usually made every half hour. The address is – Radiodiffusion Du Dahomey, B.P. 366, Cotonou.

● **TANZANIA**

Dar-es-Salaam with the Home Service in Swahili can be heard on **5050** (59.41m) 20kW from around 1900 onwards. African drums and rythmic chants/songs are a feature of this station. Listen for the Swahili announcement "Hii ni Radio Tanzania, Dar-es-Salaam."

The address is – Radio Tanzania, P.O. Box 9191, Dar-es-Salaam.

● **KENYA**

Another African station broadcasting in Swahili is Kisumu on **4804** (62.44m) 5kW. Listen for "Hii ni Sauti Ya Kenya" identification. The address is – Voice of Kenya, Box 30456, Nairobi.

● **SAO TOME**

Just above Kisumu on **4804** is Sao Tome on **4807** (62.41m) 1kW. A feature of this station is Portuguese music and songs. The schedule is from 0530 to 2300 and the address is – Emissora Nacional de Radiodifusao, Caixa Postal 44, Sao Tome. Often best heard in the U.K. from around 1930 onwards.

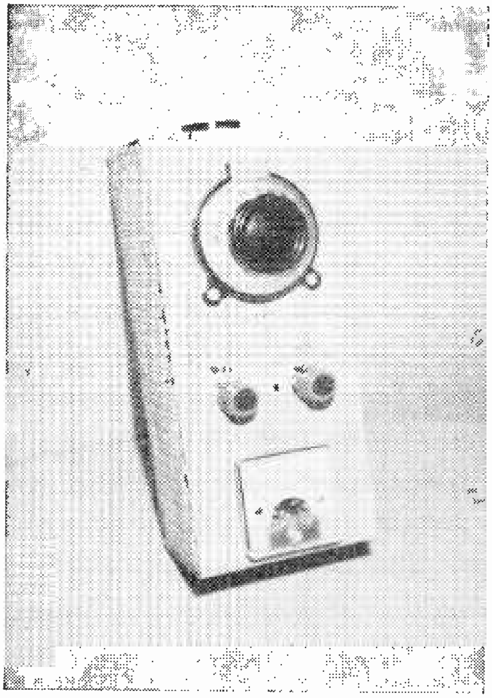
● **LATIN AMERICA**

For some relatively 'easy to log' Latin American stations, listen from around 0415 onwards on **4920** (60.98m) 1kW for YVKR Radio Carcas, Venezuela; on **4955** (60.54m) for HJCQ Radio Nacional, 50kW, Bogota, Colombia, on **4965** (60.42m for HJAF Radio Santa Fe, Bogota; and on **4945** (60.67m) for HJDH Radio Colosal, Neiva.

● **CONGO**

Bukuvu, on **4839** (62.00m) 10kW, may often be logged from around 1930 till 2000 sign-off (2100 on Saturdays and Sundays). Programme languages are French and vernaculars, listen for "Ici Bukuvu" at the beginning of each identification. The address is – B.P. 475, Bukuvu.

Acknowledgements:– Our Listening Post. ■



Front view of the gate-dip oscillator

SEMICON
GATE-DIP (

I

A. S. CARPE

Bringing the grid-dip oscillator up to
field-effect transistor. The unit descri
4 to 1

THE UNIQUE DIP-OSCILLATOR TO BE DESCRIBED CAN be constructed in two or three evenings at quite low cost. As the illustrations show, the finalised item is attractive in appearance; it is also easy to copy.

In amateur radio applications a dip-oscillator is considered an invaluable aid and is generally found more useful than a conventional signal generator. With the aid of a dip-oscillator, the tuned circuits of radio equipment under construction or test can be resonated fairly accurately without the apparatus under examination even having to be switched on! In a v.h.f. transmitter design under construction there may, for example, be some six tuned circuits to adjust prior to switch-on, and by employing a dip-oscillator the constructor can be reasonably certain of correct circuit functioning when power is eventually applied.

A dip-oscillator may also – if certain switching is included – be used alternatively as a wavemeter or 'absorption' device to check the resonant frequency of external circuits that are themselves producing oscillations.

Designs for dip-oscillators appear from time to time and valve type grid-dippers are certainly not unheard-of items. Both valve and solid-state types are in use at G3TYJ and although the valve model is generally preferred for its better frequency stability and overall sensitivity, for portability and general usage the solid-state specimen – which requires no external power supply – has much to recommend it.

Complete constructional information regarding the semiconductor type dipper will be given here but readers should appreciate the fact that it is after all but a one-off specimen and that the design is consequently dependent upon component spreads and tolerances.

SIMPLE CIRCUIT

The simplest type of solid-state dipper – and one which will work surprisingly well – is shown in

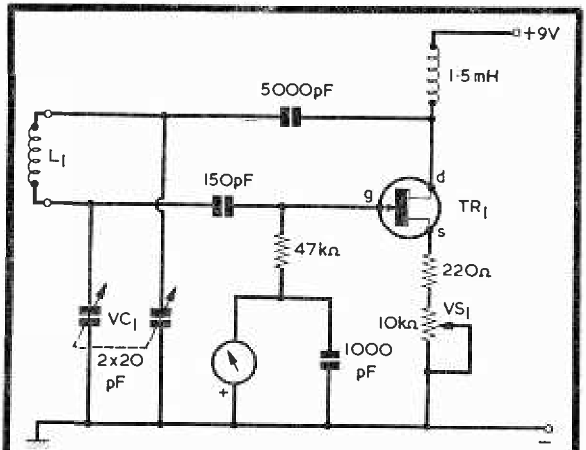


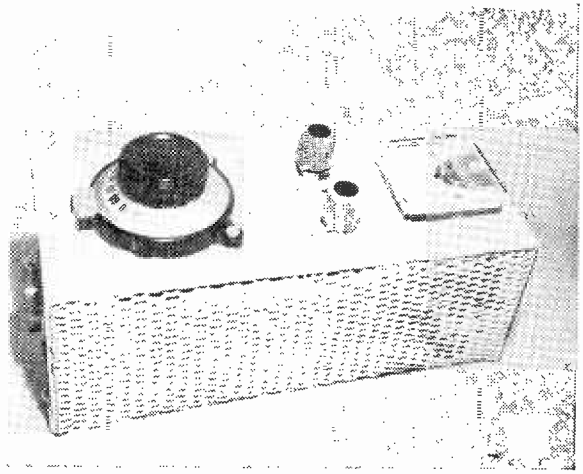
Fig. 1. A simple single-transistor gate-dip oscillator circuit

DUCTOR
SCILLATOR

Cover Feature

'ER, G3TYJ

e with the aid of a modern low-cost
l here is capable of operation from
ΛHz



A view from the side showing the expanded metal grille used in the prototype

Fig. 1 where TR1, an f.e.t., is made to oscillate at radio frequency due to regenerative feedback introduced from the drain (d) to the gate (g) circuit. The frequency range over which the circuit functions is dependent mainly on VC1 and L1, and if a plug-in coil system is used for the latter a wide range can be provided.

The transistor, which may be a type 2N3819, is sensitive to changes in its working conditions and the maximum degree of sensitivity is required for dipper use; since this does not normally coincide with maximum transistor current it is both convenient and practical to introduce a sensitivity control (VS1) into the Source (s) circuit. In the test model TR1 performed most effectively when its measured current drain was 3mA.

When TR1 is oscillating freely a potential that is negative with respect to chassis appears at the upper end of the 47kΩ resistor, the resulting current being indicated by the meter. If another coil and capacitor combination is brought close to L1 no change of current will be indicated by the meter unless both circuits are tuned to the same frequency, whereupon the meter pointer will kick downwards smartly as the external circuit absorbs power. If VC1 is provided with a scale calibrated in terms of frequency the usefulness of the device becomes immediately apparent.

The simple circuitry described is attractive except that it requires the use of a very sensitive meter – say 50μA f.s.d. – and this is not an inexpensive item.

ALTERNATIVE CIRCUITRY

By employing the circuitry depicted in Fig. 2 a cheaper and much more rugged meter movement can be used. A meter with a full-scale deflection of 1mA is employed in the test model but a 2mA type could also be used.

With switch S1 at position '3' and a battery connected, oscillations developed by TR1 appear across a small choke (RFC2) connected in the source circuit and are then fed to a shunt rectifier, D1, which supplies the base of TR2 with positive-going signals. Transistor TR2 amplifies these sufficiently to deflect the meter M1. Under certain circumstances the meter can be over-driven, therefore VP1 is incorporated as a protection device. The sensitivity of the oscillator stage is, as in the earlier circuit, controllable by VS1 in the source circuit. Again, if at any time an external tuned circuit absorbs power from L1, the signal amplitude passed to D1 will be reduced, which in turn will be indicated by M1 as TR2 collector current falls. As an economy measure choke RFC2 could possibly be dispensed with, whereupon the left-hand end of capacitor C3 could be connected to TR1 drain. When this was checked, however, it was noted that there was less isolation between the tuned circuit and the diode, and this could be undesirable.

If switch S1 is set to position '1' the instrument is switched off whilst at position '2' TR2 alone receives power. In this position the unit functions as a wave-

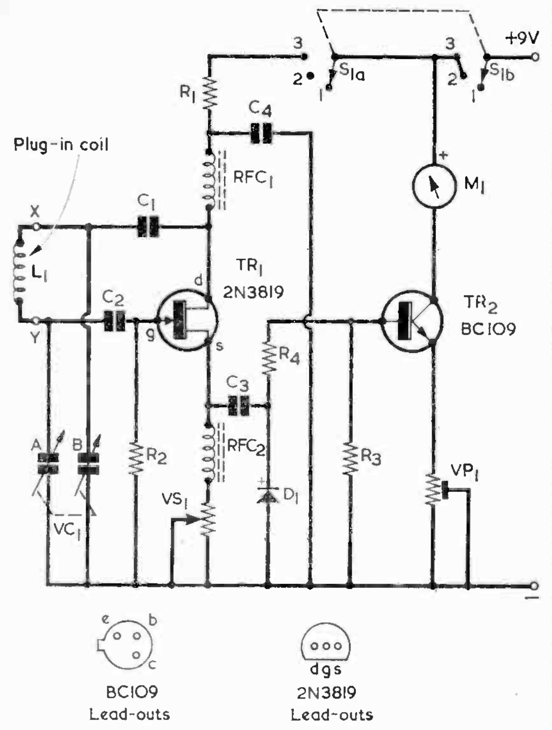


Fig. 2. The circuit of the gate-dip oscillator whose construction is described in this article

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)
R1 220Ω
R2 47kΩ
R3 220kΩ
R4 4.7kΩ
VP1 10Ω pre-set pot., miniature skeleton
VS1 10kΩ pot., linear (see text)

Capacitors
C1 5,000pF, ceramic
C2 150pF, ceramic
C3 22pF, silver-mica
C4 5,000pF, ceramic
VC1 20 + 20pF, 2-gang variable (see text)

Inductors
L1 Plug-in coils (see text)
RFC1 1.5mH r.f. choke, ferrite cored (Henry's Radio)
RFC2 1.5mH r.f. choke, ferrite cored (Henry's Radio)

Semiconductors
TR1 2N3819
TR2 BC109
D1 OA81

Meter
M1 0–1mA moving-coil, type MR2P (Eagle) or MR38P (Sew)

Switch
S1 4-pole 3-way (or 2-pole 3-way) miniature rotary

Battery
9-volt battery type PP3 (Ever Ready)

Miscellaneous
Veroboard, 0.2in. matrix, Part No. 3/1003 (Alpha Radio Supply Co., 103 Leeds Terrace, Wintoun Street, Leeds.)
Vernier dial drive type T.502 (Eagle)
2 miniature control knobs
Octal valveholder, low-loss type
Materials for plug-in coils (see text)
Materials for case
Wire, nuts, bolts, etc.

meter to indicate when an external oscillating circuit is tuned to the same frequency as L1 and VC1; when the two frequencies do not agree the pointer of meter M1 remains at its zero stop. To avoid damage to TR1, signals at very high level should not be applied to the unit when operating in this mode.

In either connection the device functions up to around 145MHz the author's model using nine coils to provide coverage from 3.8MHz to this frequency. Dip indications are normally observable at distances of several inches from the circuit under test.

CONSTRUCTION

A simple 'skeleton' case made of 18 s.w.g. aluminium accommodates the complete unit, Fig. 3 showing the scheme adopted. Considerable thought has been given to the layout and it is unlikely that it can be improved upon to any useful extent. This layout requires that VS1 be a small component. It should have a body diameter of ⅞in. or less, and components meeting this requirement are readily available.

The transistors and associated small items are assembled on a piece of Veroboard of 0.2in. matrix (available from the supplier listed in the Components List), the larger items being affixed direct to the casing.

Since some constructors may experience difficulty in making up a small scale marked in terms of frequency a vernier reduction drive, scaled 0 to 100, is fitted instead. Later, graphs relating frequency to scale reading for each coil can be made up and any errors subsequently corrected without spoiling a complete scale.

Note that in the layout of Fig. 3 VC1 is shown very close to the coil sockets to which it connects; this is desirable and many inexperienced constructors of dip oscillators make the grave error of placing these two components too far from each other. This does not greatly affect the low frequency ranges, but it completely prevents effective operation at v.h.f.

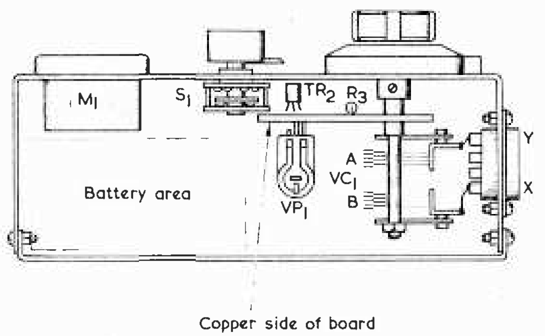


Fig. 3. Layout of major components inside the case

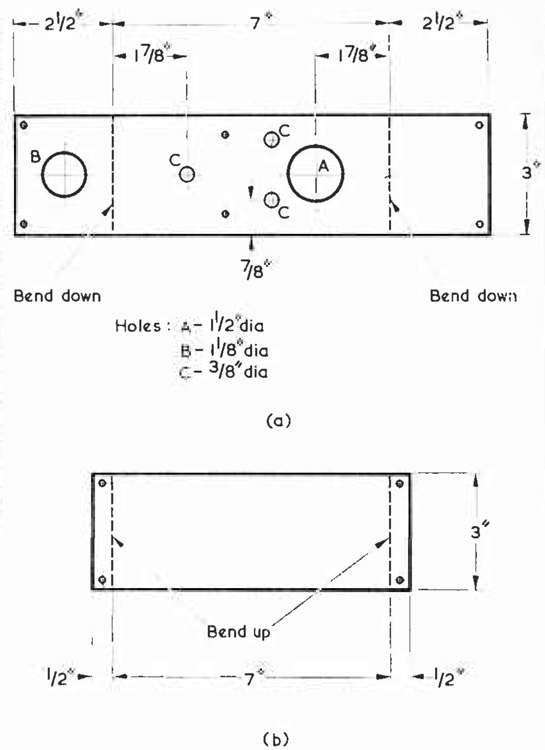


Fig. 5(a) Dimensions and drilling details of the main section of the case. Unmarked holes are 6BA clear
(b) Dimensions of the case back

Eventually, when the unit is complete the sides of the skeleton case may be filled in with expanded metal speaker grille, as can be seen in the photographs. Alternatively, sheet aluminium sides with flanges can be fitted, these being secured with self-tapping screws passing through the case into the flanges. Control VP1 can be adjusted quite easily through a ¼in. diameter hole in one side.

VEROBOARD ASSEMBLY

A piece of 0.2in. matrix Veroboard carrying a total of eleven conductor strips each with thirteen holes is used as shown in Fig. 4. Note in Fig. 4(b) the complete cross-strip severance between holes 6 and 7, this being made with the aid of a fine file or hacksaw blades. The tuning capacitor is mounted on the conductor side (on the section including holes 1 to 6) as convenient, its spindle passing through the large hole cut out for it. The moving vanes or mounting are later connected to the negative supply rail at strip H. No tuning capacitor is shown in Fig. 4 since a 20 + 20pF twin-gang component already to hand was used in the author's model and the cut-out shown for the shaft may need to be changed slightly in size or position. Any two-gang capacitor of up to 50pF per section can be utilised provided it is small in physical size. In cases of difficulty a Jackson Bros. split-stator 25 + 25pF capacitor type C.808 could be used. (When using an alternative capacitor, first cut the spindle if necessary so that, when it is fitted to the tuning drive, the Veroboard will be spaced away from the front panel by a distance slightly greater than the depth of the body of S1. Before making up the case and to avoid wasted work check also that the capacitor, when finally mounted can be accommodated within its 2½in. depth – see Fig. 5(a). If necessary, slightly increase the 2½in. dimension. – Editor.)

Except for the tuning capacitor only two other items are mounted on the copper strip side, these being VP1 and RFC2. On the plain side of the board D1 and R1 should be mounted vertically, other items being laid flat in the positions indicated. Semiconductors should be mounted last, and their leads should be held with pliers to act as a heat shunt during soldering. All leads should be bent over slightly on the conductor side prior to soldering, as spot-type joints can give trouble later.

After the Veroboard assembly is completed the main case section can be prepared on the lines indicated in Fig. 5(a), which gives essential dimensions. Hole B will take a low-loss international octal valveholder whilst the meter will be located at hole A. The hole for the tuning capacitor shaft may require slight repositioning depending on the particular item used. The simple section of Fig. 5(b) is the back member which is required later.

When the Veroboard assembly is placed in position it will be held firm at three points, these being provided by the mechanical coupling to VC1, by the connections to the coil socket and by a stiff lead from VS1 to 'earthy' strip H. The coil connections are at tags 1 and 5 of the valveholder. The final connections to the meter, switch and VS1 are clearly seen in Fig. 6; refer also to Fig. 3.

The recommended battery is the Ever Ready type PP3. There is ample space available for this in the battery area indicated in Fig. 3. It may be secured in position by a simple clamp fitted to the back member or by any other suitable means.

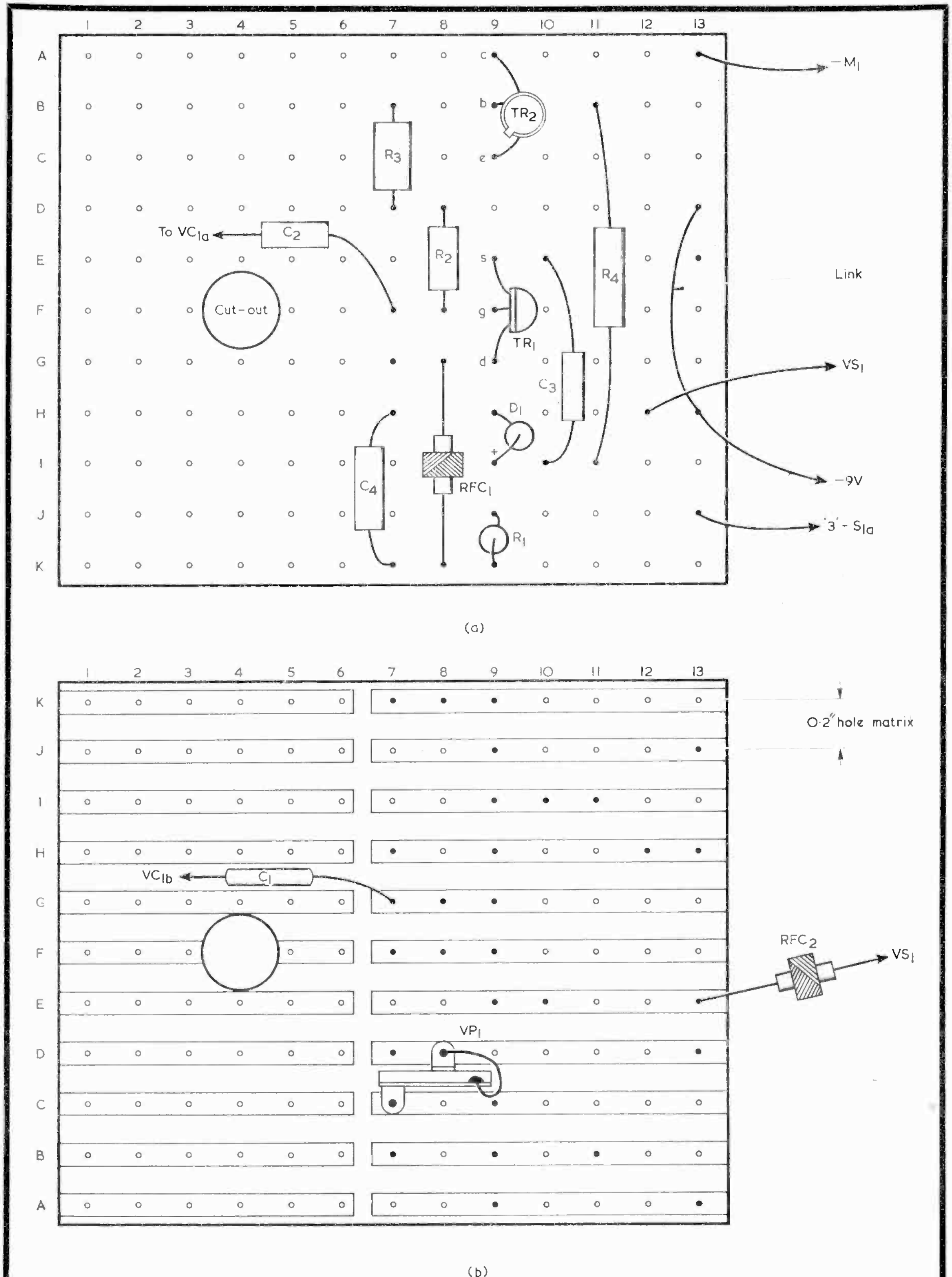


Fig. 4(a) Connections on the component side of the Veroboard
(b) Several components appear also on the copper side

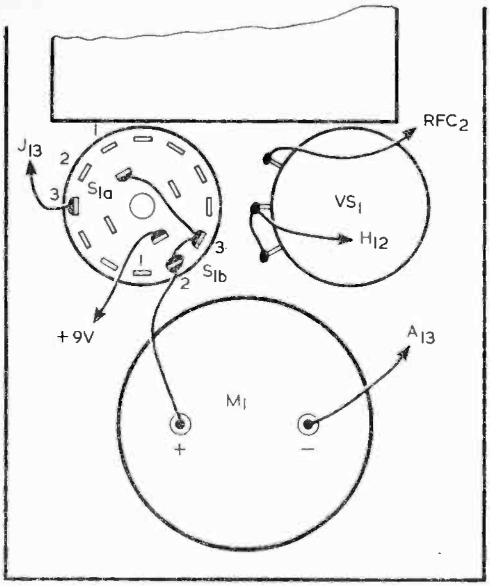


Fig. 6. Connections to the meter, switch and sensitivity control

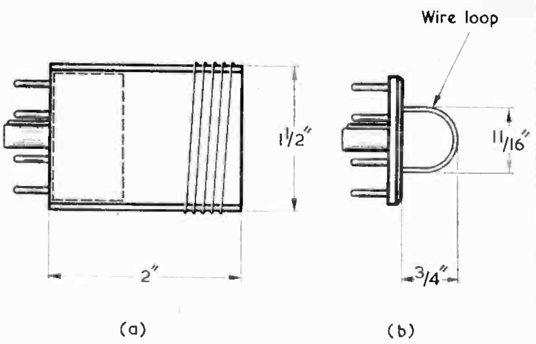


Fig. 7(a). Details of the plug-in coils
(b). The highest frequency coil consists of a loop only

COILS

Long narrow coils are quite unsuitable, and the prototype coils were wound on 2in. long plastic formers of $1\frac{1}{2}$in. outside diameter, as shown in Fig. 7(a). Plastic tubing was used for these, being force-fitted onto the bases of unwanted glass octal valves of the 6k7G or 6k7GT type. It is possible, alternatively, to obtain octal plugs to which the formers can be fitted, but these may prove to be more expensive. Hard Paxolin-type tubing with an outside diameter of $1\frac{1}{2}$in. is available from Home Radio in 6in. lengths under Cat. No. ZA25. This has an internal diameter of approximately $1\frac{3}{8}$in. and could be fitted to the valve bases if the latter were packed up slightly with tape.

To obtain the bases place the valve to be wrecked in a strong paper bag and, holding the base firmly in one hand, tap the glass bulb smartly through the bag with a hammer. Keep the face and eyes averted whilst doing this, as there is a very slight risk of flying glass escaping from the bag. Subsequently remove all debris, bearing in mind that the broken glass will have sharp edges, then fit the former to the base. Coils are wound nearer the free end of the former, as in Fig. 7(a). The coil wire terminates in pins 1 and 5, and each wire end may either travel down the outside of the former for soldering to the pin at the point where it protrudes from the base plastic, or it may be taken through a hole in the former and then passed through the pin to be soldered at its tip. With the first method, it may be necessary to file a little of the plating away from the valve pin to enable a good solder joint to be achieved.

The accompanying Table gives coil details as encountered with the prototype and its 20 + 20pF tuning capacitor. These are intended to serve as a guide since there will be variations due to different constructions and tuning capacitors. It will be seen that the Table lists eight coils wound in the manner just discussed, whilst the ninth consists of a loop of wire only. This ninth coil employs the base of an unwanted 'metal' octal valve, which has a flat instead of a tubular shape, and it is shown in Fig. 7(b).

TABLE

Coil Winding Details

(All wires are enamelled copper.)

Coil No.	*Turns*	*Spacing*	*S.W.G.*	*Coverage (MHz)*
1	40	Close	24	3.8 – 6.0
2	25	Close	24	6.0 – 9.5
3	13	Wire Dia.	24	9.5 – 16.0
4	8	Wire Dia.	24	15.5 – 20.0
5	5	Wire Dia.	24	20.0 – 33.0
6	$3\frac{1}{2}$	Wire Dia.	24	31.0 – 48.0
7	$2\frac{1}{2}$	Wire Dia.	20	47.0 – 65.0
8	$1\frac{1}{4}$	Wire Dia.	20	60.0 – 90.0
9	Loop	——	18	100.0 – 145.0

Fewer coils will be required with tuning capacitors larger in value than 20 + 20pF, and constructors may prefer to take advantage of this fact. When making up the coils it is desirable to obtain a degree of frequency overlap from one range to the next, and it is wise to remember that it is easier to take off a turn than to add one. Start with the lowest frequency coil desired and work upwards in logical fashion. Frequency coverage can be checked with a receiver.

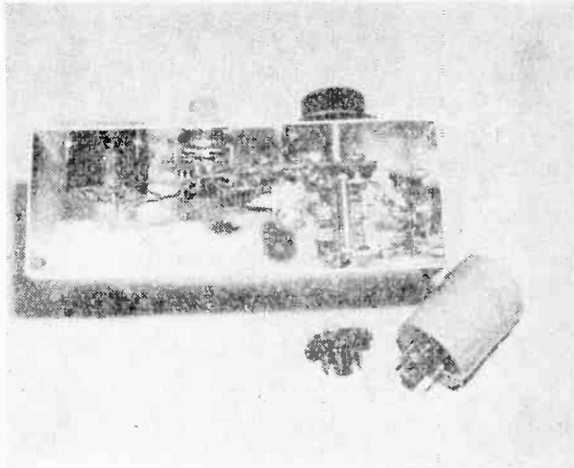
TESTS AND CALIBRATION

Initially, circuit functioning must be tested. Plug in the lowest frequency coil (which for test purposes may be similar to coil No. 1 in the Table) and set VS1 and VP1 to about half-travel, then switch on the dip-oscillator. Subsequently VP1 should be set to afford almost full-scale deflection in the meter when VS1 is adjusted for maximum sensitivity. If the coil windings are gripped between forefinger and thumb the meter pointer should fall back smartly, and the best position for VS1 is soon found. If, during this test, meter current is seen to increase rather than fall, VS1 is incorrectly set.

Some slight readjustment of VS1 is usually necessary when going from range to range but VP1 does not normally require altering if initially set up on the lowest frequency range to be used.

Calibration of the test model was carried out using the station wavemeter, communications receiver and crystal marker.

Scale readings relative to frequency can be made on graph paper for each range. It may be noted that precise calibration is hardly possible with simple apparatus of this type nor is it entirely essential since one merely requires to know approximately the operating frequency of the external circuit. In Fig. 8, for example, circuitry relating to the frequency multiplier stages of a v.h.f. transmitter is shown. Here the crystal fundamental frequency may well be 8MHz from which it is hoped to eventually extract – via coil L2 – the higher harmonic frequency of 72MHz, coil L1 being pre-tuned to 24MHz. Due to its core range or to incorrect winding L1 may actually be tunable to several harmonics of the 8MHz crystal – say 16, 24 or 32MHz. If the wrong one is taken – say that at 16MHz – V2 may well triple this to 48MHz, which is not wanted. By using the dip-oscillator beforehand, however, tuned to 24MHz *or thereabouts*, L1 core can be pre-set to show a 'dip' and L2 can similarly be pre-set to 72MHz *or thereabouts* without the circuit even being switched on. When it *is* switched on later it will already be known that both L1 and L2 are quite close to their correct frequency settings and the circuit may then be peaked for maximum output in the usual way. Later



One of the coils and the high frequency loop appear here

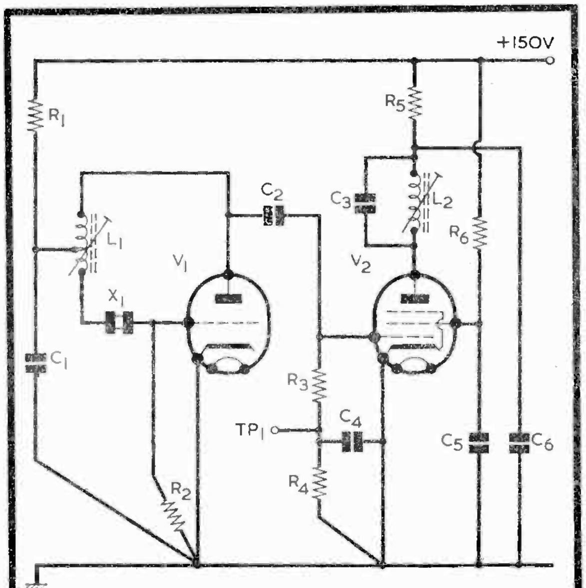
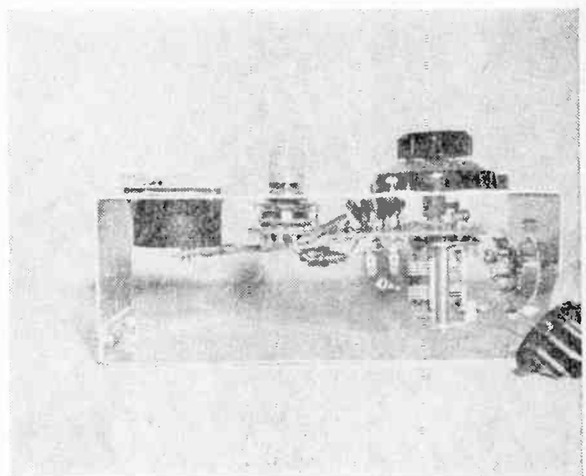


Fig. 8. Using the gate-dip oscillator described here, the coils in this circuit can be resonated without even switching it on!



Looking directly into the side of the dip oscillator still the 'dipper' may be set to act in its alternative role as a wavemeter and, if brought close to either L1 or L2 with the appropriate coil plugged in, will show an indication when the crystal oscillator stages are operating. Since the harmonic frequencies are crystal controlled the wavemeter calibration scale graphs can be back-checked – and so on.

To finalize the unit apply a coat of lacquer and add neat legends using wording from Data Publications Transfer sets. ■

Latin American Quest

(6) ARGENTINA CHILE PARAGUAY URAGUAY

IN THE PREVIOUS ARTICLE IN THIS SERIES, PUBLISHED last month, the countries of Latin America briefly reviewed were Bolivia, Brazil, Ecuador, F.Guiana and Peru. This month we deal with the remainder of the countries on the S.American continent, beginning with Argentina.

ARGENTINA – AN OUTLINE

With an area of 1,072,745 square miles and an estimated population of 21,000,000, this country is the second largest S.American nation, extending from the sub-tropics some 2,300 miles to Tierra Del Fuego. Argentina lies between the Andes and the Atlantic Ocean and has its capital at Buenos Aires.

Bordered by Chile in the West, Bolivia in the North, Paraguay, Brazil and Uruguay in the N.East and the Atlantic in the S.East, the country consists of four regions. In the West are the Andes and Andean slopes, the principal cities of which are Tucuman and Mendoza; in the North are the plains of Chaco; in the South is Patagonia and in the centre is the Pampa where most of the population and wealth are concentrated. Chief cities are Buenos Aires at the mouth of the Rio de la Plata, Rosario, La Plata, Santa Fe, Bahia Blanca, Mar Del Plata and Cordoba.

Argentina – Short Waves

Argentina is four hours behind GMT from April to October and three hours behind GMT from October to March, the language is Spanish.

Most short wave broadcast stations in the country are government controlled, either in the International Service or commercial.

Most of the Argentine stations operate on the higher frequency bands, there being both an International and a Commercial Service.

In terms of LA reception here in the U.K., the Argentine is not a difficult country to log. The powerful transmitters of the International Service present little problems for Dx'ers providing conditions are reasonable at the time. In Table IX are listed these transmitters.

The announcement to listen for, in English, is "This is the Argentine calling". The English schedule, at the time of writing, is from 2300 to 2400GMT on 11710kHz with a newscast at 2302GMT, in the service beamed to Europe.

The government owned commercial stations are listed in Table X. All of these stations are located in Buenos Aires and they are, in the main, more difficult to receive than those of the International service.

Argentina is the home of the *gaucho*, large cattle herds and the vast pampas, much of its music and songs deriving from this romantic vision. Like most of the LA countries, the programmes from Argentina are colourful and well worth hearing.

TABLE IX

kHz	*kW*	*Station*	*Schedule GMT*
6090	35	LRY1 Buenos Aires, 'Radio Belgrano'	1600 – 2200 0300 – 0800
9690	100	LRA32 Buenos Aires, 'Radio Nacional'	0000 – 0700 0900 – 1000
11710	100	LRA35 Buenos Aires, 'Radio Nacional'	1015 – 1115 1900 – 2345
11780	7.5	LRY2 Buenos Aires, 'Radio Belgrano'	1900 – 2200 0300 – 0700

TABLE X

kHz	kW	Station	Schedule GMT
5985	1	'Radio Splendid'	1200 – 0400
6090	35	'Radio Belgrano'	1800 – 1000
6120	10	'Radio El Mundo'	1600 – 2000
			0100 – 0500
9710	6	'Radio El Mundo'	0100 – 0400
9740	10	'Radio Splendid'	1200 – 0400
11775	7	'Radio El Mundo'	1800 – 0100
11780	8	'Radio Belgrano'	1800 – 1000
11880	20	'Radio Splendid'	1200 – 0400
15290	10	'Radio El Mundo'	1200 – 2000

CHILE – AN OUTLINE

Chile has an area of 286,396 square miles and a population of around 8,000,000. The country is situated on the South West coast of the continent. It is a long (about 2,600 miles) strip, never more than 250 miles wide between the Andean range and the Pacific Ocean. Chile also includes Easter Island and the Juan Fernandez Isles.

Chile itself has deserts in the North producing nitrates which are exported through the ports of Antofagasta and Arica. In the centre is a rich long valley which is the 'garden' of the country, wherein live the majority of the population (roughly 5% Indian, 30% European-descended and 65% Mestizo – Spanish/Indian). Located in this valley is the capital Santiago and other large cities including the port of Valparaiso and the nearby Vina Del Mar. Where the Andes approach the sea, a resort area of alpine-like lakes near Puerto Montt, is a natural playground. To the South of this area is the city of Punta Arenas. In the Southern tip of Chile is the frigid tundra of the Tierra Del Fuego, much featured in the Charles Darwin story.

The first of the Spanish conquerors was Almagro with an expedition from Peru in 1536, this being defeated both by the deserts and the Araucanian Indians. After 1540, Valdivia founded several Spanish cities although the resistance of the local population was not brought to an end until the late 19th century. Jose de San Martin, leading a force from Argentina through the high Uspallata Pass, gained a victory at Maipu in 1818 and made Chile an independent republic.

Chile – Short Waves

The country is four hours behind GMT and the programme language is mainly Spanish. On the short waves, Chile operates a station callsign system which is the frequency minus one cypher. Thus, CE619 operates on 6190kHz.

The country is not all that easy to log, most of the stations have powers of either 1 or 5kW although there are a few having a 10kW rating. However, such loggings are reported in the U.K. short wave listener press from time to time. The most favourable time for reception of Chilean stations is from 0300 to 0500GMT during the summer months. Table XI lists some of those stations likely to be heard here.

Other Chilean stations operate on the higher frequency bands, all with comparatively low powers. They are not listed here as we are concerned mainly with LA transmitters on the low frequency bands.

TABLE XI

kHz	kW	Station	Schedule GMT
5975	10	CE597 Santiago, 'R.Presidente Balmaceda'	1000 – 0500
6075	5	CE607 Santiago, 'Soc. Nac. de Mineria'	1100 – 0530
6120	5	CE612 Santiago, 'Soc Nac. de Agricultura'	1030 – 0700
6135	10	CE613 Concepcion, 'R.Universidad de Concepcion	1200 – 0400
6150	5	CE615 Santiago, 'La Voz de Chile' ...	1100 – 0400
6190	10	CE619 Santiago, 'Corp. Chilena de Broadcasting'	1100 – 0400

PARAGUAY – AN OUTLINE

Paraguay has an area of 157,047 square miles and a population of around 2,000,000. The country is situated in the South East of the continent being landlocked, surrounded by Argentina, Bolivia and Brazil.

The capital city is Ascuncion, other cities of note being Concepcion, Encarnacion and Villarica. The most populous part of Paraguay lies between the Paraguay and Parana rivers in the East.

To the West of the Paraguay river lies the region known as the Gran Chaco, largely uninhabited and unexploited. A war with Bolivia over the boundary of the Chaco (newspapers at the time referred to the Chaco as the 'Green Hell') from 1932 to 1935, left Paraguay victorious but exhausted.

The population of the country is largely a mixture of Spanish and Guarani strains with most Paraguayans being bilingual.

The capital city, Ascuncion, was founded in 1536 but it was not until the early 1700's that a strong central rule was established under Hernandarias. Under his rule, virtual independence from the Spanish administrators in Buenos Aires and Peru was achieved. In 1811 Paraguay overthew the Spanish officials and became completely independent.

Paraguay – Short Waves

Paraguay is four hours behind GMT and the programme languages are, as outlined above, Spanish and Guarani.

Broadcasting in Paraguay is carried out under a government administration, all stations except Radio Nacional being run on a commercial basis. All stations have the prefix ZP.

As a general rule, Paraguayan stations are not all that easy to log here in the U.K. With one exception, the short wave stations have relatively low powers – either 1 or 3kW – with programmes for internal consumption. It is not often that stations from this country are reported in the short wave press of the U.K.

The list of short wave Paraguayan stations is a short one and for that reason, all are listed on Table XII.

Probably the most notable feature of broadcasts from Paraguay is the distinctive music of the country, in which the harp largely features, the instrument being played with a gusto that is typically Latin American. The melodies are tuneful, folksy and rythmic to a high degree, many of the works being deeply rooted in the people themselves and in the flora and fauna which surround them.

TABLE XII

kHz	*kW*	*Station*	*Schedule GMT*
5273	100	ZPA1 Ascuncion, 'Radio Nacional' ...	1200 – 1800 2000 – 0300
5975	3	ZPA6 Villarica, 'Radio Guaira'	1200 – 1800 2100 – 0300
6015	1	ZPA10 Ascuncion, 'Radio Paraguay' ...	1500 – 1700 2000 – 2400
6025	3	ZPA1 Ascuncion, 'Radio Nacional' ...	1200 – 1800 2000 – 0300
6110	1	ZPA11 Ascuncion, 'Radio Charitas' ...	0930 – 0300
11850	3	ZPA3 Ascuncion, 'Radio Teleco' ...	1400 – 2300
11945	3	ZPA5 Encarnacion, 'Radio Encarnacion'	1500 – 1700 2000 – 0200
15210	3	ZPA7 Ascuncion, 'Radio Guarani' ...	1200 – 1600 1900 – 2400

URUGUAY – AN OUTLINE

Uruguay has an area of 72,152 square miles and a population of some 2,800,000. The country is situated in the South East of the continent with a capital city at Montivedeo on the South Atlantic coast.

The Rio de la Plata and the Uruguay rivers separate Uruguay from Argentina; Brazil lying to the North and the Atlantic Ocean to the East. The Banda Oriental is a rich alluvial plain on which most of the population reside, the area producing olives, wine, tobacco and wheat. To the North are the areas of grasslands, *gauchos* and the great *estancias* which have played a large part in the life of the country.

Both the Spanish and the Portuguese contended for the ownership of the country throughout the 17th and 18th century. The Spanish were ruling when the movement for independence began, Uruguay declaring for independence from Argentina in 1810. In 1814, Artigas broke with the military junta of Buenos Aires and the war for complete independence began.

In 1820 the Brazilians occupied Montevideo and in 1825, a group of patriots known as the Thirty-Three Immortals declared independence, Brazil being defeated at the battle of Ituzaingo in 1827. This was followed by a fratricidal struggle (1828 to 1851) between two political parties known as Colorados (reds) and Blancos (whites); this being mixed with a rising against Argentina resulting in the long siege of Montivideo. Not until this century has the country been free from revolutions and counter-revolutions.

Uruguay – Short Waves

Uruguay is three hours behind GMT and the programme language is Spanish. The country does not have an International Service as such and it is not all that easy to receive Uruguay mainly because of the low powers involved and the fact that most of the transmitters occupy channels used by more powerful stations. Uruguayan stations do not operate below 6000kHz and in Table XIII are listed the more powerful transmissions in the 6MHz band.

TABLE XIII

kHz	*kW*	*Station*	*Schedule GMT*
6010	15	CXA5 Montevideo, 'Radio Sarandi' ...	24 hours
6055	5	CXA53 Montevideo, 'La Voz de Melo'	24 hours
6125	10	CXA4 Montevideo, ...	1200 – 0300
6155	10	CXA13 Montevideo, 'Radio Carve' ...	1530 – 1900 2300 – 0200

CONCLUSION

In this six-part series, the author has set out to try and interest more listeners in the subject of Latin American Dx. Much more could, of course, be written about the South American continent and the wealth of stations operating within its confines. A general approach has been adopted in order to gain the widest possible audience and therefore a more specialised treatment has been avoided.

Only those countries of the South American continent have been dealt with, publication of this series coinciding with the LA 'season'.

It is hoped that readers interested in Broadcast band reception have found the series of some interest and have become actively engaged in the *Latin American Quest*. ■

NEW PRODUCT

ZINC-AIR BATTERY

An entirely new zinc-air primary dry battery which is stated to be capable of five to eight times the performance of an equivalent Leclanche cell has been developed by Crompton Parkinson Ltd., a Hawker Siddeley Electric company. The package is smaller and lighter than any conventional battery of similar capacity. Performance, as compared with other batteries, is illustrated by the accompanying graph.

The first battery in production, type 2AS, takes up the same space as two AA penlight batteries, is rated at a nominal 2.8 volts in use and has a capacity of at least 2.5 ampere-hours. It is now available to manufacturers and designers of equipment for evaluation and use.

Possible uses are in military transceivers, telecommunications, motorised toys such as model aeroplanes, and in portable tape recorders, cameras and camera lighting equipment.

The anode of the battery is contained in a tough plastic outer case and is prepared from amalgamated zinc powder. It incorporates the negative terminal of the cell and is in contact with the electrolyte, which is a concentrated solution of potassium hydroxide.

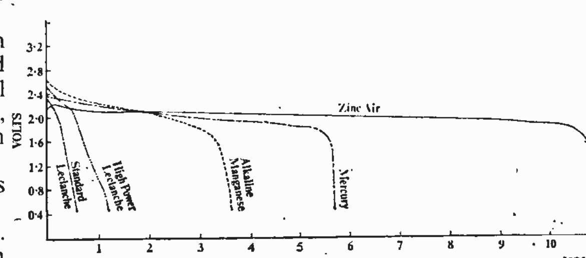
The air cathode structure consists of several layers held in an external plastic frame:

1. The outer layer, made of micro-porous p.t.f.e. film, which is hydrophobic, i.e. it allows oxygen from the atmosphere to diffuse through it into the cell while at the same time containing the liquid electrolyte so that the battery can be used in any position.
2. A layer of catalyst on the inside face of the p.t.f.e. This, being in contact with electrolyte, converts the oxygen to hydroxyl ions without itself being consumed in the process.
3. A metal mesh connected to the positive terminal of the cell which collects the current generated at the catalyst layer.
4. The final layer, which is a permeable separator. Although allowing free passage of the conducting ions. this prevents direct electrical contact between the anode and cathode.

Further details are available from Crompton Parkinson Ltd., Crompton House, Aldwych, London, W.C.2.

Typical Comparative Discharge Curves

Continuous constant current discharge of two 'AA'(penlight) cells at 250 milliamps



SIMPLIFIED SEQUENTIAL LATCHING CIRCUIT

by

M. G. ASHBY

We have recently published several articles describing on-off latching arrangements by means of which a circuit can be switched on, and then off, by sequential closures of a press-button. The circuit described in this article offers an exceptionally simple approach, and requires only two relays

It is not necessary to use more than two relays to produce a sequential latching switch action, and Fig. 1 shows a simple symmetrical circuit that will do this job.

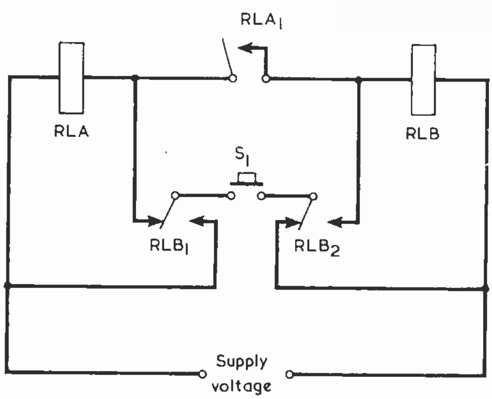


Fig. 1. The sequential switching circuit with single-pole push-button. In this diagram, and in Fig. 2, relay coils are depicted as rectangles and relay contacts, 'detached' from their coils, are shown in the de-energised position

CIRCUIT OPERATION

The circuit operates in the following manner. When S1 is depressed, RLA is energised via the normally-closed contacts of RLB, and contacts RLA1 become closed. For the time being RLB cannot operate, as its coil is short-circuited through S1. When S1 is released, RLA remains latched-up through its own contacts RLA1. Because this current is drawn through RLB coil, the two relays are energised in series and contacts RLB1 and RLB2 change over. The circuit is stable in this condition indefinitely until S1 is again depressed, whereupon RLA coil is short-circuited via its own contacts RLA1, and RLA falls out. RLB remains latched through its own contacts until S1 is released, whereupon RLB also falls out and contacts RLB1 and RLB2 return to the de-energised condition. The next push on S1 starts the cycle over again. An external circuit can be controlled by additional contacts on RLA.

If the input at S1 is thought of as a pulse, then it can be said that RLA changes state on the leading edge, and RLB on the trailing edge, of every pulse. The circuit can, in fact, be regarded very appropriately as an electro-mechanical equivalent of the steered bistable. Stages such as that of Fig. 1 can thus be cascaded to form low-speed dividers and counters, contacts on the RLA of each stage taking the place of the input switch, S1, in the following stage.

FURTHER SIMPLIFICATION

Where a double-pole switch is available at the input, the circuit can be still further simplified, as shown in Fig. 2. In this arrangement RLB needs

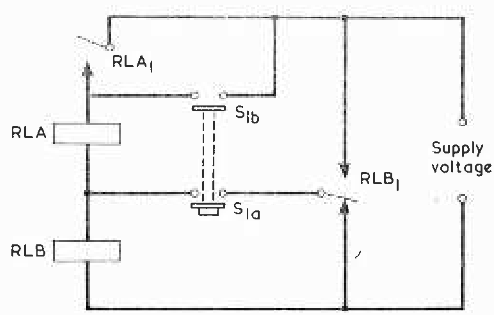


Fig. 2. With a double-pole push-button the relay circuit becomes even simpler

only a single changeover contact. When S1 is depressed, RLA is energised by the full supply voltage, since RLB is short-circuited via S1(a) and its own normally-closed contact at RLB1. When S1 is released, the two relays are held up in series via RLA1, and contacts RLB1 change over. The circuit is stable until S1 is again depressed, whereupon RLA coil is short-circuited and RLA falls out. It is now the turn of RLB to be held up by the full supply voltage, until S1 is released and the circuit reverts to its original state. Again, additional contacts on RLA can be used to control an external circuit.

SUPPLY VOLTAGE

If relays of identical type are used for RLA and RLB the supply voltage for the circuit must be approximately twice the operating voltage of the type of relay used. For two dissimilar relays, the supply voltage required is only equal to the sum of their operating voltages if the coil resistances are in approximately the same ratio as the respective operating voltages, which is the same as saying they then operate in series on the same current.

Where relays are used that do not match in this way, the supply voltage may (within limits) be raised, or relays can be padded-up with parallel resistance which can usefully take the form of indicator lamps or slave relays. Fig. 3 gives an example. Here two 9V relays, RLA and RLB, of coil resistance 2R and R respectively, are required to operate in series.

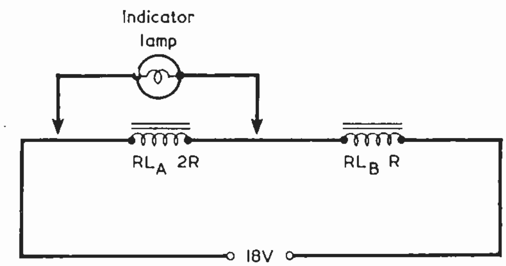


Fig. 3. Padding-up a high-resistance relay coil to give efficient series operation

On 18V only RLA will operate, as only one-third of the supply voltage (i.e. 6V) will appear across RLB. The minimum voltage to operate both relays without padding is 3 x 9 = 27V. However, by connecting in parallel with RLA coil a lamp or extra relay coil of resistance approximately 2R, both relays can be made to close on an 18V supply, as the current now rises to 18/2R, or 9/R amps, meaning that 9V appears across each relay. Where a lamp is used for padding, it must be rated to at least the *full* supply voltage, since the series resistance offered by the other relay is short-circuited during part of the cycle. ■

CURRENT SCHEDULES

Times = GMT *Frequencies = kHz*

★ JAPAN

Radio Japan, Tokio, is scheduled to the Middle East and North Africa from 1745 to 1915 in English, French and Arabic on **11965** (25.07 metres). Heard signing-on, in English, at 1745.

★ CLANDESTINE

South Vietnam Liberation Radio has a newscast in English from 1030 to 1045 on **7470** (40.18m) with **10009** (29.98m) in parallel.

★ CONGO

Pointe Noire is a regional station which relays Brazzaville from 0500 to 2000 on **4843** (61.95m) 4kW. Logged when signing-off at 2006 with announcements in French, identification at "La Voix de la Revolution Congolaise" and anthem.

★ SOUTH AFRICA

Radio South Africa, Johannesburg, currently operates an English schedule to Europe as follows – from 1800 to 1850 on **15250** (19.67m) and **21480** (13.97m). From 1900 to 1950 on **9525** (31.50m), **7270** (41.27m), **15250** and **21480.** From 2215 to 2315 on **5980** (50.17m) and **9525.** From 0015 to 0115 on **5980** and **9525.** On Sundays only, there is a transmission from 1000 to 1150 on **21535** (13.93m). All 250kW.

★ HOLLAND

Radio Nederland schedule for Europe is as follows – from 0930 to 1050 on **6020** (49.83m), also directed to West Australia and S.E. Asia on 17810 (16.84m) and 21480 (13.97m). From 1400 to 1520 on **6020,** also directed to South Asia on **17810** and **21480.** From 2000 to 2120 on **6020** and **6085** (49.30m) for Europe only. From 0930 to 1050 on Sundays only to Europe, **6020, 6140** (48.86m) and **7275** (41.24m). From 1400 to 1520, Sundays only, on **6020, 17810** and **21480,** from 2000 to 2150 on **6020** and **6085.** Address – Radio Nederland, P.O. Box 222, Hilversum.

★ CAMBODIA

The National Network from Phnom-Penh operates from 2200 to 1600 on **4907** (61.14m) 15kW. The International Service is from 2400 to 1600 on **6190** (48.47m). The transmissions in English are from 0435 to 0500, from 0540 to 0600 and from 1245 to 1300. Identification is "This is Radio Phnom-Penh, the Voice of the Cambodian Republic". Address – Radiodiffusion Nationale Khmere, 28 Avenue Sandech Chuon Nath, Phnom-Penh.

★ CONGO KINSHASHA

The 100kW outlet of RTV Congolaise on **15245** (19.68m) now has almost a 24 hour service. In addition to the parallel frequencies of **4880** (61.48m) 10kW and **9650** (31.09m), a new channel of **11865** (25.28m) is reported to have been added. The regional station at Lubumbashi is listed as using **11862** (25.29m) whilst the channels mentioned above are those of the Kinshasha transmitters.

★ GREECE

The Hellenic National Broadcasting Institute, Athens, may be heard from 2200 to 2230 on **15347** (19.55m) 7.5kW. From 1940 to 1950 short news bulletins in French, English and German are radiated.

Acknowledgements:– Our Listening Post, SCDX

In your workshop

Life is rarely easy for Smithy the Serviceman. This month, as he settles down to his crossword puzzle after lunch he is, as usual, prevented from completing it because of his assistant's avid thirst for knowledge. In this instance Smithy finds himself passing on to Dick the basic fundamentals of heat dissipation in transistors

"WHY," ASKED DICK DESPAIRingly, "do they keep *doing* it?"

Smithy entered a further word in his after-lunch crossword puzzle.

"Who," he asked, preoccupied, "are 'they'?"

"The transistor manufacturers."

"And what is it they keep doing?"

"They keep introducing new letters and symbols into their transistor data, that's what they keep doing."

"Hmm," grunted Smithy. "Well, I will agree that the letters and symbols standing for transistor characteristics have been swapped around quite a bit over the years. What's the one that's puzzling you?"

THERMAL CHARACTERISTICS

Dick pointed a finger at an entry in the transistor data sheet he had been studying.

"It's this symbol here," he replied. It consists of a capital 'T' followed by the small letters 'stg'."

"'Tstg' ?", repeated Smithy. "Why, there's nothing difficult there. 'Tstg' merely stands for storage temperature. The data sheet should state the maximum and minimum temperatures at which the transistor in question may be safely stored before it is brought into service."

"The maximum storage temperature quoted here," said Dick, "is 75°C."

"Then," replied Smithy with certainty, "the transistor in question will be a germanium type. Many of these, including in particular the earlier ones, have the low maximum storage temperature of 75°C. Metal cased silicon transistors, on the other hand, usually have maximum storage temperatures of the order of 175° to 200°C, whilst plastic encapsulated silicon transistors normally have a maximum storage temperature around 125°C."

"You refer to that 75°C figure as though it was quite low," remarked Dick. "But I would have thought that 75°C was pretty hot. After all, it's not much short of 100°C, and that's the temperature of boiling water."

"A storage temperature of 75°C is not as high as you seem to think it is," returned Smithy. "Apart from conditions in the Tropics, you can get surprisingly hot conditions in this country, too. If, for instance, the transistors happened to be positioned close to a radiator in a badly ventilated store without proper air convection, they could get much hotter than you might at first imagine."

"I see," said Dick thoughtfully. "Well, now, another symbol that's puzzling me is the capital letter 'R' followed by a small 'th' and all manner of other letters in brackets."

"I thought," snorted Smithy wrathfully, "you were going to ask me about one symbol only. Now you're trotting out a whole family of them. Dash it all, Dick, I want to get on with my crossword."

"Well," persisted Dick, "what does 'Rth' mean?"

"An upper case 'R'," replied Smithy, "followed by 'th' as a lower case subscript is a recent symbol for transistors which has replaced the old theta."

With which pronouncement Smithy retired stonily behind his newspaper.

"Corluvaduk," commented Dick bitterly, addressing himself to the electric light bulb over his bench. 'You ask him a question and he gives you an answer that's more confusing even than the question was! Did *I* say anything about upper and lower cases?"

Irately, Smithy threw his newspaper to the back of his bench, pulled his note-pad towards him and beckoned his assistant over. Elated at this sudden and unexpected capitulation on the part of the Serviceman, Dick hurried across with his stool and made himself comfortable at Smithy's side.

"It's always the same after lunch," grumbled Smithy. "Nothing else but you and your continual questions. Seeing that I'll never get any peace until your curiosity *is* satisfied, I suppose I'd better get this business over and done with now. I'll deal with the upper and lower case bit first. 'Upper case' is a printer's term for capital letters, and 'lower case' is the complementary term for small letters. The printer's type for the capital letters is kept in the 'upper case' and that for the small letters is kept in the 'lower case'. You'll quite frequently encounter the terms in technical literature dealing with symbols. Okay?"

"Blimey, yes," said Dick, intrigued. "That's something I didn't know before."

"Good," replied Smithy. "Now, the symbol 'Rth' was your basic query, so I'll get on to that next. 'Rth' stands for 'thermal resistance'. It is tending to replace the old term for thermal resistance, which was the Greek letter theta."

"Is that the letter which is like an 'O' with a line across the middle?"

"That's right."

"I've seen that letter plenty of times in transistor data sheets," said Dick, "but I never really understood what it meant. It's got something to do with the cooling of power transistors, hasn't it?"

"It has to do with the cooling of all transistors," replied Smithy, "although in practice you usually only have to apply it to power transistors. If you want to find the maximum power a power transistor can safely handle, you first of all look up the maximum junction temperature, for which the symbol is 'Tj', then work from this and the thermal resistance which opposes the dissipation of heat from the junction to the surrounding air."

"But," protested Dick, "the transistor data sheet tells you the maximum power dissipation in any case, so why bother with all this thermal resistance business?"

"With small transistors," said

Smithy in reply, "it is normally quite in order to work from the maximum power dissipation figure given in the manufacturer's data. On the other hand, you should take account of thermal resistance if you're designing a new circuit in which a large transistor is called upon to dissipate a lot of power."

"I think," pronounced Dick, frowning, "that I'll need an example or two to get the hang of all this."

"Will you?" said Smithy. "Well now, let's get out a few transistor data sheets and I'll show you what I mean."

Smithy reached up and took a file of Mullard transistor data sheets from the shelf above his bench. He turned through these at random.

"Here's a nice easy one to start off with," he remarked after a moment. "The transistor concerned is the BF194, which is a small n.p.n. silicon planar transistor in an epoxy resin encapsulation. With this transistor you could work direct from the maximum power dissipation figure quoted but, for the sake of the exercise, we'll find the maximum power dissipation by means of the thermal resistance procedure instead. The maximum junction temperature for the BF194 is 125°C, and it has a thermal resistance from junction to ambient of 0.45°C per milliwatt. The thermal resistance from junction to ambient is referred to, incidentally, as 'Rth (j-amb)'."

"What's 'ambient'?"

"It's the temperature of the ambient, or surrounding, air. Unless the transistor is operating in a hot environment this is usually assumed to be a room temperature of 25°C."

Smithy drew out his pen and commenced to draw a sketch on his note-pad. (Fig. 1).

"Now," he went on, "the usual way of visualising the dissipation of heat from a transistor is to draw two or more horizontal lines to stand for the various temperatures. In our present very simple example the transistor dissipates heat directly into the surrounding air with no heat sink or anything like that, and so we only need two horizontal lines. We can now find the maximum power which a BF194 can safely dissipate, working from the maximum junction temperature of 125°C and the Rth (j-amb) of 0.45°C per milliwatt. We say that the upper horizontal line represents the maximum junction temperature specified for the transistor, whilst the lower line represents ambient room temperature at 25°C. Heat dissipation from the upper to the lower temperature is by way of the thermal resistance."

"I suppose," suggested Dick hesitantly, "that you have to work to the *difference* between the two temperatures?"

THERMAL OHM'S LAW

"You do," confirmed Smithy. "And you carry out a calculation which is similar to that for Ohm's Law, but with power dissipation being equivalent to current, temperature difference to voltage and thermal resistance equivalent to ohmic resistance."

"I don't understand that," protested Dick. "How on earth can you say that temperature difference is equivalent to voltage? In electrical circuits it's voltage which causes current to flow, but you can't say that temperature difference causes power to appear. It's the other way round, surely?"

"It is," agreed Smithy, "and you have just put your finger on the weak point in this Ohm's Law analogy. We're so used to thinking of voltage as the actuating quantity in electrical work that we are liable to bump into a mental block when we come to this thermal business. What we have to do is to change our electrical thinking a bit and look upon *current* as the actuating electrical quantity. If we do that, everything in the thermal version snaps neatly into place. Take a look at this."

Smithy drew a further sketch on his pad. (Fig. 2).

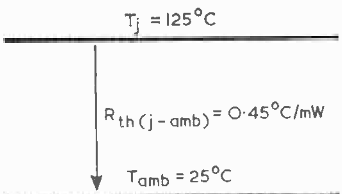


Fig. 1. Temperature diagram illustrating maximum power dissipation in the BF194 transistor at an ambient temperature of 25°C

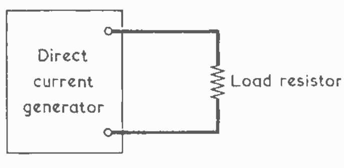


Fig. 2. The Ohm's Law analogy for the diagram of Fig. 1 becomes easier to visualise if current is assumed to be the actuating quantity in the equivalent electrical circuit

"Here," he continued, "we have a circuit in which the actuating electrical quantity is current, and it is provided by a direct current generator which couples into a resistive load. As the current provided by this generator increases, so also does the voltage appearing across the load. If the current stays the same and the resistance of the load increases, the voltage will similarly increase. And so it is with the thermal version. If the power dissipated by the transistor increases, it's the same as if the current in the electrical version increases, and the temperature difference across the thermal resistance increases also, as would the voltage in the electrical version. If the power dissipated remains constant, the temperature difference across the thermal resistance similarly increases if the value of that resistance increases."

"Blimey!" said Dick. "I can see it all now. Go on, Smithy."

"Right," said Smithy briskly. "We next work out the power dissipated in the transistor from the thermal equivalent of Ohm's Law. Instead of saying $I=\frac{E}{R}$ we say that power equals temperature difference divided by thermal resistance. With the BF194 the temperature difference is 125 minus 25, or 100°C, and thermal resistance is 0.45°C per milliwatt. In consequence, the corresponding power dissipation is 100 divided by 0.45 milliwatts."

Smithy scribbled a hasty calculation on his note-pad.

"Working to two significant figures," he remarked, "that power dissipation comes out at 220 milliwatts."

Dick leaned over and looked at the data sheet for the BF194.

"Gosh," he said, supremely impressed. "That's the actual figure for total dissipation at 25°C ambient which is quoted elsewhere on the sheet. Blimey, Smithy, you really are a bit of a genius, you know!"

"I must confess," replied Smithy modestly, "that I occasionally have the odd moment. Anyway, let's carry this thermal resistance business a bit further by finding a dissipation figure for the BF194 which isn't directly shown on the data sheet. Let's work out the total permissible dissipation if the BF194 happens to be in an ambient temperature of 40°C. This time our lower line represents 40°C, and the difference between the two temperatures is 85°C." (Fig. 3).

"Can I have a go at this one, Smithy?" asked Dick, as he pulled the Serviceman's pad towards him. "I'd like to get a bit of practice in. Now, power is temperature difference divided by thermal resistance so, in this instance, it will be 85 divided by 0.45. Which comes out as – let me see now – 189 milliwatts. So, maximum permissible dissipation for a BF194 in an ambient temperature of 40°C is 189 milliwatts."

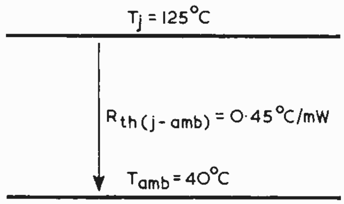


Fig. 3. Finding maximum power dissipation in the BF194 at an ambient temperature of 40°C

"Fair enough," commented Smithy, taking back his note-pad. "Let's next carry on to the more complex case which is given when we have a large power transistor bolted to a flat heat sink."

Smithy sketched the transistor and heat sink, indicating the thermal resistances. (Fig. 4).

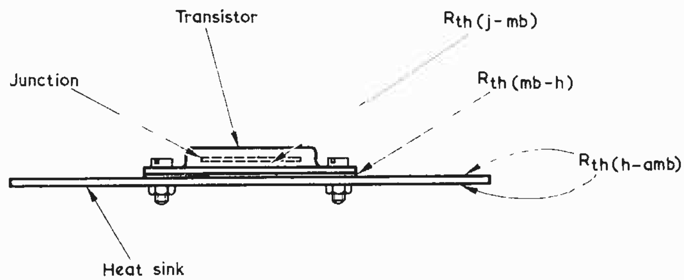


Fig. 4. Illustrating the three thermal resistances which appear between the junction of a power transistor and the ambient air when the transistor is mounted on a heat sink

"To begin with," he remarked, "the manufacturer doesn't always bother to quote an Rth figure for junction to ambient for a power transistor, since the transistor isn't intended to be used other than on a heat sink. So we have a number of thermal resistance figures interposed between the junction and ambient. The first of these is 'Rth (j–mb)' which is the thermal resistance inside the transistor between the junction and the mounting base. The mounting base, incidentally, is the flat surface of the transistor which is in contact with the flat surface of the heat sink, and it's the manufacturer's job to design the transistor so that this thermal resistance is as low as possible. Next, there is 'Rth(mb–h)'. This is the thermal resistance in the thermal coupling between the flat surface of the transistor and the flat surface of the heat sink. Two figures are normally specified here, one for the instance where the transistor is bolted directly to the heat sink, and a second for the instance where the transistor is insulated from the heat sink by a mica washer. This second figure is always higher than the first because the presence of the mica washer increases the thermal resistance of the coupling between transistor and heat sink. The final thermal resistance is that between the heat sink and ambient, which can be referred to as 'Rth(h–amb)'."

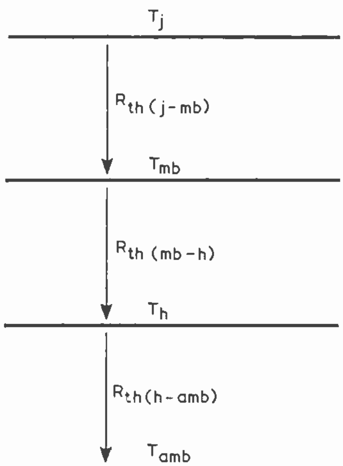
"This," said Dick slowly, "is getting a bit more complicated."

"Don't worry," Smithy reassured him, "things don't get any more difficult from now on. As you can see, we now have three thermal resistances which are effectively in series. Let's draw them up in graphical manner. I'll also sketch out the electrical analogy."

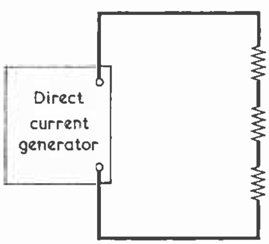
Smithy drew the temperature diagram (Fig. 5(a)) and its electrical equivalent (Fig. 5(b)).

"Now, the temperature diagram," he said, "is the same as the previous one, except that we have four horizontal lines to represent the different temperatures. The electrical equivalent has three resistors in series to represent the three thermal resistances between junction and ambient. In the electrical version, the same value of current must flow through all three resistances. With the temperature version the same amount of heat similarly has to flow through all three thermal resistances in its path from junction to ambient, and so for purposes of calculation we can add all the three resistances together, just as though they were electrical resistances. In consequence, the total thermal resistance from junction to ambient is Rth(j–mb) plus Rth(mb–h) plus Rth(h–amb)."

"Well," remarked Dick, "that certainly seems to simplify things a bit. Let's do an example."



(a)



(b)

Fig. 5(a). Temperature diagram for a power transistor on a heat sink. The horizontal lines correspond to junction temperature, mounting base temperature, heat sink temperature and ambient temperature respectively

(b). The electrical equivalent has three resistances in series

NUMERICAL EXAMPLE

"Okey-doke," said Smithy obligingly, as he returned to the transistor data sheets. "I'll choose a good old faithful with which you should be familiar, this being the OC36. The OC36 is a germanium power transistor fitted in a metal TO–3 case and has a value of Rth(j–mb) of 1.5°C per watt. If the transistor is bolted direct to the heat sink, Rth(mb–h) is 0.2°C per watt, and if it is insulated by a mica washer Rth(mb–h) is 0.5°C per watt. These two figures assume that a thin film of silicone grease is applied to all adjoining surfaces. The figures are applicable, incidentally, to all TO–3 transistors."

"What about the thermal resistance between the heat sink and ambient?"

"That depends," replied Smithy, "on the size and shape of the heat sink. A ribbed heat sink measuring about 5 inches square can be expected to have an Rth(h–amb) of 2.5°C per watt in free air, so we might as well choose that figure as an example. The maximum junction temperature for an OC36 is 90°C, and we next make up a thermal resistance diagram with actual figures. I'll assume the transistor is bolted direct to the heat sink without the mica washer, so that Rth (mb–h) is 0.2°C per watt." (Fig. 6).

"The total thermal resistance," broke in Dick whilst Smithy drew out the thermal resistance diagram, "when the OC36 is mounted direct to the heat sink is 1.5 plus 0.2 plus 2.5°C per watt, isn't it?"

"That's right," agreed Smithy, "and those figures add up to 4.2°C. I'm now going to do a calculation which may surprise you a little. The maximum power dissipation quoted for the OC36 is 30 watts, so let's find the highest ambient temperature at which it can safely work when it is dissipating that power and is directly mounted to the heat sink. Since power is temperature difference divided by thermal resistance, a little algebraic changing around tells us that temperature difference is power multiplied by thermal resistance. This agrees with the Ohm's Law analogy, since E=IR. In the present case the temperature differ-

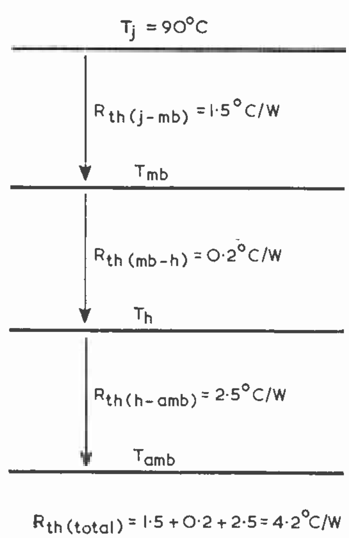


Fig. 6. Temperature diagram for an OC36 bolted directly to a heat sink having a representative thermal resistance to ambient. The maximum junction temperature for the OC36 is 90°C

ence becomes 4.2 multipled by 30, which is 126°C."

Dick laughed.

"We'd have to keep that transistor and its heat sink in the ice-box," he chuckled. "The highest safe ambient temperature at which the transistor can work is 126°C below 90°C, which is minus 36°C!"

"Exactly," grinned Smithy. "We'd obviously need some form of forced cooling if we tried to run the OC36 at 30 watts. This is an instance where you can't work to the quoted maximum power dissipation figure, and where you have to take thermal resistance into account. So, let's work the thermal resistance way. Let's assume an ambient temperature of 50°C and find the maximum power the OC36 can dissipate on our heat sink. Since the temperature difference is now 40°C only, the maximum power is equal to 40 divided by 4.2. This comes out to – hang on a moment – 9.5 watts. Which is, of course, quite a reasonable figure for transistors in the OC36 category."

"So far as I can see," said Dick, "the biggest difficulty with these thermal resistance calculations lies in the heat sink. Even if you *know* its nominal thermal resistance to ambient, this resistance could still be reduced if the sink doesn't have enough air circulating around it."

"That's true," agreed Smithy. "The best design approach for a new piece of equipment incorporating power transistors consists of setting up the circuit to be used in practical form, and of then measuring the temperature at the transistor mounting base. In a manufacturer's design laboratory this would almost certainly be done with a thermocouple thermometer. Now, there's a useful short-cut here. If you multiply the power dissipation of the transistor by its Rth(j–mb) you get the corresponding temperature difference between junction and mounting base. Let's next say we want to run an OC36 at 8 watts. Its Rth(j–mb) is 1.5°C per watt and this, multiplied by the 8 watt power figure, gives you 12°C. The maximum junction temperature is 90°C, so the maximum mounting base temperature is 90 minus 12, or 78°C. It would, therefore, be safe to dissipate 8 watts in the OC36 provided that the mounting base temperature did not rise above 78°C, and with this approach we don't even need to evaluate the remaining thermal resistances. If the mounting base temperature becomes higher than 78°C the circuit would have to be altered to reduce dissipation or the heat sink made larger or more efficient."

"It seems to me," remarked Dick, "that if you were using a particular type of transistor in a number of different circuits, it would be worthwhile making up a graph showing mounting base temperature against maximum power dissipation."

"That would be an excellent idea," replied Smithy, taking up his pen again. "It would be a very simple graph to draw up, too. The horizontal axis can be for mounting base temperature and the vertical axis for power dissipation. You then find the maximum mounting base temperature at which the transistor can dissipate its maximum rated power and plot this point on the graph. To the left of that point the graph is a straight horizontal line. To the right of the point it's a straight line going down to maximum junction temperature at zero power. This is what the graph would be like with an OC36."

Smithy indicated the graph he had been sketching out whilst he was talking. (Fig. 7).

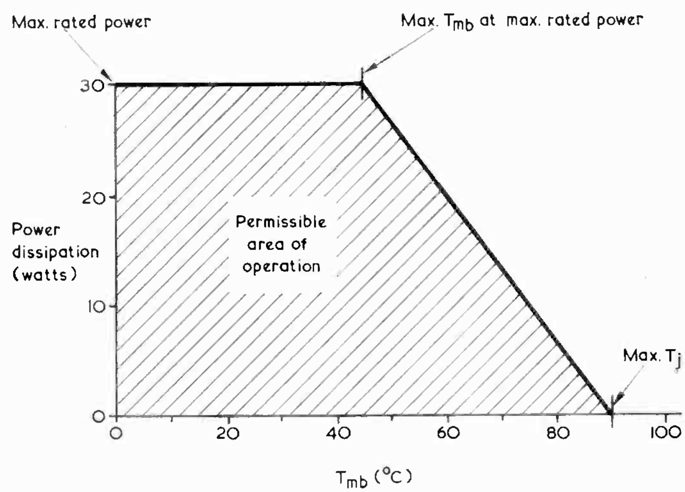


Fig. 7. Graph illustrating maximum power operating conditions for an OC36. The transistor must not be operated at any power and mounting base temperature which falls outside the shaded area

"You'll see," he went on, "that the original point plotted is given at 30 watts and 45°C. With the Rth (j–mb) of 1.5°C per watt which appears in an OC36, 30 watts corresponds to a mounting base temperature of 90 minus 45, which is 45°C."

EARLIER SYMBOLS

"Well," remarked Dick, "you've certainly given me some useful gen on this thermal resistance business."

"Good show," replied Smithy. "There are a few loose ends to tidy up, though. I've been using the more modern Rth symbols for thermal resistance, but you'll still find it expressed in terms of the Greek letter theta in many of the data sheets that are knocking around. Theta means exactly the same thing as Rth. Sometimes it's followed by the letter 'm', in which case it's the same as Rth(j–mb). If it's followed by the letter 'i' it's the same as Rth(mb–h). It may, again, be followed by 'h' whereupon it means the same as Rth(h–amb). Another point is that you'll often find the word 'case' or the small letter 'c' used as a subscript. These both mean the same as 'mounting base' or 'mb'. Hang on a jiffy and I'll write out these various terms, as they're a little difficult to keep in your head."

Smithy wrote out the terms on a fresh sheet of his note-pad (Fig. 8), tore this out and presented it with a flourish to his assistant.

$$\Theta_m = \Theta_{(j-case)} = \Theta_{(j-mb)} = R_{th(j-mb)}$$

$$\Theta_i = \Theta_{(case-h)} = \Theta_{(mb-h)} = R_{th(mb-h)}$$

$$\Theta_h = \Theta_{(h-amb)} = R_{th(h-amb)}$$

Fig. 8. A number of alternative symbols are employed to indicate thermal resistance. These and their equivalents are shown here

"Thanks, Smithy," said Dick. "This will come in useful in the future."

"After you've worked out a few problems involving thermal resistance," pronounced Smithy, "you'll find yourself getting quite familiar with the symbols, in any case. Another thing I should mention is that whilst it's very important to know the maximum power dissipation permissible in a transistor it is, in general, unwise to operate the transistor very close to, or at, that figure. It's better to run the transistor comfortably below maximum dissipation, in order to allow a reasonable safety factor."

A thought suddenly struck Dick.

"Stap me!" he exclaimed, "we've been talking about transistor power dissipation all this time, but we haven't even said yet what that dissipation actually consists of!"

"It's emitter-collector volts multiplied by collector current," said Smithy. "To be precise, the power dissipated in the base-emitter junction should be added in as well, but in practice it's usually so small in comparison that it can be ignored. Which now brings me to a final point. If a power transistor operates as an amplifier and it's in series with a load which can be represented as a resistor, greatest power is dissipated in the transistor when, during any cycle that it amplifies, half the supply voltage appears across it."

Smithy drew out the appropriate circuits. (Figs. 9(a) and (b)).

"So," he concluded, "when working out or measuring the power dissipated by a transistor, investigate the case where half the supply voltage appears across it. That's when it dissipates most heat."

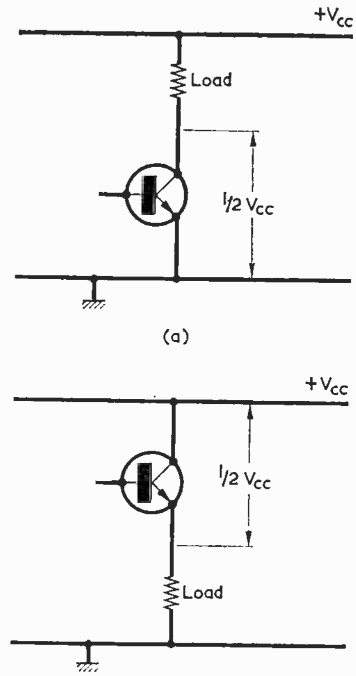


Fig. 9. Assuming a resistive load, a transistor dissipates maximum power when half the supply voltage appears across it. This applies if the load is in the collector circuit, as in (a), or in the emitter circuit, as in (b).

BACK TO WORK

Smithy looked up at the Workshop clock and sighed.

"And now," he pronounced wearily, "it's time to get back to work again. Which means that yet another of my lunch-breaks has been wasted nattering away to you when I could have been having a nice change from electronics."

There was no reply from his assistant. Smithy turned round sharply.

"Oh no," he moaned.

But it was too late, and Dick had, patently, once again fallen under the influence of his Muse.

"Here we are, Smithy," he announced proudly, "how about this bit of advice to round off the whole business of preventing overheating in transistors?

"Carry out a quick calculation
To assess the heat situation.
For a transistor will fail
And it's life you'll curtail
If it runs at excess dissipation!"

And even Smithy as, shuddering, he resumed work had to admit that this latest offering of Dick's not only had acceptable rhymes but actually scanned. More or less, that is. Here and there. ■

HELP FOR R.A.I.B.C.

The Star Short Wave Club of Leeds are organising a Grand Junk Sale for the funds of the Radio Amateur Invalid Bedfast Club.

The sale is to be held on Wednesday, 15th September, at the New Inn Hotel, Bramley Town Street, Leeds 13.

The organisers are prepared to collect junk within a 25-mile radius of Leeds. To help this worthy cause, contact T. Leeman, G8BUU, 115 Asket Drive, Leeds, LS14 1HX.

EXTRACTS FROM A DOTTY DICTIONARY

by

B. H. BAILY

Anode: Poem
Diode: Two-verse poem
Triode: Three-verse poem
Monode: Poem by French author

Dry Joint: Boring night-club

Magnetic Flux: Iron-cored solder

Dust Core: Centre of fossillised apple

Monostable: Horse box
Bistable: Large horse box
Ring Counter: Miserly jeweller

Watt: Pardon!
Kilowatt: A thousand pardons!
Megawatt: Granted!

Henry: Just a single guy
Millihenry: Henry and wife
Microhenry: A year later

Wien Bridge: A monumental discovery

Thin Film: Cause of many TV breakdowns

Thick Film: Documentary for dim viewers

Data Store: Computerised marriage-bureau

Emitter-Follower: Trailer behind a smoky car
Grounded Base: London Airport in fog
Grounded Emitter: Plane on fire
Grounded Collector: Earthbound Angel of Death

Bias: Wife's favourite word during a day out ("Bias this, Bias that . . .")

Zener Curve Knee: A complaint caused by too much stabilisation, often leading to breakdown (see also stabilisation)
Stabilisation: Result of 746 watts (one horse-power)

Long Tail Pair: Couple of lizards

Multivibrator: A whole lot of shakin' goin' on

Unijunction: The joining of one wire . . . to itself

Nucleonics: Updated Oldcleonics

Punched Tape: Boxer opening a new motorway

Core Store: Dustbin outside apple-canning factory

Core Memory: Ditto, but empty

Thermal Runaway: Fire-escape

Hertz: Ow!
Kilohertz: As above but 1,000 times worse
Megahertz: Shock from an insulation tester

Gigahertz: Shockingly funny

Farad: A man with a great capacity for putting his name on a million μFd capacitors

Megacycle: Old bike with a million wheels
Kilocycle: Old bike with no saddle (see Hertz)
Gigacycle: Funny old bike

Reverberation: A noisy pot
Pot: A safeguard against overloading (see Volume Control)
Volume Control: A single-position knob always set fully-clockwise on pop-groups' equipments

Transmitter: Competitor in a hand-shaking contest

I.C.: A common phrase generally meaning "it's far too complicated for me but hurry up and get it over with"

Semiconductor: Undergraduate fare-collector
Conductivity: Measure of sales of bus-tickets

Laser: See Maser
Maser: See Laser

Coherent Light: B.B.C. Radio 2
Incoherent Light: B.B.C. Radio 2 with atmospherics

Photo Cell: Prison studio

Electrostatic Charge: Advance of computerised battalion

Sync Pulse: Heartbeat of wife when washing the dishes
Synchronization: The installing of an American automatic dishwasher

Colour T.V.: Programme on race relations

Resistance: Current opposition (hence O.H.M.S. on tax demand envelopes)
Ohm: Where charity should begin

Parasitic Oscillation: Modern French dance

DIODE POLARITIES

by

N. STEWART

How to avoid polarity errors with surplus diodes

BEGINNERS, TOGETHER WITH some of us who have been at the electronics game for quite a few years, tend to get confused by the very wide range of signal, rectifier and zener diodes that are currently available on the home-constructor market. These appear in all sorts of shapes and sizes and with many different types of marking. When confronted with an unfamiliar diode, which may have been bought in bulk form as an equivalent to a more well-known type, the problem of determining its polarity then arises.

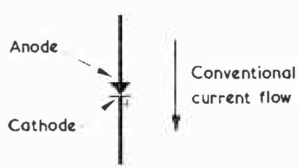


Fig. 1. The arrow-head integral with the diode symbol indicates the direction of conventional current flow when the diode conducts

SIGNAL AND RECTIFIER DIODES

The familiar signal and rectifier diode symbol appears in Fig. 1. This symbol actually consists of an arrow-head and a straight line, and the arrow-head points in the direction in which 'conventional current' flows when the diode conducts. Conventional current, which is the opposite to electron current, is assumed to flow from positive to negative. The two electrodes of the diode are called the 'anode' and the 'cathode', and they correspond to the anode and cathode of a thermionic valve diode. In circuit diagrams it is a fairly common practice to put a plus sign alongside the cathode.

Turning to the actual component, many signal and rectifier diodes have a distinctive mark, such as a white or black line, on the case, this mark being close to the cathode end. However, the mark cannot be relied on with unfamiliar components, and it is always wise to check polarity before connecting the diode into a working circuit. This is especially true with rectifier diodes, where incorrect polarity could cause the breakdown of an electrolytic capacitor following the diode. Pretty well the only 'safe' marking is a distinctive red at the cathode end of the diode but, even so, no harm results in checking a diode marked in this way if it is a completely unfamiliar type.

It is possible to find the polarity of a diode with the aid of a multitestmeter switched to an ohms range. Usually, the meter will indicate a low resistance when the positive test lead is connected to the cathode and the negative test lead to the anode, and a high or infinite resistance reading when these connections are transposed. However, the internal circuitry of some multitestmeters may be such that these indications are reversed. This point can only be determined for certain by checking a diode of known polarity with the testmeter to be used.

Rectifier diodes can always be checked with complete certainty in the circuit into which they will be connected. Fig. 2 shows a diode intended for a half-wave rectifier circuit. One end only of the diode is connected to the source of alternating voltage, the other end being left free. A d.c. voltmeter is next connected between the remaining terminal of the source of alternat-

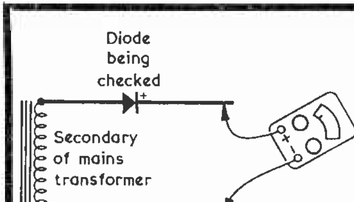


Fig. 2. The polarity of a half-wave rectifier diode may be checked with the aid of a multi-testmeter switched to read d.c. volts

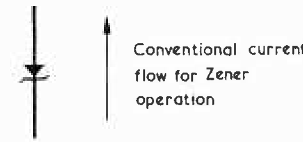


Fig. 3. The conventional current flow in a zener diode is opposite to the direction of its arrow-head

ing voltage and the free end of the diode. The voltmeter will then indicate the polarity of the rectified output from the diode without any doubt at all. If the polarity is correct, as indicated by the meter, then the free end of the diode may be connected to the subsequent smoothing circuit. The meter will, of course, give a lower reading when it is checking the diode in this manner than when the subsequent electrolytic capacitor (or capacitors) is connected. Remember that in a half-wave rectifier circuit the output from a cathode is positive (hence the plus sign in circuit diagrams) and the output from an anode is negative. This approach can also be used for sorting out the diodes for a bridge rectifier circuit.

The method of Fig. 2 is, incidentally, the only practicable way of determining polarity with selenium rectifiers, which are liable to give confusing readings when checked with a multitestmeter switched to an ohms range. The method may be used for signal diodes as well as rectifier diodes provided that the

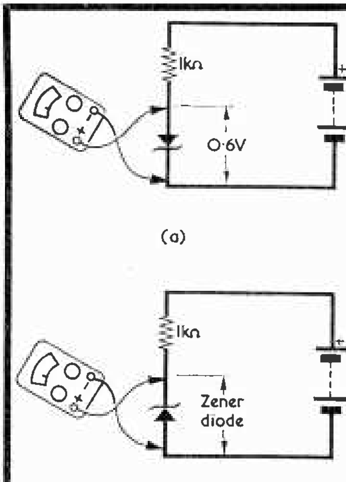


Fig. 4. Finding the polarity of a zener diode. When connected wrongly, as in (a), the voltage across it is only 0.6 volt. The diode is connected correctly in (b), whereupon the zener voltage appears across it

alternating voltage is low. A 6.3 volt heater winding on a mains transformer would be a suitable source.

ZENER DIODES

A zener diode is a silicon diode which allows the zener voltage to appear across it when it is connected in the non-conducting (as a rectifier) manner. Its symbol appears in Fig. 3 and its arrow-head indicates the direction of conventional current flow when it is acting as a rectifier diode. When it is acting as a zener diode, conventional current flows in the opposite direction.

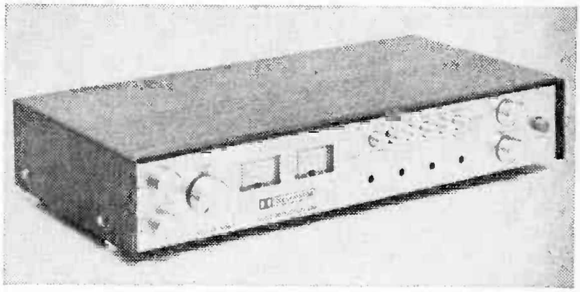
A reliable method of determining the polarity of an unknown zener diode is to apply across it a battery, whose voltage is some 3 to 6 volts greater than the zener voltage, in series with a resistor of around 1kΩ. See Figs. 4(a) and (b). If the diode is connected wrong way round for zener operation the volage across it will only be about 0.6 volt. If the diode is connected right way round for zener operation, the voltage across it will be the zener voltage. ■

TRADE NEWS

DOLBY 'B' NOISE REDUCTION UNIT

A Dolby unit for the home tape recording enthusiast is now available from Kellar Electronics Ltd., 6 Bycullah Avenue, Enfield, Middlesex. Known as the KDB1 Noise Reduction Unit, it incorporates the Dolby 'B' circuits developed from the Dolby 'A' system introduced to major recording studios some six years ago. Basically, Dolby 'B' boosts medium and high frequency signals when these reduce in level during recording, and attenuates the same signals during playback. Thus, all reproduced signals have the same relative amplitude as they had when originally recorded, but the tape hiss which would otherwise be present during quieter passages is reduced. A reduction of 10db in tape hiss is possible.

The Kellar KDB1 Noise Reduction Unit can, after a simple calibration for correct matching, be coupled to any tape recorder. The KDB1 then takes over the usual functions of the recorder. Its Dolby circuits, one per channel, are switched to the 'recording' position for stereo recording, and the same circuits are then switched to 'playback' to replay the 'Dolbyised' recording.



The Kellar Electronics KDB1 Noise Reduction Unit. This incorporates Dolby 'B' circuits and can be coupled to any tape recorder

The KDB1 also allows 'Dolbyised' pre-recorded cassettes to be replayed with correct replay characteristics.

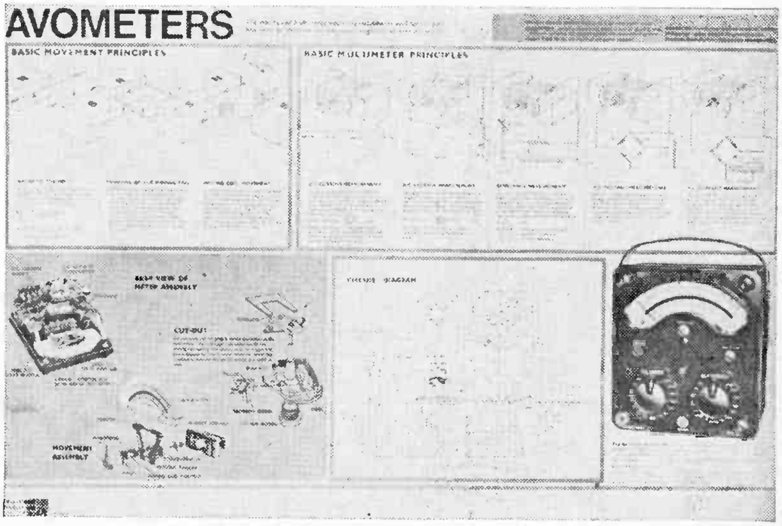
The unit is built into a black simulated leather finish steel cabinet with brushed aluminium fascia panel and control knobs. Retail price is £49.50.

AVOMETER WALL CHART

Avo Limited (Thorn Group) announce the availability of a new wall chart featuring the latest Mark 4 version of its Avometer Model 8. The improved design and layout over earlier charts is such that it will prove of great interest not only to Avometer users but also to technical schools and general education establishments as a teaching aid.

Information is presented in a clear, logical manner and the theoretical and practical information is both concise and easy to understand. Magnetic theory is developed pictorially to outline the operation of the moving coil movement, whilst a mathematical treatment is used to derive the various ranges of a multimeter.

Illustrations of the interior of the instrument include an exploded view of the movement to simplify the constructional detail and a circuit diagram provides an introduction to standard symbols and references.



The Avometer chart (size 20 x 30 in. – 508 x 762 mm.) is ideal for blackboard or wall presentation and is available from Spares Dept., Avo Limited, Avocet House, Dover, at 75p per copy, including post and packing.

Radio Topics

By Recorder

One over two pi root LC.
Gives you the resonant frequency!

THAT LITTLE JINGLE SERVED me and my fellow class-mates well in the days when we were struggling to get to grips with basic electronics. It defines, of course, the resonant frequency of a tuned circuit, and the couplet scans nicely enough for it to become reliably lodged in the old memory banks.

MNEMONICS

I wonder how many other expressions in electronics have been remembered with the aid of similar mnemonics. There used to be a terribly corny one for Ohm's Law which ran: 'Rain is 'Eavy over India'. This enables you to remember that R is E over I, or that resistance is voltage divided by current. Quite a few people I know got by with that one during their early days and, so far as I know, this particular *aide-memoire* may still be used by students.

Another horror from the past, which I record with some trepidation, runs: 'Billy Brown Read Out Yellow Gardening Books, Violet Grew White'. This bit of nonsense which, by its very incongruity, tends to stick in the mind, provides a reminder for the resistance colour code: Black, Brown, Red, Orange, Yellow, Green, Blue, Violet, Grey, White. It has, at least, the merit that many of the words in the sentence are the same as, or very similar to, the colours they represent.

Some memory aids are built-in. The most obvious of these is the arrow-head which appears in rectifier and transistor symbols, and which indicates the direction of flow of conventional current.

Conventional current is assumed to flow from positive to negative. It is interesting to note that the concept of conventional current is by no means as indigestible in our present semiconductor days as it was during the Valve Age. The mind tended to boggle at the idea of a current flowing, inside a valve, from anode to cathode. Talking of valves reminds me of another fortuitous circumstance which helps to keep a set of otherwise unconnected factors in mind. That useful trio of double-triodes, the ECC81, ECC82 and ECC83, are direct equivalents of the 12AT7, 12AU7 and 12AX7 respectively. The first set of type-numbers is in numerical order and the second set is in alphabetical order. Whoever dreamed up these three valves, incidentally, certainly did a favour for the experimenter. They all have the same pin connections, with the result that all three types could be tried out in a new circuit without any need for rewiring the valveholder.

Are there any other mnemonics in general use? One that is fairly helpful concerns the new colour code for mains leads. Green-and-Yellow for 'earth' is reasonably easy to remember because of the association with green grass, and Blue and the first syllable of 'neutral' both have the same vowel sound. This leaves Brown and 'live', between which it seems difficult to create an association.

A final little tip brings us back to Ohm's Law again. This one doesn't, perhaps, quite fall into the mnemonic category, but it can certainly prove helpful in making quick mental caluculations with transistor circuits. What is committed to mind is that 'one milliamp in one kilohm equals one volt'. It is surprising how useful this fact can be in practice. If, for instance, 2 volts are dropped across a 1kΩ resistor, then the current in that resistor, working from the 1mA-1kΩ-1V relationship, is 2mA. Similarly, a current of 1mA in a 4.7kΩ resistor results in a voltage of 4.7 volts across that resistor. A voltage of 4.7 volts is also given by a current of 10mA in a 470Ω resistor. All that the tip does is to restate Ohm's Law in terms of milliamps and kilohms, whereupon it becomes possible to carry out transistor calculations with figures that are easy to handle, and don't involve long string of noughts.

SERIES

Here's a little mathematical problem which is, really, an updated version of one I posed several years ago. What are the next two figures in the series: 0.5, 1, 2, 2.5, 5, 10, 50.......?

I'll be giving the answer at the end.

OCCUPATIONAL HAZARDS

I read that members of pop groups tend to suffer from mild deafness due to prolonged exposure to the heavily amplified sound produced by their own instruments. In these technological times there are, of course, other occupational ailments which were not evident in earlier and less complex days and, donning my general practitioner's hat, I shall now list those which I have recently encountered myself.

Monochrome malady. This is a state of combined fury and frustration, and is caused when the owner of an expensive colour television receiver finds that, on showing it off to acquaintances, all channels are putting out black-and-white signals.

Recognition Tic. This is an involuntary facial spasm induced in service engineers on discovering that the first set to be fixed for the day is the one they devoted the first half of the previous week to repairing.

Bed-Rolling Cramps. An ailment which appears only in B.B.C. property men. It is caused by the continual trundling of the double-bed onto the set for B.B.C. television plays.

Space-Flight Hysteria. Another mental condition, this is induced by B.B.C. commentators breaking in on American Apollo transmissions.

Constructor's Choler. A vexation state, brought on by the bland statement by a radio shop assistant that an OC36 is an exact equivalent for an AD162.

Shopkeeper's Twitch. Complementary to the last ailment, this is caused by the customer who refuses to take a 10kΩ 5% resistor, because the design he's working to says 10kΩ 10%.

Solder Spleen. Another constructor's affliction, this consists of an attack of intense anger on finding that a length of what is supposedly solder is actually tinned copper wire. There are frequent secondary effects, such as the uncontrolled throwing of the wire to the back of the bench where it lodges in equipment and shorts out the mains.

JUNK

One of the perverse laws of life is that if you throw out a pile of junk which has been cluttering up the place for years you will find, as soon as the Corporation rubbish lorry has disappeared round the corner, that those old items are just exactly what you want for the next job.

Junk *is* a problem and it is always difficult to know what to dispose of and what to keep. So far as nuts, bolts, small brackets and similar hardware are concerned, the best solution consists of keeping the lot. Indeed, a good collection of nuts and bolts is a definite asset, and I add to my own whenever possible. If, for instance, I replace a faulty or broken mains plug or bayonet lamp holder I always remove the screws from it before throwing it away. The screws in these fittings aren't the B.A. types we normally use in radio and a source of replacements here is very useful.

Old burnt-out iron-cored transformers are best ditched. If you are keen on winding your own transformer it might be worth-while removing and keeping the laminations, as these are difficult to come by through home-constructor retail channels. In most cases, though, it just isn't worth the bother of trying to salvage the wire on the transformer, particularly if it has been varnish-impregnated instead of wax-impregnated. On the other hand, it's usually to advantage to keep old r.f. coils and chokes even when these are quite antedeluvian, if only because it's much easier to salvage the wire from these components.

The components most likely to actually deteriorate with age whilst being stored are paper capacitors, particularly suspect being the older-fashioned ones that are encapsulated in wax or plastic. These are liable to become leaky due to the ingress of moisture. Mere physical mishandling is sufficient to break the seal at the lead-outs with the wax-covered types, and the plastic used with the earlier plastic encapsulated capacitors wasn't too stable dimensionally and tended to shrink. A good way of checking a paper tubular capacitor above $0.002\mu F$ or so for leakage is to temporarily connect it to a d.c. supply of about 200 volts, disconnect it for several seconds, then apply the two lead-outs to a shiny metal surface. If there is an evident spark when the leads touch the surface the capacitor has retained its charge and can be considered good. It is worth initially trying out this idea with a few capacitors known to be serviceable in order to get the 'feel' of it. Naturally, the working voltage of the capacitor being checked should be equal to or greater than the test voltage. Also, don't forget to keep your fingers away from the capacitor lead-outs!

A neat and inexpensive method of storing components is to keep them in glass jars with screw-on lids. Each jar can contain a specific variety of component, such as resistors within a certain range of values, and so on. The larger pickle and honey jars are quite useful for this purpose after they have been emptied, washed and dried out. The contents of each jar can be seen through the glass at a glance. Large 30-tablet Alka-Seltzer glass tubes with the labels soaked off are useful for tubular ceramic capacitors, signal diodes and the like, but the supply of these tubes depends upon the frequency of headaches within the family. They are usually quite plentiful on December 26th and January 1st.

It isn't, of course, the home-constructor only who has problems with junk. Our local Post Office telephone exchange must have been having a clear-out recently because, when I went by the exchange building one morning, I saw that somebody had put out on the pavement an open bin which was almost completely full of 1-yard lengths of cable harness. I don't often drool in public but the sight of all that lovely connecting wire just sitting there was exceptionally tempting, and it was only the necessity of maintaining my public image in our local community plus the presence of a policeman on a nearby corner that prevented me from having a dig into that bin and getting away with a good few armfuls of the loot it contained.

PROBLEM

The answer to the series problem is one hundred and five hundred (expressed in words instead of figures so that there is less risk of their accidentally catching your eye). The series represents units in new pence. ■

NEW PANORAMIC DISPLAY HAS UNIQUELY WIDE SWEEP

A completely new panoramic display unit which provides a simple visual display of all the signals in a radio frequency band, and can operate anywhere in the radio frequency spectrum from zero to 60MHz, was recently announced by Eddystone Radio. A world selling price of less than £500 makes this the lowest cost panoramic display on the market. Prototype models of this equipment were demonstrated last year, and have already aroused considerable interest. The equipment is in full production at the Eddystone plant in Birmingham.

Wide Sweep Range

The new panoramic display shows all the signals in a selected radio frequency range in the form of spikes along a horizontal frequency scale on a cathode ray tube. The sweep width is variable, with a uniquely wide maximum sweep of 10MHz available at higher frequencies.

Typical Applications

In conjunction with a suitable communications receiver, the display provides visual monitoring of an entire tuning range, thereby revealing intermittent signals and interference sources. In this way, a single panoramic display can monitor calls simultaneously on many channels in a multi-channel communications network, such as a taxi, police or ambulance service. It will also show transmitter faults such as reduced efficiency or frequency drift on any channel.

The unit has a very fine frequency resolution which allows inspection of the frequency structure of a signal. This has a variety of applications in the field of education where it can be used, for example, to demonstrate the sidebands of different types of radio transmission, or the performance of filters. Similarly, in the laboratory, the panoramic display with its very wide sweep range can provide economical frequency-spectrum analysis. An output for driving a chart recorder is also provided. The unit can also check a transmitter and aerial for correct bandwidth and lack of spurious radiation.

Fully Solid-State

The new Eddystone panoramic display is completely solid-state, apart from the cathode ray tube, and is available in versions for use from zero frequency to 60MHz by choice of plug-in r.f. units. Rugged modular construction is used throughout the unit, with provision for standard 19in. rack mounting and for camera attachment. The large 10 x 6 cm display screen gives excellent clarity, and there is a choice of image persistence times.

The new Eddystone panoramic display, model EP361, may be added to Eddystone or other makes of high-grade communications receivers, and can be operated from mains or 12V battery.

LATE NEWS

Times = GMT *Frequencies = kHz*

★ AMATEUR BANDS

● FAROE ISLANDS

Heard on several occasions around 2000 on CW, OY1R busily working through a'log jam'of calls, on **14020.**

● ANGOLA

A regular CW addict is CR6AL, often to be heard around 2030 on, or near, **14060.**

● SPITZBERGEN

Active recently has been JW7UH, using CW on **14006** around 2030.

● PUERTO RICO

Another CW regular on 14MHz is KP4AZJ who appears to favour early morning sessions, around 0530, at the lower end of the band on **14010.**

● ECUADOR

Using the SSB mode, HC2EPL is active during the early mornings (0500) on, or near, **14035.**

● COLOMBIA

For those who are looking for a Zone 9 station, listen for SSB signals from HK5BWX around 0600 on **14140.**

● TASMANIA

Several stations are currently very active from this location. Listen for VK7AR on **14120,** VK7RX on **14140** and VK7GK on **14140,** all around 0530 or so, using SSB.

● ALBANIA

For this country, try **14215** around 2030 for the SSB signals of ZA1AB.

★ BROADCAST BANDS

● ETHIOPIA

Radio Ethiopia, Addis Ababa, can now be heard on the new frequency of **9650** with the Home Service in English and Amharic. English programme is from 1630 to 1700, followed by Amharic until 1900.

● ISRAEL

Already mentioned in QSX, Kol-Yisrael has vacated the experimental **7225** frequency and is currently trying the **6000** channel. Thanks are due to B. Walsh of Romford for putting us on to this one.

● NETHERLANDS ANTILLES

Trans-World Radio, Bonaire, has changed the **11705** channel to that of **11785** for the service to Europe at 2115.

● CLANDESTINE

Radio Liberation, Hanoi, now operates on **10010** until 1430 in French and then in English. Also, Radio Liberation can be heard in French at 2000 on **14990** and **15050** until 2030.

La Voix du FUNK (Front Union Nationale Kamche) can be heard from 1430 to 1530, 2300 to 2400, 1130 to 1230 on **7020, 9085, 10085** and **12006.** Also from 2400 to 0100, from 0400 to 0500 and from 1430 to 1530 on **5000, 9985, 10085** and on **12006.**

● LIBYA

The Libyan Home Service may be heard around 1915 on the 'out of band' channel of **8630.**

● TRUCIAL COAST

Sawt es Sahil can be heard around 1800 with Arabic programming on 6040.

Acknowledgements:–BADX, SCDX, Our Listening Post. ■

MORE NEWS

CEYLON

The External Service of the Ceylon Broadcasting Corporation has an English language test transmission from 0100 to 0230 on **6075, 9570** and **15120.**

INDONESIA

Radio Ankatan Udara (Air Force Radio) has been heard signing-off at 1400 on a new channel of **3408,** this being in parallel with **2475** and **11321.**

NEPAL

Radio Nepal has been heard using the unannounced frequency of **9590** from 0720 to 0920 and from 1320 to 1650, this channel replacing the old **7165** outlet. The External Service in English is from 1350 to 1420 on Tuesdays and Saturdays. Alternative channels sometimes used are **9605** and **11970.**

PAPUA & NEW GUINEA

A new station, Radio Madamg, has been heard on **3260** (2kW), schedule is from 0700 to 1100.

Radio Marobe, also a new station, is on **3220** (2kW) from 0700 to 1200.

Radio Wewak now uses **6140** as an additional channel.

LAST LOOK ROUND

1971 WORLD RADIO–TV HANDBOOK (SUMMER SUPPLEMENT)

The 1971 World Radio-TV Handbook (Summer Supplement) is a publication that should occupy a place at the operating position of all who tune over the shortwave broadcast bands with any serious intent. Published annually in June, the Summer Supplement brings up to date much of the information contained in the Handbook itself, which is released for distribution in December each year.

Updated information is of paramount importance for those actively engaged, whether as hobbyist or professionals, in shortwave broadcast work.

The latest Summer Supplement is of 144 pages, with the important station/frequency list consisting of 22 pages. A veritable mine of information, the Supplement is available direct from the Modern Book Co., 19 Praed Street, London. W.2., at £1.10 post paid (£1.00 net).

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(Continued on page 127)

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Continued from page 125)

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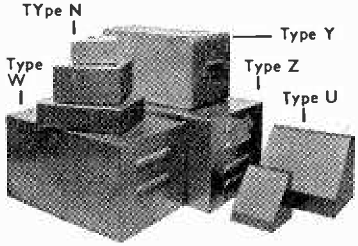

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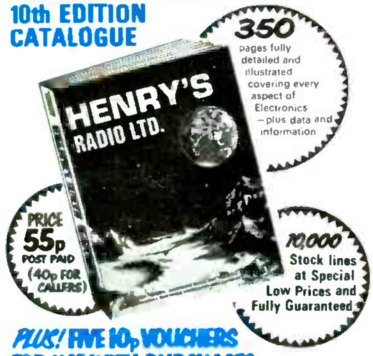

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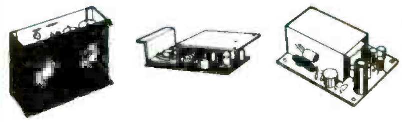

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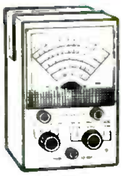

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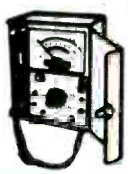

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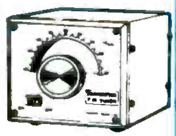

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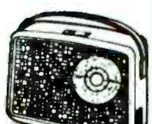

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