RADIO & ELECTRONICS CONSTRUCTOR

SEPTEMBER/OCTOBER 1977 40p

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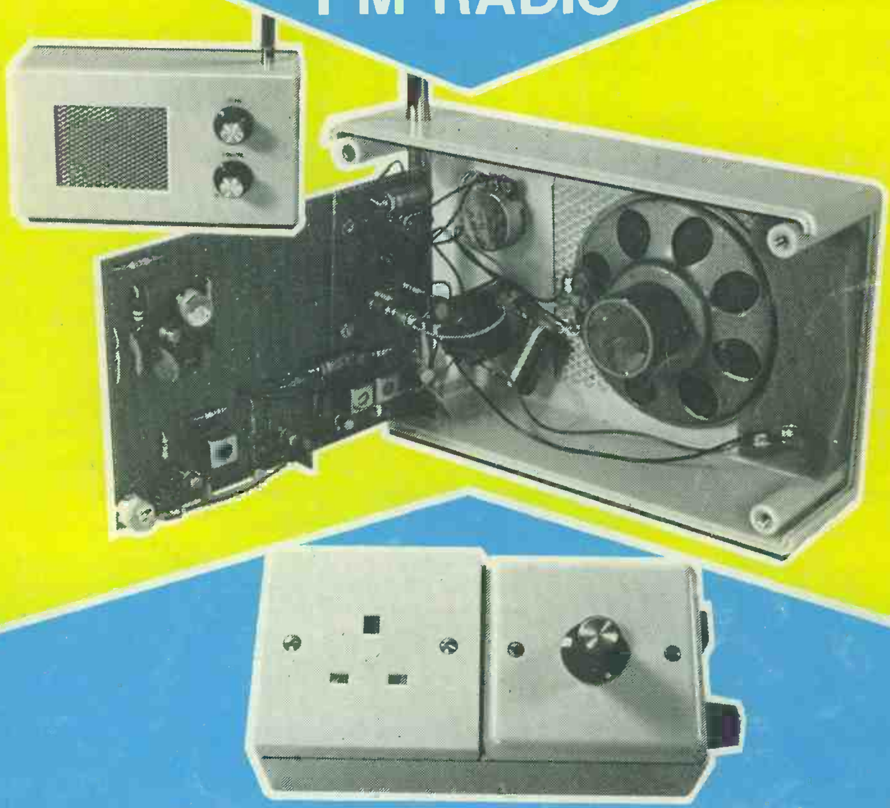

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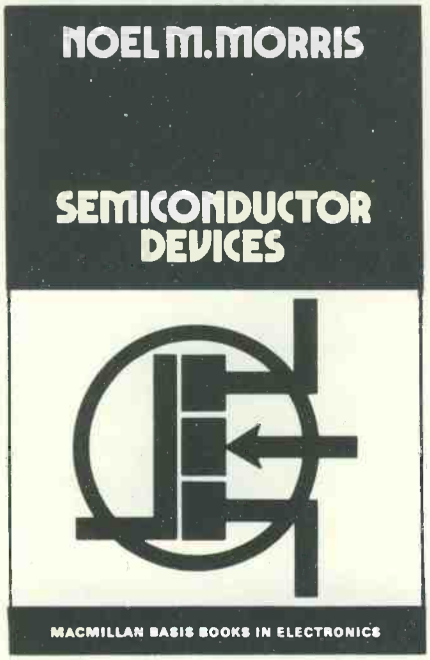

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In this introduction to semiconductor devices, the author provides a comprehensive survey of modern active and non-active semiconductor technology. Without leaning too heavily on device physics, he explains device functions and then illustrates their use with typical circuits and applications.

Following a summary of the physical basis of semiconductor elements — in non-mathematical terms — a study of bipolar and field-effect transistors leads to considerations of monolithic integrated circuits. More advanced charge-coupled devices, semiconductor memories and optoelectronic devices are studied in some detail.

CONTENTS

1. Semiconductors
2. Basic Semiconductor Devices
3. Semiconductor Diodes and the Unijunction Transistor
4. Bipolar Junction Transistors, Amplifiers & Logic Gates
5. Field-Effect Transistors, Amplifiers and Logic Gates
6. Monolithic Integrated Circuits
7. Charge-coupled Devices
8. Semiconductor Memories
9. Thyristors and other Multilayer Devices
10. Optoelectronics

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RADIO & ELECTRONICS CONSTRUCTOR

SEPTEMBER/OCTOBER 1977
Volume 31 No. 2

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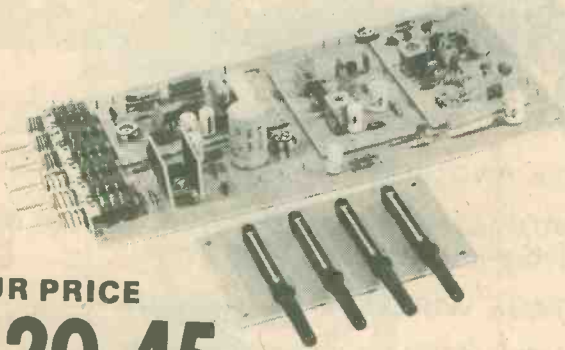
THE NOVEMBER ISSUE WILL BE PUBLISHED ON 3rd OCTOBER

BI-PAK

High quality audio e



OUR PRICE

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The 450 Tuner provides instant program selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, by simply changing the settings of the pre-set controls.

Used with your existing audio equipment or with the BI-KITS **STEREO 30** or the **MK60** Kit etc. Alternatively the **PS12** can be used if no suitable supply is available, together with the Transformer **T461**.

The S450 is supplied fully built, tested and aligned. The unit is easily installed using the simple instructions supplied.

NEW PUSH-BUTTON
STEREO FM TUNER

Fitted with Phase Lock-loop Decoder

- ☆ FET Input Stage
- ☆ VARI-CAP diode tuning
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- ☆ Multi turn pre-sets
- ☆ LED Stereo Indicator

Typical Specification

Sensitivity 3µ volts
Stereo separation 30db
Supply required 20-30v at 90 Ma max.

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A top quality stereo pre-amplifier and tone control unit. The six push-button selector switch provides a choice of inputs together with two really effective filters for high and low frequencies, plus tape output.

Frequency response + 1dB 20Hz-20KHz

Sensitivity of inputs:

1. *Tape input 100mV into 100K ohms*
2. *Radio Tuner 100mV into 100K ohms*
3. *Magnetic P.U. 3mV into 50K ohms*

P.U. Input equalises to R1AA curve within 1dB from 20Hz to 20KHz. Supply – 20 – 35V at 20mA.

Dimensions: 299mm x 89mm x 35mm

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P.&P. 45p

MK60 AUDIO KIT: Comprising: 2 x AL60. 1 x SPM80. 1 x PA100. 1 front panel and knobs. 1 Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. **COMPLETE PRICE £34.90 plus 62p postage.**

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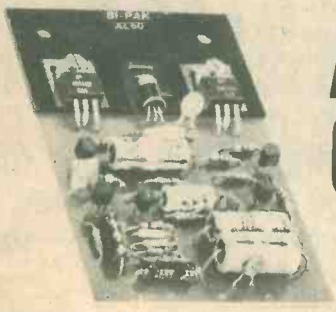

AL 60

VAT ADD 12½%

25 Watts (RMS)

● Max Heat Sink temp 90C. ● Frequency response 20Hz to 100kHz ● Distortion better than 0.1 at 1kHz ● Supply voltage 15-50v. ● Thermal Feedback ● Latest Design Improvements ● Load – 3, 4, 5 or 16ohms. ● Signal to noise ratio 80db ● Overall size 63mm. 105mm. 13mm.

Especially designed to a strict specification. Only the finest components have been used and the latest solid-state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

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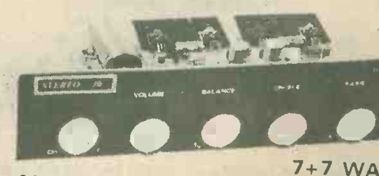
Stabilised Power Supply Type SPM80

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (r.m.s.) per channel simultaneously. With the addition of the Mains Transformer **BMT80**, the unit will provide outputs of up to 1.5A at 35V. Size: 63mm. 105mm. 30mm. Incorporating short circuit protection.

Input Voltage: 33-40 V.A.C.
Output Voltage: 33V D.C. Nominal
Output Current: 10mA-1.5 amps
Overload Current: 1.7 amps approx.
Dimensions:
105mm x 63mm x 30mm
Transformer BMT80:
£5.30 + 86p postage

£3.75

STEREO 30 COMPLETE AUDIO CHASSIS



7+7 WATTS R.M.S.

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck, etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, mains switch, fuse and fuse holder and universal mounting brackets enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available. Ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 minutes).

TRANSFORMER £3.25 plus 50p p&p

TEAK CASE £5.45 plus 70p p&p

£16.25

p. & p. 45p

Detecknowledgey

Detecknowledgey - the survey of metal locator theory and principles of operation. £1 post paid.

Bionic Ferret 4000 - the VCO system detector with Fe/NonFe discrimination, meter, loudspeaker, low power drain and high sensitivity. Price now reduced due to volume of demand to £34.26 (inc PP & VAT)
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SSB filter with 2.1kHz 6dB BW. By popular demand, we now offer this superbly smooth sideband filter - designed for receiver or generator applications. With input/output matching transformers: only £9.95.
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- 10K Coils for short wave, new leaflet available, or see catalogue.

New modular Elektrick Wireless

7122 -A three stage tuned superhet AM radio module, with 80dB AGC, varicap tuning, ceramic IF filter, meter output. For LW, MW, and now short wave - with the correct coil pack. Not band switched, but using a separate module for each desired band. Better than 10uV sensitivity, and a new easy DIY approach to radio building. SAE for full info. Each module (inc. varicaps and coil pack) £9.00 -kit.
91198 -A three stage tuned AM/NBFM receiver module, being a refined version of above, with mechanical IF, MOSFET RF, NBFM discriminator (for afc), audio notch filter, separate oscillator, provision for 'pi' network input atu (with varicaps). Again, not bandswitchable, so as to optimize each module for its specific tuning range. Kit £15.75 each.

Components as previously advertized, including

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MC1310	2.20	EF5801 as 5800 with osc op	17.45
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We would like to say more, but space has run out. Please remember p&p (25p) and VAT (12½% except where *) The catalogue has much new info since April. The new sheets will be sent on receipt of an A4 SAE. Or 40p for the complete catalogue and information package. SAE with ALL enquiries please. Callers welcome.

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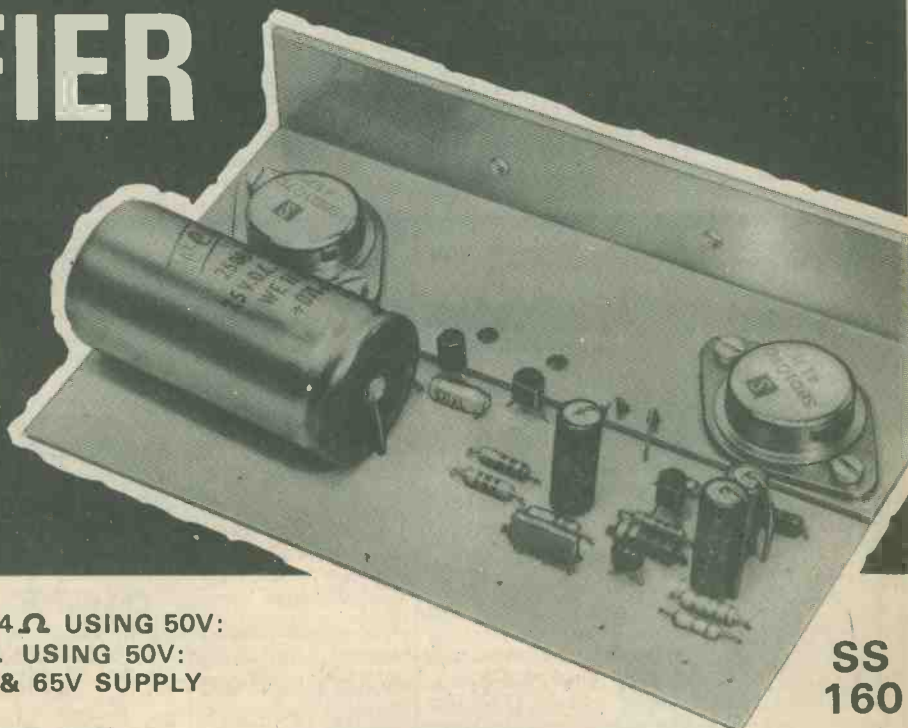

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£8.50 POST FREE INCL VAT — Large finned heatsink Post free inc VAT **75p**

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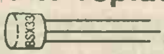

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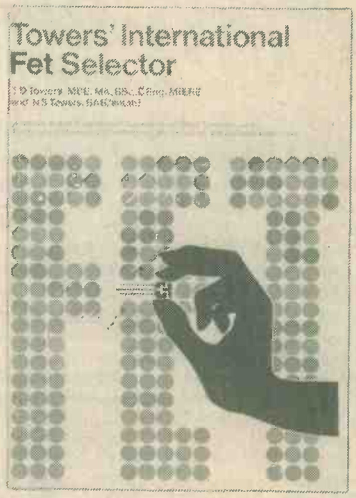

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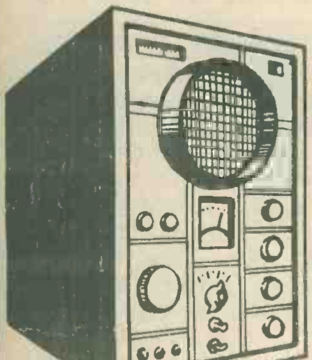

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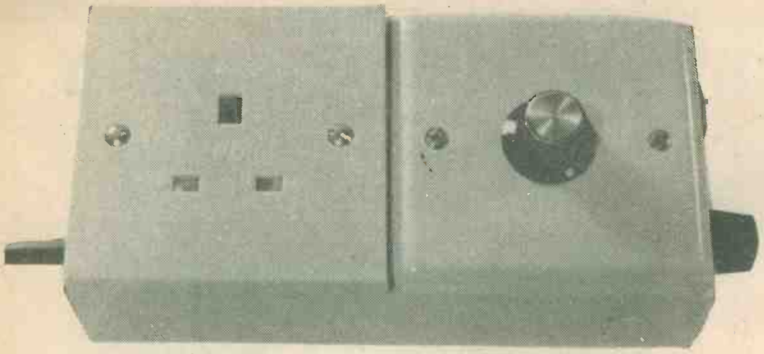


TRIAC

By A. P. Roberts

This article describes a simple lamp dimmer which can be used to control a filament lamp having a power rating of up to 250 watts. The unit incorporates a mains socket so that it can be simply connected between a standard or table lamp and a mains outlet. It employs few components and is very easy to construct. It cannot be used to control fluorescent tubes.

OPERATING PRINCIPLE

When low powers are involved it is quite feasible to vary the current fed to a load by means of a variable resistor connected in series with the load. However, this is not really very practical in domestic applications when controlling something like a 100 watt light bulb, because the power dissipated in the variable resistor could rise, at a setting where an equal voltage is dropped across both, to the same level as that dissipated in the lamp. The variable resistor would need to be an extremely large component and the power dissipated across it would simply be wasted.

A much more satisfactory method is to control the power in the load by means of a switching device connected in series with one of the supply lines. One approach could consist of a switching device which turned off over some of the half-cycles passed to the load, the power dissipated in the load reducing as more half-cycles in a group are turned off. Some power controllers do operate on the principle of removing half-cycles and they have the advantage of generating virtually no r.f. interference. Unfortunately the circuits employed tend to be rather complex and most power controls, including the one described here, use a slightly different method.

Instead of completely removing some half-cycles and leaving others unchanged, part of each half-cycle is eliminated. Thus, if half of each successive half-cycle is removed the load (assuming that this has a constant resistance) receives only half the power. This method of control has the disadvantage that a considerable amount of r.f. interference can be generated unless adequate suppression measures are included in the design. The reason for the interference is quite simple. If the control device switches on half way through a mains half-cycle, the voltage across the load will rise almost instantaneously from zero to nearly 350 volts. The combination of this very fast rise time and the relatively high currents and voltages involved result in strong harmonics being produced which extend well into the r.f. spectrum.

THE CIRCUIT

The full circuit diagram of the lamp dimmer is given in Fig. 1. The triac, TRI1, is the control element, and this is a two-way device. It is turned on by applying a small trigger current to its gate, and it remains conductive until the current flow between its two anode terminals reduces to virtually zero. It then turns off until another triggering current is applied to its gate. The gate current, and that flowing between the anodes can be in either direction.

The triac is connected in series with the live supply to the lamp. L1 is a suppression choke whilst S1 is the on-off switch for the dimmer. F1 is a 3 amp fuse and is fitted in the mains plug. A diac is connected in series with the gate of the triac and this is also a two-way device. At low voltages it exhibits a very high resistance, this reducing suddenly to a low resistance when the voltage across it exceeds a level of around 20 volts. Thus, the triac does not receive a triggering current until the voltage across C1 reaches the level at which the diac fires.

C1 is charged from the mains supply via VR1 and R1. The charging current also passes through F1, S1 and L1, but these have negligible resistance and do not affect the charging rate of C1. If VR1 is adjusted for minimum resistance the voltage across C1 lags only slightly behind the mains voltage, and so early in each half-cycle the voltage across C1 reaches diac firing level and the triac turns on. The triac stays on until the end of the half-cycle, at which instant there is zero voltage across its two anodes and it turns off, to be switched on again early in the next half-cycle when the voltage across C1 is once more sufficient to fire the

LAMP DIMMER

INCORPORATING A STANDARD TRIAC-DIAC CIRCUIT CONFIGURATION

COMPONENTS

Resistors
R1 33kΩ $\frac{1}{4}$ watt 10%
VR1 470kΩ potentiometer, linear

Capacitors
0.1μF 250V Wkg. (see text) type C280 (Mullard)
C2 0.0047μF 250V A.C. Wkg.

Inductor
L1 2A suppression choke

Semiconductors
TRI1 TR12A/400
DI1 BR100

Neon
PL1 Neon indicator with integral resistor, 250V A.C.

Switch
S1 s.p.s.t. rotary, 250V A.C. 4A

Miscellaneous
Dual plastic switch or socket box, with mains socket and blank front plate (see text)
2 plastic control knobs
6-way tagstrip (see text)
3-way mains plug with 3A fuse (F1)
3-core mains lead, nylon bolts and nuts etc.

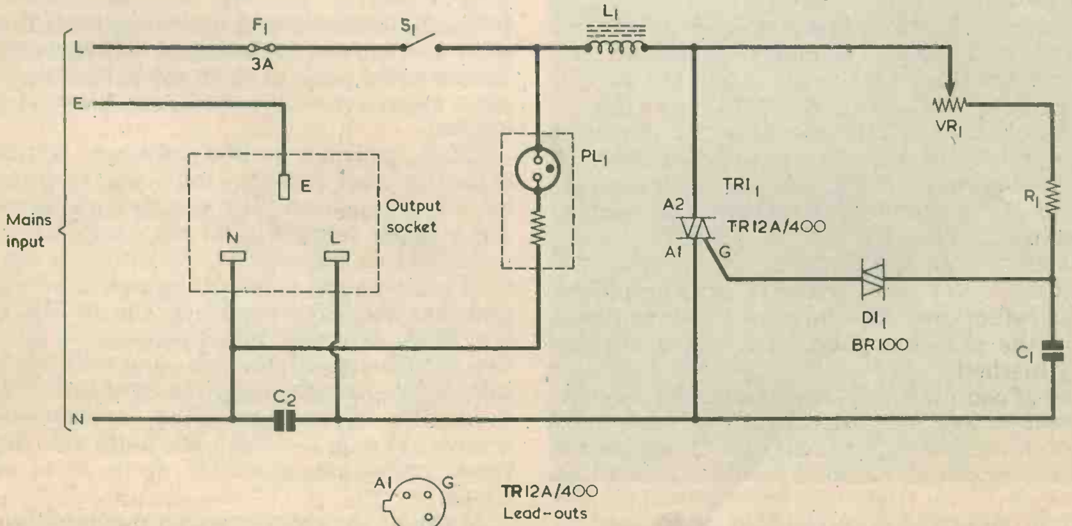


Fig. 1. The circuit of the lamp dimmer. This operates by turning on the triac after the start of each half-cycle, the instant of turn-on being controlled by VR1

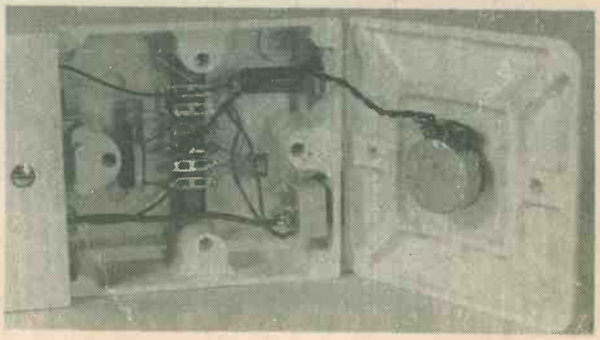
diac. The resultant waveform across the lamp is shown in Fig. 2(a). When the triac is turned on, VR1, R1 and the diac play no role in circuit operation since they are effectively short-circuited by the triac.

There is a small loss of power when VR1 is set at minimum resistance, which corresponds to maximum brightness of the lamp. As is evident from Fig. 2(a) the loss is too small to be of any significance.

If VR1 is adjusted for about half maximum resistance the voltage across C1 will lag well behind the mains voltage, and it will be much later in each half-cycle when the triac turns on. Fig. 2(b) shows the waveform across the lamp which is given when the triac turns on about half way through the half-cycle. If the lamp had a constant resistance, the power would be halved.

With VR1 adjusted to insert maximum resistance into circuit the triac is not triggered until each half-cycle is nearly finished, giving the waveform shown in Fig. 2(c). This time very little power is applied to the lamp. It can be seen, therefore, that the amount of power that is fed to the lamp can be varied by adjusting VR1.

C2 is an interference suppression capacitor, and PL1 is simply a mains indicator neon.



The electronic components are wired to a 6-way tagstrip positioned behind the plain cover

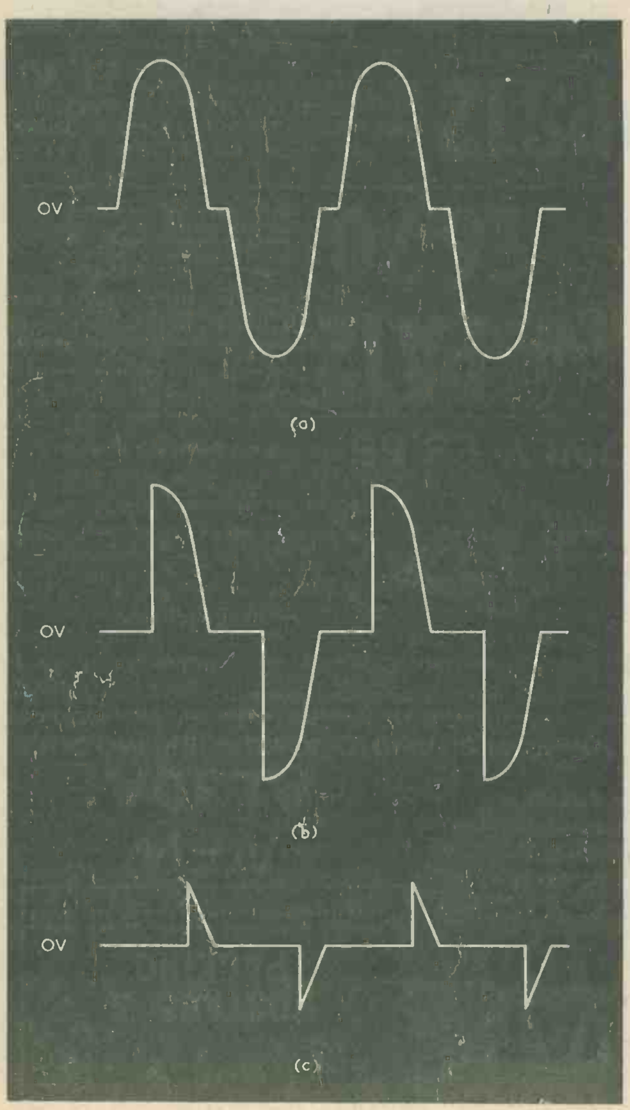


Fig. 2. The voltage waveforms across the controlled lamp when VR1 inserts (a) minimum resistance, (b) half maximum resistance, and (c) maximum resistance

COMPONENTS

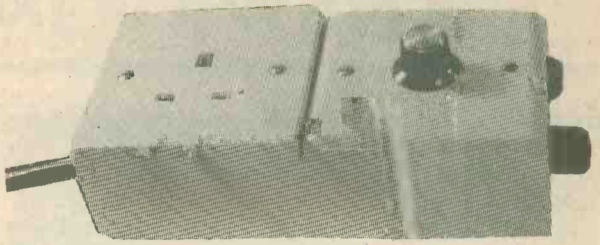
VR1 is a standard carbon track potentiometer and should be a type having a plastic rather than a metal spindle. Both the triac and the diac are available from Bi-Pak Semiconductors. The triac is a small device housed in a TO-5 can. PL1 is a panel mounting neon indicator with integral series resistor intended for 240 volt a.c. mains operation. L1 is a 2 amp suppression choke and is available from The Radio Shack.

S1 is a rotary on-off switch, and a heavy duty type rated at 4 amps at 250 volts a.c. is required here. C1 is specified as 250 volts working in the components list, since the voltage across it does not rise above the level needed for firing the diac. This does assume, however, that the circuit always functions correctly and that there are, for instance, no errors or poor connections during construction. Readers who wish to cover such eventualities may use a capacitor with a working voltage of 400 volts instead.

C2 is specified as 250 volts a.c. working. If a capacitor with this working voltage cannot be obtained, a capacitor with a d.c. working voltage of 750 volts or more will be satisfactory.

A suitable housing for the unit can consist of a dual plastic surface mounting switch or socket box, and that used by the author was an MK box, List No. 2025. A plastic blanking panel is mounted on the right hand side of this (and will be drilled to take VR1), and the output socket is fitted in position on the left hand side. The necessary mounting screws are supplied with the plate and socket. All these parts are available from local electrical shops.

Many of the components are assembled on a 6-way tagstrip. This is cut down from a 28-way tagstrip Type B, available from Doram Electronics.



Another view of the dimmer, showing the knob for switch S1 and the neon indicator

CONSTRUCTION

The plastic blanking plate has a 10mm. diameter hole drilled at its centre, and VR1 is mounted here. S1 is fitted at the lower part of the right hand side of the box, whilst PL1 is mounted on the upper part. These will both probably require 10mm. diameter holes, although some neon indicators will require a somewhat larger one. A hole is drilled in the left hand side of the box for the 3-core mains lead, and this hole is fitted with a grommet.

The 28-way tagstrip is cut down at one end to form a 7-way tagstrip. The end tag is then removed and a mounting hole drilled in its place, to give a 6-way tagstrip with mounting holes at both ends. Two 6BA clear holes for mounting the tagstrip are drilled in the base of the box, and two 6BA nylon bolts are passed through these, being secured by two nylon nuts on the inside. The tagstrip is then passed over the bolt ends and is secured by a further two nylon nuts. Note that metal bolts must not be used for securing the tagstrip.

The positions of the tagstrip, the switch and neon indicator are clearly shown in the photograph of the interior of the box, and the wiring associated with the tagstrip is shown in Fig. 3.

A few connections are not shown in this diagram. The earth wire of the mains lead connects directly to the earth terminal of the output socket. Similarly, the neutral wire of the mains lead connects directly to the neutral terminal of the output socket, a further lead from this terminal passing to PL1. Capacitor C2 is wired across the live and neutral terminals of the output socket. The mains lead is correctly terminated at its remote end with a 3-way plug fitted with the 3 amp fuse, F1. It should be secured inside the box with a plastic clamp or grip, again using nylon bolts and nuts.

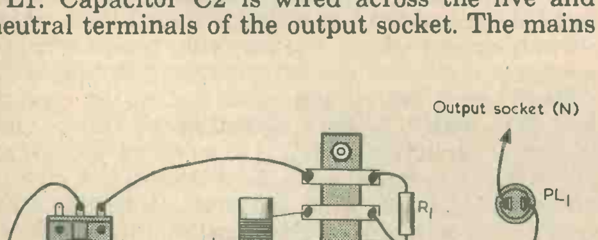


Fig. 3. The wiring around the 6-way tagstrip. Connections to the output socket are discussed in the text

L1, C1, R1 and the triac should be positioned on either side of the tagstrip, as indicated in Fig. 3 and the photograph, to ensure that they, and their connections, are well clear of the rear of VR1 when the blanking plate is screwed down. Both S1 and VR1 are fitted with plastic control knobs. The diac may be connected either way round.

OPERATION

When completed, the mains input to the dimmer is plugged into a 3-way mains socket, and the plug of the lamp is fitted to the output socket on the box. It should be found that the dimmer can vary the brightness of the lamp from its normal intensity down to zero with VR1 adjusted fully anticlockwise. Due to the tolerances in the circuit, it is just possible in some cases that the lamp will not be quite extinguished when VR1 is set fully anticlockwise, and this can be corrected by adding a capacitor of about 0.01μF in parallel with C1. Alternatively, it might happen that the lamp is extinguished well before VR1 reaches the fully anticlockwise position. In this case it would be necessary to replace C1 with a capacitor having a somewhat lower value, say 0.082μF or 0.068μF. The added or alternative capacitors may have working voltages of 250 or 400 volts, as explained earlier, according to the preference of the constructor.

Should these alterations prove necessary, they must only be carried out with the mains input plug removed from its socket. No work of any type should be carried out on the internal circuitry in the box unless the mains input plug is removed, as there is otherwise a risk of dangerous shock. The plain cover on which VR1 is mounted should always be screwed in place before the mains input is applied.

Although the unit incorporates interference suppression components, it is virtually inevitable that these will be less than 100% effective. The dimmer will cause some interference to a.m. radios which are operated in close proximity to it, and this is a problem which is common to most lamp dimmer designs. As the majority of a.m. receivers have a directional aerial of some sort, it will in most cases be possible to virtually eliminate any interference by suitable orientation of the set. ■

NEWS . . . AND .

ELECOLIT 340 NOW AVAILABLE TO CONSTRUCTORS

After five years of selling exclusively to industry, Industrial Science Ltd., of Leader House, 117-120 Snargate Street, Dover, Kent, are now introducing one of their most successful products — ELECOLIT 340 — into the consumer electronics market.

ELECOLIT 340 is a pure, silver filled, electrically conductive acryllic paint. It exhibits excellent conductivity because of the pure silver and outstanding environmental protection due to its acryllic base. ELECOLIT 340 sets by solvent evaporation similar to most good lacquer systems. It forms a tough film with good adhesion to ceramics, glass, rubber, plastic and most plastic films.

Typical applications include R.F. shielding, printed circuit repair, use as a conductive ink, prototype circuit manufacture and one of the most interesting and unusual applications of all which is to repair the rear window demister of a car by means of painting over the existing track which may have either broken or shorted out.

Although ELECOLIT 340 is air drying, conductivity can be improved by heating and typical volume resistivity figures are 0.001 ohm-cm. when cured at room temperature, whereas 0.0005 ohm-cm. when cured at 150°C.

The shelf life is a minimum of 1 year in a closed container, and the operating temperature of ELECOLIT 340 is from −60°C to +175°C.

It can be applied by painting, silk screening or roller, and if necessary it can also be thinned with a solvent to lower the viscosity.

It is expected that electronic constructors and radio enthusiasts will find numerous applications and possibilities for ELECOLIT 340 as well as being of interest to the semi-professional organisation for occasional repair and modifications to printed circuit boards.

The attached photograph shows a typical application for painting a track on to a printed circuit board or for repairing an existing track.

IBA DEMONSTRATES DIGITAL STUDIO TECHNIQUES — A WORLD FIRST

The Independent Broadcasting Authority has recently demonstrated to other European broadcast organisations the major component parts of an all-digital television studio of the future.

This it is claimed was the world's first demonstration in which it has been shown practical for all major studio vision operations, excluding picture origination, to be carried out with digital, computer-type signals — including digital vision coding and decoding, vision mixing and switching, video tape recording, and the generation of a colour-bar test signal.

The key to the all-digital television studio is the problem of recording digital signals on tape without requiring extremely high-speed tape transport. During these demonstrations a digital tape recorder was shown producing faultless half-width colour pictures. This conclusively demonstrated the feasibility and advantages of digital recording techniques currently under development in the IBA's Engineering Centre at Crawley Court, near Winchester, Hampshire. Further development is required to produce a full-width picture recorder suitable for operational use, but the system demonstrated shows that the fundamental problems have been solved successfully, and that tape consumption will be comparable to that of analogue 'Quad 2' type recorders.

The digital mixer and video tape recorder operated with signals sampled at twice colour subcarrier (Sub-Nyquist sampled PAL); these signals were produced by digitally comb-filtering a digital signal that had been sampled at four times colour subcarrier frequency. Before being reconverted to analogue the 'twice colour subcarrier signals' were changed to a 'four-times colour subcarrier' sampling rate, again using a digital comb-filter. This process has been shown to produce only a very small impairment yet has the advantage of greatly reducing the bit rate required. Further work demonstrated included an experimental 34 Mbit/s system in which, for the first time in the world, good quality signals are possible when coding the composite PAL signal.

The IBA's digital development programme is aimed at achieving an international standard for digital television. The experience gained by the team of development engineers in the design of line and field store converters has proved invaluable in looking at the inter-related problems of introducing digital techniques into studios, on the lines network, and at the transmitters.

. . . COMMENT

4 CHANNEL RECEIVER IDEAL FOR MATRIX H CONVERSION

The 'Universal' Four-Channel Receiver — the Sansui QRX 777 — is very suitable for Matrix H conversion.

There is pushbutton selection of: QS — for decoding and reproducing QS-encoded 4-channel records, tapes and FM 'quadracasts'; QS Synthesizer-Surround — for creating a 4-channel sound field spread in a full 360-degree circle around the listener from conventional 2-channel sources; QS Synthésizer-Hall — for preserving original stereo sound "on-stage" while adding concert-hall ambience from the back channels from conventional 2-channel sources; SQ — for decoding and reproducing SQ matrix 4-channel music (the phase matrix section of the QS vario-matrix decodes SQ signals with proper front/back separation); CD-4/4 CH Direct — for playing CD-4 (and Quadradisc) records in 4-channel — also for listening to any discrete 4-channel tape or aux source; 2-CH Direct — for channelling regular stereo signals to the front two speaker systems;

The Sanusi QRX 777 (or QRX 7001) — with a minimum of 35 watts times four channels and distortion less than 0.4% — is a truly universal four-channel receiver. A facility for receiving Matrix H, the BBC's new quadraphonic broadcasting system can be easily added. All 777's will in future incorporate the adaptation.

Plus Back — for additionally feeding regular stereo signals to the two back speaker systems.

Sole UK distributors are Vernitron Limited, of Thornhill, Southampton SO9 5QF.

WORLD RADIO CLUB TRANSMISSIONS

As from Wednesday, 7th September the transmissions of World Radio Club will be as follows:

Wednesday: 0815 — 0830 GMT
Wednesday: 1330 — 1345 GMT
Wednesday: 2315 — 2330 GMT
Friday: 2100 — 2115 GMT

The Sunday transmission at 0815 GMT will be cancelled

SPECIAL OFFER

Have you taken advantage of P. B. Electronics Ltd., Special Offer of FREE Blob-boards with orders for their packs?

Purchase a pack of three 2V5 Blob-boards and you receive one Free 2-IC Blob-board.

Purchase a pack of three 2-IC Blob-boards and you receive one Free 2V5 Blob-board.

See advertisement Page 69 in this issue.

BOOK RECEIVED

We were most interested to receive a non-electronics book recently, the reason being that the author is a very well known figure in the electronic components field — Mr. Alan Sproxton, Managing Director of Home Radio (Components) Ltd.

In the book 'Starting and Running a Small Business', Mr. Sproxton passes on the benefit of his many years experience as a successful business man.

Many actual examples are given illustrating the difficulties and the opportunities which the small business will encounter. It is all told with a refreshing humour and its 129 pages are practical and down to earth.

Copies may be obtained for £3.95, inclusive of postage, from Under Writers Publications, Trevail Mill, Zennor, Cornwall.

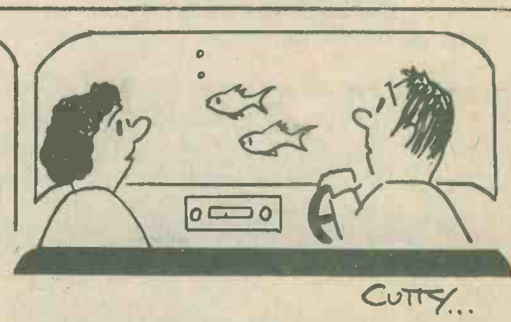
EDUCATIONAL NEWS

A theory course designed to prepare students for the City and Guilds Radio Examination in May/June 1978 will be held at the Gosforth Adult Association Classes at the Gosforth High School, Gosforth, Newcastle upon Tyne, commencing in September 1977. A morse class will run over the same period.

Although specifically for the R.A.E. the course will be ideal for anyone wanting to get an insight into radio theory.

The theory class will be held on Tuesdays and the morse class will be held on Thursdays.

Enquiries should be addressed to, The Principal, Gosforth Adult Association, Gosforth High School, Knightsbridge, Gosforth.



"This is Radio One traffic news — drivers on the A5 are warned to look out for burst mains in the Maida Vale area"

SPECIAL SERIES

Blob-a-job

No. 4

MICROPHONE PRE-AMPLIFIER

By I. R. Sinclair

A simple microphone pre-amplifier specifically designed for coupling low impedance moving-coil microphones to high fidelity amplifiers.

The signal outputs from low impedance moving-coil microphones are generally very low so that a large amount of voltage amplification is needed when these microphones are used with an amplifier of moderate gain. The microphone inputs on tape and cassette recorders are arranged to give the correct amplification for the type of microphone that is supplied with the recorder, but the use of a better quality microphone may be impossible because the gain of the built-in amplifier is insufficient. Sometimes, also, the use of a microphone with Hi-Fi equipment is needed. In this last application the amplifier input marked "MAG" will be sensitive enough but the results will be disappointing because of the equalising circuits which appear after this input; these have the effect of boosting bass and cutting treble, the last thing we want with a microphone signal. Another microphone problem concerns hum when long microphone leads are employed. Because of the very low amplitude signal voltage from a microphone, the slightest trace of hum on the long lines will be amplified to an intolereable level.

PRE-AMPLIFIER

The answer to all of these problems is a microphone pre-amplifier, which will boost the feeble signal from the microphone to a level which better suits other equipment. It will enable us to use very insensitive microphones with tape or cassette recorders by connecting the pre-amplifier between the microphone and the recorder input. We can also use the microphone with Hi-Fi equipment, plugging the microphone into the pre-amplifier and the output of the pre-amplifier into the "AUX" or "TUNER" inputs of the Hi-Fi equipment, since there is no equalisation after

COMPONENTS

Resistors
(All ¼ watt 5%)
R1 150k Ω
R2 39k Ω
R3 5.6k Ω
R4 1.8k Ω
R5 47k Ω
R6 4.7k Ω

Capacitors
(Working voltages may be higher than stated)
C1 1 μF electrolytic, 10 V. Wkg.
C2 10 μF electrolytic, 10 V. Wkg.
C3 10 μF electrolytic, 10 V. Wkg.

Semiconductors
TR1 2N3707
TR2 2N697
ZD1 BZY88C3V0

Blob Board
Blob Board type ZB-2V5

Miscellaneous
Slide switch
9 volt battery
Battery connectors
Jack socket
Phono socket
Flexible screened cable
Metal box.

these inputs. For long microphone cables, the use of the pre-amplifier close to the microphone itself boosts the signal before it is sent down the line, so that the signal needs much less amplification in the main amplifier and any hum that is picked up is amplified much less. In addition, because the pre-amplifier is self-contained and battery operated, the hum introduced by the pre-amplifier itself, assuming that it is enclosed in an earthed metal case, will be negligible.

The design used here is intended to draw very little current from the battery, and has input and output impedances that should match well to most microphones and almost any amplifier. The pre-amplifier is mainly intended for low impedance microphones including the cheaper low-output moving-coil types. The pre-amplifier is *not* intended for use with capacitor or crystal microphones having output impedances of the order of 1M Ω. The voltage gain is high, so that microphones with a very low output level can be used, and the output signal should be enough even for relatively insensitive amplifier inputs.

The pre-amplifier circuit is given in Fig. 1. Here, TR1 is the main amplifying stage, working with its emitter voltage fixed at 3 volts, as set by the zener diode ZD1. The bias at the base of TR1 is obtained by feedback from the emitter of TR2, thereby ensuring that the bias current remains stable. TR1 collector load resistor, R2, has a large value, so that the current flowing through TR1 is small. This is an advantage for a pre-amplifier input stage, because the amount of noise that is generated in a transistor is much less when the collector current is low. The amplified signal at the collector of TR1 is coupled directly to the base of TR2. This transistor uses a small collector load, R4, giving the pre-amplifier a low output impedance. TR2 emitter resistor, R6, is decoupled by C2, and bias current is fed back to TR1 without feeding back signal. The current drawn from the 9 volt supply is approximately 2.2mA.

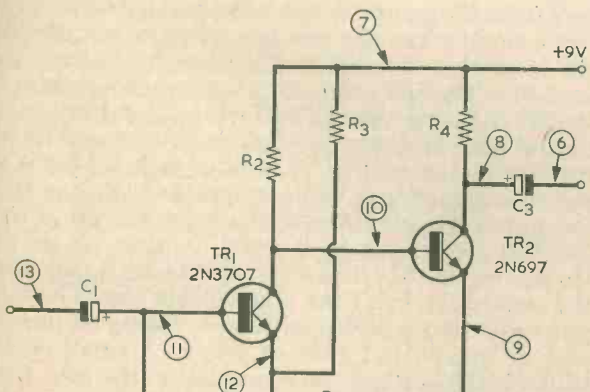
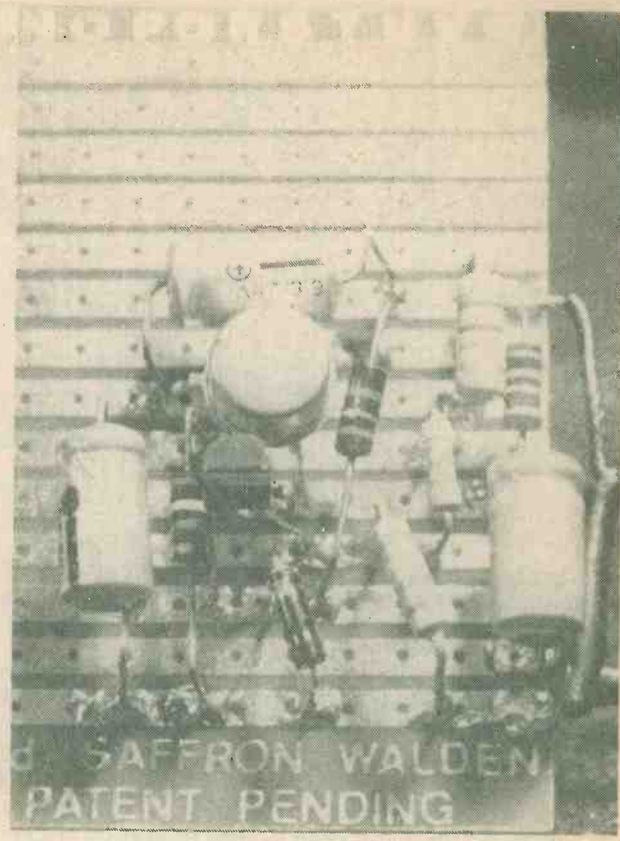


Fig. 1. The circuit of the microphone pre-amplifier. The circled numbers indicate the corresponding tracks on the Blob Board



All the components for the microphone pre-amplifier are soldered at one corner of the Blob Board

CIRCUIT ASSEMBLY

The circuit can be built on a piece of ZB-2V5 Blob Board, following the line numbers as shown in the diagram of Fig. 1. Nine lines of the ZB-2V5 Blob Board are used, and the design is arranged so that the input (line 13) and output (line 6) are well separated to assist stability.

Place all the components, one by one, over the Blob Board lines so that the lead-out wires can be cut to the correct length, assuming that the leads are already long. Tin all the ends of the wires, including those of the transistors, so that they can be blobbed in place easily (see "Blob-A-Job No. 1", which appeared in the June 1977 issue). There is no risk of damage when the lead-out wires of the transistors are tinned, as this should take less than a second for each lead.

The Blob Board layout is shown in Fig. 4. Start construction by blobbing C1 between lines 11 and 13. If a capacitor of small physical size is used it can be mounted horizontally, as shown in Fig. 2(a), but a larger type will have to be mounted end-on, as in Fig. 2(b). Remember that the positive end of the capacitor connects to line 11. Now blob on resistors R1 (line 11 to line 14), R5 (line 11 to line 9) and R2 (line 10 to line 7). Check the connections that have been made so far, and if all is well solder in TR1 with its emitter on line 12, its base on line 11 and its collector on line 10. Make sure that you have identified these connections correctly, referr-

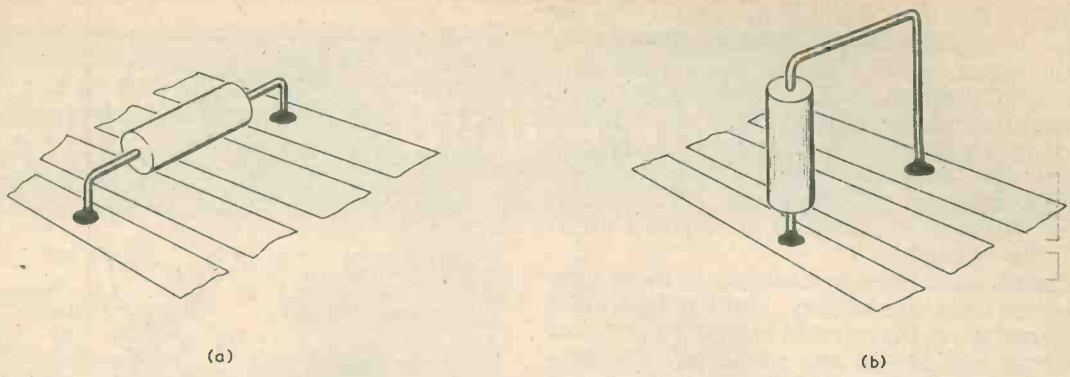


Fig. 2. Components may be fitted to the Blob Board either horizontally as in (a), or vertically as in (b)

ing to the transistor connection diagram of Fig. 3. One of the advantages of Blob Board is that if you have made a mistake at this stage the transistor can be easily removed.

With TR1 in place, blob on resistor R3 (line 7 to line 12) and the zener diode between line 12 and line 14. The cathode of the diode, marked usually by a white band, is blobbed to line 12. Now blob TR2 into place, remembering that its lead-out layout is different from that of TR1. TR2 emitter connects to line 9, its base to line 10 and its collector to line 8. Note also that the metal case of TR2 is connected to its collector, so that the case must not be allowed to touch any bare wires. Finally resistors R4 (line 7 to line 8) and R6 (line 9 to line to line 14) are blobbed into place, followed by capacitors C2 (line 9 to line 14 with positive at line 9) and C3 (line 8 to line 6 with positive at line 8). The final layout should now look like Fig. 4. Experienced constructors will realise that any layout can be used providing the components are always connected between the correct lines.

SETTING UP

The 9 volt battery for the pre-amplifier can be any size, probably the most convenient being a small PP3. A voltmeter with a resistance of 10,000 Ω per volt is required for setting up, and this is switched to a 10 volt range, or to whatever range provides clear readings of around 7 volts. Connect the battery (CAUTION — make sure that the

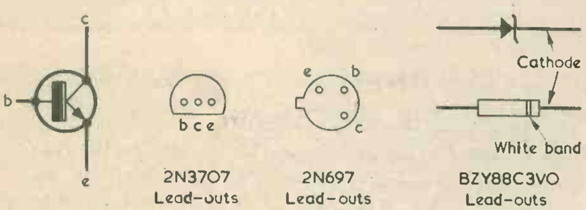


Fig. 3. Illustrating the transistor and zener diode lead-outs together with the circuit symbols. In the two transistor diagrams the lead-outs point towards the reader

polarity is correct) to the pre-amplifier and check the voltage between the negative rail and the collector of TR2. This is done by placing the negative meter lead on line 14 and the positive meter lead on line 8. The voltage we want to find here will be about 7 volts if a fresh 9 volt battery is used. The voltage should not be more than 7.5 volts nor less than 6.5 volts. If the voltage is too high, check your circuit. If the circuit is correct, try the effect of using a higher value for R5, such as 56k Ω instead of 47k Ω, or even 68k Ω if 56k Ω is not enough. If the voltage is too low and the circuit is correctly wired, use a smaller value for R5 (39k Ω or 33k Ω, for example). This check is needed because of the large differences in current gain between samples of transistors, but the values shown in the Components List will ensure satisfactory operation for most samples.

Once the voltage check has been completed, the audio behaviour of the pre-amplifier can be tested. The unit will eventually be fitted in a metal box with a jack socket for the microphone and a phono connector for the amplifier. These two sockets can be attached, using enough screened cable to allow some slack when the pre-amplifier is mounted in the box; this is most easily done by bolting the sockets to the box and taking the screened cables to the Blob Board assembly. The input cable is connected with its outer braiding on line 14 and its inner conductor on line 13. If the jack socket is of open construction it will automatically ensure that the metal box connects to the negative rail at line 14. The socket can be 2.5mm., 3.5mm. or ¼in.; if the microphone to be used is fitted with a jack plug the socket can be of the appropriate size. The output cable is connected with its braiding on line 14 and its inner conductor on line 6. A small on-off slide switch can also be mounted on the box, with one terminal wired to line 7 and the other to the positive battery connector. The negative battery connector is wired to line 14.

Now, with a battery connected, insert the jack plug of a microphone into the input jack socket, and connect through a phono lead to the "AUX" or "TUNER" socket of a Hi-Fi amplifier. Switch on the amplifier, and then the pre-amplifier, with the volume control of the main amplifier at its minimum setting. Blow gently over the microphone, and slowly turn up the volume control

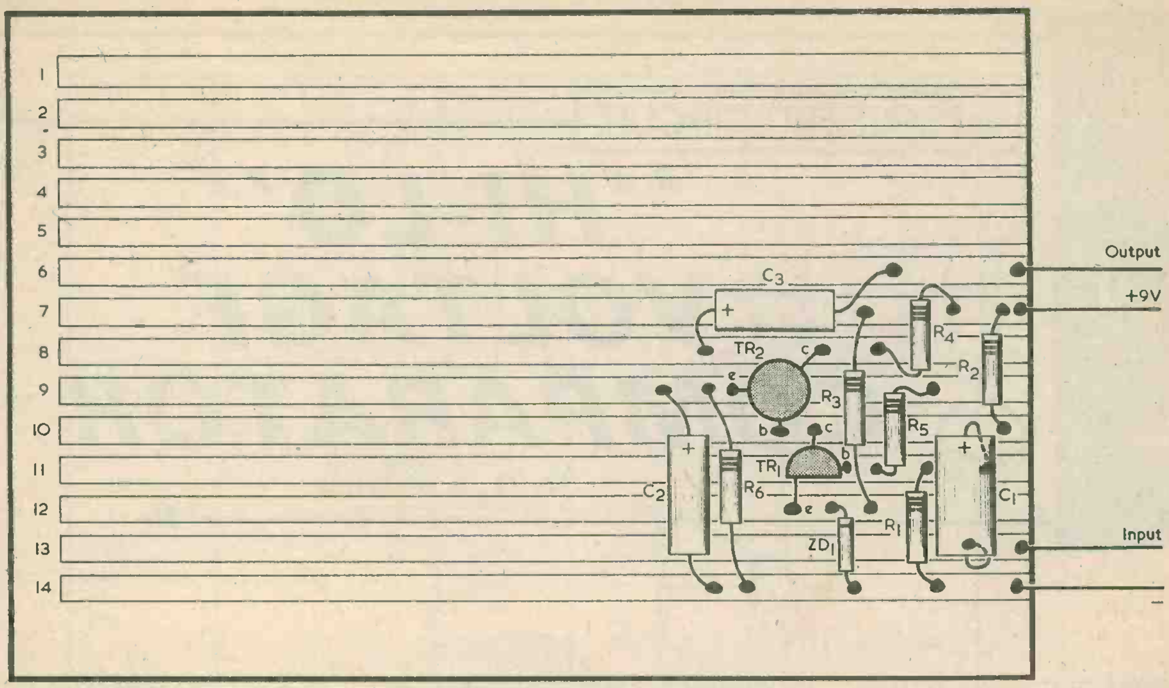


Fig. 4. The final assembly of components on the board. Note how compact the Blob Board layout is, whilst still being capable of easy checking

of the main amplifier until the sound can be heard. Be careful that you do not turn up the volume too much, as the sound from the loudspeaker will then feed back to the microphone, causing howling. When everything is working satisfactorily, switch off and remove the battery and the connections to the microphone and amplifier. Mount the Blob Board into place in the box using, say, a piece of double sided adhesive material. Clip the battery in place, and fit the battery connectors. Close the box, and your microphone pre-amplifier is ready for use. ■

VINTAGE WIRELESS CATALOGUE

Reflecting the burgeoning interest in early radio equipment is the 1977 Antique Wireless Catalogue issued by The Vintage Radio Shop, 64 Broad Street, Staple Hill, Bristol, BS16 5NL. Excluding pages giving full size reproductions of pre-war advertisements the catalogue has 27 large pages listing very many antique and pre-war components and valves. The valves themselves take up some 13 pages of the catalogue and include such well-known types as the PM2, HL2 and 215SG, together with many others of previous vintage.

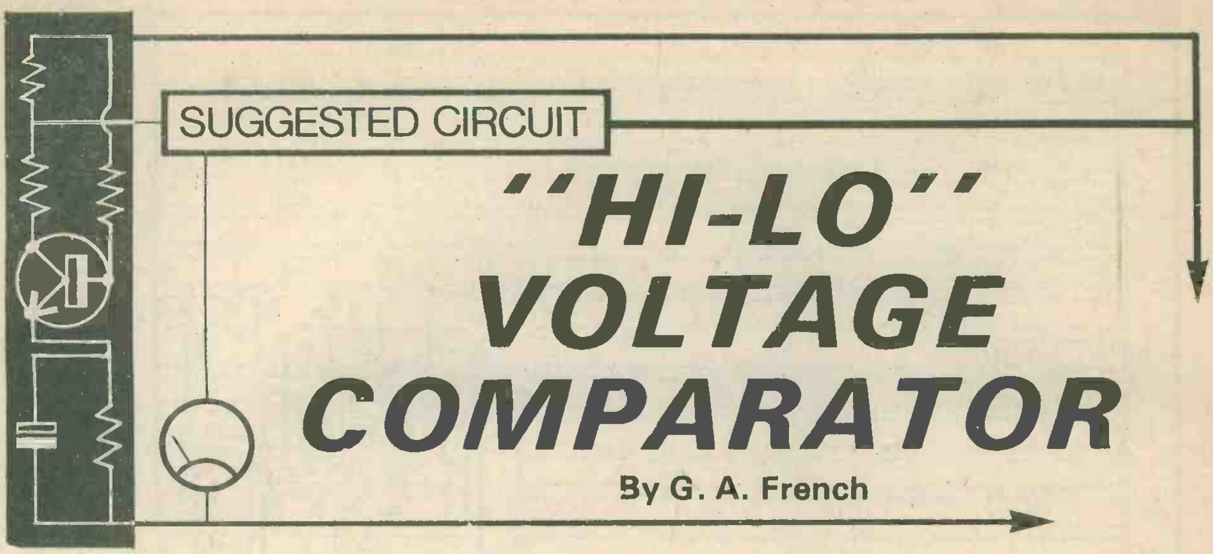
Also listed are early components of many types including r.f. coils by Telsen and Tunewell, a very wide selection of service manuals from circa 1928 to 1955 (from which photocopies can be supplied) and a host of other items too diverse to be easily categoriesed.

The catalogue can be obtained from the vintage Radio Shop for 70p, and should hold as much interest for the frankly nostalgic as for those who are seriously engaged in collecting antique wireless equipment.

MICROPROCESSOR COURSES

Limrose Electronics Ltd, of 241-243 Manchester Road, Northwich, Cheshire, are offering a range of practical workshop-type courses on Microprocessors aimed at giving 'hands-on' experience to engineers who wish to familiarise themselves with microprocessor hardware, software and interfacing techniques or who wish to increase their experience in this field. The two day intensive courses are built essentially around the 8080 and 6800 Microprocessors. Each participant has his own microcomputer to use for the duration of the course and is also provided with comprehensive course notes which are his to keep at the end of the course. The courses also briefly cover other microprocessors available, and since they are limited to a maximum of six people they can be geared to a large extent to suit the participants own particular needs and problems.

The cost is £86.40 per course, inclusive of V.A.T. For further information and dates write to the address given above.



"HI-LO" VOLTAGE COMPARATOR

By G. A. French

Numeric 7 segment light-emitting diode displays have been on the home constructor market for quite a period now, and they lend themselves to a number of interesting applications in which they display figures from 0 to 9. Two 7-segment displays are employed in the voltage comparator which is the subject of this month's "Suggested Circuit" article, but they are used in a manner which is quite different from their normal mode of operation.

VOLTAGE COMPARATOR

The voltage comparator has an input resistance of 2MΩtypical and can indicate whether a voltage is above or below a pre-determined level in the range of 2.5 to 7.5 volts. It may thus be employed to maintain a check on power supply or battery voltage, or for any similar function in which circuit operation can be defined in terms of voltage level. Voltages higher than 7.5 volts may be applied to the input via a suitable potential divider.

The input voltage level is indicated by two 7-segment displays type TIL302. The TIL302 has a nominal digit height of 0.3in. with the decimal point on the left, and the segments are identified by the letters A to G, as shown in Fig. 1(a). No use is made of the decimal point. The TIL302 has the same pin spacing as a 14 pin dual-in-line integrated circuit, and it can if desired be plugged into an i.c. holder. Pin allocations are given in Fig. 1(b), in which it will be seen that there are three common anodes. There are similar common anode displays, such as the SLA7, which have the same pinning for the cathodes but which have a single common anode for all the segments, this being connected to pin 14. With these, pins 3 and 9 are "NC" pins. Two SLA7's may be used in the voltage comparator instead of the TIL302's, if desired.

The circuit of the comparator appears in Fig. 2, in which the displays are identified as ND1 and ND2. They are meant to be mounted alongside each other with ND1 on the left and ND2 on the right. IC1 is a 741 op-amp, and the pin numbers shown apply to the 14 pin d.i.l. version of this device. The supply voltage is 9 volts nominal, and it is assumed that this is stabilized. As is shown later, the addition of a zener diode circuit at the input allows a non-stabilized supply to be used.

Pins 7 and 2 of both ND1 and ND2 are coupled to the negative rail via R6, R7, R13 and R14, with the result that segments F and E of both displays are continually illuminated. The voltage to be monitored is connected to the test points with the polarity indicated, so that the positive input is applied to the inverting input of the 741. The slider of pre-set potentiometer VR1 connects to the non-inverting input, and this potentiometer is adjusted such that the circuit responds to the pre-determined voltage level.

If, due to the input voltage being high, the inverting input of the 741 is positive of the non-inverting input, the 741 output at pin 10 goes negative. TR2 is in consequence cut off, whilst TR1 functions as an emitter follower, causing a current to flow at pins 13, 11 and 10 of ND1. Segments B, C and G of ND1 become illuminated, with the result that ND1 and ND2 display the legend "HI", as illustrated in Fig. 3(a).

Should the input voltage be low,

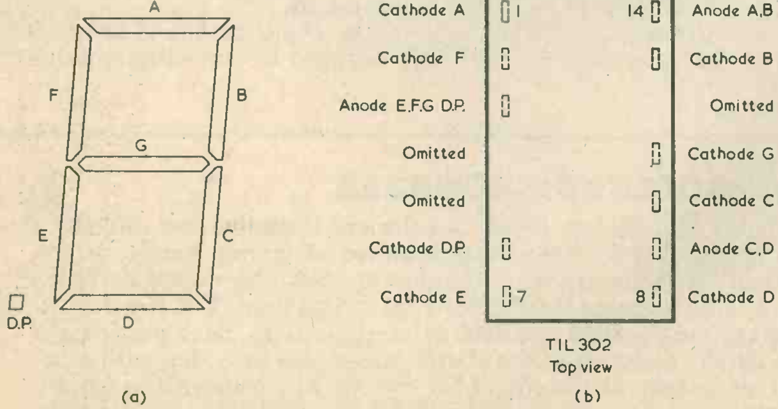


Fig. 1(a). The seven segments of a numeric display are identified by the letters A to G
(b). Pin allocations for the TIL302 7-segment display

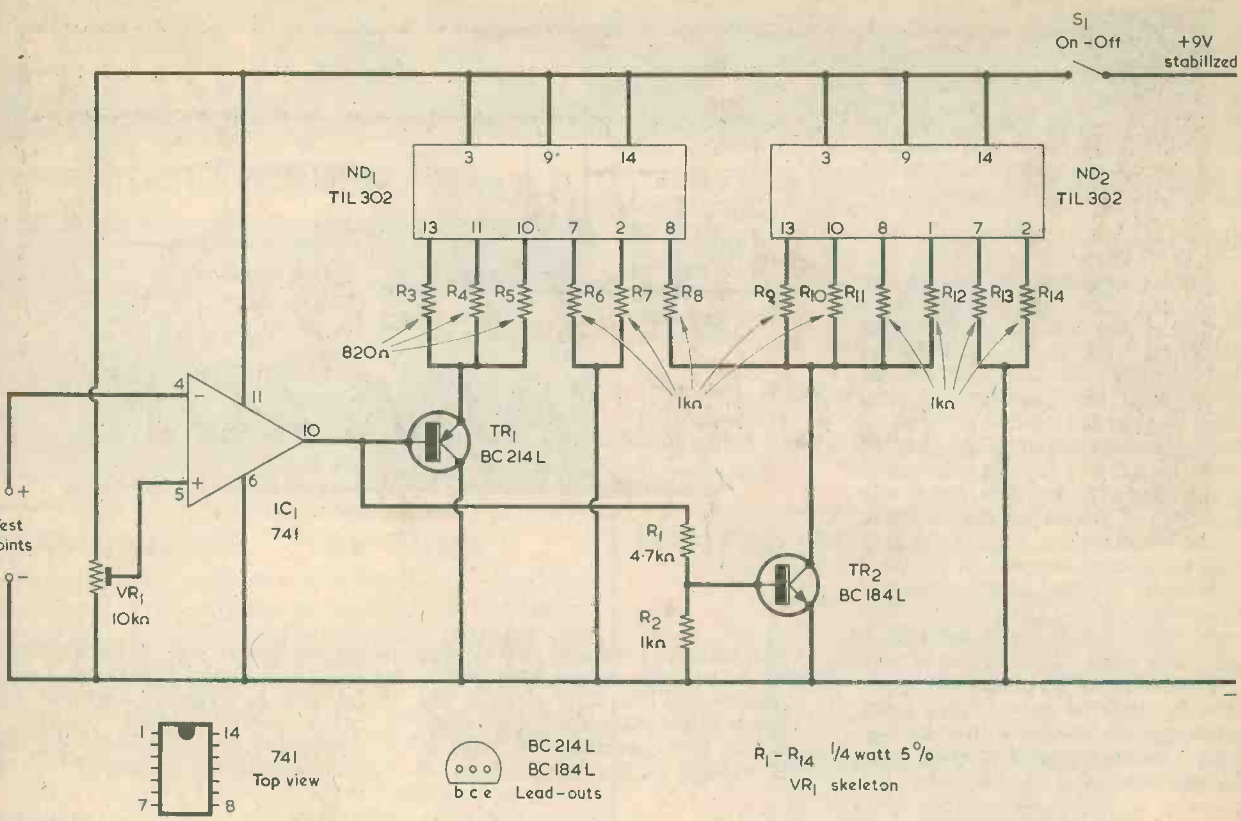


Fig. 2. The circuit of the voltage comparator

the inverting input of the 741 is negative of the non-inverting input and the output goes positive. TR1 does not now conduct because the voltage at its base is too high to allow forward current to flow in the segments of ND1 to which it is coupled. TR2, on the other hand, is turned hard on, and current flows in its collector circuit through resistors R8 to R12 inclusive. Segment D of ND1 and segments A, B, C and D of ND2 now become illuminated, causing the two displays to present the legend "LO", as in Fig. 3(b).

Thus, the state of the input voltage is exhibited, with no ambiguity, by one of two terms which are often encountered in electronic engineering practice. There is no possibility of these being misread or misunderstood.

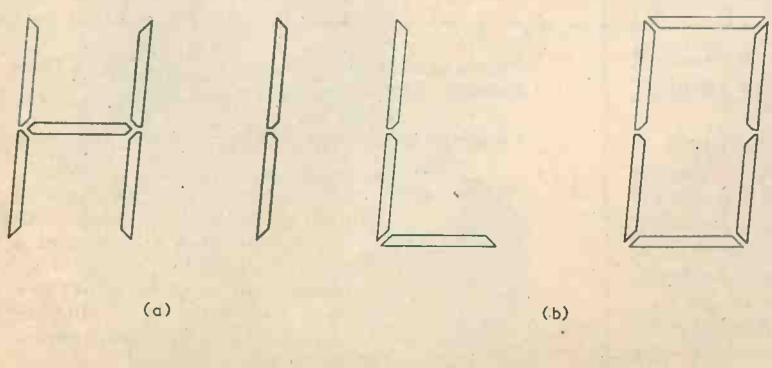


Fig. 3(a). The display which is given when the input voltage is high (b). A low input voltage produces this display

CIRCUIT DETAILS

Turning to circuit details, it is necessary to include the potential divider given by R1 and R2 in the drive circuit to TR2 base because the output of a 741 is not fully negative when it goes low. Instead, it takes up a potential, with respect to the negative rail, of slightly less than 2 volts. R1 and R2 ensure that the base of TR2 is well below the 0.6 volt level needed to turn a silicon transistor on when the 741 output takes up its low potential. When TR1 acts as an emitter follower to illuminate segments B, C and G of ND1, its emitter is slightly more than 2 volts positive of the negative rail. Because of this R3, R4 and R5 are given values lower than those of R6 to R14, to ensure that the segments they feed light up at about the same brightness.

The open-loop gain of the 741 is very high, at 200,000 times typical, with the result that the range of input voltage over which the output changes from high to low, or vice versa, is extremely small. In practice, the output will virtually snap over from one state to the other as the input voltage passes the predetermined level. This action will, however, be less well defined if the positive input lead couples to a high impedance and also picks up a high level of 50Hz mains hum voltage. The inverting input of the 741 can be taken positive up to but not beyond the positive supply rail, and it can be taken negative down to but not below the negative supply rail.

SETTING UP

The comparator is set up by applying the pre-determined voltage to the test points and then adjusting VR1 so that the legend displays are at the changeover state. With the prototype circuit, the practical voltage range available was found to be greater than the 2.5 to 7.5 volts mentioned at the start of this article, but it was felt that it would be desirable to quote conservative figures here to take up possible spread in 741 performance. Current consumption is approximately 38mA when the term "HI" is displayed and 52mA when the term "LO" is displayed.

The need for a stabilized supply may be avoided by modifying the input circuit to that shown in Fig. 4(a). The zener diode stabilizes the voltage across VR1 to nominally 6.8 volts, whilst C1 ensures that no ripple is present across the potentiometer. With this circuit the voltage range available for the comparator now becomes 2.5 volts to the voltage of the zener diode. A simple power supply incorporating a 6.3 volt heater transformer could be used, as shown in Fig. 4(b). Any other power supply offering a voltage of some 8 to 10 volts may alternatively be employed. ■

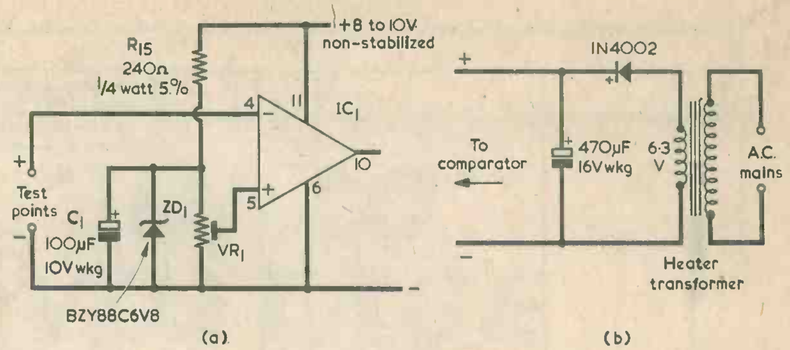


Fig. 4(a). Adding a zener diode circuit at the input enables a non-stabilized supply to be employed
(b). A suitable non-stabilized supply incorporating a 6.3 volt heater transformer

Trade News . . .

ELECTRONIC SERVICE AIDS

The Spring Edition of the fully priced Verospeed catalogue introduces a range of electronic service aids manufactured by Electrolube. Contact Treatment Oil — 2AX — is available in aerosol and dispensing pen form, and a grease containing 2 GAX can be used in mechanical applications as well as electronic. Aerosol application allows it to be used in normally inaccessible parts of equipment. Preclene, Freezer, Contact Cleaning Strips and Silicone Grease complete a range that Verospeed guarantee will be despatched on the day your order is received.

PLATIGNUM'S "TIDY TUBS"

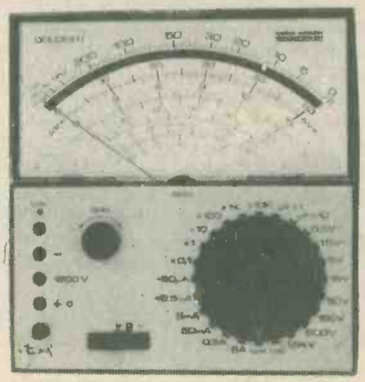
For many years the name of Platignum has been associated with writing materials and drawing equipment. Now they have come up with an idea that is as much at home in the workshop, kitchen or bathroom as it is in the office.

Called "Tidy Tubs", it is a handy 'whatnot' which can be used to keep anything from a baby's rattle to tin tacks out of the way.

Tidy Tubs are six convenient little storage compartments — each a different size — in one compact unit, so there is somewhere to put all the bits and pieces which clutter up a workbench, table or desk.

They cost £1.50 each, can be supplied in different colours and are available from good department stores and stationers.

PANTEC 'DOLOMITI'



Precision Instrument Laboratories, following their recent appointment as main agents for the Pantec range of Portable Test Instruments, have released details of the new range of Pantec multimeters etc, specifically designed to meet the requirements of the Electronics Engineer.

Low-cost, combined with performance, ranges and reliability are the main features. Typical of the range is 'Dolomiti' shown in the photograph.

Sensitivity: 20,000 ohms/V AC/DC; Ranges: 39; Current: To 5 amps AC/DC; Voltage: To 1500 volts AC/DC; Resistance: To 50 megohms; Overload protection. Price £36.50.

For further details contact: Precision Instrument Laboratories, 212 Ilderton Road, London, SE15 1NT.

P.C.B.s FOR 'SIMPLE QUAD. AMPLIFIER'

Ramar Constructor Services of Masons Road, Stratford-on-Avon, Warwickshire, CV36 9NF, inform us that they can supply printed circuit boards for the above project which was described in our June, July and August issues.

The boards which will be of first quality fibreglass laminate, roller tinned and drilled. The cost is £4.89 per set of three including V.A.T. and postage.

OHMS-CONSCIOUS CONTINUITY TESTER

By N. R. Wilson

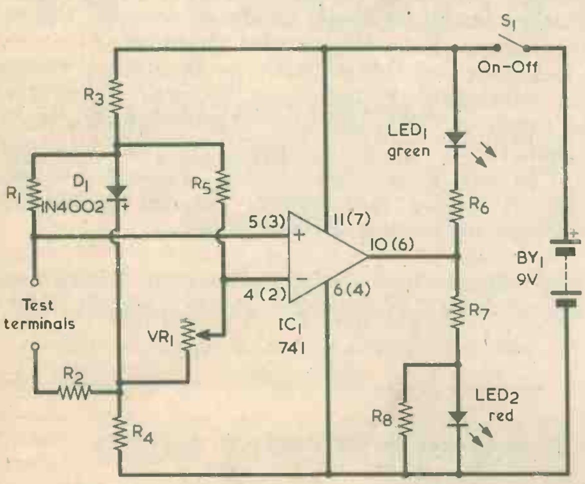
An inexpensive continuity tester which can be pre-set to any value of resistance from zero to 20 ohms.

Most continuity testers are simple uncomplicated devices which give an indication of continuity for any circuit path having a resistance from zero to quite high values. This performance is adequate for many applications but it does not allow accurate continuity checking to be carried out in circuits where the conductor being traced is connected to other conductors by components having low values of resistance.

The continuity tester to be described here is particularly intended for tracing conductors connected to low resistance components, and can be of considerable assistance in the checking of wiring harnesses and the like. It can be pre-set to respond to any resistance from zero to 20Ω, and its resolution is well below 0.5Ω. If, for instance, it is set up to indicate continuity at 5Ω, it will respond to all circuits where the resistance is 5Ω or less but will be unaffected by circuits having resistances in excess of this figure.

CIRCUIT OPERATION

The circuit of the continuity tester appears in Fig. 1. As will be seen it incorporates an operational amplifier type 741, and advantage is taken of the exceptionally high open loop gain of this device to enable low resistances to be sensed when relatively small currents pass through them.



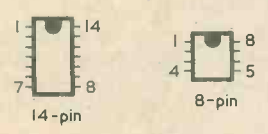


Fig. 1. The circuit of the ohms-conscious continuity tester. The green l.e.d. lights up when the test terminals are applied to a resistance having a value equal to or lower than that selected by VR1

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)
- R1 120Ω
- R2 2.2Ω
- R3 330Ω
- R4 330Ω
- R5 4.7kΩ
- R6 1kΩ
- R7 1kΩ
- R8 820Ω
- VR1 1kΩ potentiometer, linear

Semiconductors
- IC1 741
- D1 1N4002
- LED1 light-emitting diode, green
- LED2 light-emitting diode, red

Switch
- S1 s.p.s.t. toggle

Battery
- BY1 9 volt battery

Miscellaneous
- Pointer knob
- Battery connectors
- Plastic or wooden case.

The 9 volt supply is applied via R3 and R4 to the forward biased silicon diode D1, whereupon a stabilized voltage of about 0.6 volt appears across it. The current flowing in R3 and R4 is a little in excess of 12.5mA when the battery voltage is at 9 volts.

The stabilized voltage is applied to the network consisting of R5, VR1, R1, R2 and the test terminals, the latter connecting to the circuit whose continuity is to be checked. This network is basically a Wheatstone bridge, as is illustrated in Fig. 2, in which diagram the resistance between the test terminals is shown as RX.

The bridge can be considered as being balanced when the potentials at the junction of R1 and RX and at the junction of R5 and VR1 are equal. Under this circumstance the ratio of R1 to the sum of RX and R2

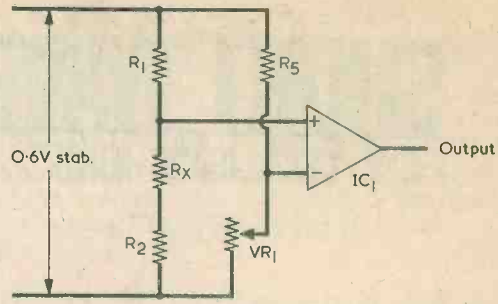


Fig. 2. Diode D1 offers a stabilized voltage of 0.6 volt, and this is applied to the bridge consisting of R1, RX (the resistance across the test terminals), R2, R5 and VR1

is equal to the ratio of R5 to the resistance inserted by VR1. The bridge is out of balance if the junction of R1 and RX is positive of the junction of R5 and VR1, and this condition causes the output of the op-amp to go positive. The bridge is also out of balance when the junction of R1 and RX is negative of the junction of R5 and VR1, and this time the output of the op-amp goes negative.

Returning to Fig. 1 it will be seen that when the output of the op-amp is positive the red l.e.d., LED2, lights up. When the op-amp output goes negative LED1, the green l.e.d., is illuminated.

Let us next assume that we connect a 10Ω resistor across the test terminals when the slider of VR1 is at the lower end of its track. The non-inverting op-amp input will then be positive of the inverting input and the red l.e.d. will light up. The slider of VR1 is slowly advanced to the point where the red l.e.d. extinguishes and the green l.e.d. is illuminated. If VR1 is left at this setting, the circuit is then in a state where the green l.e.d. will light up for all resistances applied to the test terminals of 10Ω or less, whilst the red l.e.d. will be lit for all resistances higher than this. If two test prods are connected to the test terminals, the red l.e.d. will be continually lit up, giving way to the green l.e.d. only when the test prods are applied across a circuit having a resistance of 10Ω or less. VR1 can be adjusted so that the continuity tester responds similarly to any other resistance within its range.

It might be considered possible for both l.e.d.'s to be alight when the resistance across the test terminals exactly balances the resistance inserted by VR1. However, because of the very high voltage gain of the 741, such a circuit condition corresponds to an extremely small amount of travel of VR1 slider. If a standard potentiometer is employed here it is difficult to find a setting at which both l.e.d.'s are alight. For all intents and purposes, therefore, it can be assumed that the red l.e.d. lights up for all values of resistance across the test terminals above the pre-set value selected by VR1 and that the green l.e.d. lights up for all resistances below. VR1 can be calibrated in units of resistance from zero to 20Ω.

When the test terminals are short-circuited the current flowing in R1 and R2 is approximately 5mA. This is well below the standing forward current in D1 and ensures that the performance of the circuit does not vary with falling battery voltage. With the prototype, the accuracy of the circuit was maintained for supply voltages down to less than 6 volts, at which voltages the obvious dimness of the l.e.d.'s indicated that a new battery was required. The low value resistor, R2, is inserted in series with the test terminals to ensure that VR1 can be adjusted for zero resistance across the terminals. The resistor also allows any small offset input voltage in the op-amp to be taken up.

OTHER DETAILS

Other details of the circuit can next be dealt with. It is necessary to add R8 across LED2 because the output of the 741 does not swing down to zero volts relative to the negative rail when it goes negative. Instead, it takes up a voltage slightly in excess of 2 volts, whereupon R8 ensures that the voltage across LED2 is well below that at which it commences to glow. There is no need to take the same precaution with LED1 because the op-amp output, when positive, is about 1 volt negative of the positive rail.

The 741 can be either the 14 pin d.i.l. or 8 pin d.i.l. version. In Fig. 1, pin numbers for the 8 pin package are shown in brackets after those for the 14 pin version. The current drain from the battery is approximately 17mA when either l.e.d. is illuminated. A large battery such as the PP9 would represent a good choice. The l.e.d.'s can be any small types. The author employed Doram Type 4 l.e.d.'s, which are available from Doram Electronics complete with panel-mounting bushes. With these the anode lead-out (which couples to the positive side of the supply) is the shorter of the two.

VR1 can be a standard sized carbon or wire-wound potentiometer. The latter is to be preferred if serious continual work with the continuity tester is intended.

All the components including the battery can be assembled in a plastic or wooden case with VR1, S1, LED1, LED2 and the test terminals on the front panel. VR1 is wired such that the resistance it inserts into circuit increases as its spindle is turned clockwise. It is fitted with a pointer knob and a scale.

After the unit has been constructed it is necessary to calibrate VR1. This potentiometer is set fully anticlockwise and the test terminals are short-circuited, after which S1 is turned on. The red l.e.d. will light up. VR1 is slowly adjusted clockwise until the red l.e.d. extinguishes and the green l.e.d. lights up. This is the zero resistance setting for VR1 and its scale is marked accordingly. A few low value known resistances of up to about 20Ω are then connected across the test terminals and the corresponding settings of VR1 found and marked up on its scale. The scale for VR1 should be quite linear and a complete scale from zero to 20Ω may next be prepared from these calibrations. If the unit is to be employed permanently with the same pair of test leads and test prods the initial short-circuit and the subsequent low value resistors should be applied to the test prods. The calibration of VR1 will then take in the resistance of the test leads.

In use, VR1 is set to the desired resistance value. The green l.e.d. will then light up when the test prods are applied to this resistance or any lower value. In all other circumstances the red l.e.d. will remain alight. ■

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

Last month I dealt with the subject of the reversed tape transmissions from Radio Peking, such programmes being always in the Russian language. The favourite theory is that these broadcasts are made in this manner to avoid Russian jamming and are directed to Chinese border stations not equipped with landline facilities, these stations then taping and retransmitting them, forwards of course, at a later time.

For myself I cannot accept this theory and here I am joined by a Danish colleague, a leading authority on clandestine stations and a "top flight" Dxer, Carol Feil. Writing in a recent issue of "Shortwave News", the journal of the Danish Short Wave Clubs International, he points out that the Russians are also aware of these broadcasts so why would they not jam them to prevent retransmission? The answer to that query also defeats me, for the fact is that the Russians do not jam them — your guess is as good as mine! If any reader has any plausible theory or theories then I should be pleased to hear about them.

Meanwhile, here are the details of the reversed tape transmissions from Radio Peking in Russian. From 0300 to 0355 on **6995**; **8260**; **8425**; **11455**; from 0900 to 0955 on **5220** and on **8260**; from 1830 to 1925 on **6550** and on **8345**.

The last two periods are of one transmission but the first consists of five transmissions a few seconds apart and are identical. Also, note that some of these channels can vary up to 10kHz either side of nominal. All this information according to the BBC Monitoring Service.

Of course, if you want it really tough, why not try **17490** from 0300 to 0355 when not only is it on a reversed tape but also in the single-sideband mode — oh dear!

CURRENT SCHEDULES

Times and frequencies are sometimes subject to change at short notice, the information presented here being correct at the time of writing.

● CUBA
"Radio Havana" presents an External Service in English to Europe from 2010 to 2140 on **17885**.

● EAST GERMANY
"Radio Berlin International — the Voice of the GDR", Berlin, lists programmes in English to Europe from 1830 to 1915 on **6080**, **6115**, **7185**, **7300** and on **9730** and from 2115 to 2200 on **7260**.

● SPAIN
"Radiotelevision Espanola", Madrid, offers a programme in English to Europe from 2030 to 2230 on **9505** and on **11840**, Sundays excepted.

● SOUTH AFRICA
"Radio RSA — The Voice of South Africa", Johannesburg, beams a programme in English to Europe and to East and West Africa from 2100 to 2150 on **4875**, **5980** and on **9585**.

● U.S.S.R.
"Radio Moscow" has an External Service in English to the U.K. and Eire from 1130 to 1230 on **9450**, **9720**, **11705**, **11745**, **12070** and on **15305**; from 1900 to 1930 on **7205**, **7250**, **7310**, **7390**, **9550**, **9720** and on **11830**; from 2000 to 2030 on **7205**, **7250**, **7310**, **7390**, **9550** and on **9720**; from 2100 to 2200 on **7250**, **7390**, **9550**, **9610**, **9720** and on **11805**; from 2200 to 2230 on **7390**, **9610** and on **11805**.

● BULGARIA
"Radio Sofia" broadcasts programmes in English to the U.K. and Eire from 1930 to 2000 on **9700** and **11720** and from 2130 to 2200 on **9745** and on **11750**.

AROUND THE DIAL

● ISRAEL
Jerusalem on **12077** at 2000, time-check (5 "pips"), identification and a newscast in the Domestic Service in Hebrew, scheduled on this channel from 0400 to 2305. Also logged in parallel on **9355** and on **11625**.

Jerusalem on **11655** at 2005, YL with a newscast in English, also logged in parallel on **9815**, scheduled in English on both these channels from 2000 to 2305.

● CHINA
Radio Peking on **7935** at 2016, YL in Chinese in the Domestic Service 1, scheduled here from 2000 to 2300.

Radio Peking on **9080**, YL in Chinese in the Domestic Service 1, schedule being from 2000 to 2200 and from 2203 to 1735.

Radio Peking on **7620** at 2005, OM & YL with a Chinese language lesson in the English Service directed to North and West Africa, scheduled from 1930 to 2030.

Radio Peking on **6225** at 2006, YL in Chinese in the Domestic Service 1, scheduled from 2000 to 0100 on this frequency.

● BULGARIA

Sofia on **9700** at 1937, YL with a talk about the Bulgarian education system in the English programme scheduled here from 1930 to 2000.

● COLOMBIA

Ecos del Atrato, Quibdo, on **5020** at 0300, OM with identification, YL with songs in Spanish. Schedule is from 1100 to 0400 and the power is 1kW.

Emisora Kennedy, Bogota, on **4775** at 0245, OM with identification, and, many mentions of Bogota. Schedule is from 1100 to 0400, the power is 1kW and this one sometimes also identifies as "Voz de Maria".

Emisora Nuevo Mundo, Bogota, on **4755** at 0518, OM with a newscast in Spanish. Schedule is around the clock, the power is 1kW and sometimes identifies as "Radio Caracol". It all adds to the fun you see!

Ecos de Combeima, Ibaque, on **4875** at 0257, OM with commercials, identification then Latin American music. With a 24-hour schedule and a power of 5kW, this one tends to wander in frequency from that quoted above to **4878**.

● DOMINICAN REPUBLIC

Radio Clarin, Santo Domingo, on **4850** at 0524, Latin American music, commercials, many identifications "Radio Clarin". Schedule is from 1000 to 0415 but sometimes extended to be around the clock and the power is 3kW.

● VENEZUELA

Radio Popular, Maracaibo, on **4810** at 0415, Latin American music, OM with identification, presumably on an extended schedule, which is normally from 1000 to 0400, the power being 2kW.

Radio Maracaibo on **4860** at 0420, OM with song in Spanish, also on an extended schedule, usually from 1000 to 0400. The power is 1kW.

Radio Sucre, Cumana, on a measured **4959** at 0314, light orchestral music, OM in Spanish. The schedule is from 1000 to 0600 and the power is 1kW.

La Voz de Carabobo, Valencia, on **4780** at 0333, OM with song in Spanish, local music. The schedule is from 1000 to 0400 and this one sometimes identifies as "Onda Nueva"; the power is 1kW.

Radio Bolivar, Ciudad Bolivar, on **4770** at 0225, OM with commercials, YL with songs in Spanish. Schedule is from 1000 to 0400 and the power is 1kW.

Radio Mundial, Caracas, on **5050** at 0426, guitar music, YL with songs in Spanish. Schedule is on a 24-hour basis, the power is 1kW.

Radio Yaracay, San Felipe, on **4940** at 0230, OM with identification, local folk music. Schedule is from 1000 to 0400 and the power is 10kW.

Radio Libertador, Caracas, OM and YL alternate with commercials, guitar music. Schedule is from 1000 to 0400 and the power is 1kW, the action all being on **3245**.

● ECUADOR

Emisora Progresso, Loja, on **5060** at 0330, OM with identification, piano music. The schedule is from 1200 to 0415 and the power is 5kW.

Radio Nacional Espejo, Quito, on a measured **4679** at 0314, OM with sports commentary in Spanish. Schedule is around the clock and the power is 5kW.

Radio Zaracay, Santo Domingo, on **3390** at 0311, OM in Spanish, guitar music, YL with songs. The schedule is from 1000 to 0500 but has been reported as late as 0849; the power is 10kW.

● PERU

Radio Quillabamba on **5025** at 0321, OM and YL in Spanish, Andean flute music. Schedule is from 1100 to 0400 but the closing time varies up to as late as 0520. The power is 5kW.

Radio Andina, Huancayo, on a measured **4996** at 0402, OM with announcements in Spanish, local pops on records. The schedule is from 1100 to 0600 but has been reported closing at 0450 on occasions. The power is 1kW.

Radio Andina, Huancayo, on a measured **4996** at 0402, OM with announcements in Spanish, local pops on records. The schedule is from 1100 to 0600 but has been reported closing at 0450 on occasions. The power is 1kW.

● YEMEN

Sana'a on a measured **4853** at 1853, Arabic music and songs. Schedule is from 0300 to 0700 and from 1100 to 2110; the power is 25kW.

● SAO TOME

Radio Nacional de Sao Tome on a measured **4806.5** at 2004, OM in Portuguese, YL with songs. The schedule is from 0530 to 2300 and the power is 1kW.

● GHANA

Ejura on **4980** at 1910, pop recordings (made in U.K.) with announcements in English. Schedule is from 0530 to 0800 (Saturdays and Sundays 2305) and from 1200 to 2305, the power being 20kW.

● ALBANIA

Gjirocaster on a measured **5057** at 0542, local music, songs by YL. Schedule is from 0430 to 1830 and the programme is a relay of the Tirana Home Service.

● BENIN

Cotonou on **4870** at 0548, OM with a market report in French. This one has a schedule from 0515 to 0830 and from 1615 to 2300 (Saturdays from 1600, Sundays from 1630). The power is 30kW.

● GUINEA

Conakry on **4910** at 0305, OM in vernacular, local music, African drums, the schedule being from 1230 to 0830 and the power 18kW.

● BURUNDI

Radio Cordac, Bujumbura, on a measured **4901** at 1905, OM in French, the talk being interspersed with short extracts of light music. The schedule is from 0330 to 0515 (Sundays from 0730); 1000 to 1200 and from 1630 to 1930. The power is 2.5kW.

'NOTES FOR NEWCOMERS'

KILOHMS AND MILLIAMPS

Or: "Ohms and Amps".

Or: "Megohms and Microamps".

By D. Snaith

Quite a lot of electronics has to do with the current which flows through a resistor when a certain voltage is applied across it. Voltage provides the "pressure" which causes current to flow, and the amount of current which flows is limited by the resistance.

OHM'S LAW

In Fig. 1(a) we apply a voltage of 1 volt to a resistance of 1Ω. Ohm's Law tells us that the current which flows is 1 amp. If we increase the voltage to 2 volts, twice the current, or 2 amps, flows. If we leave the voltage at 1 volt and reduce the resistance to 0.5Ω, twice the current flows again. In the first instance we are doubling the voltage and in the second instance we are halving the resistance. Both changes result in a doubling of the current.

In Fig. 1(b) the resistance is increased to 1kΩ, which is one thousand times the resistance in Fig. 1(a). If we apply a voltage of 1 volt, one-thousandth of the current, or 1mA, will flow. Most of the currents we deal with in electronics are in milliamps and so it is helpful to think in terms of these units rather than amps. The basic thing we bear in mind is that 1 volt across 1kΩ gives a current of 1mA.

We meet a number of practical examples of how we may apply this knowledge in Fig. 2. In Fig.2(a) we have an emitter bias resistor of 470Ω, across which a voltage of 1 volt is dropped. What is the emitter current? 1 volt across 1kΩ gives 1mA, the resistor has a value just below a half of 1kΩ, and so the emitter current which flows in it is a little higher than 2mA. If the voltage across the resistor had been 2 volts the current would be rather more than 4mA, and so on.

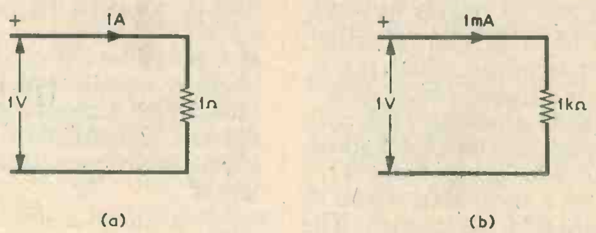


Fig 1(a) A voltage of 1 volt causes a current of 1 amp to flow in a 1Ω resistor

(b). Similarly, 1 volt gives a current of 1mA in a 1kΩ resistor

In Fig. 2(b) we have a series supply decoupling resistor of 220Ω and we find there is a voltage of 3 volts across it. If we say that 220Ω is one-fifth of 1kΩ we can proceed in the following manner. 3 volts across 1kΩ gives 3mA, so 3 volts across one-fifth of 1kΩ gives 15mA. In consequence the current flowing through the resistor, which is that drawn by the stages it supplies, is of the order of 15mA.

These last two examples give results which are accepted as being quite approximate, but they would be adequate if we were measuring the voltages across the resistors to find a fault during servicing. If we require more accurate results then we get the paper and pen out. Note that we have been able to find the values of currents without having to go through the fuss of opening the circuits concerned so that we can insert a current-reading meter.

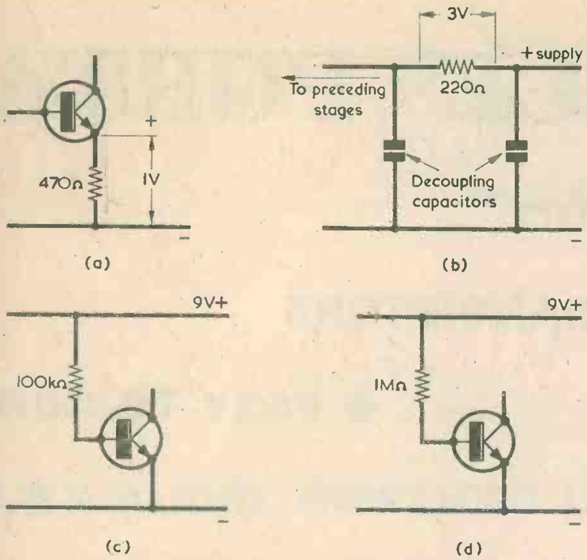


Fig. 2(a). The emitter bias resistor has a voltage of 1 volt across it

(b). Here, 3 volts are dropped across a supply decoupling resistor

(c). A simple base bias circuit for a silicon transistor

(d). The same circuit with a resistor having 10 times the previous value

BASE BIAS RESISTOR

In Fig. 2(c) a 100kΩ base bias resistor is connected between a 9 volt supply and the base of a silicon transistor. What is the base bias current which flows in the resistor? We know that about 0.6 volt is dropped across the base-emitter junction of the transistor, whereupon there must be 8.4 volts across the resistor. 1 volt across 1kΩ gives 1mA, 8.4 volts across 1kΩ gives 8.4mA, 8.4 volts across 10kΩ gives 0.84mA, and 8.4 volts across 100kΩ gives 0.084mA. So, 0.084mA is the answer. A thousandth of 1mA is 1μA, and we could also express the answer as 84μA.

We have a similar set-up in Fig. 2(d) but, this time, the bias resistor has a value of 1MΩ. Instead of working with kilohms we now take a hop to megohms. 1MΩ is equal to 1,000kΩ, so 1 volt across 1MΩ gives a current of one-thousandth of a milliamp, or 1 microamp. In Fig. 2((d) we have the same voltage of 8.4 volts across the resistor. 1 volt across 1MΩ gives 1μA, so 8.4 volts across 1MΩ gives 8.4μA. And that's the current in the resistor. It's also, you may notice, one-tenth of the current in the 100kΩ resistor of Fig. 2(c).

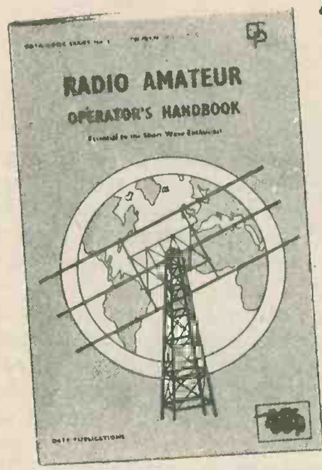
For the record, here are the three Ohm's Law equations:

$$R = \frac{V}{I}$$

$$I = \frac{V}{R}$$

$$V = IR$$

But, for simple approximate calculations of the type we have just carried out, all we need to remember is that 1 volt across 1Ω gives 1 amp, 1 volt across 1kΩ gives 1mA, and 1 volt across 1MΩ gives 1μA. For most electronic work we will use the relationship which takes in the kilohm and the milliamp. ■



‘THE PRINCE’ PORTAB

● **SUPERHET CIRCUIT**

● **5 TRANSISTORS**

● **EASY TO CONSTRU**

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Most of the entertainment receivers which are described in this and other magazines are a.m. sets for use on the medium and long wave bands. F.M. sets are rarely featured because, although they do have advantages, they also tend to be rather more difficult to construct and align.

The main advantages offered by an f.m. set are an improvement in audio quality (particularly with respect to treble response) and freedom from most types of interference. A disadvantage is that in many areas only B.B.C. Radios 2, 3, and 4 are available, and in a few districts it may not be possible to receive even these. On the other hand, it is presumably the B.B.C. stations that are of primary interest to most listeners, and in a number of areas the three national stations are augmented by local ones.

The author thought that in view of this it would be worthwhile experimenting with a simple f.m. radio design to see if it was possible to produce one that fell within the scope of the average constructor. The receiver which forms the subject of this article is the result, and although it is a little more complicated than the average a.m. superhet radio it is, nonetheless, reasonably easy to construct and its alignment is not too critical.

The receiver is completely self-contained and is capable of good results in areas where f.m. signals are reasonably strong. In fact the prototype is just able to receive four local stations reasonably well (Radio Medway, Radio London, Capital Radio and L.B.C.) even though the author lives a little outside the regions officially served by these stations. The unit can provide an output power of up to 300mW from an internal speaker with a diameter of 3 to $3\frac{1}{2}$in., and the quality is noticeably better than that produced by most a.m. sets of a comparable size.

RECEIVER CIRCUIT

The complete circuit of the receiver is shown in Fig. 1. Basically this consists of a dual gate MOSFET mixer (TR1), a separate oscillator (TR5), three stages of i.f. amplification (TR2 to TR4), a ratio detector (D1 and D2) and an integrated circuit audio amplifier (IC1).

The dual gate MOSFET mixer stage is quite conventional with the input signal being applied to the g1 terminal, the oscillator signal to the g2 terminal, and the i.f. output signal being taken from the drain via an ordinary 10.7MHz i.f.

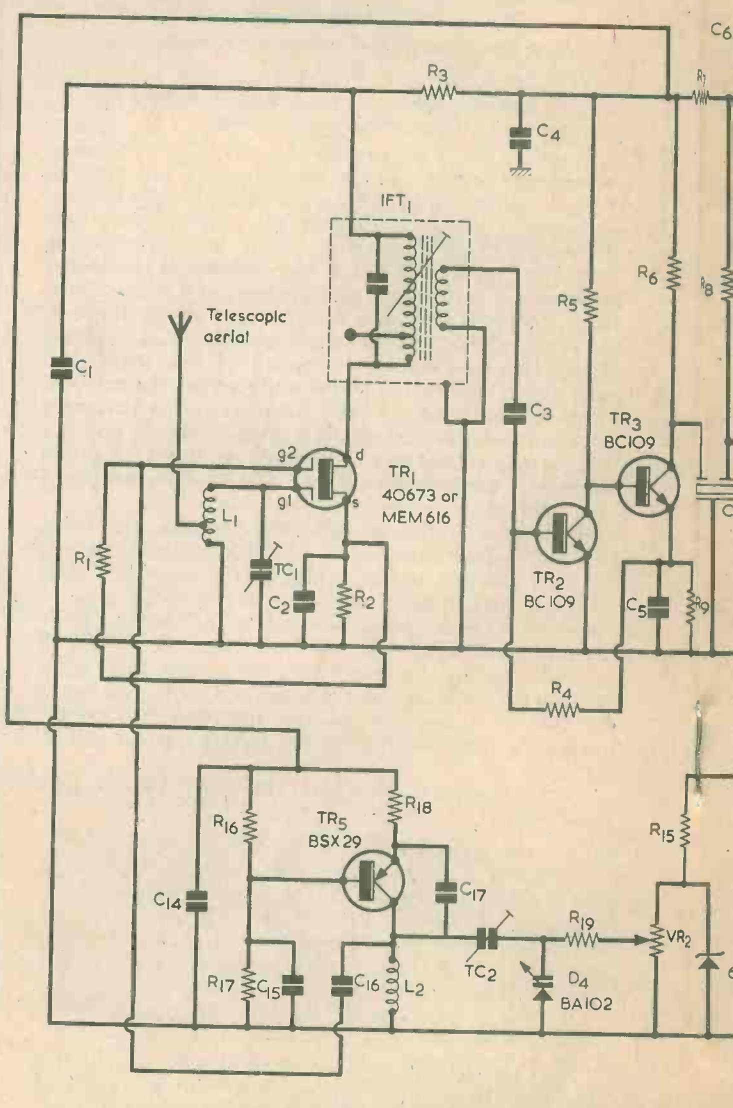

Fig. 1. The complete circuit of the f.m. portable receiv
integrated circuit offering

RINCE' PORTABLE F.M. RA

By

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● 5 TRANSISTORS

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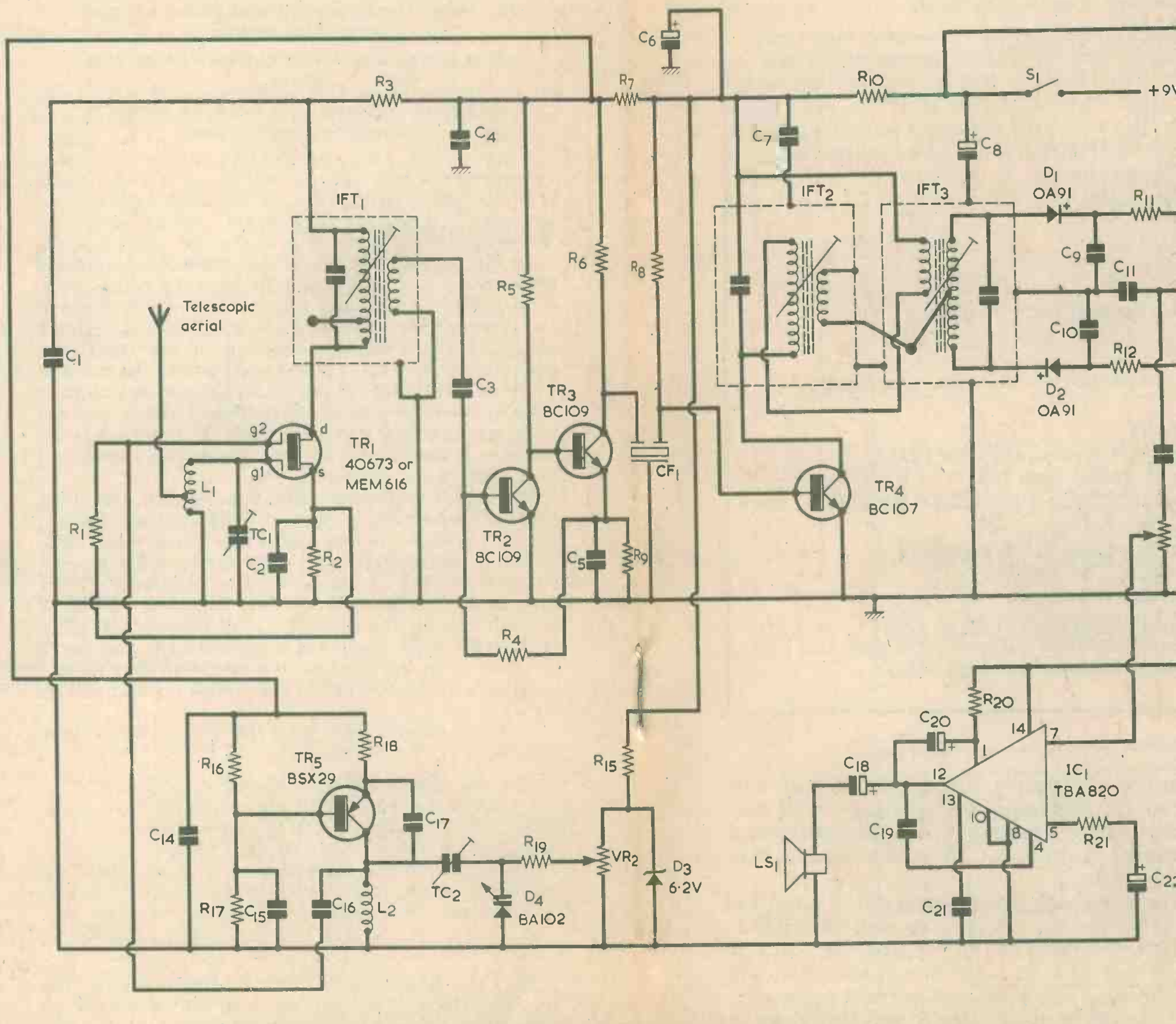
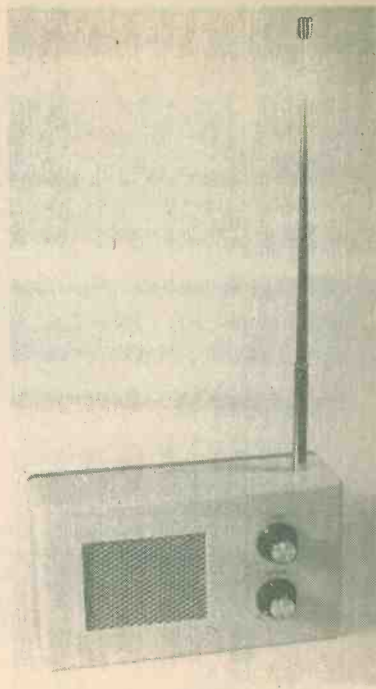


Fig. 1. The complete circuit of the f.m. portable receiver. This has varicap tuning and incorporates an a.f. integrated circuit offering a high level of gain

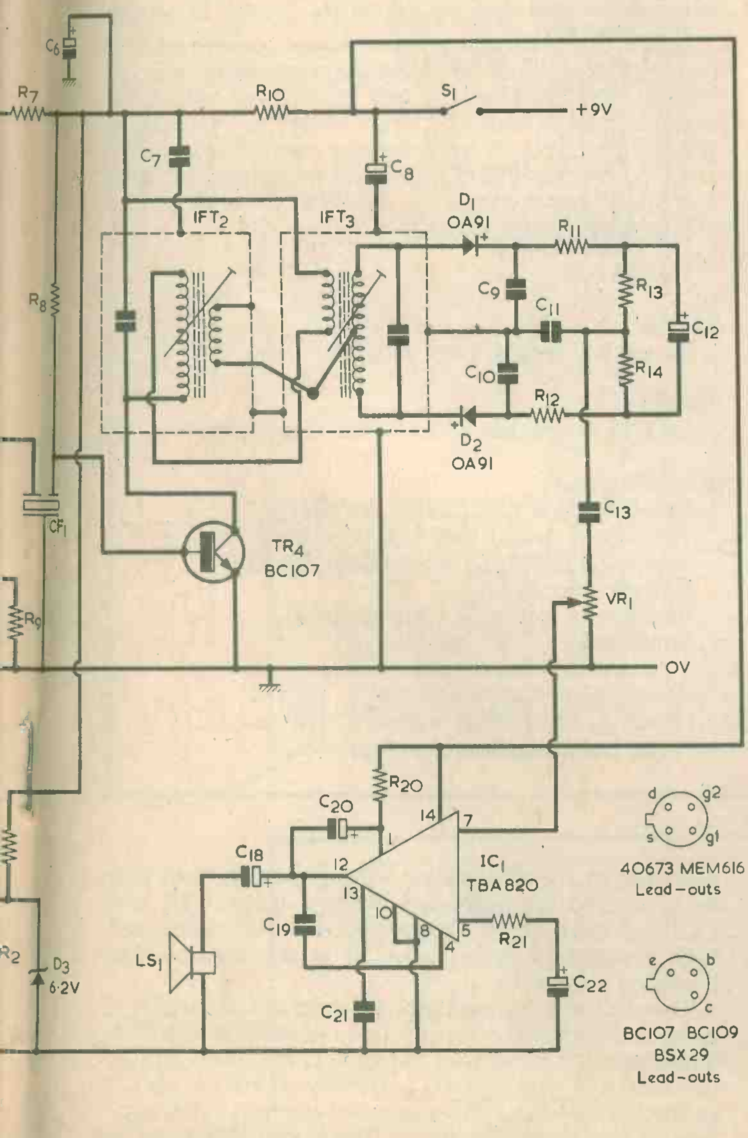
BLE F.M. RADIO

By R. A. Penfold



TRUCT

GH GAIN AUDIO AMPLIFER I.C.



receiver. This has varicap tuning and incorporates an a.f.
ffering a high level of gain

transformer. L1 and TC1 are the input tuned circuit, and this is a broad-band circuit with pre-set tuning. The aerial, which is a telescopic type, couples to a tap in L1.

A Colpitts oscillator circuit is employed and the only unusual feature about this is that it incorporates a p.n.p. transistor in what is a negative earth receiver. The output from the oscillator is extracted from TR5 collector and is coupled to TR1 g2 via C16. Varicap diode tuning is used, and the oscillator tuned coil, L2, is coupled to the tuning diode, D4, via TC2. The latter is adjusted to provide the required tuning range. R15 and D3 form a simple zener shunt regulator circuit which provides a stabilized tuning voltage. The voltage which is fed to the varicap diode by way of R19 can be adjusted by means of VR2, which thus operates as the tuning control.

The secondary winding of the first i.f. transformer is coupled to the base of TR2 by d.c. blocking capacitor C3. TR2 and TR3 are both common emitter amplifiers, and they are connected in a simple direct coupled arrangement which is often employed in audio amplifers. With the circuit values suitably modified this works very well as a high gain 10.7MHz i.f. amplifier.

The output from the collector of TR3 is coupled to the base of TR4 by way of a 10.7MHz ceramic filter. TR4 is used in the common emitter mode and it is biased by R8.

I.F. transformers IFT2 and IFT3 together provide a ratio detector transformer. These, in conjunction with D1 and D2 and the associated components, constitute the ratio detector circuit of the receiver.

C11 is the de-emphasis capacitor, and it provides a degree of treble cut to the audio output signal. This is necessary in order to compensate for the treble boost, or pre-emphasis, which is provid-

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)
R1 120kΩ
R2 3.9kΩ
R3 680Ω
R4 330kΩ
R5 820Ω
R6 330Ω
R7 390Ω
R8 560kΩ
R9 2.2kΩ
R10 220Ω
R11 680Ω
R12 680Ω
R13 5.6kΩ
R14 5.6kΩ
R15 1.8kΩ
R16 10kΩ
R17 12kΩ
R18 1kΩ
R19 470kΩ
R20 150Ω
R21 10Ω
VR1 5kΩ potentiometer, log with switch S1
VR2 100kΩ potentiometer, linear

Capacitors
C1 0.01μF disc ceramic
C2 0.01μF disc ceramic
C3 0.01μF disc ceramic
C4 0.01μF disc ceramic
C5 0.01μF disc ceramic
C6 100μF electrolytic, 10V Wkg.
C7 0.1μF type C280 (Mullard)
C8 100μF electrolytic, 10V Wkg.
C9 470pF polystyrene
C10 470pF polystyrene
C11 0.01μF disc ceramic
C12 10μF electrolytic 10V Wkg.
C13 1μF type C280 (Mullard)
C14 0.022μF disc ceramic
C15 0.01μF disc ceramic
C16 8.2pF ceramic
C17 5.6pF ceramic
C18 220μF electrolytic, 10V Wkg.
C19 330pF ceramic
C20 100μF electrolytic, 10V Wkg.
C21 0.1μF type C280 (Mullard)
C22 100μF electrolytic, 10V Wkg.
TC1 20pF ceramic trimmer (see text)
TC2 60pF ceramic trimmer (see text)

Inductors
L1, L2 see text
IFT1 10.7MHz i.f. transformer type KALS4520A (see text)
IFT2 10.7MHz i.f. transformer type 94ACS10516PJ (see text)
IFT3 10.7MHz i.f. transformer type 94FCS10517STP (see text)

Ceramic Filter
CF1 ceramic filter type CFSA10.7 (see text)

Semiconductors
IC1 TBA820
TR1 40673 or MEM616
TR2 BC109
TR3 BC109
TR4 BC107
TR5 BSX29 (see text)
D1 OA91
D2 OA91
D3 BZY88C6V2
D4 BA102

Switch
S1 s.p.s.t. toggle, part of VR1

Speaker
LS1 25Ω speaker, 3 to 3.5in. diameter

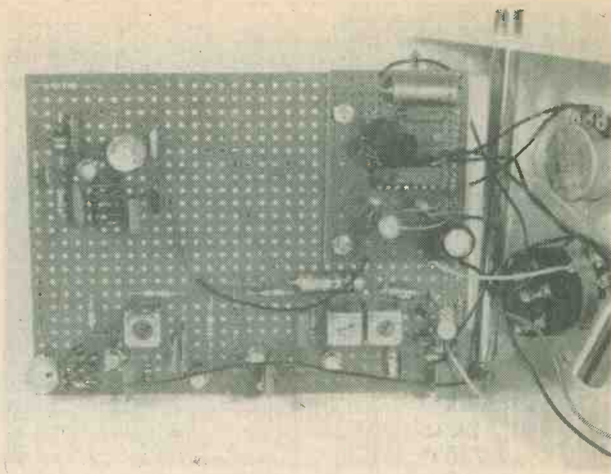
Miscellaneous
Verobox type 65-2522K (see text)
Telescopic aerial (see text)
9 volt battery type PP6 (Ever Ready)
Battery connector
Veroboard, plain, 0.15in. matrix
Veroboard, 0.1in. matrix
2 control knobs
Speaker aperture material
16 s.w.g. enamelled wire (for L1 and L2)
Nuts, bolts, 4BA solder tag, etc.

ed at the transmitter. The combined effect of using pre-emphasis and de-emphasis is an improved signal-to-noise ratio.

The output from the detector is coupled to the volume control, VR1, by C13. The signal is then fed to the input of the audio amplifier integrated circuit. The internal circuitry of this i.c. is such that no input d.c. blocking capacitor is required. R21, in company with the a.f. bypass capacitor C22, reduces the negative feedback applied internally in the i.c.; R21 is given a low value in the present circuit in order that the i.c. should have a high voltage gain. This is necessary because the output from a ratio detector is comparatively low. C20 and R20 are bootstrapping components and provide an increase in the maximum output power than can be produced for a given supply voltage. C19 and C21 are needed for frequency compensation and high frequency stability. C18 is the output d.c. blocking capacitor.

Due to the very high overall gain of the circuit it is essential that the supply lines be well decoupled. This function is carried out by C1, R3, C4, C6, R7, C7, R10, C8 and C14. S1 is the on-off switch and is ganged with VR1. The quiescent current consumption of the circuit is about 10mA and this rises to about 50mA at high volume levels.

The components are all standard types but a few comments are necessary concerning the source of some of these. The three i.f. transformers and the ceramic i.f. filter are all Toko components available from Ambit International, 37 High Street, Brentwood, Essex. Trimming capacitors TC1 and TC2 are Doram Type A, obtainable from Doram Electronics Limited, P.O. Box TR8, Wellington Road Industrial Estate, Wellington Bridge, Leeds. Also available from Doram Electronics are the transistor type BSX29 employed for TR5 and the telescopic aerial. The latter has an extended length of 975mm. with a hinge at the base of the second section.



The oscillator, mixer, i.f. amplifier and ratio detector components are mounted directly on the larger perforated board. A separate a.f. amplifier module, assembled on its own Veroboard panel, is then bolted to this

MAIN CIRCUIT BOARD

Most of the components are mounted and wired up on a plain Veroboard (i.e. without copper strips) of 0.15in. matrix measuring 5 by 3.75in. This is a standard size in which the board is sold. The mixer and i.f. circuitry is wired up near the bottom edge of the board, and this wiring is illustrated in Fig. 2. The three i.f. transformers fit well onto the board, but it is necessary to slightly enlarge the holes for their mounting lugs. Note that connections are made to nearly all of these lugs.

The other components are mounted on the board in the positions indicated in the diagram, their lead-outs being bent flat against the board underside. They are then wired together as shown in the diagram. Tinned copper wire of around 20 s.w.g. may be employed for long wiring runs or where it is necessary to extend a component lead-out. Capacitor C1 is wired under the board between the two points "A". Its lead-outs should be covered with sleeving to prevent short-circuits to other wires.

L1 is a home-made coil and is wound with 16 s.w.g. enamelled copper wire. It consists of exactly 5 turns of wire, the coil ends being bent down and

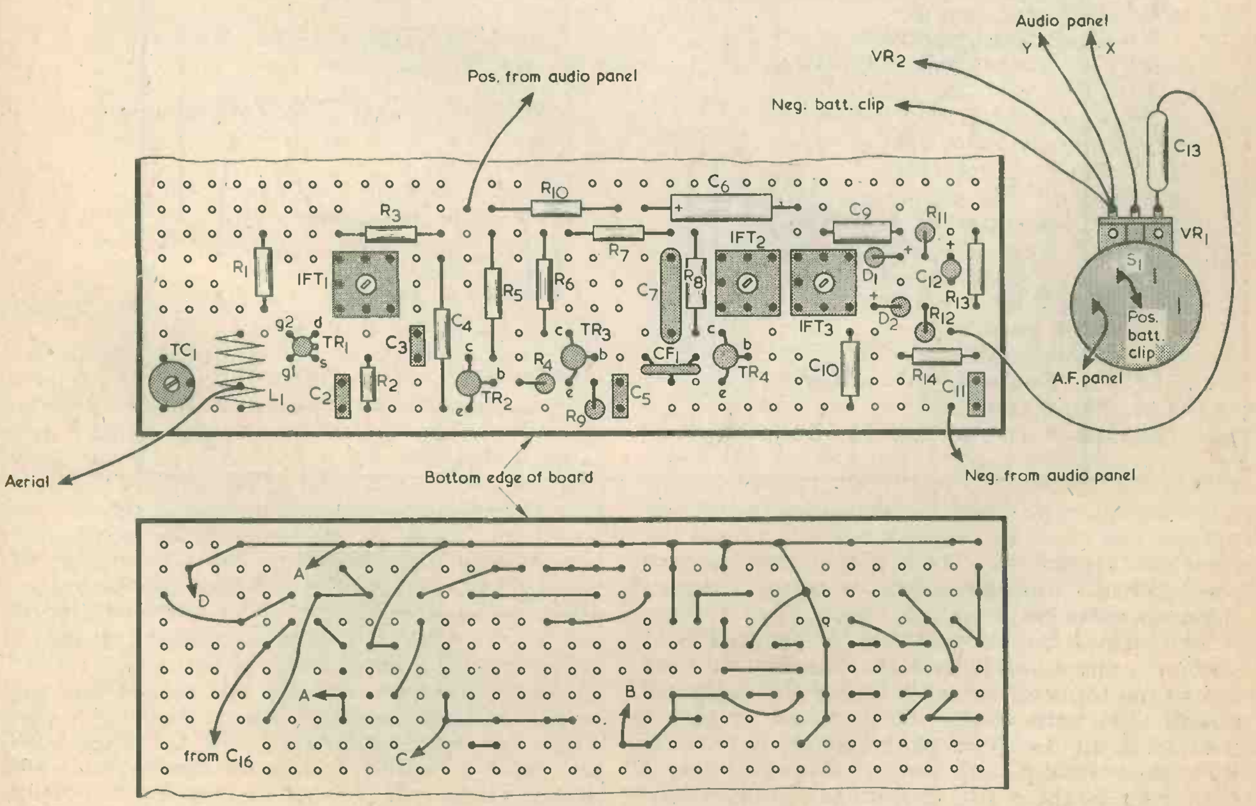
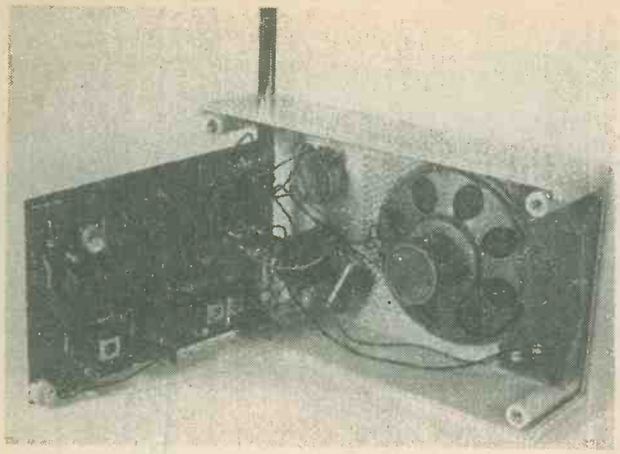


Fig. 2. The mixer and i.f. amplifier wiring. The parts are assembled at the bottom of the main component board



A view inside the receiver with the component panel displaced to show the speaker and panel controls

passed through two holes in the board 0.45in. apart. The coil is then just clear of the upper surface of the board. The coil is self-supporting and is initially wound around any cylindrical object having a diameter of $\frac{5}{16}$in., the author used the shank of a $\frac{5}{16}$in. diameter drill. The coil ends are scraped clean of enamel, as also is a point $1\frac{1}{2}$ turns from one end. This forms the tap, to which the aerial connects. The cleaned sections of the coil are tinned with solder and it is then fitted and wired to the board as shown in Fig. 2. The connection to the coil tap is made later.

OSCILLATOR STAGE

The oscillator stage is assembled on the Veroboard panel in the same way as the mixer and i.f. stages. It is wired in the upper left hand corner of the board, diagonally opposite C11. There are three points identified as "B", "C" and "D". These are connected, below the panel and using insulated wires, to the similarly identified points in Fig. 2. An insulated wire below the panel also takes a connection from C16 to R1. The oscillator wiring is shown in Fig. 3.

Coil L2 is wound and finished in exactly the same way as L1, the only difference being that L2 does not have a tap. Capacitor C17 is wired below the board.

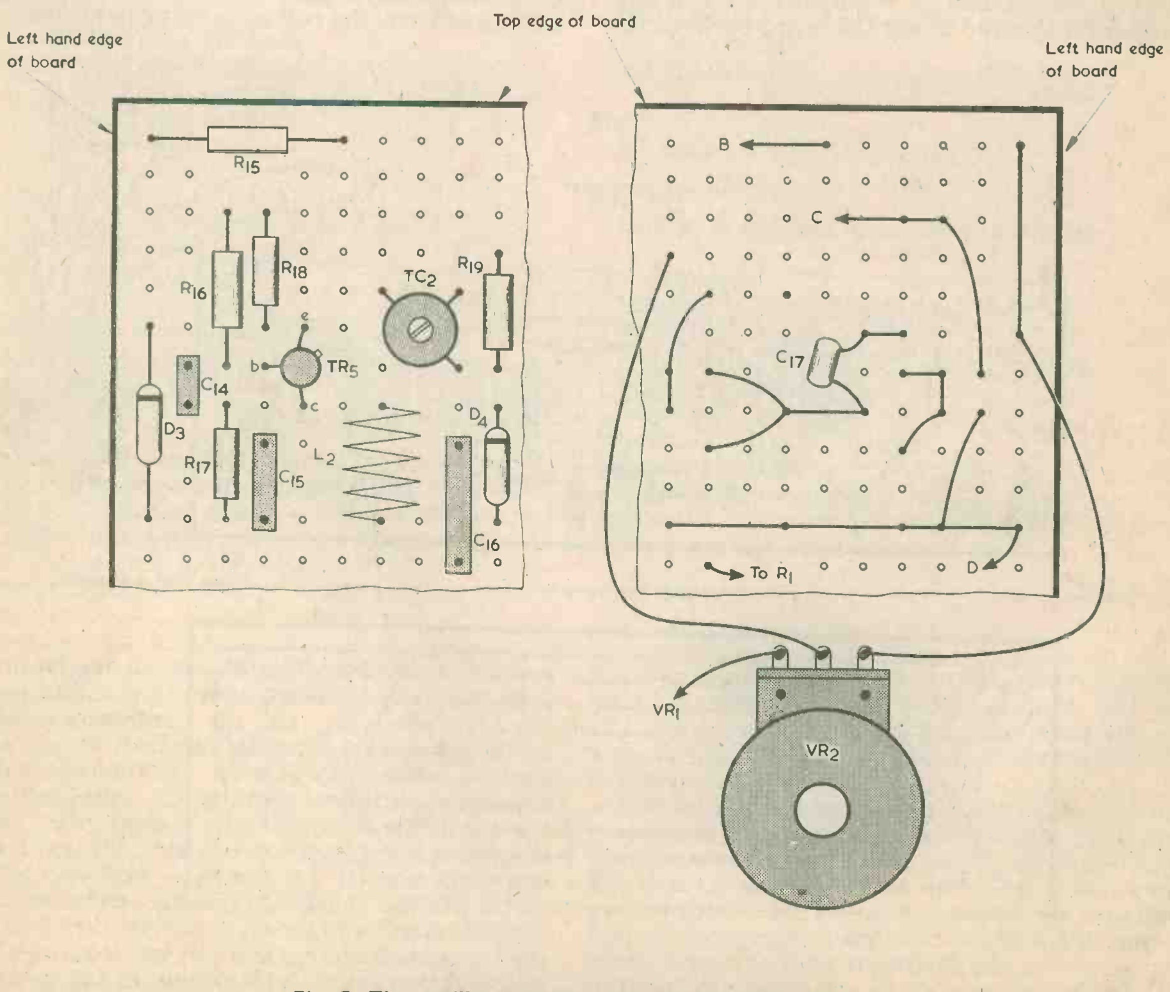


Fig. 3. The oscillator stage, which is assembled at the top left corner of the component board

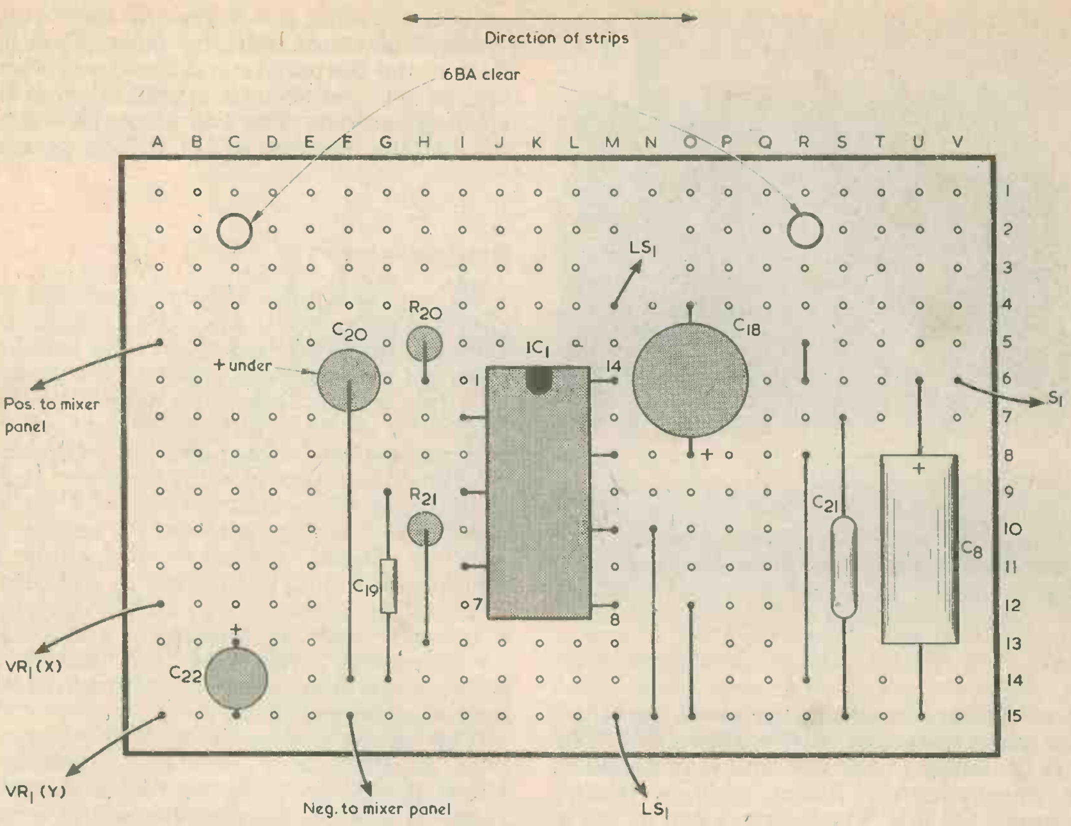


Fig. 4 The a.f. amplifier components are wired up on the Veroboard panel shown here. This is then bolted to the top right corner of the main board

AUDIO PANEL

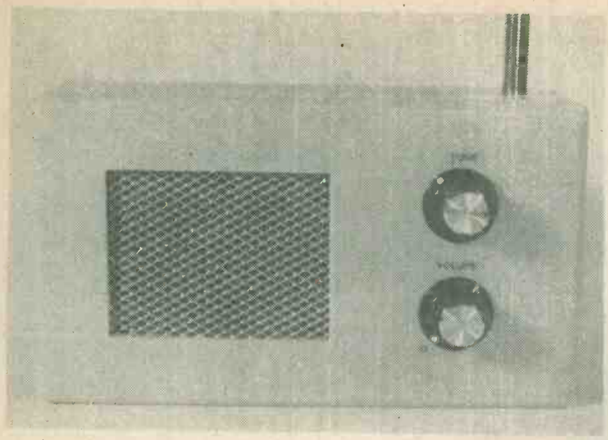
The audio amplifier is assembled on a piece of ordinary Veroboard with copper strips and a matrix of 0.1in. This board has 22 holes by 15 copper strips. The board is first cut out from a larger piece by means of a small hacksaw, after which the two mounting holes are drilled out 6BA clear. Seven breaks in the copper strips are next made, these being from 'K6" to "K12" inclusive. The components and link wires are than soldered in place, as illustrated in Fig. 4, with the i.c. being left until last. The i.c. is a quad-in-line device with its pins staggered as shown.

The audio panel is fitted by means of two 6BA bolts and nuts to the right hand top corner of the main component panel, C8 being uppermost. Two 6BA clear holes are required in the main component panel to match those in the audio panel, and small spacing washers are fitted between the two to prevent the solder joints under the audio panel from stressing the main panel. Before the audio panel is finally mounted it must be wired to the rest of the circuit. The remaining wiring is shown in Figs. 2 and 3.

THE CASE

The prototype is housed in a plastic Verobox No. 65-2522K, which has dimensions of 188 by 110 by 60mm. There should be adequate depth in the box for a standard speaker and the main component panel (which fit together in a manner which will shortly be described) but it would be advisable to check the rear speaker dimension before obtaining the box in case the speaker has an excessively large magnet. Any other plastic box having similar or larger dimensions could be used if it will accommodate the speaker and the component panel.

The general layout of the receiver inside the case can be seen from the photographs. A 9mm. diameter hole is drilled in the top of the case for the telescopic aerial and a 4BA clear hole exactly below it in the bottom of the case. The bottom hole is countersunk on the outside. A 4BA countersunk bolt is passed up through this hole and a solder tag fitted over it. The aerial is pushed down through the 9mm.hole and secured by the 4BA bolt, which passes into a tapped hole at the bottom of the aerial. A lead from the solder tag connects to the tap in L1.



The appearance of the front p nel is enhanced by legends taken from "Panel-Signs" set No. 4

VR1 and VR2 are mounted, one above the other, just to the left of the aerial. VR2 is above VR1. The speaker is mounted to the left and a rectangular aperture, approximately 75mm. wide by 60mm. high, is cut out for this. The aperture can be made with a fretsaw or a miniature round file. A piece of speaker fret is glued in place behind the aperture, and then the speaker is glued to this. Take care that the glue is applied only to the rim of the spaeker, and that none gets on to the cone or surround. The speaker is positioned so that the back of its magnet coincides with the blank central area of the main component panel when the latter is fitted in place.

In practice, it is advisable to complete the component panel before actually mounting the aerial, speaker and controls on the case. They can then be positioned such that the component panel fits comfortably into the case with the empty space at its centre behind the speaker magnet. Sufficient room must be available at the left hand side of the case for the PP6 battery.

On the prototype a piece of foam rubber is glued to the front of the case where the battery fits. A second piece of foam is placed between the speaker and battery and the component panel. The latter fits, component side forwards, against the foam, and when the back of the case is screwed into position the panel and battery are held firmly in place.

Alternatively the leads between the aerial, speaker, controls and the panel could be made longer, and the panel could then be mounted on the rear of the case using a couple of short bolts with spacing washers. The two pieces of foam holding the battery in place would still be necessary.

ALIGNMENT

Before the unit is finally assembled inside the case it is necessary to align the r.f. and i.f. circuits. With the unit switched on and the aerial extended it should be possible to receive a few stations. Note that for best reception the aerial must be either horizontal or at 45 degrees, and not vertical. Also it is directional and must be swung around to find the position which provides the strongest signal. If no signals can be located, adjust TC2 for increased capacitance and try altering the setting of TC1.

When a signal has been located, adjust TC1 with a plastic trimming tool to peak it, and then similarly adjust the cores of IFT1 and IFT3 in that order. If a fairly sensitive voltmeter is available this can be connected across C12 and used as a tuning meter. Maximum meter deflection corresponds to maximum signal strength.

The setting of the core of IFT2 is not critical. If it is adjusted backwards and forwards over its travel it will probably be found that there is a range of settings towards the centre where audio quality is at its best. This is the area to which the core should be adjusted and left. However, results should be quite satisfactory with IFT2 core at virtually any setting.

TC2 is given a setting which allows all the appropriate stations to be tuned in. If a suitable signal generator is available, TC2 can be adjusted for a tuning range of about 88 to 100 MHz. Should an adjustment in TC2 for adequate tuning range result in stations being lost at the high frequency end of the coverage, the problem may be rectified by stretching out L2 slightly. Should it not be possible to obtain adequate range at the low frequency end, L2 may be compressed slightly.

The final adjustment consists of tuning to a station at or near the centre of the tuning range, and then adjusting TC1 to peak this signal. Should the peak be just outside the range of TC1, coil L1 may be similarly slightly stretched or compressed, as appropriate.

Alignment is then complete. The receiver is finally assembled and is then ready for use.

■

BACK NUMBERS

For the benefit of new readers we would draw attention to our back number service.

We retain past issues for a period of two years and we can, occasionally, supply copies more than two years old. The cost is 40p plus 12p postage.

Before undertaking any constructional project described in a back issue, it must be borne in mind that components readily available at the time of publication may no longer be so.

We regret that we are unable to supply photo copies of articles where an issue is not available. Libraries and members of local radio clubs can often be very helpful where an issue is not available for sale.

ELECTRONIC COMMUNICATIONS PIONEER —

Dr. E. F. W. ALEXANDERSON

By Michael Lorant

It is not generally realised that transmission of speech by radio, employing a spark transmitter, was accomplished by the American R. A. Fessenden in 1900. Results were unsatisfactory, however, until the introduction of the transmitting high frequency alternator, designed and engineered by E. F. W. Alexanderson. Dr. Alexanderson was a notable pioneer in the development of radio, and this article gives a general outline of his many achievements in American radio, television and electronics.

It was Christmas Eve, 1906. On the storm-tossed North Atlantic the Morse code message "CQ . . . CQ" crackled over the earphones of ship radio operators. These code letters signalled that the message to follow would be of general interest to anyone who could hear it.

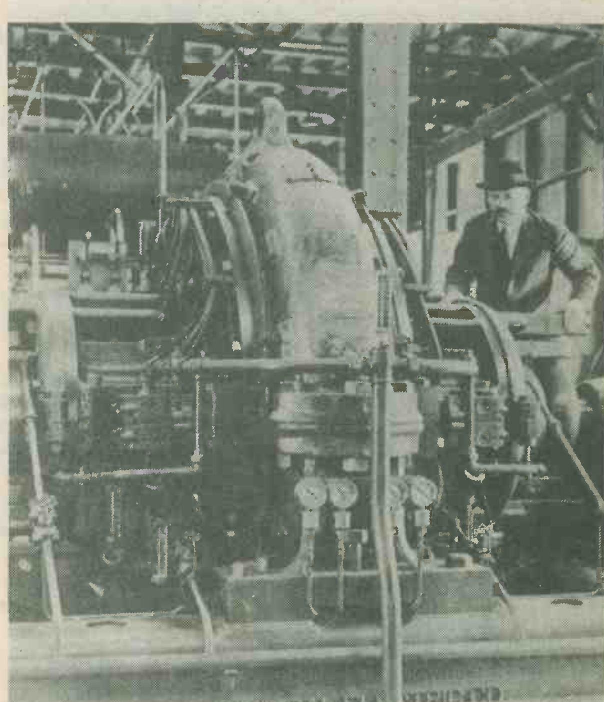
As the radio operators strained to hear, the Morse code transmission suddenly stopped. Instead, to their amazement, it was replaced — for the first time — by the sound of a human voice, then a woman singing, then someone reading a poem, then a violin solo and then a man making a speech. Thus, the world's first voice radio broadcast passed into history.

HIGH FREQUENCY ALTERNATOR

Behind that achievement stood a young General Electric engineer, Ernst Frederick Werner Alexanderson, who had spent the previous two years designing and constructing the high frequency alternator that made the broadcast possible. The project was undertaken at the request of another pioneer in radio experimentation, Prof. Reginald A. Fessenden, who had asked General Electric to build a high frequency machine that would operate at high speeds and produce a continuous wave transmission. Although the usual generator in those days operated at around 60 cycles per second, Prof. Fessenden wanted one to operate at 100,000 cycles — an idea considered fantastic by most engineers. Dr. Alexanderson, only 26 years old when he was handed the assignment, completed the equipment and installed it in the Fessenden station in time for the historic Christmas Eve broadcast.

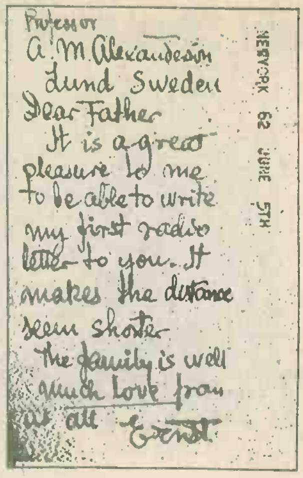
That achievement, which gave the United States its start in the field of radio communication, was to prove but one of many during Dr. Alexanderson's career. During his 46 years with General Electric, he was to receive 322 patents, nearly one every seven weeks. He died at the age of 97, on May 14, 1975 as one of the giants of the engineering profession.

Ernst F. W. Alexanderson was born on January 25, 1878, at Uppsala, Sweden, the son of Professor A. M. Alexanderson, then on the faculty of Uppsala University. The young man developed an early interest in electrical engineering which was stimulated by a year of technical work at the University of Lund in 1896. He then spent



Picture shows Dr. Ernst F. W. Alexanderson inspecting one of the 200 kilowatt high frequency alternators which gave America its start in the field of radio communication. This alternator, one of several designed by Dr. Alexanderson from 1905 to 1920, was used to send transatlantic radio telegraph messages from the Rocky Point, Long Island, station of the Radio Corporation of America. The photograph was taken in 1922

The first facsimile message sent by radio across the Atlantic on June 5th, 1924, to Dr. Alexanderson's father in Sweden



Professor
A. M. Alexanderson
Lund Sweden
Dear Father
It is a great
pleasure to me
to be able to write
my first radio
letter to you. It
makes the distance
seem shorter
the family is well
much love from
all Ernst

NEWYORK 62 JUNE 5TH

three years at the Royal Institute of Technology in Stockholm, from which he graduated in 1900 as an electrical-mechanical engineer. This was followed by a year of post-graduate work at the Technical University in Berlin, Germany.

As the son of a professor of languages, Dr. Alexanderson had learned English, German, French, and Latin in addition to his native Swedish. Thus, when a copy in English of "Alternating Current Phenomena" by Dr. Charles P. Steinmetz, General Electric's mathematical genius, fell into his hands while he was studying at the University of Berlin he was able to read the volume. It made such an impression on him that he decided to move to America to seek work with the author.

In 1901, Dr. Alexanderson arrived in the United States and visited Steinmetz in Schenectady, General Electric's research centre. In 1902, on the mathematician's recommendation, General Electric gave him a drafting job. The following year the took the company's Test Engineering Course and in 1904 he became a member of the engineering staff designing generators under the direction of Steinmetz.

When Steinmetz organized a Consulting Engineering Department in 1910, Dr. Alexanderson became a member of the group. During the next eight years a number of significant developments evolved from the alternator. For example, news of its invention had reached the ears of Guglielmo Marconi, the "father" of radio, and in 1915 he travelled from England to visit General Electric and talk with Dr. Alexanderson in Schenectady. He arranged to have a 50 kilowatt Alexanderson alternator installed in his transatlantic Marconi.Company station in New Brunswick, New Jersey.

However, Dr. Alexanderson was not content. A few years later, during World War I, he perfected a 200-kilowatt alternator, and the first unit of this size was installed at the same New Brunswick station. It was used by President Woodrow Wilson, and by Franklin D. Roosevelt, then Assistant Secretary of the Navy, in transmitting messages to the war threatres of Europe. But it was not until October 20, 1918, that the alternator was put to its first important practical test: the transmission of President Wilson's ultimatum to Germany which brought the war to a close.

In 1918 Dr. Alexanderson became head of General Electric's newly organized Radio Engineering Department. The next year, Marconi renewed negotiations — first instituted early in the war — for exclusive rights to the alternator. It was then that President Wilson appealed to General Electric not to sell and instead to help organize an American company to use the alternator. This led to the formation of the Radio Corporation of America, with Dr. Alexanderson becoming its chief engineer in 1919.

INVENTIVE GENIUS

Meanwhile, Dr. Alexanderson's inventive genius had been hard at work. Among his notable radio developments were the magnetic amplifier, the electronic amplifier, the multiple tuned antenna, the anti-static receiving antenna and the directional transmitting antenna. He also devised radio altimeters, and his studies in the polarisation of radio waves made possible effective radio direction finders.

Dr. Alexanderson's magnetic amplifer utilised the magnetic saturation effect in iron to harness the weak power circuit of the microphone to the high power of the antenna without burning out the microphone. He told E. W. Rice, Jr., then vice president and later president of General Electric, that the device might be used for transatlantic telephony. "Why does the company waste time on such a foolish dream?" Rice was asked by another executive of the company. "Well," answered Rice, "if Alexanderson thinks he has discovered the means of telephoning across the ocean I feel it my duty to look into it." His faith in Alexanderson was amptly justified and an ocean telephone service was inaugurated only a few years later.

Dr. Alexanderson himself made the magnetic amplifier obsolete with his invention of the electronic amplifier. This was essentially the application to radio telephony of

The first American home television reception took place in 1927 at the Schenectady residence of Dr. Ernst F. W. Alexanderson. The television screen is in the small square at eye level. A television system developed by Alexanderson and his co-workers transmitted pictures nationwide throughout 1928

Dr. Alexanderson (nearer the camera) and S. P. Nixdorff, a co-worker, demonstrating a radio-echo altimeter in a 1929 airborne test. The altimeter was one of the first practical applications of the reflecting properties of radio waves.

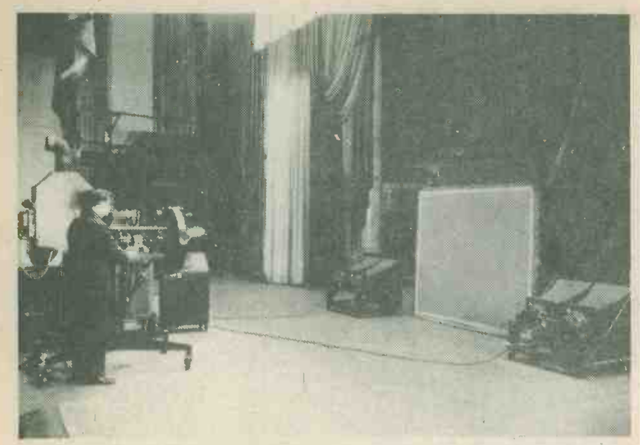
the vacuum tube improvements worked out by Dr. Irving Langmuir of the General Electric Research Laboratory. These tubes became the basis for all present-day radio broadcasting.

The anti-static receiver was another World War I development. With German submarines cutting cables and the allies complaining of German stations blanketing their wireless transmission, the U.S. government turned to Dr. Alexanderson for a means of ensuring continual communication with the armies in France. With an assistant he discovered that a wire two miles long stretched in the direction of Europe and another in the perpendicular direction balanced by coils not only eliminated the German radio barrage, but the static as well in the receiver. This system soon became an indispensable part of long-distance commercial radio reception.

From 1919 to 1924 Dr. Alexanderson divided his time between General Electric and the Radio Corporation of America, maintaining his residence and laboratory in Schenectady, but personally superintending construction of powerful radio stations in Sweden, Poland, England, Hawaii, and California, and on Long Island, New York. At the opening of a transatlantic station at Grineton, in his native Sweden, he received the Order of the North Star from King Gustav V.

In the next few years, Dr. Alexanderson performed pioneering work in American television and the transmission of pictures by radio. Using a perforated scanning disc and high frequency neon lamps, he staged in Schenectady the first home and theatre demonstrations. The first American home television reception took place in 1927 in his home, and a public demonstration was held the following year. The theatre demonstration took place on May 22, 1930 in Schenectady's Proctor's Theatre, whose orchestra was led by the image of a conductor on a seven-foot screen which also carried the faces of other performers a mile away in a General Electric laboratory.

The equipment used in the large screen television projection system demonstrated in 1930 at Proctor's Theatre, Schenectady, N.Y., is examined by Dr. Alexanderson and an associate. This system employed a mechanical scanning disk, a predecessor to present electronic TV systems.



The stage set-up for the large screen television demonstration at Proctor's Theatre. Two pairs of horn loudspeakers are positioned on either side of the screen

With General Electric's withdrawal from the affairs of the Radio Corporation of America in 1933, Dr. Alexanderson devoted himself at GE to the power applications of electronics, such as power transmission with direct current. He also continued his interest in short wave phenomena and in television. In 1933, his company's engineers in the Helderberg Hills near Schenectady regularly began to receive high definition television from New York, 129 miles away. In 1940, GE placed in service in the Helderbergs the first television relay station operating at such a distance, and began to broadcast New York programmes.

In the power and control field, Dr. Alexanderson devoted several years to the design of single-phase motors for railway electrification, and won an international competition conducted by the Melbourne, Australia, tramway authority with a specially ventilated 1,500 volt d.c. motor. He developed the phase converter system for changing single-phase into poly-phase power and vice versa.

Dr. Alexanderson worked out a system of regenerative braking by d.c. series motors represented in the locomotives of the Chicago, Milwaukee and St. Paul Railroad. His development of several new methods of operating induction motors at variable speeds was embodied in the design of electrical equipment for the battleship "New Mexico", the aircraft carrier "Lexington" and many other ships of the U.S. Navy.

The company inventor's laboratory also produced the Amplidyne, an extremely sensitive and powerful system for amplification and automatic control that was successfully applied in steel mills and other places requiring delicate control of continuous operations. The principle of the inverter used in DC power transmission found another application in the development of a variable speed a.c. motor known as a thyratron motor.

Before his retirment, in 1948, Dr. Alexanderson was elected in 1934 to the Royal Academy of Science of Sweden, the body that bestows the Nobel prizes in science. Besides the Swedish Order of the North Star he received the Medal of Honour of the Institute of Radio Engineers (1919), Knighthood of the Polish Order of Polonia Restituta (1924), the John Ericsson medal for outstanding contributions to the field of radio engineering (1928), the Edison medal from the American Institute of Electrical Engineers (1944), the Cedergren Gold Medal from the Royal Technical Institute of Sweden (1945) and the Royal Danish medal for 1946. ■

OP –

By R. S. Carlman

In some circuits employing simple logic it is desirable to have a latch, or "memory", which remains in one of two states according to the last information applied to it. Suitable latches can be made up with t.t.l. gates, but it is also possible to employ an operational amplifier.

LATCH CIRCUIT

A latch circuit using a 741 op-amp appears in Fig. 1. R1 and R2 hold the inverting input at a voltage mid-way between the supply rails. A third resistor couples the output to the non-inverting input. The input of the latch is at the non-inverting input of the i.c. and the output is at the i.c. output.

At switch-on the output can take up a high or a low voltage state. It is stable in either of these states because of the positive feedback to the non-inverting input via R3. Let us say that the output is in the high state. If we now momentarily connect the input to the negative rail the output will swing low and stay low when the connection is removed. Should we then momentarily connect the input to the positive rail the output will go high again and remain high.

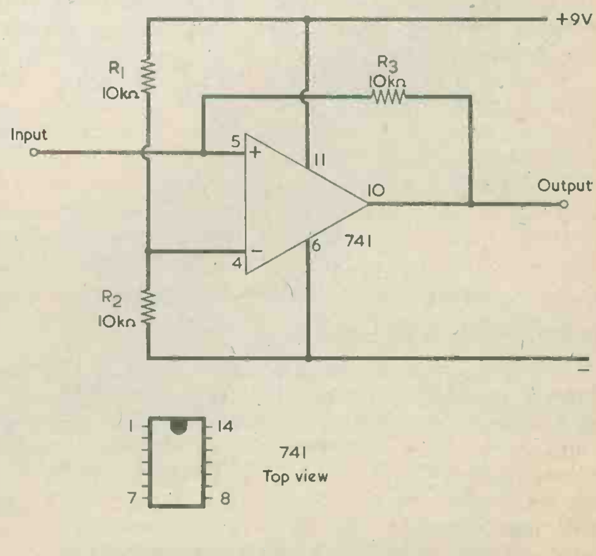
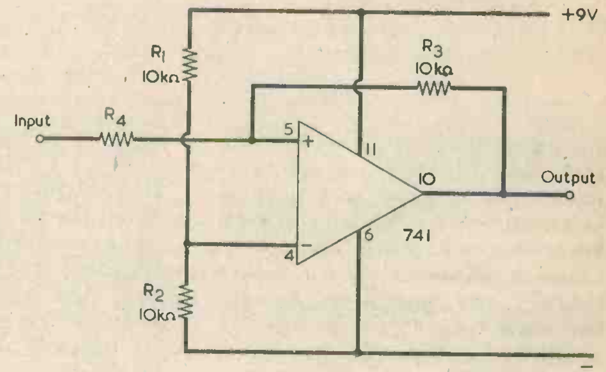


Fig. 1. The operational amplifier latch circuit. The output stays high or low according to the last voltage applied to the input. The 741 is depicted in its 14 pin d.i.l. form

AMP LATCH

A useful circuit configuration incorporating a 741 operational amplifier.

Fig. 2. Adding a resistor in series with the non-inverting input of the i.c. introduces hysteresis



The output will also be triggered low if the input is taken only slightly negative of the junction of R1 and R2, and will similarly be triggered high when the input is taken slightly positive of the junction of the two resistors.

A 9 volt supply is shown, but the circuit will work satisfactorily down to 4 volts or even less. Supply voltages higher than 9 volts may also be employed.

With a 9 volt supply the output voltage in the high state is about 8.5 volts with respect to the negative rail. In the low state the output voltage is approximately 1.8 volts. At a supply voltage of 5 volts the high and low output voltages are about 4.5 and 1.8 respectively. Unfortunately, these voltages prevent the latch from being compatible with t.t.l. The input voltage must not be taken positive of the positive supply rail or negative of the negative rail.

RESISTOR VALUES

A useful feature of the latch is that resistor values are not at all critical. If R1 and R2 have equal values, the latch will always trigger at input voltages positive and negative of the mid-supply voltage. Should R1 and R2 be given different values, triggering occurs at input voltages positive and negative of the voltage at their junction. R3 is necessary to isolate the relatively low impedance i.c. output from the input. The values of 10k Ω shown in Fig. 1 for the three resistors should meet most requirements.

The output of the latch may be employed to drive switching transistors and the like. The 741 is proof against output short-circuits and it is probably desirable to limit practical output current to a maximum of around 5mA, either positive or negative.,

If a fourth resistor is added in series with the non-inverting input of the i.c., the latch exhibits hysteresis. This resistor is shown as R4 in Fig. 2, and it can have a value equal to that of R3 or less. Let us assume that R4 is equal to 10k Ω and that the output is in the high state. With a 9 volt supply the output is then at 8.5 volts. R4 and R3 form a potential divider and the output will only swing low when their junction just goes negative of mid-supply voltage, with about 4 volts dropped across R3 and the same voltage dropped across R4. Thus, the output triggers low when the input is approximately 0.5 volt positive of the negative rail.

To take the output high again a voltage of 2.7 volts (4.5 minus 1.8 volts) has to appear across R3 and across R4, whereupon triggering occurs when the input is about 7.2 volts positive of the negative rail. Summing up, the input hysteresis in Fig. 2 when R4 is equal to 10k Ω is in the range 0.5 to 7.2 volts. (In practice the range may be a little less than this as the calculations assume that the output voltages of 8.5 and 1.8 volts are maintained despite current drawn via R3 and R4.) Lower values in R4 will produce correspondingly narrower hysteresis ranges. ■

Radio Topics

By Recorder

★★★★★★★★★★★★★

Somewhat to my surprise the pun has returned to popular favour as a form of humour. Once more the dreaded phrases, re-emerging from the '30s, "Knock, Knock," and "Who's there?" are heard throughout the land.

Radio and electronics have always produced their own crop of more or less excruciating plays on words, but I did hear two the other day which didn't make me wince quite as much as usual.

If a circuit designer uses three integrated circuits where one would be sufficient the result can be described as an "i.c. waste" (icy waste).

Or, a schoolmaster's mortarboard and gown (do any wear them these days?) may be referred to as a "Sir kit" (circuit).

After which we shall proceed hastily to the next subject.

DOPPLER SHIFT

I am indebted to reader Mark Knight of Shooters Hill, SE18, for the following notes on Doppler shift.

The Doppler shift, i.e. change in frequency observed when a source of sound, or the hearer, moves, is given as

$$\frac{V}{V \pm v1}$$

when the source moves, and

$$\frac{V \pm v2}{V}$$

when the observer moves. V is the velocity of sound, v1 is the velocity of the source and v2 the velocity of the observer. In the first formula the sign is minus when the source approaches the observer and plus when it recedes. In the second formula the sign is minus when the observer recedes and plus when he approaches. Here come the questions.

1. If motion is relative, why are the formulae different?
2. What is the formula if both move?
3. What happens if v2 is equal to V? (There are two solutions, one for approaching and one for receding.)
4. What happens if v1 is equal to V? (Again there are two solutions.) Remember that it is possible these days to move at the speed of sound!

Now for the answers.

The answer to question 1 is that the motion of the source of sound or the observer is relative to the medium of transmission, normally the atmosphere, in which V is constant (for any given temperature).

Turning to question 2, the formula when both move is

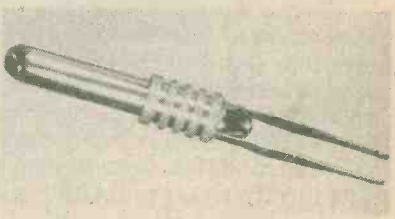
$$\frac{V \pm v2}{V \pm v1}$$

Question 3 splits up into two parts. If the observer approaches the source at the velocity of sound the frequency is doubled (this is obvious from simple substitution in the formula). And if the observer recedes at velocity V he never hears the sound — it cannot overtake him! Substitution in the formula gives the frequency as zero.

Finally, question 4 asks what happens if v1 is equal to V. If the source of sound is receding the frequency is halved (again given by substitution in the formula). But if the source of sound approaches at velocity V the result (shades of Concorde) is a loud bang! The frequency, in theory, is infinity.

THE TWEEZER-LITE

The device shown in the photograph is the "Tweezer-Lite", a product which has



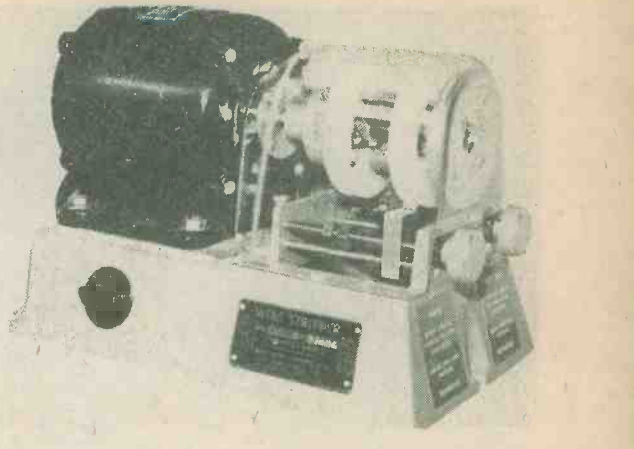
The Tweezer-Lite. The handle contains a battery and bulb which, when lit, provides pin-point illumination at the tweezer tips. Originally conceived in America as a beauty aid, the Tweezer-Lite has found many applications in medical work and in engineering where small objects need to be handled with precision.

achieved remarkable success in the United States where it originated. It is now being marketed in the British Isles by a new company, Tweezer-Lite (U.K.), 3 Cheltenham Road, Gloucester.

The tweezers themselves consist of top grade surgical stainless steel with precision tips capable of holding extremely small objects, and they are attached to a hollow handle containing a battery and bulb. The handle is twisted to light the bulb and provide pin-point illumination at the tweezer tips.

The Tweezer-Lite was designed primarily as a beauty aid, for plucking eyebrows, fixing false eyelashes and removing unwanted hair, etc., with a precision not possible with ordinary tweezers. It has now, however, graduated to applications far removed from its original concept. It is, for instance, valuable for doctors attending night road accidents, who find it ideal for swabbing and removing splinters of glass from wounds. It can also be an important addition to the instrument bag of veterinary surgeons.

The tweezers safely hold the minute screws and wires used in electronic equipment, particularly where instant light is needed in concealed or awkward areas. Philatelists, model-makers, watchmakers and jewellers are finding it an increasingly valuable tool. The Tweezer-Lite can now be bought over the counter at Selfridges and Harrods (House of Fraser).



The Rush Model C100 centrifugal wire stripping and twisting machine. Not only does this strip the insulation off wire ends, it also twists together the strands of multi-strand wire

WIRE STRIPPER

The second photograph illustrates the Rush Model C100 centrifugal wire stripping and twisting machine. This is now available from Fraser International Limited, 2/3 Hampton Court Parade, East Molesey, Surrey, KT8 9HB.

The Model C100 machine is designed for removing all types of extruded insulation from solid and stranded wires. It was especially designed for removing tough p.t.f.e. insulations, but is equally effective with nylon, p.v.c., neoprene, rubber, braided cotton, or any other insulations. The bench mounted machine strips insulation from wire and neatly twists strands of stranded conductors for wire sizes from 0.71mm. to 5.72mm.

Stripping is effected by simply inserting the wire into the front of the machine until the strip length stop is felt. The wire is then withdrawn, with its conductors neatly stripped and twisted. There are no levers or pedals to be operated.

The Model C100 is ideal for production line stripping and all adjustments can be made whilst the machine is running, without removing any covers or safety guards.

HEADPHONE PHASING

Our contributor, Sir Douglas Hall, has been carrying out some interesting experiments with headphone phasing recently. We are all used to listening to headphones which are connected in phase and are coupled to a mono musical signal. Can we detect any difference if we reverse the connections to one of the headphones so that they are working out of phase?

Apparently, the ability to detect a difference varies from person to person. The experiement is qute easy to set up. You wire up a pair of headphones with a switch which can reverse the polarity of one headphone; the headphones are then connected to a mono music signal and the switch operated a number of times so that instant comparisons between the two modes of operation can be made. Generally, the effect with the headphones out of phase is an indefinable change of tonal quality, but the out of phase condition is still quite acceptable. A listener with a trained musical ear may, however, find out of phase operation distasteful.

It would probably be best to employ headphones offering reasonably good quality rather than the more inexpensive magnetic diaphragm types for the experiment.

PRINTED BOARD COATING

Of interest to those constructors who prepare their own printed circuit boards is a recently developed product which protects the board after etching and cleaning, and assists in soldering. The product is "Circosol", a low viscosity liquid intended for painting on the board.

Apart from the artwork, staining of the freshly etched and cleaned copper surface can be a major problem with home produced printed circuit boards. A clean copper surface is essential for easy soldering, but this is highly susceptible to chemical attack by perspiration and salts from fingerprints. The copper "soaps" formed are a positive hindrance and a badly stained board becomes difficult to "wet" by the molten solder, leading to dry joints. It is also necessary to apply the soldering iron for a longer time, with a consequent risk of component fatigue or failure due to excessive heating.

If Circosol is applied to the board immediately after etching and cleaning, the board is protected by a hard coat and can be handled without the risk of fingerprints. The clean copper surface is therefore preserved. Due to its chemical nature, the coating also improves the affinity of the copper surface for solder and greatly increases wetability. The copper tracks on the finished board remain bright and shiny, giving a permanent professional finish. The Circosol coat can be soldered through at a later date should component addition be necessary, for example when repairing or prototyping.

Circosol can be obtained direct from Audio Services (Warrington), 13 Hale Street, Warrington, Cheshire, WA2 7BU.

CONSTANT CURRENT I.C.

A constant current i.c. with a difference is announced by SGS-ATES. This is the TDA 1251, and its function is not to provide a constant current but to ensure that a constant current is drawn from a supply.

In modern solid-state television sets it is common practice to provide power for various sections of the receiver from taps in the line output transformer, the voltages from these taps being rectified and smoothed with conventional circuits. A problem arises when the receiver section which is so powered is an a.f. amplifier incorporating a Class B output stage. The current demand with such a stage can vary from a few milliamps to more than 0.5 amp, according to the level of the sound output signal. These changes in current can cause variations in the width of the picture.

The SGS-ATES i.c. type TDA 1251 can be interposed between the supply voltage derived from the line output transformer and the a.f. amplifier, and it ensures that the current drawn from the line output transformer remains constant. The TDA 1251 is supplied in a 3 pin package, and it operates by diverting to chassis the current which is not drawn by the a.f. amplifier, thereby maintaining a constant total current consumption.

The i.c. has a maximum supply voltage rating of 30 volts and an output current capability of 0.6 amp. Typical load regulation is within 0.01 per cent per milliamp, for output currents ranging from 0.025 to 0.6 amp. ■

THE LARGEST "MOBILE" OPERATION OF ALL TIME

By Ron Ham

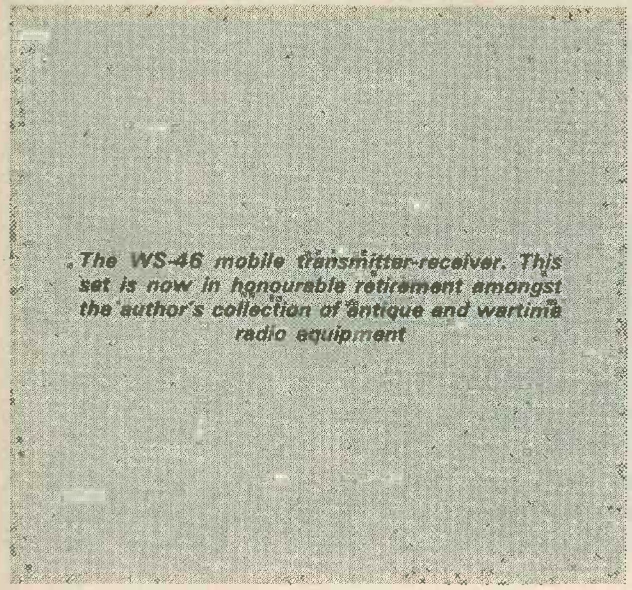
It is now more than three decades since the Allied invasion of Europe on D-Day. Particularly instrumental in the success of this operation were the wireless transmitters and receivers used by the Army, and this article describes the all-valve equipment which was employed at that time.

Like many other RSGB members, the author is a civilian wireless instructor with the Air Training Corps, in which mobile radio plays an important part in a squadron's training programme. It is so easy for us, more than three decades after D-Day, to go on exercise with a transmitter and receiver installed in our motor vehicles; we no longer have to consider bulky vibrator packs or rotary transformers to provide the high tension supply for our equipment, nor do we have to produce an abundance of *amps* to heat our valves. All of these problems have gone because of the advent of the transistor, and as we use our Bantams, Cambridges and Westminsters, or look through the advertisements in our journals and see the exotic mobile equipment on sale today, we must remember that it was not always like this.

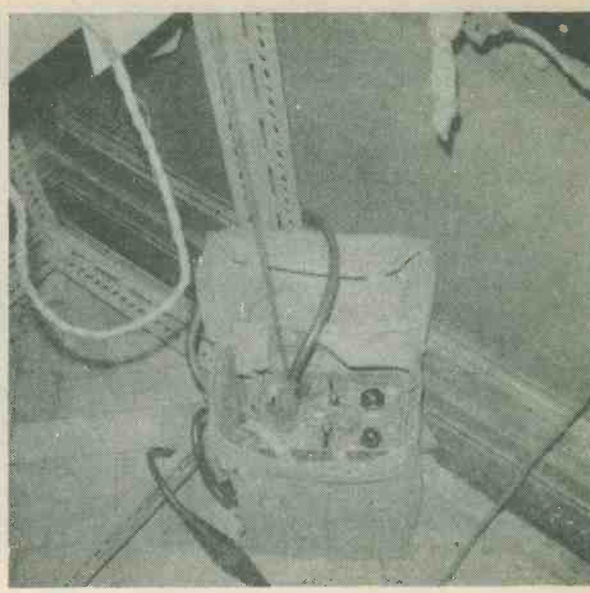
Thirty-three years ago, the Southern Counties were involved with the great invasion force which left the United Kingdom for Normandy on June 6th, 1944. Like the rest of the operation, the communications for the D-Day landings were carefully planned, and this rough, tough, job for both men and equipment must have been the largest combination of "mobile" radio systems ever used.

WIRELESS TO WAR

When wireless went to war in 1939, the radio industry answered the Government's call for specialised items of radio equipment to be carried by the foot soldier, concealed by underground agents and installed in a variety of fighting vehicles. Many of these wartime pieces have sur-



The WS-46 mobile transmitter-receiver. This set is now in honourable retirement amongst the author's collection of antique and wartime radio equipment



vived the passage of time and are now in the hands of collectors. Some are still in a usable condition.

Amongst the communications equipment which the Army took across the Channel were Wireless Sets Nos. 18, 38 and 46, all of which were powered by dry batteries. Each was simple to operate and designed to be carried by a fighting soldier.

A typical example of simplicity was the WS-38 which had two control knobs, one clearly marked for setting both the receiver and transmitter to any frequency between 6 and 9 MHz and the other for on-off, send and receive. The user carried the set in a harness at breast level together with a small signals satchel which contained batteries, junction box, special headphones for wearing under a steel helmet, throat microphones and a case of five spare valves (four type ARP12 and one type ATP4). The single rod aerial, which plugged into the top of the set, was carried in a 4 foot by 2 inch sling bag over the shoulder.

BACK-PACK SETS

The WS-38 measured 9 by 7 by 4 inches and used the same range of valves as the famous WS-18 pack-set, which measured 18 by 10 by 8in., and the WS-46 pack-set designed for the Commandos. The "Eighteen" set had separate transmitter and receiver units, both tunable through 6 to 9 MHz, and could be used to send both phone and c.w. signals. The battery was housed in the bottom of the set, and the standard headphones, hand microphone, case of spare valves and morse key, which could be attached to the operator's leg, were also carried in a signals satchel. The WS-46, measuring 12 by 6 by 4 inches had three fixed channels and required a pair of 10XJ crystals to select the transmit and receive frequencies. The set, battery, two pairs of headphones (under-helmet types) with throat microphones attached, and spare valves were all packed in a special haversack, which could be carried on a man's back. A selection of short aerial rods which could be fitted together as required were used for both the WS-18 and WS-46.

VEHICLE SETS

All of these sets could communicate with the mighty WS-19 which was almost as robust as the tank or armoured car in which it was used. This famous transmitter-receiver could be tuned from 2 to 8 MHz and incorporated an intercom amplifier for the tank crew. A special feature of this set, which was years ahead of its time, was the 235MHz v.h.f. transceiver section used for "private" tank-to-tank conversation. Like many other wartime sets the WS-19 used international octal valves (6K7 type) throughout its receiver, amplifier and modulator section. A single CV6 triode was used in the v.h.f. section and an 807 type valve in the p.a. stage of the h.f. transmitter. The latter WS-19 sets were made in Canada, and most of their dial markings were enscribed in both English and Russian.

INSTALLATION IN A VEHICLE

In a very short time problems, such as the suppression of radio interference generated by the engine, shock-proof installation of the set inside the vehicle and the flexible mounting of the aerial were overcome, and many of these wartime developments can be seen in use today. Similar problems were experienced when radio equipment was installed in both aircraft and ships.

The expected life of wartime radio equipment was very limited, yet the careful design and the high quality components and workmanship which went into military equipment will stand as a monument to one of the finest achievments of the radio industry. ■

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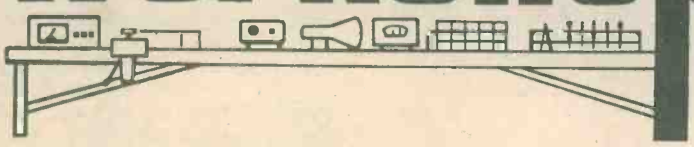
In your workshop



Once again, Dick is able to steer Smithy the Serviceman away from his normal duties in order to expla n some of the mysteries of his trade. On this occasion Smithy deals with a few of the more common misconceptions which arise in electronics and radio.

With a flourish of triumph Dick switched on the a.m.-f.m. radio on his bench and pulled up its telescopic aerial. He tuned through the f.m. band, whereupon the three B.B.C. signals and the local f.m. station were reproduced at good strength and with more than acceptable quality. He selected medium waves and was again able to tune in to a good quantity of signals. Finally, he set the receiver to long waves and brought in the BBC2 signal on 1,500 metres.

"Another job done," he boasted. "That's my fifth successful repair of the morning. I'll be making you redundant yet, Smithy!"

The long-suffering Serviceman sighed and pressed on with tracing the intermittently missing i.f. signal in the colour television chassis on his bench. He had long ago given up trying to explain to his assistant that he purposely chose the sets with the most difficult faults, each of which be looked upon as a challenge to his abilities. Either through luck or design, Dick always managed to land the easy jobs.

FERRITE ROD DIRECTIVITY

Idly, Dick turned round the receiver cabinet so that it was oriented through a full circle. The sound dropped to a low level as he passed through the two nulls given by its internal ferrite rod aerial. (Fig. 1.)

"D'you know, Smithy," he went on chattily, "you'd never get lost if you had a transistor radio! All you'd need to do is to use its ferrite rod aerial as a direction finding aerial. Find the angles of two transmitters of known location and then draw the corresponding lines on a map going through the stations. You'd be where the lines cross each other!"

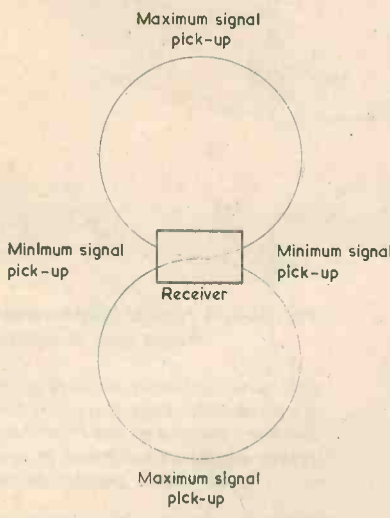


Fig. 1. The signal pick-up pattern of an a.m. radio receiver having a ferrite rod aerial

Despite himself, Smithy was intrigued by the vision of an intrepid Dick trail-blazing through the much signposted wastes of rural England, constantly monitoring his position with the aid of a transistor radio.

"Well," he remarked, "the signals from most medium and long wave stations get bent a bit if you're any real distance from them. Also, when you've found the angle at which you're receiving the signal you still don't know which end of the receiver ferrite rod is pointing at the direction from which the signal is coming. Both these effects could lead you into error."

A thunderstruck expression passed over Dick's face.

"Don't tell me," he remarked incredulously, "that you would work to the principle that the ferrite rod should *point* at the signal."

"I would," returned Smithy imperturbably.

"Then," said Dick gleefully, "I have at long last caught you out on a really gi-normous technical clanger. You're making the assumption that you rotate a direction finding aerial for *maximum* signal strength just like they do in the old spy movies. Now if you had the technical background that an engineer like myself has you'd know that you rotate a direction finding aerial for *minimum* signal strength. And why? Because the angle over which you get minimum signal strength is very much sharper than the angle over which you get maximum signal strength."

"I know," replied Smithy shortly. "That's exactly what I meant."

"But," protested Dick, "if you point the rod of a ferrite rod aerial at the source of a signal you get maximum pick-up."

"You don't, you know," snorted Smithy, turning off the colour television chassis on his bench. "You get minimum signal strength."

"I don't believe it!"

Wrathfully, Smithy took his pen from his pocket, pulled his note-pad towards him and beckoned towards his assistant.

"Come over here and I'll show you."

Dutifully, Dick walked over to Smithy's bench. The Serviceman was already scribbling out a sketch on his pad.

"Do you," asked Smithy, "remember the old frame aerials they used to have in medium and long wave portable radios before ferrite rod aerials came in?'

"Just about," replied Dick. "One of my aunts had an ancient old portable she'd bought just before the war that had a frame aerial inside it."

Smithy's irritation with his assistant diminished. There could be nothing but commiseration for a person who had such a vast number of aunts as had Dick.

"Well, fair enough," he remarked. "If your memory serves you correctly you will remember that these old frame aerials were normally wound on a rectangular wooden or insulated frame which was as large as the dimensions of the receiver cabinet would allow. A medium wave frame aerial would consist of something like ten turns of thickish enamelled wire of around s.w.g. wound side by side on such a frame."

Smithy indicated the sketch in his note-pad. (Fig. 2(a).)

"Now," he continued, "these frame aerials provided the tuned signal inductance for the receiver and had one section of the receiver 2-gang or 3-gang tuning capacitor connected across them. They worked by reason of the fact that, if they were in line with the incoming signal the signal hit the nearer side of the aerial very slightly before the further side, with the result that there was a very small phase difference in the signal voltages on the opposite sections of the frame. This phase difference meant that the signal voltages on the two frame sections were also slightly different, and so a signal voltage was induced in the turns of the aerial, causing a signal current to flow. Not a very high signal voltage admittedly but, combined with the fact that the frame was resonant at signal frequency, sufficient to give adequate signal pick-up in practice." (Fig. 2(b).)

"I should imagine," remarked Dick tentatively, "that the signal pick-up would at any rate be greater than you'd get with, say, a flat metal plate of the same area as the frame aerial."

"It would be quite a lot greater," confirmed Smithy. "If we rotate the frame so that it is broadside on to the incoming signal, the pick-up drops virtually to zero. This is because the signal has the same phase when it hits *all* the turns of the frame aerial. They are in consequence all at the same signal voltage and so no signal current flows. This gives the null position for the frame aerial. Incidentally, it also gives the null position for any loop aerial, apart from the frame aerials that were used in those old portable radios." (Fig. 2(c).)

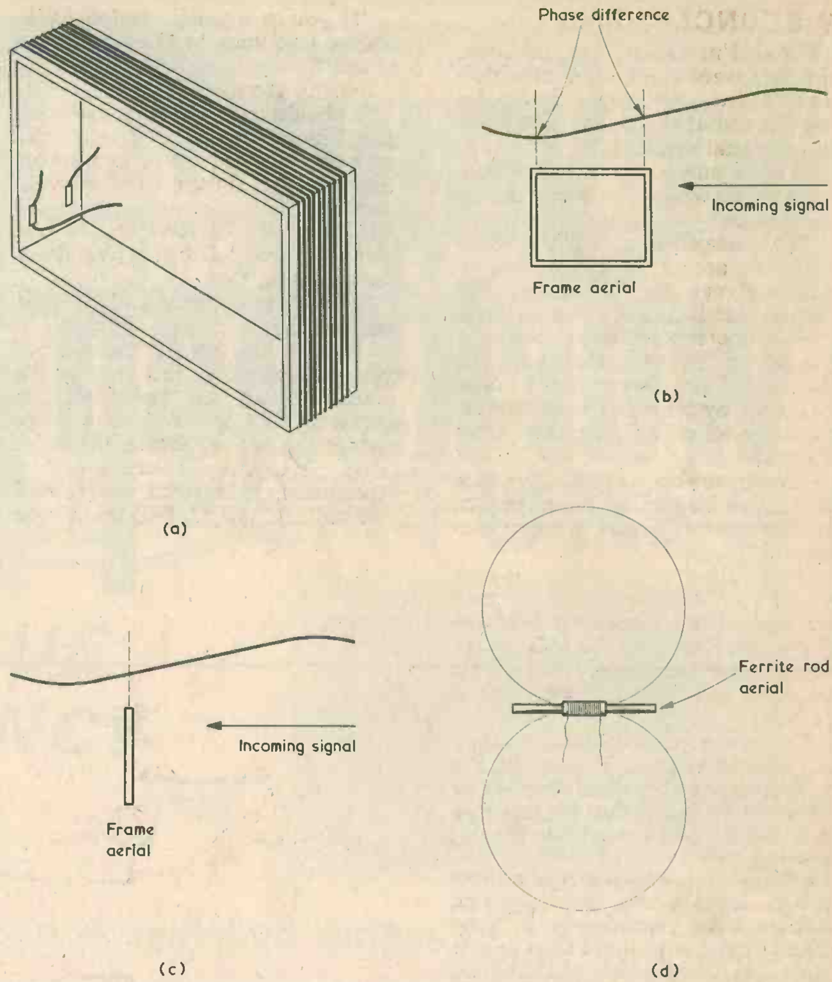


Fig. 2(a). A typical frame aerial. The aerial is wound on a wooden frame and is resonant at signal frequency

(b). When a frame aerial is in line with the incoming signal there is a phase difference between the signals induced in the nearer and further sections of the frame aerial. The phase difference is shown highly exaggerated here; in practice the signal wavelength would be much greater in relation to the aerial width

(c). When the frame aerial is broadside on to the signal there is no phase difference in the signal voltages picked up in its sections and the aerial is in the null position. Again, signal wavelength is shown greatly reduced

(d). The polar response of a ferrite rod aerial. Contrary to popular belief the nulls are given when the rod points at the source of signal

"I can see all that," stated Dick, "but how does this tie in with ferrite rod aerials?"

"Because," stated Smithy, "a ferrite rod aerial is a frame aerial with all the inductance concentrated in a small volume. The high permeability of the ferrite rod distorts the magnetic part of the incoming signal such that there is a greater magnetic signal flux in the rod than there would be in air. But otherwise the ferrite rod aerial behaves just like the frame aerial it replaces. Signal input is at a null when the coil is broadside onto the signal or, in other words, when the rod is pointing at the signal." (Fig. 2(d).)

MISCONCEPTIONS

"Well, I'm dashed," stated Dick. "So you were right after all. Blow me, I'd always thought that pointing the rod at the signal gave maximum signal strength."

"That's one of quite a few misconceptions which you bump into in electronics."

"You mean there are others?"

"There are quite a few. For instance, a very common misconception is that if you have a moving-coil voltmeter connected across a resistor of known value you can always tell the power the resistor dissipates by reading the voltage indicated and calculating the power figure."

"Come on, Smithy! The voltage reading is bound to allow you to work out what power is being dissipated."

"Not always it isn't," stated Smithy. "What's more, I can arrange a little demonstration. See if you can find me a 6.3 volt heater transformer and three 4.7 Ω 2 watt resistors and then I'll give you a surprise."

Dick went to the spares cupboard and delved around, looking for the transformer and the resistors. As he returned, he found that Smithy had also been getting a few items together.

"What I have here," proclaimed the Serviceman, "is a 6 volt 0.06 amp pilot lamp screwed into a bulb holder. Also, a common or garden 3 volt battery. This happens to be an Ever Ready No. 800 which has been knocking around, but any other 3 volt battery would do. I'm going to connect the battery and the pilot lamp in series and then add a couple of crocodile clip leads at the outside ends. Whilst I'm doing that, perhaps you could solder those three resistors in series across the secondary of that transformer. Just use mid-air joints with the outside resistor ends soldered to the transformer tags. Oh, and connect a mains lead to the primary."

"Okey-doke," said Dick obligingly.

There was silence for a few moments as the pair worked at their respective tasks.

"Did you," asked Dick brightly, as he soldered two 4.7 Ω resistors in series, "hear the story about the wolf who strayed onto the railway line?"

"I don't think I did," said Smithy, engrossed.

"Well, it walked onto the lines just as a train came along. In fact, it nearly got clear but the train ran over the tip of its tail and cut it off."

"So?"

"The poor wolf, in panic, looked back towards its tail and the wheels next went over its neck."

"What a horrible story! What on earth did you tell me that for?"

"It points out a moral."

"What moral?"

"If you're a wolf," stated Dick, "never lose your head over a piece of tail!"

Smithy groaned.

"I should have known what to expect," he complained. "Your stories get worse and worse as time goes by. How are you getting on with those resistors?"

"I've just finished connecting them up," said Dick, laying down the soldering iron.

"Good," said Smithy. "We'll get started, then."

He took the heater transformer and connected its primary to the mains. Next, he switched his testmeter to a low d.c. volts range and connected it across the pilot lamp. He then took the two crocodile clips from the lamp and 3 volt battery and clipped them both to one of the heater transformer secondary tags. The bulb glowed weakly. (Fig. 3(a).)

"There's nothing very startling there," commented Dick disparagingly. "All you're doing is applying 3 volts to a 6 volt bulb."

"I wouldn't argue with that," responded Smithy equably. "Anyway, what does the testmeter say?"

Dick glanced carelessly at the meter.

"It's indicating 3 volts," he stated. "What else could it show?"

Smithy removed one of the crocodile clips and connected it to the adjacent junction of two 4.7 Ω resistors. The lamp now shone with markedly increased brightness. (Fig. 3(b).)

"Humph," grunted Dick

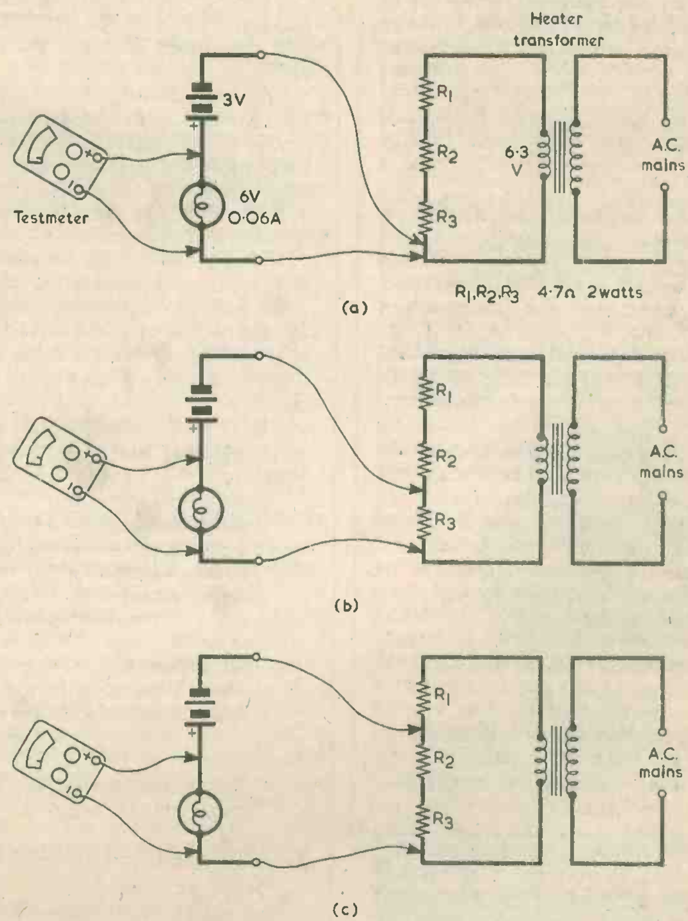


Fig. 3 (a). Smithy initially connected up the components for his demonstration in the manner shown here. The heater transformer can have a secondary current rating of 0.5 amp or more

(b). Smithy next inserted the alternating voltage appearing across R3 in series with the battery and the bulb

(c). Finally, Smithy caused the voltage across two of the resistors to be connected in series

cautiously. "The lamp must obviously be glowing brighter now because you've got 3 volts d.c. and something like 2.1 volts a.c. across it."

"Take another look at that meter."

Dick looked casually over at the meter scale. An expression of disbelief came over his face and he leaned over to look at it more closely. Suspiciously, he checked to ensure that the testmeter leads were connected correctly across the pilot lamp. Then he scowled distractedly and scratched his head.

"May I presume," probed Smithy gently, "that something ails you?"

"Too true you can presume it," replied Dick unhappily. "In fact, something's ailing me no end."

He glared down at the testmeter.

"That darned meter," he continued, "is still reading 3 volts!"

"Well I never did," said Smithy mildly. "Let's move that crocodile clip one more step up the resistor chain."

He removed the clip and reconnected it at the next junction of two 4.7 Ω resistors. This time the little pilot lamp glowed much more brightly again. (Fig. 3(c).)

Reluctantly, Dick forced himself to look at the meter.

"Hell's teeth," he moaned, "it's *still* reading 3 volts. Stap me, each time you move that crocodile clip the lamp gets brighter but the meter still goes on showing 3 volts. How on earth do you manage that, Smithy?"

"It's just," responded Smithy modestly, "a little electronic jugglery."

"Jugglery?"

"That's right. A more apt term might, perhaps, be legerdemain. Or, if you like, thaumaturgy."

"Hey," protested Dick. "Not only am I out of my depth in electronics with this thing but I'm rapidly getting out of my depth in English!"

"A pity," purred Smithy. "I was about to describe those 3 volt readings as an example of simple scientific prestidigitation."

CONSTANT READINGS

"Hold it," said Dick quickly. "Just hold it right there, Smithy. A young lad like me can undergo traumatic damage when confronted with unexplained mysteries like this. Just tell me why the meter still reads 3 volts despite the fact that the current through the bulb is obviously going up."

"The reason for that constant reading," explained Smithy, "is that a moving-coil voltmeter reads average voltage. When I had the two crocodile clips connected together there was 3 volts d.c. applied to the bulb, which the meter read correctly. But when I moved one clip to the first resistor junction there was 2.1 volts a.c. from the transformer secondary applied to the bulb in series with the battery. This is 2.1 volts r.m.s. or nearly 3 volts peak, and if we draw the consequent waveform across the bulb we get something like this."

Smithy picked up his pen and sketched out the waveform. (Fig. 4.)

"On one set of half-cycles," he resumed, "the alternating voltage adds to the 3 volts from the battery and takes the waveform up to nearly 6 volts maximum. And on the other set of half-cycles the alternating voltage subtracts from the battery 3 volts and takes the voltage down to a minimum just above zero. The average value of the waveform is still 3 volts, though, and that's what the voltmeter indicated."

"If the average voltage remains the same," queried Dick, scratching his head, "why did the bulb get brighter?"

"Because there are two lots of current going through it," stated Smithy. "There's the direct current from the battery and the alternating current resulting from the 2.1 volts a.c. which is added to it. What you have to remember is that both these currents cause a heating effect even though the alternating voltage isn't indicated by the voltmeter."

"I don't understand it. I've actually seen it happen with my own eyes but I still don't get it!"

"Let's assume," said Smithy, "that we simply applied 6.3 volts at 50Hz to the bulb. If we connected a moving-coil voltmeter across the bulb, what would it read?"

"I suppose," said Dick slowly, "it would read zero."

"Exactly," responded Smithy. "It would be reading zero because that's the average value of the alter-

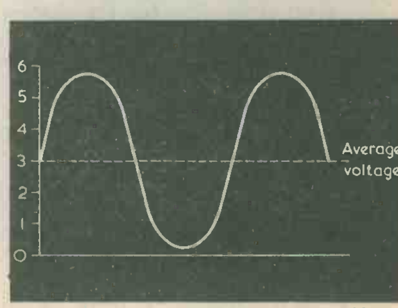


Fig. 4. Waveform given when the alternating voltage across R3 is connected in series with the battery and the bulb. The average voltage is 3 volts. The average voltage is also 3 volts when the alternating voltage across R2 and R3 is similarly inserted.

nating voltage. If the frequency of the alternating voltage were reduced from the 50Hz mains frequency down to something around 5Hz we would very probably get a movement in the meter needle. It would jiggle back and forth in time with the frequency of the alternating voltage, but the jiggling would still be centred on zero."

"I think," said Dick slowly, "that I'm beginning to get with this at long last. To take things a bit further, in the case of the 50Hz alternating voltage the moving-coil meter would read zero as you say, but there'd nevertheless be a heating effect in its coil and in its internal series resistor."

"Now you're getting nearer to the truth," remarked Smithy approvingly. "If you remember that the meter reads zero when only alternating voltage is applied to it, you can more readily understand why it reads 3 volts when a 3 volt battery is put in series with the alternating voltage."

"Yes, I understand that now," replied Dick. "When you start off with alternating voltage and *then* add a direct voltage, the reason for the meter reading becomes more obvious. Trust you, Smithy, to be crafty and do it the hard way by starting off with direct voltage."

"I just wanted to demonstrate," chuckled Smithy, "that you shouldn't always take moving-coil meter readings at their face value, particularly when there are alternating voltages wandering around. That little experiment also explains why resistors in some circuits cook up a lot more than you'd expect. If, for instance, you have a smoothing resistor in a mains power supply, that resistor could dissipate more heat than you would think from just a moving-coil meter reading of the voltage dropped across it. Not only does a direct current flow through the resistor but so also does what can be quite a sizeable alternating ripple current." (Fig. 5.)

"That clears up another little mystery."

"What's that?"

"Why the smoothing resistors in the older valve TV sets used to have such high wattages," replied Dick.

"I used to look upon that as just one of the inexplicable facts of electronic life, but I can now begin to see why it makes sense. Now there's another thing."

"Yes?"

"You were talking just now about the r.m.s. value of the alternating voltage. I know that the r.m.s. value of a sine wave is 0.707 times its peak value, but I've never understood this really. Why do we have to bother about r.m.s. values? Why not stick to nice easy things like peak values and forget all about the r.m.s. business. So far as I can see, it only confuses things!"

R.M.S. VALUES

"You're now approaching another popular misconception," stated Smithy. "Lots of people seem to think that the r.m.s. value of an alternating sine wave is just something engineers dream up to make life more difficult. It's nothing of the sort. The r.m.s. value of an alternating voltage defines its *heating* effect, as compared with a direct voltage. Going back to those old days when portable radios had frame aerials, quite a number of houses in the U.K. were supplied by d.c. instead of a.c. mains. Gradually, the old-fashioned d.c. supplies were taken out of the system until, eventually, all the domestic supplies in the U.K. were a.c."

"Then," put in Dick quickly, "we're in advance of America."

"What on earth do you mean?" said Smithy irritably. "All of America must surely be on a.c. mains."

"There's one place that isn't."

"Where's that?"

"Washington," stated Dick. "Washington's D.C."

Smithy turned an exasperated glare at his assistant's grinning face.

"Will you stop *doing* that? Now I've forgotten where I'd got to."

"You were talking about old houses being on d.c. mains."

"Oh yes, so I was. To resume, let's say that you're in a house which is on 240 volt d.c. mains. This means that the filaments of all the light bulbs in your house are heated to the correct temperature by the

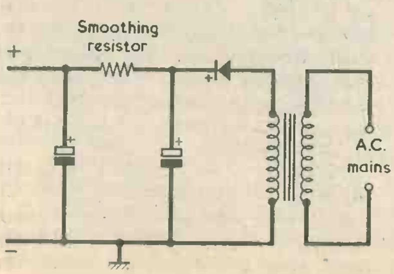
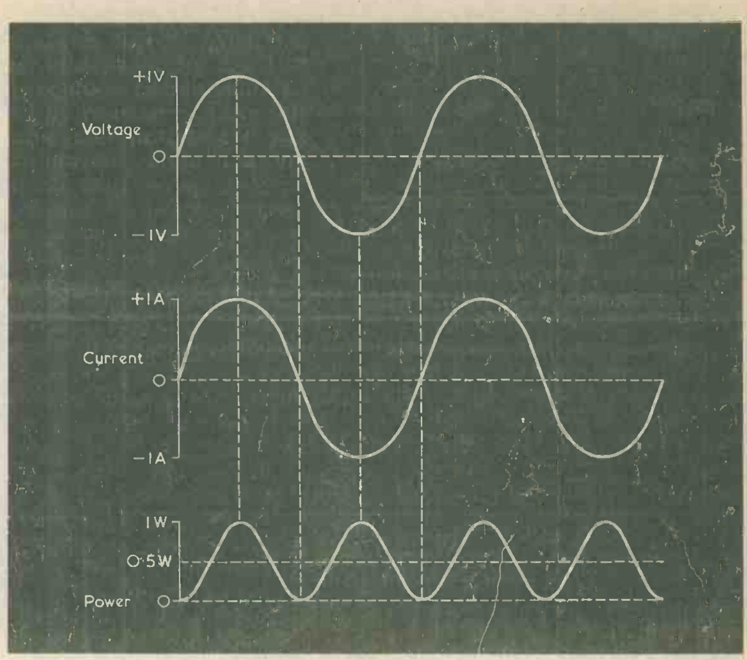


Fig. 5. The power dissipated in a power supply smoothing resistor is given by the direct current and the ripple current which passes through it

Fig. 6. The voltage and current waveforms when an alternating voltage of 1 volt peak is applied across a 1 Ω resistor. The lowest waveform shows the power dissipated in the resistor



240 volt d.c. supply. The most important job of the electricity supply is to provide light and so if we change the supply over to a.c. we want to choose a supply amplitude which similarly causes the filaments to be heated to the right temperature. This is given if we supply a.c. with an r.m.s. value of 240 volts. So far as his electric lights are concerned, a house-owner will be in just the same position with 240 volts r.m.s. alternating as he was with 240 volts direct."

"His electric fires will be the same too, of course."

"That's right."

"That seems sensible enough," said Dick judicially, "but it still doesn't explain the 0.707 business."

"I will agree," admitted Smithy, "that that's a bit harder. But it's not too difficult if we take an example with easy numbers in it, and it's simpler if we work from peak volts down to r.m.s. volts. We can kick off by assuming that we have a sinusoidal alternating voltage of 1 volt peak and that we apply it across a resistance of 1 Ω. The current which flows in that resistor is then 1 amp peak. Let's draw out the voltage and current waveforms."

Smithy picked up his pen and carefully sketched the waveforms.

"We'll add below these," he went on, "the waveform for the power dissipated as heat in the resistor. Since 1 volt multiplied by 1 amp is 1 watt, this waveform will have a peak value of 1 watt."

Smithy added the waveform. (Fig. 6.)

"There's something interesting here," said Dick. "Whereas the voltage and current cycles go negative for half the time the power waveform is always positive. Apart from the zero points, of course."

"That," confirmed Smithy, "is to be expected. The 1 Ω resistor will still dissipate power as heat regardless of the polarity of the voltage across it or the direction of the current flowing through it. Now, by inspection, the power waveform is symmetrical about a line drawn at 0.5 watt level so that, whilst the instantaneous power varies from zero to 1 watt, the average long-term power is 0.5 watt. And so we have arrived at the conclusion that applying 1 volt peak to a 1 Ω resistor causes the power dissipated as heat to be 0.5 watt. Now, power is equal to voltage squared divided by resistance and if it were a direct voltage heating the resistor we would say that the voltage squared, divided by 1 Ω, gave 0.5 watt. It follows from this that the voltage is equal to the square root of 0.5. And *that* is equal to 0.707!"

"Blimey," gasped Dick. "You got there pretty fast, didn't you? Let's linger on this a bit. We're applying an alternating voltage of 1 volt peak to a resistance of 1 Ω and we find that it gives the same heating effect as a direct voltage of 0.707 volt. Since r.m.s. value applies to the heating effect of the alternating voltage, a voltage of 1 volt peak has an r.m.s. value of 0.707 volt."

"You've got it," said Smithy cheerfully. "You can follow the same route with current. With d.c. the power dissipated in the 1 Ω resistor is equal to current squared multiplied by resistance. Take this through the same process and you find that the r.m.s. value of 1 amp peak is 0.707 amp."

LEGERDEMAIN

"Gosh," breathed Dick, "I never thought it would be that simple."

"We were using easy figures," stated Smithy. "If you follow the procedure with harder figures you still get the same answer. I should of course add, for completeness, that r.m.s. stands for 'root mean square'. If you want to indulge in a few further calculations in the reverse order you will find that the peak value of a sinusoidal alternating voltage or current is 1.414 times the r.m.s. value."

"1.414," mused Dick. "Why, that's exactly twice 0.707."

"It's also," stated Smithy, grinning, "the reciprocal of 0.707. *And* it's the square root of 2, whilst 0.707 is the square root of ½. Which represents, this time, a little mathematical legerdemain."

"Or — what was the word — thaumaturgy?"

'Thaumaturgy," concurred Smithy, "is a word which provides a good description. But there's an even better term."

"Prestidigitation?"

"Prestidigitation."

■

"Caution! — Radio Activity"

New Products

FLUKE INTRODUCES LOW-COST, POCKET-SIZED DMM

The Fluke International Corporation have introduced a new and revolutionary, low-cost, multi-function miniature digital multimeter, intended for use by both the professional engineer and the hobbyist.

Priced at £99, the Fluke Model 8020A digital multimeter features an extremely lightweight and attractive design, to withstand the rigours of frequent field use. It incorporates a 3½-digit liquid crystal display of ½ in. character height, and has the various function and range push-button selectors so arranged to allow one-handed operation by the user. A custom designed CMOS/LSI circuit provides analogue-to-digital conversion and display decoding and drive. Together, the use of the LSI circuit and LED help to ensure maximum battery life from the small 9V alkaline cell, which consequently gives up to 200 hours operation.

Standard features of the 8020A include autozero and autopolarity, and the instrument has a total of 26 ranges and six functions. These include ten voltage ranges, from 100μV to 1kV d.c. or 750V a.c. with a basic d.c. accuracy of ± 0.25%; six of resistance, from 100 milliohms to 20 megohms with a basic accuracy of ± 0.2%; three for diode test functions, of 2 kilohms, 200 kilohms and 20 megohms; and two conductance ranges.

With the inclusion of the diode test and conductance functions, the 8020A offers far more comprehensive capabilities than those normally associated with low cost, portable analogue or digital instrumentation.

In the case of the diode test function, for example, sufficient voltage is supplied to turn on a semiconductor junction, so that diodes and transistors can be tested for the correct forward bias voltage in situ. Individual paralleled resistors can also be checked, without the need to disconnect them from the circuit.

The 8020A is ideally suited to a wide range of user applications in both the professional and hobbyist fields.

DESOLDERING WICK

Tele-Production Tools Ltd., of Stiron House, Electric Avenue, Westcliff-on-Sea, Essex, manufacturer of soldering and desoldering tools, claims that the type 3S-Wick is the answer to the problems associated with desoldering, because it is vacuumised.

Manufactured by the Swiss Company, Ernest Spirig, the copper braid is de-oxydised and coated with several layers of flux and protection lacquers under vacuum.

This vacuum technique produces a capillary action between the molten solder and the wick, thereby removing the solder and leaving no corrosive residue — the wick contains practically no chlorines or halogenes. The wick is made with very soft chemicals resulting from a unique manufacturing technique.

Spirig wick is available in three standard sizes: AA for small joints; AB medium; and BB large. Each reel contains 5½ ft. of wick and is priced from 45 pence per reel.

VEROSPEED ALARM DEVICE

A miniature audible warning device for use on portable equipment and instrument front panels is now available from Verospeed. Designed to operate on a voltage range from 5 to 30 volts D.C., the device may also be used on A.C. up to 20 volts. A choice of two continuous signals, high or low frequency, is available from one unit, and solid state electronics ensure high reliability with minimum current consumption. The device is mounted via a single hole and is secured with a chromed lock ring. Verospeed guarantee same-day despatch on all orders received before 3 p.m.

Vero Electronics Limited, Industrial Estate, Chandler's Ford, Eastleigh, Hants.

RECENT TV

By Michael Lorant

THE "PHONOVID"

Scientists of the electro-optical research department of Westinghouse Electric Corporation in the United States have developed a sight-and-sound system, called "Phonovid", which reproduces monochrome television pictures from a phonograph record for educational purposes. In the system, sounds and pictures are recorded and played back electronically.

The record is not just an audio recording which triggers pictures from a slide projector. Both the audio signal and the video signal are present in the grooves of the record and both are picked up by the phonograph needle. Up to 400 still pictures and 40 minutes of voice and music are present on the two sides of a 12 inch l.p. recording, described as a "Videodisc". The pictures can be line drawings, charts, printed text or photographs. The quality of the accompanying sound is of high standard.

Phonovid thus provides a complete 400 page educational picture book on a single long-playing phonograph record. It is, in fact, a flexible, easy to operate and inexpensive audio-visual system for a great variety of educational applications, such as classroom instruction at elementary, secondary and commercial training, vocational training, and remedial instruction where repetition and opportunity for drill are essential.

Phonovid may also employ tape instead of a record, and a standard reel of audio tape holds no less than 1,200 pictures with accompanying sound. The use of tape and a television camera enables any programme to be prepared. Here the system is demonstrated by Dr. S. W. Herwald, head of Westinghouse electronic components and speciality products group

The Phonovid system in operation. Both the turntable and the television receiver are conventional, the information on the Videodisc being stored in an electronic memory which builds up a complete still picture in six seconds. A following picture is built up in the memory while the displayed picture is being shown. The disc also provides simultaneous high quality sound.

The recording is played on an ordinary turntable and the pictures and sound appear on any number of television receivers in a classroom or throughout an entire school building. Any part of the recording can be held, skipped or repeated by manually lifting the tone arm. During interruption of the sound, the picture continues to appear on the television screen, allowing discussion, emphasis or interruption of the learning material. The whole operation is no more complicated than playing a record on a hi-fi set at home.

Phonovid uses an inherently low cost high density storage medium, the long playing record, in which a large concentration of information can be stored conveniently and in a small space. Existing audio and TV equipment is compatible with the system. Without modification, Phonovid can be integrated into existing closed-circuit and standard broadcast TV systems. It can also transmit pictures over ordinary telephone lines.

The record player and the TV set which displays the pictures are entirely conventional. The key component which links the two and makes possible the television display consists of a group of electronic circuits making up what is known as a "scan converter". This employs a television scanning technique which resembles that used to obtain television pictures from the signals broadcast by weather satellites and space probes. Information coming from the phonograph record is stored in the scan converter's special memory. The memory is capable of building up and displaying a complete TV picture every six seconds. During instruction, one picture is read out repeatedly and displayed during the time that the next one is being formed from the video information in the grooves of the recording.

The Phonovid system may also be employed with a tape recorder, and 1,200 pictures and accompanying sound can be stored on a standard reel of slow-speed audio tape. With tape it is possible for the educator to prepare his own sight-and-sound programme.

THE WORLD'S MOST SENSITIVE SOLID STATE TV CAMERA

Gerald J. Michon and Hubert K. Burke, staff research scientists of General Electric Research and Development Centre, Schenectady, N.Y., have developed the world's most sensitive solid state television camera, capable of taking pictures by the glow of a candle.

Gerald J. Michon holds a solid state imager in front of an experimental model of the newly developed General Electric solid state TV camera, causing its image to appear on the monitor screen. Watching is Hubert K. Burke who also worked on the camera. The imager replaces the bulky video tube currently used in conventional TV cameras and may lead to small inexpensive TV camera for home use.

The new camera is wallet-sized and weighs less than a pound. It can be adapted for use with an ordinary television set to produce exceptionally crisp images even when light levels are extremely low.

The heart of the novel camera is a charge-injection imager — a quarter inch square metal-oxide-semiconductor chip. Covered with 10,000 pairs of miniature capacitors, the light sensing chip performs the same job as the camera tube in conventional television cameras and converts a visual image into an electronic video signal. Since the miniature camera can be fabricated with current solid state manufacturing methods, it could potentially be made for a fraction of the cost of a conventional TV camera.

In the camera, the pairs of capacitors on the imager chip function as individual light-sensing devices. As light falls on the chip each capacitor pair collects a charge proportional to the intensity of the light striking it. To process the electrical charges into a television picture each pair of capacitors is individually addressed by scanning circuits to release its charge, "injecting" this into the base of the chip. Electronic circuits process the charge to reproduce the image on a television screen. The imager can be scanned at speeds compatible with ordinary television sets.

A great advantage of the new camera is that the chip has high tolerance to defects. If a pair of capacitors should fail the result is only one minute dark spot on the screen.

In addition the camera produces the clearest and sharpest pictures known to date with solid state techniques; also, it maintains this high picture quality even under low light levels. ■

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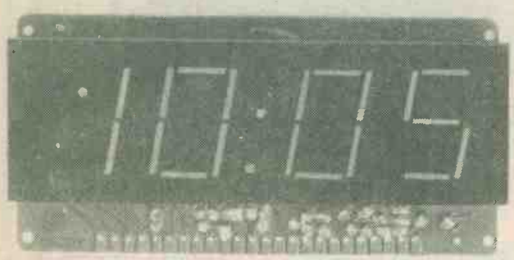

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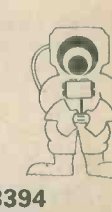

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(Continued from page 123)

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(Continued from page 125)

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(Continued from page 126)

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The silicon controlled rectifier consists basically of the p.n.p.n. structure shown in (b). To explain its functioning, this can be considered equivalent to the interconnected p.n.p. and n.p.n. structures of (c) and, in turn, to the interconnected p.n.p. transistor and n.p.n. transistor illustrated in (d).

In (e) these two transistors are connected via a load resistor to a d.c. supply. In the absence of gate current the transistors are non-conductive and only a very small leakage current flows. If, as in (f), the gate is taken positive of the cathode a forward current flows in the base-emitter junction of the lower transistor, which then draws an amplified collector current through the base-emitter junction of the upper transistor. The latter current causes an amplified collector current to flow through the base-emitter junction of the lower transistor. There is an overall regenerative effect resulting in both transistors maintaining each other in the "hard on" condition, and the voltage between anode and cathode becomes typically of the order of 1 volt. The transistors can only be turned off again by reducing the current flowing through them to a low value. In (f) the arrows indicate current flow from positive to negative.