RADIO & ELECTRONICS CONSTRUCTOR

FEBRUARY 1977

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RADIO & ELECTRONICS CONSTRUCTOR

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Volume 30

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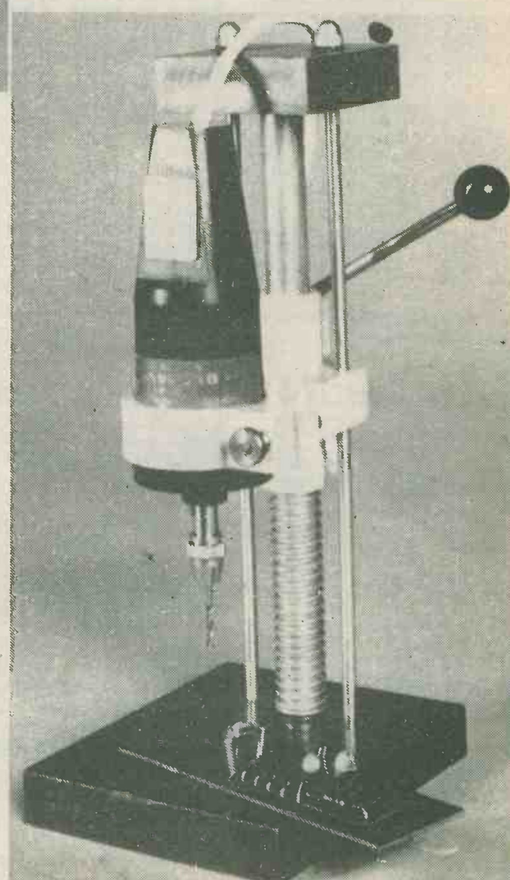

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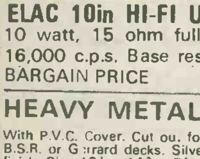

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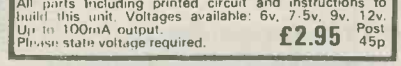

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Bass units only 10W **£4.95**
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R.C.S. 10 WATT AMPLIFIER KIT

This kit is suitable for record players, tape play back, guitars, electronic instruments or small P.A. systems. Two versions are available. A mono kit or a stereo kit. The mono kit uses 13 semiconductors. The stereo kit uses 22 semiconductors with printed front panel and volume, bass and treble controls. Spec. 10 watts output into 8 ohm. 7 watts into 15 ohms. Response 20 cps to 30K/cs. Input from 20mV high imp. Size 9½in x 3in x 2in.

Mono kit **£11.25** Stereo kit **£17.50** post 45p

LOUDSPEAKERS P.M. 3 ohms, 7 x 4in. £1.25; 6½in. £1.50; 8 x 5in. £1.60; 8in. £1.75; 10 x 6in. £1.90; 10in. £2.50.
SPECIAL OFFER LOUDSPEAKERS! All Brand New. 3 ohm, 2½in, 2⅝in, 3½in, 5in. 8 ohm, 2½in; 2¾in; 5 x 3in, 5in. 15 ohm, 3½in; 5in; 6 x 4in; 5 x 3in; 7 x 4in; 25 ohm, 2¼in, 3in, 5 x 3in, 7 x 4 in. 35 ohm, 3in, 5in. 80 ohm, 2¼in, 2½in. 120 ohm, 3in.
£1.25 EACH

TWEETER VOLUME CONTROL 15 ohm 10 watt with 1in. long threaded bush for wood panel mounting. Will suit all tweeters 75p

RICHARD ALLAN TWIN CONE LOUDSPEAKERS. 8in. diameter 4W £2.50, 10in. diameter 5W £2.95; Post 25p. 12in. diameter, 6W £3.50; 3 or 8 or 15 ohm models.
SPEAKER COVERING MATERIALS. Samples Large S.A.E.
Horn Tweeters 2-16Kc/s. 10W 8 ohm or 16 ohm £3.60.
De Luxe Horn Tweeters 2-18 Kc/s, 15W, 8 ohm £6.80
TWO WAY 3,000 cps CROSS OVERS 3, 8 or 15 ohm £1.90
3 WAY CROSSOVER 850 cps and 3000 cps (25 watt) £2.20
100 WATT HORN TWEETER £10.95

GOOOMANS CONE TWEETER £3.25

18,000 cps. 25 watts. 8 ohm.
5½in. Woofer 10 watt. Price £4.95.

ELECTRO MAGNETIC PENDULUM MECHANISM

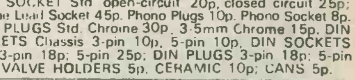
1·5v d.c. operation over 250 hrs continuous on SP2 battery, fully adjustable swing and speed. Ideal displays teaching electro magnetism or for metronome; strobe etc. 95p. Post 20p

WEYRAD TYPE COILS

P50/1AC	60p	RA2W	£1.20	Twin Gang	£2
P50/2CC	40p	OPT1	85p	Printed Circuit	85p
P50/3CC	40p	LFDT4	85p		

COAXIAL PLUG 10p. PANEL SOCKETS 10p. LINE 18p. OUTLET BOXES, SURFACE MOUNTING 40p
BALANCED TWIN RIBBON FEEDER 300 ohms, 5p yd.
JACK SOCKET Std open-circuit 20p, closed circuit 25p; Chrome Lead Socket 45p. Phono Plugs 10p. Phono Socket 8p. JACK PLUGS Std. Chrome 30p. 3·5mm Chrome 15p. DIN SOCKETS Chassis 3-pin 10p, 5-pin 10p, DIN SOCKETS Lead 3-pin 18p; 5-pin 25p; DIN PLUGS 3-pin 18p; 5-pin 25p. VALVE HOLDERS 5p. CERAMIC 10p; CANS 5p.

R.C.S. 100 WATT VALVE AMPLIFIER CHASSIS



Professional model. Four inputs. Treble, Bass, Master Volume Controls. Ideal disco, P.A. or groups. 5 speaker outputs, very robust job
S.A.E. for details **£85** plus £2.50 carr.

NEW MIXER/AMP 150 WATT

PROFESSIONAL TRANSISTOR AMPLIFIER **£68**
4 inputs, 3 outputs, separate volume treble and bass controls. Ideal disco or group, P.A. amplifier Carr. £1.50
Send for leaflets on Disco Gear, Cabinets, etc.

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Stirling Sound

Q.V. MODULES

SS.1100
100w. AMPLIFIER

SS.370
70V. POWER SUPPLY

Power and quality cost less!
Special introductory offer to save you £1.95

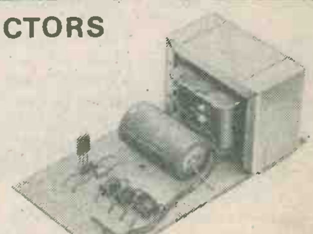
SS.1100 POWER AMP., delivers 100 watts R.M.S. into 4 ohms using a 70 volt/2A supply. Input sensitivity 500 mV for full output. Response — 10Hz to 50KHz ±1dB. S/N ratio better than 75dB. Distortion at half power typically 0.1%. With heat sink mounting bracket. 5" x 3½" x 1¼". **£9.45*** ***Full size heatsink* £1.00***

SS.370 A new heavy duty power supply unit to deliver 70 volts/2 amps. Complete with mains transformer and low-volt outlet (P/p £1.00) **£12.50***

YOU PAY ONLY £21.00* FOR THE TWO TOGETHER

There is real power and reliability in this assembly. By buying them together you save nearly £2.00 on these already competitively priced units. IDEAL FOR DISCO, P.A. and such like applications. Send only £21.00* (plus £1 p/p) for SS.1100H (with full size heatsink) and Power Unit SS.370).

MORE Q.V. MODULES FOR COST-CONSCIOUS CONSTRUCTORS



POWER AMPLIFIERS
3 to 4 watts R.M.S.

SS.103 5 watt r.m.s. mono. I.C. short circuit protection **£1.75**

SS.103–3 Stereo version of above using two I.C.s **£3.25**

SS.105 5 watts r.m.s. into 4 ohms, using 12V **£2.25**

SS.110 10 watts r.m.s. using 24V and 4 ohm load **£2.75**

SS.120 20 watts r.m.s. using 4 ohms, using 34V **£3.25**

SS.140 40 watts r.m.s. into 4 ohms using 45V. Ideal for small discos. Size 4" x 3" x ¾" **£3.95***

Suitable power units are to be found in the Stirling Sound range for the above. If ordered with Modules SS.103 to SS.120, V.A.T. becomes 12½%

TONE CONTROLS/PRE-AMPS

SS.100 Active tone control, stereo. ±15dB on bass and on treble —**£1.60**

SS.101 Pre-amp for ceramic cartridges etc. Stereo. Passive tone control details supplied **£1.60**

SS.102 Stereo pre-amp for low output magnetic P.Us R.I.A.A. corrected **£2.65**

UNIT ONE

Combined pre-amp with active tone-control circuits. ±15dB at 10Khz treble and 30Hz bass. Stereo. Vol./balance/treble/bass. 200mV out for 50mV in. Operates from 10-16V. **£7.80**

FM TUNING MODULES

SS.201 Front end tuner, two gang, slow geared drive. A.F.C. facility. Tunes 88-108 MHz —**£5.00**

SS.202 I.F. amplifier. Metering and A.F.C. facilities **£2.65**

SS.203 Stereo Decoder for use with the above or any other standard type FM mono tuners. A LED may be fitted **£3.85**

WHAY Q.V MEANS TO YOU

It means Stirling Sound QUALITY and VALUE from modules made in our own Essex factory. They are all tested, guaranteed and offer unbeatable value. Designed by highly specialised electronic engineers with wide experience of the constructor and experimenter market. WATCH HOW THE STIRLING SOUND RANGE GROWS!

POWER SUPPLY UNITS
8 models to choose from

Complete with mains transformers and low volt take-off points (except SS.312). All at 8% V.A.T. rate. Add 50p for p/p any model (except SS.300).

SS.312	12V/1A	**£3.75***
SS.318	18V/1A	**£4.15***
SS.324	24V/1A	**£4.60***
SS.334	34V/2A	**£5.20***
SS.345	45V/2A	**£6.25***
SS.350	50V/2A	**£6.75***
SS.370	70V/2A	**£12.50***

SS.310/50 Complete stabilised power supply with variable output from 10 to 50V/2A. Built-in protection against shorting —**£11.95***

SS.300 Power stabilising unit 10-50V adjustable for adding to unstabilised supplies. Built in protection against shorting (p/p 35p) **£3.25***

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with a STIRLING SOUND "SUPER SPARK" Mk. 5 Electronic Ignition Unit. Over 10,000 Super Spark Units have been sold by us. Adjustable for + or — earth; simple rev. limiting control; on-off immobilising switch; switch for instant revert to car's own ignition; neon indicator; in strong enclosed metal box 6¼" x 4⅝" x 4⅛". Inc. transformer. (P/P add 50p either model plus 8% V.A.T.)
KIT **£8.95** READY BUILT **£10.95**

WHEN ORDERING add 35p for p/p unless stated otherwise. V.A.T. add 12½% to total value of order unless price shows * when V.A.T. is 8%. Make cheques, etc. payable to Bi-Pre-Pak Ltd. Every effort is made to ensure correctness of information at time of going to press. Prices subject to alteration without notice.

Stirling Sound

A member company of the Bi-Pre-Pak group established 1959

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Goods sent at customer s risk, unless suficient payment for registration (1st class letter post) or compensation fee (parcel post) included.

VALVE BASES

Printed circuit B9A–B7G	3p
Chassis B7–B7G	9p
Shrouded chassis B7G–B9A–B8A	10p
B12A tube	9p

Speaker 6" x 4" 5 ohm ideal for car radio **70p**

TAG STRIP – 6 way **3p** 9 way **5p** Single **1p**

5 x 50pF or 2 x 220pF trimmers **20p**

BOXES — Grey polystyrene 61 x 112 x 31mm, top secured by 4 self tapping screws **32½p**

Clear perspex sliding lid, 46 x 39 x 24mm **10p**

ABS, ribbed inside 5mm centres for P.C.B., brass corner inserts, screw down lid, 50 x 100 x 25mm orange **48p**; 80 x 150 x 50mm black **70p**; 109 x 185 x 60mm black **£1.10**

ALUMINIUM

3" x 2" x1"	39p	4" x 2½" x 2"	44p	10" x 4½" x 3"	£1.02
2¾" x 5¼" x 1½"	45p	4" x 5¼" x 1½"	54p	12" x 5" x 3	£1.20
4" x 4" x 1½"	45p	7" x 5" x 2½"	79p	10" x 7" x 3"	£1.22
4" x 2¾" x 1½"	45p	8" x 6" x 3"	£1.02	12" x 8" x 3"	£1.50

SWITCHES

Pole	Way	Type	
4	2	Sub. Min. Slide	18p
6	2	Slide	20p
1	3	13 amp rotary	6p
2	2	Locking with 2 to 3 keys	£1.50
2	1	2 Amp 250V A.C. rotary	20p

12 bank, multi-pole/way push-button (4 interlocking) **30p**

S.P.S.T. 10 amp 240v. white rocker switch with neon. 1" square flush panel fitting **20p**

S.P.S.T. dot 13 amp, oblong, push-fit, rocker **15p**

AUDIO LEADS

5 pin din plug 180° both ends 1½ Mtr., **80p**

3 pin din to open end, 1½ yd twin screened **35p**

Phono to Phono plug, 6ft. **35p**

COMPUTER AND AUDIO BOARDS

VARYING PANELS WITH ZENER, GOLD BOND, SILICON, GERMANIUM, LOW AND HIGH POWER TRANSISTORS AND DIODES, HI STAB RESISTORS, CAPACITORS, ELECTROLYTICS, TRIMPOTS, POT CORES, CHOKES ETC.

3lb for **85p** + **85p** post and packing

7lb for **£1.95** + **£1.20** post and packing

1k horizontal preset with knob **3p**

3" Tape Spools **3p**, 1" Terry Clips **4p**, 12 Volt Solenoid **30p**

TV KNOB

Dark grey plastic for recessed shaft (quarter inch) with free shaft extension **5p**

ENM Ltd. cased 7-digit counter 2¼ x 1¾ x 1¼" approx. 12V d.c. (48 a.c.) or mains **75p**

ZM1162A INDICATOR TUBE

0-9 Inline End View. Rectangular Envelope 170V 2·5M/A **£1**

REGULATED TAPE MOTOR

9v d.c. nominal approx 1½" diameter **60p**

12v 8 amp Transformer **£2.50 (p&p 85p)**

Ferric Chloride, Anhydrous mil. spec. 1lb bag **40p**

Car type panel lock and key **40p**

18 volt 4 amp charger, bridge rectifier **79p**

GC10/4B **£3.00**

Telescopic aerial

Closed 9½", open 38½" Fitted right angle TV plug, **50p**

RESISTORS

⅛–¼–½ watt **1p**

1 watt **2p**

Up to 15 watt wire wound **6p**

1 or 2% five times price.

Cinch 8 way std 0.15 pitch edge connector **20p**

Semiconductor Data Book 263 pages. Covers 2N21 through to 2N5558 plus some 3N's. Type/connection/parameter details **£1.50** No VAT

POTS

Log or Lin, single or dual, switched carbon or wire-wound, rotary or slider. All types **16p**

1.5m Edgetype **3p**

Skeleton Presets

Slider, horizontal or vertical standard or submin. **5p**

THERMISTORS

VA1008, VA1034, VA1039, VA1040, VA1055, VA1066, VA1082, VA1100 } **10p**

VA1077, VA1005, VA1026 } **15p**

RELAYS

12 volt S.P.C.O octal mercury wetted high speed **40p**

P.O. 3000 type, 1,000 OHM coil, 4 pole c/o **40p**

Mains or 12v d.p.c.o heavy duty octal **50p**

3.5mm metal stereo plug **20p**

JAP 4 gang min. sealed tuning condensers **20p**

ELECTROLYTICS MFD/VOLT. Many others in stock

MFD	Up to 10V	25V	50V	70–75V	100V	200–250V	300–350V	450–500V
10	4p	5p	6p	8p	10p	12p	16p	20p
25	4p	5p	6p	8p	10p	15p	18p	20p
50	4p	5p	6p	9p	13p	18p	25p	—
100	5p	6p	10p	12p	19p	20p	—	—
250	9p	10p	11p	17p	28p	—	85p	£1
500	10p	11p	17p	24p	45p	—	—	—
1000	13p	22p	40p	75p	—	£1.50	—	—
2000	23p	37p	45p	—	—	—	—	—

As total values are too numerous to list, use this price guide to work out your actual requirements

8/20, 10/20, 12/20 **Tubular tantalum 20p each**
16-32/275V. 100-100/150V. 100-100/275V **30p**; 50-50/385V. 12,000/12V, 32-32-50/300V, 20-20-20/350V **60p**; 700 mfd/200V **£1.00**; 100-100-100-150-150/320V **£2.00**.

RS 100–0–100 micro amp null indicator Approx. 2" x ¾" x ¾" **£1.50**

INDICATORS

Bulgin D676 red, takes M.E.S. bulb **30p**

12 volt or Mains neon, red pushfit **18p**

R.S. Scale Print, pressure transfer sheet **.10p**

CAPACITOR GUIDE – maximum 500V

Up to .01 ceramic **3p.** Up to .01 poly **4p.** .013 up to .1 poly etc. **5p.** .12 up to .68 poly etc. **6p.** Silver mica up to 360pF **8p**, then to 2,200pF **11p**, then to .01 mfd **18p.**
8p. .1/600: **12p.** .01/1000, 1/350, 8/20, .1/900, .22/900, 4/16. .25/250 AC (600vDC) .1/1500 **40p.** 5/150, 2/275AC, 10/150, 40/150.

Many others and high voltage in stock.

FORDYCE DELAY UNIT

240 volt A.C./D.C. Will hold relay, etc., for approx. 15 secs after power off. Ideal for alarm circuits, etc. **£1**

CONNECTOR STRIP

Belling Lee L1469, 4 way polythene. **6p each**

1¼ glass fuses 250 m/a or 3 amp (box of 12) **6p**

Bulgin, 5mm Jack plug and switched socket (pair) **30p**

Reed Switch 28mm. body length **5p**

MAINS DROPPERS

36+79 ohm **5p**

66+66+158 ohm, 66+66+137 ohm
17+14+6 ohm, 266+14+193 ohm **5p**

50+40+1k5 ohm
285+575+148+35 ohm
25+35+97+59+30 ohm } **5p**

5¼" x 2¾" Speaker, ex-equipment 3 ohm **30p**

2 Amp Suppression Choke **8p**

PAXOLINE

3 x 2½ x 1/16" **4p**

4⅝ x ½ x ⅛", **1p**

PCV or metal clip on MES bulb Holder **4p**

VALVE RETAINER CLIP, adjustable **2p**

OUTPUT TRANSFORMERS

Sub-miniature Transistor Type **25p**

Valve type, **40p**

THE RADIO SHACK

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Transformers 6 volt ½A **25p**

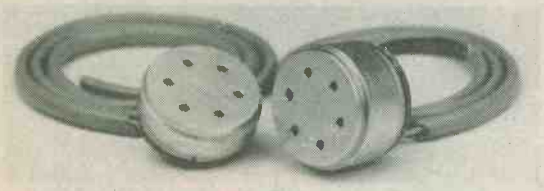
Whiteley Stentorian 3 ohm constant impedance volume control way below trade at **80p**

RS Yellow Wander Plug Box of 12 **25p**

18 SWG multicore solder **2½p foot**

NEWS . . . AND .

NEW NOISE CANCELLING MICROPHONE



The new noise cancelling microphones from Selsound — Type 3500 (right), Type 4500 (left)

From Selsound Limited comes the news that the Company's Engineers have developed a new noise cancelling microphone. This unit follows the Selsound type 2500, over 10,000 of which have been sold.

The microphone — of which there are two variations, the 3500 and 4500 — is a miniature, pressure gradient,moving coil transducer which offers marked improvement in the quality of reproduction. It is for close talking applications and the Company has developed a new principle — for which a Patent has been applied — which makes it possible to utilise the special characteristics and the high magnetic energy of recently available rare earth materials. By utilising these materials, Selsound have found it possible to achieve small size while retaining good sensitivity.

The design of Selsound types 3500 and 4500 combines high reliability allowing use under rough conditions and a large degree of shielding from external magnetic fields. The ability to discriminate between speech in close proximity and very high levels of environmental noise, even approaching the threshold of pain, is claimed to be remarkable.

The new module, designed to facilitate mounting, is available as a basic insert for inclusion in customer's own housings. alternatively, Selsound have produced an attractively styled, switched hand-held arrangement, and a boom mounting is available.

Selsound is located in Victory Close Industrial Estate,Chandlers Ford, Eastleigh, Hants.

Many constructors pursue their hobby without meeting fellow enthusiasts, either by choice or through force of circumstances. We always encourage readers to join radio clubs or organisations such as The Radio Society of Great Britain or The British Amateur Electronics Club, as enthusiasts can then cooperate to mutual advantage.

Electronics could not have developed to its importance in our everyday lives had not large numbers of people worked together as scientists, designers, manufacturers or indeed as amateurs — the latter having made a great contribution to radio communication in particular.

Therefore in this and other features we give news of activities and developments outside the scope of the individual shack or workshop. Such news can only be fragmentary in view of the enormous volume of activity. In this issue, for example, there is a brief report on some items of interest exhibited at *Electronica 76*, the great German electronics exhibition held last December.

We feel that these short news items can add much of interest to your enjoyment of the hobby and who knows you may discover, by accident or design, some aspect of electronics previously overlooked which can be reported in these pages.

AGFA CARAT CASSETTES — FERUM + CHROM NOW AVAILABLE

The advanced dual coating in AGFA CARAT cassettes produces a tape of maximum sensitivity for both high and low frequencies and at the same time offers a minimal degree of distortion.

The upper coating of chromium dioxide has optimum properties for recording high frequencies, whereas the lower layer of iron oxide ensures first class reproduction of the low frequencies. The result is a new type of cassette which gives genuine hi-fi performance, which previously might only have been expected from reel-to-reel tape.

AGFA claim the following improvements over low-noise iron oxide cassettes and chromium dioxide cassettes (optimal bias setting in each case): Noise level — 4.5 dB better than iron oxide. Frequency response — 3 dB better than chromium dioxide. Max. output level — 4 dB better than iron oxide, 1.5 dB better than chromium dioxide. Dynamic range — 8.5 dB better than iron oxide.

Ideally, a new setting Fe-Cr on the recorder is desirable to achieve the most from these new cassettes, but the improved dynamics still offer a considerable advantage in sound quality over other cassettes when used on conventional machines. On recorders with a manual Fe or Cr change-over system, the qualities of the new cassette will be turned to the best account when recording is carried out in Fe mode and reproduction in Cr mode.

Further information from: Agfa-Gevaert Limited, 27, Great West Road, Brentford, Middlesex.

COMMENT

12th APPLETON LECTURE

Sir Edward Appleton's pioneering work in the 1920's and 1930's on wave propagation in the ionosphere has helped broadcasters and other communicators considerably in understanding the medium they use. In the 12th Appleton Lecture given to the Institution of Electrical Engineers (IEE), James Redmond, Director of Engineering of the BBC, described the nature of the various ionospheric effects first brought to light by Appleton's work and discussed the possible broadcasting developments based on an understanding of these effects.

Appleton's research led to the discovery of the upper reflection layer of the ionosphere (the Appleton layer) and made possible the calculation of transmitter ranges on the MF band and the levels of interference from distant stations. As a result of this and subsequent work by others, the broadcaster has been able to predict the sometimes beneficial and sometimes harmful effects of ionospheric and other reflections on transmissions in bands which now range from a few hundred kiloherz to many gigaherz.

'TELEVISION AND RADIO 1977'

The first twenty-one years of Independent Broadcasting, including the development of the Independent Television and Independent Local Radio transmitter networks, are reviewed in the Independent Broadcasting Authority's annual handbook, "Television and Radio 1977", published on 4th January.

A new television relay station is opened by the IBA almost every week and at the end of 1976 some 250 UHF transmitting stations were in operation, bringing 39 people out of 40 in the United Kingdom within range of colour television. Many more stations remain to be built, however, in order to provide improved reception for outlying districts.

An important section of the handbook, "Better Viewing and Listening", is devoted specifically to technical operations. It describes how to get the best reception of television and radio programmes, gives details about the transmitting stations and looks at the latest technical achievements of the IBA.

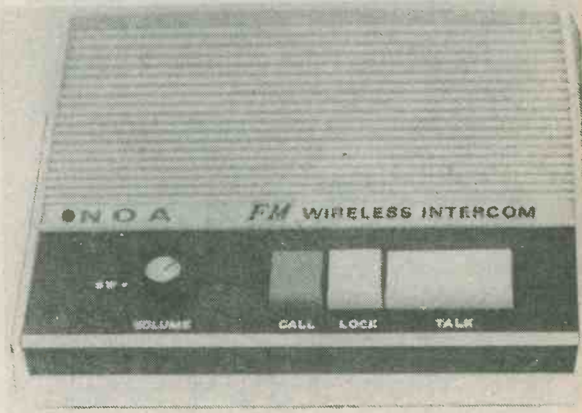
In 1976 the colour service reached the Channel Islands, new areas of the Highlands and Islands of Scotland and other remote parts of the United Kingdom. "Bringing the Pictures to You" describes some of the problems involved in extending the service.

"Technical Developments in Broadcasting" looks at the practical application of new developments and at the IBA's role in the engineering field, and describes the IBA's long-term plans for streamlining the running of its UHF transmitter network. "The Sound of ILR" examines the technical requirements of local radio, and "Good Listening to ILR" and "Good Viewing of ITV" explains how to get the best reception.

"Television and Radio 1977", is a comprehensive and detailed guide to the workings of Independent Television and Independent Local Radio. It describes the work of the IBA and the programme companies.

"Television and Radio 1977", 224 pages, 9in x 7½in, over 300 illustrations (many in colour). Price £1.40, available from newsagents and booksellers.

FM INTERCOM



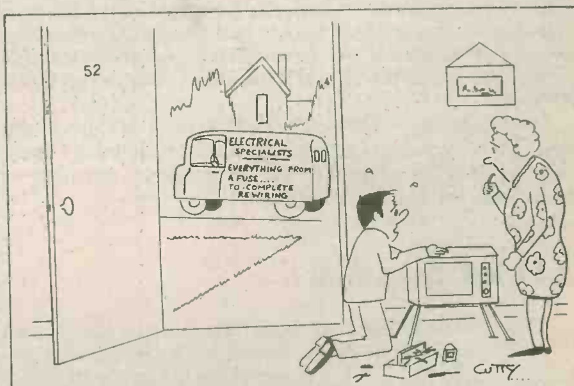
This new F.M. Intercom provides very clear two way communication which can be up to a distance of three-quarters of a mile, but both stations must be plugged into the same side of power line distribution normally on one side of the street.

The frequency of the unit is pre-set at 145 kHz and should not be adjusted.

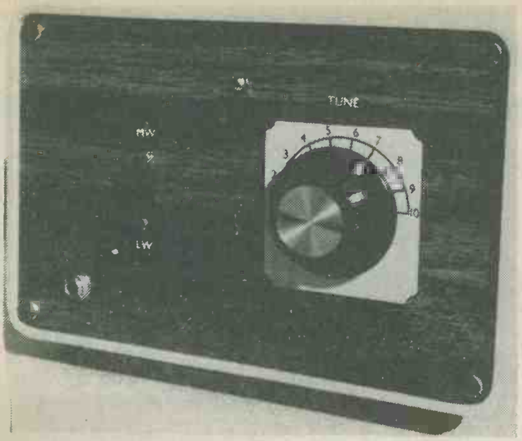
Model FN1113S comprising two stations costs £60 and additional stations cost £30 each.

Model FN116S comprising three stations costs £105 and additional stations cost £35 each. An addition of 12½% for V.A.T. must be added to all costs.

The units are obtainable from Hadley Sales Services, 112 Gilbert Road, Smethwick, Warley, West Midlands B66 4PZ.



"Have you got a bent hairpin by any chance?"



INTEGRATED CIRCUIT T.R.F. TUNER

by F. G. Rayer

This is a simple medium and long wave tuner incorporating the integrated circuit type ZN414. Although primarily intended to be employed with an amplifier which was described in an earlier issue, the circuit can be readily modified to adapt it for use with most other amplifiers or with high impedance headphones.

In the July 1976 issue of this journal the author described a 'General Purpose I.C. Amplifier,' this having its own a.c. mains supply and internal speaker, and incorporating an LM380N a.f. integrated circuit. In a second short article, 'General Purpose Pre-Amplifier' which appeared in the November 1976 issue, details were given of a single transistor pre-amplifier which could be added to the main LM380N amplifier. The present article describes a ZN414 t.r.f. tuner which may also be employed with the LM380N amplifier (either with or without the pre-amplifier) to give loudspeaker reception of medium and long wave signals. The tuner is capable of receiving local and some Continental signals on medium waves and, in areas of reasonable signal strength, the Radio 2 long wave signal on 1,500 metres.

Construction of the tuner should raise few problems and the only item of test equipment required is a multimeter having a sensitivity of 10,000Ω per volt or better on its voltage ranges.

CIRCUIT DIAGRAM

The circuit of the t.r.f. tuner appears in Fig. 1, and it will be noted that this is based on the integrated circuit type ZN414. This i.c. provides a high level of r.f. amplification and includes a transistor detector.

L1 and L2 are the medium wave and long wave sections of the ferrite rod aerial, L2 being short-circuited by S1 for medium wave reception. The ferrite aerial is

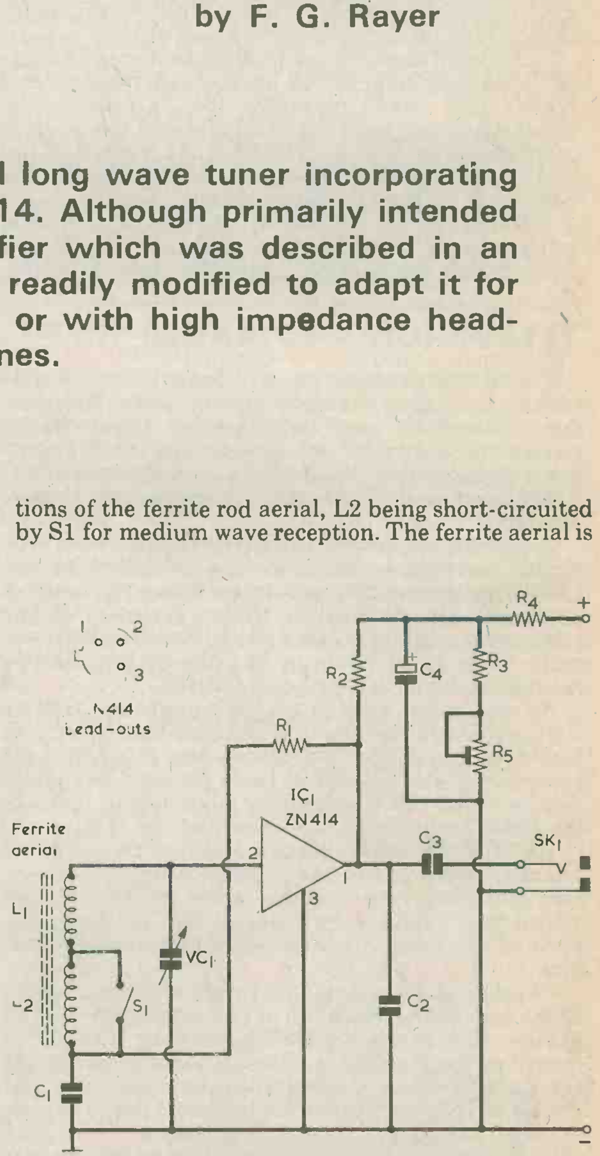


Fig. 1. The circuit of the t.r.f. tuner. This incorporates a ZN414 i.c.

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)
R1 100kΩ
R2 680Ω
R3 330Ω
R4 5.6kΩ
R5 470Ω or 500Ω pre-set potentiometer, 0.1 watt skeleton, horizontal

Capacitors
C1 0.01μF type C280 (Mullard)
C2 0.1μF type C280 (Mullard)
C3 0.1μF type C280 (Mullard)
C4 4.7μF or 5μF electrolytic, 6 V. Wkg.
VC1 208pF variable (see text)

Inductors
L1, L2 medium and long wave ferrite aerial type MW/LW.5FR (Denco)

Integrated Circuit
IC1 ZN414

Switch
S1 s.p.s.t., miniature slide (see text)

Socket
SK1 3.5mm. jack socket

Miscellaneous
Case and front panel (see text)
Control knob
Veroboard, 0.15in. matrix
Aluminium sheet (for brackets)
S.R.B.P. strip
Wander plug and socket (see text)
Bolts, nuts, wire, etc.

a ready-wound Denco component, and if difficulty is experienced in purchasing this through retail sources it may be obtained direct from the manufacturer, Denco (Clacton) Ltd., 357/9 Old Road, Clacton-on-Sea, Essex, CO15 3RH. The tuning capacitor recommended should have a maximum capacitance of 208pF, and this can consist of one section of a Jackson type '00' 208 +176pF 2-gang capacitor, no connection being made to the 176pF section. Alternatively, a Jackson type '01' single gang 208pF capacitor may be employed, this being available from Home Radio.

In ZN414 circuits the tuning capacitor is usually connected directly across the ferrite aerial coils, but in this circuit it couples to the aerial coils via the bypass capacitor C1. This method of connection causes no difference in circuit operation, and it allows the tuning capacitor to be directly mounted, without insulation, on a metal front panel which is common with the negative supply rail. R1 is the usual input bias resistor and R2 the output load for the ZN414. C2 bypasses the r.f. content of the output signal whilst C3 couples the detected a.f. signal to the output jack socket.

When used with the General Purpose I.C. Amplifier, the tuner receives its positive supply from the rectified supply in that amplifier. A single insulated red wander plug socket is added at the back of the amplifer, this being connected to the positive side of the 2,500μF reservoir capacitor inside the amplifier. A flexible lead from the tuner terminated in a matching wander plug is then connected to this socket, whereupon the positive supply is applied to R4 of Fig. 1. The current drawn by the tuner is very low and it can be used with the amplifier when the latter incorporates a mains transformer having a secondary rated at 100mA.

The supply voltage required by the ZN414 is in the range of 1.2 to 1.6 volts maximum, the manufacturer's recommended voltage being 1.3 volts. This voltage is that across C4 and is applied to the i.c. output load resistor, R2. The supply voltage from the amplifier is dropped to the required level by means of the potential divider given by R4, R3 and R5. R5 is a pre-set potentiometer and is set up so that the desired voltage may be obtained. It is adjusted after the tuner has been assembled and connected up to the amplifier. R5 is initially set to insert minimum resistance into circuit, i.e. its slider is at the lower end of its track as depicted in Fig. 1. A voltmeter having a sensitivity of 10,000 Ω per volt or better and switched to a suitable low voltage range is connected across C4, after which the resistance inserted by R5 is slowly increased until the voltmeter indicates 1.3 volts. The voltmeter is then removed. After some experience with the tuner has been obtained and the two ferrite aerial coils are correctly positioned on the ferrite rod R5 may be readjusted, with the voltmeter once more connected across C4. It will be found that at higher voltages below the maximum of 1.6 volts there are whistles at part or all of the tuning range. In general, it will be found that best reception is given when the voltage across C4 is just below the level at which the whistles appear. The voltage across C4 must not be allowed to exceed 1.6 volts.

The tuner output is coupled to the amplifier input by way of a screened lead having a 3.5mm. jack plug at each end. The screened lead braiding connects to the sleeve contact of each plug, and the centre wire to the tip contact. If the amplifier has the pre-amplifier incorporated, the plug from the tuner is fitted into the socket which couples to the LM380N input and not to the socket which couples to the pre-amplifier. The screened lead braiding also carries the negative supply from the amplifier to the tuner.

DIFFERENT VOLTAGES

If the tuner is to be employed with an alternative amplifier from which a different supply voltage is available, the value of R4 may be changed accordingly. Fig. 2 shows the values required in R4 for supply voltages of 3, 4.5, 6 and 9 volts. With these different voltages, R5 is adjusted for the requisite ZN414 supply voltage across C4 in the manner just described.

Supply voltage	Value of R_4
3V	820Ω
4·5V	1·5kΩ
6V	2·2kΩ
9V	3·9kΩ

Fig. 2. Table showing alternative values for R4 at different supply voltages

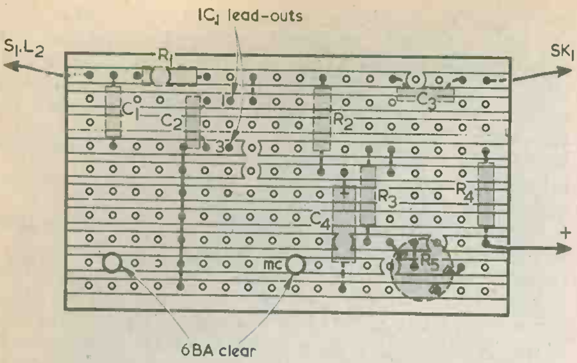


Fig. 3. The copper side of the Veroboard panel. The components appear on the other side of this panel

If it is desired that the tuner be a self-contained tuner with its own supply, C4, R3, R4 and R5 can be omitted. A single 1.5 volt dry cell type HP7 or similar is then used for the ZN414 supply. Its negative side is connected to the negative supply rail and its positive terminal via an on-off switch to R2. The circuit may then also be employed as a receiver in its own right by plugging a pair of sensitive high resistance headphones (2,000Ω per phone) into the output socket. Incidentally, a single high impedance earphone will not normally have sufficient sensitivity for satisfactory operation in this manner.

CONSTRUCTION

The small components are assembled on a piece of Veroboard of 0.15in. matrix having 18 holes by 10 copper strips. The underside of this board is shown in Fig. 3. Note that a jumper consisting of bare tinned copper wire connects to seven of the strips. This wire is on the copper side of the board. So, also is the short jumper wire under R5.

The author's tuner was assembled in a plastic case measuring approximately 6 by 4 by 4in. and having a metal front panel. Any plastic case of similar size which is capable of taking the components, and which has a plastic or metal front panel may be employed. A possible case is given by a small plastic 'lunch box' with the lid used as the front panel. These boxes are quite strong but the material of which they are made is rather brittle and care is needed when drilling holes; the drill used should be sharp and only light pressure should be applied. A good appearance can be given with lunch boxes by painting them on the *inside*. The paint must be absolutely dry before the lid is finally fitted.

A small bracket cut out from aluminium sheet is secured with 6BA screws and nuts to the 6BA clear holes in the Veroboard panel. This bracket is on the component side of the board. The bracket extends so that it is clamped between the front plate of the tuning capacitor and the front panel, as indicated in Fig. 4. Both the front panel and the bracket will require three 4BA clear holes to allow screws to pass into 4BA tapped holes in the tuning capacitor front plate. These screws need to be short, as their ends must not pass more than fractionally inside the capacitor front plate or the capacitor vanes will be damaged. Either a

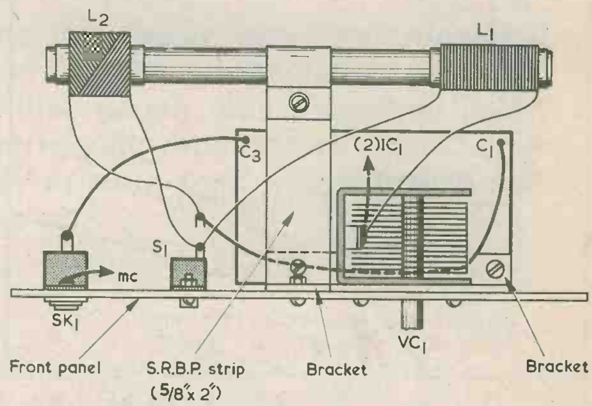
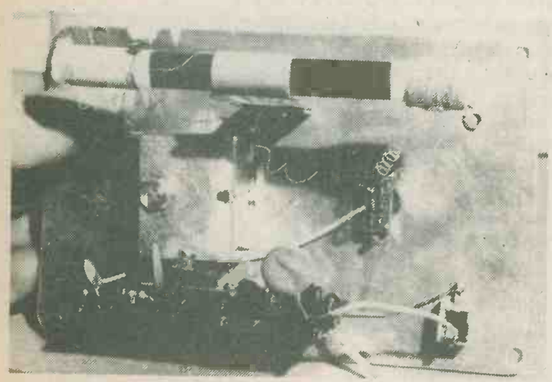


Fig. 4. Final wiring details. The lead from SK1 marked 'MC' is not needed if a metal front panel is used and the socket has an open construction



The parts of the receiver are secured to the front panel. The disc ceramic capacitors visible in the C1, C2 and C3 positions were later replaced by plastic foil components

large central hole for the spindle and the ball race may be provided, or a smaller hole can be drilled and metal spacing washers fitted over the 4BA screws between the bracket and the capacitor front plate. The bracket provides the connection between the Veroboard panel and the capacitor moving vanes.

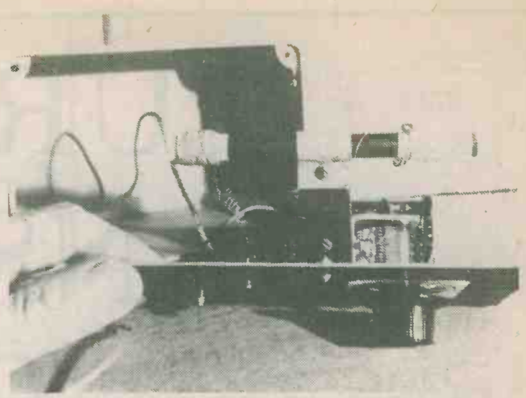
If the front panel is plastic, or if the output jack socket is of insulated construction, a solder tag should be fitted on the component side of the board at the point marked 'MC' in Fig. 3. The sleeve contact of the socket is then connected to this tag. With a metal panel and an output socket of open construction the sleeve contact is connected to the negative rail via its mounting nut and bush.

R5 is an 0.1 watt horizontal skeleton potentiometer with 0.2in. spacing between track tags and 0.4in. spacing between track and slider tags. Its tags fit comfortably into the Veroboard holes indicated in Fig. 3. Unnecessary stray capacitive coupling between lead-outs 1 and 2 of the i.c. tends to cause instability and so only lead-outs 1 and 3 are soldered to the Veroboard panel. An extension wire is soldered to lead-out 2 of the ZN414 and this is taken directly to the fixed vanes tag of the tuning capacitor.

A small right angle bracket is secured to the front panel and a strip of s.r.b.p. is bolted to this, as in Fig. 4. A band of stout card or flexible plastic is arranged to go round the ferrite aerial rod at its centre, and its ends are secured to the end of the s.r.b.p. strip with a 6BA bolt and nut. The bolts and nuts at the small metal bracket are 6BA also.

The Denco ferrite aerial has a base coupling winding on the medium wave coil and a tap in the long wave coil. These are ignored and the appropriate leads are rolled up out of the way. If necessary, they can be secured with adhesive to ensure that they do not make contact with component connections. L1 and L2 are connected in series, as in Fig. 4, with their junction soldered at S1. Fit L2 so that the direction of the winding is the same as that of L1. This can be seen by examining the coils or by following the maker's data.

The layout on the front panel is not critical. The tuning capacitor is mounted to the right and switch S1 to the left, both being centrally positioned between the top and bottom of the panel. The output jack socket is mounted near the bottom left-hand corner of the panel. The author covered the panel with self-adhesive decorative plastic, this having a wood grain appearance to match the sides and top of the amplifier. A simple scale can be fitted behind the knob for the tuning capacitor. S1 will normally be available as d.p.d.t. The unused contact tags are ignored.



Another view of the parts fitted behind the front panel

When construction is complete and the wiring has been carefully checked, the tuner is coupled to the amplifier with which it is to be used. R5 is next set up, as already described, for a voltage of 1.3. volts across C4. L1 is then moved along the ferrite rod until correct medium wave coverage is given. After this, L2 is moved along the rod such that Radio 2 on 1,500 metres is received at approximately the centre of the tuning range.

R5 is later given its final adjustment and the tuner is then ready for use. ■

CITIZENS' BAND ANNOUNCEMENT BY R.S.G.B.

The Society is aware of the numerous items that have appeared on this subject in various journals both as correspondence and as feature articles. It is apparent that much of this material has been generated by those who will profit financially from the introduction of the facility rather than potential users.

The Society is often asked to state its policy on a citizens' band. It is somewhat difficult to offer an informed opinion on a matter concerning which nothing definite is known. Understandably no guide lines are available from the administration regarding the various possibilities and it is in this context that the following statement is made.

The matter of a citizens' band is under continual consideration by the Society's Telecoms Liaison Committee and the Council approves its present views which are:

(a) The RSGB exists to safeguard the interests of its mem-members and of the Amateur Service in the UK. The Amateur Service is a defined service in the Radio Regulations (Geneva 1976) and is accorded world wide status in the same way as the professional services. A citizens' band facility exists only where a national administration is prepared to set aside spectrum space for this use.

(b) While the RSGB may have no direct interest in a citizens' band facility by its present articles of association it must, in the interests of its members, take heed of developments likely to affect the Amateur Service.

(c) The major consideration affecting the introduction of any new facility is the ability of the administration to exercise complete and effective control. Anything less is not acceptable.

(d) The RSGB is not opposed to the introduction of a short range personal communications facility provided that its location in the spectrum and the equipment used are suitable. The 27MHz band as used in the USA and some European countries is probably one of the most unsuitable frequency bands that could be envisaged. There are three main reasons:

   (i) its proximity to the amateur 28MHz band and the consequent availability of high power equipment together with the ease of illegal operation in this band,

   (ii) the existence of long distance propagation during part of the sunspot cycle, and

   (iii) the interference to television receivers, particularly those operating in Band 1.

   Having regard to equipment now available it would appear that a vhf or uhf fm service with power limitation, crystal control and type approved apparatus could be suitable.

(e) Location of a citizens' band within an existing amateur amateur service allocation is not acceptable to the RSGB. Further, if this facility is eventually allowed it ought to be located in a part of the spectrum remote from any amateur allocation to prevent illegal operation in an amateur band such as is now experienced in the USA.

TURNING TRANSISTORS ON

by J. M. Carstairs

A useful short-cut in finding the maximum base bias resistance value which will turn a transistor fully on.

In electronic switching applications we frequently encounter the situation illustrated in Fig. 1. A transistor is required to apply almost the full supply potential across a load in its collector circuit, the transistor being turned hard on by the current flowing through the base bias resistor. This resistor is returned (either directly or effectively) to the same supply rail as the load. A typical load can be a relay coil.

The basic circuit of Fig. 1 appears twice in the astable multivibrator of Fig. 2. The multivibrator does not necessarily require that each transistor turns hard on during the period in the multivibrator cycle when it is conducting, but it is normally preferable that this should happen. In consequence, the available bias current for each transistor in the multivibrator should be sufficiently high to turn the transistor fully on.

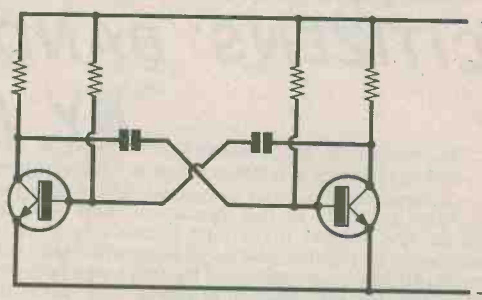


Fig. 2. The circuit of Fig. 1 appears twice in a standard astable multivibrator

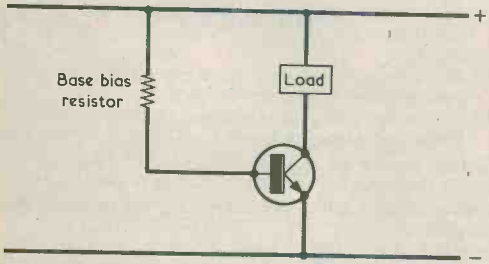


Fig. 1. A commonly encountered circuit in which it is required that the transistor be turned fully on

BIAS RESISTOR VALUE

Fig. 3(a) repeats the circuit of Fig. 1 with a 9 volt supply and the collector current value added. The transistor employed has an hFE range of 100 to 500 with the result that, if we are unlucky enough to pick a transistor which is right at the bottom of the current gain spread, it would have an hFE of 100 only. If our design is to be successful, with the transistor turned fully on, we must find a base bias resistance value

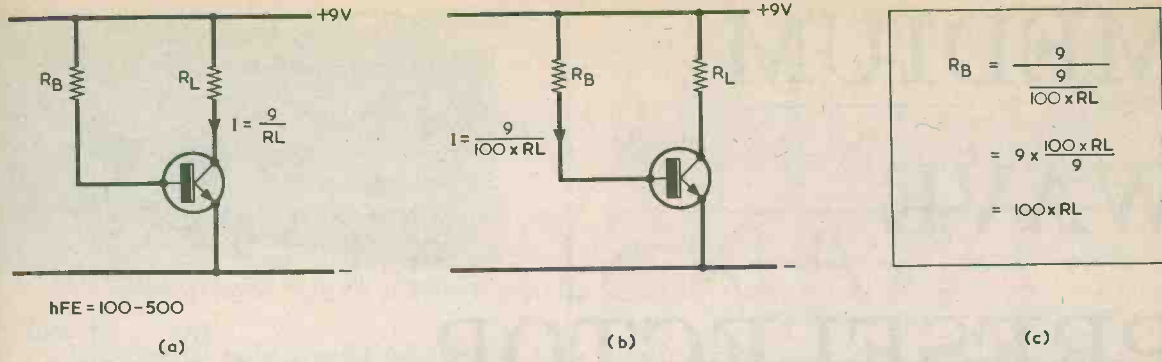


Fig. 3(a). An example of the circuit with collector current noted. (b). The minimum base current needed for satisfactory operation. (c). Calculating the corresponding maximum value for the base bias resistor

which caters for a transistor with this low gain figure.

We now make two assumptions. First, we assume that the voltage across the emitter and collector of the transistor when it is turned on is negligibly low and can be ignored. And, second, we assume that the voltage across the base and emitter is also negligibly low. Following these assumptions, the voltage across RB is always 9 volts, as is the voltage across RL when the transistor is turned hard on. From Ohm's Law (I = E/R) the current flowing in RL is 9 divided by RL.

To allow for the lowest gain transistor, the base current flowing in RB must be at least one-hundredth part of the current flowing in RL. This base current is shown in Fig. 3(b). Since there is an assumed 9 volts across RB we can now, from Ohm's Law (R = E/I), find the corresponding value of RB. This we do in Fig. 3(c), to arrive at the fact that RB is 100 times RL, and that the supply voltage does not even enter the final equation.

And this is all there is to it. Whenever we have a configuration like that of Fig. 1, we first check the hFE figures for the transistor concerned. We then multiply the collector load resistance by the lowest hFE figure in the spread and ascribe that as the maximum satisfactory value for the base bias resistor. Normally, it pays to be generous with base current in applications like this and so we would in practice give the base bias resistor a lower value than that calculated from the load resistance and hFE figure.

EXAMPLES

Several examples may be of help here. Let us say that we have a BC237 with a 1k Ω load in its collector circuit. The BC237 has an hFE spread of 125-500, so what base resistance do we require to ensure that it is fully turned on? The answer is 125 times 1kΩ, or 125kΩ. In practice we would clinch the matter by using a base resistor of say, 100kΩ, 75kΩ, or even less.

In another circuit we have an ACY20, whose hFE spread is 50-145, and we connect a relay coil in its collector circuit. The coil has a resistance of 600 Ω. The corresponding calculated maximum base bias resistance is then 50 times 600 Ω, or 30k Ω, and we would in practice use a value of 24k Ω or less to ensure that the relay is fully energised by the transistor.

The base bias resistance given by multiplying the collector load resistance by the lowest hFE figure always gives the maximum value which will ensure that the transistor turns fully on. Values lower than the calculated maximum value are in order whilst values above the calculated value should never be employed. In some instances the hFE values quoted for a transistor are at collector currents far removed from the collector current we wish to employ. To play safe it is best then to use a base bias resistor which is quite considerably lower than the calculated maximum value and it could, say, be made lower than half the calculated value. ■

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 11p 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.

MEDIUM WAVE PRESELECTOR

by
R. A. Penfold

This preselector design incorporates its own ferrite rod aerial and employs a dual gate MOSFET in the interests of low cross-modulation. It is primarily intended for use with the medium wave DX superhet described in the last two issues.

Although this preselector has been designed specifically for use in conjunction with the medium wave DX superhet described in the last two issues of this journal, it can also be employed with a communications receiver which is being used for medium wave DX reception. The unit is completely self-contained, and the only external connection that is necessary is that joining the output of the preselector to the aerial input socket of the receiver.

CIRCUIT

The circuit of the preselector is very simple, and it incorporates only a single active device. Fig. 1 shows the complete circuit, and it will be seen that it just consists of a ferrite aerial feeding a dual gate MOSFET common source amplifier.

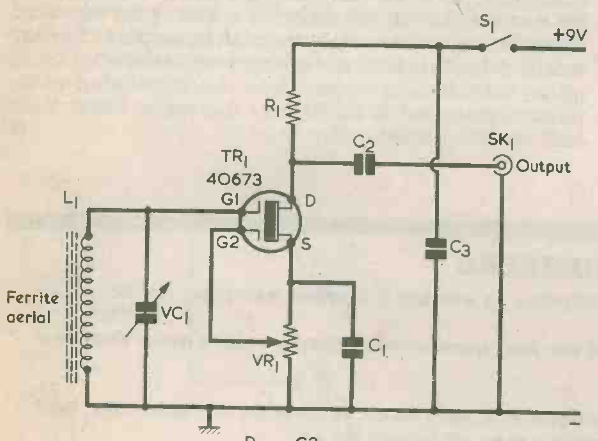


Fig. 1. The circuit of the medium wave preselector

In the diagram, L1 is the ferrite aerial winding and VC1 the tuning capacitor. VR1 is the r.f. gain control and it also forms the source bias resistor for TR1. C1 is the source bypass capacitor.

When the g2 of TR1 is a little above chassis potential, the gain from g1 is quite high. Reducing the g2 voltage results in a reduction in g1 gain. TR1 g2 connects to the slider of VR1, whereupon the gain of the preselector will be at a minimum when VR1 slider is at the lower end of its track, and at a maximum when the slider is at the top.

R1 forms the drain load for TR1, and C2 couples the output from TR1 drain to the output socket. This capacitor is required in order to provide d.c. blocking. C3 gives supply decoupling and S1 is the on-off switch.

The output impedance of the preselector is quite low and it provides a signal which is large enough to give excellent results with any reasonably sensitive receiver. Power is obtained from a PP3 battery, which has an extremely long life as the typical current consumption is only about 1mA.

Long ferrite aerials are said to have better directional properties than short ones, and so a rod about 200mm. ($7\frac{3}{4}$in.) long has been used here. The ferrite aerial used in the prototype was a dual wave Denco type FRA.1 with the long wave coil removed.

CASE CONSTRUCTION

A suitable case for the project is easily constructed from 18 s.w.g. aluminium sheet and 4mm. plywood. Details are given in Fig. 2. The front and rear panels are cut out from the aluminium, whilst the top, bottom and two sides are in plywood.

The drilling of the front panel is quite straightforward apart from the three 4BA clear mounting holes for VC1. These holes correspond with three 4BA tapped holes in the front plate of the capacitor frame, and they may be marked out with the aid of a small paper template. This has a $\frac{1}{4}$in. central hole cut out in it which is passed over the spindle of the capacitor; the positions of the three holes are then marked on the paper with a pencil, after which the paper is transferred to the front panel so that the three holes may be marked out there. When mounting the capacitor, fit spacers or washers between the front panel and the capacitor front plate to space the

COMPONENTS

Resistors
R1 100Ω, ¼ watt 10%
VR1 1kΩ potentiometer, linear

Capacitors
C1 0.047μF type C280 (Mullard)
C2 0.01μF type C280 (Mullard)
C3 0.1μF type C280 (Mullard)
VC1 365pF variable, type 01 (Jackson)

Inductor
L1 Ferrite rod aerial type FRA.1 (Denco)

Transistor
TR1 40673

Switch
S1 s.p.s.t. rotary

Socket
SK1 Coaxial socket, flush mounting

Miscellaneous
2 small control knobs
Large control knob
9-volt battery type PP3 (Ever Ready)
Battery connectors
4 rubber feet
Plain perforated s.r.b.p. panel, 0.1in. matrix
Materials for case (see text)
Wire, nuts, screws, etc.

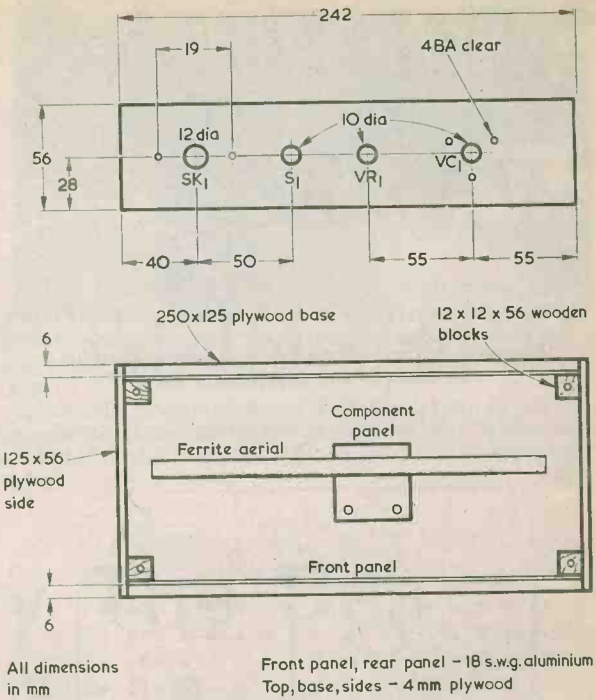


Fig. 2. Constructional details for the front panel and the case. The rear panel and the case top are described in the text

capacitor off slightly. The three 4BA mounting bolts must be short; if their ends pass more than fractionally inside the front plate of the capacitor they can damage the fixed or moving vanes. When SK1 is mounted, a solder tag is fitted under the securing nut nearer S1. This last component, incidentally, can be any small s.p.s.t. switch. The switch visible in the photographs is a multi-pole type with no connections made to the unused poles.

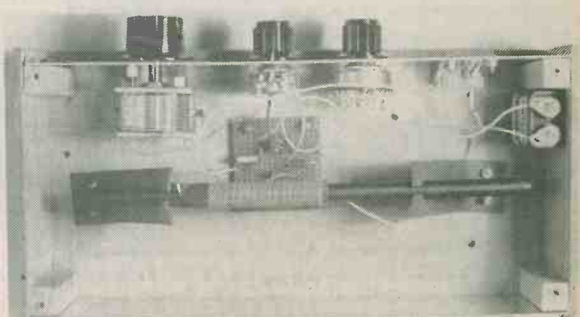
Not shown in Fig. 2 are two holes which are needed at each end of the front panel for mounting it to the wooden part of the case. These holes are best marked out and drilled after the wooden sections have been assembled.

The rear panel is identical with the front panel except, of course, that it does not require the holes shown in Fig. 2 for the controls and output socket.

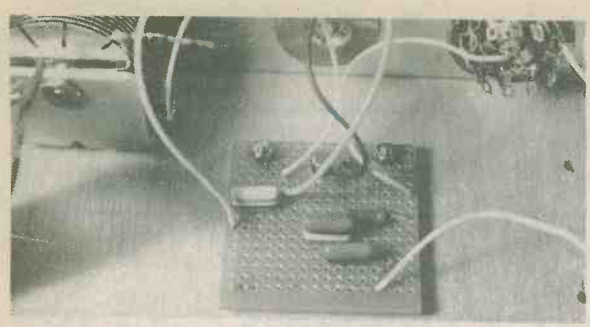
A good quality adhesive such as Bostik No. 1 is employed to glue together the sides, base and 12 by 12mm. reinforcing corner pieces. When the glue has set firmly, the front and rear panels are fixed in position with woodscrews passing into the corner pieces, four screws for each panel. Note that the panels are set back from the front and rear of the wooden section by about 6mm. Four rubber feet are affixed at the corners of the base.

The lid of the case has the same dimensions as the base. It is held in place by a woodscrew at each corner, the screws passing into the upper ends of the reinforcing corner pieces. An attractive finish can be imparted to the case by giving the wooden parts several coats of paint or applying a self-adhesive plastic material, such as Fablon. A satin varnish was employed with the prototype.

The approximate positions taken up by the component panel (to be described next) and the ferrite aerial are also shown in Fig. 2. The aerial is supplied complete with two mounting brackets. These are secured to the base of the case by means of four 6BA bolts and nuts. As already stated, the long wave coil is removed. The ferrite rod is not fitted permanently to its brackets until after the mounting holes for the component panel have been drilled and the panel mounted in place. This is because it may be damaged otherwise during the drilling and mounting operation.



The layout inside the case. The ferrite aerial is well clear of large metal areas and is, in consequence, capable of offering a high efficiency



The ease of construction is well exemplified by this view of the component panel

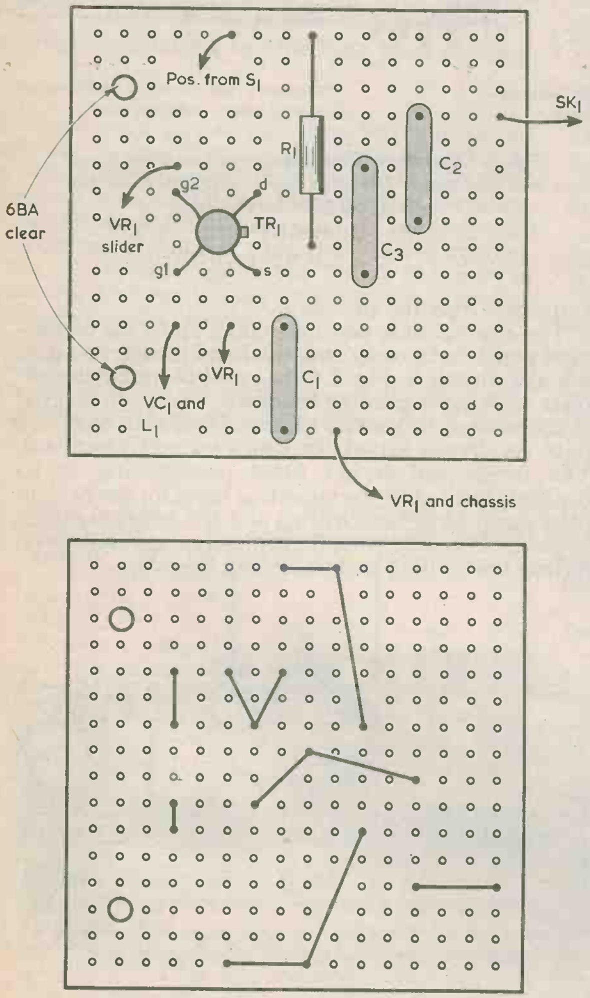


Fig. 3. How the parts on the component panel are assembled and wired up

COMPONENT PANEL

Fig. 3 gives details of the wiring on the component panel. The parts are assembled on a piece of plain perforated s.r.b.p. board of 0.1in. matrix having 16 by 16 holes.

The two 6BA clear mounting holes are first drilled out and the board is then employed as a template for marking out and drilling the corresponding two holes in the bottom of the case. The components are next wired up on the board, flexible insulated wires being fitted for external connections. The board is then mounted with 6BA bolts and nuts to the case bottom. Spacing washers are required between the board and the case bottom as, without these, the panel may crack when the nuts and bolts are tightened.

The connections external to the board are then completed. The lead to 'VR1 and chassis' connects first to the track tag of VR1 which corresponds to full anticlockwise rotation of its spindle. A second lead then continues this connection to the tag under the securing nut for SK1. The lead to 'VR1' connects to the remaining track tag of the potentiometer. The lead to 'VC1 and L1' connects to the fixed vanes tag of VC1, to which is also connected one lead of the ferrite aerial winding. The other external connections in Fig. 3 are self-evident and require no further explanation.

The remaining ferrite aerial winding lead connects to the tag of VR1 which has already been connected to the solder tag at SK1. The negative battery lead connects to the tag at SK1, whilst the positive battery lead connects to the appropriate tag of switch S1. The battery is installed at the extreme left end of the case, as seen from the front.

It will be noted that, whilst the front panel is at the same potential as the negative supply rail, no connection is made to the rear panel. There is no necessity to make any connection to this panel.

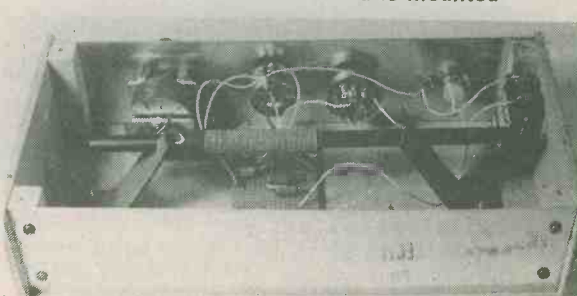
USING THE UNIT

The preselector is connected to the receiver via a length of 75Ω coaxial cable, the outer braiding of which bonds together the preselector front panel and the receiver chassis. The coaxial cable should be no longer than is absolutely necessary.

VC1 should always be adjusted to peak the desired signal, and it will need adjustment every time the tuning of the receiver is changed by a significant amount. This will ensure the greatest freedom from unwanted signals and will provide good stability. The tuning of the preselector is quite sharp, but there is no need to fit a slow motion drive if a large control knob is fitted.

The position of the coil on the ferrite rod deter-

A view from the rear, illustrating the manner in which the ferrite aerial rod is mounted



mines the frequency coverage of the unit. The coil can be placed in any position which enables VC1 to tune over the same range as the receiver. The preselector covers a range of frequencies that is wider than the normal medium wave band, and the positioning of the coil is therefore not critical. When a suitable position has been found, the coil is held in place on the rod by means of a band of insulating tape. This ensures that the coil will remain firmly in the correct position.

It would be normal practice for the r.f. gain control in the preselector to be advanced no further than is necessary to provide good signal strength from a desired transmission. Too high an output could cause an excessive signal level in the receiver and increase the possibility of cross-modulation with unwanted signals. However, the author found that, with a MOSFET in the preselector and another in the receiver mixer stage, there was very little trouble with cross-modulation even when the r.f. gain control was well advanced. The good r.f. selectivity resulting from the use of the preselector also aids in giving freedom from cross-modulation.

The preselector alongside the medium wave DX superhet which was described in the last two issues of this journal

If the preselector is employed with receivers other than that described in the last two issues the risk of cross-modulation may be higher, whereupon the setting of the preselector r.f. gain control is more important.

It should be remembered that the ferrite aerial is directional. If necessary, the preselector can be rotated so that it peaks a wanted signal or nulls an interfering signal. ■

Pioneers By The Sea

by Ron Ham

There are few things which will restrain the enthusiasm of the keen radio amateur who is working with new equipment at frequencies higher than the norm. Our contributor reminisces on two sets of experiments separated by 30 years and both, strangely enough, centred on Littlehampton in Sussex.

Since the late 1940's, frequencies in the range of 40 to 70MHz have been employed by the BBC to provide many homes in the United Kingdom with television pictures and, during the past decade, radio amateurs have freely used frequencies above 1,000MHz for communication.

Today, we are inclined to take these facts for granted, but things were not always like this as the writer discovered recently when researching material about early amateur radio activity.

REPORT FROM 1932

In September 1932 the following item was published in **The T. & R. Bulletin** which, at that time, was the official journal of the Radio Society of Great Britain.

'The event of the month was a 56mc. camp by the sea. On Saturday, July 26, G2DC, G6GZ and 2BRP went down to Rustington, Sussex, with a complete TX and fixed up the camp.

'With the dawn of Sunday came the rain, which continued throughout the day. In spite of the awful weather, G2NH, G2YD, G2DZ, G2MR, G5JZ, G5UI, G6NK and G6BU arrived during the course of the morning. By this time, the weather was so bad that it was decided to abandon the camp and to move into Littlehampton. This was done, and midday found us with the 56mc. transmitter set up in a garage. The aerial, a half-wave ZEPP, was attached to an old curtain pole stuck in the ground and about 10 feet high. G2DC then cruised about Littlehampton with his RX in a car and R9 signals were received while on the move with little or no difficulty.'

30 YEARS LATER

This reminded the writer of an event he witnessed 30 years later, almost to the day, when a small group of amateurs carried out a similar experiment. But this time the frequency used was 1,240MHz higher.

In July 1962, G3FP and G3FEX met at the Littlehampton house of the late Eric Cosh, G2DDD, where Eric had previously installed some home-brew equipment for the 23 centimetre band. During the morning, G3FEX arrived by car in which he had his 23 centimetre transmitter and an 18 inch dish reflector behind a FEX special dipole.

After lunch, G3FP and G2DDD settled down by their receiver while G3FEX set off with his transmitter on a tour around Littlehampton in his car, with the writer sitting in the back holding the dish aerial out of the window.

On arrival back at G2DDD, we were told that strong signals were removed most of the time, and the reflection of these u.h.f. signals from high buildings was very pronounced. Incidentally, this latter experiment took place over 14 years ago, long before today's super semiconductors were available for the band.

The enthusiasm of these radio pioneers should never be forgotten. ■

RECENT PUBLICATIONS

SEMICONDUCTOR DEVICES. By Noel M. Morris. 191 pages, 235 x 150mm. ($9\frac{1}{4}$ x 6in.) Published by The Macmillan Press Ltd. Price £4.35.

The title of this book is no misnomer; it is designated "Semiconductor Devices" and it covers all semiconductor devices currently in use. For completeness it even takes in liquid crystal displays, although these are not in the semiconductor family.

The book commences with the physical basics of semiconductor materials, discussing atomic structure, energy bands, Fermi energy level, holes, electrons and allied subjects up to metal-to-semiconductor junctions and applications of semiconductor materials. The second chapter carries on to the simpler semiconductor devices such as thermistors, magnetoresistors and photoconductors, and is followed by a chapter devoted to diodes and the unijunction transistor.

The bipolar transistor appears in the fourth chapter, which also describes transistor amplifiers and logic gates, whilst the fifth chapter deals similarly with field-effect transistors. The sixth chapter proceeds to integrated circuits and includes information on such frequently misunderstood items as Schottky diodes and Schottky transistors. Charge-coupled devices and semiconductor memories are described in the next two chapters, being followed by a chapter covering thyristors and other multi-layer devices. The tenth and final chapter is devoted to optoelectronics and discusses devices which are activated by light and devices which generate light.

Mathematics at a very simple level is employed where applicable and the book forms an excellent text and reference work both for readers who wish to expand their understanding of semiconductor devices and for the more experienced who wish to revise or update their existing knowledge. The book is one of the Macmillan Basis Books in Electronics and the normal price is quoted at the head of this review. It is understood that it may be obtained at a lower price, as noted elsewhere in this issue.

VHF/UHF MANUAL, Third Edition. By D. S. Evans, PhD, AIM, G3RPE and G. R. Jessop, CEng, MIERE, G6JP. 416 pages, 245 x 185mm. ($9\frac{3}{4}$ x $7\frac{1}{4}$in.) Published by the Radio Society of Great Britain. Price £4.95.

Ever since its inception in 1969 the R.S.G.B. "VHF/UHF Manual" has been a best seller around the world as a standard text book on the theory and practice of amateur transmission and reception at frequencies above 30MHz. This third edition maintains the standard of the previous editions and includes for the first time a complete chapter on amateur microwave techniques up to 24GHz. Another innovation is a chapter on space communication which is particularly intended to assist the amateur in making the most of this exciting development. A data section has been added, and this includes inductance charts for small v.h.f. coils and rods. In general, the whole book has been revised and updated, and it is now presented in a larger format.

As with all R.S.G.B. technical publications, the book is liberally illustrated with clear diagrams and photographs. Numerous circuits and drawings are employed in the description of practical v.h.f. and u.h.f. equipment, with active devices ranging from valves to integrated circuits.

If necessary, "VHF/UHF Manual" may be obtained direct, at the cover price plus postage, from Radio Society of Great Britain, 35 Doughty Street, London WC1N 2AE.

110 ELECTRONIC ALARM PROJECTS FOR THE HOME CONSTRUCTOR. By R. M. Marston. 120 pages, 215 x 135mm. ($8\frac{1}{2}$ x $5\frac{1}{4}$in.) Published by The Butterworth Group. Price £2.95.

Most electronic alarms are, in general, relatively simple circuits to assemble and wire up but they can nevertheless incorporate a considerable amount of ingenuity in their conception and operation. In this book R. M. Marston describes a very wide range of alarms, employing electronic components that are readily available to the home constructor.

The first chapter deals with alarms which are actuated by the closing or opening of a set of contacts. The contacts may be those of a microswitch, a pressure-pad switch or a magnetically operated dry reed switch. Alarms are sounded by a bell or buzzer which is turned on by a relay or silicon controlled rectifier. Alternatively, the alarm can be given by a speaker coupled to an audio oscillator which may, if desired, be pulsed or offer a warble-tone. Latching facilities for the more comprehensive circuits are provided.

This approach continues into the second chapter, in which burglar alarms are described, and the third chapter, which covers temperature-operated alarms. Here, the temperature sensing device can be a thermostat, a thermistor or a silicon diode. The fourth chapter is devoted to light-sensitive alarms incorporating a light dependent resistor, and include alarms which are actuated by smoke.

Next follows a chapter on miscellaneous alarm circuits, whilst the sixth chapter deals with automobile anti-theft circuits. The final chapter discusses instrumentation alarms, which are triggered by electrical malfunctions.

A notable feature is the extensive use of CMOS logic elements. These reduce stand-by current consumption to very low levels, a valuable advantage when the alarms are battery powered.

SUGGESTED CIRCUIT

ELECTROLYTIC CAPACITANCE METER

By G. A. French

A component whose value is notoriously difficult to measure with simple test equipment is the electrolytic capacitor. Apart from the fact that electrolytic capacitors have high values of capacitance and consequently low reactances, it is also necessary to apply polarising voltages to them during the process of measurement. These two factors introduce complications when attempts are made to measure electrolytic capacitance with basic bridge circuits and the like.

This month's article in the "Suggested Circuit" series describes a circuit which is capable of offering reasonably accurate measurements of the values of electrolytic capacitors by taking advantage of the behaviour of two capacitors when they are connected in series. It will also indicate whether or not a capacitor being measured has an excessive leakage current. Repeatability of readings is excellent and the main limitation on accuracy is imposed by the fact that the standard capacitors against which measurements are made are themselves electrolytic, and can therefore be subject to the rather wide tolerances on value which apply to aluminium electrolytic capacitors. However, two of the three standard capacitors could, at a slightly higher cost, be tantalum types with a tolerance of 20%, whereupon the accuracy of readings on the corresponding two ranges becomes quite attractive when it is considered that the capacitors being checked are electrolytic types.

The circuit has three ranges and is capable of measuring capacitance from 2μF to 5,000μF. The only expensive item in the circuit is a 0-100μA meter, and this can be dispensed with if a multimeter having a 0-100μA, or a 0-50μA, d.c. current range is available.

BASIC PRINCIPLE

The capacitance meter functions by reason of the distribution of charge when two discharged capacitors in series are connected to a direct voltage. Fig. 1(a) shows the two capacitors, which are designated CA and CB respectively. The terms CA and CB apply also to their capacitance values. When the switch in this diagram is open the two capacitors are discharged.

Closing the switch, as in Fig. 1(b), causes the two capacitors to charge, the total voltage across them being equal to the supply voltage. The relationship between charge, voltage and capacitance for a capacitor is given by

$$Q=VC$$

where Q is the quantity of electricity in coulombs which has flown to create the charge, V is the voltage across the charged capacitor and C is the value of the capacitor in farads. Q, the quantity of electricity, defines the number of electrons which have flown to set up the charge. Since the two capacitors are in series it is obvious that there has

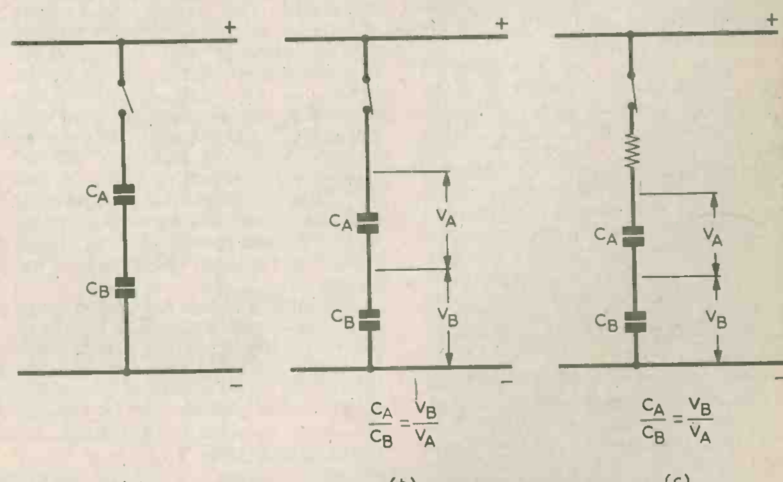


Fig. 1(a). Two discharged capacitors in series. The terms CA and CB apply both to the capacitors and their capacitance
(b). Closing the switch causes the voltages across the capacitors to have the relationship shown in the equation
(c). The same relationship exists when resistance is inserted in series with the capacitors

been the same flow of electrons in each, whereupon both capacitors have the same value of Q.

The flow of electrons occurs at the instant of closing the switch. If the capacitors had high values the flow of electrons could be indicated by a current-reading meter, and this meter will give the same reading if it is inserted into the charging circuit at any point. The electrons do not, of course, flow through the capacitors themselves; they flow to constitute a self-retaining electric field between the capacitor plates.

Since the value of Q is the same for both CA and CB, it follows that the expression VC will also be the same for both capacitors. Taking the voltage expressions shown in Fig. 1(b), CA multiplied by VA is then equal to CB multiplied by VB, this simplifying to the equation shown in the diagram.

It is an easy matter, with high value capacitors, to measure the voltage VB, whereupon if either CA or CB is known it is possible to determine the value of the other capacitor. It is not necessary to know the value of VA because this will simply be the supply voltage minus VB. Should we use the circuit for measuring unknown capacitors either CA or CB can be the unknown capacitor, with the remaining capacitor being a known standard component. However, if CA is the standard capacitor and CB the unknown capacitor, the voltage VB will reduce as the value of CB increases. On the other hand, if CB is the standard the voltage VB increases as the unknown capacitance, CA, increases. Psychologically, there is a marginal advantage in having voltage VB increase as the unknown capacitance increases (even when there is not a linear relationship between the two) and in the practical capacitance meter CB is the known standard and CA the unknown test capacitor.

In Figs. 1(a) and (b) it is assumed that there is no series resistance in the circuit. In practice some resistance must be present, and in Fig. 1(c) a physical resistor is inserted in series with the two capacitors. This resistor can have a relatively high value whereupon, after closure of the switch, a significant time elapses before the two capacitors become fully charged. When they are fully charged the same voltage and capacitance relationship as in Fig. 1 (b) exists, because once again there has been the same flow of electrons in each.

Some readers may find it difficult to visualise the d.c. conditions of Figs. 1(b) and (c) in terms of electron flow and the consequent voltage across each capacitor. They may find it helpful, alternatively, to assume that after the closing of the switch the two capacitors are subjected to a small fraction of an alternating voltage cycle, whereupon the voltages across them become proportional to their reactances. Since capacitive reactance is inversely proportional to

$C_B = 100\mu F$	$V_{supply} = 100V$	
$C_A\ (\mu F)$	V_A	V_B
10	91	9
20	83	17
30	77	23
40	71	29
50	67	33
60	62	38
70	59	41
80	56	44
90	53	47
100	50	50
200	33	67
300	25	75
400	20	80
500	17	83
1,000	9	91

Fig. 2. Table showing the values of VA and VB for different values of CA under the conditions noted. To ensure accurate meter readings only the range from 20 to 500µF is employed in the practical capacitance measuring circuit

capacitance value, the same results are given.

If, in Figs. 1(b) and (c), CA is equal to CB, it is obvious that VB will be equal to VA. Should CA be twice CB, then VB will be twice VA. When CA is four times CB, VB will be four times VA.

Fig. 2 gives a table showing the values of VA and VB for different values of CA, it being assumed that CB is 100µF and the supply voltage is 100 volts. The voltage figures are calculated to two significant figures. The capacitance and voltage ratios just mentioned can be noted in the table, as also can other readily calculable ratios, such as occur with CA at 50µF and at 300µF. As we have already seen, the value of VB increases with increasing value in CA. To obtain good indications of capacitance against meter resolution, only the range between 20 and 500µF is used in the practical version of the meter.

The table assumes a supply voltage to 100 volts, whereupon the figures in the VB column represent a percentage of supply voltage, and can be considered as a percentage of any other supply voltage which may be chosen.

FULL CIRCUIT

The full circuit of the electrolytic capacitance meter appears in Fig. 3. Here, CA is replaced by the test capacitor and CB is replaced by C1, C2 or C3 according to the position of the range switch S2. When S2 is in position 2 it selects a 100µF capacitor and the usable part of the resultant range is taken as being 20 to 500µF. On position 1, S2 selects a 10µF capacitor and the resultant range is 2 to 50uF. The 1,000µF capacitor, C3, is switched in on position 3, giving a range of 200 to 5,000µF. Thus, the total measurement capability is 2 to 5,000µF, with good overlap between ranges.

When S1(a)(b) is in position 2, the test capacitor and the standard capacitor are held discharged via the 33Ω resistors R2 and R3 respectively. Setting S1(a)(b) to position 1 removes the short-circuits from the capacitors and allows them to charge via R1. The voltage across the capacitors increases until it reaches approximately 5.1 volts, whereupon zener diode ZD1 becomes conductive and no further charging current flows. The two capacitors can, in consequence, be looked upon as having a supply voltage that is equal to the zener voltage of ZD1. This voltage will be adequately stable despite relatively wide variations in voltage from the 9 volt battery BY1.

The voltage across the standard capacitor switched in by S2 is measured by a simple electronic voltmeter which draws negligible input current. This incorporates the Darlington pair given by TR1 and TR2, which offers an extremely high level of current gain from the base of TR1 to the emitter of TR2. M1, in series with R5 and VR1, gives an indication of the voltage at the emitter of TR2. VR1 is set up so that the meter gives an f.s.d. reading when the voltage at the base of TR1 is the same as the zener voltage of ZD1. Since the scale of M1 is graduated from 0 to 100, the readings it gives are precisely the same as those in the VB column in Fig. 2.

The voltage at the emitter of TR2 is about 1.2 volts negative of that at the base of TR1 because of the base-emitter voltage drops in the two transistors. The negative terminal of the meter has to be taken to a voltage which is similarly negative of the lower 9 volt rail, in order that it will read zero when the voltage across the standard capacitor is zero. The meter terminal is in consequence returned to the slider of VR2, which functions as a panel set-zero control. Resistor R4 is included to ensure that an emitter current still flows under zero voltage conditions. Without R4 the electronic voltmeter would be non-linear near the zero volt end of the scale and it would be impossible to zero-set the meter.

Switch S3(a)(b) is the on-off switch, and it disconnects both batteries when it is turned off. The current drawn from BY1 with S1(a)(b) in position 1 is normally about 4mA, which flows mainly through R1, whilst that from BY2 is approximately 6mA.

In use, the capacitor to be measured is connected with correct polarity to the test terminals, S1(a)(b) being in position 2. S2 is set to the range required. The capacitance meter is turned on and S1(a)(b) set to position 1. The reading in M1 will then rise until it reaches a steady level. S1(a)(b) is next taken back to position 2 and returned to position 1. If the reading in M1 is the same as before then the value of the test capacitor can be taken from this. Should the reading be lower than before, then S1(a)(b) should be operated one or more times again until the same reading is given by the meter on successive occasions when the switch is at position 1. The reason for this procedure is that some capacitors, if they have been in store for a considerable period, draw an initial polarising current, in excess of the normal leakage current, which "forms" the electrolyte in the capacitor. This current flows for only a short period before the capacitor reverts to normal functioning, but it will cause the capacitance meter to give a false high reading when it exists. The author checked a considerable number of capacitors in the prototype circuit and found that about one in a dozen exhibited the polarising current effect, and that even the worst case was cleared after S1(a)(b) was operated four times. All the remainder gave the requisite final reading at the first and all subsequent operations of S1(a)(b).

It may be considered surprising that voltage conditions remain stable after S1(a)(b) has been set to position 1 and the capacitors have charged, and it may be thought that the voltage applied to the base of TR1 could drift due to leakage current in the capacitors. In practice, it was found that the voltage at TR1 base remained quite steady after S1(a)(b) had been operated, and certainly so for a far longer period than was needed to read M1. This performance is typical of what is offered by normal modern electrolytic capacitors. If the test capacitor passes a high leakage current, the reading in M1 will tend to gradually increase, but such an effect was not present with any of the capacitors checked by the author.

COMPONENTS

All the components can be standard parts. S1(a)(b) should be a d.p.d.t. toggle switch, as it is essential that the short-circuits be removed from the capacitors before R1 is connected to the test capacitor. S2 may be a rotary switch and S3(a)(b) either toggle or rotary. VR1 can be a standard or miniature skeleton potentiometer. Alternative values which can be employed for VR1 and VR2 are 22kΩ and 470Ω respectively.

As was mentioned at the start of this article, the standard capacitors are electrolytic, with the usual broad tolerance on capacitance. It is possible, however, for C1 and C2 to be 20%

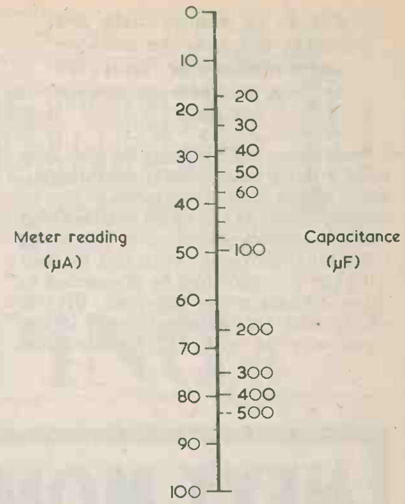


Fig. 4. Conversion chart for Range 2

tantalum and these would impart a relatively good degree of accuracy to Ranges 1 and 2. C3 would still have to be an aluminium component although it could, if desired, be selected (with a fair degree of accuracy) with S2 set to Range 2, working to a reading of 91μA in the meter. So far as aluminium electrolytic capacitors are concerned, Mullard tubular subminiature types appear to have the closest tolerance, at plus 50 and minus 10%. The working voltages of C1, C2 and C3 can have any value between 5 and 30 volts.

The testmeter may be assembled in a plastic or wooden case. A metal case is probably best avoided due to the difficulty of finding a chassis point in the circuit which (as would be desirable) is common with one side of the test capacitor. Mounted on the front panel are the meter, the three switches and VR2.

When the unit is completed, it is necessary to set up VR1. The test terminals are short-circuited together and the capacitance meter is switched on with S1(a)(b) in position 2. VR1 should be adjusted to insert maximum resistance into circuit. VR2 is then adjusted for a zero reading in the meter. S1(a)(b) is next set to position 1 and VR1 adjusted for an f.s.d. reading in M1. S1(a)(b) is returned to position 2 and VR2 readjusted, if necessary. S1(a)(b) is then finally taken to position 1 and VR1 given any further final small adjustment that may be needed. The short-circuit is removed from the test terminals. No further adjustment is required in VR1. VR2 is adjusted from time to time during the use of the meter to take up falling voltage in BY2.

Since it is difficult to translate M1 readings into capacitance values by way of a table, Fig. 4 gives a conversion chart for Range 2. Capacitance values are divided by 10 on Range 1 and multiplied by 10 on Range 3.

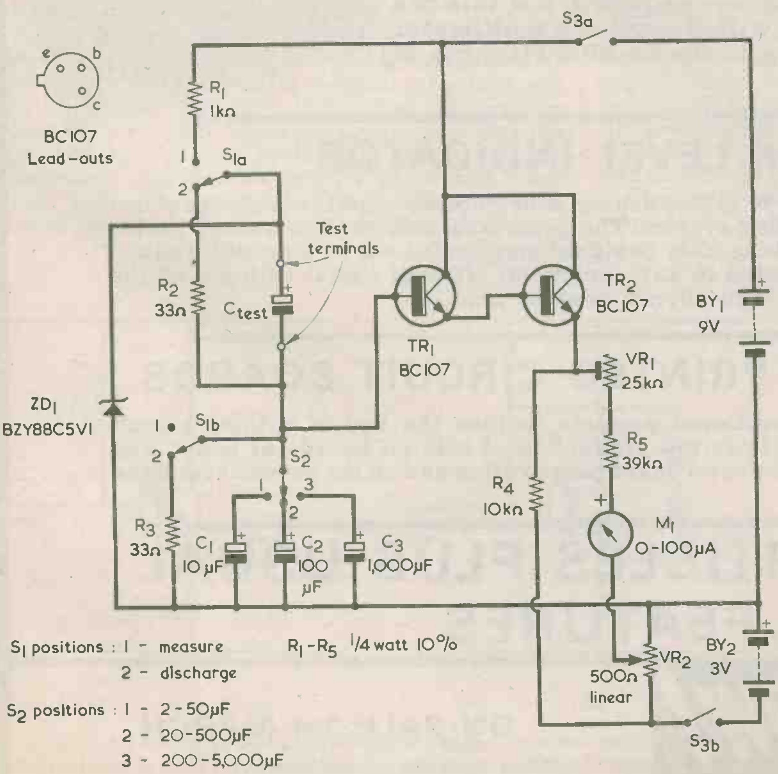
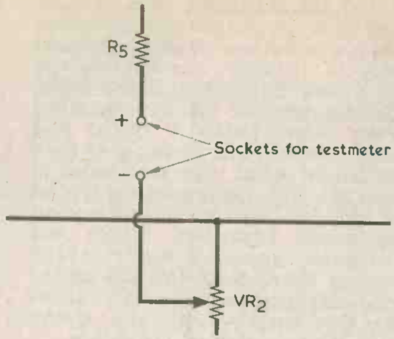


Fig. 3. The full working circuit of the capacitance meter

Fig. 5. To reduce costs, the meter M1 may be omitted and a multimeter connected to two sockets, as shown here



Some constructors may be reluctant to fit a fairly costly meter to an instrument which is not used extensively. In consequence, M1 may be omitted and two test sockets added, as in Fig. 5. An external multimeter switched to read 0-100μA d.c. can then be connected to these sockets when required. VR1 is set up with this external meter in the same way as with M1 in the unit.

Many testmeters have a 0-50μA range instead of a 0-100μA range, and this may also be employed, with R5 increased to 75kΩ and VR1 to 50kΩ or 47kΩ. The meter reading graduations in Fig. 4 then need to be changed from 0-100 to 0-50. ■

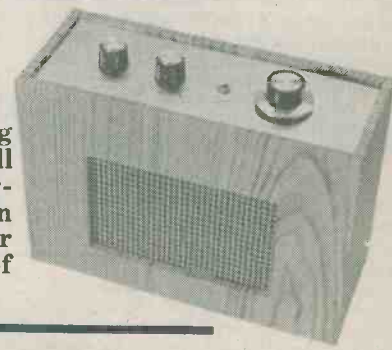
CMOS VOLTMETER

With reference to last month's article, some readers have experienced difficulty in obtaining the CA3130T. They are obtainable from Anglia Components, Burdett Road, Wisbech, Cambs., PE13 2PS, price £1.30 each inclusive of V.A.T. and postage.

NEXT MONTH IN RADIO & ELECTRONICS CONSTRUCTOR

SPECIAL FEATURES

MEDIUM AND LONG WAVE SUPERHET — Part 1 (2 Parts)



A basic design for a superhet receiver covering the medium and long wave bands. As with all conventional superhets, alignment of the mixer-oscillator and i.f. stages is required, but this can be carried out either with the aid of a multimeter or simply by working to the audible strength of received signals.

STEREO PEAK LEVEL INDICATOR

VU-meters are not able to give warning of brief peak signals which can cause overloading in a recording system. The peak level indicator described in this article responds instantaneously to signal amplitudes above a predetermined level, and can be connected to any equipment offering signal voltages at the overload level of more than 500mV peak-to-peak.

PRODUCING PRINTED CIRCUIT BOARDS

Many electronic constructional projects feature the use of printed circuit boards. This article reviews the production of printed boards at home, and offers much practical advice on board preparation and on the essential etching process.

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'NOTES FOR NEWCOMERS'

BOOTSTRAPPING

by

D. Snaith

Bootstrapping circuits are very common in present-day a.f. amplifiers. This article describes how they function and the advantages they provide.

Some eloquent and evocative expressions appear in electronics, notable amongst these being the term 'bootstrapping'. Bootstrap circuits were employed occasionally in the old days of valves, and they have now come fully into their own with transistor a.f. amplifiers. This is because of the ease with which bootstrapping can be employed in circuits incorporating emitter followers.

BATTERY BOOTSTRAP

In Fig. 1(a) we have a simple emitter follower stage, with R1 as the base bias resistor and R2 as the emitter load resistor. We apply an input signal to the base and take an output signal from the emitter. The resistor values are such that under no-signal conditions the base and emitter are at voltages which are approximately mid-way between the upper and lower supply rails. The transistor offers a relatively high current gain, with the result that the current flowing into the base is much lower than the current flowing out of the emitter. The value of R1 is correspondingly higher than the value of R2.

The voltage at the emitter of an emitter follower is lower than that at the base by a nearly constant voltage dropped across the base-emitter junction of the transistor. With silicon transistors this voltage drop is of the order of 0.65 volt. If we take the base positive by 1 volt the emitter goes positive by 1 volt. Similarly, if we take the base negative by 1 volt the emitter goes 1 volt negative as well. Thus, if an alternating input signal with a peak value of 1 volt is applied to the base the output voltage at the emitter has a peak value of 1 volt also. The emitter 'follows' the base (hence the name of the configuration) and the voltage gain can be taken as one, or unity. In practice the voltage gain is very slightly lower than unity.

The input impedance of the emitter follower is equal to R1 in parallel with the input impedance of

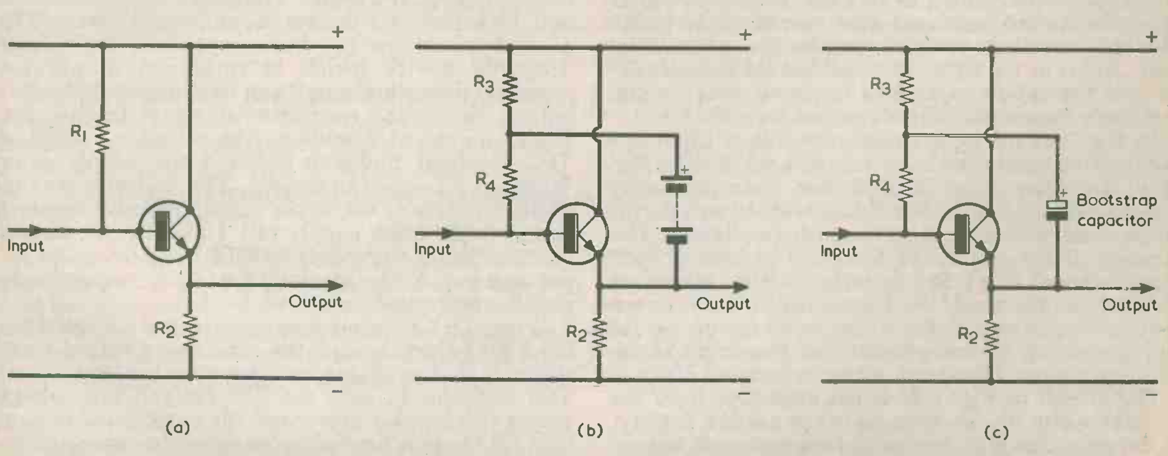


Fig. 1(a). A simple emitter follower stage. The input can be an audio frequency signal (b). The base bias resistor is split into two separate resistors, and the battery bootstraps their junction to the emitter (c). A more practical approach consists of employing a capacitor instead of the battery

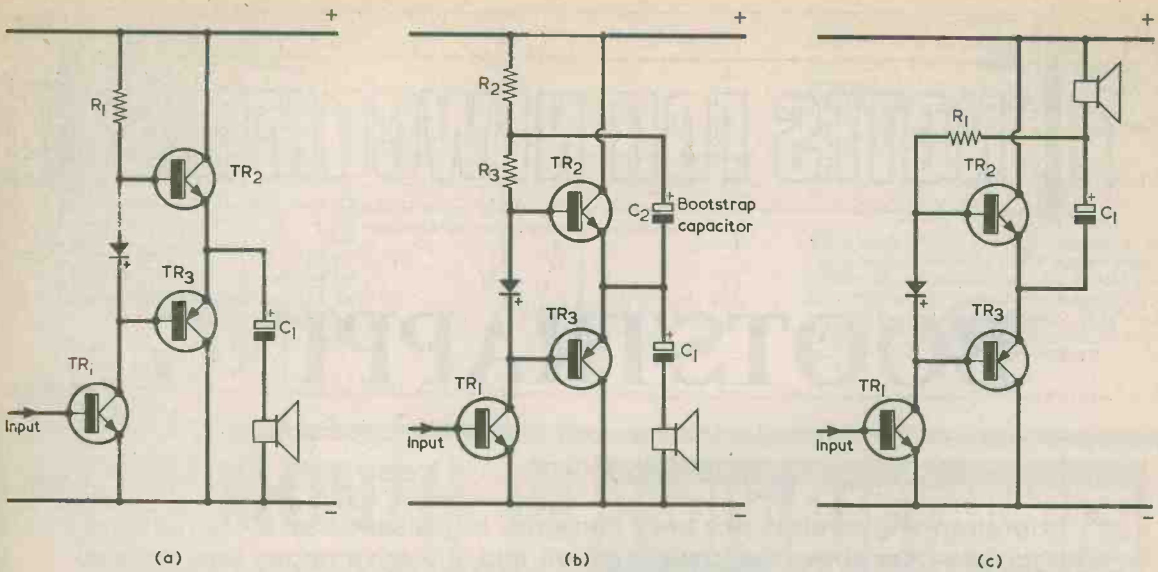


Fig. 2(a). A complementary a.f. output stage (b). Performance is improved by incorporating a bootstrap coupling back to the driver transistor collector load (c). A very simple output stage bootstrap circuit

the transistor at its base. With an emitter follower, base input impedance is approximately equal to the emitter load resistance, R2, multiplied by the hFE (d.c. current gain) of the transistor.

In Fig. 1(b) we split R1 into two resistors, R3 and R4, and connect a battery between their junction and the emitter of the transistor. The battery voltage is lower than the supply voltage and is such that the standing voltages in the circuit at the base and emitter remain the same as before. If we take the base positive by 1 volt the emitter goes positive by 1 volt as before, but so now does the upper end of R4. The same thing happens if we take the base of the transistor negative by 1 volt; the upper end of R4 goes negative by 1 volt too. The outcome is that the voltage across R4 remains constant despite the changes in transistor base voltage caused by the signal. When an alternating voltage such as an audio frequency signal is applied to the base no signal current flows in R4 because the voltage across it remains the same all the time. So far as the signal is concerned R4 does not exist and the input impedance becomes equal to the transistor base input impedance on its own.

In Fig. 1(a) the input impedance is base input impedance in parallel with the base bias resistor. In Fig. 1(b) the base bias resistor has been virtually eliminated so far as the signal is concerned and the input impedance is that of the transistor on its own. The junction of R3 and R4 is described as having been 'bootstrapped' by the battery to the transistor emitter, and the result has been a significant increase in signal input impedance. If we recall the phrase 'to pull oneself up by one's bootstraps' the origin of the electronic term 'bootstrap' starts to become clear.

The circuit of Fig. 1(b) is not attractive from the practical point of view because of the use of a battery. As, however, the only function of the battery is to apply the alternating signal at the transistor emitter to the junction of R3 and R4, it can be conveniently replaced by a capacitor having a low reactance at the lowest signal frequency to be handled, as in Fig. 1(c). Immediately following switch-on the capacitor charges to the standing voltage between the junction of R3 and R4 and the transistor emitter, after which it passes signal voltages from the emitter to the junction of R3 and R4. The performance of the circuit is not quite as perfect as was assumed when discussing Fig. 1(b), because the voltage gain of the transistor is very slightly lower than unity and because, now, there may be a slight loss of signal voltage coupling in the capacitor at low frequencies, but it closely approaches the perfect performance.

OUTPUT STAGE

Bootstrapping is very commonly employed in the driver and output stages of transistor a.f. amplifiers. Fig. 2(a) shows a typical output stage without bootstrapping, and in this TR1 is the driver transistor and TR2 and TR3 the output emitter followers. The diode between the two bases represents the voltage dropping device which is employed to prevent crossover distortion, and it can be considered as offering no significant resistance at signal frequencies. Under quiescent conditions the collector voltage of TR1 is about mid-way between the supply rails. When an a.f. signal is present, TR1 collector may go positive nearly to the upper supply rail and negative nearly to the lower supply rail. Dutifully, the output emitters follow the collector of TR1 and drive the upper terminal of the speaker, via C1, correspondingly positive and negative.

When TR1 collector goes positive, the current driving TR2 (which is then the conducting output transistor) is that available via TR1 collector load, R1. If TR1 collector is near the positive rail the voltage across this resistor is low and the current it can pass into TR2 base is limited by its value. In consequence, if distortion of large positive-going signal half-cycles is to be avoided R1 needs to have a fairly low value, lower perhaps than is justified during the rest of the signal cycle.

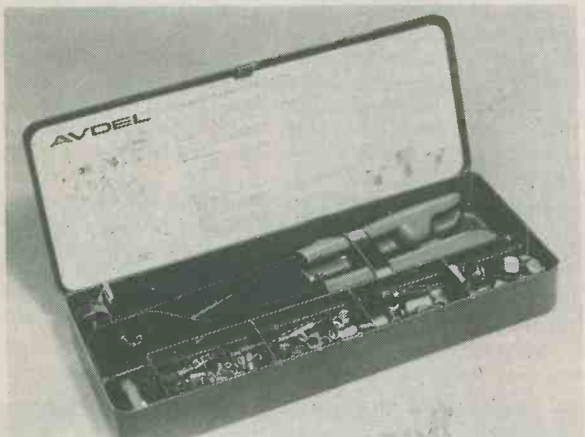
This difficulty is eradicated in Fig. 2(b) by splitting R1 into two resistors, R2 and R3, and bootstrapping their junction to the output emitters via C2. The upper end of R3 now goes positive and negative in sympathy with the output emitters and (ideally) no signal voltage appears across it. There is no problem with output base drive current when the collector of TR1 goes highly positive because the upper end of R3 is taken well positive, too. It will, indeed, go positive of the upper supply rail.

A further advantage is that the provision of bootstrapping causes the signal current flowing in R3 to be much lower than that in R1 of Fig. 2(a). In consequence, TR1 can offer a higher efficiency because part of its signal output is not wasted in its collector load resistor, as it was without bootstrapping.

An even simpler output stage bootstrap circuit appears in Fig. 2(c). Here, the speaker is connected to the upper supply rail and is driven via the capacitor C1. Under quiescent conditions the lower terminal of the speaker is at the same potential as the upper supply rail. When an a.f. signal is present the lower terminal of the speaker goes positive and negative of the upper supply rail as the output signal is fed to it. To achieve bootstrapping, the upper end of TR1 collector load resistor, R1, is then simply connected to the lower terminal of the speaker. ■

LABORATORY KIT

Introduction of boxed kits of nutserts and Avex rivets, with tools



Verospeed, the new Distribution Division of Vero Electronics Ltd., have now begun to introduce products in their own right. Two of the first such products are manufactured by Avdel Ltd., and consist of boxed kits of nutserts and Avex rivets complete with hand placing tools.

The thin sheet nutsert kit (see photograph) with its new easy to use hand tool is housed in an attractive steel box and includes a selection of M3, M4, M5 and M6 nutserts with the appropriate nose bushes and mandrels. The tool has been developed specifically to place a one piece insert giving designers a strong, deep vibration-proof steel thread in thin sheet applications down to a thickness of .020in. The operation requires access to only one side of the sheet, making it ideal for square tubing and box frame cabinets.

The threaded nutsert can be placed after painting without damage to the surface, thereby eliminating the need to blank prepared holes. M3 threaded nutserts are manufactured from brass and zinc plated. All others are made of steel and are also zinc plated. Additional nutserts can be supplied separately in packs of 100.

The Avex rivet kit follows the same principle as the nutsert kit, including a high quality, extremely robust hand tool ergonomically designed to place and positively fix an Avex in plastic, metal and wood — in fact, anywhere that two or more materials need to be joined tightly together. A selection of 3.2mm ($\frac{1}{8}$in.) and 4mm ($\frac{5}{32}$in.) rivets is alos housed in the same box.

Avex rivets are capable of joining a wide range of material thickness — a feature which drastically reduces the number of different sizes required for variable thickness applications.

The Avex rivet can be installed from one side of the work only — ideal for hollow tube applications. The expansion of the rivet during installation fills the hole and clamps the components tightly together. The rivet material flows both behind and in front of the stem during installation; the stem head is retained to plug the tail end of the rivet bore. This gives a vibration and weather proof seal and also means that hole size tolerances are less critical during assembly. All this is incorporated in the design of the rivet — all the operator has to do is insert the rivet in the nose of the tool, place the rivet in the hole and squeeze.

Details from Verospeed, Industrial Estate, Chandlers Ford, Eastleigh, Hants.

electronica 76

A report on some of the interesting exhibits: By David Gibson.

Electronica, the Munich electronics exhibition colossus, is over until 1978. Held every two years, this enormous German electronics show occupied some 80,000 square metres with its 20 "Halls." To get from a low number Hall to a higher number, one took a bus! Something like 1,600 companies had goods on display and exhibitors came from all over the world.

And what a galaxy of electronics interest it turned out to be. Even apparently uninteresting things like a mains cable caused a stir — perhaps it was because of the robot which kept dipping the luckless cable into a pot of molten solder — without any ill effects to the cable! The manufacturers claim that their cable can withstand temperatures up to +210°C. Phew!

At the other end of the technology scale was a tiny solid state television camera, about the size of a single lens reflex photographic camera. It used a 64 x 64 array of light sensitive diodes as its sensor. By splitting the image up into 4,096 little bits (64 x64) it was able to process the picture digitally. Resolution was surprisingly good and the accompanying electronics very simple.

Buzz word at the exhibition was "Microprocessor." This is the tiny chip (IC) which does all the work in routing and controlling all the signals in the modern computer (for example), making sure that all these signals, which are racing around the circuit in fractions of a second, arrive at the right place and at the right time; quite a task.

With just three chips you can build a computer — until Electronica. Now, a company has launched a complete computer on a single chip, and with an erasable memory in it, too. Housed in a 40-pin DIL package the whole thing looks just like any other DIL, just a little bigger. Perhaps the James Bond wrist watch computer isn't quite so far away after all?

The Germans view microprocessors very seriously as a major component and one which will influence electronics more and more in the coming years. Official figures in Germany put the sales of microprocessor ICs at around five million Deustchmarks (5M DM), that's about £1¼M. But over the next decade they forecast that this annual world sales figure will rise dramatically to 2000M DM (about £500M).

Two devices which drew much interest came from Japan. One was a shirt button size transducer. Placed in contact with the human body it can sense blood pressure which can then be measured.

The other device, similar in size, turned out to be a miniature ultrasonic humidifier. It transforms water into a very fine mist of the order of only a few microns.

Real miniaturisation was everywhere. One trimmer capacitor shown was only 3.5mm. in diameter. The newest V-Cal capacitors were interesting: they are fixed variable capacitors!

Basically the V-Cals comprise a little slab of ceramic with individual, minute plates sandwiched inside. These devices have a small pattern of tiny contacts on each side of their bodies. By connecting or shorting together these contacts in different patterns, one can vary the otherwise "fixed" capacitance between quite wide limits. Using an ordinary lead pencil one can 'draw' a short circuit with the lead between these contacts. Capacitance can be varied from 2pF to 57pF.

And now for something completely different — as the man on the Rockwell stand proclaimed. He was right, too. There was the Dynavit heart-monitoring bicycle exerciser; electronic, of course. To use it, you merely entered your weight, age and sex etc into the bicycle via a small calculator type keyboard on the

An electronic printer in a suitcase. Information is typed into a "memory." On pressing a button the entire information is printed out on electro-sensitive paper

One of the many electronic games exhibited. On the screen is the final score in a game of "bowls"

cycle itself. By wearing a small wristband sensor, your heart rate is automatically fed into the system. During your exercise period a built-in microcomputer calculates your "health factor" and displays this continually on a digital readout. The health factor scale goes from 0 to 150 with 50-75 being about average. Highly athletic types scored between 75 and 100. Your scribe's score will not be mentioned — sufficient to observe that he was immediately offered a cup of warm tea and a chair!

How small is small? One exhibitor showed four 'red' matches. But the head of one match had been removed and replaced by something slightly smaller — a filament light bulb. Ratings for this range of micro-miniature bulbs is 1V or 1.5V, and current from 6mA to 20mA. Dare I say, "Strike a light"?

Television games proved a popular feature and drew large crowds. One company has a games unit which may be used with colour or B/W receivers. It proved interesting in that a small cassette tape cartridge is used to programme in different games. One cassette, for example, gives four games; noughts and crosses, shooting gallery, and two doodle games which enable the user to draw (or doodle) with a choice of three colours (on colour receivers) and four line thicknesses.

Another cassette allowed the user to play the card game Black Jack against an electronic dealer while another variation on the same cassette catered for two players and a dealer.

The company says it intends building up a library of cassettes. At the moment three cassettes are offered giving a choice of eight different games. One further useful asset; the games can be made easy or difficult simply by pressing a button. There are four buttons giving four levels of required skill — Greenhorn, Amateur, Pro and Master.

And so the show went on. Television cameras so sensitive that they can transmit pictures when the scene is lit from the light of a single star (true — much to the joy of the Military). Other TV cameras differentiated between levels of heat and were sensitive in the infra red region only. One exhibitor amused passers by with a television screen which showed people passing in infra red (not a pretty sight!).

One clever radio receiver on show had an automatic scanning and tuning system. It will, on command, scan a set number of specified frequencies and, if a signal comes up on any one of them, will immediately spring to life, tune in the station and turn up the volume. It can scan the whole band, too, and can also be instructed to search for the strongest signal. A boon to short wave listeners but, alas, a professional piece of equipment and rather expensive.

Italian semiconductor manufactured SGS-ATES amused and fascinated music fans with a mini electronic organ rhythm generator. It generated manual, semi-automatic or fully automatic rhythms at the touch of a switch. It gave chords and arpeggios, too. Further, these could be played at an infinitely variable speed (just select and leave) and the whole tone rhythm could be raised or lowered over three octaves.

The SGS-ATES Mini electronic organ rhythm generator

A large number of audio and radio ICs were in evidence. One German manufacturer highlighted the TDA 2850 chip which houses the f.m. i.f. section of a receiver plus a 4W audio amplifier. Previously, they claimed, two chips were necessary to couple i.f. circuit with this level of audio power.

For the serious radio experimenter a frequency synthesizer IC was on show. It is capable of deriving practically any number of frequencies from a single quartz crystal and with the same stability as the crystal to which it is locked. Its range is 0 to 2.5MHz but a prescaler is available which extends this range (where needed) to 800MHz. It is possible to select any channel spacing starting from 100Hz.

The items mentioned represent a tiny fraction of the many interesting things on display. It is frightening to think that at the next Electronica, in two years time, a completely new batch of electronic wonders will be on show; an indication of the rate of innovation in electronics. ■

Photographs by David Gibson

MAG
CART
PRE-AMP

By R. Aen

Many hi-fi amplifiers have a in ceramic pick-up only. This acl amplifier which brings the outp o the same level as that of a ceram the necessary frequency re

It is probably true to say that the weakest links in most budget hi-fi record reproducing systems are the speakers and the cartridge. The reason is simple. In these days of inexpensive integrated circuits it is not difficult to design a low cost amplifier which has very low levels of noise and distortion and a very wide frequency response. To achieve low distortion and a wide, flat frequency response from speakers and cartridges is far more difficult, and in consequence this tends to greatly boost the price of very high quality units.

Most inexpensive audio systems use a ceramic cartridge and, unless this happens to be one of the few high quality types, a considerable improvement in the performance of the system can be achieved by replacing it with a magnetic type. Of course, magnetic pick-ups are more expensive than ceramic ones but not exorbitantly so, and this is almost certainly the most cost-effective way of improving most budget systems.

Unfortunately, it is not always a simple matter of changing the pick-up. Apart from such physical problems as determining whether the cartridge can be fitted to the pick-up arm and if the tracking weight can be adjusted to the correct level, it is very probable that the amplifier will not have an input suitable for a magnetic cartridge. The output from a magnetic cartridge is of the order of 100 times lower than that from a ceramic cartridge, and it is also necessary to provide electrical circuits to equalize its frequency response.

It will be helpful here to briefly consider certain aspects of disc recording before proceeding to the main subject of the present article. This is a practical design for a pre-amplifier which can be used as a ceramic to magnetic cartridge input converter and which can therefore be interposed between a magnetic cartridge and an amplifier input intended for a ceramic pick-up. The circuit could also be used as the magnetic pick-up pre-amplifier in a complete home constructed amplifier.

TYPES OF RECORDING

The basic method of modulating the audio signal onto a groove cut in the disc is well known. It is probably less well known that there are two recording systems which can be used when cutting the groove into the disc. These systems are called 'constant amplitude' and 'constant velocity' recording.

With constant amplitude recording the side-to-side displacement of the groove is proportional to the amplitude of the recorded signal, and the extent of

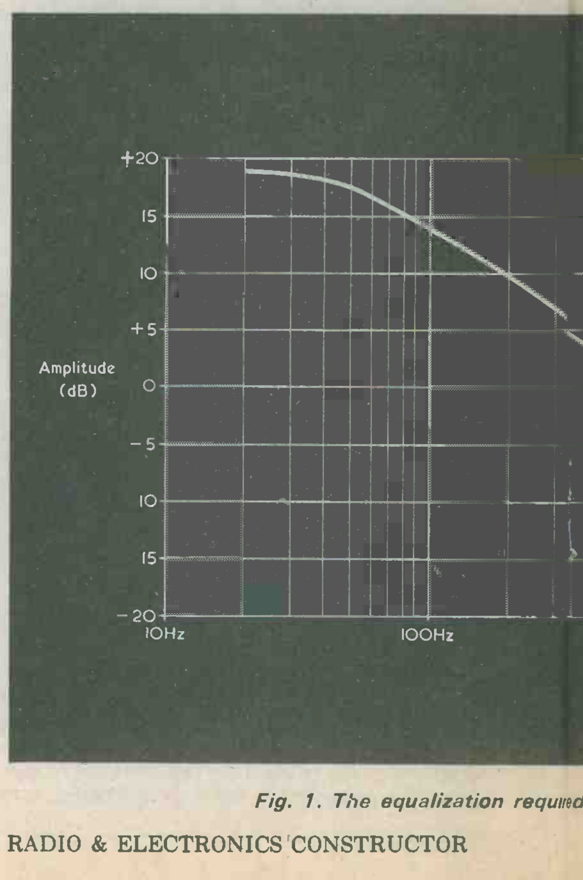


Fig. 1. The equalization requ

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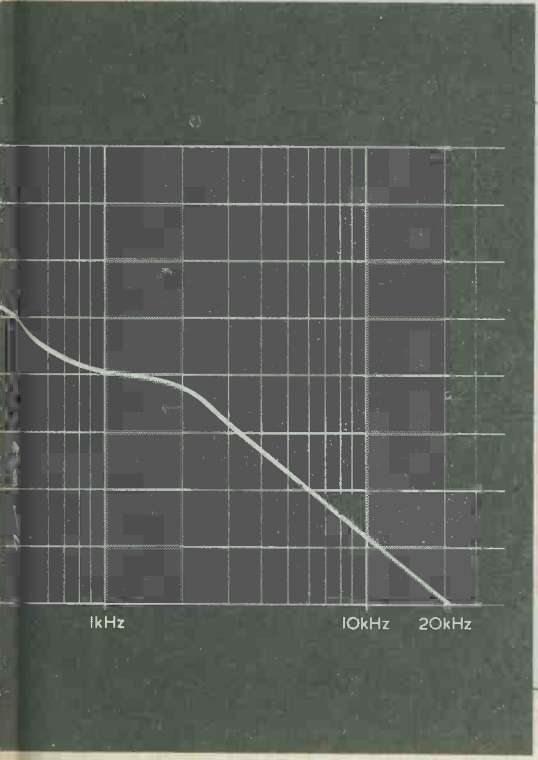
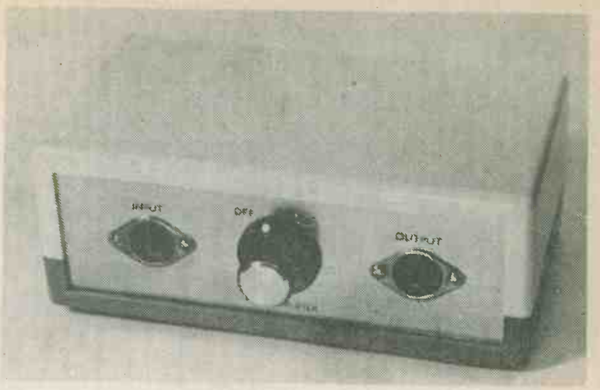
n input which is suitable for a rticle describes a stereo pre- ut of a magnetic cartridge up to nic pick-up, and which also gives response equalization.



red with a magnetic cartridge



this displacement is independent of frequency. A ceramic cartridge has an output amplitude which is proportional to the level of the record groove modulation, and this type of cartridge is therefore compatible with constant amplitude recording.

Constant velocity recording produces a speed of stylus movement which is proportional to the amplitude of the recorded signal. For a single recorded frequency this is no different to constant amplitude recording, since in order to increase the stylus speed the amplitude of the groove modulation must be increased. However, as frequency increases, the speed of the stylus will increase for a given level of recording signal. Thus, with constant velocity recording the amplitude of the groove modulation decreases with increasing frequency.

The output amplitude from a magnetic pick-up is dependent upon stylus velocity, and so a magnetic cartridge is compatible with constant velocity recording.

It is often said that discs are cut using the constant amplitude system and that no equalization is needed when a ceramic pick-up is used, and that equalization in the form of treble cut and bass boost is needed when a magnetic cartridge is employed. This is not entirely accurate, and in fact a form of constant velocity recording is used, but with a certain amount of treble boost. This enables treble cut to be applied in the playback equipment, giving a flat overall frequency response with a greatly improved signal-to-noise ratio.

A certain amount of bass cut is given to the recorded signal, and this is necessary as otherwise there would be excessively large groove modulation on high amplitude bass signals, with a possibility of groove wall collapse. Bass boost must be applied in the playback equipment for an overall flat response to be obtained.

The use of bass cut and treble boost during recording produces an approximation of constant amplitude recording. It is therefore possible to employ a ceramic cartridge quite successfully with a disc recorded by this system, even without any equalization in the playback equipment. When using a magnetic cartridge though, bass boost and treble cut must be added in order to obtain an overall flat frequency response.

The replay equalization characteristic which a magnetic cartridge pre-amplifier must provide is shown in Fig. 1. This is the complement of the recording characteristic.

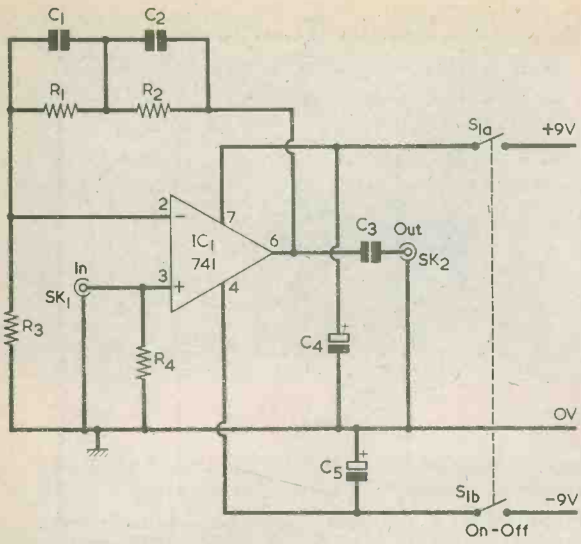


Fig. 2. The circuit of the left hand channel of the magnetic cartridge pre-amplifier. Apart from C4 and C5, this is duplicated in the right hand channel

PRACTICAL CIRCUIT

Fig. 2 gives a practical circuit for a pre-amplifier offering the gain and frequency equalization required for a magnetic cartridge. This circuit is for one channel in a stereo pre-amplifier, the other channel being identical.

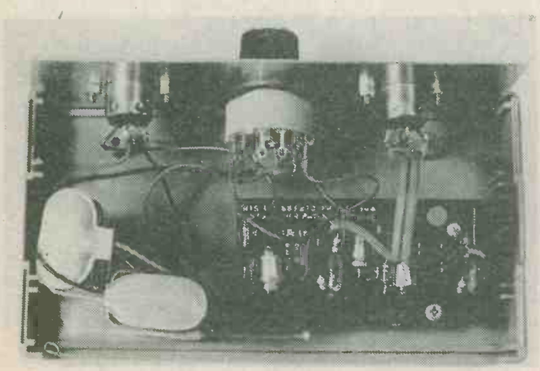
The pre-amplifier incorporates an operational amplifier i.c., which provides a high performance at low cost. The voltage gain of the circuit is equal to the sum of the impedance between the inverting input and chassis plus the impedance between the output and the inverting input, divided by the impedance between the inverting input and chassis. Two capacitors, C1 and C2, are included in the network between the output and the inverting input, and their reactance decreases as frequency increases. In general, therefore, voltage gain reduces as frequency increases, as is required by the response curve of Fig. 1.

C2 offers treble cut for the higher frequencies, and bass boost is provided by C1. The circuit requires a fairly high gain as the output from most magnetic cartridges at middle frequencies is only about 5mV. A signal amplitude of the order of 300mV is available at the output of the pre-amplifier, and this should be sufficient for the ceramic cartridge input of most amplifiers. C3 provides d.c. blocking at the output.

The input impedance is approximately equal to the value of R4 at the non-inverting input of the amplifier. This is 47kΩ, which is the recommended load impedance for most magnetic cartridges. A few cartridges require a different load impedance and the value of R4 can be correspondingly altered, if necessary. The input circuit is a little unusual in that there is no series d.c. blocking capacitor, whereupon the input bias current for the i.c. flows through the magnetic cartridge. However, the current will be in the order of nanoamps and this will not affect cartridge operation.

Two 9 volt PP3 batteries power the pre-amplifier, giving the usual dual supply rail required by an operational amplifier. Current consumption is only 3mA and the batteries will in consequence have a long life. S1 (a) (b) is the on-off switch and C4 and C5 are supply bypass capacitors.

A high level of performance is achieved, with an unweighted signal to noise ratio (input short-circuited) of approximately 66dB being obtained with the prototype. Total harmonic distortion is only a small fraction of 1%, and the unit has a high overload margin of almost 26dB.



A view of the interior, showing the component panel and the screened leads connecting to the input socket

COMPONENTS

Resistors
(All $\frac{1}{4}$ watt 5%)
R1, R1 (a) 220kΩ
R2, R2 (a) 15kΩ
R3, R3 (a) 390 Ω
R4, R4 (a) 47k Ω

Capacitors
C1, C1 (a) 0.018μF plastic foil (see text)
C2, C2 (a) 0.0047μF plastic foil
C3, C3 (a) 0.1μF plastic foil
C4 10μF electrolytic, 10V. Wkg.
C5 10μF electrolytic, 10V. Wkg.

Integrated Circuits
IC1, IC1 (a) 741 in 8-pin d.i.l.

Switch
S1 (a) (b) 2-pole 2-way rotary

Sockets
SK1 input socket (see text)
SK2 output socket (see text)

Miscellaneous
Verobox type 75-1238D
2 batteries type PP9 (Ever Ready)
2 battery connectors
Control knob
Veroboard, 0.1in. matrix
Screened cable
Wire, solder, etc.

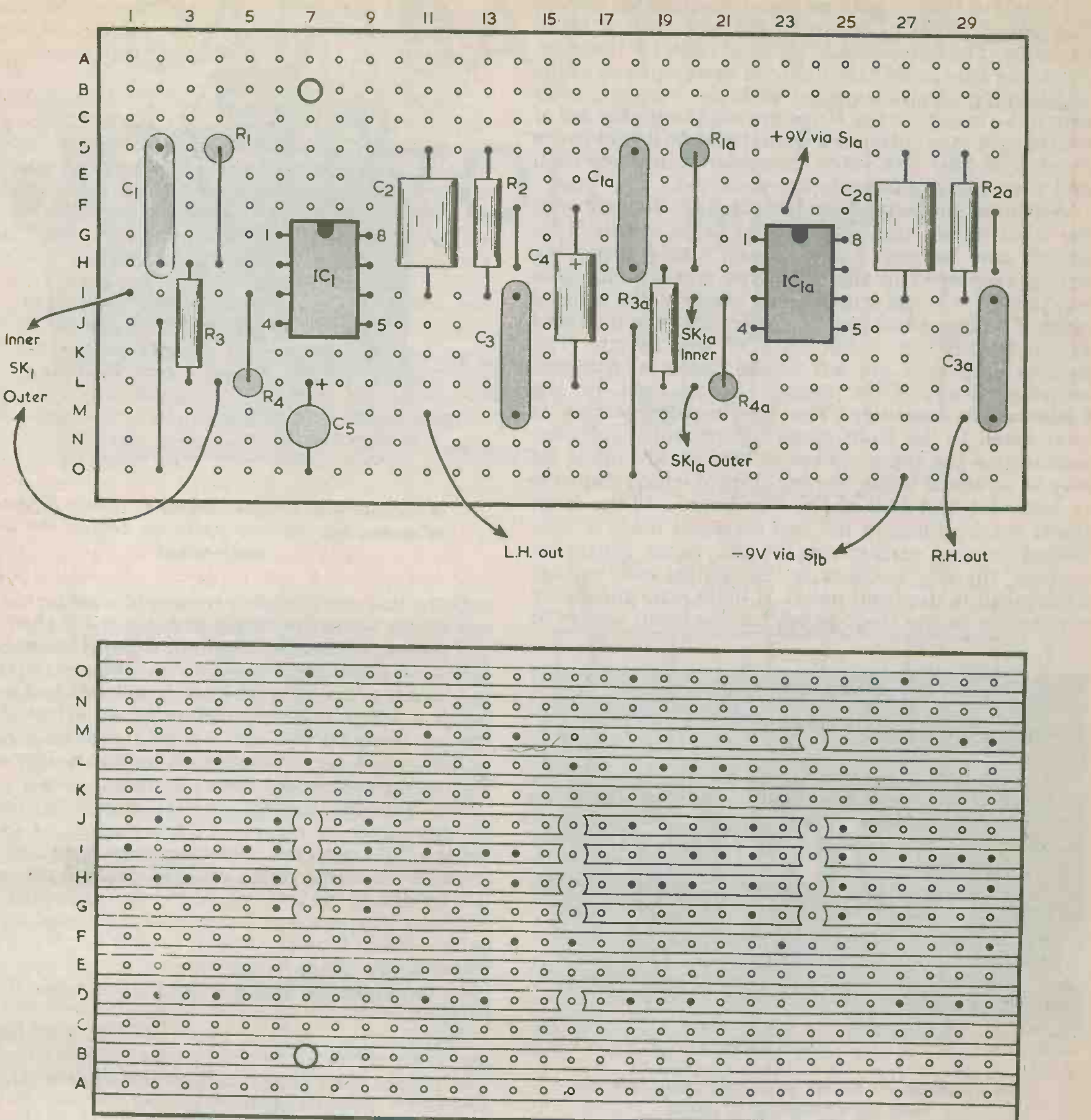


Fig. 3. The pre-amplifier components are assembled on a Veroboard panel. The component and copper sides of the panel are shown here

CONSTRUCTION

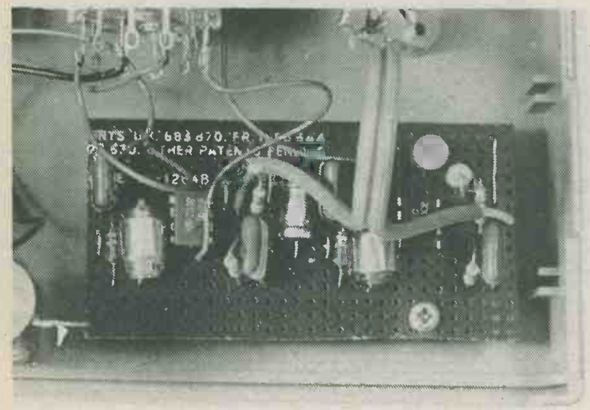
All the small components are assembled on a Veroboard panel of 0.1in. matrix, and full details of this are given in Fig. 3. Since the pre-amplifier is intended for stereo operation, all the components, apart from C4 and C5, are duplicated. Those in the left hand channel have the usual component number identification whilst those in the right hand channel have the suffix 'a'.

It will be noted that C1 and C1 (a) have the rather unusual value of 0.018μF. If capacitors with this value cannot be obtained it will be in order to employ 0.015μF plastic foil capacitors with 3,000pF (or 2,700pF) silvered mica capacitors in parallel. Polystyrene 0.018μF capacitors are available from Electrovalue Limited, 28 St. Judes Road, Englefield Green, Egham, Surrey. These are rather bulky, with a length of 32mm., but they could still be fitted onto the Veroboard panel.

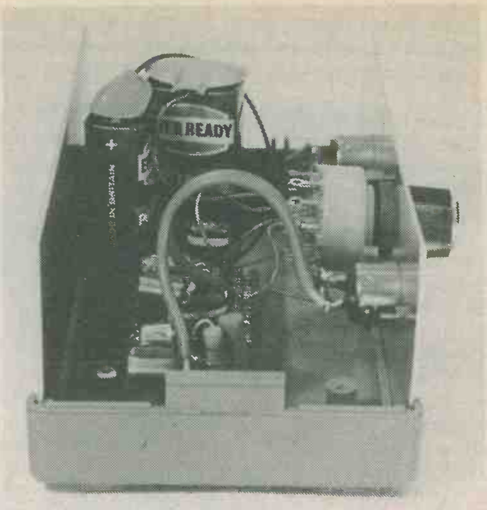
The unit is housed in a Verobox measuring 154 by 85 by 60mm., this being available from retailers, including Maplin Electronic Supplies, P.O. Box 3, Rayleigh, Essex.

Construction commences by cutting out a Veroboard panel of the required size with a small hacksaw. The panel should have 30 holes by 15 strips. Next, the hole at B7 is drilled out to accept one of the self-tapping screws supplied with the Verobox, after which the breaks in the strips are made with the aid of a Vero spot face cutter or a small twist drill held in the hand. The four link wires are soldered in place first, and then the components are mounted.

A 10mm. diameter hole is drilled in the centre of the front panel, and S1 (a) (b) is fitted to this. This switch can be any 2-pole 2-way rotary type; the switch employed in the prototype was a multi-pole component with no connections made to the unused poles. The input and output sockets are then mounted symmetrically on either side of the switch. The sockets employed are left to the choice of the constructor, 3-way DIN sockets being used in the author's pre-amplifier. The Veroboard assembly is next wired to the front panel components. The connections to the input socket or sockets are made by way of screened leads, the braiding of which connects to holes L4 and L20 of the Veroboard. At the front panel the braiding of the two screened leads is connected to the earthy side of the input socket or sockets, thereby connecting the central zero voltage supply rail to the front panel. If there is no automatic connection to the front panel via the input socket or sockets, this can be made by way of a solder tag under one of the socket securing nuts.



The component panel is comfortably laid out with no crowding of parts



A side view of the pre-amplifier. There is plenty of space for the two batteries behind the output socket

Two leads from the Veroboard panel connect to S1 (a) (b), and a further two unscreened leads to the output socket or sockets. The positive 9 volt and negative 9 volt battery leads are connected to S1 (a) (b), and the two leads for the zero voltage rail to an earthy tag of the output socket or sockets (or to a solder tag under one of the socket securing nuts).

When all this wiring has been completed the component panel is secured to the bottom of the case behind SK1 and S1. The Verobox specified has a suitable mounting pillar, and the panel is mounted on this by one of the self-tapping screws provided. There is plenty of space for the batteries to stand vertically behind SK2. A piece of foam rubber or plastic can be glued to the inside of the case lid at the appropriate place to retain the batteries in position when the lid is fitted.

In use, it is essential that the dual lead from the magnetic cartridge to the pre-amplifier be screened. The output lead from the pre-amplifier to the main amplifier should also be screened. ■

CATALOGUE

Now available is the 1977 Tandy catalogue. Fully illustrated, with many pages in colour, it lists more than 2,000 items which can be obtained at the 160 Tandy Stores currently operating in the U.K.

A large number of the items are manufactured domestic entertainment products, including in particular three stereo cassette decks incorporating Dolby circuitry, and a comprehensive music centre. There is an extensive list of radio receivers, these ranging from tiny portable broadcast band sets to a.m.-f.m. stereo units. The world of high fidelity is very well catered for and the catalogue offers a wide choice of speakers, headphones, amplifiers and other audio equipment. Many accessories are listed and even to be found are such items as sprung plastic inserts for the centres of 45 r.p.m. records.

The radio hobbyist is catered for as well, and included amongst the pages of the catalogue are lists of transistors, resistors, capacitors, integrated circuits, l.e.d.'s, photocells and many other items employed by the constructor. Further to be found are tools, soldering irons, equipment cases and multimeters, as well as kits for simple electronic projects.

The 1977 Tandy catalogue has 100 pages and may be obtained free at any Tandy Store. ■

CAR BATTERY MONITOR

By F. T. Jones

A simple circuit which gives a visual indication of car battery voltage. It is suitable for both 12 volt and 6 volt systems.

This little unit can be added to any car and it indicates the state of the battery by monitoring its voltage. Indications are given by three light-emitting diodes, of which one is green, one is yellow and the third is red. The green l.e.d. lights up when the voltage is equal to or greater than that of a fully charged battery, the yellow l.e.d. lights up for battery voltages between the charged and the discharged states and the red l.e.d. lights up for voltages at or below that of a discharged battery. One version of the circuit may be employed with a 12 volt car system and the other with a 6 volt system.

OPERATING VOLTAGES

The voltages at which the green l.e.d. gives way to the yellow and at which the yellow gives way to the red are pre-set, and can have any values within reason which are favoured by the user. The author feels that, in a 12 volt system, the voltage corresponding to a charged battery should be 13 volts and that corresponding to a discharged battery 10 volts, and these figures will be employed in the following description of circuit operation.

Fig. 1 shows the circuit of the unit and it will be assumed that this has the component values applicable to the 12 volt version. The two circuit points at the left connect to the car battery. It will be helpful to look upon the battery voltage as being initially very low, well below 10 volts, and then observe what happens as it is increased.

As soon as the battery voltage is raised above some 3 volts the red l.e.d., LED3, commences to glow, and it continues to glow as battery voltage increases. When the voltage comes close to 10 volts the potential at the slider of VR2 with respect to the negative rail rises to that needed (about 1.2 volts) for current to flow in the base-emitter junctions of the silicon transistors, TR3 and TR4. TR4 commences to draw a collector current through R4 and the yellow l.e.d., LED2. As the battery voltage further increases TR4 becomes turned fully on with only a low voltage, of about 0.2 volt or less, between its collector and emitter. The yellow l.e.d. glows at full brightness. Part of TR4 collector current flows through the now forward-biased diode, D2, whereupon the voltage across the red l.e.d. falls to 0.8 volt or less and it extinguishes.

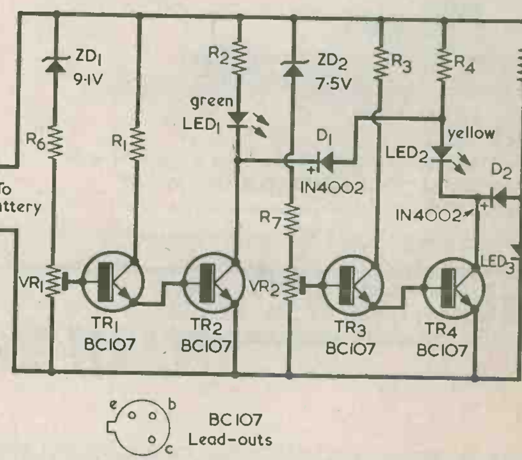


Fig. 1. The circuit of the car battery monitor. The l.e.d.'s light up as explained in the text to indicate battery voltage

The battery voltage continues to increase, with the yellow l.e.d. alight on its own. When the voltage reaches the 13 volt level, current flows from the slider of VR1 into the base of TR1 and a similar action to that given with TR3 and TR4 takes place. At about 13 volts TR2 turns fully on, causing the green l.e.d. LED1, to light up. At the same time D1 is now forward-biased and the voltage across the yellow l.e.d. becomes too low for this to be illuminated, and it extinguishes. The green l.e.d. then stays alight for all voltages above 13 volts.

COMPONENTS

12 VOLT VERSION

Resistors

(All fixed values 5%)

R1 10kΩ ¼ watt
R2 1kΩ ½ watt
R3 10kΩ ¼ watt
R4 1kΩ ½ watt
R5 1kΩ ½ watt
R6 2.7kΩ ¼ watt
R7 2.7kΩ ¼ watt
VR1 10kΩ pre-set potentiometer, skeleton, 0.25 watt
VR2 10kΩ pre-set potentiometer, skeleton, 0.25 watt

Semiconductors

TR1-TR4 BC107
ZD1 zener diode, 9.1V 5%, 400mW
ZD2 zener diode, 7.5V 5%, 400mW
D1, D2 1N4002
LED1 green l.e.d.
LED2 yellow l.e.d.
LED3 red l.e.d.

6 VOLT VERSION

Resistors

(All ¼ watt 5%)

R1 4.7kΩ
R2 390Ω
R3 4.7kΩ
R4 390Ω
R5 390Ω

Semiconductors

ZD1 zener diode, 4.3V 5%, 400mW
ZD2 zener diode, 3V 5%, 400mW

All remaining components as for 12 volt version.

The process just described would have occurred in reverse order if we had commenced with a battery voltage higher than 13 volts and reduced it to lower than 10 volts. The battery voltages at which the two pairs of transistors become turned on are, of course, controlled by the settings of VR1 and VR2. The manner in which these two potentiometers are set up is described later.

CIRCUIT PERFORMANCE

Fig. 2 shows the performance of the circuit in terms of battery voltage versus subjective observation of the l.e.d.'s. As battery voltage rises to 10 volts the red l.e.d. extinguishes rapidly whilst the yellow l.e.d. lights up with a slightly less rapid increase in brightness. A similiar effect takes place at 13 volts, at which the yellow l.e.d. extinguishes quickly and there is a slightly slower increase in brightness in the green l.e.d. It will be seen that there are two small areas of overlap, at which two l.e.d.'s are alight at the same time. This is an advantage, since two fairly precise indications of battery voltage are then given.

In the circuit, the voltage across VR1 and R6 is equal to the battery voltage less the fixed voltage dropped across zener diode ZD1. As a result the voltage rise across VR1 track is more rapid, with battery voltage increase, than would occur if a fixed resistor were employed instead of the zener diode. R6 is included in series with VR1 to limit current if VR1 slider is set to the upper end of the track. R7 is connected in series with VR2 for the same reason. The collector of TR1 is returned to the positive rail via R1 instead of being connected to the collector of TR2, as occurs in the familiar Darlington configuration. This method of connection gives slightly increased gain and permits TR2 collector to fall to 0.2 volt or less with respect to the negative rail when it is turned fully on whereas, with the Darlington configuration, the collector of TR2 would fall to some 0.8 volt. These are marginal advantages, but they nevertheless merit the inclusion of an extra fixed resistor. The remarks concerning ZD1, R1, TR1 and TR2 apply similarly to ZD2, R3, TR3 and TR4.

The three l.e.d.'s can be any types having maximum forward current ratings in the region of 30 to 60mA, and in the circuit they are operated at about 10mA or more. Suitable components are the light-emitting diodes Type 4, which are available from Doram Electronics Limited, P.O. Box TR8, Wellington Road Industrial Estate, Wellington Bridge, Leeds, LS12 2UF. These are supplied with a panel mounting bush, and the anode lead (which connects to R2, R4 or R5 as applicable) is identified by being shorter than the cathode lead. Diodes D1 and D2 are simply small silicon rectifiers, and 1N4002's were used by the author. VR1 and VR2 are skeleton pre-set potentiometers. They should be rated at 0.25 watt or more.

SETTING UP

The circuit is set up by applying the requisite voltages to the unit and adjusting VR1 and VR2 accordingly. Initially, the sliders of both these potentiometers are at the negative ends of their tracks. If

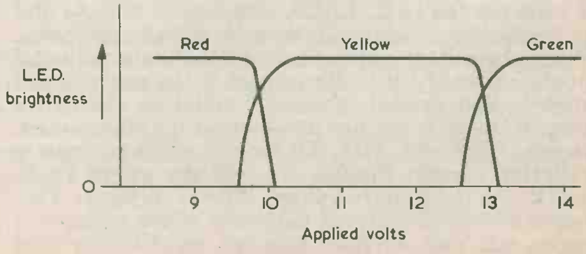


Fig. 2. Illustrating how the l.e.d.'s light up at different voltages from the battery

the discharge and charge voltages to be chosen are 10 and 13 volts respectively, a 10 volt supply is first applied. VR2 slider is then adjusted so that both the yellow and the red l.e.d.'s are illuminated. A supply voltage of 13 volts is next applied and VR1 is adjusted to cause both the green and the yellow l.e.d.'s to light up. The unit is then set up. As already stated, VR1 and VR2 can be adjusted for other battery input voltages.

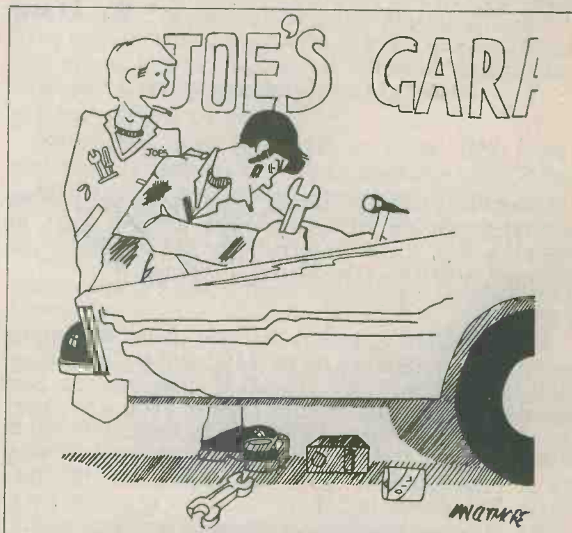
Obtaining the requisite input voltage is a very simple matter if a variable voltage power supply is available. Alternatively, batteries can be employed and it is in order to use dry batteries here if combinations can be devised which give the desired voltages. The input voltage should be checked with a voltmeter.

The current drawn from the battery is about 10mA when the red l.e.d. is alight, this rising to about 23mA when the yellow l.e.d. is illuminated and to about 37mA when the green l.e.d. is lit up. Such values are negligibly low in an electrical system where current levels are normally defined in amps.

6 VOLT VERSION

The 6 volt version of the unit has the same circuit as the 12 volt version, but some of the component values are changed. Most of the fixed resistance values are reduced, as also are the voltages of the zener diodes, and the altered values are listed in the accompanying Components List. The 6 volt version functions in exactly the same manner as the 12 volt version, and can be set up for discharge and charge voltages at or near 5 and 6.5 respectively. The transition from one l.e.d. to another as voltage changes is rather less sharp than occurs with the 12 volt circuit.

The circuit may be assembled in any manner desired, the only components which need to be visible being the three l.e.d.'s. The parts should be accommodated in a fairly cool part of the car and, of course, care must be taken to prevent short-circuits to the vehicle metalwork. The unit can be wired to the battery circuit after the ignition switch. Alternatively, it can be connected directly to the battery, with its own on-off switch in series with the non-earthy battery lead. ■



"Are you sure you are familiar with computerised Aston Martins?"

CAN ANYONE HELP?

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

"ELPICO" Car Radio CRP 700A — T. A. Taylor, 45 Linkhay, South Chard, Somerset — Service data to borrow or purchase.

Martin Transistorised FM Tuner — W. Mullen, 9 Field Lane, Braunton, Devon — Any information, purchase or loan.

R7303, R1466, BC1206C (28v Aircraft) — R. Marsh, 7 Gawsworthy Close, Holmes Chapel, Crewe, Cheshire — Circuits and other details needed.

Ceefax Unit — D. Bullivent, 9 Meadow Lane, Ryhall, Stamford, Lincs. PE9 4EP — Plans or details of any kit manufactured.

CRT, VCR 97(10/E/222) — Dr. A. V. Forage, Box 84, Dover, Tasmania 7116 — Data and pin connections required.

HRO National Receiver — A. Clancy, 5 Carlton Mansions, 387 Coldharbour Lane, Brixton, London SW9 8QD — Valve line up and/or Service Sheet or Handbook required, all expenses paid.

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

Recent attempts at 'Dxing Laos' have not proved successful but for those who care to have a try at receiving this 'rare country' (in radio terms) the following notes may be of some interest.

● **LAOS**

The Laotion External Service from Vientiane operates from 0400 to 0630; 1100 to 1400 and from 2300 to 0130 on **7145**. For U.K. listeners the best times would be from around 1300 to 1400 when they are in French (1300 to 1330) and in English (1330 to 1400 sign-off); from 2300 to about 2400 when they are in Thai (2300 to 2330) and Vietnamese (2330 to 2400). The power is 25kW.

The Domestic Service from Vientiane would probably best be heard here in the U.K. (if at all) from around 1300 through to 1430 sign-off on **6210**. From 1300 to 1400 there is a programme on Literature and Art, 1400 to 1430 General News including commentary, all in Laotion of course. Other channels in use at this time are **4245, 5160, 6130, 6200** (logged last year on **6199**), **7310** and on **7480**. At the 2330 sign-on, try on **5160**; the only other channel in use at this time being **6130** and that is hopeless!

For real super-Dx why not try some of the Regional Service stations such as Savannakhet on **7385** from 2300 sign-on or at 1330. A word of warning here, Radio Peking opens at 1400 on this channel in Tamil to South Asia.

Or there is Xieng Khouang on **4603** and **6693** from 2300 sign-on or try again just prior to the 1400 sign-off when they are relaying Vientiane.

All that still leaves Luang Prabang on **6985, 8175** or **8395** and note that only one of the latter channels will be operative at any one time. Listen from the 2300 sign-on or from around 1400 to 1430 sign-off, during which period they are relaying Vientiane.

A check recently showed that the recommended channels are all clear of QRM except **6693** which sports a running teletype transmitter quite frequently.

CURRENT SCHEDULES

● **VIETNAM**

Radio Hanoi, the "Voice of Vietnam", operates an External Service in which broadcasts to Europe in English are as follows — from 1800 to 1900 and from 2030 to 2130 on **10040** and **15012**.

● **LAOS**

Of interest to Dxers would be the Regional Services (Domestic), the first being Xieng Khouang from 2300 to 0100; 0400 to 0600 and from 1000 to 1400 on **4603** and **6693**. The second transmitter is Luang Prabang from 2300 to 0200; 0400 to 0600 and from 1000 to 1430 on **6985, 8175** and on **8395**.

● **CLANDESTINE**

"National Voice of Iran" may be heard on **6025** when in Persian from 1730 to 1745 and from 1800 to 1815 or in Azerbaijani from 1745 to 1800. The programmes are pro-communist and anti-Shah and are thought to emanate from Radio Baku. Listen for the identification "Seda-ye Melli-ye Iran".

● **SOMALIA**

The Somali Broadcasting Service, Mogadishu, presents an External Service in which an English programme is radiated from 1100 to 1130 on **9585**.

● **BELGIUM**

Apart from a short programme directed to the U.S.A. once a month, the only English transmission from Brussels is that directed to Africa from 1730 to 1800 on **9745** and **11940**.

● **VENEZUELA**

"Radio Nacional de Venezuela", Caracas, offers a programme in English to Europe and the Americas from 2200 to 2300 on **6170** and on **15390**.

AROUND THE DIAL

● **CLANDESTINE**

Radio Iran Courier on **11415** at 1802, OM in Farsi to Iran. This station operates at various times throughout the afternoon and early evenings, probably the best time for listeners here in the U.K. would be the scheduled 1720 to 1810 period. The transmission can also be heard in parallel on **11695** but note that on Fridays the sign-on is at 1620. Programmes are anti-Shah, Iranian Government, Western interests in Iran and CENTO; pro-communist and Tudeh Party of Iran (local communist organisation).

Voice of the Thai People on **9423** at 1553, YL and OM alternate with harangues in Thai. This one closes at 1615 (slightly variable) and is thought to be located in China.

● **CHINA**

Radio Peking on a measured **7504** at 2008, YL in Standard Chinese in a Domestic 1st programme for home consumption, scheduled on this channel from 2000 to 1735; also to be heard in parallel on **6665**.

Radio Peking on **6225** at 2054, YL with songs, local orchestral items complete with mixed choir. This is the 1st Domestic Service scheduled here from 2000 to 0100.

Radio Peking on **6345** at 2100 when signing-on with interval signal and "East is Red" in 2nd Domestic Service which is scheduled from 2100 to 2330 at this point on the dial.

Radio Peking on **6590** at 1815, YL in English to South Asia, scheduled from 1800 to 1900.

Radio Peking on **7780** at 1821, OM and YL alternate in German to Europe, scheduled from 1800 to 1900.

Radio Peking on **3450** at 1613, OM in Standard Chinese in 1st Domestic Service, schedule from 1250 to 1735.

Radio Peking on **9080** at 1620, YL in Standard Chinese in 1st Domestic Service, schedule 1133 to 1735.

Radio Peking on **6410** at 1625, OM in Urdu to India and Pakistan, scheduled from 1630 to 1700.

Radio Peking on **7620** at 1628, YL in English to East and South Africa, schedule is from 1600 to 1700.

Radio Peking on **6645** at 2015, YL and OM alternate in Albanian to Albania — where else? Schedule is from 2000 to 2030 and may also be heard in parallel on **7590.**

Radio Peking on a measured **6932.5** at 2025, OM in Portuguese to Africa and Europe, scheduled from 2000 to 2100 on this channel and in parallel on **6345.**

Lanzhou on **4865** at 2327, YL with a talk in Chinese. The schedule of this regional station is from 0950 to 1600 and from 2150 to 0600.

PLA (People's Liberation Army) Fuzhou on **4330** at 2028, OM in Chinese to Taiwan and other offshore islands, scheduled from 1000 to 0144.

Shenyang on a measured **4832** at 2215, OM in Chinese. Schedule is from 0720 to 1515, 2040 to 0100 and from 0250 to 0535.

● MALAYSIA

Radio Malaysia, Penang, on **4985** at 1520, OM with a talk in English about local tropical diseases and cures. This station operates both in English and vernaculars and the schdule is from 0530 to 0630 (Saturdays to 1630), from 0930 to 1630 (Sundays to 1630) and from 2230 to 0130. The power is 10kW.

● THAILAND

Bangkok on **4830** at 1540, distinctive local-type music interspersed with long announcements by YL in Thai. Radio Thailand operates throughout from 2300 to 1600 and the power is 10kW. Bangkok is the seaport capital of Thailand and is on the banks of the Menam river 20 miles inland from the sea. Rice, tea and teak are the main exports.

● BURMA

Rangoon on **4725** at 1410, military marches with choral songs in patriotic-style. This one radiates in Burmese and vernaculars from 1000 to 1415, the power is 50kW. The city of Rangoon is the capital of Burma and has two cathedrals, many mosques and pagodas. Despite the schedule however, the writer has logged Rangoon as late as 1450 and still going strong!

● INDONESIA

RRI (Radio Republik Indonesia) Ujang Pandang on a measured **4719** at 1400, typical local-style music, YL with songs, OM announcer in Indonesian. The schedule is from 1225 to 1530 (Saturdays until 1600) and the power is 50kW. Ujung Pandang is situated in Propinsi Sulawesi Selatan (literally Province Celebes South).

RRI Banda Aceh on a measured **4954.5** at 1525, short excerpts of orchestral music Euro-style, YL announcer then OM with a local song in vernacular. The schedule is from 0800 to 1600 and from 2300 to 0015 (Sundays to 0600), the power is 10kW. Banda Aceh is in Sumatera (Sumatra) and located in Daerah Istimewa Aceh (literally District Special Aceh).

RRI Jakarta on **4805** at 1540, OM in Indonesian, gamelan mx. Schedule is from 1000 to 1600 and from 2155 to 0100 and the power is 20kW. On Java (Jawa), this one is located in Daerah Khusus Jakarta Raya (literally District Special Jakarta Great).

● PAKISTAN

Radio Pakistan on **5010** at 0139, OM with a newscast in vernacular, many mentions of Pakistan, programme of local music. Presumably Karachi in a move from **5020** where they normally operate a link to Islamabad from May to August from 1615 to 1900.

Karachi can also be logged on **3330** at 1534, at which time we heard them radiating a programme in Urdu.

● TIBET

Lhasa on **4035** at 1533, OM in Tibetan until 1540 when the signal was wiped out by commercial QRM.

● MALAYSIA — 2

Sibu, Sarawak, on **5005** at 1440, programme of local pops complete with traditional orchestra.

● VIETNAM

Radio Hanoi on a measured **3999** at 1447, OM in Vietnamese to the former South Vietnam in a relay of the 1st Network, scheduled on this channel from 1230 to 1600.

Radio Hanoi on a measured **4932** at 1454, OM and YL in Vietnamese to S. Vietnam, scheduled from 2055 to 1600 (1st Network).

Radio Hanoi on a measured **4994** at 1432, YL and OM alternate in Vietnamese. This is the Home Service 2, scheduled from 2245 to 1600.

● KHMER REPUBLIC

Phnom-Penh on a measured **4908** at 1425, local music, OM in vernacular (presumably Cambodian)).

● NORTH KOREA

Radio Pyongyang on **6770** at 1415, OM in French, military music in a programme directed to S.E. Asia, scheduled from 1400 to 1600.

● SAO TOME

Radio Nacional de Sao Tome on a measured **4807** at 1948, YL with a newscast in Portuguese. Schedule is from 0530 to 2300 and the power is 1kW.

● CAPE VERDE

Voz do Sao Vicente, on a measured **3931** at 2154, OM's with a discussion in Portuguese. Schedule Monday to Friday 0700 to 0830; Sunday 1100 to 1400, 1500 to 1630; Saturday 1600 to 2030; daily 2030 to 2400, the power is 10kW.

Radio Clube Cabo Verde on a measured **3886** at 2054, OM in Portuguese amid a welter of commercial QRM!

● NOW HEAR THIS

Voice of the Revolutionary Party for Reunification, Haeju, North Korea, on a measured **4554** at 2140, YL with a song in Korean, local orchestral music, OM in Korean with a (political?) harangue at 2152.

V.H.F. A.M. SUPERHET

Part 1

By D. F. W. Featherstone

This battery operated superhet covers 70 to 147MHz and thereby offers reception on both the 4 metre and 2 metre amateur bands as well as on the frequencies between. Range selection is achieved by means of plug-in coil pack modules, and the design is presented for the more experienced constructor who is capable of working out his own component and wiring layouts. The concluding article will appear in next month's issue.

The v.h.f. bands carry many transmissions besides those in Band II, and they are usually amplitude modulated. This receiver is designed to cover the 70 and 145MHz amateur bands and the frequencies which lie between them. The very stable design should enable coverage to be extended at both ends of this frequency range if desired, but this has not yet been confirmed by the author.

The receiver uses a superheterodyne circuit with a separate local oscillator running below signal frequency. The four bands are selected by inserting home-wound plug-in coil packs, and this method avoids the problems usually associated with v.h.f. switching. The receiver is sensitive, stable and easy to align, and can be built at relatively low cost. The four bands give ample equivalent scale length for accurate tuning, and the items of test equipment required are an r.f. signal generator, an electronic or high resistance voltmeter and a millivoltmeter.

THE CIRCUIT

From the circuit diagrams it can be seen that two power supplies are used. A 9 volt negative supply powers the r.f. amplifier, local oscillator and a.g.c. amplifier at a total current of under 3mA, and a 9 volt positive supply is used for all other stages. With the a.f. amplifier shown, the current drawn from the 9 volt positive supply is about 10mA.

Fig. 1 shows the r.f. amplifier, in which TR1 is a grounded base transistor. The aerial signal is fed by C1 to the emitter and R3 provides acceptable impedance matching to a 75Ω coaxial feeder. The negative supply is decoupled by R2 and C3, whilst C2 grounds the base for r.f. VR1 is used to set the collector current of TR1 and C4 limits the effective maximum capacitance of VC1(a). The r.f. tuning coil of the coil pack in use is connected between pins 1 and 4 of the B7G valve base, SKT2, and a tapping, from which the output is taken, is connected to pin 7. The output then passes via C5 to the base of the mixer transistor.

Fig. 2 shows the circuit of the local oscillator, TR3. This is similar to the r.f. amplifier but the input consists of positive feedback via C10 and the output is applied, via C9, to the emitter of the mixer transistor.

The mixer, 10.7MHz i.f. amplifiers and a.g.c. amplifier are shown in Fig. 3. The collector current of

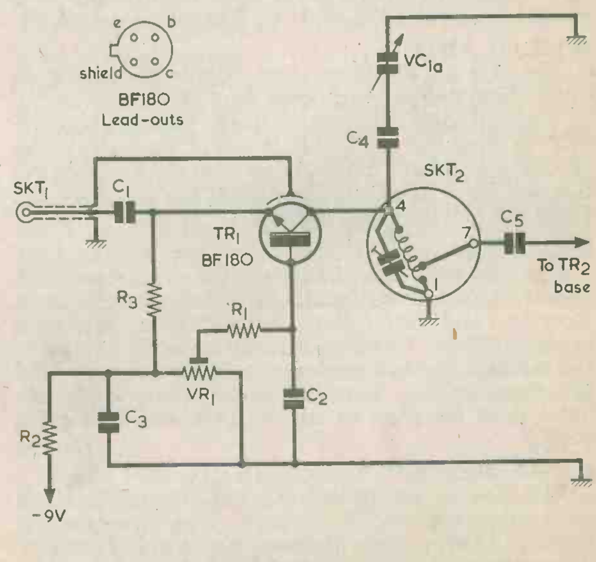


Fig. 1. The circuit of the r.f. amplifier stage

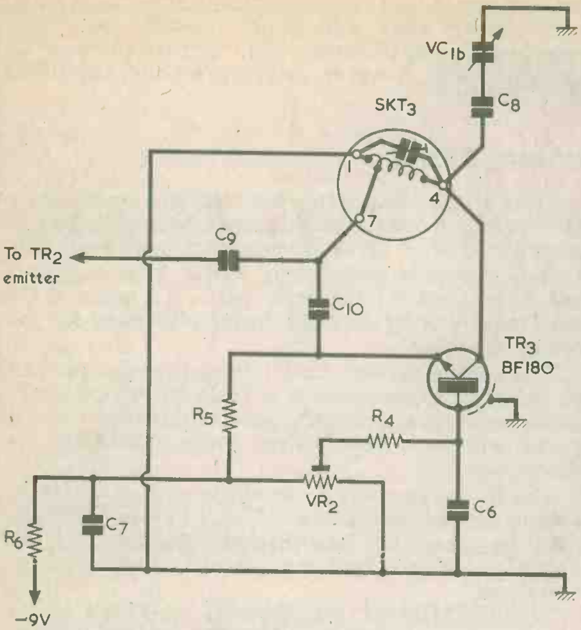
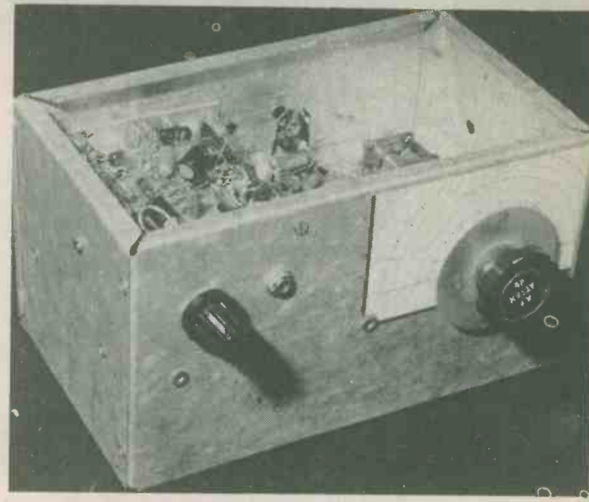


Fig. 2. The receiver local oscillator also employs a grounded base transistor



Front view of the v.h.f. a.m. superhet. There are only two controls, these being for a.f. gain and tuning

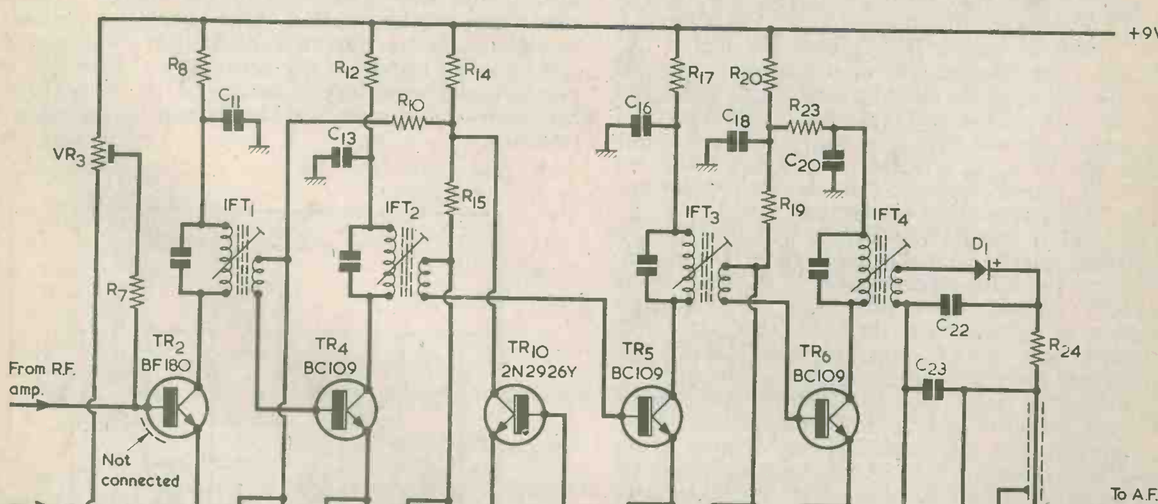
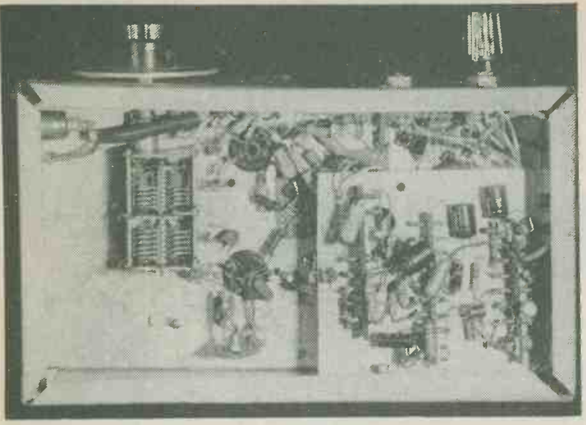


Fig. 3. The mixer, i.f. amplifier and detector stages



Top view of the chassis. The a.f. amplifier sub-chassis is mounted above the main chassis

the mixer, TR2, is set by VR3, and R7 prevents loss of signal while adjustments are being made. TR2 supply is decoupled by R8 and C11 and the difference frequency of the r.f. and local oscillator signals is selected by IFT1.

TR4 and TR5 are normal i.f. amplifiers, the base bias currents for both passing through R14. TR6 is the final i.f. amplifier feeding into the detector circuit. IFT4 is a modified version of the other i.f. transformers to enable it to match the higher impedance of the detector. The modification consists of carefully removing the existing secondary, which has only one or two turns, and replacing it with 8 turns of thin enamel covered wire. The wire employed by the author was 38 s.w.g. Alternatively, a ratio detector type of i.f. transformer could be used with only one section of the secondary connected.

The receiver has good sensitivity with only two i.f. amplifying stages and it may be tried in this way initially, but the third stage was found to give a much improved signal-to-noise ratio and to give better reception of signals from the more distant mobile sources. If only two i.f. stages are used the final i.f. transformer must still, of course, be modified.

The detector circuit supplies both the audio signal to the a.f. amplifier and d.c. to the delayed amplified a.g.c. system. The a.f. amplifier, Fig. 4, gives ample output for a crystal or high impedance earphone, or it will drive a small loudspeaker if a suitable transformer is connected in place of R37.

TR10 is the a.g.c. amplifier. The potential divider chain, D2, D3, R40 and D4, holds TR10 emitter at 0.4 volt negative of chassis. TR10 collector is connected to the junction of R10, R14 and R15 which, under no-signal conditions, has a potential of 3 volts positive of chassis. TR10 base is held at chassis potential by VR4. If a signal is present the upper end of VR4 track becomes more positive due to the action of D1. When this voltage reaches about 0.25 volt positive the base-emitter junction of TR10 is at 0.65 volt and TR10 starts to conduct, drawing current through R14 and thus lowering the voltage at the junction of R10, R14 and R15. This lowers the base current of TR4 and TR5, thereby reducing their stage gain. As TR10 does not start to conduct until the detector output reaches 0.25 volt there is no a.g.c. action when weak signals are present, and these receive full amplification. Any further increase of signal strength, however, produces a much amplified a.g.c. action.

COMPONENTS

Most of the components are standard parts, but a few require comment at this stage. VC1(a)(b) is a 2-gang 17 + 17pF variable capacitor, and a suitable type is available from Home Radio. This capacitor has an integral 3:1 reduction gear. The value of C8 may require to be changed during alignment for optimum tracking.

There are eight coil pack trimmers and these can be mica components with a range of 1.5 to 20pF. Other points concerning the parts required for the coil packs will be covered when their construction is described.

The layout employs seven single anchor points for supply connections in the r.f. and i.f. stages. These may be given by lead-through insulators. Alternatively, 1,000pF feed-through capacitors could be employed.

The 10.7MHz i.f. transformers employed in the prototype were single-tuned types, with the primary tuned and the secondary untuned. It would be possible to use double-tuned types, although this point has not been checked by the author. It is unlikely that double-tuned transformers would reduce stability but, should this occur, one of the emitter bypass capacitors can be omitted. Alternatively, a double-tuned transformer can be converted to single-tuned operation by removing the secondary and adding a new untuned secondary consisting of two turns of the coil wire wound over the earthy end of the tuned primary.

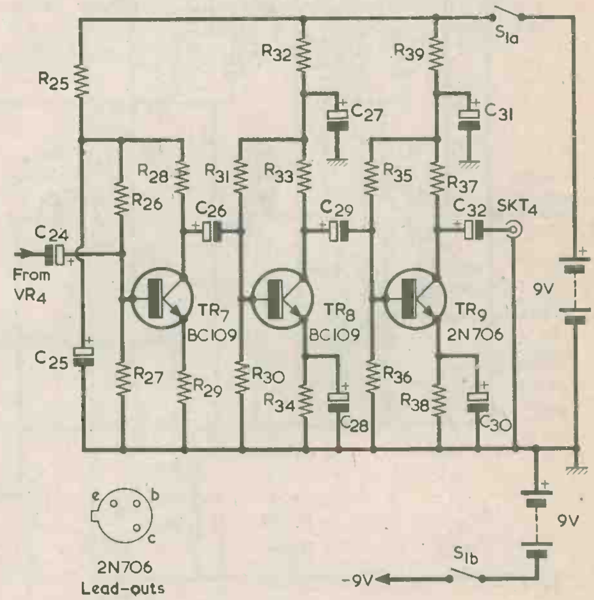


Fig. 4. The circuit of the 3-transistor a.f. amplifier

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)
- R1 3.9kΩ
- R2 1kΩ
- R3 120Ω
- R4 2.7kΩ
- R5 1kΩ
- R6 1kΩ
- R7 5.6kΩ
- R8 1kΩ
- R9 1kΩ
- R10 22kΩ
- R11 10kΩ
- R12 1kΩ
- R13 470Ω
- R14 27kΩ
- R15 18kΩ
- R16 10kΩ
- R17 390Ω
- R18 220Ω
- R19 39kΩ
- R20 560Ω
- R21 6.8kΩ
- R22 220Ω
- R23 560Ω
- R24 470Ω
- R25 220Ω
- R26 47kΩ
- R27 6.8kΩ
- R28 8.2kΩ
- R29 390Ω
- R30 6.2kΩ
- R31 56kΩ
- R32 1kΩ
- R33 6.2kΩ
- R34 220Ω
- R35 39kΩ
- R36 4.3kΩ
- R37 3.9kΩ
- R38 100Ω
- R39 560Ω
- R40 390Ω
- R41 4.7kΩ
- VR1 10kΩ pre-set potentiometer, miniature skeleton, vertical
- VR2 25kΩ pre-set potentiometer, miniature skeleton, vertical
- VR3 25kΩ pre-set potentiometer, miniature skeleton, vertical
- VR4 5kΩ potentiometer, log, with switch S1(a)(b)

Capacitors
- C1 200pF silvered mica
- C2 0.01μF plastic foil
- C3 1,000pF silvered mica
- C4 15pF silvered mica
- C5 1.5pF silvered mica or ceramic
- C6 0.01μF plastic foil
- C7 1,00μpF silvered mica
- C8 15pF silvered mica (see text)
- C9 8.2pF ceramic
- C10 4.7pF ceramic
- C11 0.05μF plastic foil
- C12 0.02μF plastic foil
- C13 0.05μF plastic foil
- C14 0.01μF plastic foil
- C15 0.05μF plastic foil
- C16 0.05μF plastic foil
- C17 0.01μF plastic foil
- C18 0.1μF plastic foil
- C19 0.05μF plastic foil
- C20 0.1μF plastic foil
- C21 0.05μF plastic foil
- C22 1,000pF silvered mica
- C23 1,000pF silvered mica
- C24 10μF electrolytic, 10 V. Wkg.
- C25 50μF electrolytic, 10 V. Wkg.
- C26 32μF electrolytic, 10 V. Wkg.
- C27 50μF electrolytic, 10 V. Wkg.
- C28 10μF electrolytic, 10 V. Wkg.
- C29 16μF electrolytic, 10 V. Wkg.
- C30 32μF electrolytic, 10 V. Wkg.
- C31 50μF electrolytic, 10 V. Wkg.
- C32 2.2μF electrolytic, 10 V. Wkg.
- C33 1uF electrolytic, 10 V. Wkg.
- VC1(a)(b) 17 + 17pF 2-gang variable.
- 8-off trimmers, 1.5-20pF (see text)

Inductors
- IFT1-4 10.7MHz i.f. transformers (see text)
- 8-off coils, home-wound (see text)

Semiconductors
- TR1 BF180
- TR2 BF180
- TR3 BF180
- TR4 BC109
- TR5 BC109
- TR6 BC109
- TR7 BC109
- TR8 BC109
- TR9 2N706
- TR10 2N2926Y
- D1 OA90
- D2 OA91
- D3 OA91
- D4 6.8V zener diode, 400mW

Switch
- S1(a)(b) d.p.s.t. toggle, part of VR4

Sockets
- SKT1 coaxial socket
- SKT2 B7G valveholder, low-loss
- SKT3 B7G valveholder, low-loss
- SKT4 3.5mm. jack socket

Miscellaneous
- 2-off 9V batteries, type as desired
- Battery connectors
- 2-off knobs
- Perforated s.r.b.p. board, 0.1in. matrix
- Tagstrips, as required
- Materials for coil packs (see text)
- Materials for case (see text)

CONSTRUCTION

The author constructed the case and chassis of the receiver from 22 s.w.g. galvanised mild steel, which can be obtained from builders' merchants. General details are given in Fig. 5. The front panel is 4 by 7in. and has holes for VR4, SKT4 and VC1, as well as for the chassis securing bolts. The rear panel is 4 by 7.1in. and has two holes for access to VR2 and VR3. The slightly longer length is required as the end flanges pass over the side panels. Hole positioning is best determined with the aid of the components concerned. The whole receiver could be made smaller, but the size chosen leaves space for batteries if portable operation is required.

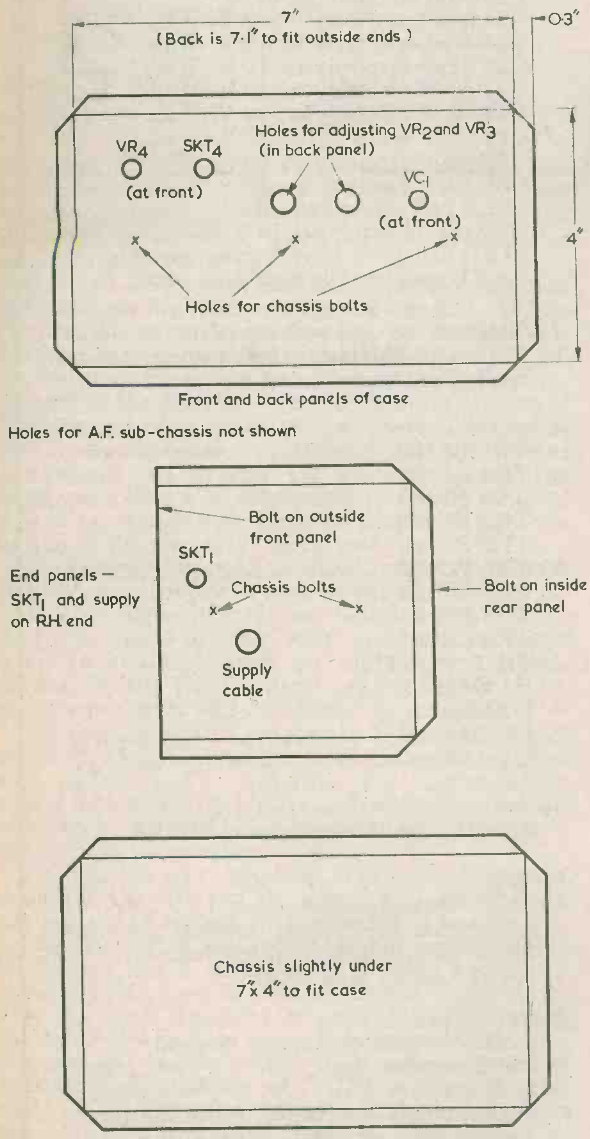
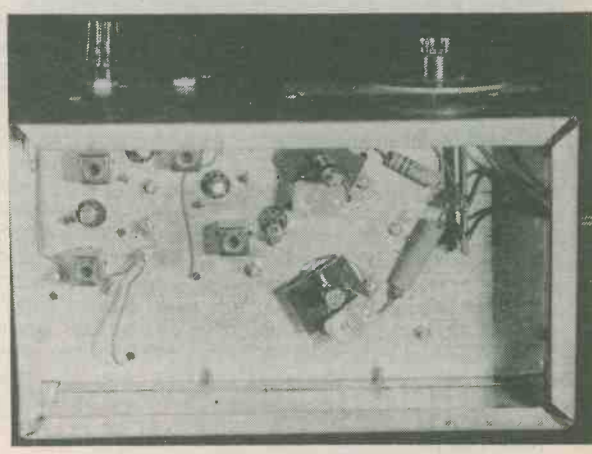


Fig. 5. Details of the receiver case. The 0.3in. flanges are bent through 90 degrees in the direction required

The chassis is a flat flanged plate mounted so that its surface is mid-way between the top and bottom of the case. The bodies of the mixer and i.f. transistors, the i.f. transformers and the coil packs are all below the chassis. A lid can be fitted to the case later, and the base is left open to enable the coil packs to be changed.

The tuning capacitor should be mounted so that the spindle is at least 1.6in. from the right hand end of the case to allow space for fitting a tuning scale. This also leaves room between the tuning capacitor and the case end on the inside for one of the two batteries.

The general layout on the chassis of the r.f. and i.f. stages is given in Fig. 6. SKT2 and SKT3 are B7G valve bases, mounted on the chassis underside with their tags uppermost. Before fitting these, remove the sockets for pins 2, 3, 5 and 6, together with the centre metal screen. Also, file flat the slightly raised part in the centre so that the coil packs will seat firmly.



A view from underneath. The coil packs, the i.f. transformers and the mixer and i.f. transistors are all mounted below the chassis

Holes for the i.f. transformer pins are drilled $\frac{3}{32}$in. and those for fixing lugs $\frac{1}{16}$in. Fig. 7 shows how the transformers may be mounted. After passing the pins and lugs through the appropriate holes, a piece of 24 s.w.g. bare tinned copper wire is fitted between the two lugs and is then soldered to them.

Four $\frac{3}{8}$in. holes are drilled at the positions for TR2, TR4, TR5 and TR6, after which a piece of plain perforated s.r.b.p. board of 0.1in. matrix, and measuring 0.5 by 0.75in., is secured under the chassis at each hole, as in Fig. 8. The transistors are held in position by passing their lead-outs through holes in the boards, with connections made above the chassis.

Fig. 6 also gives general wiring details including the positioning of chassis connections where this is important. Not all the components appear in the diagram and the constructor should consult the circuits of Figs. 1, 2 and 3 when necessary. Some components, such as R2, are below the chassis. Also below the chassis, under VC1(a)(b), is a 3-way tagstrip for the battery connections. In the author's receiver the battery leads pass through a hole in the right hand side panel, but they can be alternatively routed if the batteries are to be positioned inside the receiver.

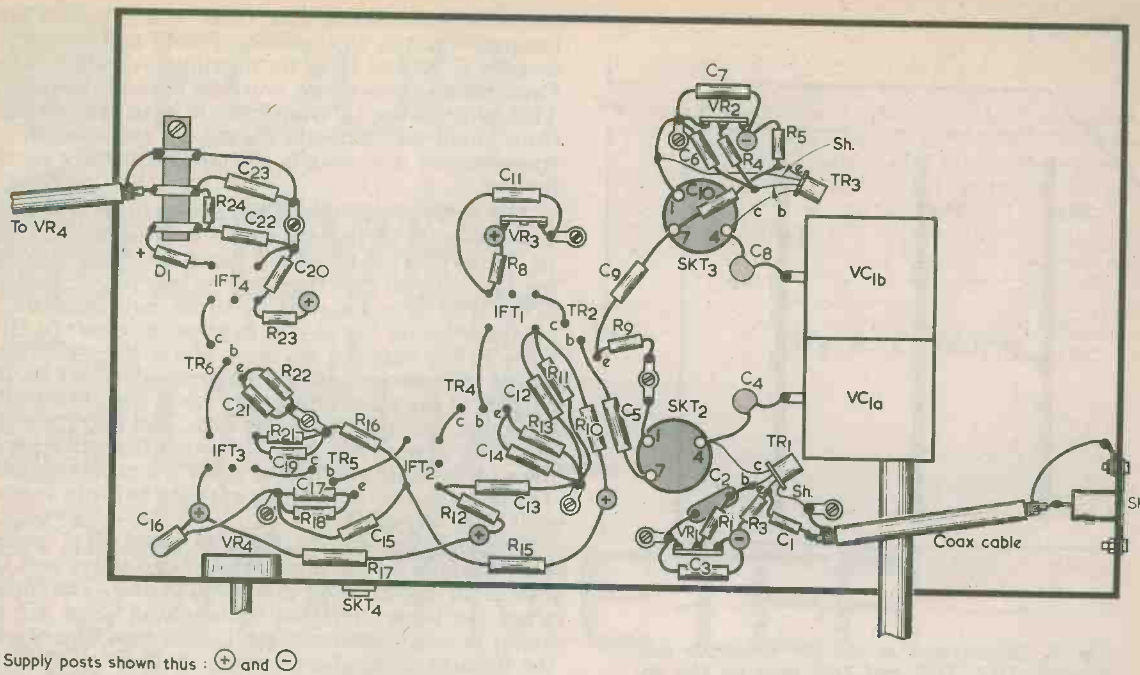


Fig. 6. General layout of wiring in the r.f. and i.f. stages. This diagram is intended mainly to show the positions where chassis connections are made, and not all components are shown. Some of the positive supply points do not connect directly to the positive 9 volt supply, but do so via decoupling resistors

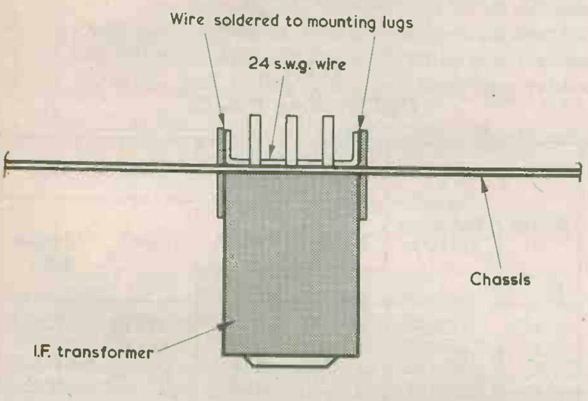


Fig. 7. The i.f. transformers are secured by laying a piece of tinned copper wire across the top of the chassis and soldering it to the mounting lugs

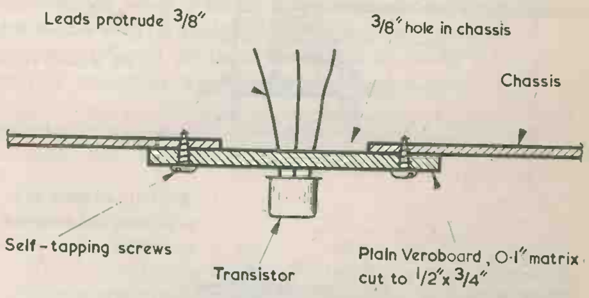


Fig. 8. The mixer and i.f. transistors are positioned below the chassis with their lead-outs passing through the holes of 0.1in. plain perforated board

TR10 and the a.g.c. components are not fitted until alignment has been carried out. They are wired later on a tagstrip fitted to the front panel above SKT4.

The a.f. amplifier is assembled on a sub-chassis having the dimensions given in Fig. 9. This is bolted to the rear panel and left hand side panel, and is parallel to and about 1in. above the main chassis. It has three 8-way tagstrips with TR7, TR8 and TR9 taking up the approximate positions shown. The wiring layout of the a.f. amplifier is unimportant provided that the normal common-sense rules, such as keeping output wiring away from input wiring, are observed. The leads from the remainder of the receiver to the a.f. amplifier should be long enough to enable it to be positioned outside the case during setting up.

SETTING UP

When assembly is complete make a thorough visual check and set VR1, VR2 and VR3 sliders to the more negative ends of their tracks before connecting the batteries. Initially apply power via a suitable meter to check that current consumption is not excessive. The current from the negative supply should be very low until the two coil packs are fitted. Adjust VR3 to obtain 0.2 volt across R9. Connect a meter

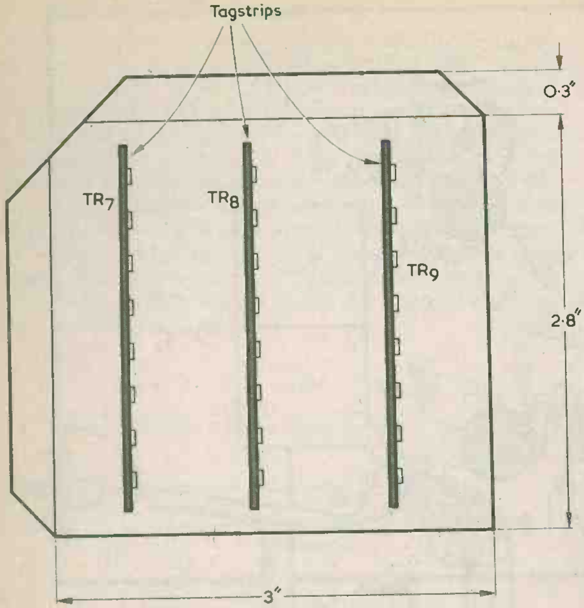


Fig. 9. Dimensions of the a.f. amplifier sub-chassis. TR7, TR8 and TR9 take up the approximate positions indicated

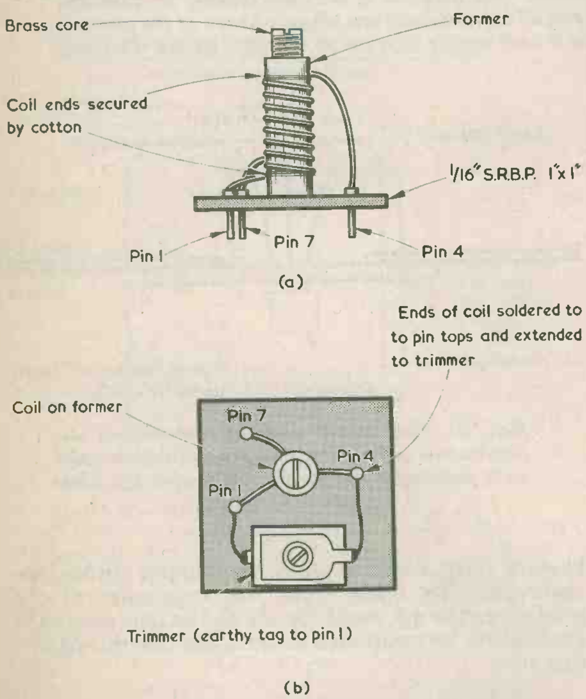


Fig. 10(a). Side view of a coil pack assembly. For clarity the trimmer is omitted (b). Top view of the coil pack

switched to a 0.5 volt or lower range across VR4 and apply a signal generator set to 10.7MHz, via a 100pF capacitor, to the base of TR6. Adjust the core of IFT4 for maximum meter reading, reducing the signal generator output as necessary to give a low but readable meter deflection. Next, connect the signal generator output to the base of TR5 and adjust the cores of IFT3 and IFT4 for maximum meter reading. Continue this procedure, working back to the base of TR2, until all the i.f. transformers have been aligned. Only small adjustments should be required as i.f. transformers are usually set approximately at the factory.

The pairs of coil packs have next to be made up. The assembly of the coil packs is illustrated in Fig. 10. Three pins are fitted to a panel of s.r.b.p. measuring 1 by 1 in. so that they will fit into pins 1, 4 and 7 of the B7G valve base. An accurate method of marking the holes for the pins is to press the pins of a B7G valve firmly onto the top sheet of a writing pad. This leaves indentations in the paper conforming to the pattern of the pins. Place the s.r.b.p. underneath the top sheet, holding the paper firm, and mark out the positions of pins 1, 4 and 7 through the paper on to the s.r.b.p. using a scriber or other sharp pointed tool. The pins used by the author were the half-pin version of 0.15in. Veropins.

The coil formers are fixed to the s.r.b.p. panels with Araldite or a similar powerful adhesive and are 20mm. in length by 4.5mm. in diameter. The tuning slugs are brass. Suitable formers and slugs will be found in many discarded v.h.f. television tuners, and the formers could also be made up from plastic tubing. The Home Radio coil former type CR27, with dimensions of 21 by 5mm., will also be satisfactory, if its base is removed, although some means of fitting this with a brass slug will need to be devised. The slug can, of course, be cut from a brass bolt with a screwdriver slot cut across one end. Its length can be of the order of 10 to 15mm.

Table 1

Coil Winding Details

Range	Signal Frequency (MHz)	R.F. Coil		Oscillator Coil	
		Turns	Length (in.)	Turns	Length (in.)
1	70-90	$2\frac{1}{2}+10$	0.35	$2\frac{1}{2}+12$	0.35
2	85-105	$2+8\frac{1}{2}$	0.35	$2\frac{1}{2}+9$	0.4
3	110-130	$1\frac{1}{4}+4\frac{1}{2}$	0.4	$2+5\frac{1}{2}$	0.5
4	120-147	$\frac{3}{4}+4$	0.35	$2+4\frac{1}{2}$	0.35

Coil winding details are given in Table 1. All the coils are wound with 24 s.w.g. enamelled copper wire. It is helpful to remove the enamel and tin the coil wire connecting to pin 4 over about an inch from the end, as this allows adjustments to be made in coil length during alignment. The table indicates the tapping point for each coil. Thus, the r.f. coil for Range 1 has $12\frac{1}{2}$ turns overall, with a tap $2\frac{1}{2}$ turns from the earthy end.

NEXT MONTH

Further details on the alignment of the receiver will be given in next month's concluding article.

(To be concluded)

FOUR LEVEL DIGITAL VOLTMETER

By K. T. Wong

This neat digital voltmeter circuit causes successive l.e.d.'s to be illuminated as input voltage increases. It is primarily intended for operation with a variable voltage power supply offering outputs up to 9 volts and having an unstabilized voltage available of 14 to 21 volts, but it has other applications where visual indications of voltage are required.

In some instances, a voltmeter which gives approximate indications of certain voltages is quite adequate. Such is the case, for instance, with variable voltage power supplies, which are becoming very popular among home constructors due to the high cost of dry batteries. The most commonly employed voltages are probably 3, 4.5, 6, 7.5 and 9 volts; a circuit was in consequence designed to indicate these voltages by means of a number of light-emitting diodes. An accuracy of better than 5% was found to be practically feasible at low cost. The unit should also appeal to novelty builders.

CIRCUIT DETAILS

The block diagram for a single voltage indicator is shown in Fig. 1. Here, a voltage comparator compares the input voltage with a reference voltage. When the input voltage exceeds a certain level the voltage comparator produces an output which activates the l.e.d. driver, which in turn causes the l.e.d. to light up. To indicate a number of voltages the stages are duplicated and each voltage comparator is fed with a different reference voltage.

Two simple methods of obtaining the reference voltages are available, as shown in Fig. 2. One of these consists of a potential divider network placed across an accurate voltage source, whilst the other consists of accurate resistors connected to a constant current source, whereupon accurate voltages are dropped across them.

The first method demands a fairly complex circuit for the accurate voltage source and is rather inflexible when adjustment of the voltage divider is anticipated.

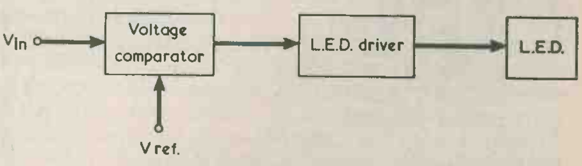


Fig. 1. Block diagram illustrating the functioning of a single voltage indicator

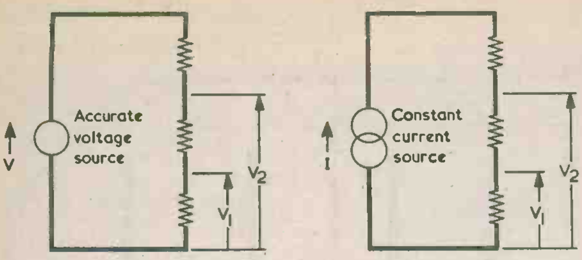


Fig. 2. Two methods of obtaining accurate reference voltages

COMPONENTS

Resistors

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

R1 100Ω pre-set potentiometer, 0.1 watt horizontal
R2 15 kΩ
R3 1MΩ
R4 1MΩ
R5 1MΩ
R6 1MΩ
R7 150Ω (see text)
R8 150Ω (see text)
R9 150Ω (see text)
R10 240Ω (see text)
R11 330kΩ
R12 330kΩ
R13 330kΩ
R14 330kΩ
R15 2.7kΩ
R16 2.7kΩ
R17 2.7kΩ
R18 2.7kΩ
R19 330Ω ½ watt

Semiconductors

TR1 BCY71
TR2 BC169C
TR3 BCY71
TR4 BC169C
TR5 BCY71
TR6 BC169C
TR7 BCY71
TR8 BC169C
TR9 BCY71
D1 1N4148
D2 1N4148
D3 BZY88C9V1
LED1 TIL209
LED2 TIL209
LED3 TIL209
LED4 TIL209

Miscellaneous

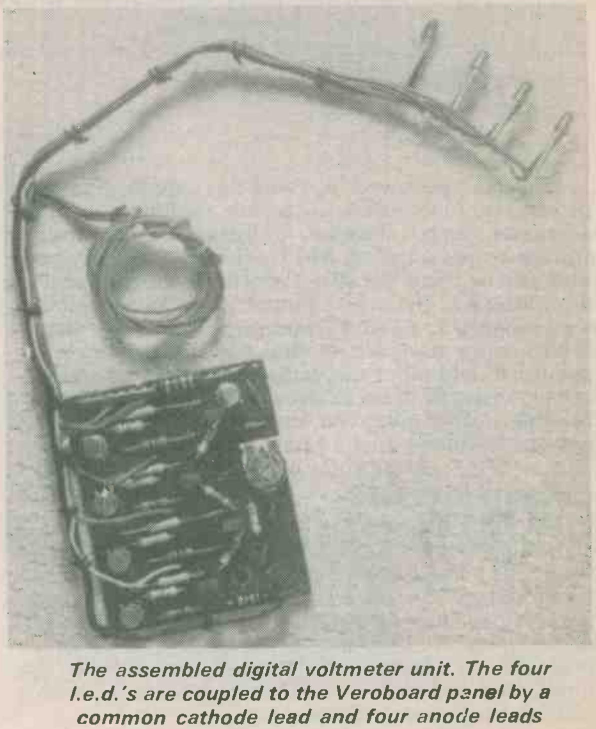
Veroboard, 0.1 in. matrix
Connecting wire

On the other hand, a constant current source can be readily designed and the resistor network is more easily adjusted when different reference voltages are needed.

The final circuit is shown in Fig. 3. Transistors TR2, TR4, TR6 and TR8 are the voltage comparators, each comparing the input voltage with the reference voltage at its emitter. When the input voltage just exceeds the reference voltage plus the base-emitter voltage at any of the comparator transistors the transistor turns on and provides base current for the corresponding l.e.d. driver transistor. The driver transistors are TR3, TR5, TR7 and TR9, and they control LED1, LED2, LED3 and LED4 respectively.

If the input voltage is increased in the positive direction from zero, LED4 commences to light up at 3 volts, LED3 at 4.5 volts, LED2 at 6 volts and LED1 at 7.5 volts. Thus, at 7.5 volts all the l.e.d.'s are alight.

TR1 is the constant current source, and R1 is set up to give a constant current of 10mA. This current permits the use of preferred values in the resistor chain consisting of R7, R8, R9 and R10. The author used 5% resistors in the prototype but closer tolerance components may be employed, if desired. In the interests of good long term stability, these four resistors should be high stability types. The amplitude of the constant current is made relatively large so that, when the base and collector currents of the voltage comparators are added to the current in the resistor chain, the error incurred is sufficiently small. The base currents of the voltage comparators have been kept low by using large series base resistors. These are R3, R4, R5 and R6. As a significant amount of base current is necessary to activate an l.e.d. driver into turning on an l.e.d., there will be a small input voltage range between the level where the l.e.d. is just coming on and where it is adequately bright. The value of the



The assembled digital voltmeter unit. The four l.e.d.'s are coupled to the Veroboard panel by a common cathode lead and four anode leads

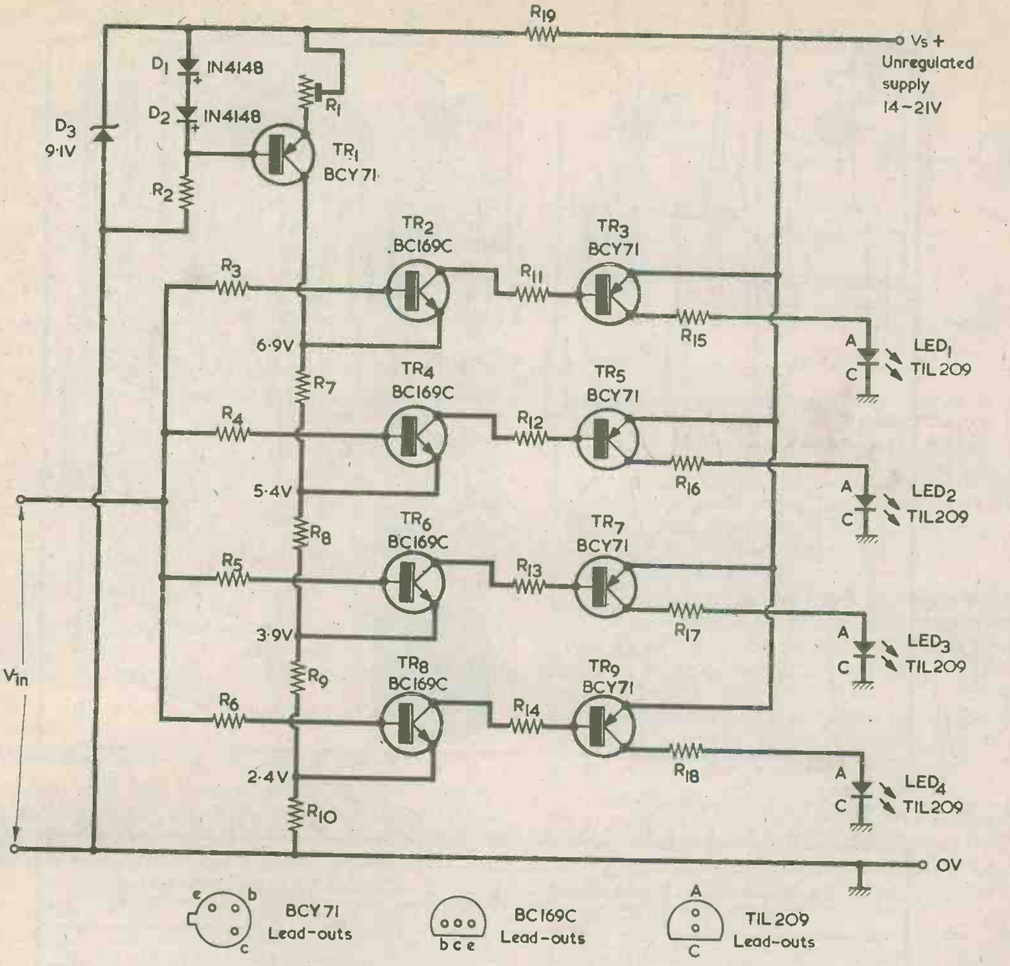


Fig. 3. The circuit of the digital voltmeter

comparator base resistors was chosen such that this range is only about 0.1 volt while still allowing the base current to be kept low when the input voltage is at a high level. Similarly, the collector currents of the voltage comparators are kept small by inserting 330kΩ resistors in the collector circuits. Current limiting resistors of 2.7kΩ are connected in series with the l.e.d.'s. These cause equal currents to flow in the l.e.d.'s and ensure equal brightness.

The voltage supply to the constant current source is stabilized by zener diode D3, which is fed by R19. The zener diode prevents variations in supply voltage from seriously affecting the accuracy of the voltmeter. The l.e.d. drivers are fed from the unregulated supply and this is found to be perfectly satisfactory. There is in consequence a saving of the cost of a voltage stabilizer for the whole circuit. The accuracy of the prototype was found to be well within the 5% quoted at the beginning of this article for all supply voltages between 14 and 21 volts.

The circuit shown in Fig. 3 can only be used to indicate 3, 4.5, 6 and 7.5 volts. The reason is purely an economic one; if the unit is used with a power supply that is designed to provide a maximum of 9 volts it will be superfluous to have a 9 volt indication. A modification which permits indication at 9 volts, is, however, described later.

The current consumption of the unit has been kept to the minimum to reduce loading of the power supply whilst maintaining a good level of brightness in the light-emitting diodes.

There is a very slight risk that an l.e.d. may not turn fully on if its driver transistor happens to have an exceptionally low gain. Should this occur the value of the series base resistor to the transistor concerned should be reduced below the specified value of 330kΩ. The reduced value will definitely not need to be lower than 150kΩ. The chance of this event happening is extremely small, and the point is mentioned only to provide completeness of information.

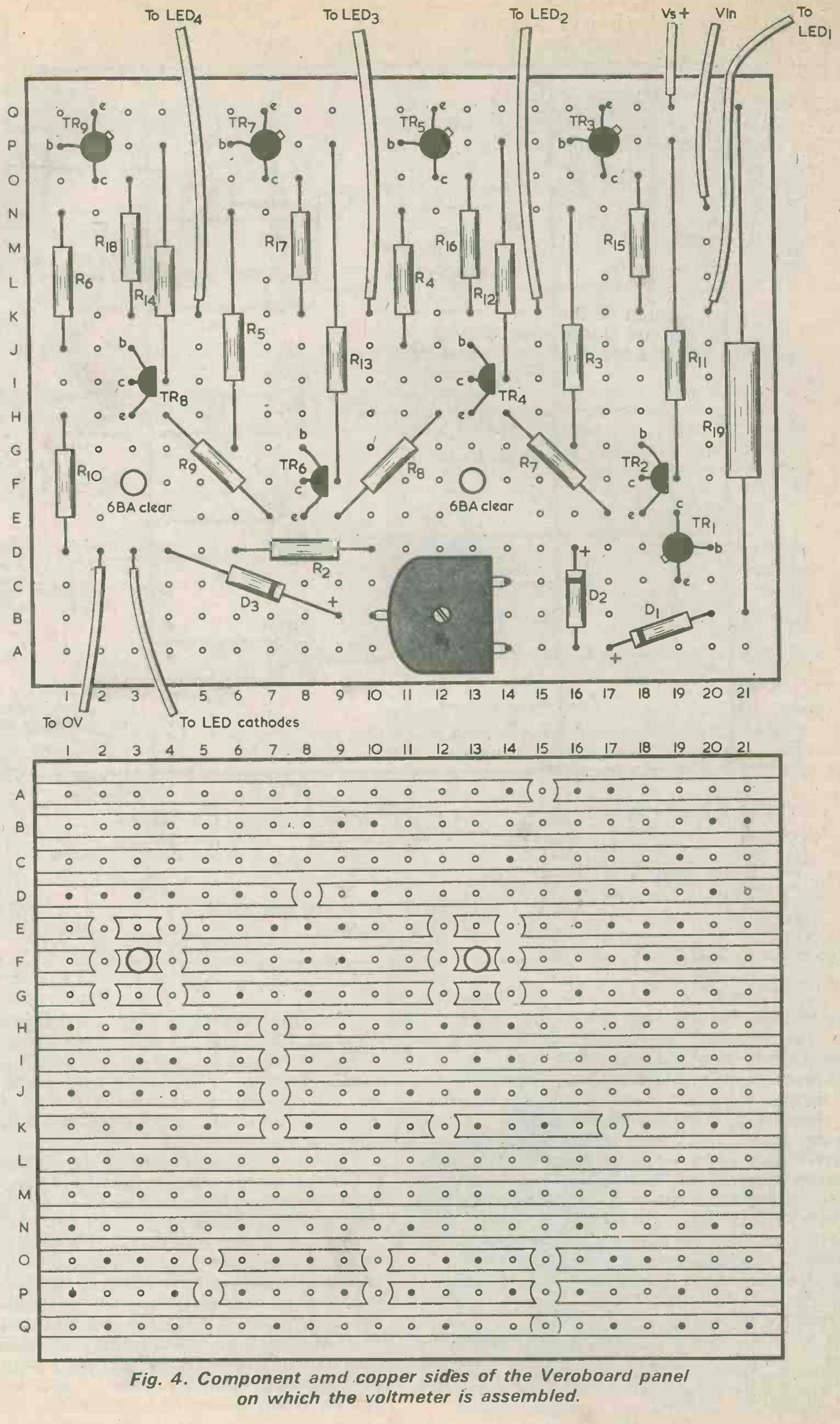


Fig. 4. Component amd copper sides of the Veroboard panel on which the voltmeter is assembled.

ASSEMBLY

The circuit is assembled on a 0.1 in. matrix Veroboard panel having 21 holes by 17 strips. Fig. 4 shows the component and copper sides of the Veroboard. It is mounted by two 6BA screws passing through the two 6BA clear holes.

The board is first cut to size and the rough edges cleaned up with a file. The two 6BA clear holes are drilled and the copper strips are cut at the holes indicated in Fig. 4 with a Vero spot face cutter or a twist drill held in the hand. The diodes and resistors are mounted horizontally while the transistors are mounted vertically in the normal manner. The insulated wires connecting to the l.e.d.'s, the supply and the input voltage are soldered in last.

The l.e.d.'s are mounted on the front panel of the power supply unit and are suitably labelled. All the cathodes are soldered to a common lead connected to the zero volt line. The anodes are connected to their respective drivers by other insulated wires. To produce a neat layout these wires are loomed together when the wiring is completed. Alternatively, the whole Veroboard panel may be mounted directly at the front panel. The l.e.d.'s could then be mounted directly on the Veroboard with strip 'L' as the common line for the cathodes, an insulated wire link being fitted between strip 'L' and the zero volt line. Mounting would be no problem with this method of assembly as the holes for the l.e.d.'s on the Veroboard are equally spaced. The board would be suitably spaced from the front panel and fixed with two 6BA screws.

SETTING UP

When the unit has been assembled, the constant current has to be set up. This process is carried out with the aid of a testmeter having a sensitivity of 10,000Ω per volt or better on its voltage ranges. The testmeter is connected between the collector of TR1 and the zero voltage line, and the pre-set potentiometer is adjusted for a reading of 6.9 volts. The circuit is then left in this condition for ten minutes after which the voltage reading is checked and, if necessary, the pre-set potentiometer is readjusted for the reading of 6.9 volts. This period of 10 minutes allows the constant current components to stabilize thermally. The voltmeter is then disconnected and the unit is ready for use.

The circuit is not temperature compensated as this would put up the cost of the unit, but its accuracy will not be seriously affected if changes in ambient temperature are small. This point should be kept in mind when positioning the Veroboard panel inside the power supply.

The unit is checked by connecting its input to the output of the variable voltage power supply. A voltmeter is also connected across the output of the power supply. At precise voltages of 3, 4.5, 6 and 7.5 volts the appropriate l.e.d.'s should have reasonable brightness. After a few test runs checking voltmeter readings and l.e.d. brightness the constructor should be able to set the power supply to these voltages working just to the brightness of the l.e.d.'s.

9 VOLT INDICATION

As was explained earlier, the circuit of Fig. 3 does not provide an indication for 9 volts. If such an indication is required the add-on circuit shown in Fig. 5 may be incorporated. The three 1N4148 silicon diodes give a voltage delay of approximately 1.5 volts and are returned to the 6.9 volt reference point at the junction of R7 and TR1 collector. The l.e.d. turn-on characteristic is not, however, as good as is that for the l.e.d.'s in the circuit of Fig. 3.

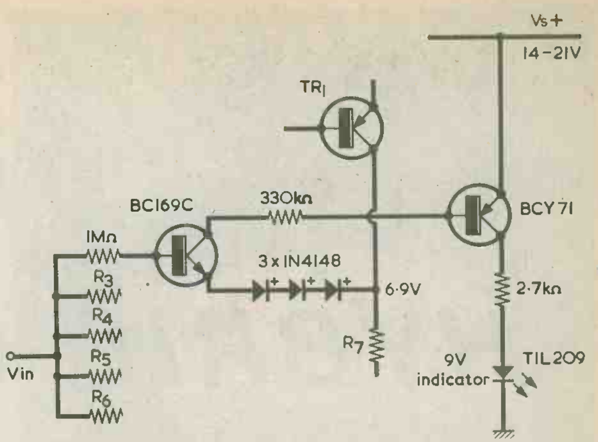


Fig. 5. An add-on circuit which gives an indication for 9 volts

The unit may also be used for fault-finding by giving rough voltage readings. Loading problems are minimal as the input resistance is well above 100kΩ. Another obvious application is as a logic probe for testing digital circuits. With t.t.l. circuits using positive logic, no l.e.d. will light up for a logic 0 whilst the 3 and 4.5 volt l.e.d.'s will light up for a logic 1. ■

RADIO AMATEUR LICENCES

From January 1, 1977, the Home Office will be issuing four new types of radio amateur licence which will replace all existing amateur licences when they become due for renewal.

The new Amateur Licence A (full facilities) and B (having certain limitations) will include all those facilities available to holders of the existing Amateur (Sound) Licences A or B, and will also include operation from a vehicle, or vessel other than at sea, or as a pedestrian; facsimile, amateur television, slow scan television, data on amateur bands 144-146 MHz and above, as well as double sideband suppressed carrier operation will also be included; and Emergency County Planning Officers will be added to the categories able to call upon Raynet (emergency communications).

The purposes of the new-style licences are:

(1) to give more flexibility to British radio amateurs, so that they may pursue their hobby without having to make special application for several of the above facilities at present needing separate licences or authorities:

(2) to enable the Home Office to deal with the increase in applications for amateur licences and regulatory work over the next few years with the minimum of delay.

Existing facilities authorised by a total of 20 licences and special authorities will thus be contained (with a few exceptions) in the new Amateur Licence A or B; and for Aliens combined fixed and mobile facilities in the Amateur Licence C or D. The new fee for all UK amateur licences will be £5.50.

CHIP RESISTORS IN HYBRID CIRCUITS

By Michael Lorant

Despite the advent of the monolithic single chip integrated circuit, the hybrid thin film circuit still flourishes. In this short article we examine a unique component intended specifically for hybrid manufacture: the chip resistor.

The role of the chip resistor in up-to-date hybrid circuit manufacture may not be immediately apparent. In general, hybrid circuits consist of thin-film circuits in which wiring and passive components are deposited in the form of a thin film on a ceramic or glass substrate, and to which other components, active and passive, may be connected by soldering, bonding or welding. Chip resistors may be added to thin film circuits and can be of assistance during the development of a hybrid circuit as they enable circuit parameters to be altered more readily than is the case where resistors are directly deposited on the substrate.

The ability, during development of a new circuit, to build a hybrid 'breadboard' with lead lengths and component placements exactly like those of the final manufactured design has obvious merit. During this stage of engineering, resistor values are easily changed and circuit performance, current levels, biasing, etc., can be readily optimised.

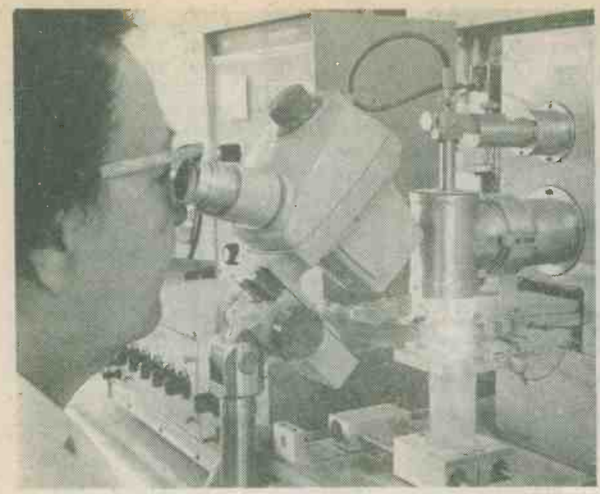
When resistance changes are required in the deposited material, even the smallest alteration requires complete readjustment in all the steps leading to the finished product: layout, artwork, photographic reduction, screen making and firing. Such a procedure is expensive and time-wasting.

FURTHER ADVANTAGE

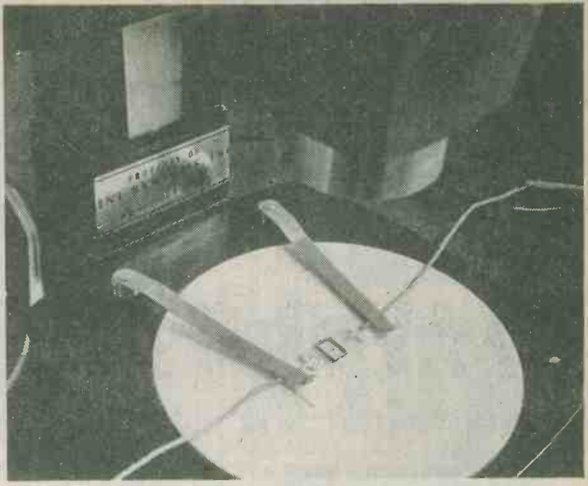
A further advantage of chip resistors arises due to the limited range of resistances that can generally be screen-printed using a single resistivity material. If a circuit requires only one or two resistances that are significantly higher or lower in value than the majority it can be more economical to use specific resistor chips.

Two varieties of chip resistors are available, in the United States, from Mini-Systems, Inc. One has gold electrodes for face-up wire bond assembly, whilst the other is tinned for solder reflow connection. This second type has the registered trade-mark 'Flip-R'. The wire bond version is electrically isolated between front and back, and the reflow solder type has insulation over its resistor body. Either device may be used as a cross-over in the circuit, thereby eliminating metal cross-over screening. Because of their accurate size and geometry, these resistor chips fit into designated locations without hidden short-circuits.

One pass of resistive ink has caused 256 resistor squares to be created on a single substrate. Measuring no more than 50 by 50 mils, each tiny square will later be cut out to form an individual resistor



After firing, the resistors are subjected to an abrasive trimmer, which brings them to the final required value. An electronic monitor automatically shuts off the trimmer when 1% accuracy has been reached



Here a chip resistor, under microscopic examination, is overloaded at 30 times its nominal power rating. The resistor glows red but does not fail

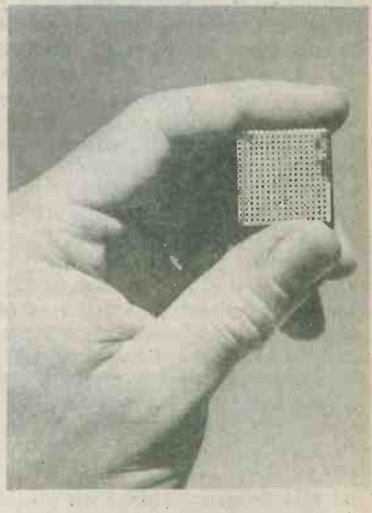
On the standard Mini-Systems chip, which is only 0.05in. square, the resistor body itself measures 0.035 by 0.035in. Temperature coefficients of the resistors are consistent and predictable. The coefficient tends to be more negative above 100kΩ due to a greater glass content in the resistive material, and to be more positive below 100 Ω because of a higher metal content. With mid-range values, careful blending of materials can produce a temperature coefficient significantly better than those of most discrete resistors.

PROPERTIES

When choosing chip materials, first consideration should be for electrical properties, ease of processing and predictability. Frequently, even the most expensive material represents only a minute portion of the total circuit cost, and a slightly higher material cost is insignificant if it permits an overall improved circuit yield. Another factor is that not all chip materials are compatible, and 'equivalent' materials have to be carefully evaluated before substituting.

During the trimming operation, probes to monitor resistance value are applied to each square in turn. Also directed at the square is a small carbide nozzle through which are ejected abrasive particles at high speed

After firing and trimming, the substrate is sliced to produce the individual resistors. Some chips have already been removed from this block of resistors



Resistance shift with chip resistors is less than 0.4% after 10,000 hours at 150 degrees Centigrade in air. Without overglazing, drift is less than 0.1% after 10 days at 95% relative humidity. When loaded to 50 watts per square inch, resistive stability is better than 0.5% after 10,000 hours at 85 degrees Centigrade. Soldering changes the resistance value by less than 0.1%. ■

In your workshop

This month Smithy the Serviceman, aided as always by his able assistant Dick, embarks on the unusual project of compiling a crossword puzzle incorporating as many technical words as possible. Not only does the venture succeed but it also produces several minor surprises.

"What's a word of six letters meaning 'pertaining to problems'?"

"Are there any letters already in?"

Smithy peered more closely at his newspaper.

"It's blank blank, O," he announced, "blank TY."

"'Grotty'," responded Dick immediately. "The word you want is 'grotty'."

Smithy ran his ball-point pen along the line of his crossword puzzle.

"Well," he said dubiously, "it fits. If the G at the start is right, the very last word in this crossword is G something FF something R."

"What's the clue?"

"'South African native of Bantu stock'."

"'Gaffer'," stated Dick without hesitation.

"Are you sure?" asked Smithy doubtfully. "I thought gaffers are people who order other people around."

"That's where the word comes from," explained Dick. "The Gaffers used to be the leading tribe in South Africa and they told all the other tribes what to do."

"Okay, fair enough," said Smithy in a satisfied tone as he entered the last two words of the puzzle. "Then that's got today's crossword done."

PUZZLE MAKING

The Serviceman tossed the newspaper over to the back of his bench, picked up his disgraceful tin mug and drank deeply.

"There's still half an hour of lunchtime to go yet," he remarked complainingly. "These darned crosswords are getting too easy nowadays. You can fill them in in no time at all."

Dick nodded in sympathy and then froze momentarily as a sudden inspiration visited him.

"Hey Smithy," he exclaimed excitedly, "I've just had one marvellous idea."

"Have you? What is it?"

"Why don't we make up a crossword of our own?"

"Our own crossword?"

"Our own crossword," confirmed Dick eagerly. "We can make up a really technical one. We won't put just any old words in it and we'll make it all up with technical terms."

Smithy looked at his assistant with an expression approaching respect.

"That's not a bad idea at all," he remarked thoughtfully. "But I think we'd better allow ourselves just a few non-technical words."

"All right," responded Dick. "We'll ration ourselves to three non-technical words."

Smithy drained his mug, then handed it over to his assistant.

"We'd better make it four," he stated. "We don't want to rupture our brains trying to do something that's too difficult. Look, you fill up my mug and I'll start making out a crossword pattern."

As Dick replenished the Serviceman's mug from the collection of cracked crockery alongside the Workshop sink, Smithy pulled his note-pad towards him, picked up a ruler and started to draw out a crossword puzzle pattern. He was still at work on this when Dick returned with a fresh mug of tea, and several more minutes elapsed before Smithy finally put the ruler to one side and declared that the crossword pattern was complete. (Fig. 1.)

"There you are," he announced proudly. "One crossword pattern all ready to be filled in. As you can see, it's all symmetrical just as you'd have in a newspaper crossword."

Smithy took a prodigious draught from his mug whilst Dick gazed at his note-pad.

"Let's kick off on the top line," suggested Dick. "What we want for starters is an eight letter word for 1 across."

"That shouldn't be too hard," pronounced Smithy, placing his mug on the bench. "All we need is any technical word of the right length which hasn't got any awkward letters like X or Z in it."

Dick's brow furrowed as he concentrated.

"Isn't it ridiculous?" he said irritably after some moments. "We've got the whole field of technical words to choose from, and I can't for the life of me think of a single one with eight letters."

"Well, we've got to put *something* in," stated Smithy, "or we'll never get started at all. I know a word. 'Vertical'."

"'Vertical'?"

"Like you have in vertical scanning in a TV set. As opposed to horizontal scanning."

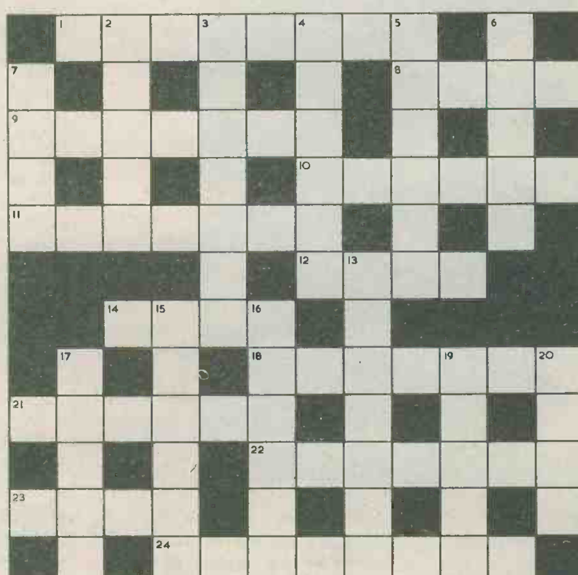


Fig. 1. The crossword puzzle pattern drawn up by Smithy

Smithy entered the word in the crossword.

"Fair enough," remarked Dick as he watched him. "That means that 2 down starts with an E. How about 'erode'? You get erosion when something gets eaten away."

"All right," said Smithy, writing in the word.

"And 3 down," continued Dick keenly, "can be 'thermic.' As in those thermic lances which are all the rage these days for cracking safes. There's a C at the start of 4 down and it's got six letters. That can be 'camera'."

"Here, take it easy," grumbled Smithy, busy with his pen. "Give me a chance to get them all in."

"I tell you," boasted Dick. "If it's technical terms you want you only have to come to me."

"All right, smarty-pants," snorted Smithy. "If you're so clever, see if you can find something for 9 across. It's blank blank O blank E blank M."

Dick frowned.

"Now, let's think. What we want is a seven letter word that ends in E something M."

The pair concentrated.

"I've got it," said Smithy suddenly. "'Beam'. 'Beam' ends in E blank M."

"But it's only got four letters," objected Dick.

"That's no problem," retorted Smithy. "The full entry can consist of CROBEAM."

"'Crobeam'? There's no such word."

"It isn't one word, you idiot. It's 'C.R.O. beam'. Cathode ray oscilloscope beam!"

Exultantly, Smithy wrote in the letters.

"Blimey, Smithy," commented Dick, "you're stretching things a bit, aren't you?"

"Not at all," replied Smithy. "'C.R.O. beam' is a perfectly respectable technical term. Now, 7 down has four letters with the second letter being C. That could be 'acid' and . . ."

Smithy's voice faded away and he gazed with a perplexed expression at the crossword puzzle.

"What's up, Smithy?" Dick's voice broke in. "'Acid' would be a jolly good word for 7 down."

"I know it would," replied Smithy pensively, "but I've just thought of something else. Look, let's leave 7 down alone for a bit, but we'll still start 11 across with a D. That makes it D blank E blank M blank R."

"There's just no technical word at all," said Dick slowly, "that fits those letters."

"No, there isn't," agreed Smithy. "Well, we'll just have to use up one of our ration of non-technical words. I'll make 11 across 'dreamer'."

SECOND SECTION

Smithy filled in the line of the puzzle, and they both looked critically at the section they had completed. (Fig. 2.)

"That's not too bad at all," commented Smithy cheerfully. "Let's have a stab at the top right hand part next. We'd better fill in 5 down. That's got six letters and it begins with L."

Smithy picked up his mug and drank copiously whilst Dick scratched his head.

"I'm a bit stumped here, Smithy," remarked Dick. "Have you got any ideas?"

"Oh yes," replied Smithy, as he put the mug back on his bench and wiped his lips with the back of his hand. "How about 'lambda'?"

"'Lambda'? What in heck is 'lambda'?"

"It's a Greek letter," stated Smithy. "In electronics it stands for wavelength. If you've got a half-wave dipole you say that its length is lambda divided by 2." (Fig. 3.)

"Do you?" said Dick. "Well, that should be okay, then."

He watched Smithy write the word into the puzzle.

"10 across," he went on thoughtfully, "is six letters starting with E blank B. How about 'emboss'?"

"An excellent word," pronounced Smithy approvingly. "And it's quite technical, too. You emboss a piece of

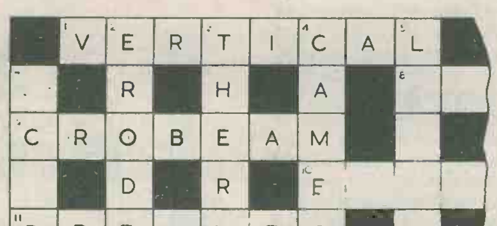


Fig. 2. Dick and Smithy's first steps in compiling the puzzle

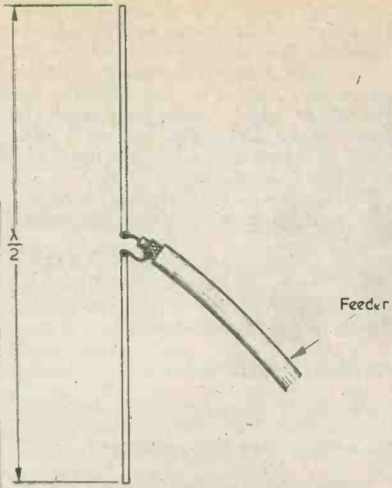


Fig. 3. The Greek letter lambda stands for wavelength. Here, it denotes the length of a half-wave dipole

sheet metal when you raise a pattern on it by pressure. I see that 8 across has four letters and that it starts with A. So 'atom' will fit in nicely there."

Smithy entered the words.

"6 down comes next next," remarked Dick. "Something O something S something. Dash it all, I don't seem to be able to think of anything except 'posse'!"

"You've been seeing too many Westerns."

"Or 'horse'."

"Now that's more like it," said Smithy, taking up his pen.

"You're not going to put in 'horse,' are you?"

"I'm going to put in a word very close to it," said Smithy, "and which you've just reminded me of. 'Morse'."

"Now why," said Dick irritatedly, "didn't I think of that? Well, all we've got left in this section is 12 across. A blank A blank."

"That's dead easy," remarked Smithy. "AJAR."

"'Ajar'?" repeated Dick uncomprehendingly. "Do you mean like when is a door not a door?"

"No," replied Smithy. "What I mean is two words. 'A' and 'jar'."

"But that's not a technical term."

"Yes it is," said Smithy. "A jar is a unit of capacitance. It was used by the Royal Navy in the past until they changed over to microfarads."

"Well, that's something I didn't know before," said Dick, impressed by this information. "I suppose they used jars in the old days when they had press gangs and scurvy, and things like that."

"You've got it," stated Smithy. "They changed over from the jar after they posted the press gangs to Fleet Street and had eradicated scurvy by adding lager and lime to the rum ration."

Dick sighed.

"Gosh," he said wistfully, "those must have been colourful times. The only excitement you get these days is in books, and they all seem to be about the C.I.A. Incidentally, Smithy, what *does* C.I.A. stand for?"

"'Caught In the Act' they tell me," replied Smithy. "Anyway, we are wandering a long way from our main object, which is supposed to be making up a crossword puzzle. Don't forget we've already finished the second part of it."

Smithy indicated the last section which they had compiled. (Fig. 4.)

THIRD SECTION

"Stap me," remarked Dick, "so we have. Hey, Smithy, making up crossword puzzles is quite good fun, isn't it?"

"It certainly makes a break from our usual activities," agreed Smithy, reaching once more for his mug. "I'd suggest we tackle the lower right hand part next."

Smithy drank deeply.

"We'd better fill in 13 down next," said Dick, looking at the puzzle. "that's got seven letters and it starts with J. How about 'jumpers'?"

"Jumpers'?" repeated Smithy, lowering the mug to the surface of his bench.

"You know," said Dick impatiently. "Lengths of wire which you use for connecting things together. Usually, jumper wires are flexible and they have crocodile clips or plugs at the ends."

Smithy surveyed the puzzle as so far completed.

"'Jumpers'," he remarked slowly, "would be an admirable word. That makes the third letter of 18 across M, so I'll put in 'numeral' there."

"Very good," stated Dick, as Smithy wrote in the last two words. "Let me have a go now, with 19 down. That's got five letters, starting with R."

Smithy looked at him speculatively.

"I can," he remarked gently, "think

Fig. 4. Making up the top right hand section of the crossword

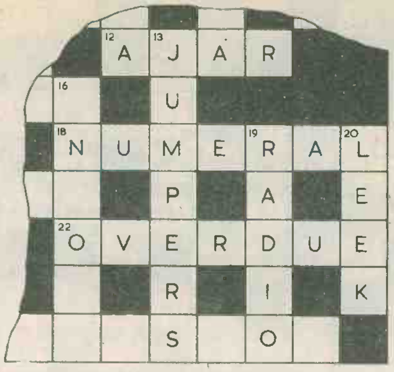


Fig. 5. The words entered in the lower right hand section

of an extremely common technical word which has five letters and starts with R."

"Can you? I'm blowed if I can!"

"It ends," said Smithy slowly, "with O."

"Does it? Oh blimey, of course! You mean 'radio'."

A satisfied gleam appeared momentarily in Smithy's eyes.

"That's exactly what I mean," he remarked, busy with his pen. "I'm now going to use a second non-technical word, and I'll make 22 across 'overdue'. Here we are."

Smithy entered the word.

"That leaves us 20 down," said Dick, scratching his head. "L blank E blank. I think we had better make that LEEK."

" 'Leek' doesn't sound very technical to me."

"Well it is. Don't you remember that in the old days they used to have high resistance grid leaks. The word stands for resistance."

"You great nit," growled Smithy. "That word is spelt LEAK, not LEEK."

"I don't care," said Dick mutinously. "If you can have a jar I'm going to have a leek. It's a unit of Welsh resistance!"

Smithy threw up his hands in despair.

"All right, all right," he said, "I give in. Well, that's got the third part done, even though we've had to bend things a bit to get it finished." (Fig. 5.)

COMPLETE SOLUTION

The pair looked at the puzzle.

"There's only about half a dozen words left now," remarked Dick. "And we've still got two non-technical words in hand."

Smithy grunted but made no further comment at this statement.

"What about 14 across?" continued Dick. "Blank blank C blank."

"I've got just the right word for that," stated Smithy. " 'Foci'."

" 'Foci'?" queried Dick. "Is there such a word?"

"Of course there is," retorted Smithy. "It's the plural of 'focus'. And since you say we've got two non-technical words in hand I'm going to use them up right now. I'm going to make 15 down 'outlaw' and I'm going to make 17 down 'embar'. That last word, by the way, means to shut in or stop."

There was a bewildered expression on Dick's face as Smithy entered the words into the puzzle.

"You're up to something, Smithy," he said suspiciously "I can feel it in my bones."

"What, me?" enquired Smithy blandly. "Now, why on earth should I be up to anything? Let's next take a look at 23 across. Something A something A. Can you think of a word that will fit in there?"

Dick frowned and an awed look came into his face.

"You can't mean," he stammered fearfully, "you don't mean — 'Data'?" as in . . .

"I do," said Smithy reverently, "Data Publications."

The Workshop went very quiet.

"Data Publications," resumed Smithy in a hushed tone, "who have financed our Workshop, through fat years and lean years, ever since those far-off days when we started up in business. Data Publications, from whose palatial offices in Maida Vale comes the finance which purchases all our equipment, from the most expensive signal generator to the humblest neon screwdriver. Who actually built the Workshop itself."

"I can only express myself," intoned Dick solemnly, "in terms of the utmost venereal respect."

Smithy looked shattered.

My boy, my boy," he cried brokenly, "the word is 'venerable'."

"Ah yes," stuttered Dick, "I meant

■	1 V	2 E	R	3 T	I	4 C	A	5 L	■	6 M	■
7 K	■	R	■	H	■	A	■	8 A	T	O	M
9 C	R	O	B	E	A	M	■	M	■	R	■
I	■	D	■	R	■	10 E	M	B	O	S	S
11 D	R	E	A	M	E	R	■	D	■	E	■
■	■	■	■	I	■	12 A	13 J	A	R	■	■
■	■	14 F	15 O	C	16 I	■	U	■	■	■	■
■	17 E	■	U	■	18 N	U	M	E	19 R	A	20 L
21	M		T		Y	■	P	■	A	■	E
■	B	■	L	■	22 O	V	E	R	D	U	E
23 D	A	T	A	■	U	■	R	■	I	■	K
■	R	■	24 W	O	R	K	S	H	O	P	■

Fig. 6. The crossword puzzle with only one important word, at 21 across, to be entered for completion

in terms of the utmost venerable respect."

"Let us now," stated Smithy gravely, "inscribe the term 'data' in our puzzle."

Ceremoniously, he entered the word. Dick watched mutely.

"I don't think I like this," he remarked uneasily. "This crossword puzzle seems to be assuming a life of its own. It's almost as though it's taking over from us."

"Well," said Smithy musingly, "we certainly seem to be coming to some quite interesting parts."

"Don't forget," Dick pointed out, "that we've run out of our ration of non-technical words. Everything we put in from now on *must* be technical."

"Don't worry about that," said Smithy soothingly. "Let's have a go at 16 down next."

"Dick examined the puzzle.

"That," he remarked, "is IN blank O blank blank. Blimey, I certainly can't think of anything to fit that."

"Try it," suggested Smithy, "as two words, the first word having two letters and the second word having four letters."

"Well," stated Dick, "the first word is already completed, and it's 'in'. So the second word is blank O blank blank."

"Can you think of a suitable word," prompted Smithy, "which could follow 'in' and have O as the second letter?"

"Why yes," exclaimed Dick. "The second word could be 'your'. So, 16 down is 'in your'."

"You've got it," confirmed Smithy, writing down the missing letters. "And that makes 24 across W blank R blank S blank O blank."

"Which," said Dick, hastily grabbing the pen from Smithy's hand and entering the letters in the puzzle, "can mean only one word. 'Workshop'!"

"That's it," grinned Smithy.

"Well, that *is* a turn-up for the book, and no mistake. Who'd have thought this puzzle would have involved us as much as it has done."

"You're in it, too."

"Me? Where?"

"At 7 down," replied Smithy. "If you remember, we left that one blank. I wasn't able to get you in right way round, but at least you can get in upside-down!"

Smithy took the pen from Dick and wrote Dick's name backwards in the 7 down space. (Fig. 6.)

THE LAST WORD

"And that," stated Smithy with immense satisfaction, "is that. One technical crossword finished."

Dick gazed at the puzzle with the fondness of the creative artist.

"We've certainly done a really sizeable job here," he stated. "From now on I'll have a little more respect for those geysers who compile the crosswords in the newspapers. Hallo, there's still one word missing."

"Is there?" said Smithy innocently.

"There is," stated Dick. "It's 21 across, blank M blank T blank Y. Dash it all, we've still got to dream up something technical to go in there before the puzzle is complete."

"Well," chuckled Smithy, "don't think that you're the only person who can find his way into a crossword puzzle."

"Blank M blank T blank Y," mused Dick, "Now what on earth will fit in there?"

Dick scowled at the final entry, and then his brow cleared. He took up the pen and happily completed the entry for 21 across.

SMITHY.

And you can't get more technical than that. ■

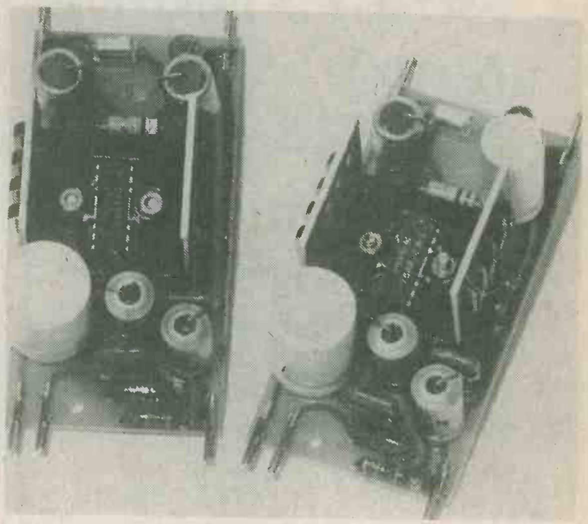
New Products

CHEKITS AMPLIFIER MODULES

The accompanying photograph shows the power amplifier modules type 75-X (10 watt) and 75-B (7 watt) which are now available in kit form from Chekits Limited. The two modules are basically the same except that the 75-X employs an integrated circuit type TCA 940 whilst the 75-B incorporates an i.c. type TBA810AS.

Each amplifier consists of a printed board on which are mounted the integrated circuit and all the components required for output d.c. isolation, supply bypass, compensation and bootstrapping. A large heat sink centrally disposed on the board provides cooling for the integrated circuit, and five connecting pins at the board edges allow the module to be wired to the input, speaker and power supply.

Further details are available from Chekits Limited, 56 Fortis Green Road, Muswell Hill, London, N10 3HN. Chekits Limited state that a pre-amplifier suitable for use with the 75-X or 75-B power amplifier is currently under development.



TWO NEW LOW COST SIGNAL GENERATORS

Marconi Instruments Limited, of Chelmsford, Essex, a GEC-Marconi Electronics company, has added two new versions of its highly successful TF 2015 10-520MHz general purpose a.m./f.m. signal generator to its wide range of test and measuring instruments.

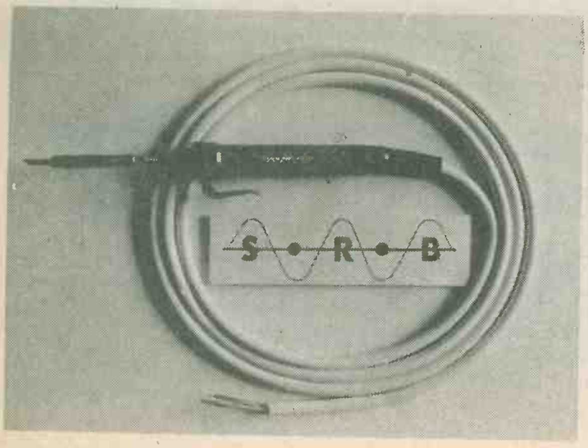
The two new versions offer alternative deviation ranges: TF 2015/1 is a narrow deviation instrument with three ranges of 2.5kHz, 5kHz and 25kHz full scale while TF 2015/2 is a wide deviation variant with ranges of 20kHz, 100kHz and 500kHz.

The TF 2015/1 is particularly suitable for mobile radio and other narrow band applications where the ease of setting low deviations makes it ideal in manufacture and servicing. In contrast the TF 2015/2 is designed for measurements on multi-channel systems such as those used in data communication and telemetry.

The TF 2015 Series

Fundamental frequency generation is used throughout, completely eliminating non-harmonic spurious components. The range is covered in eleven switched bands using separate oscillators, each band having an easily-read scale with only the range scale in use visible at any time.

LIGHTWEIGHT MINIATURE SOLDERING IRON



S. & R. Brewster Limited, of 86-88 Union Street, Plymouth, is now producing a new lightweight, slimline, miniature soldering iron under their trademark S.R.B. with over 30 years of specialised know-how behind it.

The S.R.B. iron operates at 220-240 V., 16-18 W. and fully complies with the latest Consumer Protection Regulations. A new bit securing method (Prov. Pat.) provides high efficiency heat flow and permits rapid interchange from the standard 3mm. bit to alternative 1.5, 4.5 and 6 mm. bits which are also available in addition to the one supplied as standard on the iron. It can be used pen fashion for fine work and a robust suspension hook is incorporated in the body moulding to facilitate quick, positive hang-up and retrieve. Quality control testing is on a 100% basis, every S.R.B. iron being tested to 1500 V. AC for leakage. Although competitively priced, the S.R.B. iron is designed and produced to high standards and all components are easily replaceable.

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ANTIQUE RADIO BOOKS. Newnes *"Television & Short Wave Handbook"* by F. J. Camm, 1935, £3.00. News Chronicle *"Wireless Constructor's Encyclopaedia"* by F. J. Camm, 3rd edition, circa 1930, £3.50. Prices include postage and packing. Box No. G318.

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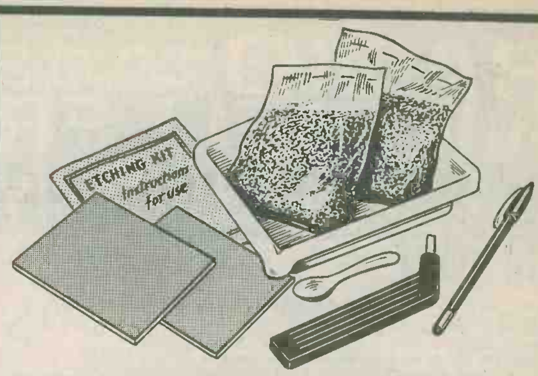
(Continued on page 453)



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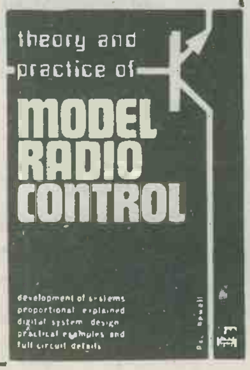

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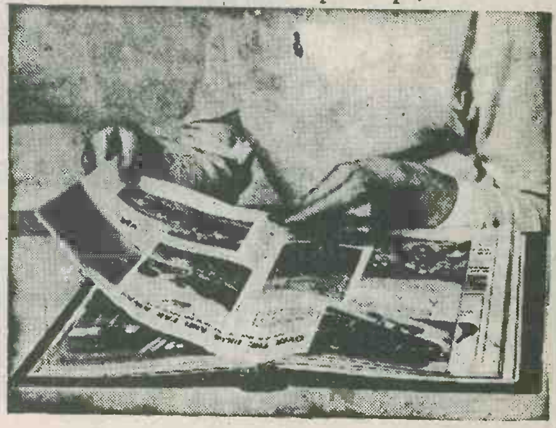

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In (c) the shunt has a value which causes f.s.d. to be given at 10mA. When this current flows, 9mA passes through the shunt and the remaining 1mA passes through the meter. Since the same voltage appears across the meter and the shunt, the shunt requires a resistance (Rs) of 100Ω divided by 9.

The shunt has a value, in (d), which increases f.s.d. to 100mA. When a current of 100mA flows, 99mA passes through the shunt and the remaining 1mA flows through the meter. As the current flowing in the shunt is 99 times that flowing in the meter, the value of the shunt is 100Ω divided by 99. In (e) the shunt produces an f.s.d. value of 200mA. This time, 199mA flows through the shunt and 1mA through the meter.

The effect of connecting a shunt across a moving-coil meter can be described as "scale multiplying" and the amount of f.s.d. increase as "scale multiplying factor". In (c) the scale multiplying factor is 10, in (d) it is 100 and in (e) it is 200. The figures we have already seen bring us to a general equation for the determination of shunt resistance, this being shown in (f).