RADIO & ELECTRONICS CONSTRUCTOR

APRIL 1979
Volume 32 No. 8

Published Monthly
(3rd of preceding Month)

First Published 1947

Incorporating The Radio Amateur

Editorial and Advertising Offices
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Annual Subscription: £7.50, Overseas £8.50 (U.S.A. and Canada $15.00) including postage. Remittances should be made payable to "Data Publications Ltd". Overseas readers, please pay by cheque or International Money Order.

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Production— Web Offset.

Published in Great Britain by the Proprietors and Publishers, Data Publications Ltd, 57 Maida Vale, London W9 1SN.

The ***Radio & Electronics Constructor*** is printed by Swale Press Ltd.

THE MAY ISSUE
WILL BE PUBLISHED
ON 4th APRIL

TESTBENCH AMPLIFIER

By M. V. Hastings

High Input impedance, greater than 1MΩ

This simple amplifier is used by the author as a piece of test equipment for audio signal tracing and for testing newly constructed projects such as receivers, tuners, tone generators and signal generators. However, there are other possible applications for it, such as a low volume guitar practice amplifier. A general purpose unit of this nature can prove to be extremely useful and versatile.

The circuit is basically a direct coupled Class B design and it has the unusual feature of employing a Jugfet input transistor. The latter enables the amplifier to have a high input impedance, a valuable feature when it is used for signal tracing and experimental work.

INPUT IMPEDANCE

The input impedance is a little over 1M Ω at the full volume control setting, the impedance increasing to a maximum of some 2M Ω at lower settings. It requires an input level of about 30mV r.m.s. for full output. The amplifier has its own speaker, this being a miniature type with a diameter of less than 2½in. and having any impedance between 40 Ω and 80 Ω. Output power varies with the speaker impedance, being about 200mW with a 40 Ω speaker and 100mW when an 80 Ω speaker is used. The unweighted noise figure is better than -60dB with the volume control at maximum and the input left open-circuit. Distortion level is only a few percent provided the circuit is not overdriven, and the performance is perfectly adequate for a low cost audio amplifier intended for testbench use.

The basic stage line-up is illustrated in the simplified diagram of Fig. 1. For the time being, it will prove of help if we ignore the fact that TR1 is a Jugfet device and assume instead that it is a normal p.n.p. bipolar silicon transistor with its emitter connecting to C4 and R6, its base to the slider of R1 and its collector to the base of TR2. Thus, TR1 feeds the common emitter amplifier, TR2, which in turn feeds the complementary emitter follower output stage incorporating TR3 and TR4.

The emitter of TR1 is connected to the output of the amplifier via R6 rather than to the positive supply rail. Due to the phase inversion provided by TR2 there is, in consequence, 100 per cent negative feedback under d.c. conditions. For maximum output power before clipping on positive and negative audio half-cycles occurs it is necessary for the output emitters to be at half the supply voltage under no-signal conditions. The output emitters can then swing by equal voltages in both positive and negative directions before clipping occurs. Since, at d.c., there is unity voltage gain from the emitter of TR1 to the amplifier output, the no-signal voltage at the output emitters can be set to the half-supply voltage by the simple process of adjusting the pre-set potentiometer R1, and thereby varying the bias voltage on the base of TR1.

If, as has been assumed up to now, TR1 were a bipolar p.n.p. transistor, its base would be about 0.65 volt negative of its emitter and it would not in practice be necessary to use the pre-set potentiometer. This is because all the bipolar transistors likely to be used in the TR1 position would exhibit the same 0.65 volt drop between the base and the emitter. R1 could then be replaced by two fixed resistors of suitable values, with the knowledge that the same no-signal voltages would appear in all amplifiers made up to the circuit.

But — and we can now end the assumption that TR1 is a p.n.p. transistor — this transistor is actually a Jugfet device. The bias requirements for a Jugfet are quite different from those for a bipolar transistor, and under normal working conditions

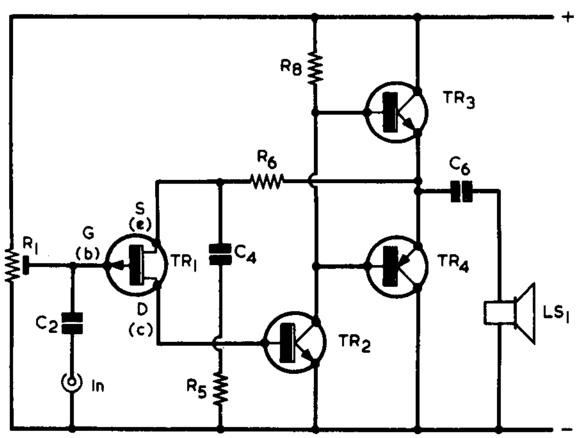

Fig. 1. Simplified diagram illustrating the stage line-up of the amplifier

LOW COST

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DESIGN

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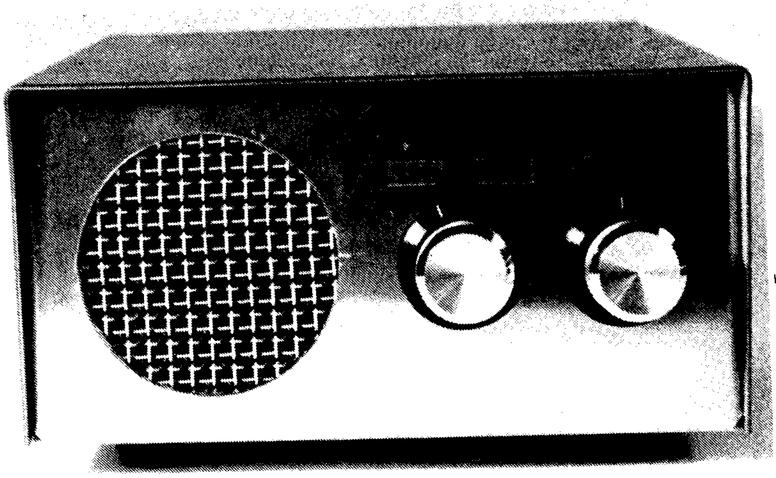


IDEAL FOR BEGINNERS

the Jugfet base is reverse biased with effect to its source. With a p-channel Jugfet, such as is used in the present amplifier, the gate will be positive of its source. Furthermore, the bias voltage required can vary between one Jugfet and another of the same type number, the range of variation being of the order of 0.5 to 3 volts.

This variation in Jugfet bias voltage makes it necessary to employ the pre-set potentiometer R1 instead of the two fixed resistors which would be all that were needed with a bipolar transistor in the TR1 position. However, the only complication introduced is that R1 has to be set up for half supply voltage at the output emitters after the amplifier has been constructed.

Whilst there is 100 per cent feedback under d.c. conditions, the feedback situation alters considerably at audio frequencies since C4 exhibits a low impedance at these frequencies. The a.f. voltage gain then becomes approximately equal to the value of R6 divided by that of R5.

Finally, the two capacitors C2 and C6 provide d.c. blocking at the input and output respectively.

PRACTICAL CIRCUIT

The full circuit of the Testbench Amplifier is given in Fig. 2. This is much the same as the simplified circuit of Fig. 1, although a few more components are included to meet practical requirements.

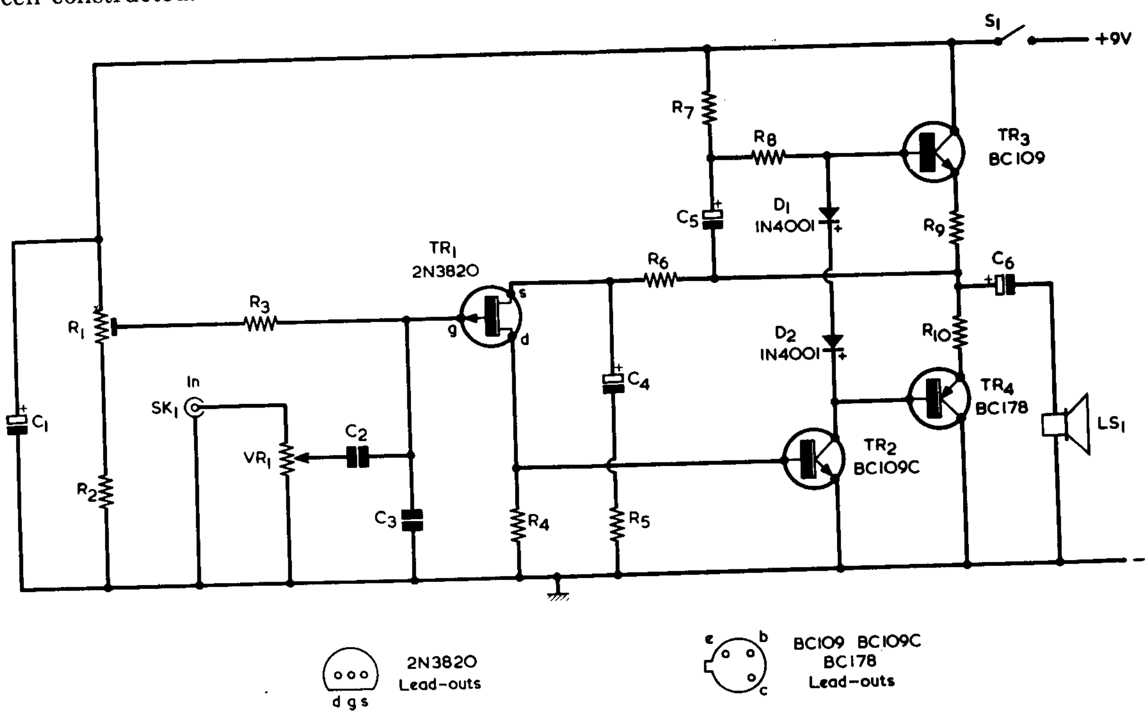
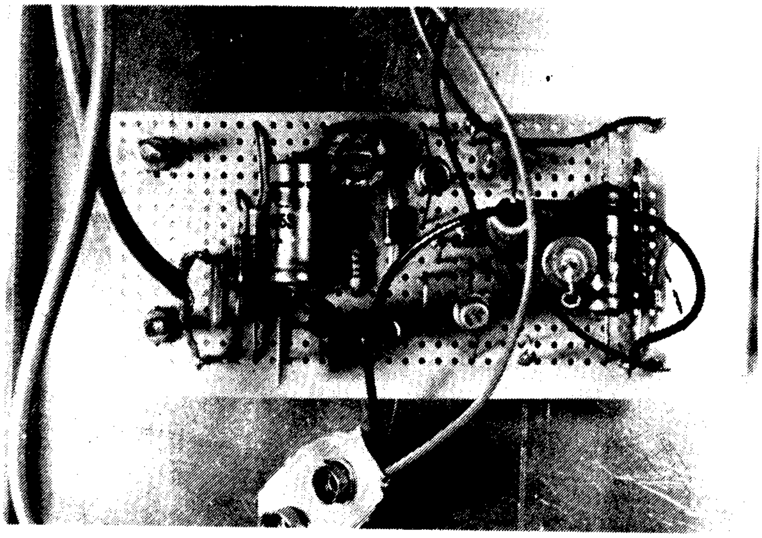


Fig. 2. Complete working circuit of the testbench amplifier. The f.e.t. in the TR1 position allows the amplifier to have a high input impedance, with the result that there is very little loading on any audio circuit to which it is connected



A close-up view of the Veroboard panel. Veropins are employed at the points where external connections are made to it

Volume control VR1 has been introduced at the input, together with R2 to reduce the shunting effect of R1. Since TR1 has an input impedance vastly greater than 1M Ω at low frequencies the input impedance is determined by the values of VR1 and R2. It is necessary for a testbench amplifier to have a high input impedance in order that it places little loading on any equipment to which it is connected.

As already mentioned, the voltage gain is equal to R6 divided by R5. With the values chosen for these two resistors the gain calculates at approximately 100 times.

The output and input of the amplifier are in phase, and since the input is at high impedance and there is a relatively high level of gain, any stray feedback from output to input could cause instability.

The risk of instability is removed in the practical circuit by the use of screened wire in the input volume control wiring, and the provision of C3 between the gate of TR1 and chassis. C3 reduces the input impedance at high frequencies, where stray feedback capacitances could otherwise cause possible instability.

R4 is the drain load for TR1 and, as TR2 requires about 0.65 volt between its base and emitter, it sets the operating current for TR1. With R4 at 680 Ω the current is approximately 1mA, most of which flows in the resistor.

COMPONENTS

Resistors

(All fixed values ¼ watt 5% unless otherwise stated)

R1 10kΩ pre-set potentiometer, 0.1 watt, horizontal

R2 10k Ω
R3 2.2M Ω 10%
R4 680Ω
R5 10 Ω
R6 1k Ω
R7 150Ω
R8 1kΩ
R9 2.2Ω
R10 2.2 Ω
VR1 2M Ω or 2.2M Ω potentiometer, log.

Capacitors

C1 100µF electrolytic, 10V Wkg.
C2 0.022µF type C280
C3 330pF ceramic plate
C4 220µF electrolytic, 10V Wkg.
C5 100µF electrolytic, 10V Wkg.
C6 220µF electrolytic, 10V Wkg.

Semiconductors

TR1 2N3820
TR2 BC109C
TR3 BC109
TR4 BC178
D1 1N4001
D2 1N4001

Switch

S1 s.p.s.t. rotary

Socket

SK1 3.5mm. jack socket (see text)

Speaker

LS1 40-80Ω miniature speaker (see text)

Miscellaneous

Metal instrument case (see text)
4 rubber feet
2 control knobs
Veroboard, 0.1in. matrix
9-volt battery (see text)
Battery connector
Screened cable
Speaker fret or fabric
Veropins (for 0.1in. board)
Nuts, bolts, wire, etc.

The two silicon diodes D1 and D2 produce a standing bias across the bases of the output transistors which, under quiescent conditions, allows the transistors to pass a small emitter current. This prevents crossover distortion. It should be noted that the diodes should be rectifier types and not small signal diodes as the latter could drop too high a voltage and cause an excessive quiescent output current. R9 and R10 help to prevent thermal runaway in TR3 and TR4.

The collector load resistance for TR2 consists of R7 and R8 in series. The output signal is fed to the junction of these resistors via C5. This bootstrapping technique allows the output stage to have the maximum possible output voltage swing on positive half-cycles.

S1 is the on-off switch and C1 is the only supply decoupling component which is required in the amplifier. Quiescent current consumption is about 7mA, but this can rise to some 50mA at high volume levels with a 40 Ω speaker. The rise in current at high output levels reduces with increasing speaker impedances.

TR2 is specified as a high gain BC109C, whilst TR3 is specified simply as a BC109. Where gain-selected transistors are available, TR3 may be a BC109A, BC109B or BC109C. S1 is called up as an s.p.s.t. rotary switch. A d.p.s.t. switch with one pole unused could alternatively be used.

CONSTRUCTION

The small components are assembled on a piece of 0.1in. matrix Veroboard having 15 copper strips by 33 holes. The ten breaks in the strips are first made, using a Vero spot face cutting tool or a small twist drill held in the hand, after which the two mounting holes are drilled out 6BA clear. The components are then soldered in position. Veropins suitable for 0.1in. Veroboard are fitted at the points where connections are made to the input screened wire, the speaker, S1 and the negative battery lead. These external connections are made later.

It is necessary to fit the amplifier in a metal case so that its circuitry is screened from sources of electrical interference such as mains cables, and the prototype is housed in a metal instrument case type C2 which is available from Harrison Brothers, P.O. Box 55, Westcliff-on-Sea, Essex, SS0 7LQ. This has approximate dimensions of 5 by 6 by 2½in.

The speaker is mounted on the left hand side of the front panel and requires a circular cut-out about 45mm. in diameter. A piece of speaker fret or cloth is then glued in place behind this cut-out. Most miniature speakers have no provision for nut and bolt mounting and so the speaker is glued in place behind the fret or cloth. Great care must be taken to ensure that no adhesive gets on to the speaker diaphragm or its surround.

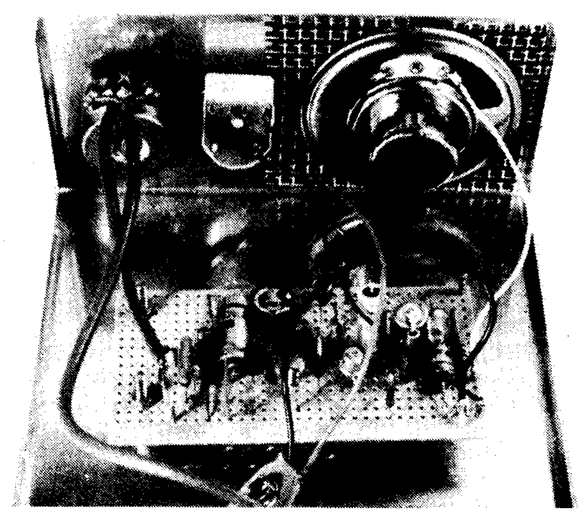
S1 and VR1 are mounted side by side to the right of the speaker, with S1 being closer to the speaker. These require standard 10mm. diameter mounting holes. In the prototype, input socket SK1 is mounted on the rear panel of the case. There is ample space for it on the front panel, however, and it can alternatively be mounted here if preferred. SK1 must be a 3.5mm. jack socket of open construction (i.e. not one with an insulated body) since its mounting bush and nut provide the chassis connection to the amplifier negative rail by way of the input screened wire braiding.

The component board is mounted on the base of the case with the mounting holes at the volume control end. It is secured by two 6BA bolts and nuts, with spacing washers over the bolts to keep the board underside well clear of the metal case.

The point-to-point wiring to the remaining components is then completed, and this is also illustrated in Fig. 3. As already stated, the wiring from the board to VR1, and from VR1 to the input socket, employes screened cable to prevent possible stray capacitive couplings from the output.

There is plenty of space for the battery to the rear of the component board. A PP3 battery will offer quite a long life if the amplifier is used intermittently, but for extended use a larger battery, such as a PP6, will be more economical. The author used Bostik "Blue Tack" to prevent the battery moving around but a probably better alternative would consist of securing it in place with a simple home-made aluminium bracket.

The smaller components are all wired up on a Veroboard panel. There is space for the battery behind this panel



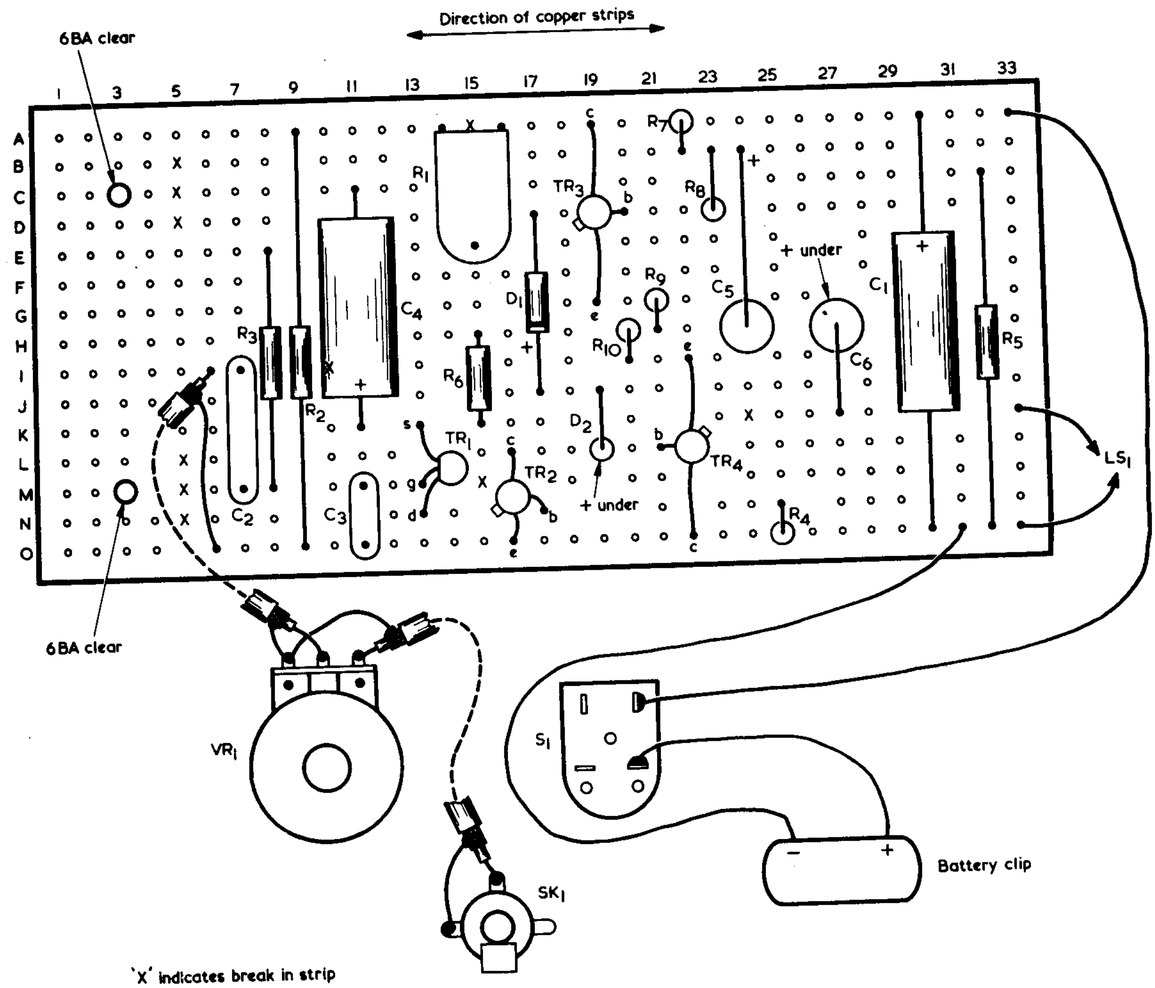
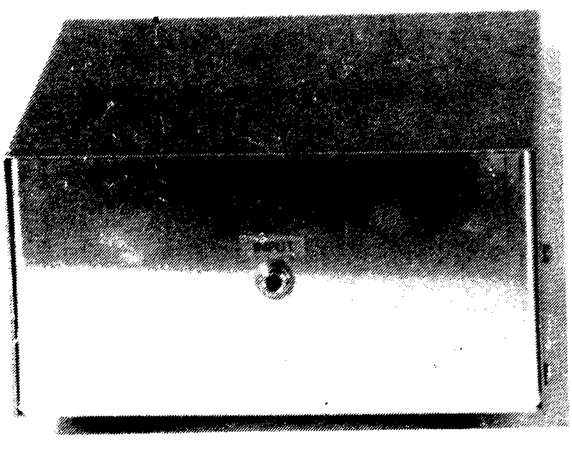


Fig. 3. The wiring up of the amplifier is rendered reasonably simple by the use of a Veroboard panel. Layout on the panel and the connections to external components are shown here.

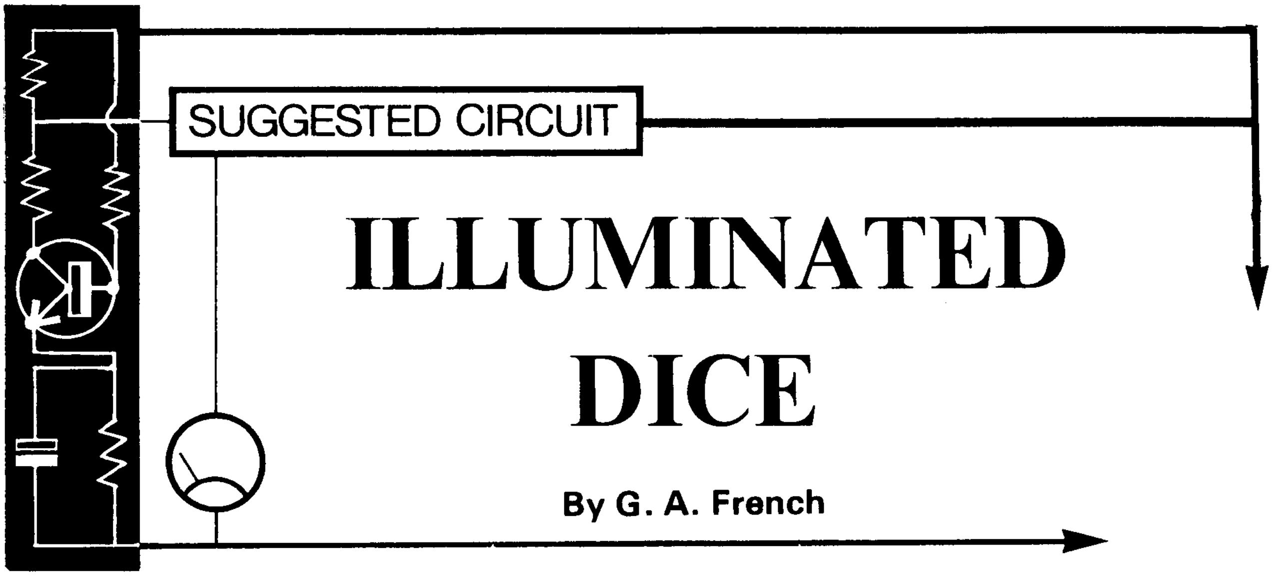


The input socket is mounted on the rear panel in the prototype amplifier. It can alternatively be mounted on the front panel, if desired

ADJUSTMENT

After the amplifier has been completed and its wiring checked, R1 should be adjusted so that its slider is roughly central on its track. A multimeter switched to a suitable voltage range then has its negative test clip connected to chassis and its positive test clip to the output transistor emitters. A suitable test point is at the lead of R9 which passes into hole H21. Take care that the testmeter clip does not touch adjacent wires or metal transistor cases. Switch on with a battery connected and then adjust VR1 until the meter gives a reading of 4.5 volts. The testmeter clips are removed and the amplifier is ready for use.

Because of the high input impedance of the amplifier, screened wire must be used to couple it to the equipment from which input signals are being taken. The wire is connected to the input jack plug such that its braiding is common with the plug sleeve and thereby couples to the metal housing of the amplifier. ■



ILLUMINATED DICE

By G. A. French

Several circuits which reproduce the action of a dice in giving randomly chosen numbers from 1 to 6 at the touch of a switch or button have appeared in these pages, readout being by means of six l.e.d.'s numbered 1 to 6 or by a 7-segment display. A project giving readout by six l.e.d.'s was contributed by the author under the title "Electronic Dice", and it appeared in the issue for February 1978.

It has since occurred to the writer that a striking method of presenting the numbers 1 to 6 would consist of having l.e.d.'s light up to form the patterns given by the dots on an actual dice itself, and the present article describes a suitable circuit for achieving this end. The appropriate l.e.d.'s are illuminated by operating a switch, and the result is a surprisingly attractive and arresting form of display. It is possible that the appeal of the project rests in the fact that the l.e.d.'s produce a pattern which is familiar from the days of childhood and which therefore incurs a degree of nostalgia. Added to that is the fact that the numbers displayed are completely random; this particular dice can in no way be loaded!

DOT PATTERN

Before looking into circuit details it is first of all desirable to analyse the different dot displays which are needed to present the numbers 1 to 6 in the dice pattern. These are shown in Fig. 1, where the number 1 is represented by a single central dot, the number 2 by two dots on a diagonal slope and so on.

The dice numbers can all be produced by the appropriate selection of one or more of seven l.e.d.'s laid out in the manner shown in Fig. 2. These are lettered A to G, and the accompanying Table shows which

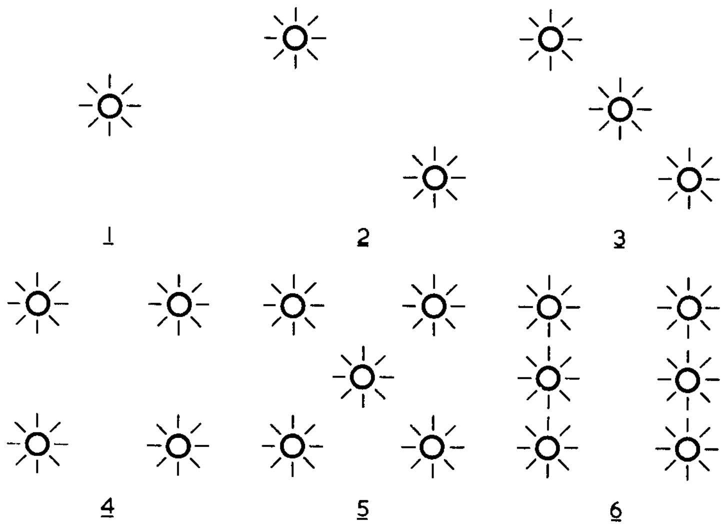


Fig. 1. Dot patterns, represented by illuminated l.e.d.'s, for dice numbers from 1 to 6

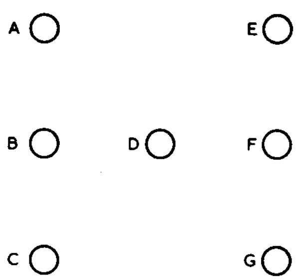


Fig. 2. Seven l.e.d.'s are required, and these are shown here lettered A to G

TABLE

Number	Lit l.e.d.'s
1	D
2	AG
3	ADG
4	ACEG
5	ACDEG
6	ABCEFG

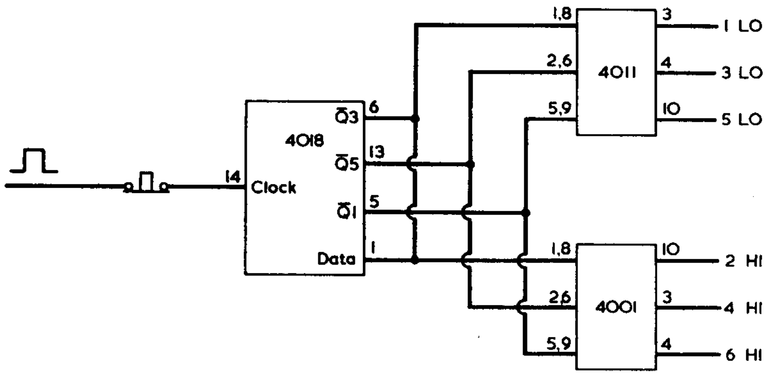


Fig. 3. Number generator circuit. This gives successive outputs from 1 to 6

l.e.d.'s are lit up for each number. It then becomes necessary for an electronic coder to select the l.e.d.'s corresponding to each number.

NUMBER GENERATOR

The first requirement of the electronics in the dice is to produce the numbers 1 to 6 in random fashion at the operation of a switch, and a suitable number generator for this purpose is that used in the earlier "Electronic Dice" article, which is reproduced in basic form in Fig. 3. This incorporates a CMOS presettable divide-by-n counter type 4018, a quad 2-input NAND gate type 4011 and a quad 2-input NOR gate type 4001. Only three of the gates in the 4011 and the 4001 are used in the circuit.

The 4018 is preset to divide by 6, this being achieved by returning its not-Q3 output at pin 6 to its data input at pin 1. Regularly spaced positive-going pulses are fed to the clock input at pin 14, advancing the counter by one step at each positive edge. The not-Q1, not-Q3 and not-Q5 outputs are gated by the 4011 and the 4001 to produce successive outputs from 1 to 6. Until they are actuated, all the outputs of the 4011 are high (i.e. close to the positive rail) and all the outputs of the 4001 are low (i.e. close to the negative rail).

At the first positive pulse in a 6-number cycle, pin 3 of the 4011 goes low. The next positive pulse returns it to the high state and causes pin 10 of the 4001 to go high. The following pulses successively cause pin 4 of the 4011 to go low, pin 3 of the 4001 to go high, pin 10 of the 4011 to go low and pin 4 of the 4001 to go high. The next positive pulse takes pin 3 of the 4011 low again and the sequence repeats.

When the push-to-break button in series with the clock input is pressed the flow of positive pulses to the 4018 ceases, and the circuit rests in the state it held at the instant of breaking the push-button contacts. In "Electronic Dice" the 4011 and 4001 outputs then lit one of six l.e.d.'s by way of emitter followers or common emitter transistor amplifiers. The dice was "thrown", in consequence, by pressing the push-button.

The manner in which the numbers 1 to 6 are extracted from the not-Q1, not-Q3 and not-Q5 outputs of the 4018 is rather complex, and interested readers will find an explanation in the "Electronic Dice" article together with an earlier article in the Suggested Circuit series, "CD4018 Truth Tables". The latter was published in the June 1977 issue of *Radio & Electronics Constructor.*

OUTPUT CODING

For the present application it is necessary to code the outputs of the 4011 and 4001 in order that the l.e.d.'s be illuminated, and this can be carried out with the aid of discrete transistors. If we return to the Table we see that l.e.d. A and l.e.d. G are lit for all numbers except 1. It follows that the simplest method of driving these two l.e.d.'s is to have them normally lit and inhibited in the presence of a 1 output. The appropriate circuit is shown in Fig. 4(a). Here, the common emitter n.p.n. transistor is conductive for all the numbers except 1, when pin 3 of the 4011 goes low.

The Table also tells us that l.e.d. D lights up for 1, 3 and 5. A suitable circuit for lighting this l.e.d. appears in Fig. 4(b), in which the transistor is a p.n.p. emitter follower. The l.e.d. lights up when either pin 3, pin 4 or pin 10 of the 4011 goes low. The three diodes prevent short-circuits between any low output and the remaining high outputs.

Another "one-off" situation is given with the number 6, this being the only number which requires l.e.d. B and l.e.d. F. These can be fed by a common emitter n.p.n. transistor coupled to pin 4 of the 4001. This pin goes high only at number 6. See Fig. 5(a).

Only two l.e.d.'s are now left, l.e.d. C and l.e.d. E, and these light up at 4, 5 and 6. Numbers 4 and 6 can be catered for by coupling a common emitter n.p.n. transistor to pins 3 and 4 of the 4001, series diodes being added to prevent short-circuits between outputs. At number 5, the n.p.n. transistor is non-conductive and the two l.e.d.'s are driven by a p.n.p. emitter follower coupled to pin 10 of the 4011. The diode in series with the base of the p.n.p. transistor ensures that its maximum base-emitter reverse voltage rating is not exceeded when the base is high and the emitter is low. The arrangement is shown in Fig. 5(b).

The circuits of Figs. 4(a) to 5(b) provide all the coding that is required to drive the seven dice l.e.d.'s. It will be noted that the output at pin 10 of the 4001 is not used, whereupon the gate connecting to pins 8, 9 and 10 of this i.c. can be excluded from the final circuit.

COMPLETE CIRCUIT

The complete circuit of the illuminated dice project is shown in Fig. 6. The positive-going pulses for the clock input of the 4018 are obtained from a standard 555 oscillator running at approximately 150Hz. The pulses are fed to the 4018 via S1(a) and cease when this switch is set to position 2. At the same time, S1(b) applies the positive supply to the dice l.e.d.'s. Thus, when S1(a) (b) is in the "Shake" position the l.e.d.'s are extinguished. Putting the switch to "Throw" causes the appropriate l.e.d.'s in the dice display to be lit. The effect is far more striking than is given if the l.e.d.'s are left on all the time to give a flickering display which changes to a fixed pattern when the pulse input to the 4018 is interrupted. There is, also, much less current drain from the 6 volt battery.

The coding circuitry has already been described in detail, and Fig. 6 gives the component values and transistor types. TR1 is in the circuit of Fig. 4(a), and TR3 in that of Fig. 4(b). Fig. 5(a) is given by TR2 and its immediate components, whilst the two transistors of Fig. 5(b) appear as TR4 and TR5.

L.E.D.H is not part of the dice pattern, and is included to act as a reminder that the unit is switched on. It extinguishes when S1(a) (b) is put to "Throw" and the other l.e.d.'s are illuminated, and also of course when the circuit is switched off at S2. L.E.D.H should have a

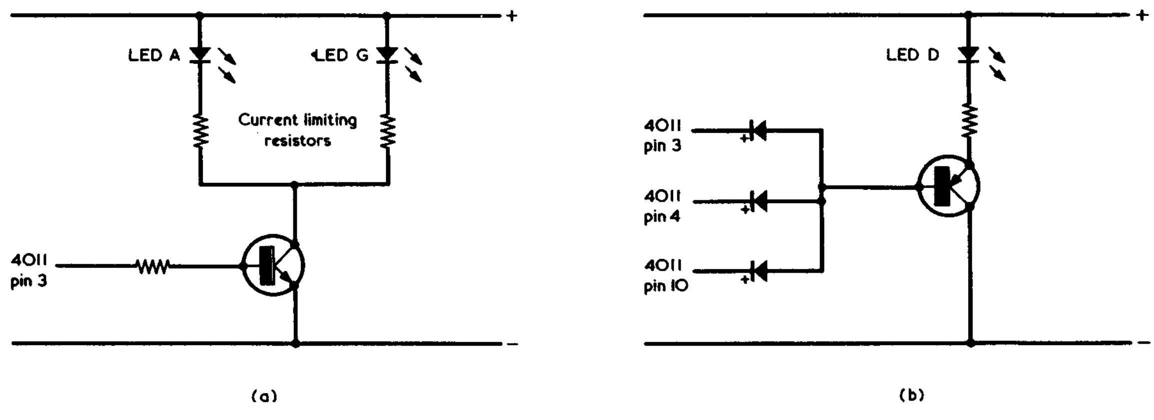


Fig. 4(a). Coding circuit for driving l.e.d.'s A and G. (b). The circuit required for l.e.d. D

different colour from the other l.e.d.'s. L.E.D.A to l.e.d.G could, for instance, all be green whilst l.e.d. H is red. The l.e.d.'s are normal small types with panel-mounting bushes.

A suitable front panel layout is shown in Fig. 7, the dimensions being approximately 4½in. high by 4in. wide. S1(a) (b) and S2 are small slide switches and l.e.d. A to l.e.d. G are laid out in the same manner as in Fig. 2. When the unit is switched on with S1(a) (b) at the "Shake" position, only l.e.d. H becomes alight. The dice number is shown when S1(a) (b) is set to "Throw". For the next number it is returned to "Shake" and then put to "Throw" again.

Current consumption is around 10mA with S1(a) (b) in the "Shake" position. In the "Throw" position the current drain depends mainly upon the number of l.e.d.'s which are lit, each l.e.d. drawing about 15mA. When the number 6 is displayed the l.e.d. current rises to some 90mA. The 6 volt supply could consist of two No. 800 cycle lamp batteries in series or four SP2 cells. Battery consumption can be reduced by increasing the values of the 270Ω current limiting resistors in series with the l.e.d.'s, but the author feels that the most impressive effect is given when the l.e.d.'s are lit really brightly.

As a final point, the circuit can be slowed down for testing purposes by connecting a 22μF electrolytic capacitor across C2. The 555 then completes a cycle in about 3 seconds. If the positive rail is temporarily connected to the l.e.d. anodes, thus bypassing S1(b), the l.e.d.'s go slowly through the dice numbers from 1 to 6 and then start again when S1(a) is in position 1. If, with the circuit in this condition, S1(a) is taken to position 2 the 4018 will probably hop through several numbers. This is merely the result of contact bounce in S1(a) and is

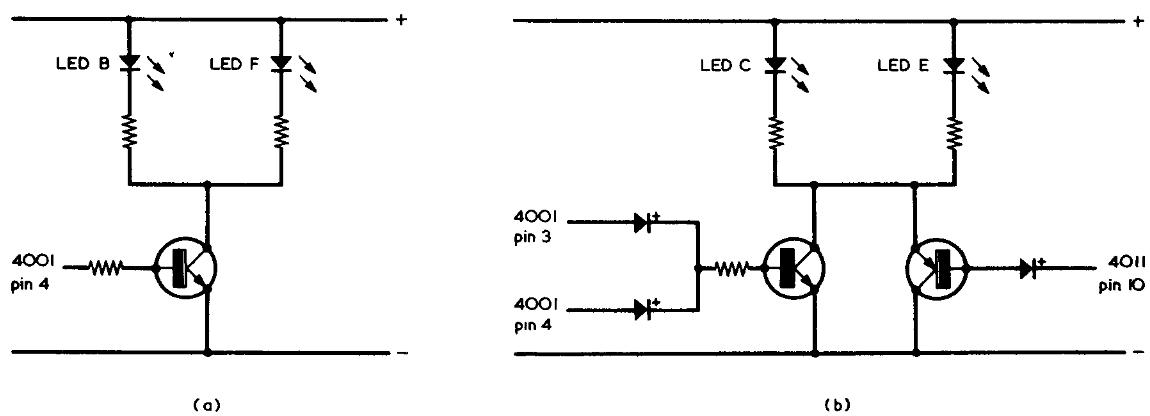


Fig. 5(a). A simple circuit is adequate for l.e.d.'s B and F. (b). A more complex arrangement is needed for C and E

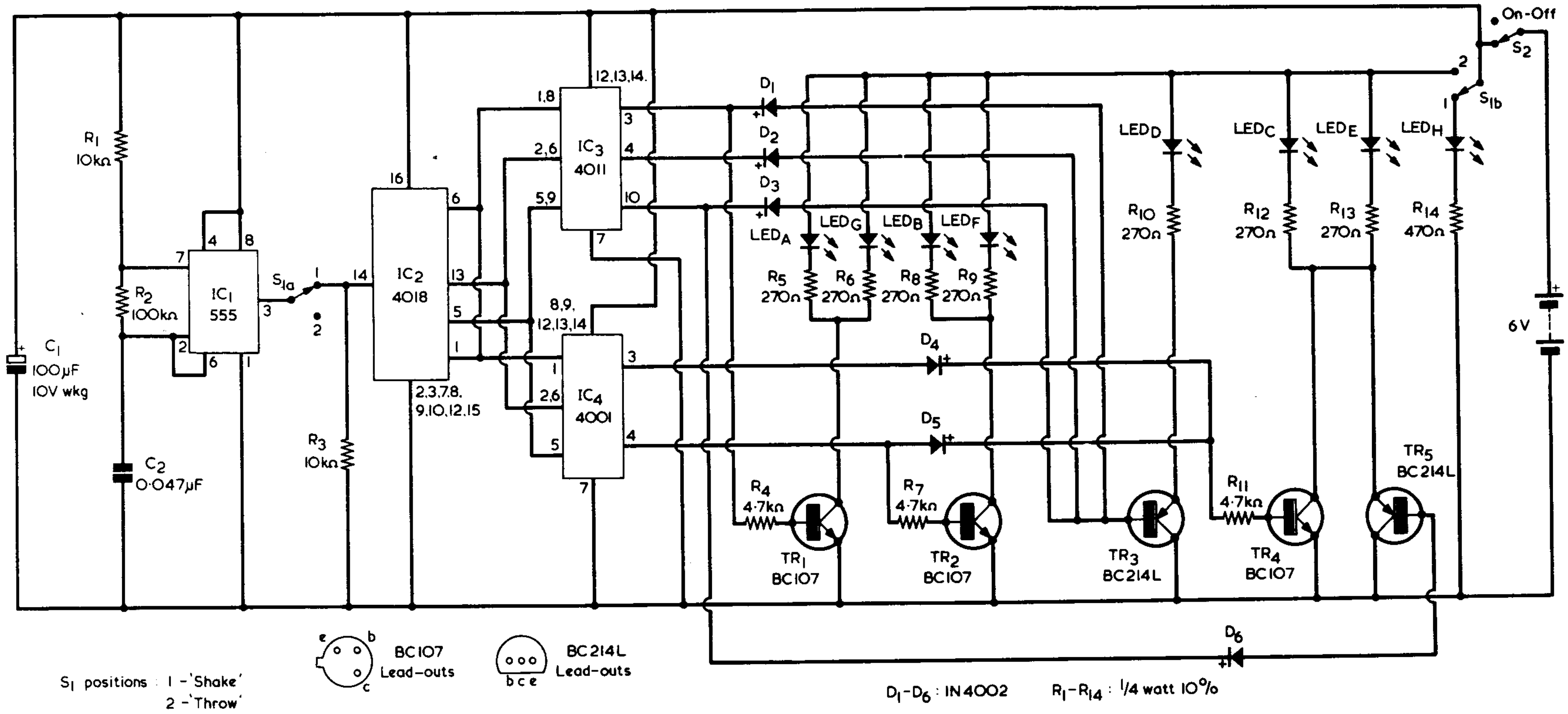


Fig. 6. The complete circuit of the illuminated dice. No connections are made to i.c. pins whose numbers are not shown

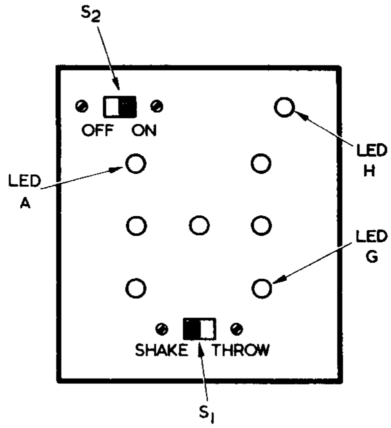


Fig. 7. The illuminated dice may be housed in a small case having the front panel layout shown here

not a fault condition. Immediately after switch-on the circuit goes through two non-standard steps before starting the 1 to 6 cycle. This is due to the 4018 outputs settling into their final repetitive states and the effect, which is only noticeable when the circuit has been slowed down, can be ignored. ■

FINGER TROUBLE

Readers will have been mystified by the fact that last month's "Suggested Circuit" had the misleading title "Electronic 'Hangman' ". The correct title should have been "The Finger Pinger". We much regret the error and can only plead the extra work involved in bringing our publication date forward after the delayed February issue.

NEWS . . . AND

A HELPING HAND

One of the pleasing aspects of our hobby is the number of enthusiasts who are prepared to spend their spare time in helping others. In some cases it is a case of helping the community by using a knowledge of electronics in organisations such as the Radio Amateur Emergency Network, or, in helping others with a common interest in electronics in such organisations as The British Amateur Electronics Club (B.A.E.C.). From time to time we will give some information and background on the activities of societies like the foregoing. This month we give some information on the B.A.E.C.

The B.A.E.C. started out as a local amateur club in Penarth, Glamorgan. In 1966 the members decided to open their membership to anyone interested in electronics irrespective of where they lived. It was appreciated that many electronic enthusiasts do not have the opportunity of enjoying the help and companionship that membership of a club can bring. By means of a regularly published Newsletter (40 large pages in the last issue) containing not only technical articles but also topics of interest, correspondence columns, news, requests for technical help, arrangements for exchanges and borrowing of equipment etc., a club atmosphere is created. At the same time help is readily available for members living near each other to form themselves into groups where they can meet personally.

The main base of the club is still in Penarth where once a year the club organises a very successful exhibition of projects built by members, both as joint activities and as individual exhibits. Each year from the proceeds a substantial sum is donated to Cancer Research.

We congratulate all who work so hard and unselfishly for B.A.E.C., and we wish it growing success in the future. Any reader wishing to know more about it should write to the Honorary Secretary, J. G. Margetts, 42 Old Vicarage Green, Keynsham, Bristol.

HAND-HELD 50MHz FREQUENCY COUNTER

Continental Specialties Corporation announce the introduction of a low-cost, hand-held frequency counter with a guaranteed operational frequency range of 100Hz to 50MHz.

Known as the Mini-Max, this 6-digit battery-powered instrument has a crystal controlled time base accurate to 3ppm, with automatic compensation for changes in battery power. It is capable of accurately measuring the frequency of signals with peak amplitudes as low as 30mV, and is fully protected against input transients up to 100V.

The Mini-Max incorporates a 6-digit LED display with magnified 0.1in. characters. Decimal points for KHz and MHz are automatically inserted when the instrument is switched on, and all zeros to the left of the first non-zero character are blanked. Other features include auto-ranging and auto-polarity, and no switching is required to cater for changes in input frequency.

Operational characteristics include a resolution of 100Hz throughout its frequency range, input impedance greater than 1 megohm, peak input of 100V, and maximum sensitivity of 30mV. The display is updated six times per second.

Priced at £54.00, the Mini-Max is supplied complete with antenna and input lead.

'TELEVISION & RADIO 1979'

Technical innovation is highlighted in the new edition of the Independent Broadcasting Authority's handbook, 'Television & Radio 1979'.

A key section of the book, 'Better Viewing and Listening' outlines the pace-setting work of IBA engineers. Amongst their achievements described in 'Progress in Engineering' have been the development of ORACLE — the IBA's teletext service, the portable communication satellite groundstations and the progress in developing digital studio equipment.

The first full year of operation of the advanced Regional Operations Centre at Croydon, from which an engineer can supervise by remote control the television transmitters serving almost 20,000,000 people from the Wash to Dorset, was marked during 1978. The success of this centre foreshadows three more centres to be built in the future which will significantly improve the efficiency and reliability of the IBA's transmitter network throughout the rest of the country.

'Television & Radio 1979', is a comprehensive guide to the workings of Independent Television and Independent Local Radio and has 224 pages, 9in. by 7⅝in., with over 300 illustrations, many of them in colour. It is published by the IBA, price £2.50 from newsagents and booksellers.

. . . COMMENT

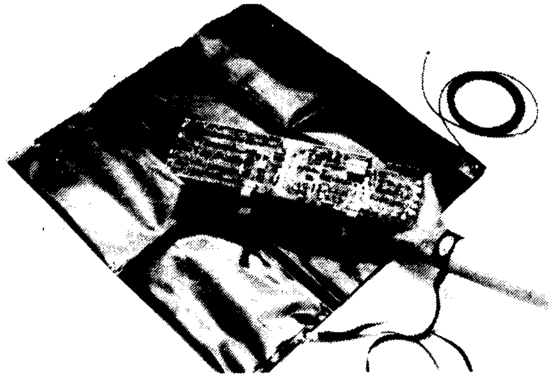
PORTABLE FIELD SERVICE KITS FOR STATIC ELIMINATION

A portable field service kit which can prevent electrostatic charge from damaging sensitive electronic components during service operations is now available from 3M United Kingdom Limited. Its handy size and contents have been designed for use by service engineers.

This is the "Velostat" 8005 Field Service Grounding Kit, which provides an effective method of draining electrostatic charge from the service engineer to ground before it can destroy sophisticated components, such as MOS, bi-polar devices and micro-processors.

Research has shown that thousands of volts of electrostatic charge can be generated and stored in a technician's body by simply walking across floors and sliding on and off stools. When a technician or engineer handles a printed circuit board, the electrostatic charge flows from him through the circuitry, literally blowing components or damaging them to create a more difficult service problem of intermittent malfunction. For instance, a straight 90-volt electrostatic discharge from a handler can blow devices.

The "Velostat" Portable Service Kits have been designed to give compactness with portability for servicing personnel. A kit consists of a "Velostat" Table Top (24 inches square), a conductive wrist strap and a ground cord. The Table Top has convenient storage pockets and can be rolled or folded to fit neatly in tool cases.



The new "Velostat" 8005 Field Service Grounding Kit

EXHIBITIONS

Exhibitions for the electronics hobbyist seem to be growing apace. Following the great success of the Breadboard '78 exhibition at the Seymour Hall (attended by more than 10,000 people!) we are learning of additional exhibitions to be held this year.

A newcomer, of which we can give some early news, is to be called 'The Great British Electronics Bazaar'. It is to be held at the Alexandra Palace from 28th to 30th June 1979.

This exhibition is being mounted by The Evan Steadman Communications Group, well-known as promoters of exhibitions for the electronics industry. The Electronics Bazaar will cater primarily for the amateur and hobbyist. Exhibitors will fall into the following main categories — makers of electronic kits (from radios to electronic organs), personal computing kits, printed circuits, breadboards, component and low-cost test equipment suppliers.

In addition to exhibitor's stands there will be talks and lectures. The well-known technical author and occasional contributor to our pages, David Gibson, will, for example, be conducting an important session when he will lecture on 'How to choose and use a microprocessor'.

Alexandra Palace is an ideal exhibition centre with its large area, easy access to the North Circular Road and extensive car parking facilities.

The whole project sounds very exciting and just the thing for our readers.

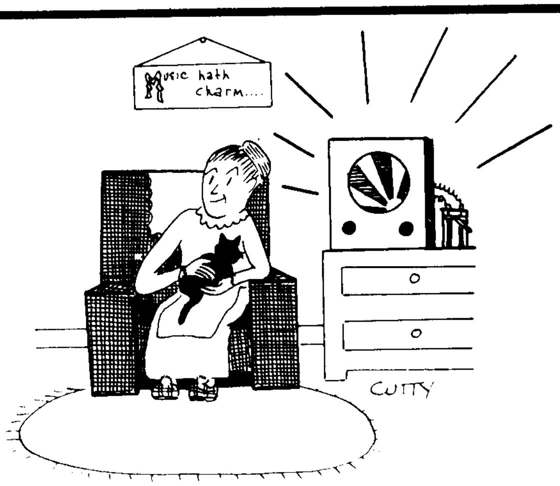
COMPONENT BARGAINS

● Home Radio (Components) Ltd., of 234-240 London Road, Mitcham, Surrey CR4 3HD, are reorganising their stocks as they move them into a new warehouse. This gives Home Radio the opportunity to dispose of substantial items of surplus stock at bargain prices.

These special prices are available to callers only during the period 24th to 31st March next and all the stock offered is new. A call at their premises during the above period could be very rewarding.

● In our February issue we gave preliminary notice of a rather intriguing offer by Messrs. Brian J. Reed of 161 St. John's Hill, Battersea, London SW11 1TQ. On 22nd March the business will not only celebrate 21 years of serving the electronics world but also the personal birthday of the proprietor.

Any reader who sends a birthday card with his order will receive, in addition, a packet of components, at the choice of the proprietor, to the approximate value of 20% of the order.



"And now for all you Punk rockers"

F.M. TUNING INDICATOR

By John Baker

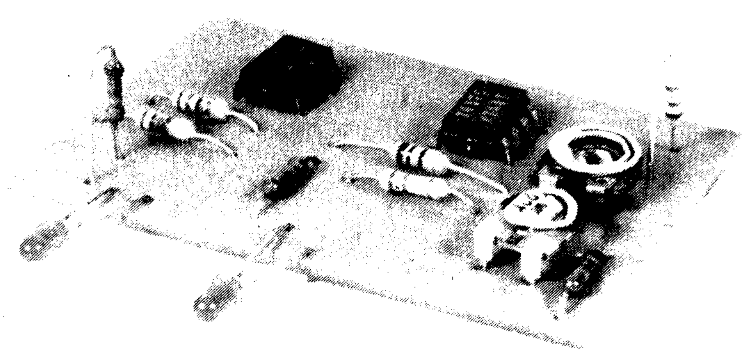
● Inexpensive design, suitable for quadrature f.m. detectors

● Employs two l.e.d.'s and dispenses with a costly meter

When tuning in a signal on an f.m. receiver there is normally a range of tuning control settings which allow a reasonably good audio output to be obtained. With weak stations the tuning range may be limited whilst with strong stations it can be quite wide. In both instances it is desirable for the signal to be tuned to the centre of the i.f. and detector responses, and considerable distortion at high modulation levels may occur if this is not done. It is fairly easy to judge the central tuning position with weak signals but it is more difficult to do so with strong signals and their consequent wide tuning range.

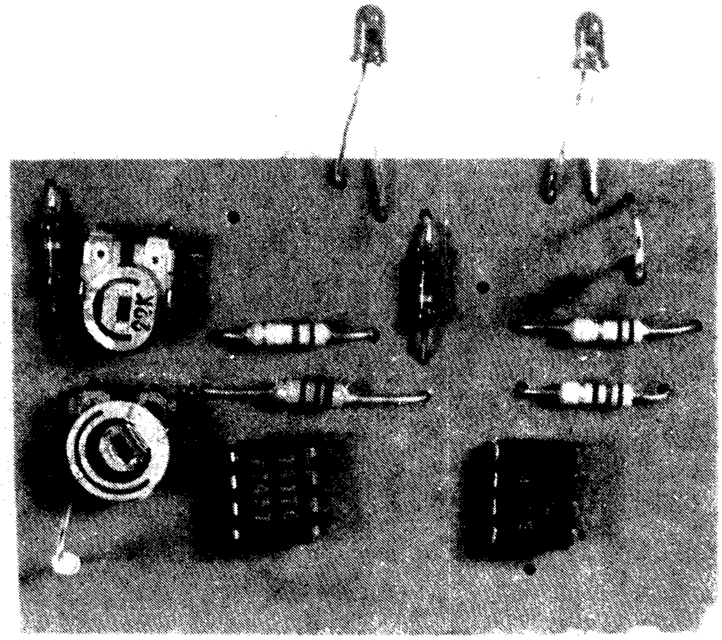
For this reason it is common for some form of tuning indicator to be fitted to f.m. tuners and receivers, one of the most frequently employed types being a centre-zero meter. Alternative methods use an indicator light or lights. Tuning meters tend to be difficult and relatively expensive to obtain and they often have awkward mounting arrangements. The alternative indicators employing lights become more attractive therefore so far as the home-constructor is concerned.

The simple tuning indicator described in this article uses two l.e.d.'s in place of a tuning meter. When the tuning is correct both l.e.d.'s are switched off. If the tuning is off centre one of the l.e.d.'s will light up to indicate the direction in which the tuning is in error. Also, the greater the tuning error, the brighter the l.e.d. will light up. The indicator is thus analagous to a conventional centre-zero tuning meter, and is used in precisely the same way. Results are of the same order as those given with the centre-zero meter.



The tuning indicator consists of a neat little printed board assembly. Power is obtained from the f.m. tuner or receiver in which it is fitted

Looking down on the printed board. The two i.c.'s are 741 op-amps



THE CIRCUIT

The indicator is intended for use with a quadrature f.m. detector, the voltage output of which is approximately central between the supply rails when a signal is correctly tuned in, or when no input signal is present. Adjusting the tuning to one side of the correct setting causes the detector output to swing positive up to a few hundred millivolts, and adjusting the tuning to the other side of the correct setting results in the output swinging negative by a similar amount. The greater the tuning error, the larger is the change in the output potential. The author's prototype tuning indicator is fitted to a home-made f.m. receiver incorporating an SN76660N i.c. detector.

What is probably the most obvious configuration for the tuning indicator is a simple window discriminator type of circuit using a couple of operational amplifiers as comparators, as shown in block diagram form in Fig. 1. The values of RA, RB and RC in the potential divider are chosen such that the voltage at the junction of RA and RB is fractionally above the correct detector output voltage, and the voltage at the junction of RB and RC is fractionally below. When the input voltage is correct, or very nearly so, both comparator outputs must obviously be high, and the l.e.d. indicators driven from these outputs will both be turned off.

If the input tuning voltage goes too high by a significant amount, the inverting input of Comparator 1 will become positive of the non-inverting input and the comparator output will go low, causing LED1 to light up. The non-inverting input of Comparator 2 is still positive of its inverting input and LED2 will remain extinguished. Should the input voltage go significantly negative of the correct level it is the input polarities of Comparator 1 which remained unchanged, with LED1 extinguished, whilst the non-inverting input of Comparator 2 goes negative of its inverting input. The

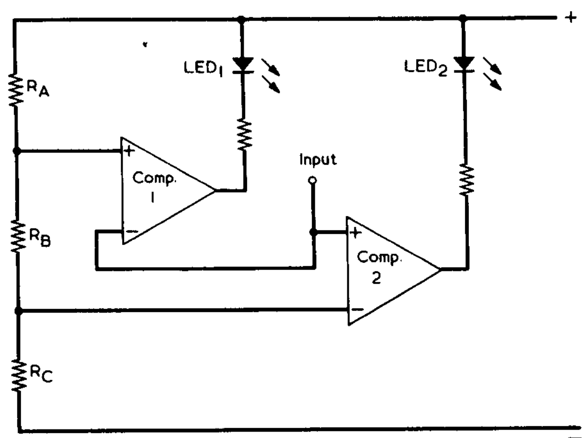


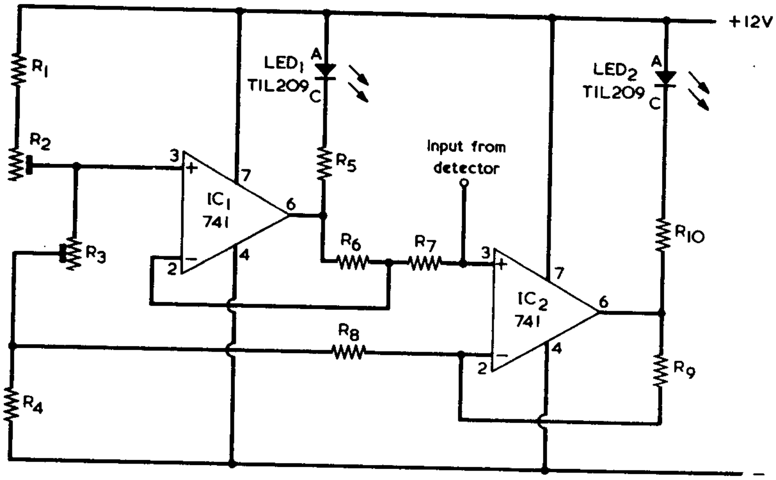
Fig. 1. A basic approach for indicating input voltages which go positive or negative of the supply centre voltage

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)
- R1 8.2kΩ
- R2 22kΩ pre-set potentiometer, 0.1 watt, horizontal
- R3 1kΩ pre-set potentiometer, 0.1 watt, horizontal
- R4 15kΩ
- R5 1.5kΩ
- R6 5.6MΩ
- R7 180kΩ
- R8 180kΩ
- R9 5.6MΩ
- R10 1.5kΩ

Semiconductors
- IC1 741 in 8-pin d.i.l.
- IC2 741 in 8-pin d.i.l.
- LED1 TIL209 or similar
- LED2 TIL209 or similar

Miscellaneous
- 2 l.e.d. panel mounting bushes
- Materials for printed circuit board
- Wire, solder, etc.



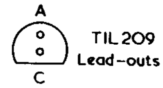


Fig. 2. The complete circuit of the tuning indicator. Negative feedback loops limit the voltage gain of each op-amp to about 31 times

output of Comparator 2 goes low and LED2 lights up.

The arrangement of Fig. 1 provides the required basic action but it suffers from the practical disadvantage that there are no intermediate levels of illumination in the l.e.d.'s. Due to the high open loop gain of the operational amplifiers one l.e.d. will either be fully on or totally extinguished.

In the working circuit of Fig. 2 this problem is overcome by adding discrete negative feedback loops to each comparator to limit the voltage gain to about 31 times. The feedback network for IC1 consists of R6 and R7, and that for IC2 consists of R9 and R8.

R2 enables the circuit to be adjusted to suit the particular input voltage given by the detector to which the indicator is connected. R3 controls the limits of the central voltage range over which both l.e.d.'s are extinguished. The lower the resistance inserted into circuit by R3, the smaller is this central voltage range.

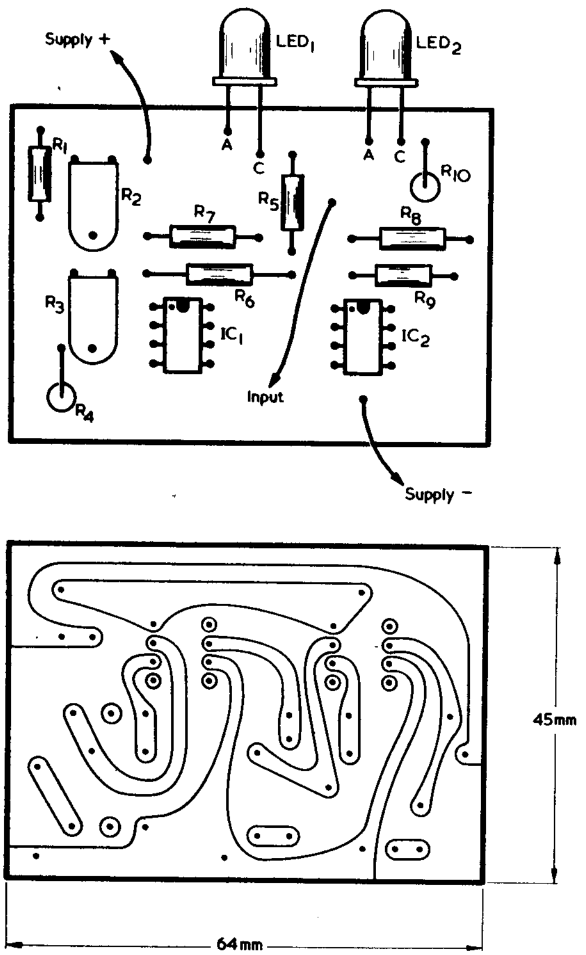


Fig. 3. The tuning indicator is assembled on a small printed circuit board. This is reproduced full size here

ASSEMBLY

All the components are assembled on a printed circuit board measuring 64 by 45mm., and both sides of this board are illustrated actual size in Fig. 3. No mounting holes are provided since the board will be supported by LED1 and LED2 when these are fitted into their panel mounting bushes.

The audio output from the f.m. detector is normally taken via a d.c. blocking capacitor. The input for the tuning indicator must, of course be taken from the detector side of this capacitor. The positive and negative supplies for the indicator are taken from the supply rails which feed the detector.

R3 is initially set to insert minimum resistance (adjusted fully clockwise) and the f.m. tuner or receiver is switched on. One or other of the l.e.d.'s should then light up. The tuner is adjusted so that no station is received and there is only background noise from its output, whereupon R2 is adjusted to the setting where both l.e.d.'s are lit at the same intensity. R3 is then set to insert sufficient resistance for both l.e.d.'s to extinguish. It may be found that this results in the indicator being a little over-critical, with the slightest tuning error causing one or other of the l.e.d.'s to light up dimly. The effect can be cured by adjusting R3 for a small further increase in resistance.

With a 12 volt supply the current consumption of the indicator is about 2mA only when both l.e.d.'s are turned off, and is approximately 7.5mA with one l.e.d. at full brightness. Virtually any tuner or receiver should be able to supply this additional current without any difficulties arising. The unit will also work satisfactorily on any other supply voltage between about 9 and 18 volts, with proportional changes in the current drawn. ■

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

● COLOMBIA

Radio Colosal, Neiva, on **4945** at 0300, OM with identification followed by a newscast in Spanish then into a programme of local pops on records. The schedule is on a 24-hour basis and the power is 2.5kW. This is one of the easiest Colombians to receive here in the UK.

Radio Guatapuri, Valledupar, on **4815** at 0210, OM with a sports commentary in Spanish. The schedule is from 0930 to 0600 and the power is 1kW.

Emisora Nuevo Mundo, Bogota, on **4755** at 0428, OM with a talk about Colombian affairs in Spanish, many mentions of place-names. The schedule is on a 24-hour basis and the power is 1kW. Sometimes also identifies as "Radio Caracol".

Radio Bucaramanga, Bucaramanga, on **4845** at 0330, OM with identification then local pops on records. The schedule is from 1000 to 0400 and the power is 1kW.

Radio Surcolombiana, Neiva, on **5010** at 0320, OM announcer with local pops on records. The schedule is around the clock and the power is 2.5kW.

Ecos del Atrato, Quibdo, on **5020** at 0314, YL with love songs, OM announcer with Colombian place-names. The schedule is from 1100 to 0400 and the power is 1kW.

Ondas del Meta, Villavicencio, on **4885** at 0245, OM identification in Spanish, Latin American type music.

Radio Santa Fe, Bogota, on **4965** at 0250, OM with announcements, guitar music in a programme of local-style music. The schedule is around the clock and the power is 5kW.

There are, of course, many other Colombians on the 60 metre band, why not try one of the most difficult to receive — La Voz del Caqueta, Florencia, on **5035**? The schedule is from 1000 to 0500 but the power is only 0.5kW.

CURRENT SCHEDULES

These schedules are correct at the time of writing but some are subject to change, both with respect to times and frequencies, at short notice.

● SOUTH KOREA

"Radio Korea", Seoul, broadcasts in English to Europe as follows — from 0530 to 0600 on **9870**; from 1330 to 1400 on **9870** and **11965**; from 2000 to 2030 (also directed to the Americas) on **7550** and on **11860** and from 2300 to 2330 on **7550** and on **9640**.

● TURKEY

"The Voice of Turkey", Ankara, presents programmes in English for Europe, the Middle East and North America from 2130 to 2255 on **6185**, **7170**, **9515** and on **11955**.

● SPAIN

"Radio Exterior de Espana", Madrid, has programmes in English to Europe from 2030 to 2130 on **7155**, **9505** and on **11840** with alternative channels on **6045**, **6100** and **7275**; from 2130 to 2230 on **7155**, **9505** and on **11840** with an alternative channel on **7275**.

● ALGIERS

"Radio of the Democratic People's Republic of Algeria", Algiers, lists a programme in English for Europe, North Africa and the Middle East from 1900 to 2000 on **9510** and **11075** but these channels are subject to short notice variation.

● LIBYA

The External Service from Tripoli is relayed by the Cyclops station in Malta. Entirely in Arabic, the transmissions are from 0700 to 0800 on **5960** and on **7135** and from 1800 to 2000 on **5960**.

● FINLAND

Transmissions in English for Europe are as follows — from 0800 to 0930 (Sundays only) on **11755** and on **21495**; from 0930 to 1000 on **11755**, **15270** and on **21495**; from 1300 to 1330 on **11755**, **15105** and on **15265** (extended to 1430 on Sunday); from 1430 to 1500 on **6120**, **11755**, **15210** and on **17870**; from 1930 to 2000 on **9575**, **11755** and on **15265**; from 2130 to 2200 on **9575** and on **15270**.

● FINLAND

Helsinki on **15270** at 0932, OM with English programme to Europe and North Africa, scheduled from 0930 to 0955.

● HUNGARY

Radio Budapest on **15225** at 1822, OM with the Italian programme for Europe, scheduled from 1800 to 1830.

● ECUADOR

HCJB Quito on **15295** at 2000, OM with a religious programme in English intended for Europe after 4 pips time-check and identification. The programme is scheduled from 1900 to 2030.

● U.S.A.

WINB Red Lion on **15185** at 2036, OM with station identification and programme in English for Europe.

● SOCIETY ISLANDS

Papeete, Tahiti on **15170** at 0430, OM in Tahitian, local-type music, YL's with soft, lilting, Polynesian songs.

● COSTA RICA

Emisora Radio Reloj, San Jose, on a measured **4832** at 0141, OM with a love song in Spanish. The schedule is around the clock and the power is 1kW.

● YEMEN

San'a on a measured **4853** at 1815, Arabic music with OM announcer. The schedule is from 0300 to 0700 (Friday until 1000) and from 1100 to 2115 (Saturday until 2030) and the power is 100kW.

● SURINAM

SRS, Paramaribo, on **4850** at 0309, YL with pop song in Dutch. The schedule of this one is from 0815 until 0330 and the power is 10kW.

● SAO TOME

Radio Nacional de Sao Tome on a measured **4807** at 1925, local-style folk music, guitar music with songs. The schedule is from 0530 to 2300 and the power is 10kW.

● USSR

Radio Moscow on **15150** at 1245, OM with the English programme to Asia ('Peace and Progress') scheduled here from 1230 to 1300.

Radio Moscow on **15140** at 1850, OM with the Hausa programme to Africa, scheduled from 1830 to 1900.

Radio Moscow on **15465** at 0515, OM and YL alternate with the English programme for Africa, scheduled from 0400 through to 0700 on this and many other channels.

Archangelsk on **5015** at 0251, OM announcer, local music and songs. This station relays Moscow 2 from 0200 through to 2200.

● CHINA

Radio Peking on **9944** at 1530, YL announcer with the Vietnamese programme to Vietnam, scheduled here from 1500 to 1600.

Radio Peking on **11650** at 1515, OM and YL alternate with the English programme to South Asia, scheduled from 1500 to 1600.

Radio Peking on **11695** at 1525, YL with the Hindi programme to South Asia, scheduled from 1500 to 1600.

Radio Peking on **15045** at 1650, YL with the English programme for East and South Africa, scheduled from 1600 to 1700. Also at 1310, OM with the programme in Malay, scheduled from 1300 to 1400.

Radio Peking on **9920** at 1640, OM with the Swahili programme for East Africa, scheduled from 1630 to 1730.

Radio Peking on **11100** at 2040, YL with the programme for Taiwan, scheduled from 0830 to 1500 and from 2000 to 0600 (Sunday until 0705).

Radio Peking on a measured **11302** at 2049, OM with the English programme for Europe, scheduled from 2030 to 2130.

Radio Peking on **11330** at 2052, YL with songs in the Domestic Service 1 programme, scheduled here from 2000 to 1735.

● W. GERMANY

Deutsche Welle on **15275** at 0930, OM with identification and programme in English to Asia and Australia, scheduled here from 0930 to 1030.

● VENEZUELA

Radio Maracaibo on **4860** at 0123, local pops on records with OM announcer in Spanish, the schedule being from 0900 to 0400 and the power is 1kW.

Radio Bolivar, Cuidad Bolivar, on **4770** at 0202, OM with heartrending love song (how they suffer!); with local announcements in Spanish after identification. The schedule is from 1000 to 0300 and the power is 1kW.

Radio Continente, Caracas, on **5030** at 0217, local pops on records with OM announcer. The schedule is from 0900 to 0500 (Sunday until 0400) and the power is 10kW. Sometimes identifies as Radio Relòj Continente.

Radio Popular, Maracaibo, on **4810** at 0442, OM with identification, two chimes, then a local-style music programme. The schedule of this one is from 0900 (Sunday from 1000) until 0500 and the power is 2kW.

Radio Barquisimeto on **4990** at 0014, YL with pop song, local-style dance music. The schedule is from 1000 to 0400 and the power is 15kW.

Radio Sucre, Cumana, on a measured **4959** at 0338, OM with commercials in Spanish, series of chimes between announcements then into a programme of local-style dance music. The schedule is from 1000 to 0400 and the power is 1kW.

Radio Lara, Baraquisimeto, on **4800** at 0325, OM with a ballad in Spanish followed by a piano solo. The schedule is from 0958 through to 0400 and the power is 10kW.

Radio Juventud, Barquisimeto, on **4900** at 0120, OM with pop song in Spanish, after OM announcements. The schedule is from 1000 to 0400 and the power is 10kW.

Radio Universo, Barquisimeto, on **4880** at 0122, local pops on records with OM announcer. Scheduled from 1000 to 0400 this one has a power of 10kW.

Ecos del Torbes, San Cristobal, on **4980** at 0256, OM with announcements and commercials in Spanish, Latin American-style music. The schedule is from 1000 to 0400 (Sunday until 2400) and the power is 10kW.

Radio Rumbos, Caracas on **4970** at 0258, OM with commercials, local-style musical programme. The schedule is around the clock and the power is 10kW.

VHF MAINS TABLE RADIO

Part 1

By
R. A. Penfold

Sensitive Band II receiver incorporating two integrated circuits and featuring negligible running costs

It is approximately one hundred times cheaper to run a radio receiver from the mains than it is to use batteries as the power source. Unless the portability of battery operation is of major importance a mains powered receiver is the more economical choice. A mains set obviously requires some additional components for its power supply, and these incur increased initial cost. However, this cost will soon be recovered in the form of saved expenditure on batteries.

The mains table type of receiver used to be very popular and, after almost completely disappearing from the scene, it now appears to be returning, frequently with the option of battery operation or with added facilities such as clocks or cassette recorders.

This 2-part article describes a relatively simple home-constructor design for a v.h.f. mains table radio. In Part 1 we shall examine the circuit design and the components required and will then commence construction. Part 2, to be published next month, will complete the constructional information. The radio tunes from about 88MHz to a little over 100MHz. This is slightly less than the full v.h.f. Band II, but is still in excess of the section of the band which is occupied by broadcast stations in the U.K. The receiver has a maximum output power of about 1 watt r.m.s. to an internal 8 Ω elliptical speaker, and this provides more than adequate volume for normal domestic requirements. The prototype gives good reception of the three main B.B.C. v.h.f. broadcasts and a local radio station using just a few feet of wire as an aerial. The set is therefore reasonably sensitive, as the author lives just outside the area officially served by the local station. The receiver running costs are negligible.

It should be noted that, although this design is quite simple for a v.h.f. set of its quality, it is not really suitable for a beginner to radio construction as it is still, in some respects, a fairly difficult project.

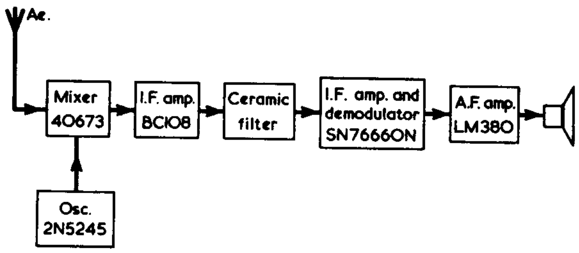


Fig. 1. The f.m. receiver is a relatively simple superhet design. The various stages are shown here

BLOCK DIAGRAM

Fig. 1 shows the basic arrangement of the receiver in block diagram form. As may be seen, it is a superhet design.

The aerial signal is coupled to a dual gate MOSFET mixer type 40673. Quite good results are given without the use of an r.f. amplifier to precede the mixer and with only a single tuned circuit to provide r.f. selectivity. A simple but stable oscillator incorporating a 2N5245 f.e.t. is also coupled to the mixer, and the 10.7MHz i.f. output from the mixer is applied to a BC108 i.f. amplifier.

A ceramic filter is interposed between the output of the i.f. amplifier stage and the input of a further i.f. amplifier and demodulator stage. The ceramic filter provides most of the circuit's i.f. selectivity and it has the advantage of requiring no alignment or other adjustments. This greatly eases the alignment of the finished receiver.

The combined i.f. amplifier and demodulator stage uses an SN76660N integrated circuit, which provides most of the i.f. gain (about 60dB). The demodulator is of the quadrature type, and this has a low distortion level of less than 1% and is very easy to adjust.

A single i.c. is used in the audio amplifier, and the LM380 device employed here also provides a low distortion level. The output quality of the receiver is therefore good, and is mainly limited by the speaker and enclosure used.

MIXER AND I.F. STAGES

The circuit of the mixer, oscillator, i.f. amplifier, and demodulator stages is shown in Fig. 2. The oscillator, TR1, is a Jugfet, employed here in the source follower mode. C4 and C5 in series together with L1 form the oscillator tuned circuit. There is less than unity gain from the gate to the source of TR1 and so, to maintain oscillation, the transistor source is connected to the junction of C4 and C5. In consequence, the source is effectively connecting to a tap in the capacitive side of the tuned circuit, and the resultant step-up in the voltage applied to the gate allows oscillation to take place. Despite its simplicity, this type of oscillator is very stable and reliable.

The oscillator is tuned by means of the varicap diode D6, which is coupled to the tuned circuit via

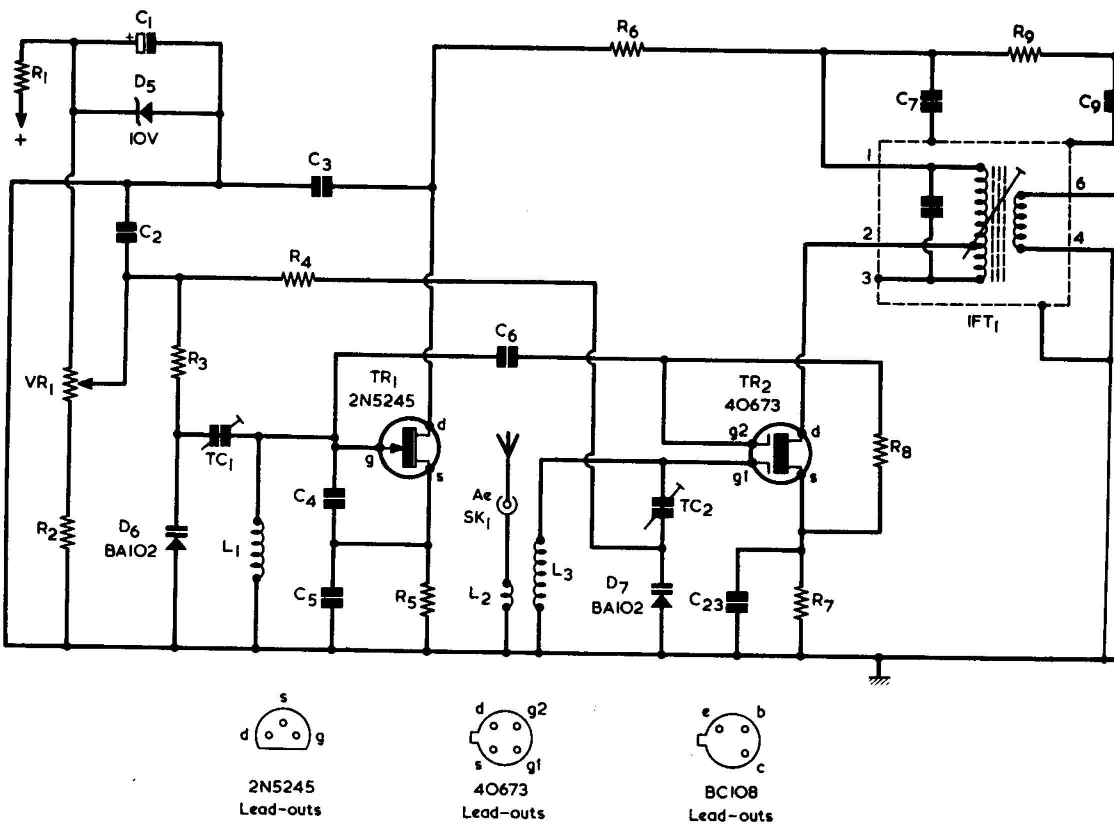
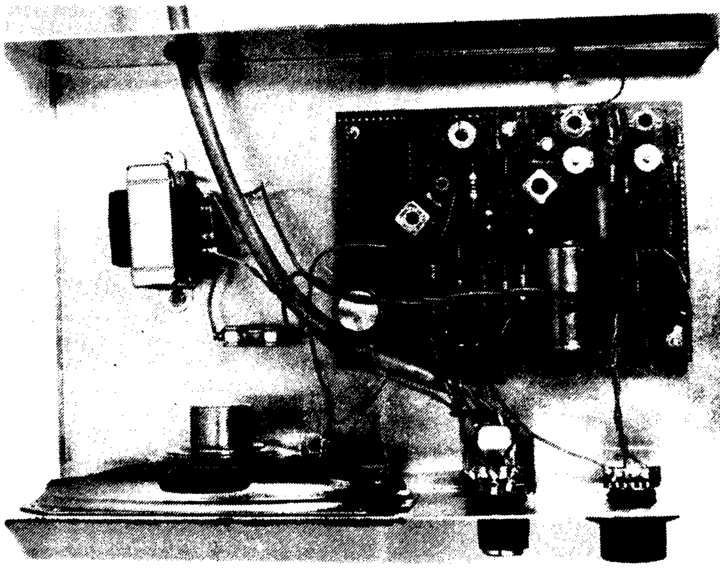


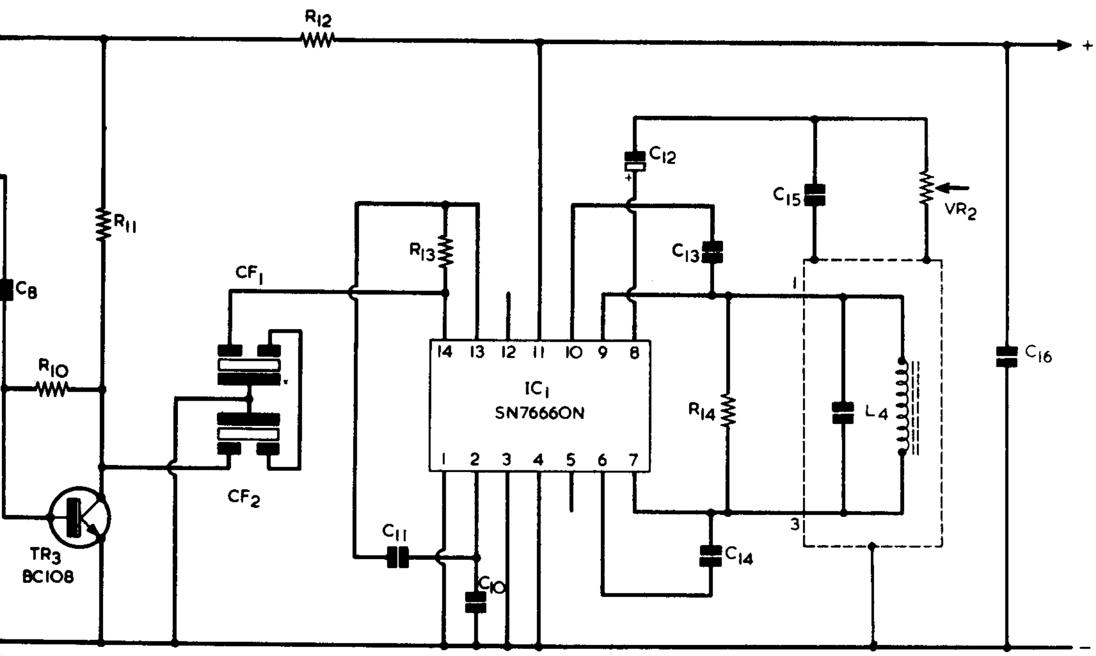
Fig. 2. The circuit of the oscillator, mixer,

Since almost all the components are assembled on a perforated board, layout problems inside the case are virtually eliminated



TC1. The trimmer is adjusted to give the correct tuning range. The tuning control is VR1, the slider of which couples to D6 by way of R3. The capacitance of D6 reduces with increasing tuning voltage, and so the higher the tuning voltage the higher the oscillator (and reception) frequency.

TR2 is used in a conventional dual gate MOSFET mixer configuration. L3 biases the gate 1 and forms the signal tuned circuit in company with TC2 and D7. The latter provides the aerial tuning, the tuning voltage being obtained from VR1 slider by way of R4. R7 is the source bias resistor and C23 is its bypass capacitor. R8 biases the gate 2 to the same voltage as that at the source, this being about 0.5 volt positive of the negative rail. C6 couples the oscillator signal to the gate 2. The oscillator signal modulates the aerial signal, since the gain from the gate 1 to the drain is controlled by the gate 2 voltage. This action produces the required mixing action, and the 10.7MHz i.f. signal is



nd demodulator stages of the receiver

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)
R1 4.7kΩ
R2 5.6kΩ
R3 120kΩ
R4 120kΩ
R5 1kΩ
R6 390Ω
R7 1kΩ
R8 120kΩ
R9 220Ω
R10 150kΩ
R11 330Ω
R12 100Ω
R13 330Ω
R14 8.2kΩ
R15 470Ω
R16 10kΩ
R17 5.6kΩ
R18 680kΩ
R19 470Ω
VR1 100kΩ potentiometer, linear
VR2 5kΩ potentiometer, log, with switch S1(a)(b)

Capacitors
C1 10μF electrolytic, 25V Wkg.
C2 0.22μF type C280
C3 0.01μF ceramic disc or ceramic plate
C4 10pF polystyrene
C5 39pF polystyrene or silvered mica
C6 10pF polystyrene
C7 0.01μF ceramic disc or ceramic plate
C8 0.01μF ceramic disc or ceramic plate
C9 0.01μF ceramic disc or ceramic plate
C10 0.033μF ceramic disc or ceramic plate
C11 0.01μF ceramic disc or ceramic plate
C12 3.3μF electrolytic, 25V Wkg.
C13 33pF ceramic plate
C14 33pF ceramic plate
C15 0.033μF type C280
C16 0.1μF ceramic disc
C17 100μF electrolytic, 25V Wkg.
C18 68pF ceramic plate
C19 10μF electrolytic, 16V Wkg.
C20 2,200μF electrolytic, 16V Wkg.
C21 1,500μF electrolytic, 25V Wkg.
C22 0.1μF type C280
C23 0.0047μF ceramic disc or ceramic plate
TC1 5.5 to 60pF foil trimmer
TC2 5.5 to 60pF foil trimmer

Inductors
L1 4½ turn S18 coil type 301KN-0400
L2 see text
L3 4½ turn S18 coil type 301KN-0400
L4 f.m. detector coil type KACSK586HM
IFT1 f.m. i.f. transformer type KALS4520A
T1 mains transformer, secondary 12V at 500mA (see text)

Filters
CF1 ceramic filter type CFSE10.7
CF2 ceramic filter type CFSE10.7

Semiconductors
TR1 2N5245
TR2 40673
TR3 BC108
IC1 SN76660N
IC2 LM380
D1-D4 1N4001
D5 BZY88C10V
D6 BA102
D7 BA102

Loudspeaker
LS1 8Ω 5 x 3in. (see text)

Switch
S1(a)(b) d.p.s.t. toggle, part of VR2

Fuse
FS1 500mA cartridge fuse, 20mm.

Socket
SK1 wander plug socket (see text)

Miscellaneous
Metal case (see text)
Plain perforated s.r.b.p. board, 0.1in. matrix, 5 x 3.75in.
Chassis mounting fuseholder, 20mm.
2 control knobs
Speaker fabric
Bolts, wire, solder, etc.

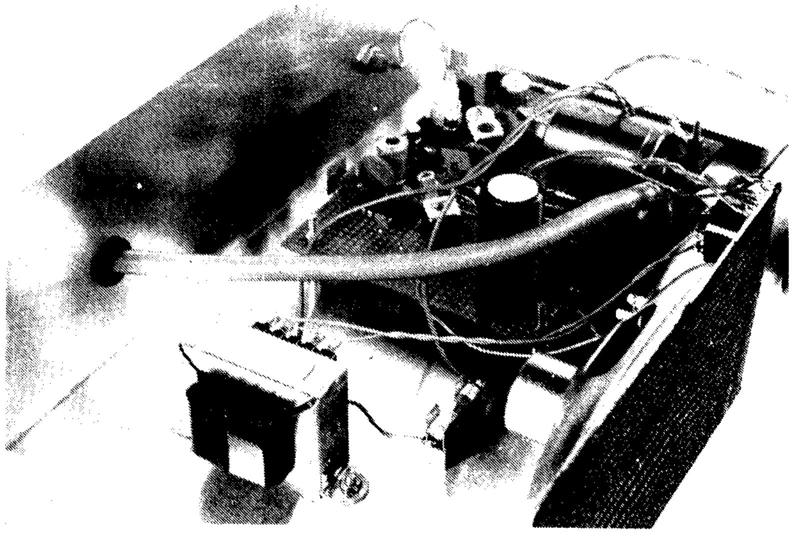
developed across the tuned winding of IFT1. The fixed capacitor in this tuned circuit is an integral part of the transformer. The oscillator frequency can be either 10.7MHz above the signal frequency or 10.7MHz below it; in this receiver the oscillator frequency is below the signal frequency.

TR3 is a straightforward common emitter amplifier. Its bias and collector load resistors have values which give good gain at 10.7MHz and which allow a satisfactory match into the following ceramic filter. Although the BC108 employed for TR3 is usually looked upon as an audio transistor, it works well in its present role.

A single ceramic filter could be used between the BC107 and the SN76660N, but a 2-stage filter gives better selectivity and performance. The CFSE 10.7 ceramic filters employed in this design have an input and output impedance of 330Ω and so two filters can simply be connected in cascade to provide the required filter characteristic.

The impedance at the i.c. input is set at the correct level by R13. C10 and C11 are decoupling capacitors, and are the only discrete components required by the i.f. amplifying section of the SN76660N. L4 is the quadrature coil required for demodulation, the capacitor connected across it being integral with the coil unit as supplied. R4 damps the resultant tuned circuit, giving a better demodulation characteristic. C13 and C14 are quadrature feed components.

Looking into the receiver from one end



The audio output is obtained from pin 8 of the i.c. and is passed via d.c. blocking capacitor C12 to volume control VR2. C15 provides de-emphasis of the higher frequencies, to cancel the pre-emphasis applied to the signal at the transmitter. The overall effect of pre-emphasis and de-emphasis is to produce a flat frequency response with an improved signal-to-noise ratio. C15 has a value slightly higher than that needed just for de-emphasis, and thereby applies a small amount of treble cut to the demodulated signal. This is advisable as, due to the response of relatively small speakers, the audible output of the receiver would otherwise have an excessive higher frequency content.

AUDIO AND POWER SUPPLY

The circuit of the audio amplifier and power supply appears in Fig. 3. The amplifier stage employs an LM380 i.c. and a few external discrete components. The LM380 can accept input signals which are ground referenced, and an input is taken direct from VR2 slider via r.f. stopper R17.

The LM380 provides a voltage gain of approximately 50 times (34dB), this being set by an internal fixed negative feedback loop in the device. As many readers will be aware, the gain of an LM380 can be reduced by means of additional negative feedback via a discrete feedback circuit. It is probably less well known that the gain can also be increased by using a discrete positive feedback loop. It is necessary to do this here as the a.f. gain in the receiver would otherwise be inadequate.

The positive feedback loop is comprised of R18, R16 and C18. C18 reduces the amount of feedback at very high frequencies, and the circuit will oscillate if this capacitor is omitted. The circuit will also oscillate if the attenuation through the positive feedback loop is less than 50 times (i.e. the closed loop voltage gain of the LM380) since the positive feedback would then more than cancel out the negative feedback. With the specified values for R18 and R16 the voltage gain of the circuit is boosted to about two or three times its normal level, and this provides more than adequate

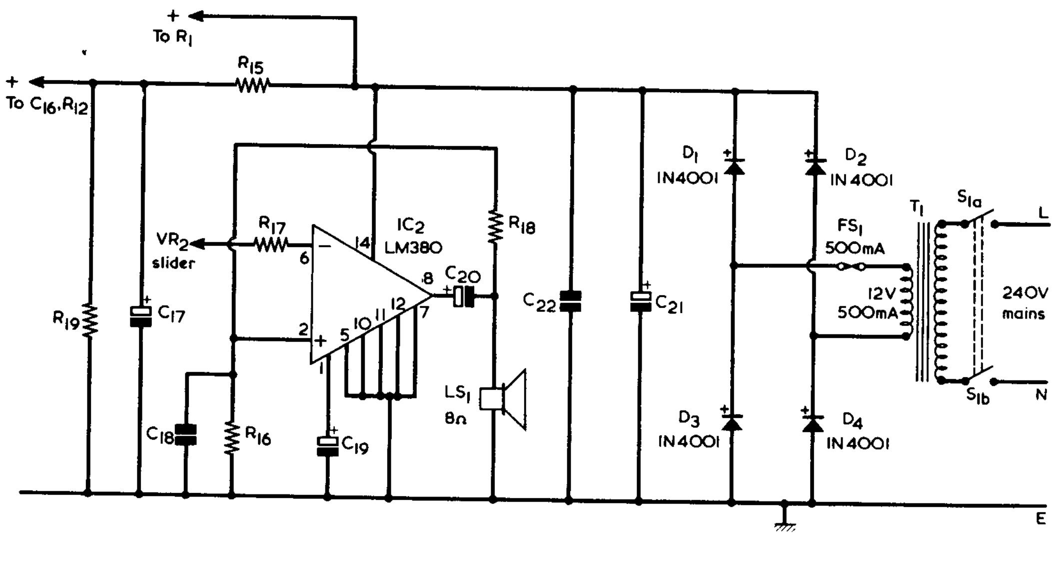
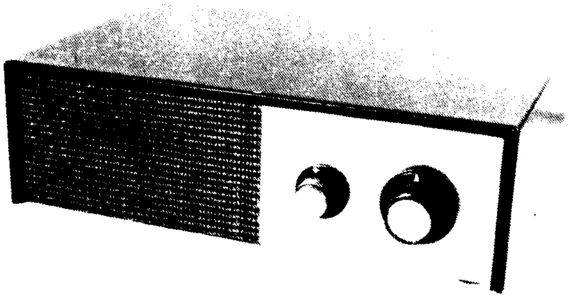


Fig. 3. The remaining receiver stages. These consist of the LM380 audio amplifier and the power supply



The front panel appearance is enhanced by the speaker fabric to the left. For neatness this is passed for a small distance under the bottom of the case

output volume and power. The positive feedback has the effect of increasing any inadequacies in the frequency response of the circuit, whereupon it is necessary to employ a high value output capacitor, C20, to obtain a good bass response. The high frequency response of the circuit is very flat, and is therefore not significantly affected by the positive feedback. Note that the feedback must be taken from the negative side of C20 in order to avoid upsetting the input biasing.

C19 decouples the internal supply rail to the pre-amplifier inside the LM380, and this gives greatly improved supply ripple rejection. The circuit will provide an output power of about 1 watt r.m.s. into an 8 Ω speaker and, although the positive feedback causes a slight reduction in the noise and distortion performance of the amplifier, it is still very good in both respects. The LM380 is nominally a 2 to 3 watt device, but it needs heatsinking to provide an output at this level for more than very short periods, and for the sake of simplicity heatsinking has been omitted here. The device cannot be damaged by overdriving it as thermal protection is incorporated in its internal circuitry. It also has output short-circuit protection.

The power supply is a straightforward unregulated type using full-wave bridge rectification. In order to provide good oscillator frequency stability the tuning voltage must be stabilized, and this is achieved by the voltage regulator incorporating R1, D5 and C1. These last three components are in Fig. 2. The mains on-off switch, S1(a)(b), is ganged with VR2.

COMPONENTS

A few of the components are rather specialised and are not generally available. These are the two ceramic filters, IFT1, L1, L3 and the two trimmers, TC1 and TC2. They are all obtainable from Ambit International. L1 and L3 have ferrite cores which are removed by the constructor. L2, incidentally, is a single turn of wire which is added to L3 during assembly of the receiver.

T1 is an R.S. Components 6VA miniature mains transformer having two 6 volt secondaries rated at 500mA, which are connected in series to give a total secondary voltage of 12 volts. The speaker is an 8 Ω type with nominal dimensions of 5 by 3in. and is also an R.S. Components item. Its actual dimensions are 5.4 by 2.75in. and so it fits comfortably into the case, which has a height of 3in.

Both the transformer and the speaker were obtained from Doram Electronics but, as this company has left the component market, they now have to be obtained from R.S. Components. Readers who have access to R.S. Components may order the parts directly but other readers will have to obtain them through a retailer. They may be obtained (subject to a minimum order value of £2) from Ace Mailtronix Limited, Tootal Street, Wakefield, West Yorkshire, WF1 5JR.

The case was a type BC4 obtained from Harrison Bros. P.O. Box 55, Westcliff-on-Sea, Essex, SS0 7LQ, and measuring about 10 by 6½ by 3 in. Any other metal case of similar dimensions will be satisfactory and, as may be seen from the photograph of the interior of the receiver, layout is very simple. The only components on the base of the housing are the mains transformer, the fuseholder and the plain perforated component board. (The board, which is of 0.1in. matrix, measures 5 by 3.75in., and this is a standard size in which it is sold.) It is preferable to use a case of all-metal construction as this will screen the receiver circuitry and prevent i.f. breakthrough.

The SN76660N i.c. is available from a number of suppliers including Bi-Pak Semiconductors.

CONSTRUCTION

A very simple front panel layout is employed, with VR1 at the right, VR2 next to it, and the speaker mounted at the extreme left. A cut-out to suit the speaker is required in the panel, this being about 4 by 1½in. The cut-out can be made with the aid of a fretsaw. The speaker can be bolted in place using countersunk bolts, or it may be glued in position by means of a good quality general purpose adhesive. Great care must be taken to ensure that no glue gets on to the speaker diaphragm or its corrugated surround as its performance could then be impaired. A piece of speaker material is glued to the left hand section of the front panel and a neat appearance is given if its lower edge is taken a little way under the case. (It should be mentioned at this stage that an optional tone control can also be fitted to the front panel and that details of this will be given in next month's issue. Readers who wish to fit this tone control should, in consequence, undertake no work on the front panel until they have read Part 2 of this article.)

Mains transformer T1 and the fuseholder are mounted on the base of the case to the rear of the speaker. A hole for the mains lead is made in the rear panel approximately behind the transformer, and this must be fitted with a grommet. The aerial socket, SK1, is mounted on the other side of the rear and should be close to coil L2, L3 (the positioning of which will be dealt with in more detail next month). The prototype receiver uses a simple wire aerial and so SK1 is an insulated wander plug socket. However, the receiver can be used with a more sophisticated aerial, if desired, this being coupled to the set via coaxial cable. In this case a surface mounting coaxial socket should be used, and this will automatically obtain its chassis connection by way of its mounting bolts and nuts.

IFT1 and L4 are supplied with their cores fairly close to their final setting. In consequence, these cores should not be touched or adjusted until the receiver is aligned after it has been completed.

(To be concluded)

DOUBLE DECCERS

A SPECIAL SERIES FEATURING S-DeCs

No. 6

By Ian Sinclair

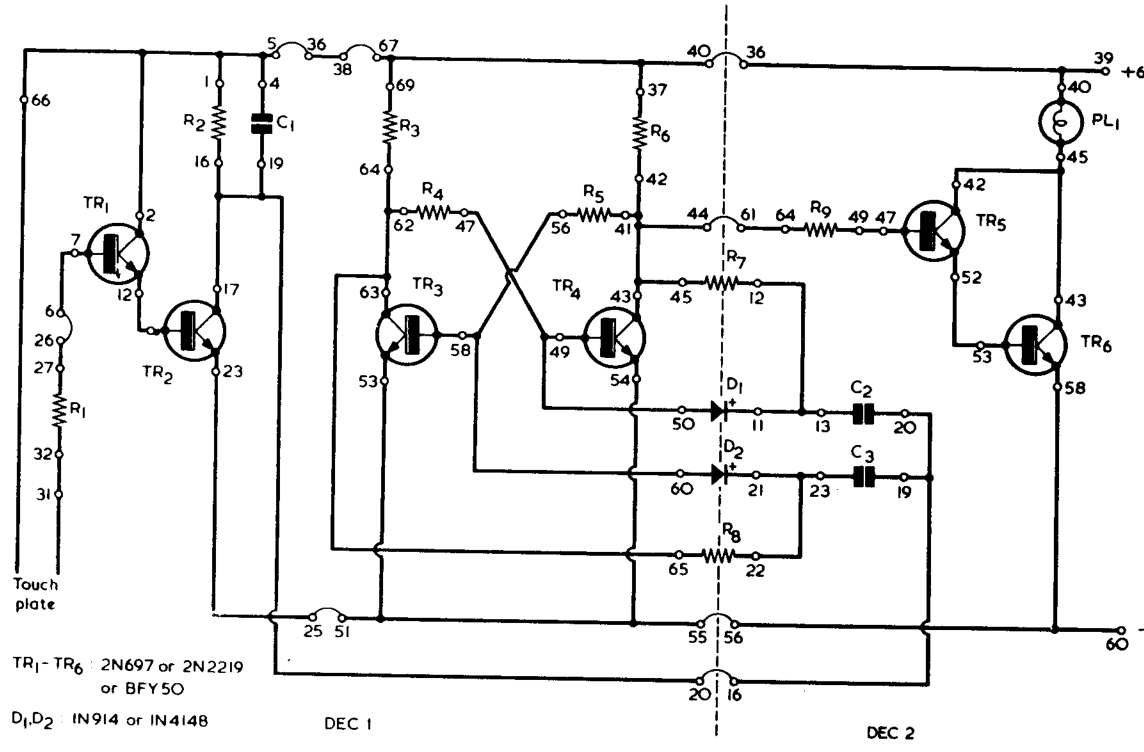
TOUCH-LIGHT CIRCUIT

Touch plate circuit switches a lamp or energises a relay

In this circuit a low voltage lamp is switched on or off when a pair of sensing wires or contacts is touched. This is the basis of the circuits used for such purposes as TV touch-tuners, and the circuit can be employed to control greater loads by replacing the lamp with a relay. The circuit has been deliberately designed not to be *too* sensitive, as excessive sensitivity leads to problems such as unwanted switching when hairs or insects touch the sensors or, in some cases, even when currents of humid air reach the contacts.

DETECTOR CIRCUIT

In our circuit, TR1 and TR2 form a very sensitive detector. TR1 is connected as an emitter follower which acts as a current amplifier for any current flowing in its base circuit. One of the sensing wires or plates is connected to this base through a 150kΩ resistor, and the other is connected to the positive supply. Bridging the wires or plates with the relatively high resistance of a finger will therefore allow a small current to flow into the base of TR1.



The circuit of the touch-light control. The lamp lights and extinguishes successively when the touch plate is touched with a finger

COMPONENTS

Resistors
(All ¼ watt 5%)
R1 150kΩ
R2 12kΩ
R3 1.8kΩ
R4 22kΩ
R5 22kΩ
R6 1.8kΩ
R7 150kΩ
R8 150kΩ
R9 22kΩ

Capacitors
C1 0.001μF polyester or mylar
C2 0.001μF polyester or mylar
C3 0.001μF polyester or mylar

Semiconductors
TR1-TR6 2N697 or 2N2219 or BFY50
D1 1N914 or 1N4148
D2 1N914 or 1N4148
D3 1N4001 (see text)

Lamp
PL1 6V, 60mA, m.e.s.

Miscellaneous
2-off S-DeC
6V battery
Lampholder, m.e.s.
Relay (see text)
Materials for touch plate (see text)

A small current flowing into TR1 base will cause the appearnce of a much greater current at its emitter — the amount of gain in this stage is the current gain, hFE, of the transistor. This greater current flows into the base of TR2, which gives further current amplification, so that the collector current of TR2 is very much larger than the input current at TR1 base.

When TR2 is turned off its collector voltage is high, at or very near the 6 volt supply voltage, but when TR2 switches on because of the sensing contacts being touched the voltage at the collector drops. C1 prevents the change of voltage being too abrupt, so that multiple triggering is avoided. Without C1, an intermittent contact at the sensing wires or plates can cause the circuit to switch on and off repeatedly. The puise that we use for triggering is the negative-going voltage step at the collector of TR2 when the sensing wires or plates are touched, and it is passed via the link wire joining point of 20 of DeC 1 to point 16 of DeC 2.

TR3 and TR4 are arranged in the now-familiar bistable circuit which we saw in the third article in the Double Deccer series and also in last month's article. C2 and C3 couple the negative-going trigger pulses to the steering diodes, D1 and D2. Each time the sensing wires or plates are touched, therefore, the bistable will switch over, so that the collector of TR4 will switch alternately between a high voltage of nearly 6 volts and a low voltage of about 0.2 volt.

The collector of TR4 is coupled through a wire link and the current limiting resistor R9 to another pair of transistors, TR5 and TR6. These are connected in tandem and deliver a large output current for a very small input current. This type of circuit is not really necessary to operate a low consumption 6 volt bulb, but it has been used so that the optional relay can be fully driven instead. When the collector voltage of TR4 is high PL1 will be switched on, and when the collector voltage is low PL1 will be switched off. Touching the sensor wires or plates will cause the circuit to switch over.

To operate high voltage or high power circuits, the lamp PL1 can be replaced by the coil of a relay and the connections that are needed are shown in Fig. 2. The relay chosen should be capable of energising reliably at a coil voltage of around 5 volts to allow for the small voltage dropped across TR5 and TR6 when these are turned on, and the current available from TR6 for the coil is up to 200mA maximum. There are, of course, a number of suitable relays available which require coil currents very much lower than this figure, and such relays can be employed in the circuit. The contacts and insulation in the relay should be suitable for the load to be switched. When the circuit controlled by the relay is at a high voltage, such as the main supply voltage, it is essential that all precautions against accidental shock be observed. Also, the 6 volt positive rail should be connected to mains earth.

It is necessary for a diode to be connected across the relay coil to prevent the formation of a high reverse voltage across it when TR5 and TR6 switch off. When the current through an inductor (and the coil of a relay is an inductor) is suddenly interrupted a large reverse voltage is induced which can be many times greater than the previous voltage across the coil. In the present circuit the voltage, if allowed to appear, could cause the breakdown of TR5 and TR6. However, the diode across the relay coil supresses the voltage and prevents damage to the transistors. The diode does not conduct during the time that the coil is energised.

SENSING ARRANGEMENTS

The simplest possible sensing arrangement for test purposes consists of two bare wires plugged into the S-DeC at the appropriate points. Touching or gripping both of these wires at the same time should cause the circuit to switch over although, if TR1 and TR2 should happen to have very low current gain figures, it may be necessary to moisten the finger or fingers. More reliable sensing is obtained if a touch plate is made up, since this will provide a much greater contact area. The touch plate can consist of a piece of printed circuit board of any desired shape, as shown in Fig. 3. A dividing line is cut down the centre using a knife, saw-blade or Abrafile so that the two areas of copper are insulated from each other. The pieces of copper can then be soldered to the insulated wires of a 2-core cable which terminates at points 66 and 31 of DeC 1. Remember that the strands of a flexible wire should be lightly soldered together to produce what is effectively a single wire before the wire is inserted into an S-DeC connection point. Even if TR1 and TR2 have rather low gains, the large contact area of the touch plate should provide reliable switching. Inventive constructors can devise other types of touch plate having two metal surfaces insulated from each other.

S-DEC CONSTRUCTION

Start by linking the two S-DeCs together, end to end, to form one long DeC. Now plug in the wire links, eight in all, and then the components which also link the DeC's. These are R7, D1, D2 and R8. Ensure that these components are correctly

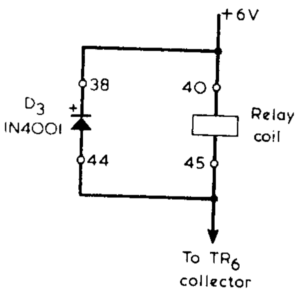


Fig 2. The circuit can alternatively control a relay, the coil of which is connected in place of the lamp. A protective diode is wired across the coil

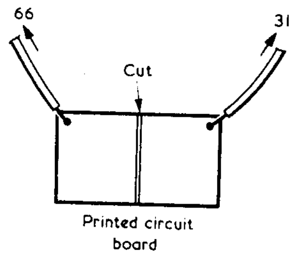


Fig 3. One way of making up the touch plate. A cut is made in the copper of a printed circuit board, giving two adjacent copper areas which can be bridged by a finger

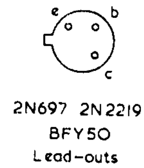


Fig 4. All the transistor types specified have the lead-out layout shown here. The lead-outs are pointing towards the reader

positioned before moving on to the next step. In particular, ensure that the two diodes are connected with correct polarity.

Now plug in the capacitors and then the transistors. All the transistors are n.p.n. types and have the same lead-out pattern. Plug in the leads for the lamp PL1, which can be mounted on a panel fitted to one of the DeCs. Plug in the remaining resistors and the sensing wires or plate, connect the battery, and the circuit is ready to test.

When the relay operated version is built it may be necessary to use a 6 volt mains power supply if the relay chosen draws a heavy current. The relay coil connects via two insulated leads to points 40 and 45 of the DeC 2 section of the unit, with the protective diode connecting to points 38 and 44. Take care to connect the diode with correct polarity. If it is connected with incorrect polarity, TR6 will pass an excessive current when it turns on. Make quite certain that all the safety precautions referred to earlier in this article are observed if the relay is used to switch high or mains voltages. ■

New Products

5 NEW MODULES FROM BI-PAK

BI-PAK Semiconductors recently added the following modules to their excellent range:—

AL120 AMPLIFIER: A very low distortion 50 watt power amplifier.

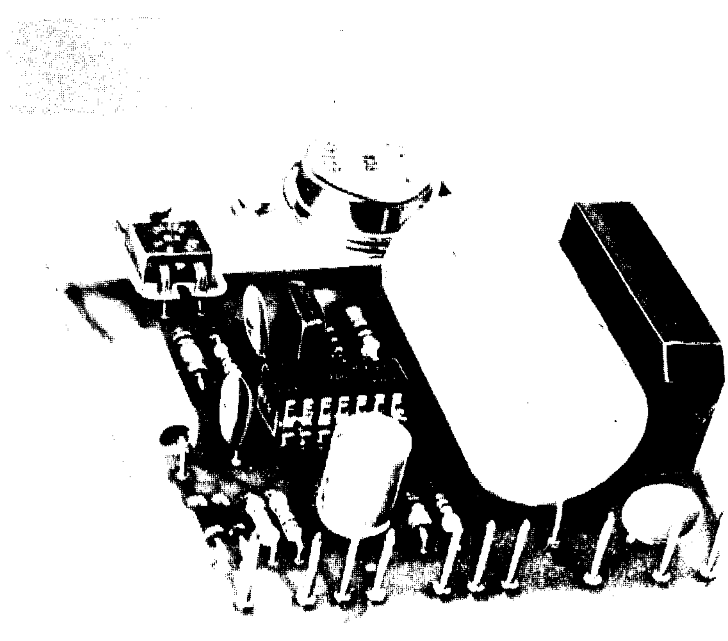
SPM120 POWER SUPPLY: A fixed voltage stabilised power supply with an O/P voltage of either 45v, 55v or 65v.

GE100 Mk2 EQUALISER: Ten channel monographic equaliser.

VPS30 POWER SUPPLY: This highly useful module is shown in the accompanying photograph.

PA200 STEREO PRE-AMPLIFIER: A variation of the long-established and very popular PA100.

Further details of the above and the rest of their large range of high quality modules can be seen in their advertisements in this magazine or write enclosing S.A.E. for further details to:—BI-PAK Semiconductors, P.O. Box 6, Ware, Herts.

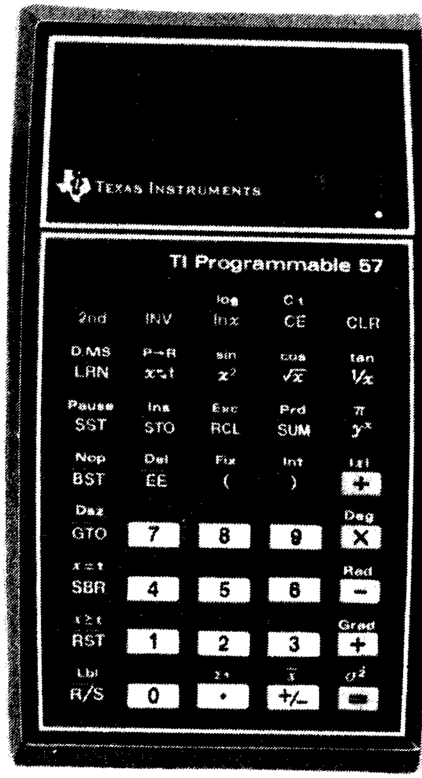


EXCLUSIVE NEW SERIES

TUNE-IN TO PROGRAMS

Part 3

By Ian Sinclair



The keyboard of the Texas Instruments TI-57 programmable calculator. Most keys have a second function, whereupon facilities are nearly double the number of keys provided

Do You Remember ...?

Memories are used along with a program so that numbers can be kept in readiness for use at the correct place in the program, or so that answers can be accumulated without having to be displayed. Take a simple example: the addition of two resistor values in parallel. The formula for this is 1/R = 1/R1 + 1/R2, so that when we calculate this we will have two resistance values, of R1 and R2, to feed into the calculator.

We could, of course, break off the calculation to feed in the value of R2 at the right time. The program would look as in Fig. 1, with [R/S] used to stop the calculator for the entry of the next value. This, however, rather defeats the whole idea of using a program. The satisfactory answer is to use memories to hold the values until they are needed.

Program	***Procedure***
LRN	
1/x	
+	Enter value of R1 in ohms
R/S	Press R/S
1/x	Enter value of R2 in ohms
=	Press R/S
1/x	Read R(total) from display
R/S	
LRN	

Fig. 1

ENTERING A MEMORY

To place a number into a memory the number must be on display, and the [STO] key must then be pressed to instruct the calculator that the number is to be stored. The [STO] key ***must*** be followed by a number, 0 to 7 for the Texas Instruments T1-57 (0 to 9 for the CBM PRO-100) which instructs the calculator which of its memories is to be used. If you don't follow [STO] by a number, or if you use an impossible number such as 8, for example, you will promptly get the error signal flashing up on the display. The [STO] instruction can be used either inside a program to store an intermediate answer, or outside the program to store a figure ready for use as part of the setting-up procedure.

Let's suppose, then, that we can store the values of R1 and R2, using memories 1 and 2 (just taking two numbers at random — it's easier to remember that the value of R1 is stored in memory 1 and R2 in memory 2). The program will now need to include the instructions to recall these numbers from the memories at the right time in the program, and this is done by using the [RCL] key. Once again, the [RCL] key ***must*** be followed by a number which instructs the calculator which memory has to be recalled.

A program for the calculation of resistors in parallel might therefore look something like that of Fig. 2, with each number taken out of its memory, inverted, and added to the next (inverted) number, so that the final answer is found by a last 1/x operation.

Program	Procedure
LRN	
RCL 1	
1/x	Enter value of R1 (ohms) STO 1
+	Enter value of R2 (ohms) STO 2
RCL 2	CLR
1/x	RST
=	R/S
1/x	Read R(total) from display
R/S	
LRN	

Fig. 2

In this program we've made use of another memory, the temporary store within the calculator. When the first figure is inverted by the instruction [1/x] the value flashes on the display, but the use of the [+] key places this number in a temporary store until we have something to add to it. The "something" is the number we get when the second number has been recalled and inverted. The addition is carried out when the [=] key is pressed (or used in the program). Not all calculators have this facility, and a few might require the use of brackets between the [+] step and the [=] step. The Texas T1-57 with its Algebraic Operating System, is particularly easy to use from this point of view.

We could have tidied up this program quite a bit, because we didn't really need to use two memories. We could just as easily have entered the first number into the display before starting the program, and so used the simple program of Fig. 3.

Program	Procedure
LRN	
1/x	
+	RST
RCL 1	Enter value of R1 (ohms) STO 1
1/x	Enter value of R2 (ohms)
=	R/S
1/x	Read R(total) from display
R/S	
LRN	

Fig. 3

SUM AND PRODUCT

The T1-57 also permits each memory to be used to accumulate numbers. Going back to the example of parallel resistors, suppose we have several resistors in parallel, so that the formula becomes:

$$1/R = 1/R1 + 1/R2 + 1/R3 + 1/R4 + \ldots$$

In a program like this, we need to take each number, invert it by using the [1/x] instruction and then add the inverted number to all the other inverted numbers. Now we could make use of the temporary store of the T1-57 again, because the sequence of instructions is a simple one which doesn't need the use of the [=] instruction until the end. For other programs, however, the temporary store cannot be used like this, but we can make use of the [SUM] key. When we place a number into a memory using the [STO] key, anything else which may have been in that memory is erased and replaced by the new stored number. When we use the [SUM] key, the number in the display is ***added*** to the number in the memory, it doesn't replace it. A program for the resultant of four resistors in parallel might therefore look something like that of Fig. 4 if we make full use of the stores.

The [SUM] key does a different job when the [INV] key is pressed or programmed just before it. Using [INV] [SUM] causes the displayed number to be subtracted from the stored number. This is a step we do not use very often in electronics calculations, but it is handy for finding what value of resistance has to be placed in parallel with an existing resistor to lower the value to some required figure. A very common use of the [INV] [SUM] step is in a count-down. For example, if we include the steps [5] [INV] [SUM] [1] in a program, then 5 will be subtracted from the contents of memory 1 on each run through. This would be useful if memory 1 had been loaded with, for example, a value of frequency and we wanted to lower the frequency by 5kHz each time.

We're not finished with the [SUM] key, though, because above it is written [Prd], meaning product, and activated by [2nd] [SUM]. This combination of keys causes the displayed number to be multiplied by the number in the memory, keeping the result in the memory. For example, suppose we want to calculate the resistance of Rn of a resistor at n degrees Centigrade, knowing the resistance Ro at zero degrees Centigrade. The formula is:

$$Rn = Ro\ (1 + nt)$$

where t is the value of the temperature coefficient of resistance.

This problem can be tackled by storing the value of temperature n in memory 1, multiplying by the value of t, using [Prd], and then adding 1 by using the steps [1] [SUM] [1]. The multiplication by Ro can then be carried out by using [RCL] [2] [Prd] [1] if the value of Ro is stored in memory 2. The whole program is shown in Fig. 5.

Just for an encore, if you use the sequence [INV] [2nd] [SUM] the number in the store is ***divided*** by the number in the display. Remember, though, that the [SUM] or [Prd] instruction must be followed by the number of the memory. When division is needed, the keys [INV] and [2nd] can be pressed in either order, so that you can use [2nd] [INV] [SUM] or [INV] [2nd] [SUM]. Memories which can be used for summing, obtaining products and dividing in this way are called fully addressable memories — the use of memory addressing like this can often save several program steps and is therefore a good habit to cultivate.

Fig. 4	Program	Procedure
		Enter value of R1 (ohms) STO 1
	LRN RCL 1 1/x STO 0	Enter value of R2 (ohms) STO 2
	RCL 2 1/x SUM 0	Enter value of R3 (ohms) STO 3
	RCL 3 1/x SUM 0	Enter value of R4 (ohms) STO 4
	RCL 4 1/x SUM 0	CLR
	RCL 0 1/x R/S LRN	RST
		R/S
		Read R(total) from display

OTHER MEMORY FEATURES

Several of the memories of the T1-57 are used for special jobs, and some of these jobs will be discussed in more detail later in this series. For example, memory 0 can be used for an automatic countdown, using the [Dsz] key, and memory 7 (which is referred to as the test or "t" register) is used along with the [x = t], [x ≥ t] and [x ⇕ t] keys; more details of all these are given later.

If you have a very complicated expression to work out on the T1-57 which uses several sets of brackets inside each other (a process called nesting), memories 5 and 6 can be taken over as temporary stores, so that these memories cannot be used for anything else. This very seldom occurs, though, because there is practically always a way of programming which can avoid the problem if we must have the use of these memories.

The main problems which inexperienced users encounter with the use of memories are:

(a) forgetting to use the reference number,

(b) recalling the wrong memory,

(c) forgetting to load memories before running a program.

All of the memories (but not the program memory) can be cleared with no effect on the program. Using the memory clear key [C.t] (operated by pressing [2nd] [CE]) clears only memory 7 (the test register), but the sequence [INV] [2nd] [CE] clears all of the memories. Switching off and on again will, of course, clear everything — including the program.

DOUBLE USE OF MEMORIES

Both the T1-57 and the PRO-100 have a useful feature that lets us use each memory for two numbers subject to some restrictions. Impossible? Not if you remember the [Int] key, which is activated by pressing [2nd] [)]. The instruction [Int] means "take the integral part of a decimal". For example, if we have the number 36.145 in store 1, then the sequence [RCL] [1] [Int] will produce the number 36, which is the integral (whole number) part on the display. Now if we use the key sequence [INV] [Int], the fractional part of the number is similarly selected, so that for the same number [RCL] [1] [INV] [Int] will cause 0.145 to appear on the display. How can we use this? Suppose, for example, that we are using the expression

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

to find the resonant frequency of a circuit containing inductance L and capacitance C. With any luck we should be able to use L values in μH, which will all be whole numbers (integers), and C values in nanofarads (1nF = 1,000pF) which for radio frequency circuits will be fractional values.

This way we could represent the values of 75μH and 150pF as 75μH and 0.15nF, and code this as 75.15. Store this number in memory 1, and we can use a programme to separate the parts, multiply up (because the formula is given for C in farads and L in henries) and give the frequency in Hz. Easier still, we can make use of the modified formula:

$$f = \frac{5.03}{\sqrt{LC}}$$

with C in nF, L in μH and F in MHz. The program

Fig. 5	Program	Procedure
		Enter value of t STO 0
	LRN RCL 0 Prd 1	Enter value of n STO 1
	1SUM1 RCL 2 Prd 1	Enter value of RO STO 2
	RCL 1 R/S LRN	CLR
		RST
		R/S
		Read value of Rn from display

Program	***Procedure***
LRN RCL 1 Int STO 0 RCL 1 INV Int Prd 0 RCL 0 $\sqrt{x}$ 1/x X 5.03 = R/S LRN	Enter coded numbers STO 1 Fix 2 RST R/S Display shows frequency in MHz Example: L = 75μH, C = 150pF is entered as 75.15 STO 1 Result is 1.50MHz

Note the use of the step [Fix] [2]. This gives all results to two decimal places only, though the working is in eight places. For higher accuracy, [Fix] [3] (or larger number) may be used. The use of [Fix] [2] makes results easier to read during a short pause.

Fig. 6

Program	***Procedure***
LRN RCL 1 Int STO 0 RCL 1 INV Int Prd 0 RCL 0 $\sqrt{x}$ 1/x X 5.03 = R/S RCL 2 STO 1 RST LRN	Code one set of values STO 1 Code another set of values STO 2 Fix 2 RST R/S Display shows first resonant frequency R/S Display shows second resonant frequency

Fig. 7

now looks as in Fig. 6, and we can extend it to deal with more than one pair of values, as in Fig. 7.

Now that we can include memory steps into programs, the next move is to make use of the chance that this gives us to program the calculator to make decisions, by comparing the number in the display with a number stored in a memory. That's the subject of the next "Tune-In", next month.

INDUSTRIAL NOTE

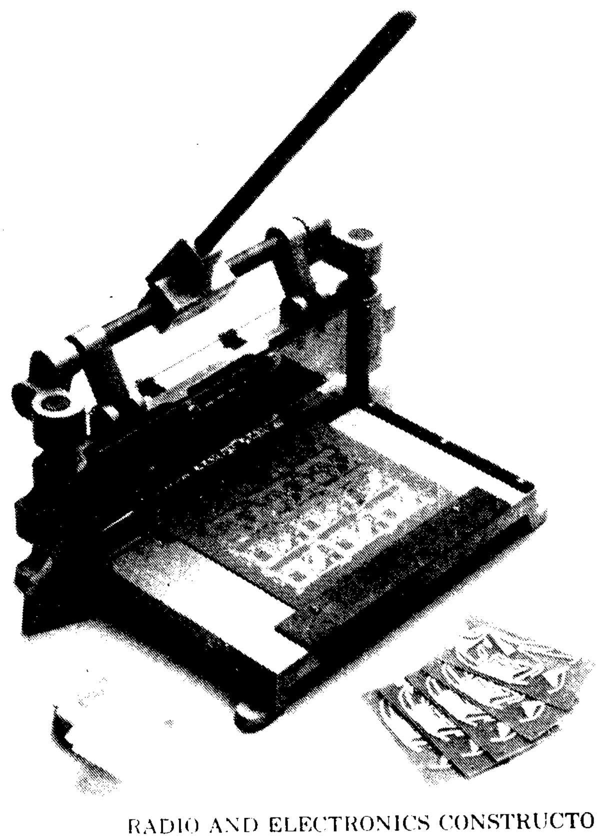
MULTI PURPOSE GUILLOTINE FOR THE PRINTED CIRCUIT INDUSTRY

New from CuPRO Equipment is the MS-6 Multi Purpose Guillotine for the printed circuit industry. The Guillotine will easily cut fibre glass and paper based laminates up to ⅛" thick without shattering and burr free. It will also cut sheet metal up to $\frac{1}{16}$" thick. By the addition of a punch bar the MS-6 can be used for pilot hole punching vital for accurate repeat registrations. A further accessory consisting of two individual punches allows the Guillotine to punch two randomly located holes along a single axis. The corner notcher attachment is particularly useful for cutting 90° corner notches.

The Press Brake attachment makes 90° bends in soft aluminium or sheet steel up to 22 guage, ideal for forming front panels. The final attachment is a drilling machine and routing machine attachment. The Drill has variable speed control from 5,000 to 25,000 rmp suitable for stack drilling pcbs, four collets are supplied and the drill can easily be converted to a routing machine.

An air powered version, or a foot powered version of the MS-6 is available for volume operations. The standard guillotine weighs 24 lb and requires a bench space of 15" wide by 13" deep.

Further details from Lektrokit Ltd., Sutton Industrial Park, London Road, Earley, Reading, Berks. RG6 1AZ.



In your work-shop

APRIL FOOL CIRCUITS

Circuits that shouldn't work — but they do!

"In electronic circuits," said Smithy, sipping from his disgraceful tin mug, "you always want to look out for the unexpected. Particularly when there are diodes and transistors knocking around."

Smithy placed the mug on his bench and brushed a few crumbs off his knees. He and his assistant, Dick, had just finished their lunch-time sandwiches, and now had some thirty minutes to pass before returning to their labours. Inevitably, Dick had steered the conversation to matters pertaining to electronics and, equally inevitably, Smithy had risen to the bait and had commenced to expound on the subject.

"Why," asked Dick, "do you have to be so careful about diodes and transistors? Surely you can't have components much simpler than they are."

ZENER REGULATOR

"Simple they may be," replied Smithy, "but they can still spring some surprises on you. Let's see if I can think of an example."

He pondered for a moment and then reached across his bench to pick up his note-pad. Taking a pen from his overall jacket he scribbled out a circuit. (Fig. 1(a).)

"Now, what is this?" he asked, tearing off the note-pad sheet and passing it to his assistant.

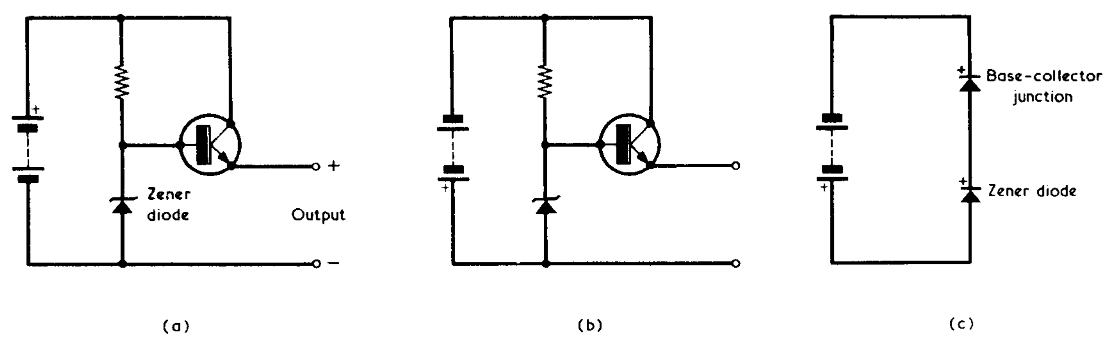
"It's a zener diode voltage regulator circuit," responded Dick promptly. "The positive side of the battery couples to the zener diode by way of the series resistor, and a stabilized voltage then appears across the diode. The base of the transistor connects to the zener diode and it acts as an emitter follower. The voltage at the emitter of the transistor is the same as that at its base, less the small voltage dropped across the base-emitter junction. So you have a regulated voltage at the transistor emitter, too."

"Very good. In fact, it's a perfectly standard circuit, isn't it?"

"Definitely."

"And so it is," confirmed Smithy. "Now what would happen if, by accident, we were to connect the battery to it wrong way round?" (Fig. 1(b).)

Dick frowned at the circuit.



(a) (b) (c)

Fig. 1(a). A very common voltage regulator circuit incorporating a zener diode and an emitter follower transistor

(b). The circuit which is given if the battery is accidentally connected with incorrect polarity

(c). Effectively presented to the battery are the forward biased zener diode and base-collector junction of the transistor in series

"Why, nothing would happen. There wouldn't be any regulated voltage from the transistor, of course, because the supply polarity is wrong."

"No excess current flowing anywhere?"

"Of course not."

"And that's where you're wrong," retorted Smithy triumphantly. "I'll agree that this particular instance is a bit contrived, but it still demonstrates the hidden perils that can lurk in even simple circuits incorporating transistors and diodes. In practice, one hell of a current will flow!"

"Through what?"

"Through the zener diode and the base-collector junction of the transistor," replied Smithy. "To start off with, a zener diode is an ordinary silicon diode which only exhibits its voltage stabilizing effect when it's reverse biased. If it's forward biased it acts just like any other silicon diode and it drops about 0.6 volt. It becomes forward biased in that regulator circuit when the battery is connected wrong way round."

"Blimey," said Dick. "I'd forgotten about that."

"And the zener diode," went on Smithy, "connects to what is effectively another forward biased diode, this being the base-collector junction of the transistor. The result is that the incorrectly connected battery is applied to two forward biased diodes in series, which is very nearly equivalent to a dead short. Either the battery will be run down very rapidly or the zener diode or the transistor will burn out." (Fig. 1(c).)

"Stap me," remarked Dick. "That's really something to think about. But still, you don't normally design an electronic circuit so that it has to withstand an incorrectly connected supply, do you?"

"Not always," agreed Smithy, "although it can be an eventuality which has to be borne in mind. Now you've got me going on unusual circuit effects I've been able to recall a few really weird examples. Since we are about to enter the month of April, I'll call them my 'April Fool Circuits'."

DELAY CIRCUIT

Smithy sketched out another circuit on his note-pad. (Fig. 2.)

"What on earth is that?" asked Dick, who had now risen from his stool and was standing beside the Serviceman.

"It's a circuit for energising a relay," explained Smithy. "When the switch is closed the relay is de-energised. The relay becomes energised when you open the switch."

"Come on, Smithy. You're having me on!"

"No I'm not. I'm perfectly serious and the circuit works on quite legitimate electronic principles."

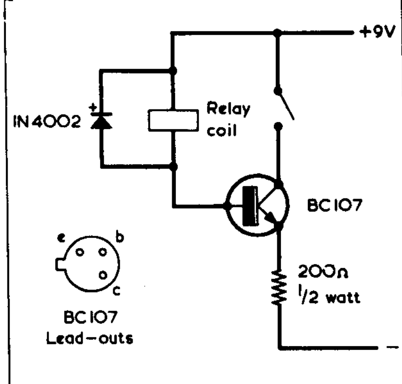


Fig. 2. How to drive a relay coil from the base of a transistor! The relay energises when the switch is opened

"I don't believe it!"

"Try it out in practice. It won't take you more than a few minutes to solder up the few components that are needed for the circuit."

"All right, I will," said Dick decisively. "Incidentally, what's the diode across the relay coil intended to do?"

"It stops the formation of high back-e.m.f. voltages across the coil when the relay releases. It's the usual diode you have in any circuit when a transistor drives a relay."

"Ah yes," stated Dick, "but in any circuit that I have ever seen the relay coil is driven by the transistor collector or by the transistor emitter. Who ever heard of driving a relay coil by way of a transistor base?"

"Just you make up the circuit, and you'll soon find out what it does," replied Smithy. "The circuit requires a relay with a coil resistance around the 500 Ω mark. One of those little 410 Ω 'Open Relay' types which are sold by Maplin Electronic Supplies would be just the job, and I'm certain we've got one knocking around in the spares cupboard."

"Right," said Dick with alacrity. "I'll have this circuit of yours wired up in no time at all."

And, indeed, it was not long before Dick announced that he was just soldering the last joint of the circuit. Smithy wandered over to his assistant's bench to survey his handiwork. Dick had wired up the transistor and the resistor on an odd length of tagboard, with flexible leads to the switch and the relay, which lay on the bench surface. He applied two crocodile clip leads to the circuit for the supply connection and picked up a PP9 battery from the back of his bench.

"The switch should be closed at the beginning," said Smithy.

"Righty-ho."

Dick ensured that the switch was closed, then connected the crocodile leads to the battery.

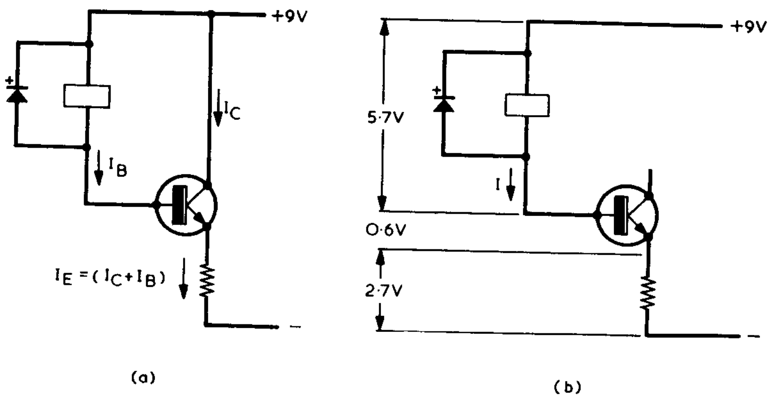


Fig. 3(a). The situation which exists in Fig. 2 when the switch is closed. Only a small base current flows through the relay coil

(b). When the switch is opened, all transistor currents disappear. A d.c. circuit is set up through the relay coil, the base-emitter junction of the transistor and the 200 Ω resistor

Nothing happened.

"There you are," jeered Dick. "This circuit of yours is a load of old rubbish!"

Smithy peered at him mildly.

"Try opening the switch."

Carelessly, Dick put out his hand and set the switch to the open position. With a click the relay armature snapped over to the energised position. Incredulously, Dick turned the switch on again, whereupon the relay armature released. Once more he opened the switch and once more the relay energised.

"Ye gods," gasped Dick. "What's this circuit working with — black magic?"

"I told you that it was a perfectly respectable circuit," grinned Smithy.

"How does it work, then?"

"Well," replied Smithy, "consider the case when the switch is closed. What you have then is a simple emitter follower, with emitter current flowing into the 200 Ω resistor. Now the emitter current is the sum of the collector current and the base current and it will in practice cause some 8 volts or more to be built up across the resistor, so that the current will be of the order of 40mA. The base current will be very much lower than the collector current and it certainly won't be sufficient to cause the relay to energise. In any case, the voltage across the relay coil will only be about half a volt, if that." (Fig. 3(a).)

"Okay, so the relay does not energise. Why does it energise when the switch is opened?"

"Because the current which flows through the relay coil increases by a considerable amount. With the switch closed the relay current was merely the base current needed to sustain the collector and emitter current flowing in the 200 Ω resistor. When the switch is opened the whole situation changes. There obviously cannot now be any collector current and the only current which can flow in the circuit is that in the relay coil, the base-emitter junction of the transistor and the 200 Ω resistor. The base-emitter junction acts like a forward biased silicon diode with a voltage drop across it of 0.6 volt. The remaining voltage is shared between the relay coil and the 200 Ω resistor, giving a little more than 5.5 volts across the coil and a little more than 2.5 volts across the resistor." (Fig. 3(b).)

UPSIDE-DOWN CIRCUIT

"Hell's teeth," snorted Dick. "That circuit is really a stinker."

"Would you like to have a go at another relay driver circuit?"

"Does it follow basic electronic theory?"

"Oh yes. Also, it's just as simple as the last one."

"Show me."

Smithy drew a further circuit on his note-pad and handed it over to Dick. (Fig. 4.)

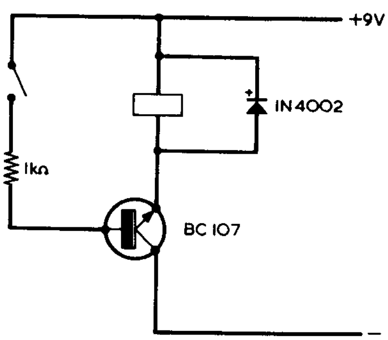


Fig. 4. Another relay driver forms the second of Smithy's April Fool circuits. A suitable relay is the "Open Relay" with 410 Ω coil which is available from Maplin Electronic Supplies. Believe it or not, the circuit functions with most BC107 transistors

"Corluvaduk," moaned Dick unbelievingly, "what's *this*!"

"It's a relay driver circuit," repeated Smithy. "This time the relay energises when the switch is closed."

"Have a heart Smithy, you can't possibly be serious about this. For a start, the transistor is an n.p.n. type and its collector is going to the *negative* rail! And, for Pete's sake, it can't possibly be an emitter follower even then because the base goes up to the *positive* rail through the 1kΩ resistor! Ye gods, Smithy, what *is* it?"

"It's a perfectly honest electronic circuit," said Smithy calmly. "If you check it out in practical form you'll see what happens."

"This passes all possible understanding," stated Dick unhappily. "D'you know, Smithy, a young working lad like me could suffer a grevious trauma to his psyche when confronted with a circuit like this. It just can't work!"

"Try it."

Rebelliously, Dick picked up his soldering iron and stripped down the previous circuit he had assembled. He then wired up the new circuit. As he did so, Smithy beamed at him benignly and continued to sip at his post-lunch tea.

"Well," said Dick eventually, putting his soldering iron down on its rest with a crash, "it's all finished now except for connecting the battery."

"Very good," commended Smithy. "This time, start off with the switch open."

Obediently, Dick connected the circuit to the PP9 battery whilst Smithy watched the relay. It did not energise. Smithy put out his hand and turned the switch on. The relay armature clicked smartly to the energised position. Smithy turned the switch off and the armature released. The bemused Dick grabbed the switch from Smithy and operated it several times himself. At all times the relay energised when the switch was closed and de-energised when it was open.

"I simply," wailed Dick, "cannot believe my eyes. We've got a transistor here which is not connected in the common emitter mode, the common collector mode or the common base mode, and yet the flaming thing is *amplifying!* It must be amplifying because the current in the 1kΩ resistor has got to be less than the current flowing in the relay coil."

"Quite a good little circuit, isn't it?"

"Good? I reckon it's downright malevolent. In the old days they'd have burnt you at the stake for dreaming up circuits like this one."

"I've got an even better one for you," said Smithy. "Do you feel like trying it out for me?"

Dick shrugged his shoulders helplessly.

"What have I got to lose?"

CRAZY MULTIVIB

Cheerfully, Smithy got out his pen once more and proceeded to draw up a further circuit. This was a little more complicated than the previous ones, and several minutes elapsed before he was able to present it to his assistant. The latter regarded it with unrelieved horror. (Fig. 5.)

"What," he spluttered, "do you call this?"

"It's an oscillator," explained Smithy soothingly. "Actually, it's a multivibrator with a calculated running frequency of rather less than 100Hz. As you can see, you need two 1kΩ resistors and two 10kΩ resistors, and these can all be 10% types. The two capacitors are 1μF polyester. And, of course, there are the two BC107 transistors."

"Oh yes," intoned Dick sarcastically, "we mustn't forget the two transistors. Two n.p.n. transistors, just like in your last circuit, with their collectors going to the negative supply line."

"That's right," grinned Smithy.

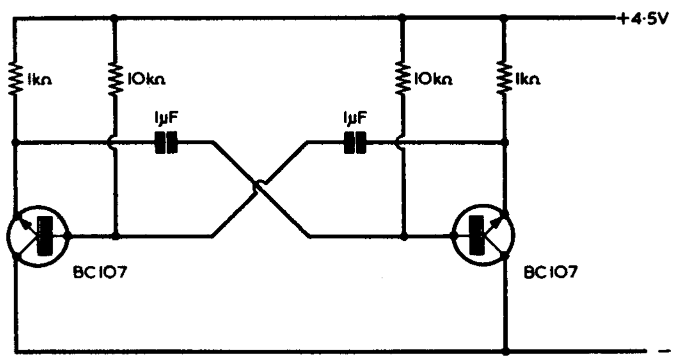


Fig. 5. Crazy multivibrator circuit. Operation is not guaranteed but the circuit will oscillate with nearly all transistors of the BC107 type

"Incidentally, the supply voltage is 4.5 volts this time, but I don't think you'll have any difficulty sorting out a suitable battery."

"I'll have a stab at it," said Dick.

He settled down to wiring up Smithy's new circuit, and he soon had the components assembled on the piece of tagboard he was using. He found a 4-cell battery holder, fitted four HP7 cells in it, and tapped off 4.5 volts by inserting a piece of thin tinplate between two of the cells in the holder. As he proceeded with his task, Smithy walked over to the "Repaired" racks and picked up a small medium wave and v.h.f. radio that he had serviced during the morning. He then watched Dick as he completed the wiring.

"I am," announced Dick, as he put down his soldering iron, "now going to connect this maniacal circuit of yours to the 4.5 volt battery."

He clipped two leads to his improvised battery.

"At least," he went on in a tone of mock relief, "it hasn't blown up in a puff of blue smoke or levitated itself off the bench."

Smithy switched on the radio, selected a quiet point on the medium wave band and held it close to the multivibrator wiring. A faint reedy buzz became audible behind the background hiss from the radio speaker.

"It seems to be working quite well," he stated complacently, "although I'm certain that you'll need evidence that's more concrete than the picking up of its tone on a medium wave radio. Have you got a pair of high resistance phones knocking around?"

Dick delved into the debris on his bench.

"I've got a 1kΩ magnetic earphone here."

"Good," said Smithy. "Then couple it to the emitter and collector of one of the transistors via a capacitor of around 0.01 to 0.05μF."

Dick found a 0.022μF capacitor and quickly rigged up the earphone circuit. (Fig. 6.)

"You're right," he said in an awe-struck voice as he held the earphone to his ear. This circuit *is* oscillating, and it's oscillating good and strong, too!"

He passed the earphone over to Smithy. It was reproducing, at good strength, a clear tone of the same frequency as that picked up on the radio.

TRANSISTOR OPERATION

"Do you believe that that circuit works now?" asked Smithy.

"I do," said Dick. "But I haven't got the faintest clue why it does, though."

"We could, of course, have alternatively checked it by coupling it to an a.f. amplifier or to, say, a crystal earphone."

"Okay, Smithy, I said I'm convinced it works. But *why?*"

"The reason why the multivibrator works, and also why the previous relay circuit works, is a property of the bipolar transistor that is frequently forgotten. We were using n.p.n. transistors in these circuits, and I hardly need to tell you that we can represent an n.p.n. transistor as two blocks of n. type semiconductor material with a thin slice of p. material in the middle." (Fig. 7.)

"That's right," said Dick quickly. "One of the n. blocks is the emitter, the other is the collector and the thin slice of p. material is the base."

"Exactly," stated Smithy. "But, seeing that the arrangement of n. and p. type materials is symmetric, why can't we also say that the n. type block we're calling the emitter is actually a collector, and that the n. type block we're calling the collector is actually an emitter?"

"Can we do that?"

"Of course we can — you've just done it with those last two circuits! If you treat the collector of any bipolar transistor as an emitter and the emitter as a collector then you've got another transistor."

"That means," protested Dick, "that the transistor is working wrong way round."

"That's right."

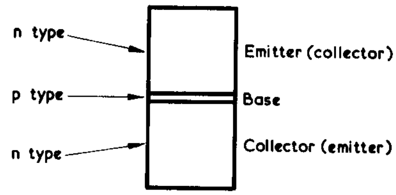


Fig. 7. An n.p.n. transistor can be represented as two blocks of n. type semiconductor material with a thin slice of p. type material between them

"But the transistor isn't even designed to work in that manner."

"I know it isn't," said Smithy. "Yet it will still work as a transistor if you connect it up in this wrong way round fashion. The current gain will be very much lower than the current gain given when the transistor is connected properly, but there will almost certainly still be *some* current gain. We had the transistor connected wrong way round in the second relay driver circuit and since the circuit only needed a current gain figure of a little more than 2 times, the circuit worked. In the multivibrator circuit the base resistors were 10kΩ and the emitter-cum-collector load resistors were 1kΩ, and so the wrong way round transistors had to have a current gain of at least 10 times. We got away with it in that circuit, too!"

"Well, blow me," said Dick. "This idea of using a transistor wrong way round is something I'd never realised could even happen."

"It is a bit surprising," agreed Smithy, "when you bump into the effect for the first time. Since we're using transistors out of their specification, there's no guarantee that either the relay driver or the multivibrator circuit will work with all BC107 transistors. But it will certainly work with most. If the circuits don't operate with particular BC107's, it's worth trying others from a different batch, incidentally."

BACK TO WORK

With these words, Smithy reached for his mug and drained it. He handed it to his assistant who, wordlessly, went through the ritual of refilling it from the cracked and battered Workshop tea-pot.

Smithy glanced up at the clock and noted, with some surprise, that he and his assistant should have been back at work at least five minutes earlier. He sighed contently and decided that a small further inroad into official working time wouldn't do any harm just for once. After all, if he and Dick could successfully get transistors to work with all circuit rules broken, there was no reason why they shouldn't also judiciously bend the rules a little so far as working hours were concerned. ■

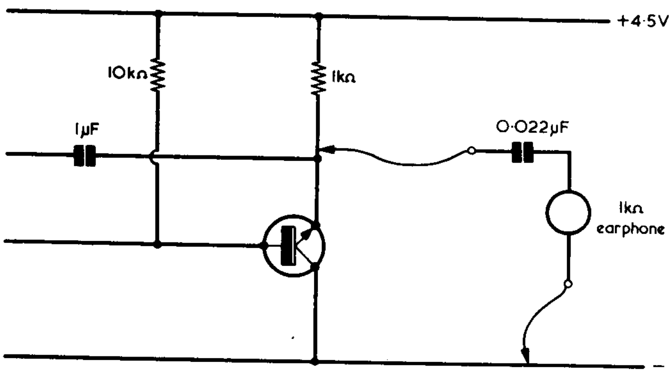
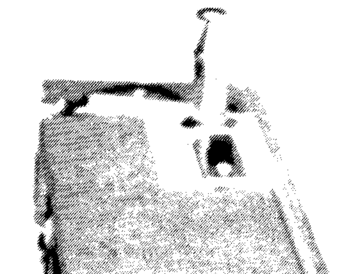


Fig. 6. Dick checked the multivibrator by coupling a magnetic earphone and series capacitor across one of the transistors. The multivibrator can be coupled to any fairly high impedance reproducer or a.f. amplifier input

BAND II PORTABLE

Part 2 By Sir Douglas Hall, Bt., KCMG

Concluding details on this unique and ingenious receiver design



The receiver assembly without the knob frame fitted

In this concluding article we complete the constructional details for this receiver. References will be necessary here to Figs. 2 and 3, which were published in last month's issue.

SPEAKER MOUNTING

To avoid microphonic feedback howl, the speaker is fitted on a rubber mounting. As is shown in Fig. 4(a), four small woodscrews are fixed to the panel of Fig. 2(c) outside the periphery of the speaker. Two rubber bands about 3in. long and $\frac{1}{4}$in. wide are next required. Pass one rubber band loop through one of the speaker mounting holes so that it enters from the front of the speaker. Hold the band end in place by passing a bolt or a nail through it, take the main length of the band along the front of the speaker and pass the other end through the relevant speaker hole, as shown in Fig. 4(a). Keep this end in place temporarily by means of another bolt or nail. Repeat the procedure with the second rubber band and the remaining two speaker holes. Next transfer the loop ends of the bands, one by one, from the temporary holding bolt or nail to the appropriate woodscrew, again following Fig. 4(a). When the operation is completed it will be found that the speaker is held securely behind its aperture in the panel of Fig. 2(c) but without its frame touching the panel at any point, being mechanically isolated from it by the rubber bands. The edges of the speaker frame must not touch the sections of Fig. 2(b), upper or lower. If there is any danger of this, part of these sections should be cut away, as indicated by the dashed lines in Fig. 2(b).

Now cut out the sections of Fig. 4(b) to 4(e) inclusive. Use $\frac{1}{4}$in. plywood for Fig. 4(b), (c) and (d), and $\frac{1}{8}$ in. s.r.b.p. for Fig. 4(e). Sections 4(b) and 4(e) should be covered with Fablon or Contact of the type decided on for covering the finished receiver.

Fit S1 to the upper Fig. 2(b) section. Fit together, by means of woodscrews, the sections 2(a), 2(b), 2(c), the 13-way tagboard, 4(d) and 4(e), as shown in Fig. 4(g), but at this stage do not screw the top end of the tagboard to the end of the upper Fig. 2(b). Figs. 4(f) and (h) show in greater detail how some of these parts fit together.

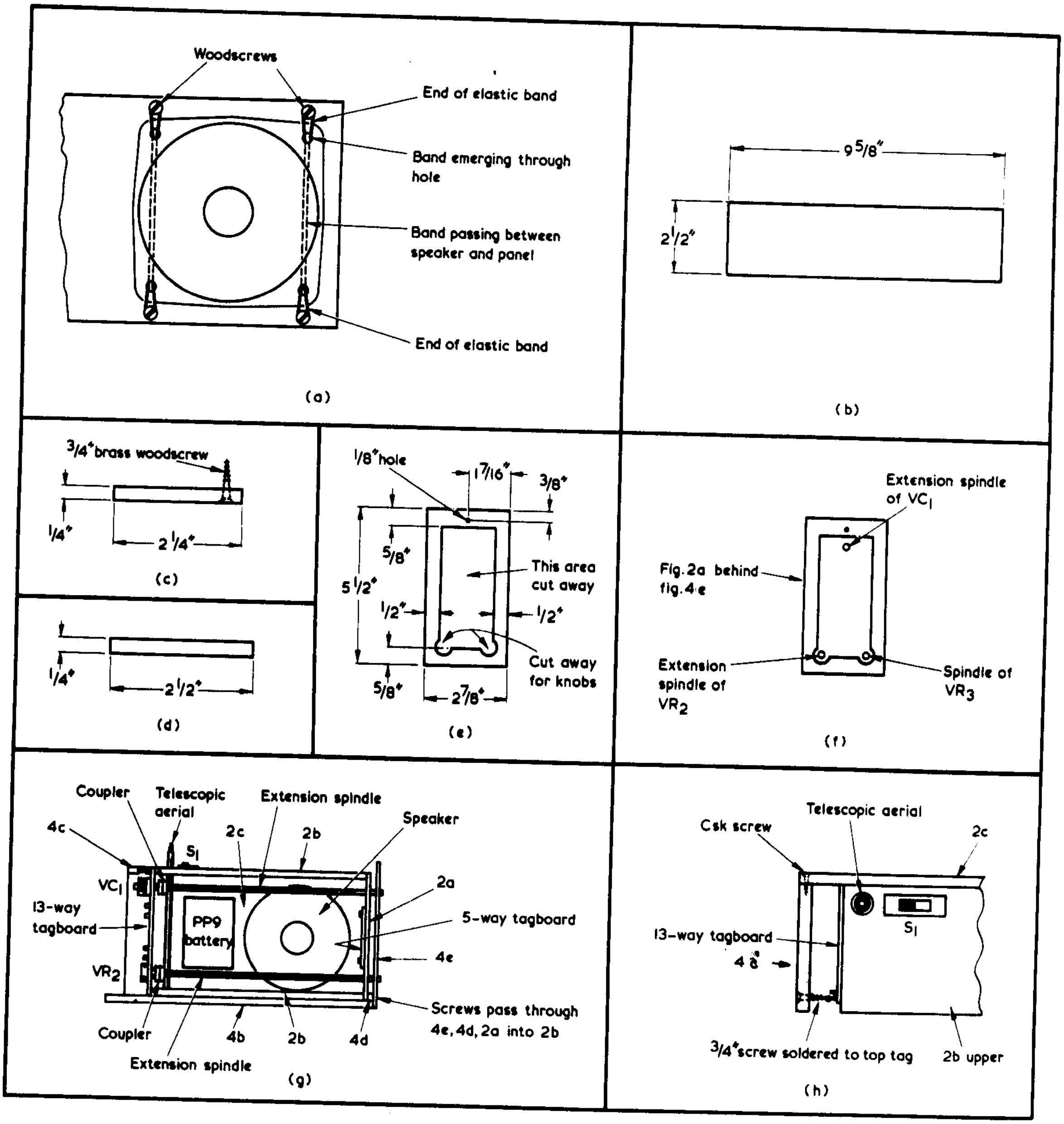


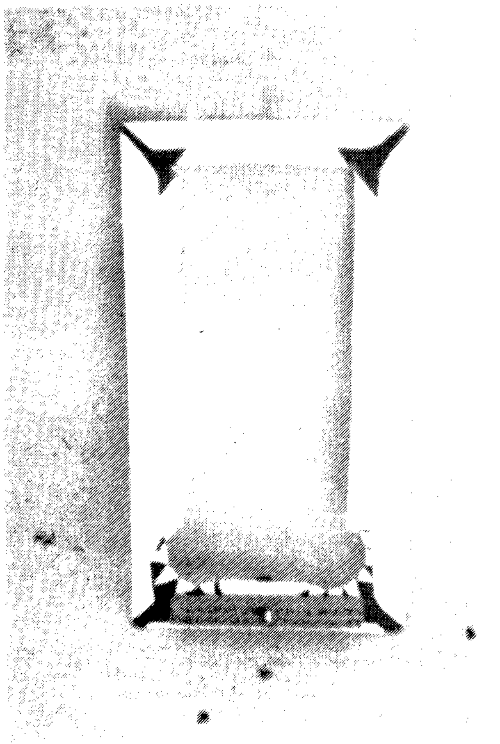
Fig. 4(a). A "floating" mounting for the speaker. This prevents microphonic feedback to the tuning capacitor (b) The base plate of the receiver assembly (c) The receiver carrying handle passes under this bar when the case is made up (d) Spacing bar (e) The frame at the end of the receiver where the control knobs appear (f) Illustrating the positions of control spindles (g) The assembly of the complete receiver (h) Detail showing the manner in which the item of Fig. 4(c) is fitted in place

Next fit VC1, on its rubber mounting, to the upper end of the 13 way tagboard in the manner which was described last month. Also screw the upper end of the tagboard to the end of the upper Fig. 2(b) item. Fit the item of Fig. 4(c), as shown in Figs. 4(g) and (h). Pass the telescopic aerial through the round hole in the upper Fig. 2(b) piece and secure its base to the lower Fig. 2(b) panel so that it is upright. This will normally require drilling a hole in the lower Fig. 2(b) item to take an aerial mounting bolt. Arrange the mounting so that a solder tag is available at the bottom of the aerial to enable a connection to be made to it. Then fit the base plate of Fig. 4(b).

At this stage, sections 4(b) and 4(e), both covered in Fablon or Contact, form part of the case, the rest of which will be described later. The item of Fig. 4(c) will hold one end of the handle when the receiver is fitted in the case. Note that the end of the brass woodscrew which passes through it is soldered, as illustrated in Fig. 4(h) to the top tag of the tagboard against which it rests.

Wiring up is now completed. First wire in VC1, using flexible wire. Then complete the wiring to the aerial, to S1, to the speaker and to the PP9 battery, as shown, in Figs. 3(e) and (f). Also complete the wiring between the two tagboards.

The polystyrene extension rods are now added to



The inside appearance of the knob frame after it has been covered with Fablon or Contact

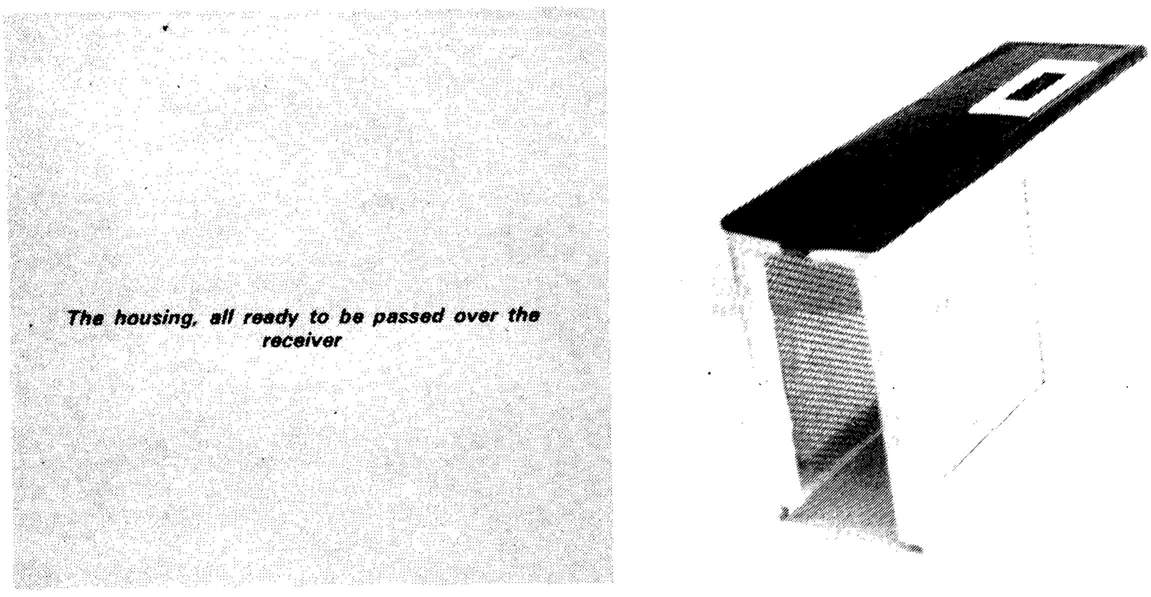
the spindles of VC1 and VR2. Flexible couplers are made up by sticking together two $\frac{1}{4}$in. grommets with Araldite. The spindle and extension rod ends may be built up with a turn or two of Sellotape to ensure that they make a tight fit inside the grommet into which they are passed. Do not allow the ends of the extension rods to be in contact with the component spindle ends inside the flexible couplers. The extension rod for VC1 passes through a $\frac{1}{4}$in. grommet fitted in the upper $\frac{3}{8}$in. hole in the piece of Fig. 2(a). It should be a loose fit in this grommet and, if necessary, the appropriate section of the rod should be filed down a little to achieve this. This filing down will, of course, have to be carried out before the extension rod is finally fitted into its flexible coupler. There is a slight horizontal displacement between the spindle of VC1 and the hole in the item of Fig. 2(a), but this is more than adequately taken up by the flexible coupler.

The knobs should now be fitted. If the specified knobs are not used, do not cut down the extension spindles and VR3 spindle until it has been checked whether the knobs have to be fitted so that they are outside the frame of Fig. 4(e). If this happens, incidentally, the appearance is less neat.

SETTING UP

The receiver may now be set up. Adjust the slider of VR1 to a central position and the slider of VR4 to the negative end of its track — this is fully clockwise in Fig. 3(f). Both the PP3 and the PP9 batteries should be new, and the PP3 battery is not connected at this stage. Fit the edge of the PP9 battery into the cut-out provided for it in the Fig. 2(c) panel, then suitably position a woodscrew in the lower Fig. 2(b) item to support it in place. Connect up to the PP9 battery with a meter, switched to give a clear current reading of 12mA, in series with one of the leads. Switch on and slowly adjust VR4 until the 12mA reading is obtained. Switch off, remove the meter and connect fully to the PP9 battery.

Fit the PP3 battery, extend the aerial and switch on again. There may be a loud hiss, and adjusting VC1 may produce distorted signals from the local BBC transmitters. If this occurs, adjust VR1 in a clockwise direction, as seen in Fig. 3(e), until the signals can be resolved in a distortion-free state with VR2 advanced by about one-third and with the new PP3 battery. It is possible that there will be no signals, or only weak signals, in which case turn VR1 clockwise until a louder hiss denotes oscillation and signals can then be resolved as described. Do not adjust VR1 anticlockwise so that only about a fifth or less of its track remains in circuit, as this could damage a component. The apparent necessity for such an adjustment also indicates a fault in the circuit. Do not adjust VR1



The housing, all ready to be passed over the receiver

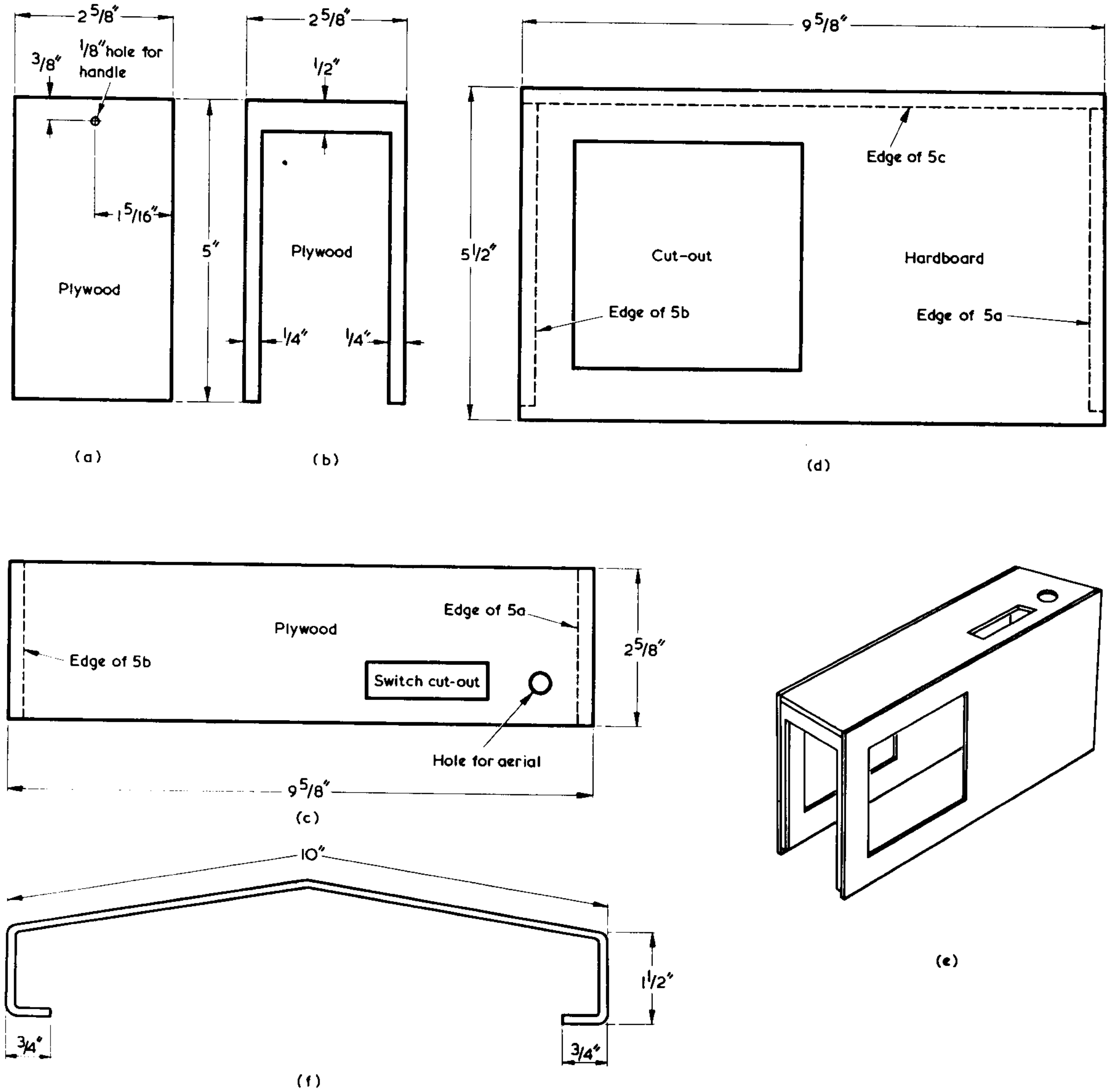


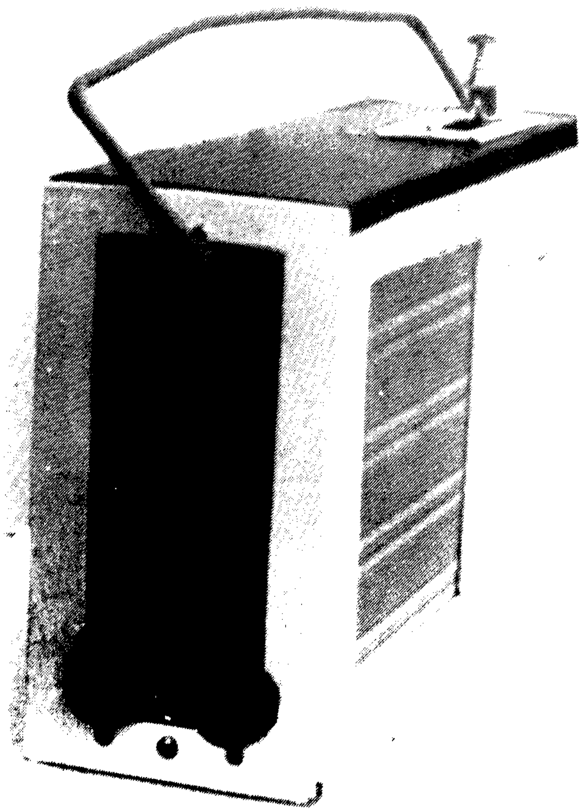
Fig. 5(a) One of the case panels (b) The case frame which appears at the same end as the control knobs (c) Top of the case. As is explained in the text, the dimensions here, and in (a) and (b) are for guidance only (d) How, the parts fit together (e) Perspective view of the case (f) Details of a simple wire handle

again, but there is some advantage in re-adjusting VR4 once more, after about 20 hours use, when the new PP9 battery has settled down. Do not then later re-adjust VR4 when another new battery is fitted.

If it is not possible to tune up in frequency to the local independent station, separate the turns of L1 a little. On the other hand, should it not be possible to tune down in frequency to Radio 2, the turns of L1 can be closed up a little. In strong reception areas results may be best with the aerial closed down partially or even completely. Normally, control volume by VR3, but back down VR2 if there is distortion due to a very powerful incoming signal, or microphonic howling due to too high an oscillator amplitude. If the output appears to contain too much treble, increase the value of C12.

CABINET

A suggested case is shown in Fig. 5. Fig. 5(d) is the front and consists of hardboard. A second piece of hardboard forms the back and it has the same dimensions and the same cut-out as the front. When the case is assembled the two cut-outs are opposite each other, i.e. they are both nearer the control knob end. The case is assembled as shown in Fig. 5(d) and (e), and is then covered with Fablon. It slips over the receiver assembly with the open frame end, shown in Fig. 5(e) on the left, sliding between sections Fig. 2(a) and Fig. 4(e), as shown in Fig. 4(g). The case will have to be turned through 180 degrees from the position shown in Fig. 5(e) in order to fit it to the receiver assembly as illustrated in Fig. 4(g). Both these diagrams have been drawn for maximum clarity, but they are not



The receiver, complete in its case and with the wire carrying handle in place.

"in phase" with each other. Two pieces of speaker fabric should be placed in the appropriate positions, in front of and behind the speaker.

When the case has been fitted to the chassis, a 1/8 in. drill should be passed through the hole shown at the top of the frame of Fig. 4(e). A corresponding 1/8 in. hole is then made at the top of the section of Fig. 5(b). There is already a 1/8in. hole in the item of Fig. 5(a). These two holes take the ends of the wire handle shown in Fig. 5(f), which can be made from stout wire, such as is used in wire coat hangers. This handle holds the case and the receiver assembly together.

It must be emphasised that the dimensions shown in Fig. 5 are for guidance only and they do not allow for any dimensional tolerances in the receiver assembly. In practice the case must be made up to accommodate the particular receiver assembly, as constructed.

(Concluded)

Radio Topics

By Recorder

★★★★★★★★★

WELSH DEVELOPMENT

A firm coming into the news quite frequently lately is the Government backed electronics factory of Galatrek Engineering in the Snowdonia National Park. One of their latest designs, and visible in the accompanying photograph, is what is described as "the plug which thinks for itself."

This ingenious 3-pin 13 amp plug can be fitted into a mains socket whereupon, by means of neon indicators on its front, it will indicate one of the following conditions: (1) the socket is safe; (2) danger, reverse polarity; (3) danger, no earth; (4) danger, live fault; (5) danger, neutral fault.

The plug can be used by do-it-yourself buffs, craftsmen, tradesmen, householders and installers of domestic electronic equipment. Initially it was designed for C & A Modes to protect machinery in their stores throughout the U.K.

The full address of the manufacturer is Galatrek Engineering, Scotland Street, Llanrwst, Gwynedd, North Wales.

"The plug which thinks for itself." When inserted into a 13 amp mains socket, indicators on the front of the plug show whether the socket is wired safely or whether there are any of four basic faults. The plug is manufactured by Galatrek Engineering

The accent these days appears to be on nostalgia, and this is well exemplified by the current interest in vintage radio sets. I have to confess that I become a little disturbed now and again when I find that radio equipment which I dealt with in the normal course of events not so many years ago (to my mind at any rate) has now fallen into the slot of "vintage"!

VINTAGE VERACITY

Quite a few enthusiasts are currently active not only in the collection of vintage radio sets but also in the process of bringing them back to working order. And here a little problem arises. If a component in a vintage radio has to be replaced in order to get it to work, should the replacement be a modern part or one which was made at around the same period as the set itself? Commonsense suggests that a modern component should be employed, but those who are searching for true vintage veracity may well wish to employ components from the period in which the set was manufactured.

In one instance, however, it can be actually dangerous to employ really old components, and this is when the parts concerned are electrolytic capacitors. Some of the pre-war h.t. smoothing electrolytics, believe it or not, used to occasionally *explode* if they developed an internal short-circuit or passed too high a leakage or ripple current! So, if you are trying out a very old mains radio and are connecting it to the mains for the first time for many, many years, keep well away from the electrolytics until you are satisfied that all is going well.

My thoughts in this direction are partly prompted not by vintage radios but by vintage cars, in which there is an even greater interest. I had the good fortune to attend several open-air motor rallies during our recent so-called "summer" and was quite fascinated by the early cars, traction engines and stationary engines which were on view, still in full working order. There is something warming to the heart in the sight of the owner of a 1908 stationary engine sitting behind it in a deck chair and beaming away at it as it happily chugs away. And I saw one little item of radio interest: a small steam engine and dynamo unit. During World War II these units were dropped behind the Japanese lines to enable the batteries of clandestine radios to be charged. An ingenious choice of power indeed; the steam engines could be fuelled by any combustible material, and they would be far quieter in operation than any petrol powered motor.

FLASHING L.E.D.

Currently available from Norbain Optoelectronics Division, Norbain House, Arkwright Road, Reading, is what appears to be the first flashing light-emitting diode to appear on the electronics market. The l.e.d. has a built-in integrated circuit which causes it to flash on and off at approximately 3 pulses per second, and it can be driven directly by standard t.t.l. and CMOS circuits, thereby eliminating the need for external switching circuitry. Manufactured by Litronix, the l.e.d. has the type number FRL 4403.

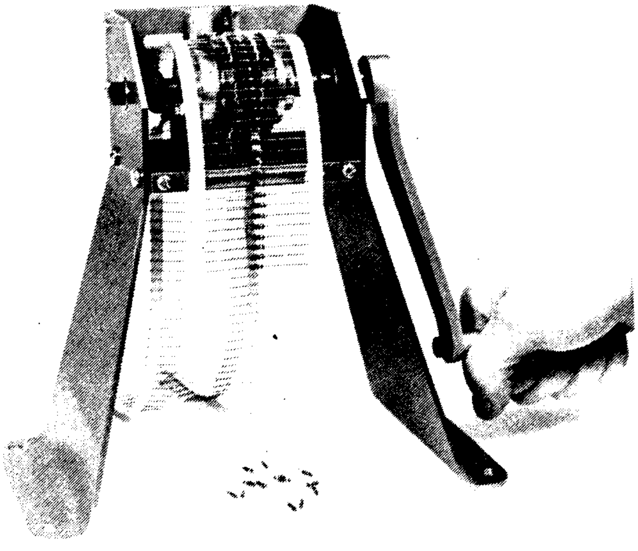
The l.e.d. employs gallium aresenide phosphide technology and has a red diffused plastic lens. Maximum dissipation is 200 milliwatts at 250 degrees Centigrade. There is a large full flood radiating area and a wide viewing angle, and the l.e.d. will lend itself particularly well to applications where it can give warning of potential or actual running condition failure in any processing system.

LEAD FORMING

Eraser International Ltd., 2/3 Hampton Court Parade, East Molesey, Surrey, have announced the availability of a new, hand operated, high speed component lead cutting and forming machine. The Wybar Model ARM1 "Side Winder" is designed to cut and bend at right angles the leads of axial components such as resistors, diodes and capacitors, etc.

The ARM1 is a compact bench-mounted machine which is fully adjustable to accommodate different size components, and which may be set by the use of an Allen key for any dimension of bend required. The machine will process most axial components which are mounted on bandoliers. The components are formed and cut by the turn of a handle — the faster the handle is turned the higher the production rate. Rates in excess of 40,000 components per hour are possible. The machine is ideal for both low and high production environments, due to its low cost in comparison with automatic equipment.

All cutting and forming dies are manufactured from high quality tungsten carbide, and the cutting blades are regrindable.



Axial component lead-outs are cut and bent to pre-formed shapes simply by turning the handle of the Model ARM1 "Side Winder" machine marketed by Eraser International, Ltd.

MOTOR SPEED CONTROL

An integrated circuit specifically intended for dc. motor speed control is described in a release by Fairchild Camera & Instrument (UK) Ltd., of 230 High Street, Potters Bar, Herts. The i.c. has the Fairchild proprietary type number μA7392 and is in a 14-pin d.i.l. package.

The μA7392 is designed to provide precision closed-loop speed control of d.c. motors in systems where a tachometer reference signal is available as an indication of speed. It is particularly suited for design situations where current requirements are either less than 300mA or greater than 2 amps (when drive can be provided through an external power transistor or power Darlington). The tachometer frequency can be generated in any manner, the only constraint being that the signal available at the device input terminals must exceed 100mV peak-to-peak.

Possible types of tachogenerator which can be used include a multiple pole motor winding, an optical pick-up from the motor's shaft or an optical or magnetic pick-up from a tape recorder capstan or record turntable.

On receipt of the tachogenerator signal the μA7392 first converts it into a pulse with a defined width and amplitude, the pulse being then integrated to generate a sawtooth waveform. This sawtooth is next compared with a d.c. reference to produce a pulse width modulated signal, the duty cycle of which is related to the error signal. Average output current available from the i.c. is up to 300mA.

The motor inductance itself provides adequate smoothing, so ensuring that what is essentially a direct current passes through it. This requires that the tachometer frequency be a sufficiently large multiple of the motor speed.

Two distinct design advantages are offered by the μA7392 system. First, speed regulation is independent of the amplitude of the tachometer signal, since it depends only on the frequency. Second, at higher battery voltages the system is more efficient than equivalent d.c. control systems. The result is extended life for battery powered equipment.

Specific design features include precision performance (frequency-to-voltage conversion stability is typically 0.1% for supply voltages from 10 to 16), on-chip thermal shutdown and over-voltage protection.

INDOOR AERIALS

It is surprising how effective radio and television receivers can be with the most elementary of aerials. For years I have had a 405 line television set working in a spare room, and I got excellent results on this with a home-made dipole consisting of two lengths of coaxial cable each cut to about a quarter wavelength of the local Band I channel. These were positioned more or less vertically, like a true dipole, in a corner of the room, the braiding of the upper length connecting to the centre conductor of a third piece of coaxial cable, and the braiding of the lower length connecting to the braiding of the third cable. The last cable connected the dipole to the set. Despite the frightful mismatch this arrangement also gave good results on Band III signals as well.

With small sound receivers we are largely conditioned to use indoor aerials, too. On medium and long waves we have become used to the performance given with internal ferrite rod aerials, despite the surprisingly high degree of attenuation which is found in large ferro-concrete buildings. Some years ago I knocked up a very simple t.r.f. receiver for 1,500 metres only which relied for nearly all its selectivity and its sensitivity on the ferrite aerial itself. The set worked perfectly at my house, but when I took it with me to a large London hotel the results were very disappointing. The strongest 1,500 metre signal was given when I took the set over to the window of the room in which I was trying it out! The radio worked perfectly, later, in an ordinary London house. The attenuating effect of large buildings is much less noticeable, of course, with conventional a.m. superhets having plenty of gain in hand.

F.M. reception with the pull-up telescopic aerial provided on most v.h.f. sets can also vary considerably according to the surroundings, and it is sometimes necessary to position the set and its aerial quite critically for best performance. For stereo reception an external aerial is, of course, well-nigh essential.

An external aerial is also a very good thing for a colour TV receiver, but some friends of mine don't agree. As witness they point to their own colour receiver which gives a completely acceptable picture on a tiny set-top aerial, the only shortcoming being a very slight graininess due to background noise which is just perceptible. The aerial gives one odd effect, though. The TV is positioned close to a wall dividing the living room from the kitchen, and when anyone goes to the kitchen cupboard on the other side of the wall the colour drops out, leaving a black and white picture. As my friends remark happily, they can always tell if the kids are raiding tne cupboard!

If, incidentally, you are thinking of buying an indoor TV aerial, don't forget that the higher gain u.h.f. types are graded in groups, and that you want the correct group for the channels in your district. For the record, aerials in Group A are for Channels 21 to 34, in Group B for Channels 39 to 51, in Group C for Channels 50 to 66, in Group D for Channels 49 to 68, and in Group E for Channels 39 to 68. ■