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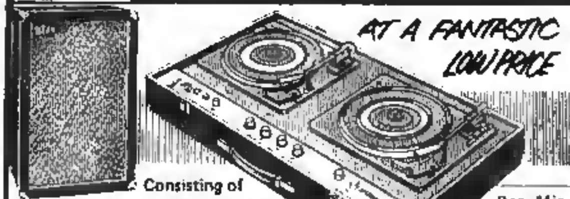
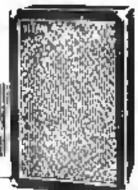

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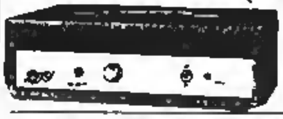

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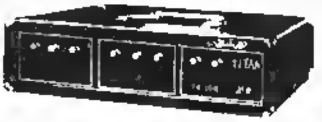

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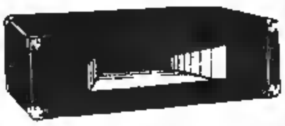

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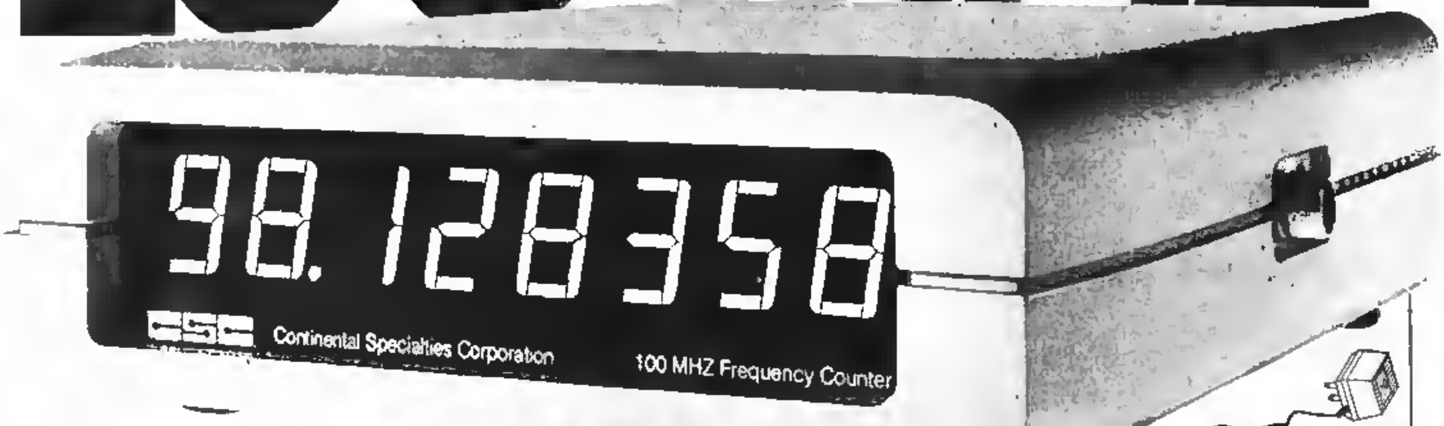

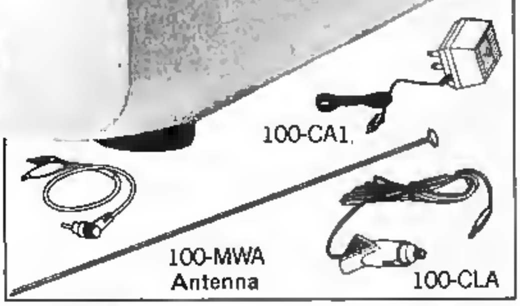

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BC108 0·12
BC109 0·13
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BC327 0·22*
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2N3904 0·21*
2N3905 0·22*
2N3906 0·22*
2N4058 0·20*
2N4059 0·15*
2N4060 0·20*
2N4061 0·17*
2N4062 0·16*
2N4124 0·17*
2N4126 0·17*
2N4286 0·20*
2N4288 0·25*
2N4289 0·25*
2N5457 0·35*
2N5458 0·35*
2N5459 0·35*
3N125 1·75
3N141 0·85

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CBL31 1·50
CL33 2·00*
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DF96 1·00*
DK91† 0·55*
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DK96 1·10*
DL92 0·75*
DL94 1·20*
DL96 1·10*
DY86/7† 0·45*
DY802 0·60*
E88CC† 1·00
EABC80 0·40*
EAC91 0·50
EAF42 1·25*
EAF801 1·75*
EB41 1·75*
EB91† 0·30*
EBC33 1·75*
EBC41 1·25*
EBC81 1·10*
EBC90 0·45
EBF80 0·45*
EBF83 1·23*
EBF89† 0·40*
EBL31 2·50*
ECC40 1·23*
ECC81† 0·50*
ECC82† 0·47*

ECC83† 0·55*
ECC84† 0·50*
ECC85† 0·55*
ECC88† 0·75*
ECC91† 0·55*
ECC189 1·00*
ECF80† 0·60*
ECF82† 0·60*
ECH35 2·00*
ECH42 1·15*
ECH81† 0·50*
ECH83 0·85*
ECH84† 0·85*
ECL80† 0·60*
ECL82† 0·55*
ECL83 1·50*
ECL86† 0·65*
ECLL800 7·00*
EF37A† 1·60*
EF39† 1·60*
EF40 1·15*
EF41 1·20*
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EF80† 0·45*
EF83 1·75*
EF85† 0·50*
EF86† 0·45*
EF89 0·80*
EF91† 0·65*
EF92† 0·75*
EF98 1·25*
EF183† 0·50*
EF184† 0·50*

EH90 0·75*
EL32 1·50*
EL33 3·50*
EL41 1·25*
EL42 1·75*
EL81 1·10*
EL84† 0·45*
EL86† 0·50*
EL91 3·85*
EL95† 0·80*
EL360 2·75*
EM80 1·10*
EM81 1·00*
EM84 1·00*
EM85 1·25*
EM87 1·50*
EN91† 0·55
EY51† 0·75*
EY86† 0·50*
EZ40 1·25*
EZ41 1·25*
EZ80† 0·30*
EZ81† 0·35*
EZ90† 0·45*
GZ32 0·75*
GZ33 4·00*
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OB2† 0·45

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OD3† 0·45
OZ4 0·75*
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PC88† 0·85*
PC97 1·08*
PC900† 0·75*
PCC84† 0·45*
PCC88 0·85*
PCC89† 1·05*
PCC189† 0·85*
PCF80 0·72*
PCF82† 0·50*
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PCF87† 1·00*
PCF200† 1·05*
PCF201† 1·05*
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PCF802† 0·68*
PCF805 1·44*
PCF806 0·80*
PCF808 1·44*
PCL82† 0·50*
PCL83† 0·92*
PCL84† 0·50*
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PL83† 0·55*

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PL504/500† 1·20*
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6AK6 0·85*
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6AM4 2·30*
6AM5 3·05*
6AM6† 0·65*
6AN5 2·50*
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6AR5 0·70*
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7404 0·28
7405 0·23
7406 0·55
7407 0·35
7408 0·28
7409 0·28
7410 0·20

7412 0·28
7413 0·45
7416 0·40
7417 0·40
7420 0·20
7422 0·25
7423 0·35
7425 0·35
7427 0·35
7428 0·50
7430 0·20

7432 0·38
7433 0·37
7437 0·42
7438 0·37
7440 0·22
7441AN 0·62
7442 0·78
7447AN 1·20
7450 0·20
7451 0·20
7453 0·20

7454 0·20
7460 0·20
7470 0·35
7472 0·30
7473 0·30
7474 0·40
7475 0·50
7476 0·42
7480 0·60
7482 0·65
7483 1·00
7484 1·00
7486 0·40
7490 0·52

7491AN 0·85
7492 0·60
7493 0·70
7494 0·80
7495 0·80
7496 0·90
7497 3·47
74100 1·75
74107 0·45
74109 0·65
74110 0·57
74111 0·86
74116 1·60
74118 0·95

74119 2·00
74120 1·10
74121 0·45
74122 0·60
74123 1·00
74125 0·80
74126 0·60
74128 0·80
74132 0·68
74136 0·68
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74143 3·00
74144 3·00

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74157 0·90
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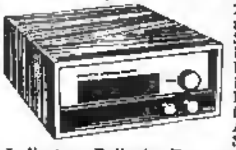

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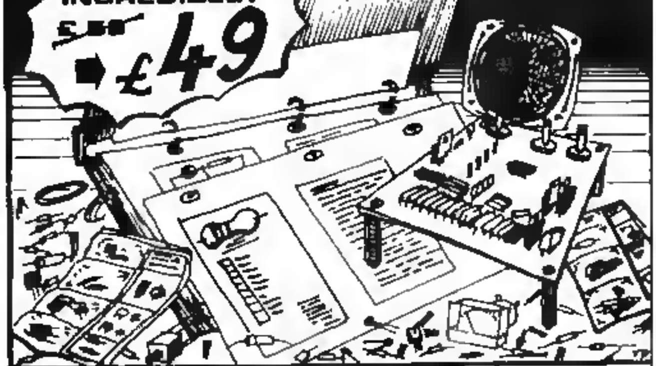

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BACK NUMBERS

We are very glad to announce the re-establishment of a PW Back Numbers Service for our readers. In future back numbers dated from June 1977 only will be available from our Post Sales Department for 65p, which includes postage and packing. Cheques and Postal Orders should be made payable to IPC Magazines Ltd.

Send your orders to:- Post Sales Department, IPC Magazines Ltd., Lavington House, Lavington Street, London SE1 0PF.

The British Connection

ELSEWHERE in this issue there appears a letter from a reader, prompted by a news item on electrical safety which was published in our March 1978 issue. Whilst I do not feel that *PW* is really the place to conduct a campaign for a "simple, safe plug", as he suggests, perhaps a few comments would not be out of place.

There are already on the market at least two makes of 13A plugs designed in such a way as to allow the live, neutral and earth cores of the lead being attached to be cut and stripped to the same length. These plugs are made by Crabtree and MK Electric. The latter's also incorporates a "press-in" cord grip, whose only disadvantage seems to be that fairly strong fingers are required if a heavy-gauge lead is to be fitted.

When the 13A plug was originally introduced, there were four standard fuse ratings—2, 5, 10 and 13 amps. A few years ago, the range was reduced to just two, of 3 and 13 amps, partly with the intention of trying to overcome the problem of over-fusing of small appliances. It was hoped that, by cutting the stock-holding required, electrical retailers might be persuaded to offer their customers the choice of plugs fitted with the appropriately rated fuse.

There has been limited success in achieving this aim. Some small electrical shops will ask a customer at the time of purchase, what sort of appliance the plug is intended for, and ensure that the correct fuse is fitted. At least one large chain of self-service stores offers a choice of 13A plugs fitted with 3 amp or 13 amp fuses, identified by an attached label.

Unfortunately, not everyone is sufficiently aware of the purpose of fuses to be able to make the correct selection. In a recent discussion on this very subject, the opinion was expressed by a very intelligent young lady: "When in doubt, fit the larger fuse. It would be safer because there would be less risk of it blowing". Clearly, more effort is needed to educate the public in this important aspect of electrical safety. In at least some of our schools, young people are, thankfully, now being taught about such things. Reaching the adult population is more of a problem.

Incidentally, before I am accused of being a male chauvinist, let me say that, in my experience, ignorance of the rudimentary principles of electrical safety (or any other sort of safety, for that matter) is very definitely not confined to the female of our species!

While on the subject of electrical safety in general, and 13A plugs in particular, another comment seems appropriate. Why is it that, when all such plugs are designed and type-tested to comply with British Standard Specification 1363, so many of them are incapable of carrying a full 13 amp load without overheating of the live connection? The heating causes corrosion of the end-caps of the fuse-link, and of its retaining clips, and the effects are usually cumulative. In one such case of my experience, sufficient heat was conducted to the mating socket to cause the polythene insulation to melt and peel away from the live conductor of the incoming supply cable over the first centimetre or so from the socket terminal. There are very few makes of 13A plug which I would use to feed a 3 kilowatt heater.

Geoffrey C. Arnold

PLEASE NOTE

We do not operate a Technical Query Service except on matters concerning constructional articles published in PW. We do not supply service sheets or information on commercial radios, TV's or electronic equipment.

All queries must be accompanied by a stamped self-addressed envelope otherwise a reply cannot be guaranteed.

NEWS... NEWS... NEWS...

New catalogue

The Winter 1978 Heathkit catalogue lists several new products of interest to the electronics enthusiast, including a range of low-cost, high-performance test equipment. The catalogue is available, free of charge, from *Heath (Gloucester) Ltd., Gloucester GL2 6EE.*

Dear old pals

Television and radio as "Good Companions" provide the theme of the introduction to the sixteenth edition of the Independent Broadcasting Authority's annual handbook "Television & Radio 1978", published on 20th January, 1978.

The handbook is a comprehensive and detailed guide to the workings of Independent Television and Independent Local Radio, describing the work of the Authority and the programme companies. Available from newsagents and booksellers.

"Television & Radio 1978", 224 pages, 228mm x 194mm, over 300 illustrations (many in colour), Price £1·85.

Mobile Rally

We are informed that the "Welsh Amateur Mobile Rally" will be held on Sunday, 21st May, 1978, at the Barry Rugby Football Club, Myneth Duffan, Barry, South Glamorgan.

Entrance is free and the organisers are hoping for a much larger rally this year. Further details from:

Simon Lloyd Hughes GW8NUN, 1 Min y Mor, Barry, South Glamorgan, CF6 8QC.

Keep it going

The Society of Electronic and Radio Technicians have organised a symposium to study "Electronic Maintenance Management".

Specialist studies of the many factors have been made and S.E.R.T. have arranged the symposium to coordinate current knowledge and opinion in the field. It will be of especial interest and value to those occupying supervisory and managerial positions in service departments, also those in maintenance sections of user industries.

Contributions have been arranged from many major industries and organisations including an opening address by the chairman of EMI Electronics, Dr. P. Allaway.

The symposium will be held at the University of Surrey from 10-12 April, 1978 and is residential. Accommodation, all meals, social activities and full documentation are included in the cost, which is £98 plus VAT. (£82 plus VAT S.E.R.T. members.)

For details apply to:

I. R. G. Channing, S.E.R.T., Faraday House, 8-10, Charing Cross Road, London WC2H 0HP. Tel: 01-240 1152.

RAYNET

A RAYNET symposium to be held on Saturday, 15th April, 1978, at the Post House Hotel, Leicester. Commencing at 10am the cost is £4·00 which includes buffet lunch.

Subjects will include: RAYNET yesterday, today and tomorrow; RAYNET and repeaters; Liaison with user services; Exercises; Live incident case histories; Equipment etc. and discussion periods.

Further details from:

G8CAC QTHR—M. G. Barker, 3 Burley Close, Desford, Leics. LE9 9HX.

Game of Kings

A new addition to the electronic game market, is the Gammonmaster II. This sophisticated, totally computerised backgammon game is designed for excitement and ease of play. It will defeat the average player more often than not, and compete evenly with experts.

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Although the machine likes to play an aggressive offensive game, it will change its strategy depending on how you choose to play—Running game, Block and Hit, Back game—it can also play a semi-back game, blot hitting contest and bear-off strategies.

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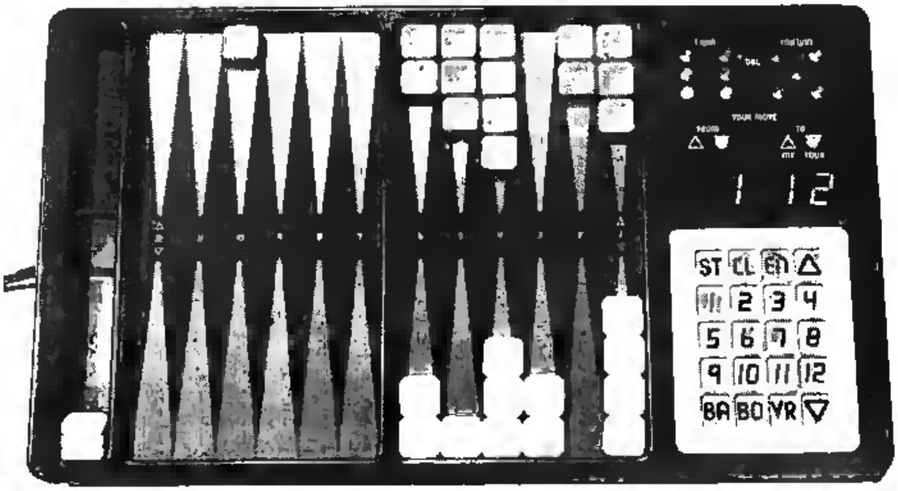
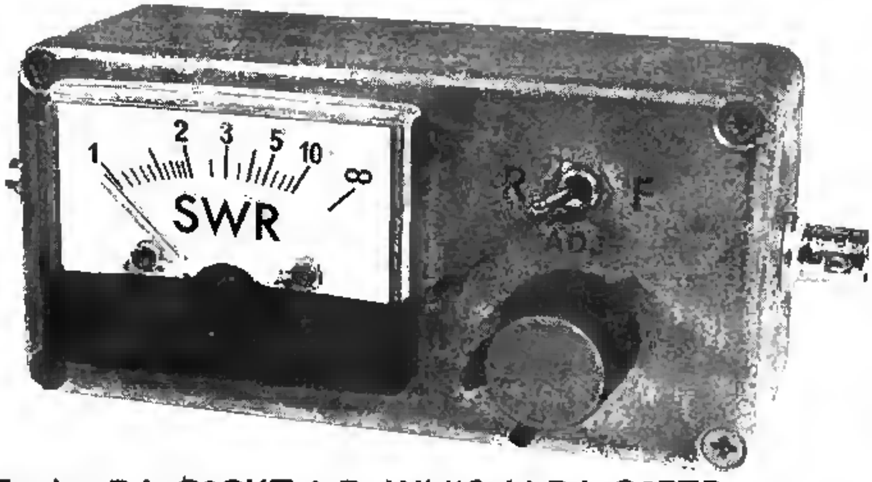


A 2 metre VSWR Bridge



M. H. Tooley BA G8CKT & D. Whitfield BA G8FTB

Introduction

Matching the aerial to the transmitter, in order to obtain maximum radiated power, is an important consideration for any radio amateur hoping to obtain the best results from his equipment: this can be achieved by using some form of standing wave meter in the tuning-up procedure. The standing wave ratio (s.w.r.) is a measure of the efficiency of an aerial system: the closer the s.w.r. is to unity, the greater the proportion of transmitter power actually radiated. Although the s.w.r. only approaches unity under ideal conditions, in practical situations its measurement will provide a very useful evaluation of the system's performance.

The instrument described is an s.w.r. bridge which will provide a constant, on-the-air reading whilst allowing meaningful measurements to be made on the relative merits of different aerials and aerial sites. It is suitable for use in the feeders of v.h.f. transmitters having outputs of between 1W and 100W.

Circuit Description

An s.w.r. bridge works by sampling the amount of power flowing in each direction along the aerial feeder. This is achieved by the use of a Maxwell bridge transmission line coupler, as shown in **Fig. 1**. The reactive arms of the bridge are formed by the distributed capacitance and mutual inductance of the coupled lines. The two sampling lines L1 and L2, shown in the circuit diagram of **Fig. 2**, are coupled to the main aerial feeder and respectively terminated at opposite ends by R1 and R2, thus providing two outputs which are proportional to the forward and reflected signals present. Diodes D1, D2 and capacitors C1, C2 convert the sampled signals to d.c. for measurement on a conventional meter M1. Potentiometer VR1 adjusts the sensitivity of the circuit and ferrite beads prevent stray r.f. pick-up in the wiring.

In practice, the bridge can be used either way round due to the symmetry of the circuit, but for convenience, SK1 is assigned to the transmitter and SK2 to the load; this allows S1 to be designated "forward" and "reflected."

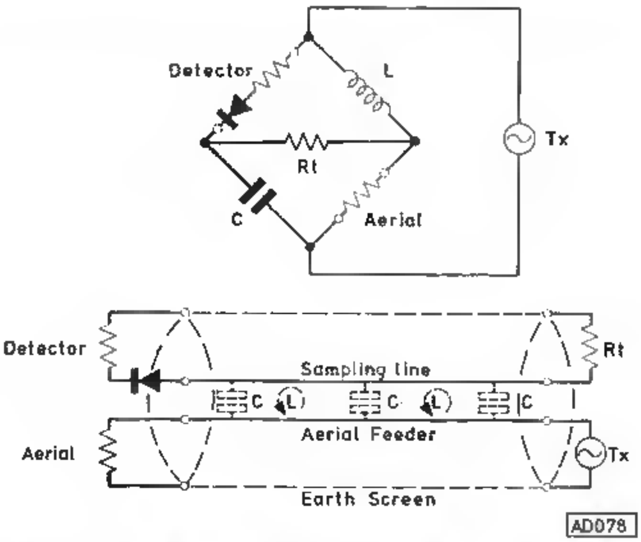


Fig. 1: Theoretical diagram of the Maxwell Bridge transmission line coupler

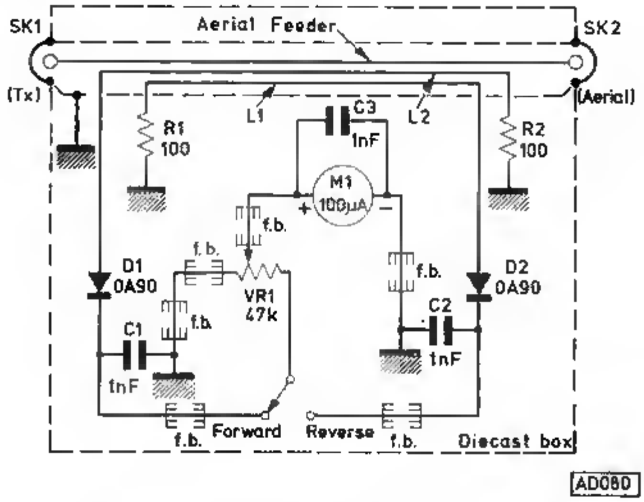


Fig. 2: Complete circuit diagram of the 2m VSWR bridge

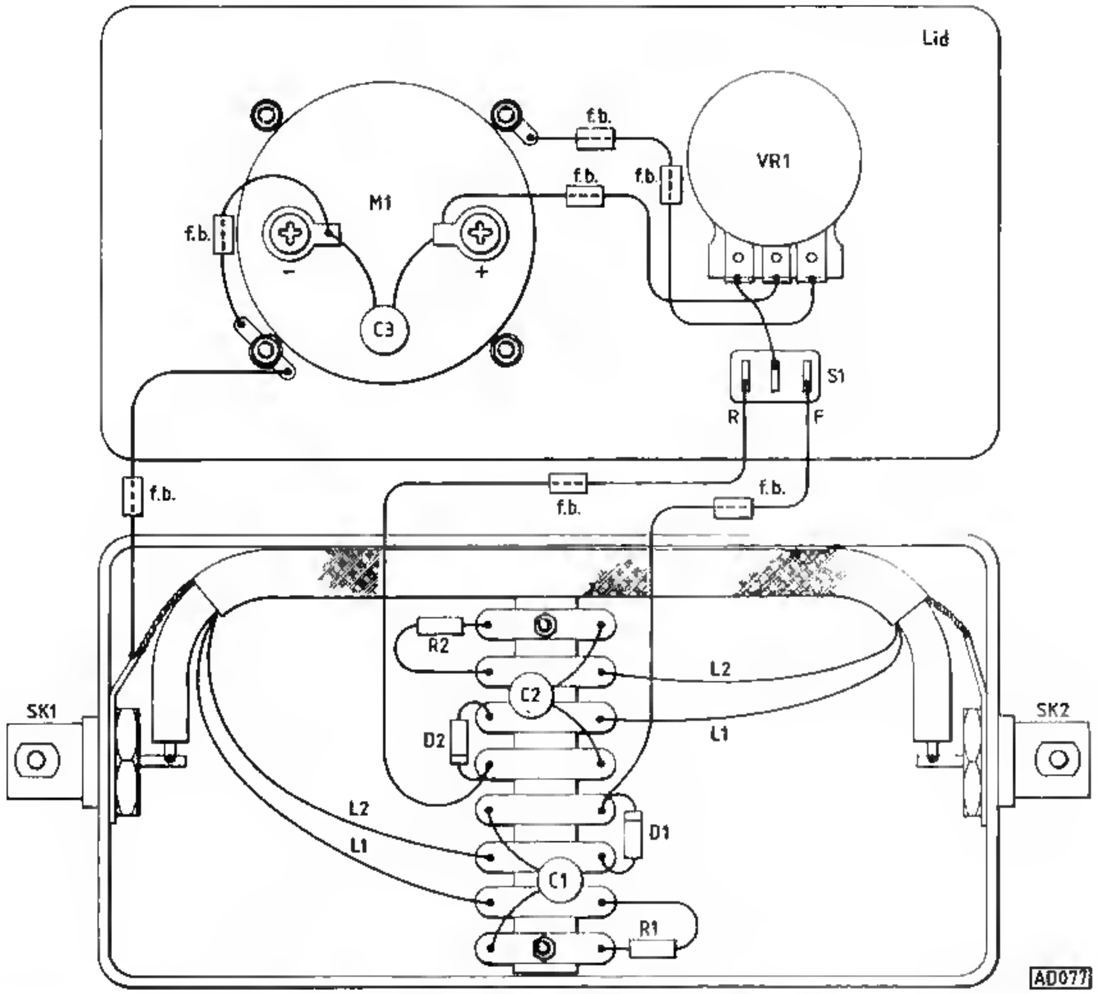


Fig. 3: Wiring layout inside the diecast box

Construction

The instrument is built into a small diecast box, which also acts as a screen. In obtaining a suitable box it is important to ensure that the depth is sufficient to provide adequate clearance for the meter movement.

The component layout is shown in **Fig. 3.** A tag strip is mounted so that the end connections are earthed via fixing screws, whilst the remaining ones are isolated: this is best done by using additional 8BA nuts to space the tag strip from the case.

It is important that the physical placement of the diodes, resistors and pickup lines is symmetrical: the better the symmetry, the better will be the electrical balance of the bridge. If matched resistors, diodes and capacitors are used, electrical balance will be even better than is possible with random-selected components. Since the bridge is essentially relative-reading, this condition, while highly desirable, is not vital for satisfactory results.

The germanium detector diodes should be matched for similar characteristics using the circuit of **Fig. 4.** A pair of diodes should be chosen such that on test there is no appreciable meter deflection as the applied voltage is varied from 0 to 9V. The meter used for evaluating the diodes should be as sensitive as possible, e.g. an Avo Model 8 on its 50μA range.

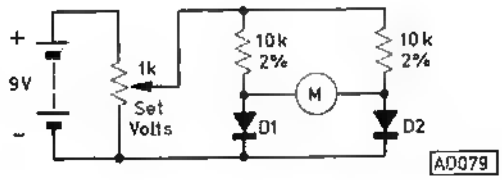


Fig. 4: Circuit used for comparing diode characteristics

The coaxial line is made from a 140mm length of low-loss coaxial cable (see component list). Its outer p.v.c. sheath should first be carefully removed and the copper braid "bunched" to allow the two sampling lines to be introduced under it. The lines should be of equal length and should be run inside the braid, with care being taken to keep them close together with no kinking. They should come out about 20mm from each end of the cable.

The accuracy of the instrument is dependent on the matching of the terminating resistors to the impedance of the sampling lines, thus the constructional details for the coaxial line should be closely followed.

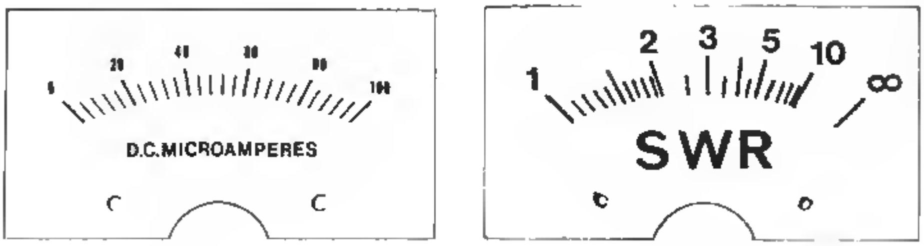


Fig. 5: Meter calibration scale for use with Maplin type '2 in PAN' meter. The original 100μA meter scale (left). Replacement scale for s.w.r. measurement (right). Both shown actual size

Calibration

Using the recommended meter movement the instrument may be calibrated simply by copying the scale shown full size in **Fig. 5.** For alternative types of movement a table of calibration points is given The new meter scale is best marked with the scale plate detached from the movement, using a fine pen and drawing ink, pencil or dry transfers.

S.W.R.	Reverse Reading (μA)	S.W.R.	Reverse Reading (μA)
1:1	0	2·5:1	43
1·1:1	5	3:1	50
1 2:1	9	3·5:1	56
1·3:1	13	4:1	60
1·4:1	17	4·5:1	64
1·5:1	20	5:1	67
1·6:1	23	6:1	71
1·7:1	26	7:1	75
1·8:1	29	8:1	78
1·9:1	31	9:1	80
2:1	33	10:1	82

Using the S.W.R. Bridge

Attach the output of the v.h.f. transmitter to SK1 and the aerial system or some other form of load to SK2, using matched feeder. Set S1 to read forward power and turn VR1 fully anticlockwise for minimum meter sensitivity. Apply r.f. power from the transmitter and adjust VR1 for a full-scale meter reading. Leaving the setting of VR1 unchanged, set S1 to read reverse power: the meter will now indicate s.w.r. directly.

It should be noted that continuous high-power operation of the s.w.r. bridge without a load may cause the 100 ohm resistors and the diodes to be destroyed. The bridge may be left permanently inline with the feeder between transmitter and aerial, as it introduces no significant signal degradation in either direction. Constructors should be wary of placing too much importance on absolute s.w.r. readings; the real value of the bridge lies in its ability to indicate relative forward and reverse power levels. It will be found invaluable as a general aid in the adjustment of transmitters and aerials. ●

★ components

Capacitors
- C1 1nF disc ceramic
- C2 1nF disc ceramic
- C3 1nF disc ceramic

Resistors
- R1 100 ohms ¼W 2%
- R2 100 ohms ¼W 2%
- VR1 47kΩ linear carbon

Diodes
- D1 OA90
- D2 OA90 (See text)

Sockets
- SK1 50Ω BNC
- SK2 50Ω BNC

Lines
- L1 250mm 26 s.w.g. enamelled copper wire.
- L2 250mm 26 s.w.g. enamelled copper wire.
- 140mm low-loss 50Ω coaxial cable of capacitance 56pF/m (UR203).

Miscellaneous

Diecast box approximately 120mm × 60mm × 44mm. 100μA 2in panel meter. Miniature single pole c/o toggle switch. Control knob with position indicator, Miniature 8-way horizontal tag strip. Earth tags, 5 required. Ferrite beads, 6 required (from TMP Electronic Supplies, Britannia Stores, Leeswood, Mold, Clwydd CH7 4SD N. Wales).

HOTLINES

A REVIEW OF RECENT DEVELOPMENTS
In general, the author does not have any more information on products than appears in the article.

Pulse probe

Nurses flitting around the wards, seizing wrists and checking pulses might be said to be getting to grips with the problem. However, a British company looks like putting an end to this age-old hospital custom. It is launching a unique little gadget which looks about the size of a fat pocket watch. All your ministering angel has to do is to hold the little device firmly on your wrist, and after only ten seconds your pulse is displayed accurately and digitally on a midget l.e.d. readout

A tiny piezoelectric transducer beneath a thin plastic membrane senses the pulse and in the absence of any pressure here the unit will automatically switch itself off. Pulses from 40 to 200/minute can be detected and read off to an accuracy of $\pm$ 3% $\pm$ 1 digit and the device will operate for several months (about 3,000 separate "pulses takings") on a single 5·6V battery. When the battery does run down, a decimal dot appears in the display.

Ideal for busy hospitals, and for the "average" high powered business man intent on watching his blood pressure—take a pulse Miss Jones.

Mini glimmers

Aren't l.e.d.s small compared to, say, the average torch bulb? News has just arrived that they're even smaller, thanks to a German manufacturer who is to bring out very small solid state lights!

These l.e.d.s are only one millimeter wide—which amounts to barely one twentyfifth of the good old fashioned British inch. They are to be available in the "usual" l.e.d. colours: green, red and yellow. Brightness is impressive—1mcd at 10mA. Commercial applications are seen as solid state dial indicators where a number of l.e.d.s are put in a line (or semicircle like the electronic speedos in cars). Another possibility is to use just a lonely one to light up l.c.d. watch faces at the touch of a button. They would also be ideal for use in photographic applications where, in some cameras, l.e.d.s light to show exposure details etc in the viewfinder of an s.l.r. camera. Please note, these are not yet available, but when they are, the numbers to watch for are LD171, LD161 and LD121 the number differences denoting a different colour. Just the thing for making a bionic glow-worm!

CQ tick tock

Talking small, times are changing—especially in the digital watch field. Up until now the favourite frequency for quartz crystals in timepieces was 32kHz. Now, a German manufacturer has employed a 4MHz crystal. Not only that, but it's been incorporated onto an i.c. There are many arguments for the higher frequency. The 4MHz crystals are cheaper to manufacture, and they have greater mechanical and thermal stability. It is interesting to note that the new i.c. oscillator draws only 6μA at 1·5V. There might be an outlet here for Hams who have an interest in miniature transmitters and receivers. Perhaps we will get Ham pirate stations coupling their wrist watches to a ten element yagi, or working half the world using 300ft of wire and a Timex!

For those with an interest in oscillators which are admittedly a little larger (but at least in production) I note that an American company regularly advertises some crystal oscillators which are housed in a d.i.l. (dual in-line) package. It's the same size as a 14-pin i.c. but is 0·5in. high. Frequency range available is from 6MHz to 60MHz, and at a temperature between -10°C and $+60$°C they have an accuracy of $+0{\cdot}0005$%. Cost (guessing 1·9 dollars = £1) is around £27.

Family programming

The age of the home computer is here and I predict that it will be a major industry in Britain within the next decade. Certainly people will end up using a home computer (for various things) like they currently play with home TV games.

Having said that, I was very interested to hear about the new COSMAC VIP. The VIP stands for Video Interface Processor. This truly magnificent beastie lets its master (or mistress) both create and play video games—and generate graphics, and develop microprocessor functions. The manufacturers describe it as a computer on a card. It's easy to program and, what's more, you can easily create your own programs. It's currently only available in the US (as far as I know) where it is sold in kit form. A "Cook book" is provided and part of this is devoted to telling you about programs for 20 different games. Some of these are purely fun games; others are educational. These are loaded and recorded on an ordinary cassette recorder. After this, all you need do is to connect your COSMAC VIP to a video monitor, or you can connect it to an ordinary black-and-white TV via a simple r.f. modulator. Price of the kit in the US is approximately £150.

Chip chat

If you are a tape recorder buff, then watch out for the magic number LM1818. You won't see it until very late this year (hopefully) but when you do you'll find it's an i.c. which contains all of the active electronics (except the bias/erase oscillator) needed to build a complete tape recorder. Buried in its little package are some very good design ideas. Like the incorporation of electronic switching from record to playback and vice versa. Using this chip, it's good bye to those six-pole changeover switches often found in tape recorders. The i.c. also incorporates two monitor amplifiers (for playback and record) plus another two preamplifiers for microphone and playback respectively. And the manufacturer has even thought to include some automatic levelling electronics for the equalisation of voice and any background sound. Other control circuitry employed enables the chip to comfortably handle anything from d.c. up to top audio without those plops when the record/play back switch is actuated. Finally, there is a meter driving circuit.

Ginsberg

'purbeck'

Part 2

OSCILLOSCOPE

IAN HICKMAN

This part deals with the first stages of construction and covers the Raw Supplies (Board 1) and the Stabilised Supplies (Board 2).

First build up the Raw Supplies, Board 1, as in Figs. 1 and 3.

Fig. 2 gives the circuit diagram of this board and a new series of component numbers has been started, as can be seen. Thus any component's number locates the board on which it is used (or mainframe/front panel for numbers under 100).

The Raw Supplies board produces a +300V output at pin 10. Without R101 the output would be in excess of +350V, but with it the conduction angle of the rectifiers D101 and D102 is substantially increased. The increased conduction angle greatly reduces the volt drop in section B of the 250-0-250V winding of T1 on positive peaks.

This in turn increases the negative output from the tripler circuit D105-D107 and associated capacitors. In fact −1150V approx. is produced at the junction of D107 and C106 at nominal mains voltage. This permits the use of a simple shunt stabiliser R104, D108-D112, providing a −800V stabilised e.h.t. output at pin 7.

In conjunction with the centre tap of the 12·9-0-12·9V winding, bridge rectifier D113 provides plus and minus 17V raw outputs at pins 4 and 5 respectively—the reservoir capacitors C19 and C20 are mounted on the mainframe. R102 and D103, D104 produce a clipped sine wave—approximately square—at pin 1. This is made available at the front panel (SK3) and provides a useful check on the accuracy and linearity of the lower timebase ranges.

Having made up the Raw Supplies board, check that all the polarised components are in the right way round (this board is unusual in that there are only four components which aren't polarised!) and mount it in the mainframe. Make off the connections to T1, insulating the ends of leads not yet needed, C19 and C20 and you are almost ready to switch on!

First, just fit a temporary link from Board 1 pin 6 to chassis—this will later be removed to leave a single common earth point at Board 3 edge connector when fitted. On test you should find around −800V at Board 1 pin 7 (all voltages are measured with respect to chassis), but the voltage at pin 10 will be around +360V as no current is being drawn.

Likewise, the plus and minus 17V raw supplies at pins 4 and 5 will be nearer 20V for the same reason.

In the absence of the load provided by the resistor string R16, VR6, R17, VR5 across the −800V Stabilised output, diodes D108-D112 will be passing more current than usual, so do not run the circuit for longer than necessary to check the output voltages.

After disconnecting the mains supply, always discharge the high voltage capacitors. Two feet of wire with a crocodile clip at one end (to pick up anywhere convenient on the chassis) and a 470Ω resistor in an insulated hand-grip at the other, touched on the positive end of C101 for a second or two and then likewise on the negative end of C106, can save you from a very unpleasant shock.

Having progressed so far, it's time to turn our attention to the Stabilisers, Board 2. Figs. 5 and 7 show the component layout and track side of the board respectively, whilst Fig. 6 gives the circuit diagram.

The stabiliser circuits are all fairly conventional.

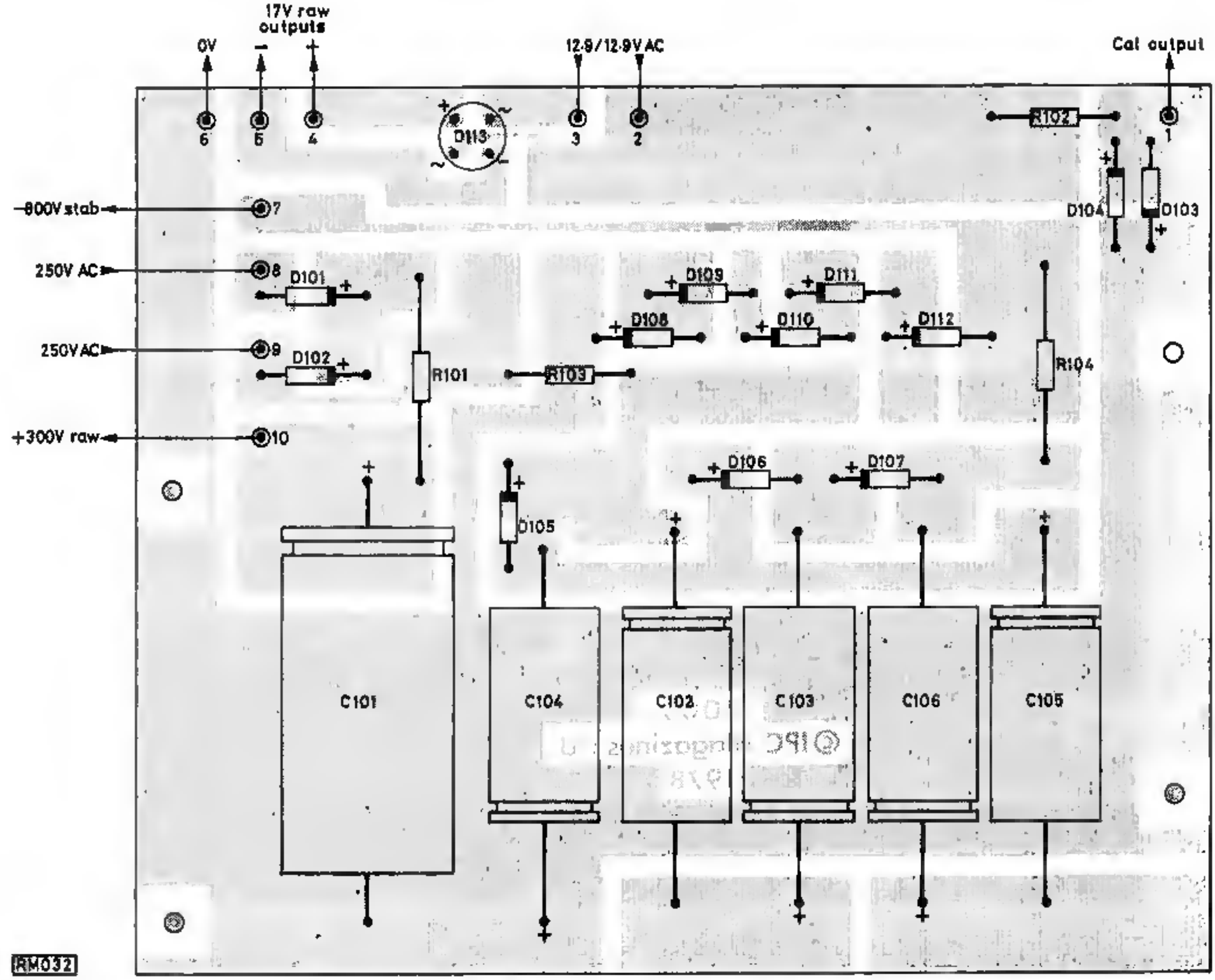
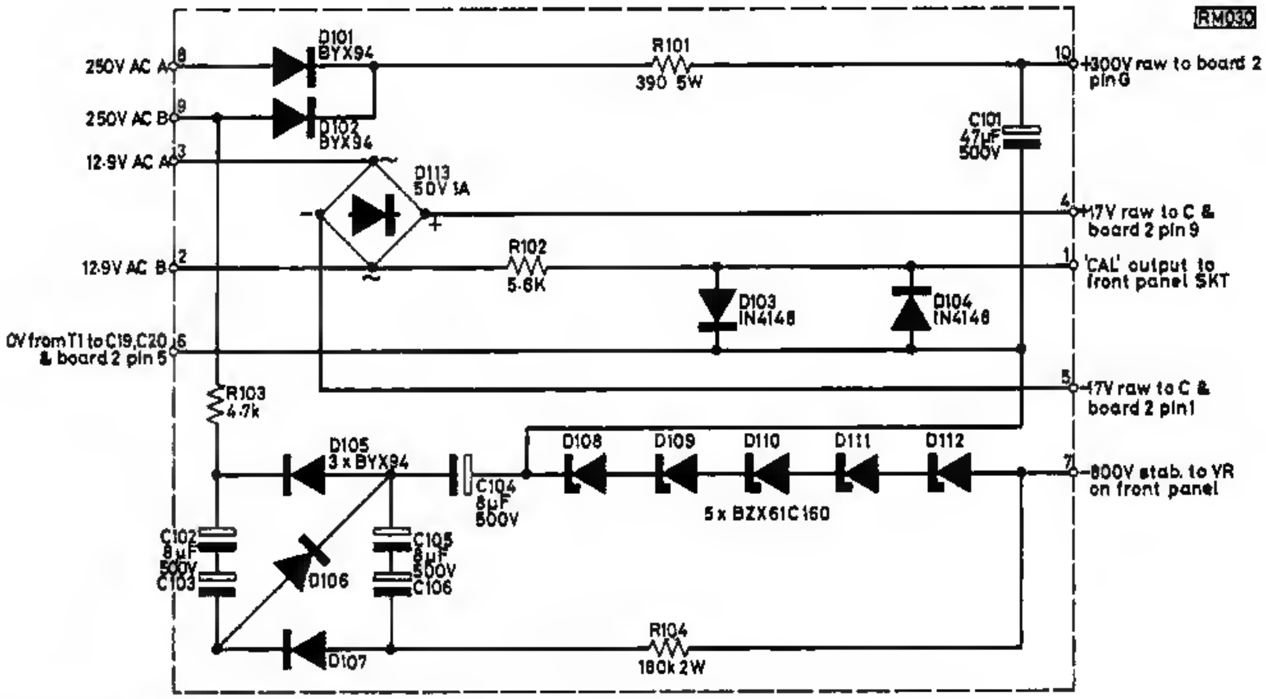


Fig. 1: (above): Component placement for the Raw Supplies Board 1. Care must be taken with component placing to avoid adjacent cans touching and also to ensure correct polarity

Fig. 2: (below): Circuit diagram of the Raw Supplies Board 1



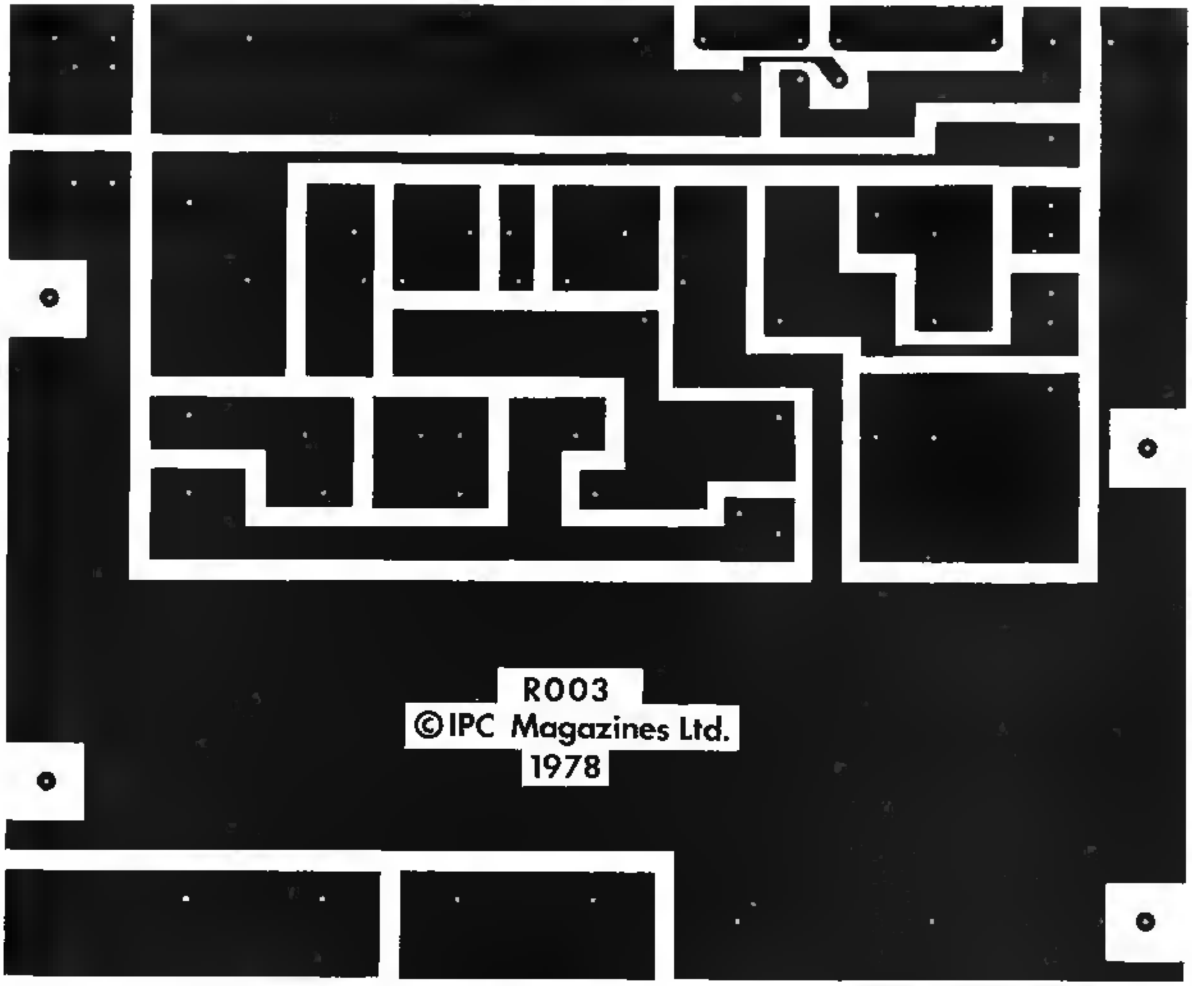


Fig. 3: Copper side of Board 1. A ready drilled board is available from Watford Electronics

★ components

BOARD 1, RAW SUPPLIES

Resistors
$\frac{1}{4}$W 5% carbon film unless otherwise specified

R101	390Ω 5W
R102	5·6kΩ
R103	4·7kΩ $\frac{1}{2}$W
R104	180kΩ 2W

Diodes

D101	BYX94
D103, 104	1N4148
D105-107	BYX94
D108-112	BZX61C160
D113	50V 1A Bridge rect. wire leads

Capacitors

C101	47μF 500V
C102-106	8μF 500V

Miscellaneous
Printed circuit board
Double Sided Wiring Pins—10

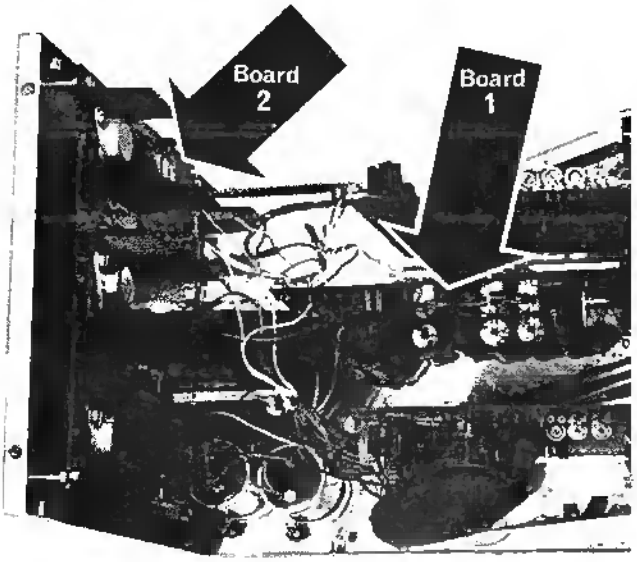


Fig. 4: Part of the inside of the case showing the positioning of the two power supply boards

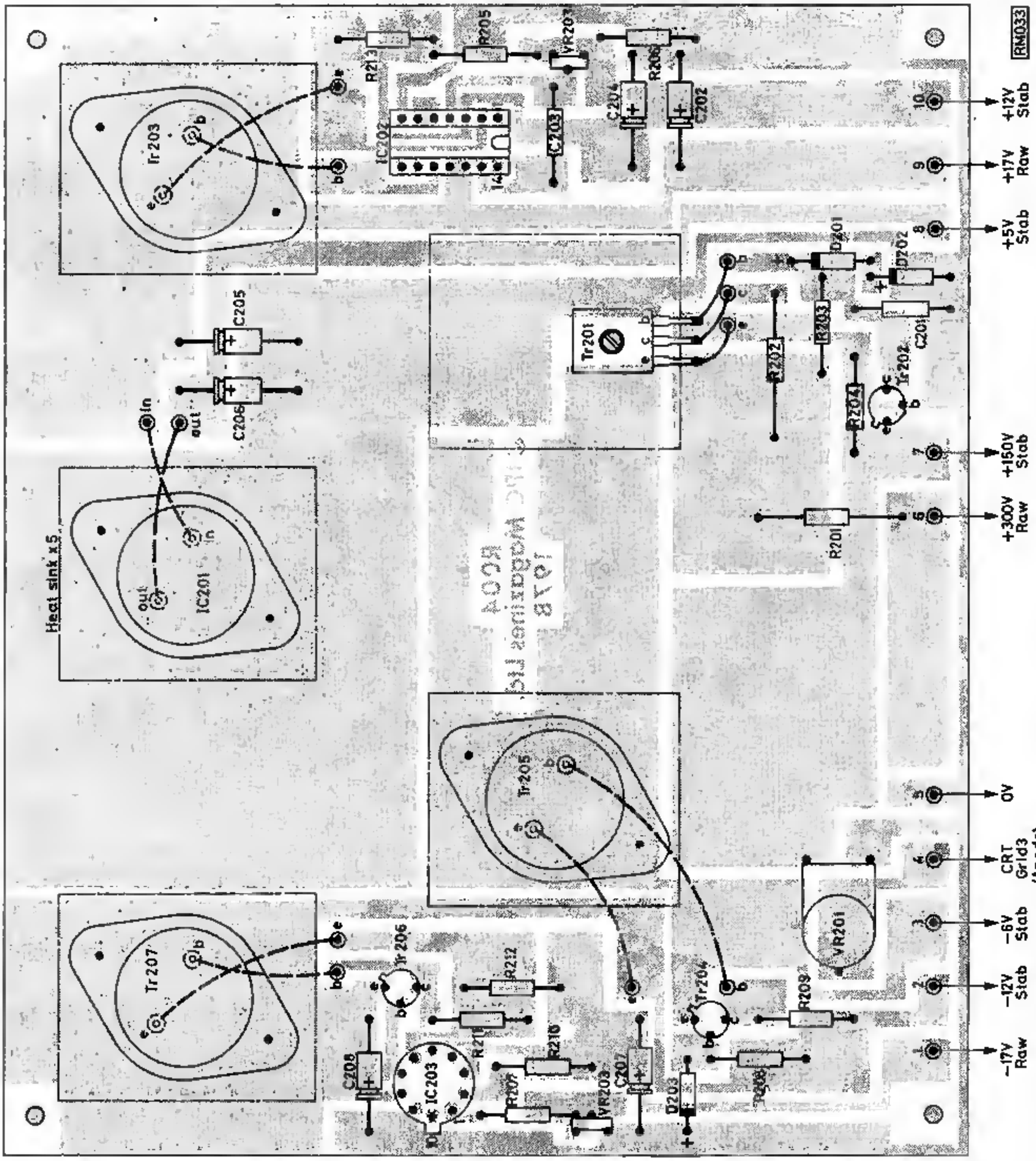


Fig. 5: Component placement for the Stabilised Supplies Board 2

The +12V supply uses a 723 (IC 202) augmented by a 2N3055 which, like the other supplies, is fitted with a heat sink. R204 sets the short circuit current for this supply at a little over 100mA. The load drawn from this supply in the completed instrument is around 40mA, which makes the heat sink hardly necessary. However, as explained earlier, heatsinks enable the stabilised supplies to withstand a short circuit of limited duration. Further, the cool running under normal conditions should ensure high reliability, with servicing required seldom if ever.

The +5V supply is also produced from the +17V raw, by IC201. The LM309 contains both overcurrent and overtemperature shut-down and needs only bypass capacitors at input and output.

The −12V supply is produced by an LM304 (IC203), augmented by Tr206 and Tr207. This supply is more heavily loaded, as it also accepts all the return current drawn by the X and Y deflection amplifiers from the +150V supply. R212 therefore sets the short circuit current at around 300mA.

Like the other i.c. stabilisers, IC203 is provided with bypass capacitors at input and output, to prevent any possibility of high frequency instability. The −6V supply, which is comparatively lightly loaded, is produced by Tr204, Tr205 and associated components, using the stabilised −12V as its raw supply. This makes it current limited by virtue of the current limit circuit of IC203.

The +150V Stabiliser Tr201, Tr202 and associated

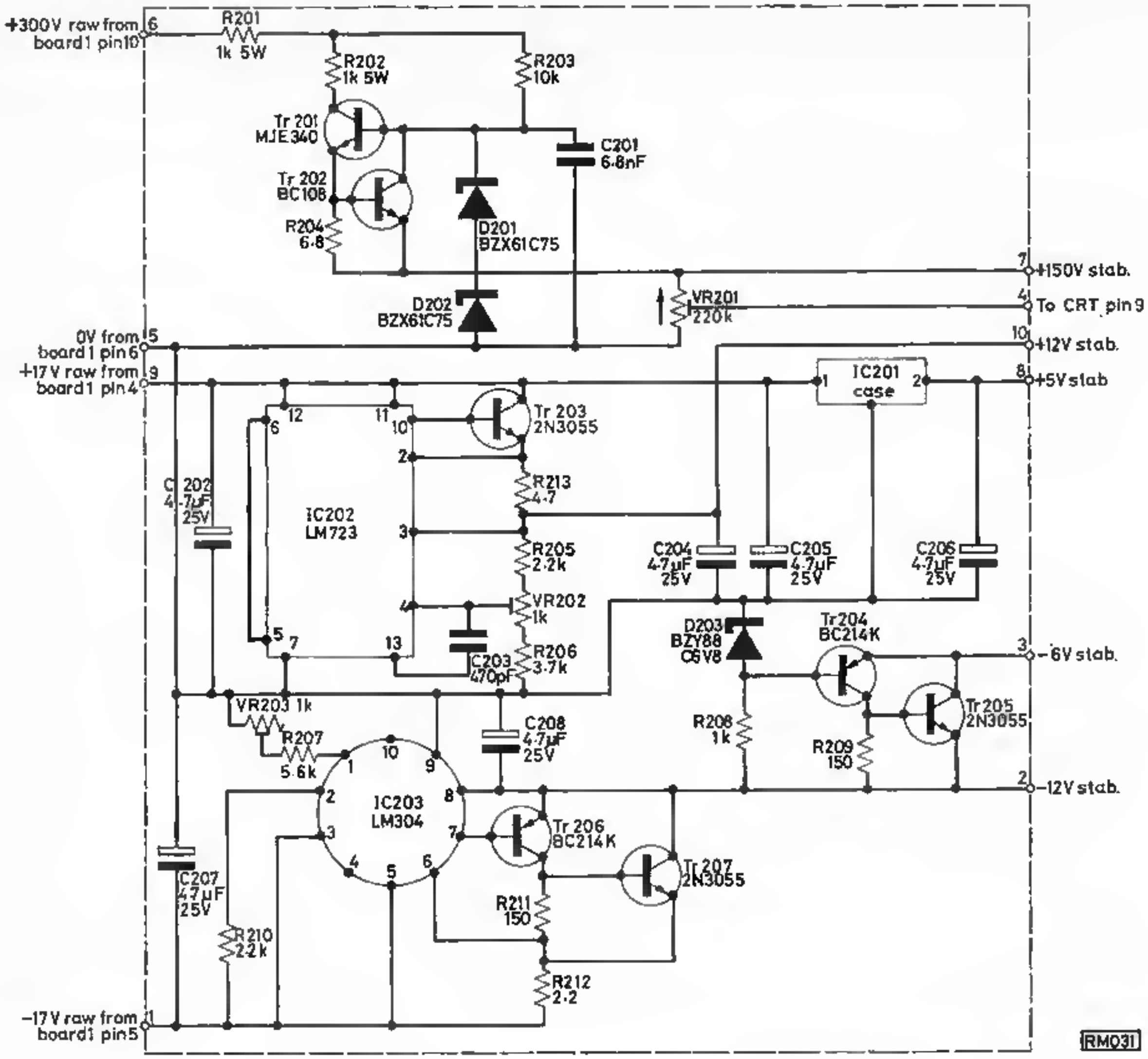


Fig. 6: Circuit diagram of the Stabilised Supplies Board 2

★ components

BOARD 2, STABILISED SUPPLIES

Resistors

¼W 5% carbon film unless otherwise specified

R201, 203	1kΩ 5W
R203	10kΩ ¼W
R204	6·8Ω
R205	2·2kΩ
R206	3·9kΩ
R207	5·6kΩ
R208	1kΩ
R209	150Ω
R210	2·2kΩ
R211	150Ω
R212	2·2Ω
R213	4·7Ω

Potentiometers

VR201	220kΩ ¼W Horizontal skeleton
VR202	1kΩ min vertical skeleton
VR203	1kΩ min vertical skeleton

Diodes

D201, 202	BZX61C75
D203	BZY88C6V8

Capacitors

C201	6·8μF
C202	4·7μF 25V
C203	470pF ceramic
C204-208	4·7μF 25V

Transistors

Tr201	MJE340
Tr202	BC108
Tr203	2N3055
Tr204	BC214K
Tr205	2N3055
Tr206	BC214K
Tr207	2N3055

Integrated circuits

IC1	LM309
IC2	LM723
IC3	LM304

Miscellaneous

Printed circuit board
Double sided wiring pins—10
Heat sinks, fingered, TO3 7·2°C per Watt—5

Fig. 7: Copper side of Board 2. A ready drilled board is available from Watford Electronics

components is also a discrete design. A +150V reference is provided by 75V Zener diodes D201, D202 and this controls emitter follower Tr201. Current limiting at about 80mA is provided by R204 and Tr202. R201 and R202 reduce the +300V raw supply to about +200V at the collector of Tr201, reducing the dissipation in this device. It is fitted with the same size heatsink (7·2°C per watt) as the other stabilisers, which necessitates drilling a 6BA clearance hole, as the heat-sink is ready drilled for a TO3 rather than a TO126. VR201 is mounted on this board for convenience. It is a preset potentiometer for Astigmatism adjustment of the c.r.t. display and its use will be covered later.

Next month's instalment will cover the front panel wiring as well as the interwiring of the power supplies. For this stage the case will be required and this can be obtained from Watford Electronics together with the printed circuit boards and all the other components needed.
As this project is proving very popular you are advised to place a regular order for Practical Wireless with your newsagent now.

PHASE-LOCKED LOOPS

C. BUDD

Much has been said and written in recent years about the virtues of a circuit known as the phase-locked loop (p.l.l.), particularly in connection with communication systems. This article aims to explain its principles of operation in a way that will be useful to the constructor.

Introduction

To illustrate what a phase-locked loop can do suppose that we have a signal of varying frequency and amplitude mixed with noise of comparable amplitude, and we wish to produce a signal of the same frequency but of constant amplitude and free from noise. One way of achieving this would be to pass the signal through a tuned, limiting amplifier such as that used to amplify the intermediate frequency in a v.h.f./f.m. receiver. A drawback of this method is that the tuned stages of the amplifier would have to have sufficient bandwidth to pass the full range of frequencies expected, and the wider the bandwidth required the greater will be the amount of noise passed through to the output.

The phase-locked loop, as we shall see, provides a far more attractive and noise-resistant alternative. In fact, the p.l.l. can be thought of as a convenient way of generating a copy of a signal in such a way as to preserve frequency variations but eliminate amplitude variations and noise.

Principles

The basic schematic diagram of a phase-locked loop is shown in **Figure 1**. The functions of some of the sections shown may call for explanation.

The phase-sensitive detector is simply a circuit with two inputs and one output such that if two signals of the same frequency are applied to the inputs, the output voltage will be dependent on the phase angle between them. In fact, any "mixer" stage in which two signals of different frequencies are combined to produce a third on another frequency is a form of phase-sensitive detector. The phase-locked loop as a whole may operate with continuously varying sine-wave signals or, in a digital system, with rectangular pulses.

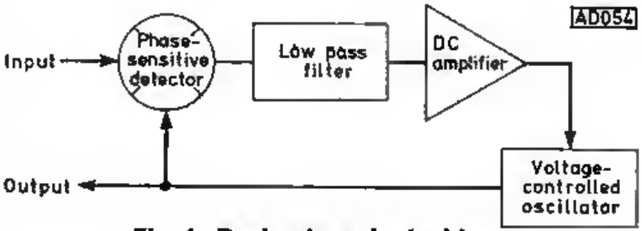
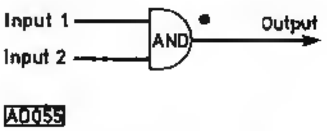


Fig. 1: Basic phase-locked loop

In the digital case, the simplest form of phase-sensitive detector is a simple two-input AND gate, as illustrated in **Figure 2**. Here, two streams of pulses of the same frequency but differing in phase are applied to the inputs of the gate. The output of an AND gate is "high" whenever all inputs are high and "low" otherwise. Thus, the fraction of the time for which the output is high and, hence, the mean voltage at the output, will depend only on the phase angle between the two square waves.



Truth Table

Input 1	Input 2	Output
Low	Low	Low
High	Low	Low
Low	High	Low
High	High	High

Fig. 2: A simple AND gate may be used as a form of phase-sensitive detector

The purpose of the low-pass filter is to remove any unwanted high frequency components from the output of the phase-sensitive detector, since it is the d.c. component that principally concerns us. The filter may be exceedingly simple, often consisting of one capacitor and one resistor, and will be designed to attenuate signals at frequencies above a certain maximum. This maximum frequency passed will have a profound effect on the performance of the circuit.

The voltage-controlled oscillator, as the name suggests, is an oscillator with frequency controlled by an applied voltage. Generally, the relationship between frequency and controlling voltage will be linear. The frequency of oscillation when the control voltage is zero is known as the "free-running" or "centre" frequency.

Now, suppose a signal with frequency equal to the free-running frequency of the v.c.o. is applied to the input of the loop. The applied signal and the signal from the v.c.o. will not, generally, be in phase and so the p.s.d. will produce a d.c. output which will change the frequency of the v.c.o. The resulting speeding-up or slowing-down of the v.c.o. will alter the phase angle between the two signals applied to the p.s.d. By arranging for the frequency of the v.c.o. always to vary in the appropriate direction, it can be ensured that the phase angle will always decrease. As it does so, the output from the p.s.d. will approach zero and the frequency of the v.c.o. will return to its free-running value.

Thus, by a process of negative feedback between the p.s.d. and the v.c.o. the output signal (from the v.c.o.) is matched in phase and in frequency to the input signal.

But suppose that the input frequency is not equal to the v.c.o.'s free-running frequency? Provided that

the input frequency and the free-running frequency are sufficiently close, the same locking by negative feedback will occur and the loop will settle down with the v.c.o. frequency equal to the input frequency and the phase angle between v.c.o. and input just right to produce the d.c. output from the p.s.d. required to bias the v.c.o. to the input frequency. The reason why the phase-locked loop is so called is now clear; it operates by a process of negative phase feedback.

Because the low-pass filter passes such a narrow band of low frequencies the circuit is extremely insensitive to random noise and interference, and can lock on to, and produce, a noise-free replica of a frequency-varying signal buried deep in noise.

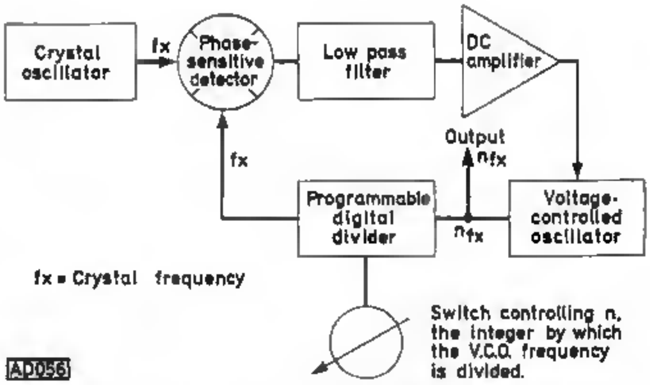


Fig. 3: The use of a phase-locked loop in a crystal controlled frequency synthesiser

Limitations

There are, of course, limitations. The p.l.l. will lock on to only those frequencies within a limited band around the centre frequency. The width of this band is determined by, among other things, the sensitivity of the v.c.o. to changes in the control voltage. The range of frequencies over which lock can be maintained is *not* affected by the characteristics of the low-pass filter. If a signal of constant frequency is suddenly applied to the input of the phase-locked loop, whether or not locking occurs depends on whether or not the frequency of the signal is within the "capture range" of the loop. Once phase-lock has been achieved, it can be maintained at frequencies outside the capture range provided that the frequency remains inside a wider range known as the "tracking range". If, for some reason, lock is lost while the frequency is inside the tracking range but outside the capture range, locking will not occur again until the frequency returns inside the capture range.

Another limitation is that a phase-locked loop can only follow a locked frequency-varying signal at a finite rate, known as the "maximum tracking rate". If the input frequency varies at a rate greater than the maximum tracking rate, phase-lock will be lost and the signal will have to be re-captured. The rate of tracking is limited by the characteristics of the low-pass filter, since it is this which limits the rate at which the control voltage applied to the v.c.o. can vary. Since the bandwidth of the low-pass filter also limits sensitivity to noise, it is clear that we have a trade-off between immunity to noise and tracking rate. A greater tracking rate can be achieved, but at the cost of greater sensitivity to noise.

Applications

A complete phase-locked loop can now be constructed from a single i.c. and few discrete components. The Signetics NE560B, NE561B and NE562B are particularly versatile.

The most obvious application of the phase-locked loop is as an f.m. discriminator offering easy alignment and excellent immunity from noise. In this application, the f.m. i.f. signal is applied to the input of the loop and the audio output is taken from the control input of the v.c.o. Since the frequency-voltage relationship for the v.c.o. will be linear, the control voltage will vary linearly with the i.f. frequency while the loop is locked.

The p.l.l. can also be used advantageously to demodulate an a.m. signal. This can be done by applying the a.m. signal (perhaps at i.f.) to the input of the phase-locked loop to lock the loop to the carrier signal, and using the output from the loop (after phase-shifting to bring it into phase with the original carrier) to control an electronic switch to invert every alternate half-cycle of the a.m. signal. The "chopped up" signal is then passed through a low-pass filter to remove the r.f. component and leave only the a.f. which is an exact copy of the original modulating signal. One advantage of this system over the conventional germanium diode a.m. detector is that it has a linear response (which the germanium diode does not) and therefore introduces less distortion. Also, in the f.m. case, the use of a phase-locked loop provides better immunity to noise and interference.

Still in the field of communications, a digital phase-locked loop can be used to "synthesise" signals on many fixed frequencies, each with crystal controlled stability and precision but employing only one crystal. Such a digital "frequency synthesiser" is illustrated in **Figure 3**. Here, a programmable digital divider is included in the feedback loop of the phase-locked loop so that the frequency of the pulses applied to the p.s.d. is not the frequency of the v.c.o., but the v.c.o. frequency divided by an adjustable whole number determined by the output frequency required. Thus, the v.c.o. is locked not to the crystal frequency, but to an adjustable whole number multiple of the crystal frequency and the loop can generate a wide range of fixed frequencies, all with crystal control but without employing a large number of expensive crystals.

Practical Circuits

The Signetics NE561B i.c. is a particularly versatile p.l.l. "chip" and priced at between £3 and £5 at present. The device contains a basic phase-locked loop together with a multiplier for a.m. demodulation, a limiting circuit in the feedback loop and two audio preamplifiers for the a.m. and f.m. outputs. The v.c.o. is of the relaxation type. That is to say, its frequency is determined by the values of resistors and capacitors. The simple practical circuits given in **Figures 4 and 5** and described below are intended simply as rough guides to what can be done in practice and are, of course, capable of refinements.

Figure 4 shows an NE561B used as an FM demodulator intended to operate on the usual i.f. centre frequency of 10·7 MHz. C1, C2, C3 and C4 are intended as r.f. bypass capacitors and coupling capacitors and are in no way critical. R1, R2, C5 and C6 determine the characteristics of the low-pass filter. C7 and VC1 together control the centre frequency of the v.c.o. VC1 can be adjusted to give a centre frequency of 10·7 MHz and then left set.

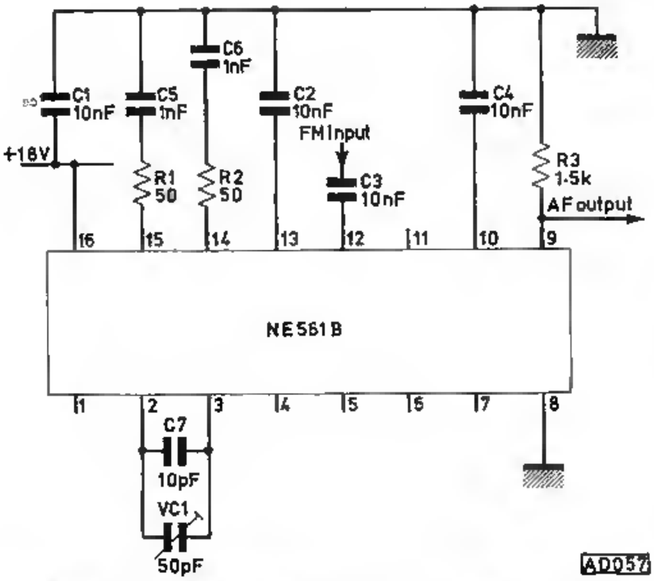


Fig. 4: An NE561B used as an f.m. discriminator

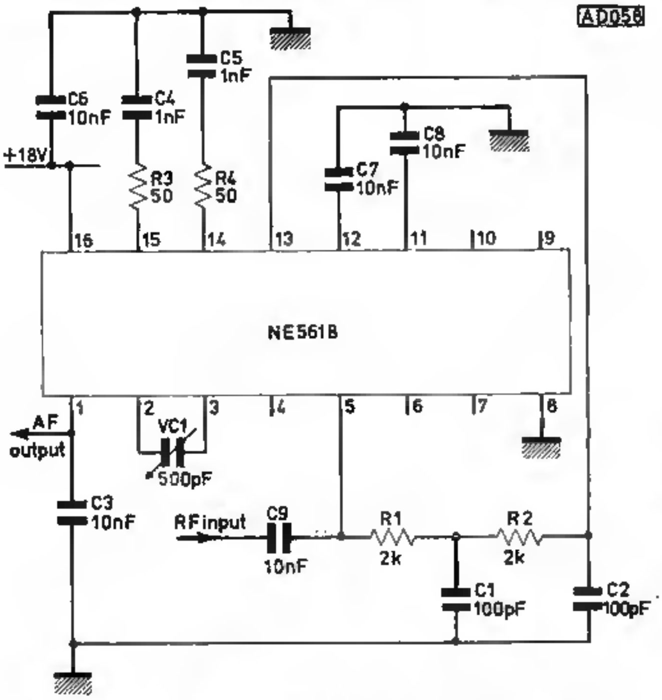
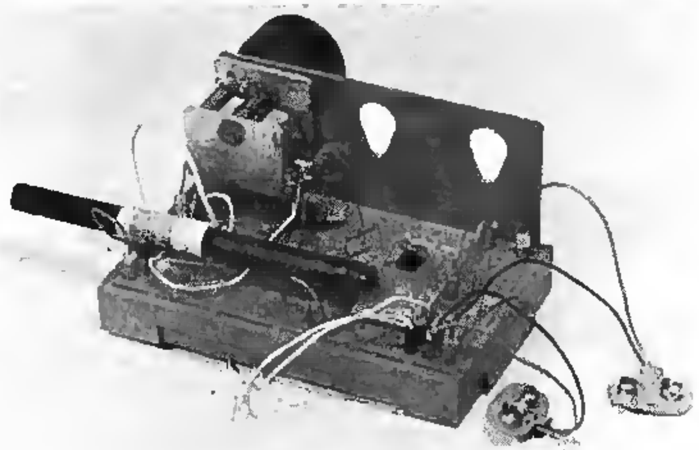


Fig. 5: An NE561B used as an a.m. demodulator

With some simple additional circuitry the NE561B can also be used to demodulate a.m. as shown in the circuit of Figure 5. Here, the variable capacitor between pins 2 and 3 determines the band covered. If necessary, fine tuning can be applied via pin 6. R1, R2, C1 and C2 form the 90° phase-shift network necessary to ensure that the output of the v.c.o. and the incoming a.m. signal are in phase when applied to the inputs of the multiplier. The values of VC1, C4, C5, R3 and R4 quoted are suitable for the medium waveband. Thus, a single i.c. and a few passive components can replace the i.f. and detection stages of a superhet receiver with considerable advantages in terms of distortion and noise.

In spite of its wide range of uses, the phase-locked loop has only recently become an economically attractive device with the advent of whole p.l.l.s in a single integrated circuit. ●

µ-DeCnology



DAVID GIBSON

3

THIS MONTH

'The 741 Receiver'

In both of the previous µDeCnology circuits we've employed a fairly common practice of using a single power supply or battery. However, the basic "text-book" op. amp. circuits commonly show a balanced power supply. So this month, we are going to go by the book!

Fig. 1 shows the balanced power supply configuration. Both inputs (inverting and non-inverting; remember?) and the output share a common connection—point B. The two 9V batteries are connected in series

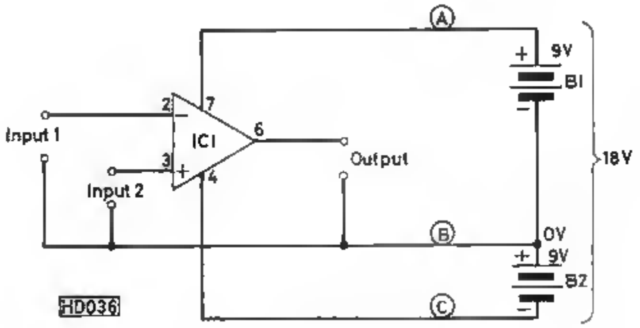


Fig. 1: Balanced supply details.

and, of course, the total voltage applied to the op. amp. (between pins 7 and 4) is 18V, the maximum for the 741.

When talking about voltage it is necessary to specify two points. Here, we've done this by stating that it is pin 4 and pin 7 that have 18V across them.

If we use point B as one reference point, then there is plus nine volts (+9V) between it and pin 7; and minus nine volts (−9V) between point B and pin 4. Our earlier discussions (*Practical Wireless*, March issue 1978) about inverting and non-inverting circuit configurations are still valid.

In previous µDeCnology articles, we looked at a simple open loop inverting d.c. amplifier. This is extremely simple but has certain disadvantages. To avoid these, we are going to use our 741 op. amp. in a closed loop inverting d.c. amplifier configuration (although we will be using it to amplify a.c. signals).

These two basic circuits are shown together in **Fig. 2** so that the differences can be clearly seen.

To see how the basic and purely theoretical text-book circuit of **Fig. 2b** is used in practice, look at the simple radio receiver in **Fig. 3**.

Here we have a balanced power supply (two 9V

★ components

R1	330Ω
R2	3·3MΩ
C1	0·1µF
C2	0·1µF see text
VC1	300pF or 500pF Variable capacitor
D1	OA91 diode
IC1	741 op. amp
L1	Ferrite rod see text (9·5mm dia × 95mm long)
One	µDeC
One	µDeC d.i.l. carrier
EP1	Acos red spot 1kΩ earpiece
Two	PP9 9V batteries

Solid cored wire or DeC jumper leads.
24 s.w.g. enamelled copper wire
Plastic covered wire for aerial and earth

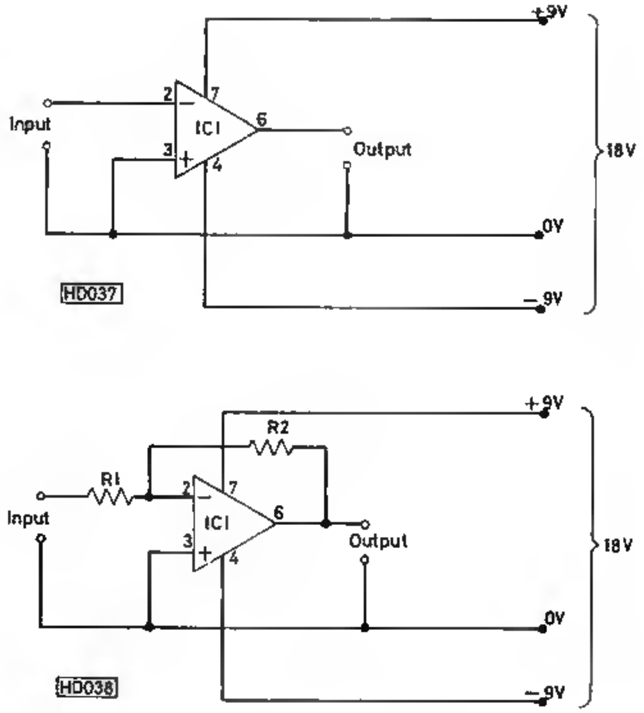


Fig. 2: Open and closed loop configurations (above and below respectively).

batteries). Note also the two resistors R2 and R1 whose ratio determines the overall gain.

Tuning capacitor VC1 and coil L1 "tune" in the radio frequency (r.f.) signals. Diode D1 rectifies the r.f. signals and feeds the resultant audio frequency (a.f.) signal to the op. amp. via C1. The latter is used to block the otherwise d.c. connection between the pin 2 input and the 0 volts line via D1 and the coil.

For medium wave coverage, L1 is 65 turns of wire (24 swg enamelled used in the prototype) close wound on a 9·5mm dia x 95mm length of ferrite rod. The tapping point is nine turns up from the earth or zero volts end.

The 741 gives good amplification as shown and provides ample signal to power a small earpiece. Increasing the value of C2 to 4·7µF was found to give better reproduction of the lower frequencies. If you use an electrolytic capacitor here, connect the positive lead to pin 6, negative side to the earpiece. C1 is not critical and any value from 0·01µF to 0·1µF will work well. The diode may be connected in either polarity and will still work.

Constructing your circuit on the µDeC B is extremely simple. Just plug the components, by their own leads, into the µDeC hole letter numbers shown in Fig. 3. The 741 op. amp. will still be in its holder from the last project. If the receiver is to be permanent, simply transfer the components to a piece of Blob Board.

Since all variable capacitors have some means of mounting them, the tuning capacitor can be mounted onto a suitably small case, the Blob Board simply stuck to the frame of the capacitor with a suitable adhesive, thus the whole receiver is in one piece. (Hold coil to Blob Board with elastic band!)

Using 2·5 metres of wire as an aerial but no earth, the prototype gave excellent results with two 9V batteries as a source of power. The current drawn was around 0·9mA and so the circuit is extremely economical. It will also function on lower voltages. Using a single battery and connecting the 0 volts line to negative gave inferior results. As with most simple receivers, a good aerial and earth is an asset, especially in difficult areas of reception. Using less turns on the coil and/or a smaller value for VC1 (say 100pF) should enable higher frequencies to be covered. With a good aerial, foreign stations might possibly be received.

If the r.f. circuitry (VC1/L1/D1) is removed, and a crystal microphone plugged in to µDeC holes F10 and A23, the unit will function as a microphone preamplifier and the results heard quite clearly in the earpiece. To this end, one could use the circuit with a probe instead of the mike to check a.f. circuitry. Alternatively, using the diode as a probe, r.f. circuits in receivers etc could be checked out.

The total cost of components is very low for this circuit and it could make a very useful bedside receiver. The batteries should last a very long time since the entire receiver draws less than 1mA. On no account should higher voltages be used.

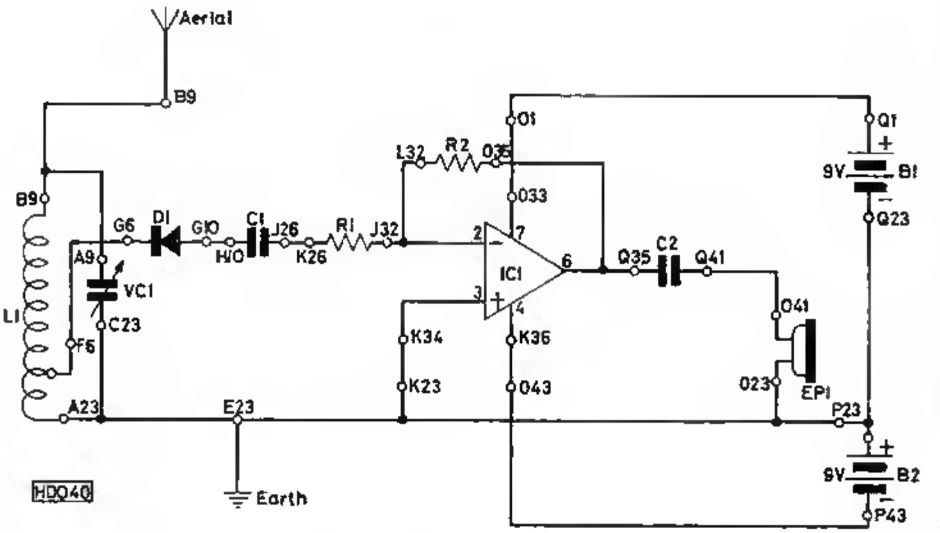


Fig. 3: The complete circuit diagram of the simple 741 receiver.

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practical WIRELESS

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You can be among the first to play the latest in video games—the PW Bovington Tank Game. All the thrills and noise of tanks locked in combat can be yours when you build this exciting and unique game which is suitable for any 625-line u.h.f. television set.

SIMPLE DARKROOM TIMER

A project for the photographic amateur, this simple timer will switch off your enlarger after a preset time interval. The front panel control gives nine easily selected exposure times.

STATESIDE CALLING

The first of an occasional series of newsletters from Joe Kasser G3ZCZ (/W3), resident in the USA. This one takes a broad look at Amateur radio, broadcast viewing and listening, and Citizen's Band activities.

PLUS:–THE CONCLUDING PART OF OUR POPULAR SERIES 'SO YOU WANT TO PASS THE R.A.E.?'

AUDIO DISTORTION METER

Audio Distortion Meter

The original Audio Distortion Meter designed by F. C. Judd appeared in *Practical Wireless* in April, 1972, and since that time, both professional and home constructed audio amplifiers have improved considerably in their specifications.

Until 1972 distortion measurements down to 0·1% were good enough for most amplifiers currently available, but since that time the distortion content of amplifiers has dropped lower and lower. Today a typical figure would be around 0·01% with the top designs as low as 0·001%. The need for an improved distortion meter was becoming of increasing importance.

The design now described is based on the original F. C. Judd version. A number of improvements have been made, resulting in a distortion meter capable of measurements down to below 0·01%. A low pass filter is also included.

Principle of Operation

The principle of operation of a distortion meter is to remove the fundamental frequency and leave all the harmonics and spurious signals unattenuated. These remaining signals are presented to an a.c. millivoltmeter and their combined levels compared with the unattenuated original signal. Because all the harmonics are measured together, this is called Total Harmonic Distortion, (or t.h.d.).

From the above it will be realised that the fundamental frequency must be removed completely because any part remaining will add to the harmonics present and cause a higher reading on the meter, resulting in a measurement of distortion higher than the true distortion present.

Nulling out the Fundamental

Various methods can be used for this and the original t.h.d. meter used a Wien bridge. This method has been retained but the circuit used now makes use of more negative feed back resulting in a lower inherent noise level and a higher rejection ratio of the fundamental frequency. With the new design the fundamental can be rejected by over 80dB while the second harmonic is only reduced by less than 1dB.

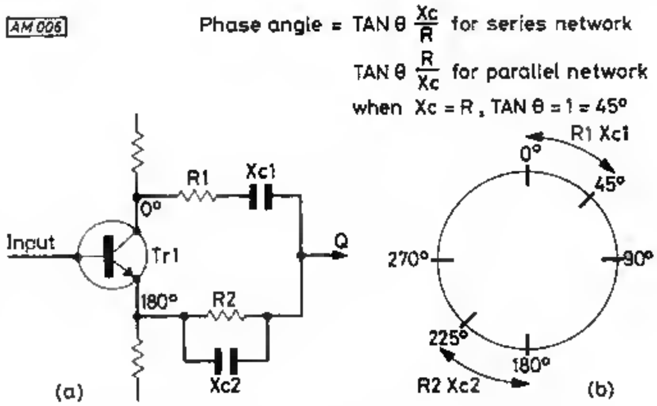
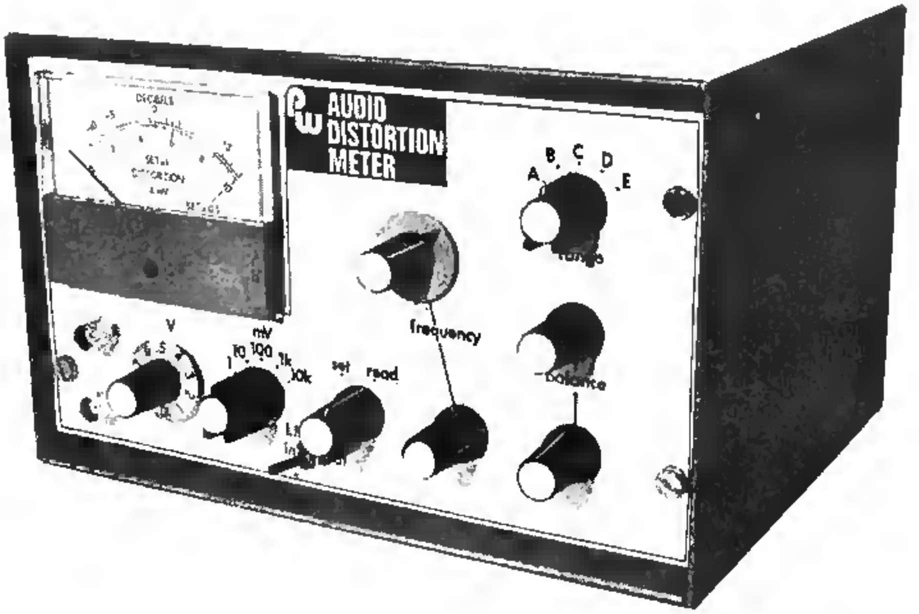


Fig. 1: (a) Basic circuit of the Bridge. (b) Phase angle diagram

The basic circuit of the bridge is shown in **Fig. 1.** Tr1 is used as a phase splitter and provides a signal to each half of the bridge 180° out of phase, if the two outputs were simply joined together all the outputs would cancel. By putting an RC network in each half, it is possible to unbalance the output at all frequencies other than the wanted rejection frequency.

This rejection frequency occurs when the phase angle for a resistor and reactance (Xc) in series equals the phase angle from the resistor and reactance in parallel, bearing in mind that the signal through each combination starts off 180° out of phase.

For example at 1kHz, Xc is approx 3·4kΩ, if we set the R value also to 3·4kΩ the phase shift through the series network will be $\text{Tan}\ \theta = \frac{Xc}{R}$ where Tan θ is the tangent of the angle of lead and Xc is the reactance. In our example, Xc = 3·4kΩ and R = 3·4kΩ, therefore Tan θ = 1 and θ = 45°, in the parallel case the phase is equal to $\text{Tan}\ \theta = \frac{R}{Xc}$ therefore in our example, Tan θ also equals 1 and θ = 45°. At the collector of Tr1 (making this our reference point) the phase is 0°. After the series C and R we have 45°. From the emitter we start at 180° and after the parallel C and R we have 180 + 45 = 225°, looking at the diagram in **Fig. 1b** we can see that 1kHz signal now arrives at point Q exactly 180° out of phase and therefore cancels out. For



E.A.RULE

PART 1

other frequencies the bridge is not balanced and little cancellation takes place. In practice, tolerances in capacitors and resistors make it necessary to have a means of adjusting the amplitude of the two signals (balance) and the phase angle (fine frequency).

By adjusting the values in the bridge it is possible to obtain an exact 180° phase relationship at any one frequency, resulting in its cancellation and leaving the remaining harmonics to be passed on to the next stage.

Practical Circuit

The practical circuit is shown in **Fig. 2.** It has five frequency ranges, covering 15Hz to 30,000Hz and coarse and fine control adjustments are provided for both amplitude and frequency so that exact phase cancellation of the signals can be obtained. This is most important as the amount of cancellation obtained sets the limit to how low the distortion can be measured.

The controls and components used should be of the best quality available. Junk box parts are not recommended for this part of the circuit. Another factor which sets a limit on the measurement range is noise, and for this reason metal oxide resistors should be used in the bridge circuit.

The use of BC384 or BC413 transistors is recommended. Other types can be used but may result in a higher residual noise level. This would limit the usefulness of the instrument for the lower measurements. If other types are used it may be advisable to

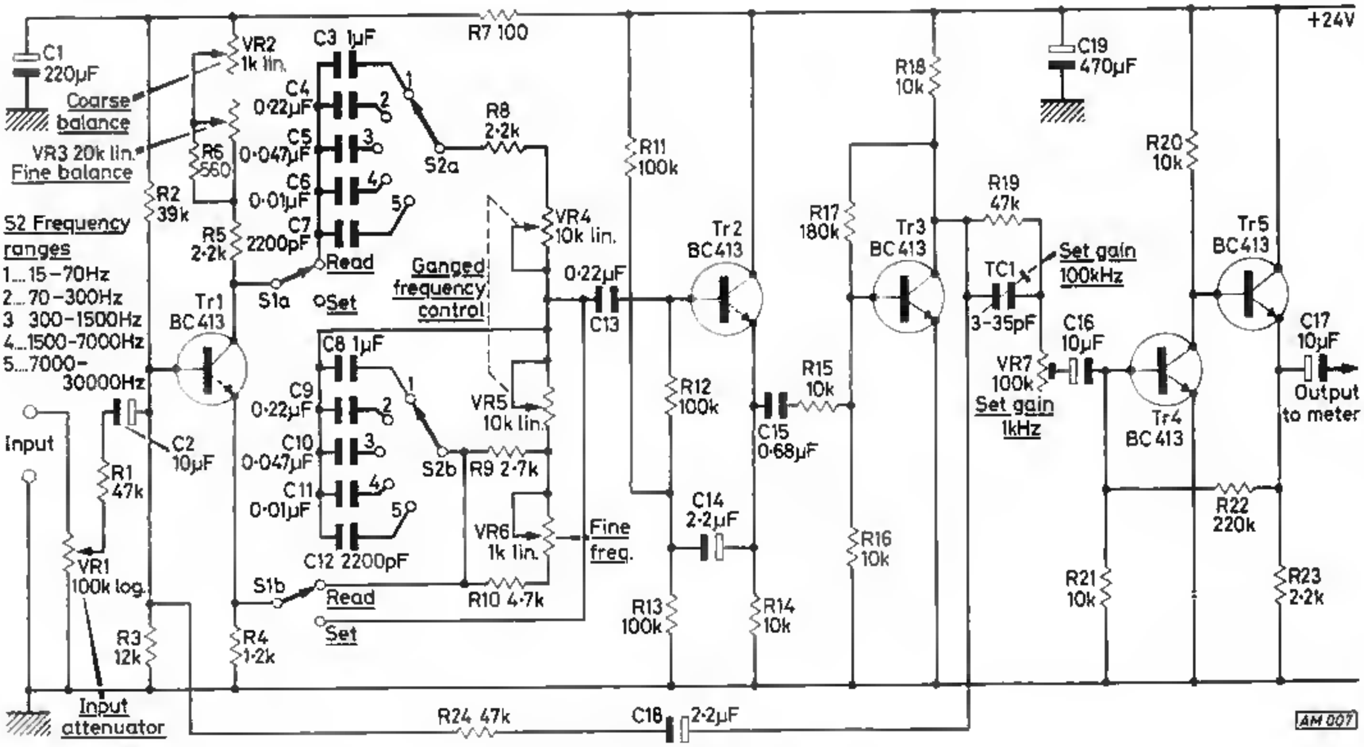


Fig. 2: The Bridge circuit

try a few in the bridge circuit to see if noise is a problem and select the best.

Tr2 provides a high impedance load for the bridge and a low impedance output for the next stage. Tr3, 4 and 5 provide some voltage gain and impedance match so that the output from the bridge is at a suitable level to feed the millivoltmeter and oscilloscope.

The Millivoltmeter

The circuit of the millivoltmeter is shown in **Fig. 3.** The input attenuator has 20dB steps. 10dB steps could be used but would require a meter which has a 0-1 and 0-3 range suitable for a 10dB attenuator. Not all meters have the correct relationships as a 10dB range would require the meter to have actual scales of 0-1 and 0-3·16. In practice, 20dB ranges are simple to use and make for a simpler circuit.

Tr6 and Tr7 provide a high impedance load for the attenuator and a means of adjusting the gain, as well as a low impedance match to the next stage, Tr8, 9 are the millivoltmeter amplifier stages with overall negative feedback to ensure a linear scale on the meter.

The meter is a 0-1mA with a scale marking of 0-10. (The author was able to obtain a 0-1 milliamp meter with a calibrated scale marked in dB and per cent distortion at one of the radio amateur rallies, often a good source of cheap surplus new components).

★ specification

RANGES

Voltage (minimum) for f.s.d.
10V, 1V, 100mV, 10mV, 1mV

Frequency (millivolt meter)
−1dB at 8Hz and 120kHz

Distortion measurement
With inputs above 10V. From 100% to less than 0·01%
Residual noise less than 0·4mV (0·004%)

Bridge frequency
15Hz—30kHz

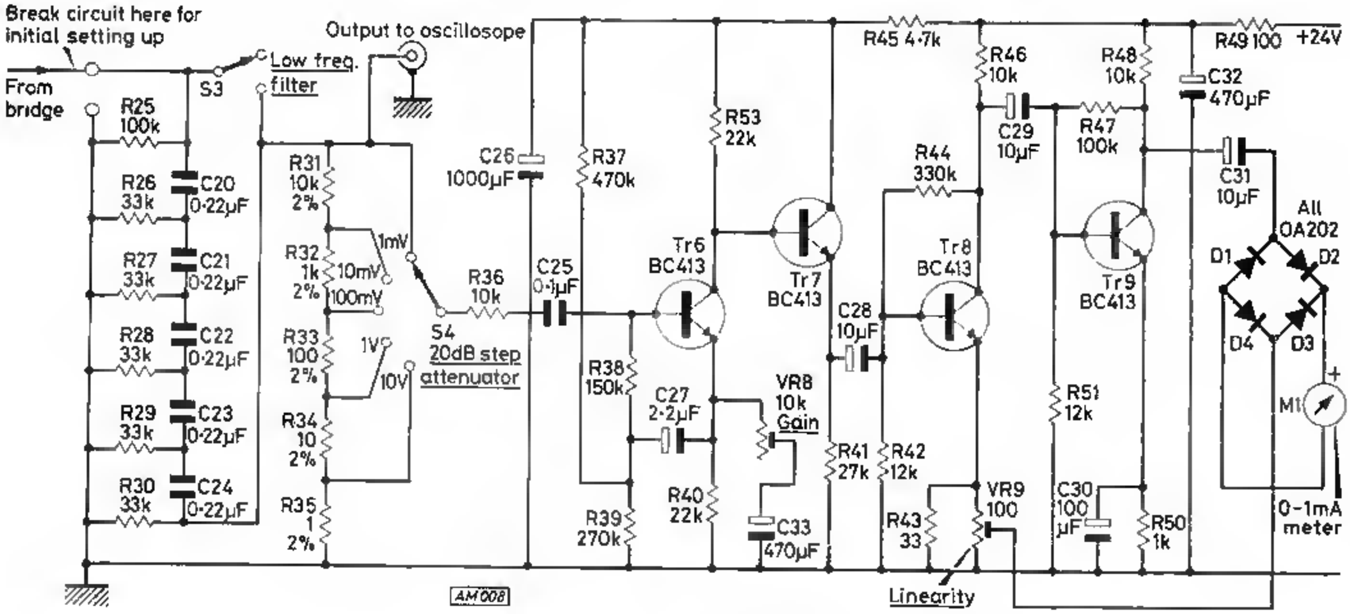
SELECTIVITY OF BRIDGE
With fundamental nulled out to −80dB second harmonic is less than −1dB

LOW PASS FILTER
−3dB at 450Hz
−22dB at 50Hz

MAXIMUM INPUT VOLTAGE
100 volts. A dc blocking capacitor must be used if d.c. is present on input signal. Use at least 10μF and observe polarity if an electrolytic type is used.

INPUT IMPEDANCE
30—100kΩ (depending on attenuator settings)

Fig. 3: The Millivoltmeter circuit



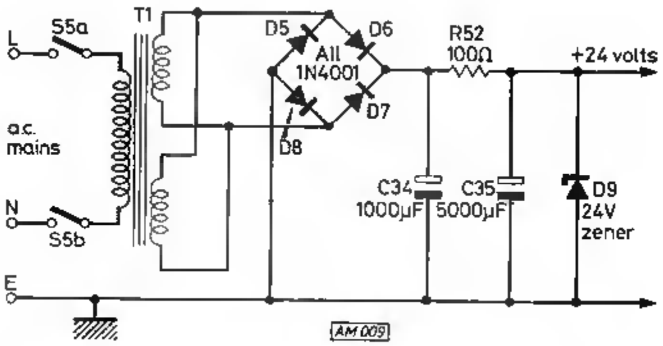


Fig. 4: The Power Supply circuit

Power Supply

The power supply must be stabilised and a suitable circuit is shown in **Fig. 4.** The transformer should be mounted as far from the bridge and meter circuits as possible. As the current drain of the distortion meter is low, dry batteries could be used.

Low Pass Filter

This is connected between the bridge output and the millivolt meter attenuator. The filter has a −3dB turnover at 450Hz and is used when measuring signals above 1kHz when hum is present and would otherwise effect the reading.

CONCLUDED NEXT MONTH

PRODUCTION LINES

alan martin

New AVO d.m.m.

Avo Ltd. are launching a completely new instrument, the 'Avometer DA116' digital multimeter, designed for both servicing and the laboratory.

The 13mm high characters in the liquid crystal display provide a wide field of view and is easily read in all ambient light conditions. There are clear indications of an over-range condition and low battery voltage.

Internally, the instrument employs the latest technology, with large-scale integrated circuits. A single integrated circuit is used for the analogue to digital conversion, which uses a dual slope technique with automatic zero correction.

Range selection is by a rotary switch in conjunction with a function switch. All measurements except the 10A range are by means of a single pair of sockets in the front panel.

Voltage measurements for both a.c. and d.c. are from 200mV to 1000V full scale. Current measurements may be made from the 200uA full scale to 10A full scale. In all cases the actual maximum indication is 1999. The 10A range is via a separate unprotected socket. The other current ranges are protected by a 2A fuse located in the positive socket.

Two special ranges have been designed for this instrument. The first is the High Speed Ohms range, to speed up continuity testing. On this range the response time of the instrument and display is reduced by a factor of ten. There are six normal resistance ranges measuring up to 20MΩ. The second new range is the Junction Test range, which can be used to test diode and transistor junctions under forward or reverse bias. The display indicates the voltage drop across the junction for a nominal current of 0·5mA.

The instrument has been designed as a portable unit, housed in a two-tone grey ABS case. Powered by four easily obtainable, SP11 type batteries, which should give an operating life of well over 500 hours.

The new leads have been designed with user safety in mind and have no exposed metal parts.

Costing £99 + 8% VAT, the Avometer DA116 is available through appointed distributors both in the UK and overseas.

Avo Ltd., Archcliffe Road, Dover, Kent CT17 9EN. Tel: 0304 202620.

Speed cat

Verospeed, the Vero Group's distributor to the electronics industry, has now published its Spring 1978 catalogue. The fully-priced handbook now stands at 52 pages, and contains over 1,000 product lines.

Among new items now available from stock are capacitors, digital panel meters, metal and plastic boxes, l.e.d.'s, a wide range of switches and a selection of hand tools for assembly and production.

For Verospeed to operate their speedy despatch system it is essential that cash is sent with order, and must include 8 per cent VAT.

Please quote "Spring Catalogue AB006" when applying to:

Verospeed, Barton Park Industrial Estate, Eastleigh, Hampshire SO5 5RR. Tel: 0703 618525.

Get spliced

Have you ever had the misfortune to suffer from a jammed or broken cassette tape?

If so, 3M have just introduced the very thing to get you out of trouble; the Scotch Cassette Editing and Repair Kit.

The kit consists of a pencil-like splicing block that contains adhesive-tipped polyester strips. These strips are inserted into the cassette, and pick up the tape ends. Splicing is simplified by means of splicing tabs and cutting guides at 45° for normal splicing and 90° for close editing, giving a professional finish.

The Scotch Editing and Repair Kit is available from record shops, major department stores and hi-fi equipment retailers. The suggested retail price is £1·52+VAT.

3M United Kingdom Ltd., 380-384, Harrow Road, London W9 2HU. Tel: 01-286 6044.

Long-range timer

The Exar XR-2242 is a monolithic timer/counter capable of producing ultra-long time delays from micro-seconds to days. Two timing circuits can be cascaded easily, to generate time delays or timing intervals up to one year.

The main features are; wide supply range: 4·5V to 15V, TTL and DTL compatible outputs, timing from micro-seconds to days, high accuracy: 0·5 per cent typically, excellent supply rejection; 0·2 per cent per volt typically, monostable and astable operation.

Price is £1·05 plus 60p P&P plus 8% VAT. Further information available from:

Rastra Electronics Ltd., 275-281 Kings Street, Hammersmith, London W6 9NF. Tel: 01-748 3143.

So you want to pass the R.A.E. (Radio Amateurs' Examination)? No. 9

John Thornton Lawrence GW3JGA & Ken McCoy GW8CMY

RECEIVERS

The purpose of a radio receiver is to acquire an r.f. signal containing information in the form of modulation and to process it into audible or visual intelligence.

A receiver must have adequate amplification or "gain" in order to provide sufficient sensitivity to resolve the weakest signal satisfactorily without introducing significant noise or distortion within its own stages. It must also possess adequate selectivity to separate the required signal from unwanted or interfering ones and have appropriate demodulation facilities for extracting the information from the carrier. Receivers employ various techniques to achieve these functions and the ultimate performance usually depends on the degree of sophistication utilised—often reflected in the price.

The various types of modulation have already been examined in the section on transmitters and are listed in Appendix "B" of *"How to become a Radio Amateur"*.

A communications receiver of the type used by amateurs will normally cover one or more of the allocated frequency bands and be capable of satisfactorily interpreting several modes of modulation.

The TRF (tuned radio frequency) Receiver

The circuit diagram of a t.r.f. receiver using junction field effect transistors is shown in **Fig. 72.** Although we have not dealt with this type of device previously, for practical purposes it can be considered to be a low-voltage solid state equivalent of the valve.

In the diagram the aerial is inductively coupled to the r.f. tuned circuit L2, VC1. The signal is applied to the gate of Tr1, amplified and coupled via L3 to the r.f. tuned circuit L5, VC2. The output from L5 is rectified by D1 and the demodulated a.f. appears across C3 and R3. The r.f. from L5, together with the a.f. signal, is amplified by Tr2 and then filtered out by L6 and C5, a.f. being routed via C6 and VR1 to the a.f. amplifier and on to the headphones.

To improve selectivity and sensitivity, controlled **regeneration**, in the form of positive r.f. feedback, is taken from the drain of Tr2 through L4, which is inductively coupled to L5 and the regeneration control VC3.

In operation, VC3 is advanced until the circuit begins to oscillate, indicated by a hiss at the a.f. output. The control is then backed off until the oscillation just ceases and the tuning capacitor VC1/VC2 is adjusted to "tune-in" the required signal.

The threshold of oscillation is the most sensitive condition for the receiver and, due to the positive feedback increasing the effective "Q" of the tuned circuit L5, VC2, it is also the most selective.

If the receiver is to be used for the reception of c.w. (A1) signals, then the regeneration is advanced until the circuit just breaks into oscillation: the pitch of the beat frequency tone will depend on the setting of the tuning control.

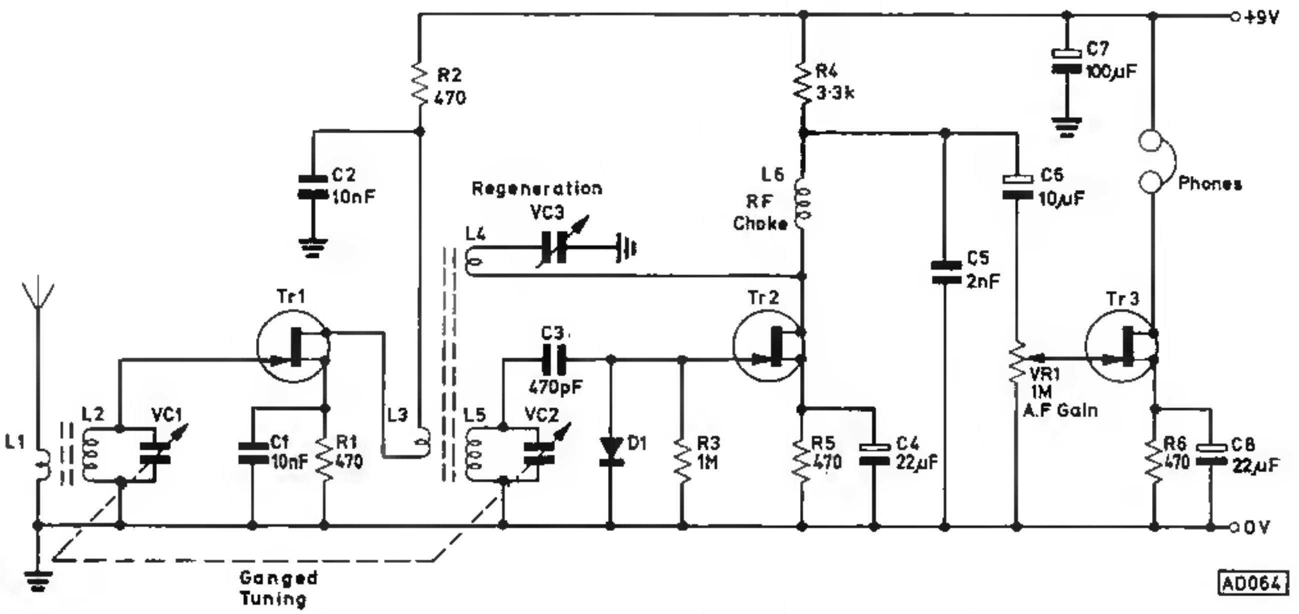


Fig. 72: Circuit of a basic t.r.f. receiver.

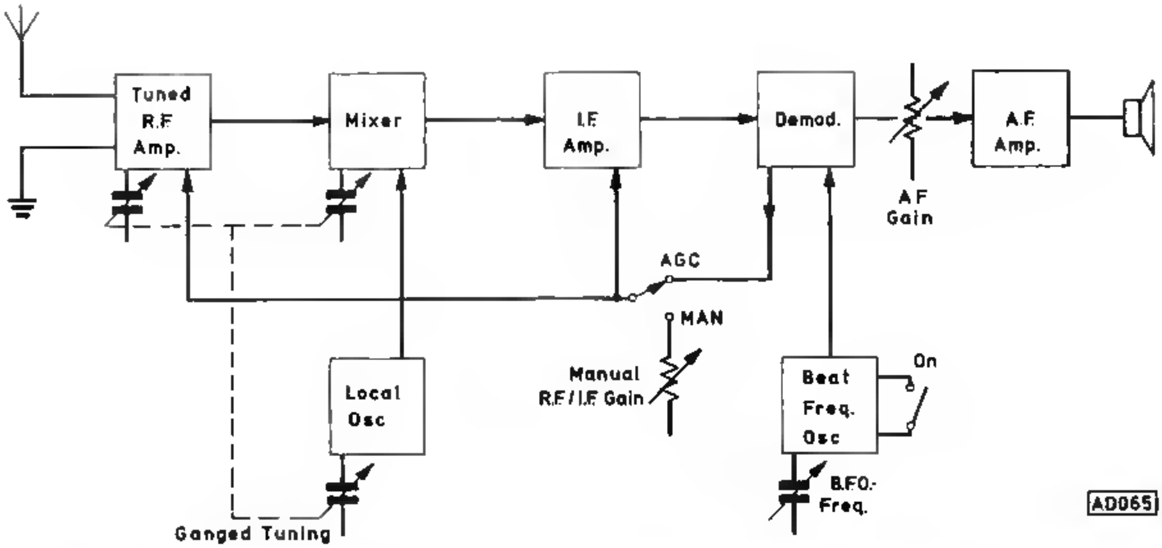


Fig. 73: Block diagram of a basic superhet receiver.

Simplicity is the main advantage of this type of receiver and its disadvantages are: limited selectivity, easily swamped by strong signals on adjacent frequencies, and the radiation of an r.f. signal when oscillating. Radiation is minimised however, by the use of an r.f. amplifier stage between the aerial and the dectector. The addition of further r.f. amplifier stages brings some improvement in performance but the ganging of the tuning capacitors and multiple coil switching for various frequency ranges makes this approach somewhat impractical.

Receivers of the t.r.f. type have a long history going back to the early days of broadcasting, and there are many old-timers who will tell you how they first received America on a home built 0-V-1 (dectector and one a.f. stage). Regrettably, they are no longer adequate for serious communication purposes in present-day conditions.

The Superheterodyne Receiver

The fundamental difference between the t.r.f. and the superhet receiver is that the selectivity of the former is obtained in its tuned circuits at the incoming radio frequency whereas in the superhet, incoming signals are converted in the frequency-changer section, to a fixed **intermediate frequency** (i.f.). Here the required selectivity and amplification can readily be obtained, prior to feeding the appropriate demodulator stage. A block diagram of a basic superhet receiver is shown in **Fig. 73.**

To convert the incoming signal frequency to the i.f. a local oscillator and mixer stage are employed as the frequency changer. The local oscillator has a frequency which is different from the incoming signal by an amount exactly equal to the i.f. For example:

Local oscillator frequency	=	2·350MHz
Intermediate frequency	=	0·450MHz
Input signal $f_{osc}-f_{i.f.}$	=	1·900MHz

Note that it is the local oscillator and intermediate frequencies which determine the signal frequency being received; in the example the incoming signal is 450kHz below the local oscillator.

However, using the same i.f. and local oscillator frequencies, we find that our superhet will also receive signals on a different frequency, known as the **image frequency** or **second channel.**

Local oscillator frequency	=	2·350MHz
Intermediate frequency	=	0·450MHz
Image $f_{osc}+f_{i.f.}$	=	2·800MHz

This is demonstrated in **Fig. 74.**

Second Channel Image Response

To reduce the unwanted image or second channel response, it is essential that the tuned circuits in the r.f. stage and prior to the mixer, only accept the desired signal and reject the image. This means that as the receiver is tuned over the frequency band the local oscillator and r.f. tuned circuits (although on different frequencies) must "track" one another. This is done by mechanically "ganging" the tuning capacitors and choosing appropriate values in the tuned circuits.

The amount by which the image response is reduced or suppressed depends on the selectivity of the r.f. stages and the relative frequency of the i.f. In general, a higher-frequency receiver will require a higher frequency i.f. Typical examples are given in the Table.

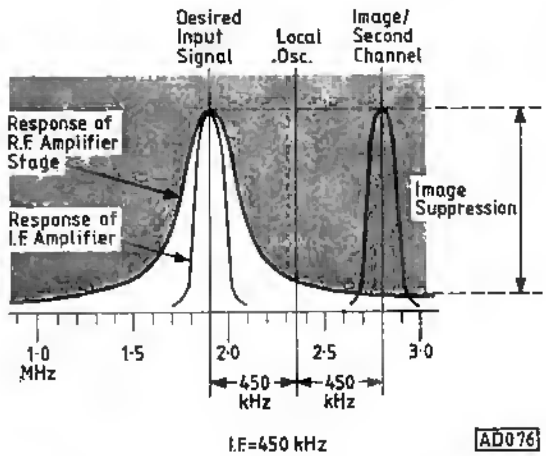


Fig. 74: Suppression of the second channel or image response.

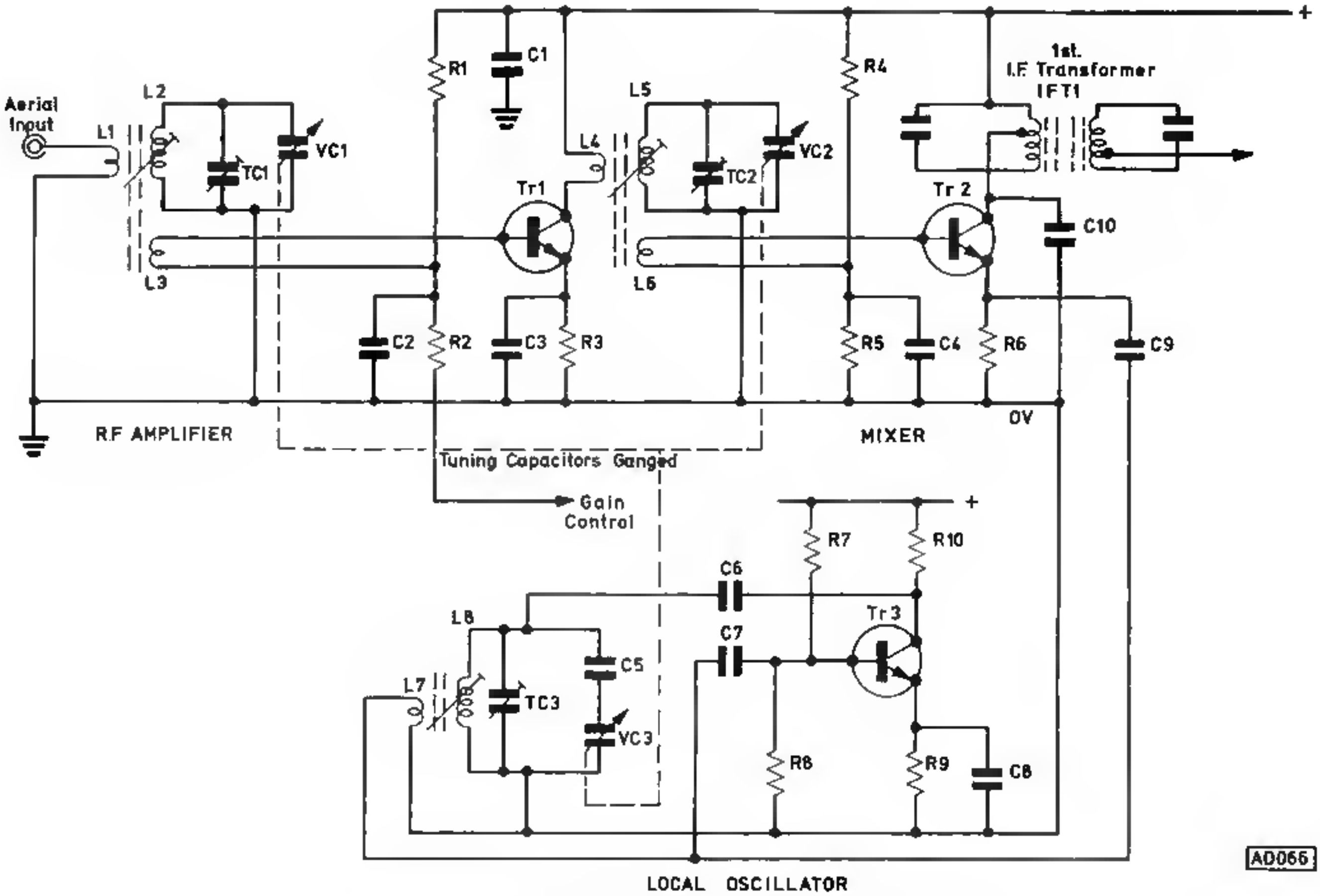


Fig. 75: Circuit of a typical r.f. amplifier and frequency changer.

TABLE

Receiver Type	Input r.f.	Typical i.f.
Domestic Radio	600kHz—1·6MHz	470kHz
Communications Receiver	2·0MHz—30MHz	1·6MHz
VHF Receiver	144MHz—146MHz	10·7MHz

In the higher-frequency receivers, employing a high frequency i.f. it is sometimes necessary to convert again to a lower i.f. in order that the desired selectivity is achieved: this is known as **double conversion.**

RF Amplifier and Frequency Changer

Let us now look at the receiver circuit in more detail, starting with the r.f. amplifier shown in **Fig. 75.**

Incoming r.f. signals are coupled by L1 to the tuned circuit L2-VC1 and to the base coupling winding L3. They are amplified by Tr1 and the output is coupled by L4 to the tuned circuit L5-VC2 and to the base coupling winding L6. Amplified r.f. signals are thus applied to the base of the mixer stage transistor Tr2.

The local oscillator stage consists of the tuned circuit L8-VC3 and associated transistor Tr3. Coupling L7 is arranged to give positive feedback and so maintain oscillation. The inclusion of C5 in series with VC3 modifies the tuning range of the oscillator so that it "tracks" the signal tuned circuits, maintaining the correct frequency difference (equal to the i.f.) over the tuning range.

The local oscillator output is coupled to the emitter of Tr2 by C9. Mixing of the r.f. and local oscillator signals is achieved by Tr2 and at the collector the difference frequency is coupled out by the i.f. transformer IFT1. Capacitor C10 provides a return path for the remaining frequencies present in the mixer stage.

You will notice TC1, TC2 and TC3 in parallel with each tuning capacitor; these are adjusted during alignment to bring all the circuits into resonance at the h.f. end of the tuning range, l.f. resonance being achieved by the adjustment of L2, L5 and L8. Aligned in this way, the tuned circuits will "track" with reasonable accuracy over the whole of the range. This receiver has only one band and additional coils and trimmers would be required for each extra range. These would normally be switched into circuit by means of a rotary wafer switch.

IF Amplifier

The dual purpose of the i.f. amplifier is to amplify the incoming i.f. signal to the required level for application to the demodulator, and to provide the required band-pass characteristic or selectivity.

One method is to employ sufficient transistors or valves to provide the required amplification and couple these through double-tuned i.f. transformers

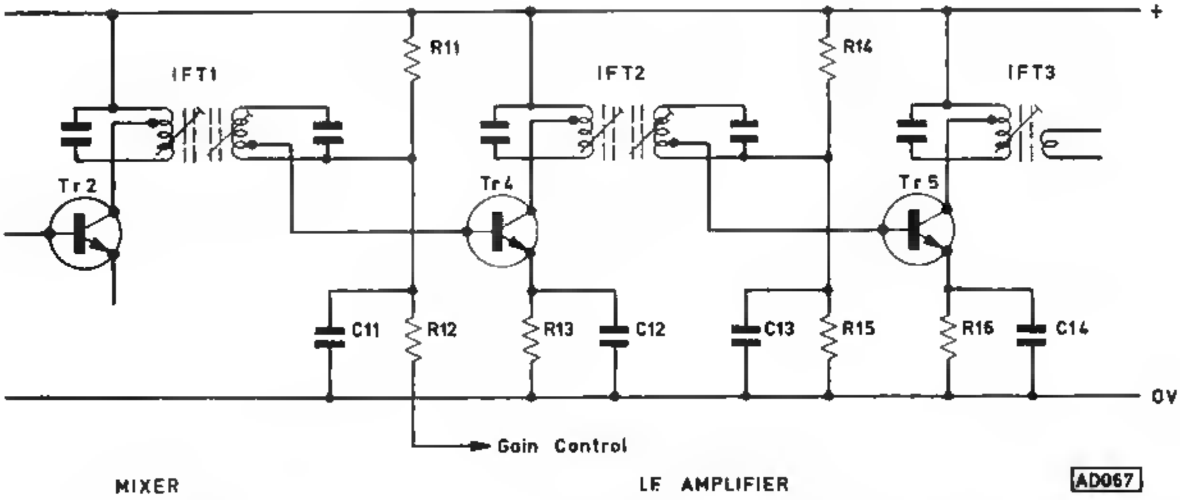


Fig. 76: A basic i.f. amplifier.

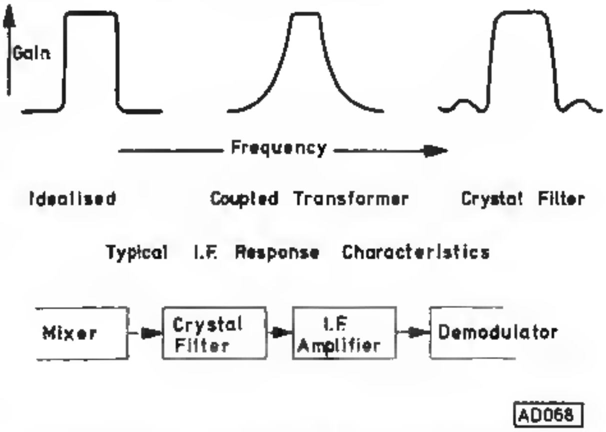


Fig. 77: Using a crystal filter to obtain i.f. selectivity.

in order to obtain the required selectivity, as shown in **Fig. 76.** Careful alignment of the i.f. transformers is necessary to obtain the optimum band-pass characteristics.

In recent years more use has been made of factory adjusted crystal filters to provide excellent and guaranteed parameters. The crystal filter is normally fitted immediately after the mixer and is followed by a conventional or integrated circuit i.f. amplifier, as shown in **Fig. 77.**

Demodulation

Amplitude modulation is demodulated by using a conventional diode **envelope detector** as shown in **Fig. 78.**

The output from the final i.f. transformer is rectified by D1. An i.f. filter is formed by C15, R17 and C16, which removes the i.f. "ripple", leaving a direct voltage, the value of which is dependent upon the strength of the incoming signal. The amplitude modulation appears as an a.f. signal, superimposed on this voltage, across the a.f. "gain" control VR2. The a.f. signal is passed by C17 to an a.f. amplifier stage. The demodulator waveforms are similar to those shown in Fig. 47.

Automatic Gain Control

The direct voltage appearing across VR2 can be fed back via the a.g.c. line to control the gain of the r.f. and i.f. stages. A strong input signal will thus reduce the gain of the receiver and vice versa, resulting in a relatively constant level of output even when propagation conditions cause fading of the tuned signal.

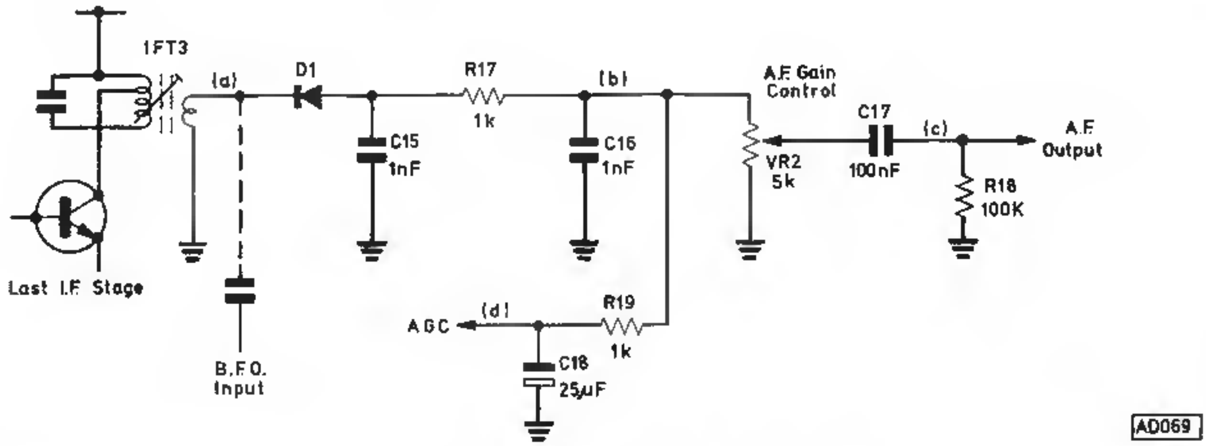


Fig. 78: Circuit of a basic a.m. (envelope) demodulator.

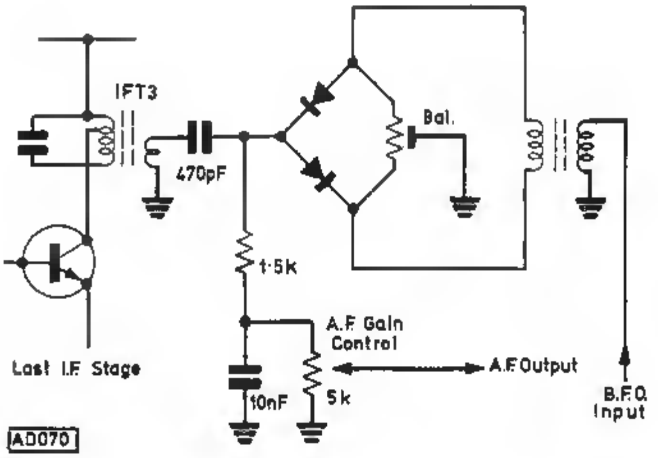


Fig. 79: The balanced demodulator.

The low-pass filter formed by R19 and C18 allows a slowly-changing voltage to be fed back to compensate for fading but prevents a.f. signals from reaching the a.g.c. line.

Beat Frequency Oscillator

When receiving c.w. it is necessary to mix the i.f. signal appearing at the demodulator with another oscillator to produce an a.f. beat note. Suppose we decide that a comfortable listening pitch would be 1kHz and the intermediate frequency is 450kHz, then the beat frequency oscillator would be adjusted to 451kHz (or 449kHz) to produce a difference frequency of 1kHz.

SSB Demodulation

The same b.f.o. can be used when receiving s.s.b. signals to re-insert the carrier, so enabling the signal to be demodulated. In this mode, as with c.w. it is more satisfactory to switch out the a.g.c. and to use the manual r.f. gain control in order to adjust the signal level at the demodulator stage for optimum results.

The b.f.o. must insert the carrier in the correct position relative to the s.s.b. modulation or the a.f. modulation will be shifted in frequency (and sound like Donald Duck, or worse).

Receivers designed specifically for s.s.b. reception employ a balanced demodulator as shown in **Fig. 79.** Compare this with Fig. 56 in the Transmitter section.

The circuit of the **b.f.o.** is almost identical to that of the receiver local oscillator except that the tuning range will be restricted to about 5kHz above and below the i.f.

AF Amplifier

The receiver a.f. stage is usually quite conventional and would normally be provided with sufficient power output to drive a small loudspeaker or headphones.

Narrow Band FM Demodulation

Where the receiver is used for n.b.f.m. signals a separate demodulator is required. This will consist of an **amplitude limiter** stage to remove any a.m. which may be present, and a **frequency discriminator** as shown in **Fig. 80.** The discriminator compares the relative phase of the voltage appearing across the tuned secondary winding of an i.f. transformer with the voltage applied to the primary winding. With zero deviation, the two diodes will conduct equally, resulting in zero output. When the frequency is varied the relative phase varies and one diode conducts more than the other, resulting in an unbalanced signal of a particular polarity appearing in the output. The frequency/voltage characteristic of the discriminator is shown in Fig. 80.

Other types of discriminators can be used and details of these are given in Chapter 4 of the RSGB *VHF-UHF Handbook*.

Converters

A converter is basically a self-contained frequency changer stage which can be used ahead of the receiver to allow it to tune a different frequency range. For example, a two metre converter would convert the 144-146MHz input to, say 28-30MHz output for

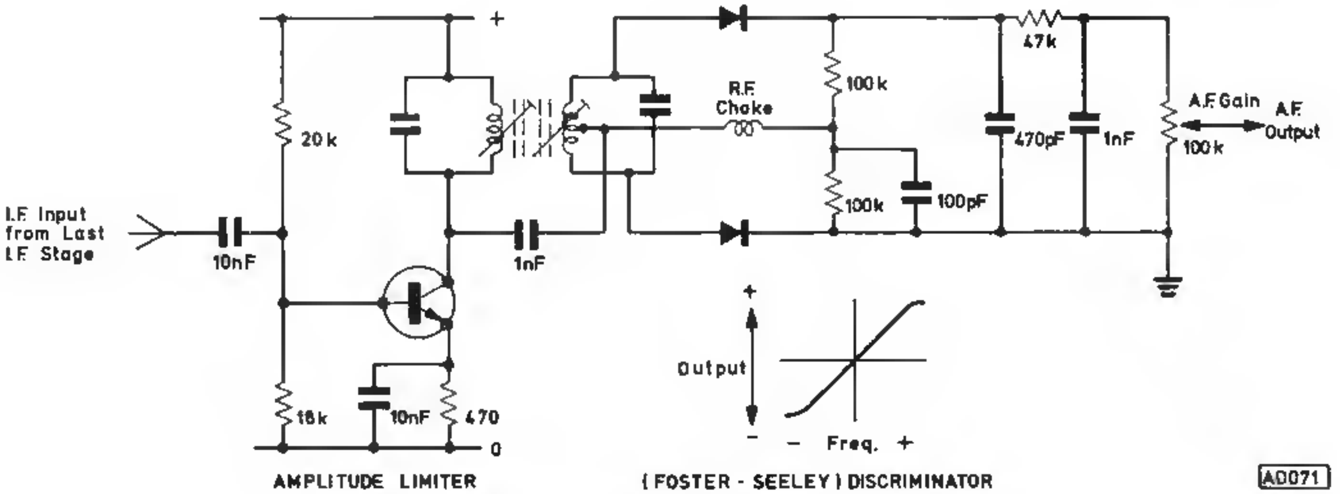


Fig. 80: Circuit of one form of f.m. discriminator.

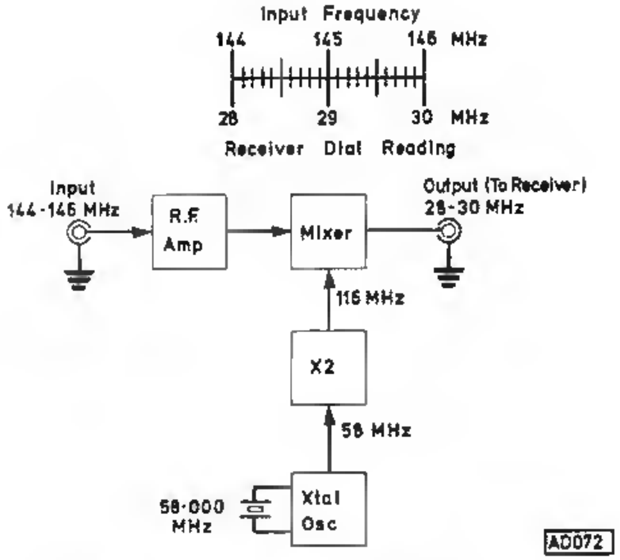


Fig. 81: Block diagram of a 2-metre converter, and how the input frequency and receiver dial reading are related.

reception on a receiver capable of tuning these frequencies. A block diagram of a 2-metre converter is shown in **Fig. 81.** Note that here the oscillator frequency is fixed and the receiver is used as a "tuneable i.f.".

CONSTRUCTION

If you are a budding transmitter or receiver constructor, please remember that the circuits appearing in this series are typical examples with typical component values; they are not presented as tried and tested, ready-to-build designs. Layout, component lead length, etc., greatly influence r.f. circuits, so if you are just itching to build something, stick to a fully detailed design, at least for your first attempt.

RADIO WAVES

The radio wave is a form of **electromagnetic radiation** which, in free space, travels at the speed of light, i.e., 300,000,000 metres per second (300×10^6m/sec).

The relationship between frequency (f) and wavelength (λ, Greek letter Lambda) is given by the expression:

$$\lambda\,(\text{metres}) = \frac{\text{Velocity of propagation (m/sec)}}{f\,(\text{hertz})}$$

By inserting the velocity constant of 300×10^6 metres per second we then have

$$\lambda\,(\text{metres}) = \frac{300 \times 10^6}{f\,(\text{hertz})} = \frac{300}{f\,(\text{megahertz})}$$

For example, what is the wavelength of a radio wave whose frequency is 2MHz?

$$\lambda = \frac{300}{2} = 150 \text{ metres}$$

Conversely, given the wavelength, we can determine the frequency. If a radio signal has a wavelength of 3 metres, what is its frequency?

$$f\,(\text{MHz}) = \frac{300}{3} = 100\text{MHz}$$

Propagation of Radio Waves

The radiation from an aerial moves outwards at a constant velocity, in concentric circles of increasing radii.

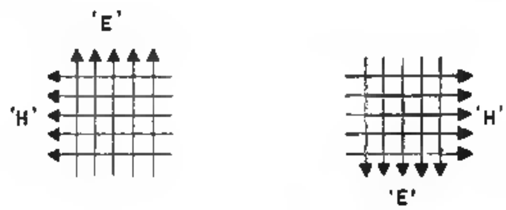
A radio wave may be visualised as having an electric field with an associated and inseparable magnetic field at right-angles to it. Diagrammatic representation of such a wave is shown in **Fig. 82**; the magnetic and electric fields are always in phase.

Radio waves may be reflected, refracted (bent) and absorbed, just as in the case of light. Reflection, refraction and absorption of radio waves, in the range 1-70MHz takes place in a region above the surface of the earth known as the **ionosphere**, which extends from an altitude of about 100km to around 400km.

In the ionosphere, air molecules are ionised due to the influence of ultra-violet radiation from the sun; that is, they break up into free electrons and positive ions. The ionised regions so formed have the property of reflecting radio waves and they play an essential part in long-distance shortwave propagation. The ionisation forms into layers which vary in height and density from day to night (as shown in **Fig. 83**) and with the seasons.

F-Layer

During daytime the F-layer separates into the F_1 and F_2 layers. At night and in mid-winter the two merge into the single F-layer again, but at a somewhat lower altitude. In the absence of sunlight, recombination of ions and electrons slowly takes place and in the F-layer, ionisation is at a minimum just before dawn.



Electrical & Magnetic Fields, Wave Approaching Observer

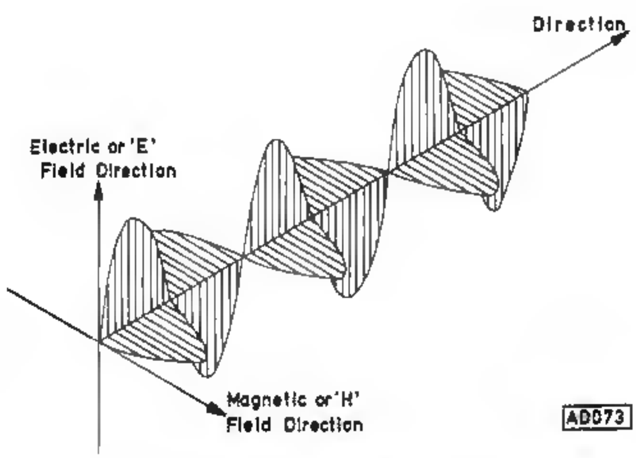


Fig. 82: Propagation of an electromagnetic wave.

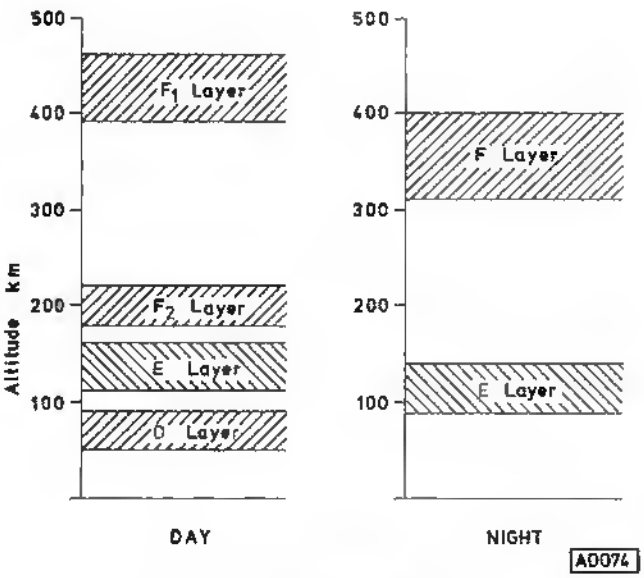


Fig. 83: The ionospheric layers.

E-Layer

The E-layer region remains at about the same altitude during both day and night, but the intensity of ionisation (and hence its reflective properties) increases with the presence of sunlight and is maximum at noon. In the absence of sunlight, recombination commences fairly rapidly but a certain level of ionisation persists.

D-Layer

Ionisation level in the D-layer is dependent upon the "height" of the sun. The layer disappears at night time and the mechanism of formation and dispersal is not fully understood.

Reflection capabilities of the various layers depend not only on the intensity of the ionisation but also on the angle at which the wave arrives and its frequency. A higher frequency wave requires a greater degree of ionisation to cause reflection.

Types of Propagated Waves (Fig. 84)
(a) Ground wave

The ground wave, as its name suggests, follows the earth's contour and is eventually attenuated to nothing.

(b) Sky Wave (Ionospheric Wave)

The sky wave is the part of radiation leaving the transmitter which returns to earth again due to reflection (and some refraction) by an ionised layer.

(c) Escape Wave

For a given frequency, there is an associated maximum angle of transmission, above which the transmitted wave will no longer be reflected by the ionised layer in question, but will penetrate and continue beyond it: this is referred to as the escape wave. This angle is associated with the **maximum usable frequency** (m.u.f.), which will be looked at later on.

Skip Zone and Skip Distance

Between the end of the ground wave and the point at which the sky wave returns to earth is a region known as the skip zone. Within this region the transmitter at T in Fig. 84 cannot be received. The distance between T and the nearest point at which the sky wave is received is known as the skip distance.

Critical Frequency

At the lower frequencies, a signal directed vertically into the ionosphere will be reflected back to the transmission point.

However, if the frequency of this signal is progressively increased, a point is reached where reflection just fails to take place. The frequency at this point is known as the critical frequency (for the particular ionised layer under consideration).

Maximum Usable Frequency (MUF)

It is often a requirement to transmit signals over a particularly defined distance. Let us consider the path of wave (b) in Fig. 84 and imagine that we wish to transmit signals to a receiver at R1.

If the transmitter frequency is increased, wave (b) would penetrate the ionised layer, as wave (c) (escape wave) and not be reflected. For reflection to occur at the higher frequency, it would be necessary to lower the transmission angle, in which case the reflected wave would not return to earth at the desired receiving point, R1, but beyond it at R2.

Thus, for a given required transmission distance and a given ionised layer, there is a maximum frequency above which the transmitted wave will not be received.

The maximum point at which such reflection takes place, with the wave still returning to earth at a required distance, is known as the maximum usable frequency (m.u.f.).

The longest signal path for a particular layer is obtained when the wave leaves the earth and approaches the layer at the most oblique angle possible. This gives a range, using the F2-layer of about 4,000km and for the E-layer, about 2,500km. If we consider a simple omni-directional aerial, the wavefront will move out from it like an expanding bubble. When we speak of a particular transmission angle we are referring to the behaviour of a part of the

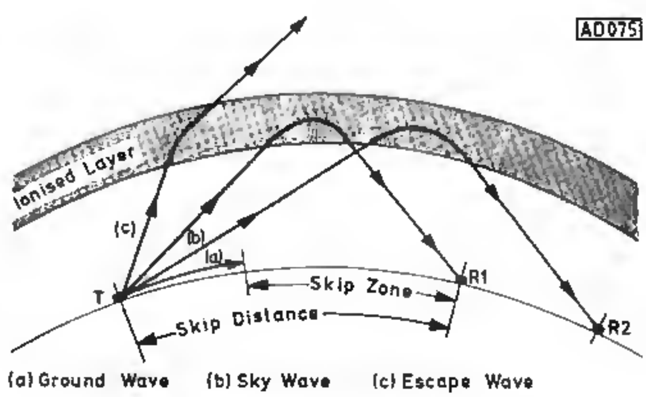


Fig. 84: Ionospheric propagation.

wave-front which is leaving the aerial in this way. At a given frequency, waves (a), (b) and (c) in Fig. 84 all exist simultaneously.

Fading

Propagation conditions are rarely, if ever, static and fluctuations of the received signal, commonly called fading, can be attributed to a variety of reasons. If the signal from the transmitter arrives at the receiver by more than one path, the relative phase variations can either reinforce or cancel one another, causing rapid and severe fading.

Polarisation of the radio wave may be changed by propagation conditions, resulting in an apparent reduction of strength. The signal may also be attenuated by varying degrees when reflected by an ionised layer, particularly when the frequency is close to the maximum usable frequency. At v.h.f. and u.h.f., fading may be attributed to varying atmospheric conditions, temperature, humidity etc.

Sunspots

Sunspots are regions of magnetic disturbance on the surface of the sun. Greatly increased ultra-violet and X-radiation are associated with sunspots, which have a profound effect on the intensity of ionisation in the ionosphere.

Activity tends to reach a maximum at approximately 11 year intervals, and as the level of ionisation follows this pattern, we experience exceptionally long-distance signal paths on the higher frequencies at these times.

Severe sunspot disturbance causes rapid fluctuations on the ionised layers, the general effect of which is to increase the m.u.f., at the same time often producing a radio fade-out, lasting from a few minutes to an hour.

Patches of intense ionisation sometimes occur in the E-layer, particularly in the summer, and these will reflect frequencies much higher than usual—70MHz and beyond. This is called Sporadic E propagation and is responsible for Band I television interference.

Tropospheric Propagation

The troposphere is the region which extends from the surface of the earth to a height of 10km. It is the atmospheric conditions (temperature and humidity) in the troposphere which affect the long distance propagation of v.h.f. and u.h.f. radio waves.

The refraction of v.h.f. and u.h.f. waves is caused by the varying dielectric constant, with altitude, of the air above the surface of the earth. This causes the waves to bend and follow the approximate curvature of the earth's surface.

Conditions of humidity at low altitudes together with increased temperature at higher altitudes (temperature inversion) provide conditions which cause the wave to be "ducted" for considerable distances with very little attenuation.

Propagation on the Amateur Bands

1·8MHz (160m) Generally speaking this is a local working band, up to about 70 miles in daytime, with an increase in range to several hundred miles at night.

3·5MHz (80m) Daytime contacts can be made over several hundred miles. Night time distances very considerably but can be several thousands of miles in the winter.

7MHz (40m) Much the same as 80m but varies considerably depending on the condition of the sunspot cycle. Good long distance (DX) band on winter nights and early mornings.

14MHz (20m) Most consistent DX band, open during daytime at most times of the year, dawn and dusk being the most favourable times for long distance (over 5000 miles) contacts.

21MHz (15m) Similar to 20m but more affected by the sunspot cycle. Best in Spring and late Autumn, up to the hours of darkness.

28MHz (10m) Very much affected by ionospheric condition. Excellent DX band in sunspot maximum years.

70MHz (4m) Mainly a local working band, up to 100 miles but occasionally affected by "Sporadic E" when the range can exceed many hundreds of miles.

144MHz/432MHz (2m/70cm) Ranges up to 100 miles can be achieved on these bands. Range is affected by local obstructions, hills, etc. Greater distances up to several hundred miles can be achieved under unusual tropospheric conditions.

1296 MHz (23cm) Similar to 70cm but more affected by local terrain. The other s.h.f. and microwave bands each have their own special characteristics and are affected by tropospheric conditions, rain, etc.

Correction to RAE Part 6 (February 1978, p 769)

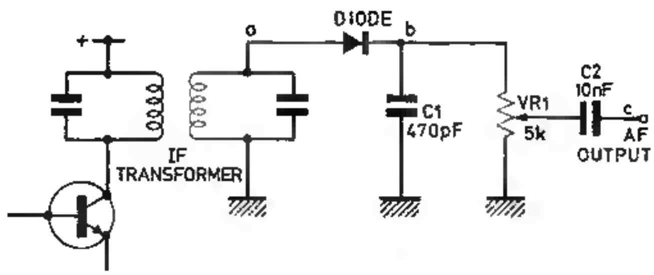


Fig. 47 (amended).

We regret that an error has come to light in the circuit diagram of the diode detector shown in Fig. 47 (page 769) of R.A.E. Part 6. As illustrated, there is no d.c. path for the detector diode current and point "b" referred to in the text has been inadvertently omitted. The corrected version is given in "Fig. 47 amended" shown here.

NEXT MONTH

The final part of this series will cover Aerials, Interference Suppression and general advice for the examinee.

DX'ers Audio Filter

R.A.PENFOLD

Introduction

Of the many thousands of short wave receivers which are in amateur hands at present, there can be relatively few which have really good i.f. filtering. Most sets, from the old R1155 to modern Japanese designs, have a bandwidth which is just wide enough to accommodate a.m. signals, and is therefore a little more than double that required for s.s.b. reception. With the severe crowding on amateur bands, particularly at weekends, this is a serious drawback for the s.s.b. DX-er.

It is possible to improve the selectivity of a set by the addition of a mechanical filter, Q multiplier, or some similar device, but this is not always feasible: some degree of modification to the set is entailed, which not everyone is prepared to do.

Audio Filtering

Another possibility is to process the audio output of the set. It is not then necessary to modify it in any way, since the filtering can be done by a self-contained unit connected between the output socket of the set and the speaker or headphones.

Such a unit is described in this article and it provides the three types of filtering listed below.

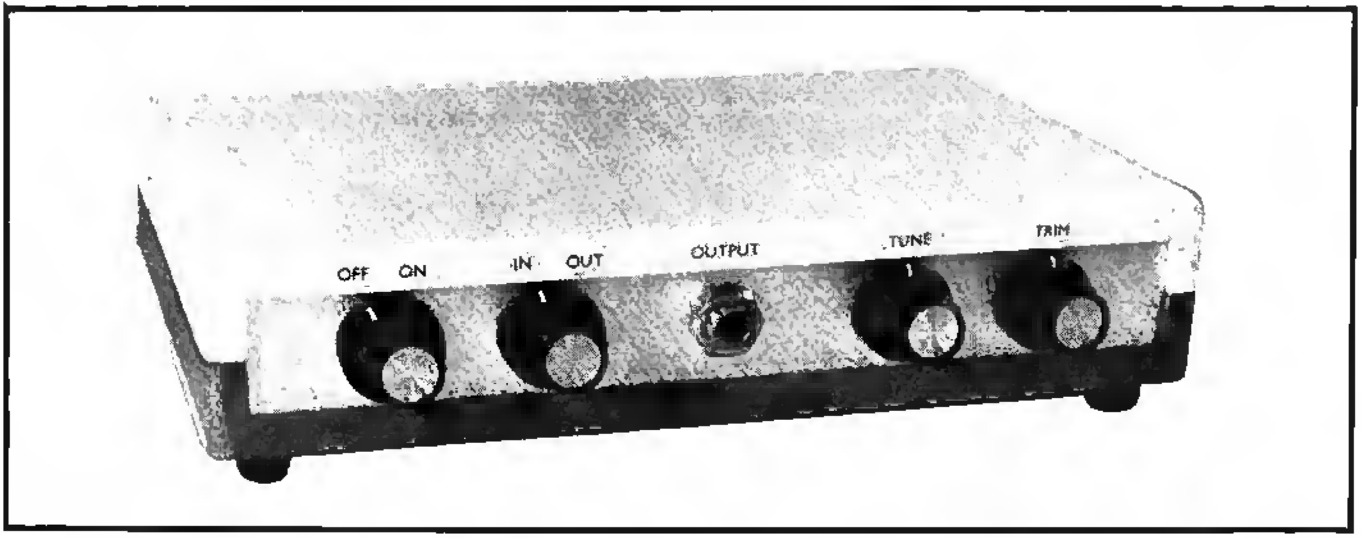
1. Low Pass Filtering (with signals at frequencies above a couple of kHz or so being rapidly rolled off).
2. High Pass Filtering (with signals at frequencies below a few hundred Hz being rapidly rolled off).
3. Tuneable Notch Filtering (a narrow slot of very high attenuation which can be tuned over a range of about 100Hz to beyond the upper frequency limit of human hearing).

Type 1 is effective at reducing adjacent channel interference where the offending signal is well away from the carrier insertion oscillator (c.i.o.) frequency, and the audio signals produced are therefore at fairly high frequencies. Type 2 is helpful in reducing interference from signals roughly centred around the c.i.o. frequency, and therefore produce rather low audio output frequencies. The latter type of filtering is used to null the heterodyne produced by a carrier wave in the passband of the receiver.

How effective or otherwise the unit proves to be is largely dependent upon the quality of the signal to be processed: obviously it can be of no benefit to a signal which is completely free from any form of interference. On the other hand, when Top Band DX-ing, the unit has produced near-perfect signals where they were previously completely drowned by the heterodyne from a commercial station.

The Circuit

The circuit, which is shown in Fig. 1, is based on an LM3900N i.c. This device contains four current differencing amplifiers, one of which is used in the low pass filter, another is employed in the high pass filter, and the remaining two are used in the notch filter.



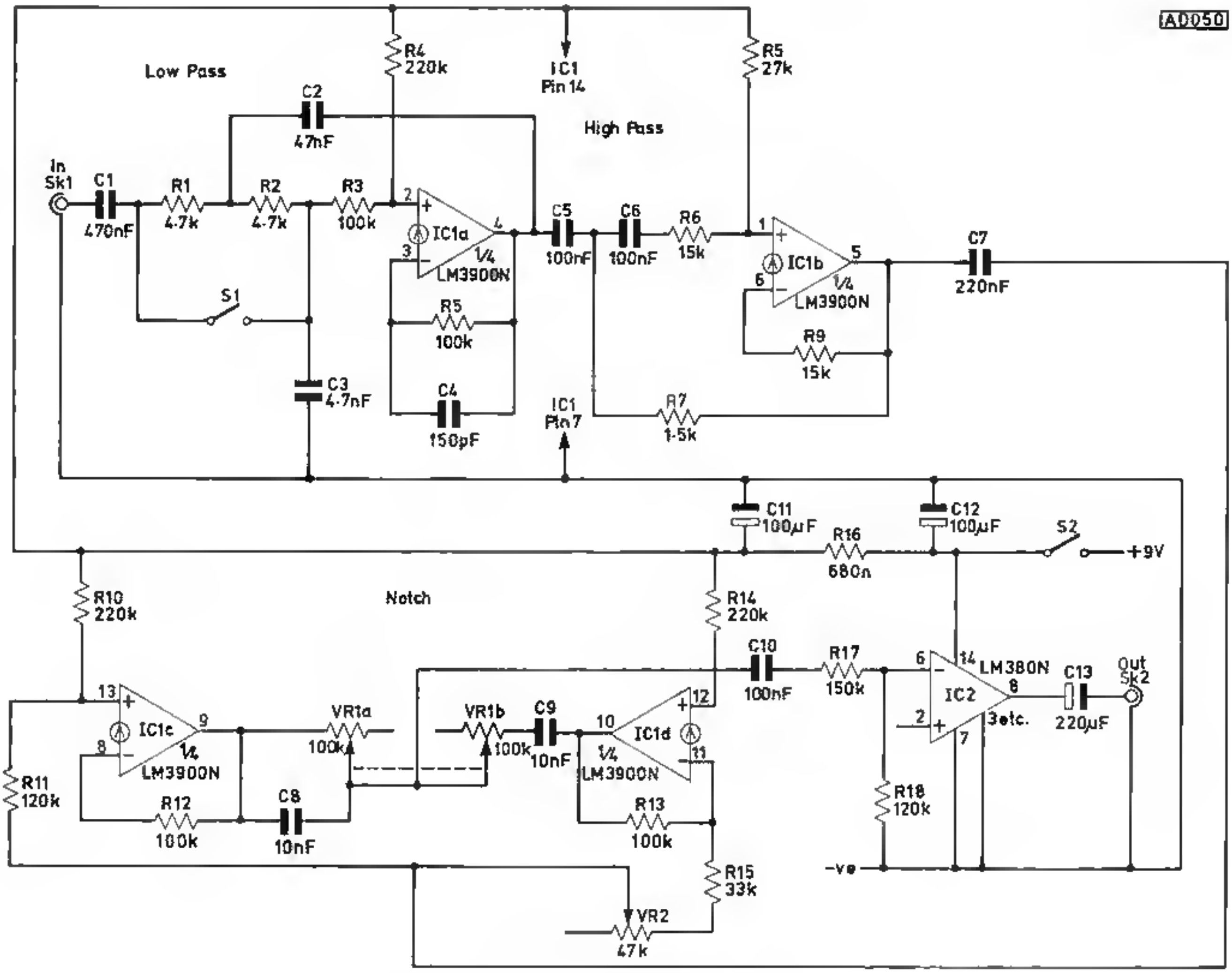


Fig. 1: Complete circuit of the audio filter unit.

Probably the low and high pass filter circuits will look rather familiar to many readers as they are of a well known type often used for scratch and rumble filters in hi-fi equipment. The amplifier which is used in the low pass filter is biased as a unity gain non-inverting amplifier by R3, R4 and R5. C1 provides d.c. blocking at the input whilst R1, R2 and C3 form a simple R-C top cut filter.

The "bootstrapping" capacitor C2 has no significant effect at middle and low frequencies; this is because the amplifier has unity gain and any change in the voltage at the input end of C2 is matched by a virtually identical change at its output end. Thus it has an apparent infinite impedance and so produces no effect on the circuit.

At high frequencies the circuit does not achieve unity gain due to the presence of the top cut filter. Changes in potential at the input end of C2 are then not fully matched by similar changes at the output end. This gives C2 some effective impedance and in conjunction with R1 it provides a second R-C top cut filter.

Normally this type of circuit achieves a roll-off rate of about 12dB per octave, but a much faster fall in high frequency response is provided by this particular version, seen by referring to the low pass filter response graph, shown in Fig. 2(a). The increased roll-off speed is due to C4, which provides greater negative feedback over the amplifier at high frequencies. In itself this feedback reduces the gain of the amplifier and so provides a faster roll-off, but it also increases the effectiveness of the bootstrapping circuitry.

When S1 is closed, the low pass filter action is largely removed, although C4 still provides the circuit with a small amount of roll-off.

Operation of the high pass filter is similar to that of the low pass type. The amplifier is biased as a unity gain non-inverting type; a simple high pass filter circuit is formed at the input of C5, C6, and the input impedance of the amplifier circuit (approximately equal to the value of R6). The bootstrapping resistor R7 would appear to have an infinite impedance at middle and high frequencies, and has a significant impedance at low frequencies where the gain of the circuit falls below unity. A second high pass filter circuit is then formed in conjunction with C5, and the response of this filter circuit is shown in Fig. 2(b).

C7 couples the output of the high pass filter to the notch filter stage. One of the amplifiers used is biased in the non-inverting mode by R10, R11 and R12, while the other amplifier is biased as an inverting type by R14, R13, R15 and VR2. Anti-phase signals are therefore produced at the outputs.

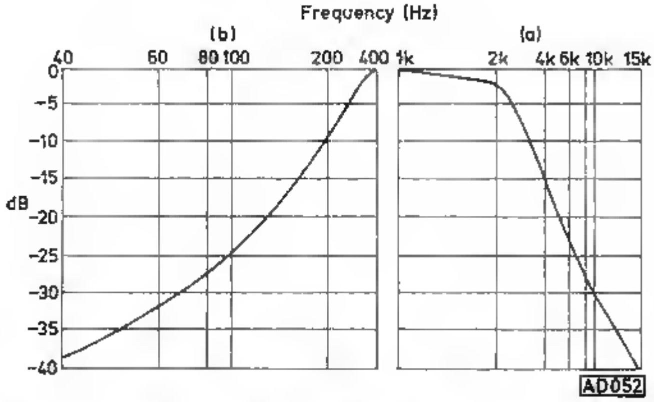
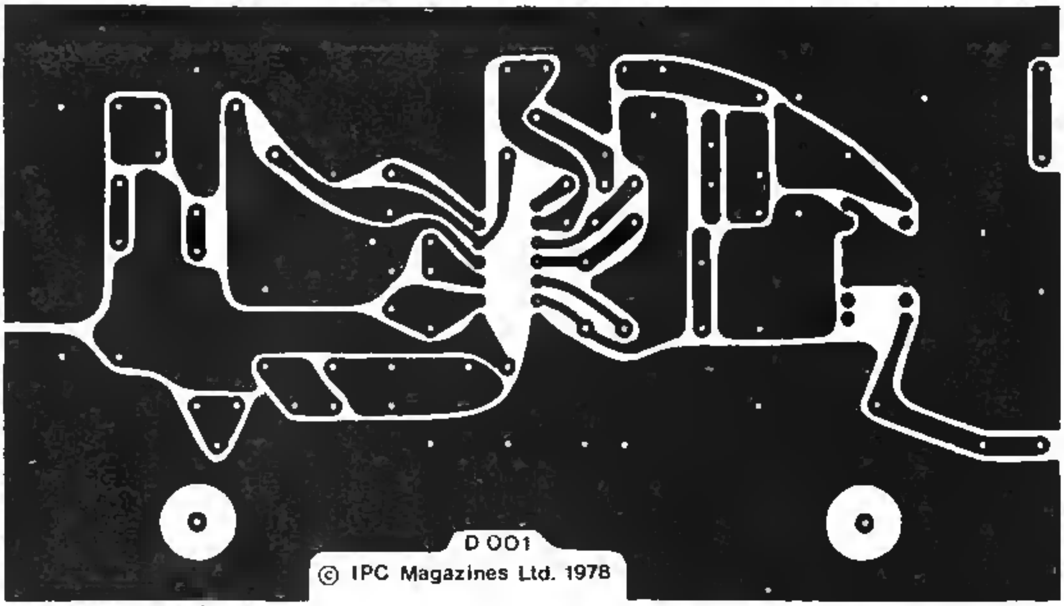
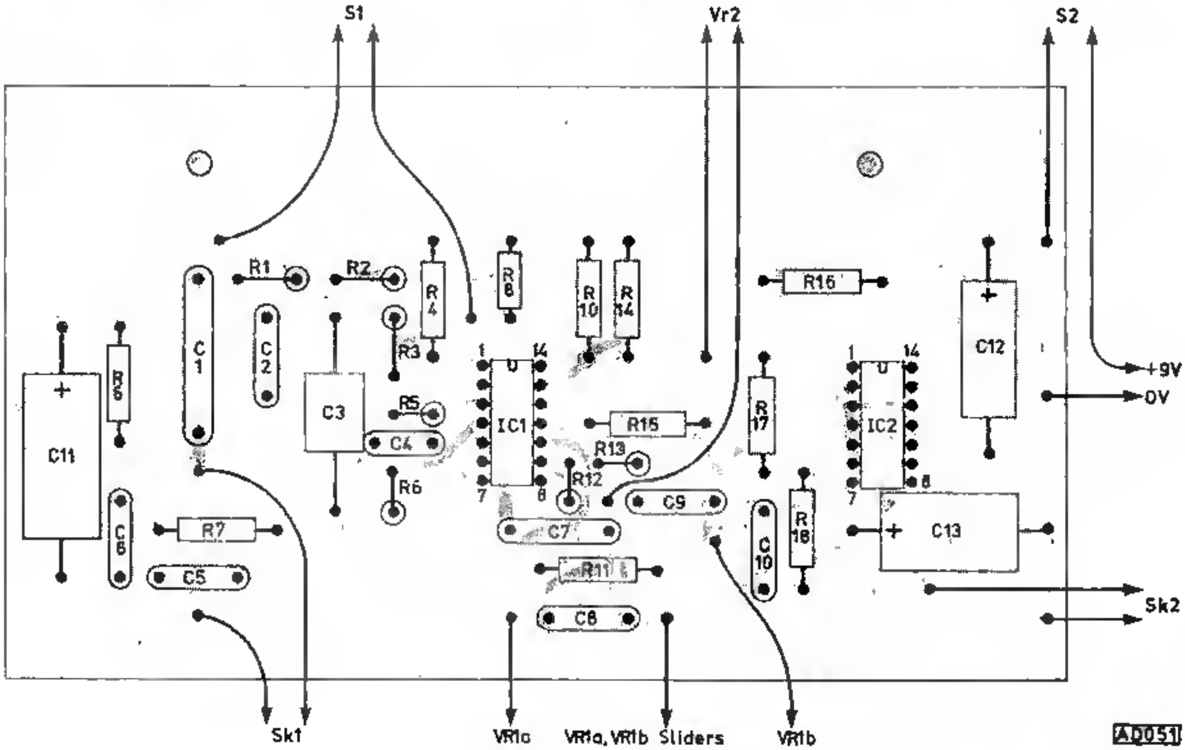


Fig. 2: Frequency response curves of the low-pass filter (a), and the high-pass filter (b).

Fig. 3 (below): Printed circuit board pattern, shown full size, plus component layout and details of off-board connections.





A phase-shift network is used in the output circuit of each amplifier, with one network using VR1a and C8, and the other comprising VR1b and C9. At one frequency there will be an identical phase-shift through the two networks and so the anti-phase signals will largely cancel one another out at this point. In fact, VR2 sets the gain of the inverting amplifier and this control is adjusted so that the two anti-phase signals at VR1 sliders precisely cancel each other out. By critical adjustment of VR2 it is possible to obtain an extremely high level of attenuation, and one is usually able to render any heterodyne inaudible.

At frequencies other than the notch, some difference exists in the two levels of phase shift, and so complete cancelling does not occur. There is an attenuation of a few dB close to the notch frequency, but this is not important in practice.

The output stage uses the well known LM380N i.c., and this enables the unit to drive virtually any type of headphones, but it can also be used with most loudspeakers. The prototype was fed from the phones socket of a Trio QR-666 receiver and was used in conjunction with either 16-ohm headphones or an 8-ohm loudspeaker. The unit is very versatile though, and it should be possible to fit it into most receiving situations.

Construction

Apart from the battery and controls, all the components are mounted on a p.c.b. This is illustrated actual size in Fig. 3 and it is prepared and wired in the conventional manner.

★ components

Resistors

All miniature ¼W 5%

R1	4·7k	R10	220k
R2	4·7k	R11	120k
R3	100k	R12	100k
R4	220k	R13	100k
R5	100k	R14	220k
R6	15k	R15	33k
R7	1·5k	R16	680 ohms
R8	27k	R17	150k
R9	15k	R18	120k

VR1 100k plus 100k linear dual gang potentiometer
VR2 47k lin. carbon

Capacitors

C1 470nF type C280
C2 47nF type C280
C3 4·7nF polystyrene etc
C4 150pF ceramic
C5 100nF type C280
C6 100nF type C280
C7 220nF type C280
C8 10nF type C280
C9 10nF type C280
C10 100nF type C280
C11 100μF 10v
C12 100μF 10v
C13 220μF 6·3v

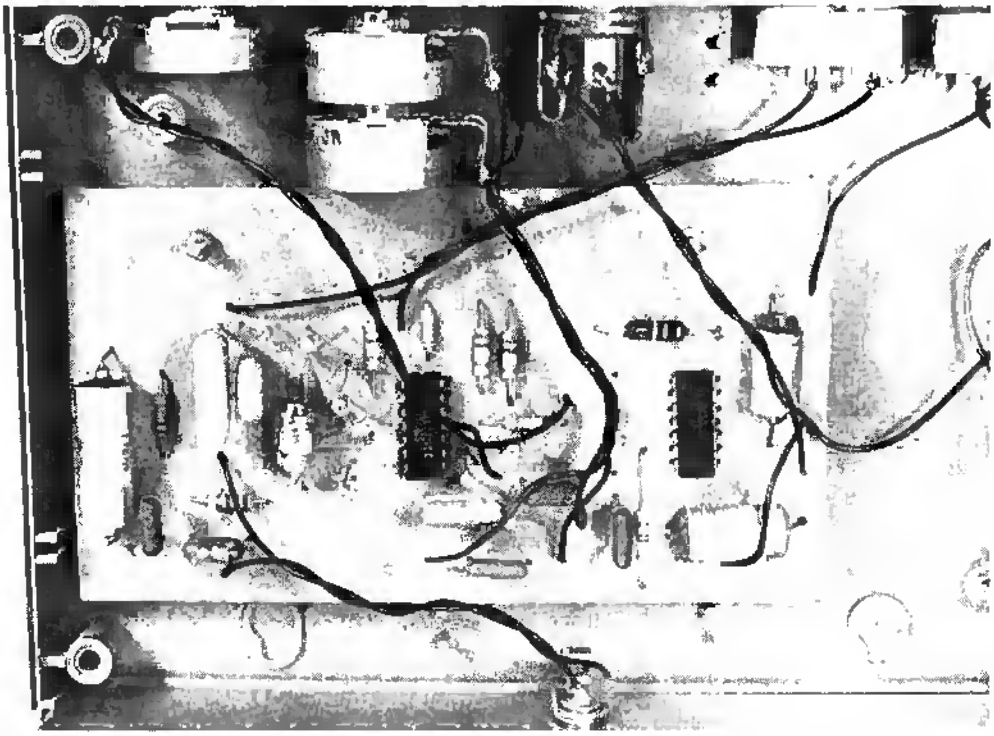
Semiconductors

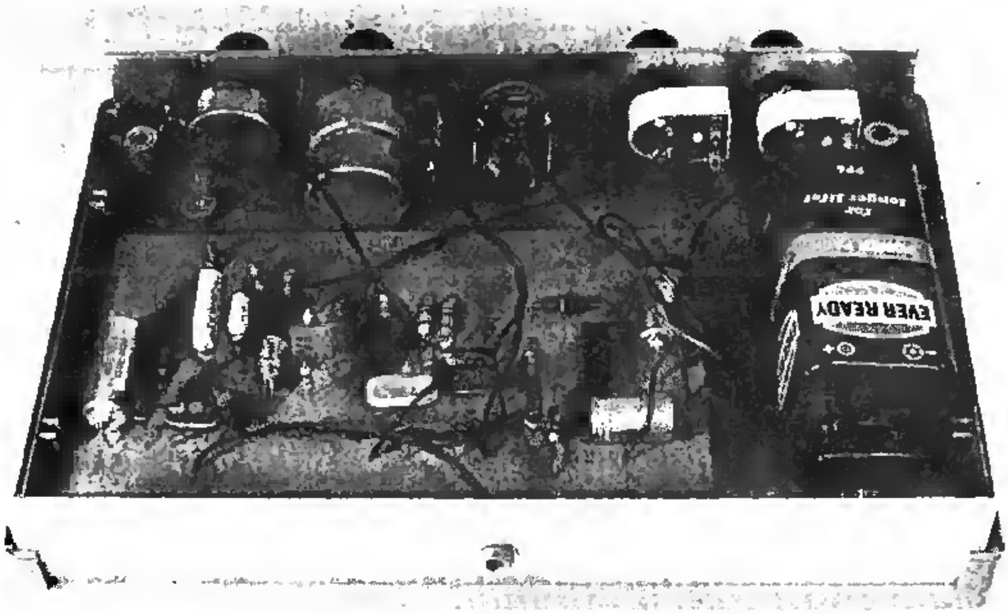
IC1 LM3900n or CA8401E
IC2 LM380N

Miscellaneous

Verocase or similar housing
Two rotary on/off switches (S1 and S2)
3·5mm jack and 6·3mm jack
Materials for p.c.b.
PP6 or similar 9v battery and clips to suit
Four control knobs
Wire, solder, etc

A view of the p.c.b. and internal wiring of the prototype filter unit.





An internal view of the audio filter. The input socket is mounted on the rear panel.

The prototype was housed in a Verocase which had outside dimensions of about 205×140×40mm, but any case of a similar size should be suitable. The general layout is not particularly critical and can be seen by referring to the photographs.

In use

The receiver and filter are connected together by a short lead which is terminated in suitable plugs. There is no need to use screened lead if the receiver has a low output impedance.

Low frequencies do not significantly aid the intelligibility of speech and many people find that clarity is actually improved by their removal. The high pass filter does not therefore have an in/out switch.

A somewhat different situation exists in the case of high frequencies, since these do provide a significant contribution to intelligibility. There is no point in switching in the low pass filter when a signal has little or no high frequency interference but does have middle or low frequency interference. This would simply reduce the level of the wanted signal in comparison to the interfering one.

Adjustment of the notch filter is very simple. When initially testing the unit VR2 should be set at about half maximum resistance. VR1 is then adjusted to null any whistle which is produced by the heterodyne from a carrier wave, after which VR2 is re-set for maximum attenuation of this signal: by carefully altering these controls it is possible to obtain an extremely high level of rejection. Once the correct setting for VR2 has been found, only a small variation will be necessary for other settings of VR1. Some slight readjustment will be needed for optimum attenuation though.

When the notch filter is not required, simply rotate VR1 to the maximum operating frequency (minimum resistance). The rejection notch then lies outside the range of human hearing, and so the filter is, in effect, out of circuit.

It is worth noting that although the filter will virtually eliminate the fundamental signal produced by a heterodyne, it will not cut out any harmonics (double or treble the fundamental frequency etc.) which are produced by distortion in the receiver. In most cases such harmonics will be of negligible proportions.

The audio output is controlled by the volume control of the receiver in the normal way. ●

LETTERS

13A Mains Plugs

The reason why there are so many badly connected mains plugs in British homes is that the great majority of plugs sold are far too difficult to connect. It is astonishing that the manufacturers have not long since devised a plug which can be wired up easily in a few seconds by a clumsy housewife using a nail-file as a screwdriver.

The cord should be gripped automatically when the lid is screwed home. The length of wire needed for each lead should be the same—at present, the earth lead has to be longer than the neutral, and the live lead shorter than either, which makes those well-meaning appliance manufacturers who solder and bind the ends of their leads look silly.

Finally, it seems incredible folly to sell all those plugs with 13 amp fuses. It is horrifying to think of the thousands of table lamps, hair curlers, electric clocks, etc., fitted with massive fuses just because nobody is going to go back to the shop for a 3 amp fuse. All plugs should be sold empty, with an attached packet providing three different fuses.

Practical Wireless would do a useful service by conducting a campaign for a "simple, safe plug".

B. M. Crowther,
Dorking.

For a comment on the above letter, see **The British Connection**, *on page 18 of this issue. Ed.*

ON THE AIR

BROADCAST BANDS

SHORT WAVE BROADCASTS

by Charles Molloy G8BUS

An unusual log comes from G8PG (**Gus Taylor**, Greasby, Wirral) who has a vintage 1923 crystal receiver complete with cat's whisker detector. Tuning is by means of a slider on the tuning coil. Although intended for use on the medium waves this receiver goes down to the 49m band and when connected to a 60ft long wire it gave headphone reception of Vatican Radio at 2000 and Radio Moscow DX Club in English, Prague radio and an unidentified station in Spanish, all between 2250 and 2300. Unable to resist the challenge, your scribe knocked up a crystal set using a Denco Maxi-Q blue range 4 inductor, an OA71 germanium diode (silicon diodes will not do) a variable capacitor of unknown value and a pair of high impedance phones, all joined together with leads and 'croc' clips. When connected to a 90ft long wire, stations were heard on the 31m, 41m and 49m bands. The depth of fading was a surprise—even the strongest signal faded right down, an effect that is obscured when using a receiver with lots of gain and a.g.c. The *L/C* ratio, i.e. the ratio of inductance to capacitance of the tuned circuit should be as high as possible. The 1923 crystal set uses a large inductor tuned by its self capacitance. Improved results were obtained with my lash-up when I used a home-made inductor of 15 turns on a 1½ inch former tuned with a 100pF variable.

Chris Howles (Lichfield) was surprised to hear a broadcast from Reykjavik on approximately 12090kHz, as he did not think that Iceland had a short-wave service. According to the *World Radio and TV Handbook*, Iceland is on medium and long waves only. There is however an unlisted service for fishermen, with programmes of music, news and weather reports on 12175kHz (25·64m) which can be heard at 1200. This station will QSL. DXers who want to add Iceland to their list of countries verified should send a report, together with an International Reply Coupon to Gufenes Radio, PO Box 442, Reykjavik, Iceland.

Old-timers will remember station TFJ Reykjavik which used to be on 12235kHz (24·52m) with a regular s.w. service. This was the first station I ever heard on the short waves, using a one-valver made to a design by F. J. Camm which appeared in *PW* in the mid-1930s. The tuning coil was wound on postal tubing, the h.f. choke was made of fine wire wound in sections on a glass test tube and the tuning and reaction controls were each fitted with a slow-motion drive. A fair degree of skill is required to operate a straight set with reaction, a skill which once acquired is never forgotten and helps the DXer to squeeze the last drop out of more complicated gear.

Chris asks whether it is better to send all his log for the month, or just a selection. Only those items likely to be of interest to other DXers should be included, together with the date, time, frequency (if known), signal strength in SIO and some details of the receiver and aerial used. Unusual loggings, stations on new channels or heard at unusual times of the day, will interest others.

Another convert to the new Yaesu Musen FRG7 is **Robert Whitrow** of 29 Ena Avenue, Neath, West Glamorgan SA11 3AD, who would like to hear from FRG7 owners who have ideas on a suitable aerial for use with this receiver. Robert uses a Joystick plus 3B Joymatch on the medium waves and a half-wave dipole (no size mentioned) fed via co-ax cable, for s.w. reception, all being situated in the roof space. A dipole is a balanced aerial and balanced 75 ohm feeder should be used to connect it to the dipole (A, A1) input to the receiver. Co-ax is unbalanced electrically, and the screen will act as an aerial, picking up local noise, if it is used with a dipole. Robert wonders if it would be worth investing in a "proper" short-wave aerial.

Multi-band trap dipoles are available commercially. A trap dipole has one or more parallel tuned circuits called traps, in series with each half of the dipole. At high frequencies, the trap behaves like an insulator, only the centre portion of the aerial being used. At low frequencies, the traps act as loading coils and consequently the two arms of the dipole can be made shorter than usual. A half-wave dipole cut for the 49m band would have an overall length of 78ft. The Mosley SWL7 trap dipole, for example, has an overall length of 40ft and it resonates on the 49m, 31m, 25m, 19m, 16m, 13m and 11m bands. A trap dipole will not pick up any more signal than a dipole cut for the band in use. In fact it will probably pick up slightly less signal, but it occupies a lot less space than a dipole for each band and it is a lot simpler to erect as well. Details of commercially made short-wave aerials can be had from Mosley Electronics, 196 Norwich Road, New Costessey, Norwich NR5 0EX, or from Lambda Antenna Stud Farm, Whiteball, Wellington, Somerset.

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CIRCUIT TECHNOLOGY:
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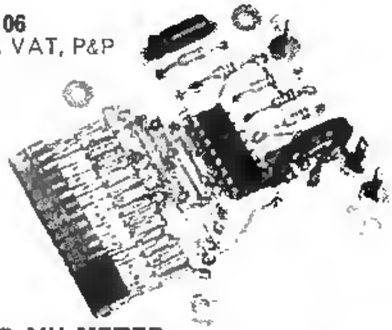

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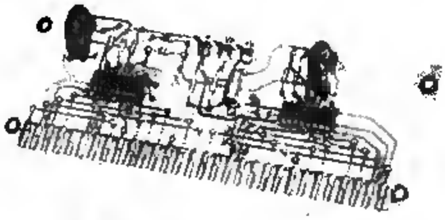

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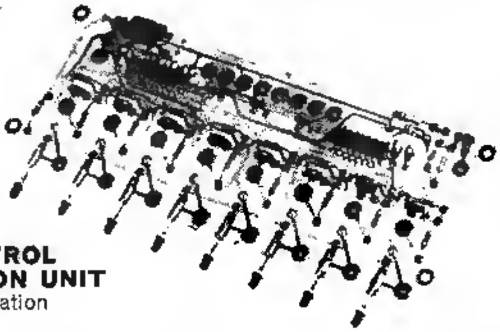

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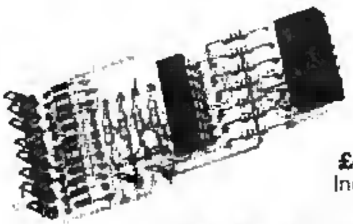

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NUMERICAL DISPLAY
Pre-selected channel number

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Personally, I prefer a long wire. My 90-footer goes from a chimney on top of the house to a 20ft mast at the bottom of the garden. End-fed by a a.t.u., this aerial has picked up a lot of weak signals including Reunion, when it was on the 120m band. Not everyone has the space for a long wire and the trap dipole could then be attractive.

Fred Pilkington (G3IAG) writes from Newmarket to say that from the information in this column he was able to listen to Radio Australia again after 20 years. "It was quite exciting for me to listen to them again and 21570kHz seems a good frequency". Fred uses an FRG7 and he is hoping to build a digital readout unit for use with it. DX heard on 60m includes Ghana on 4980kHz at 2300, Lagos on 4990 from 2245-2305 with a programme in English about a book published by Radio Nigeria which covers the story of broadcasting there during the period 1951-77. This book may be of interest to DXers like Fred who was a Radio Officer in the MN in 1952/53 and used to visit Radio Nigeria when it was starting up and had its transmitters in a caravan.

"Could you please tell me whereabouts and when I could listen to Rhodesia and New Zealand?" asks **J. Thackray** of Leeds who has an Eddystone 840 and a 30ft long wire. Rhodesia does not have a s.w. service but it does have a domestic service on the tropical bands. Gwelo is on 3306kHz (African Service) from 0325-0615 and 1515-2200 and on 3396 (General Service) from 0350-0615 and 1515-2100. Listen for these 90m outlets when there is a path of darkness. The answer about New Zealand comes from **Jack Shone** (Wrexham) who found RNZ on 15130 after WYFR went off at 1853. RNZ identified a couple of minutes later and was heard until 2000. Another station of interest heard by Jack on Sundays is the internal service of Radio Australia on 9669 from 1200 to 1300. Reception was with a Realistic DX160 used with a Joystick, ATU and crystal calibrator.

Jack raises an interesting point regarding the higher frequencies closing after dark. There is DX to be heard on the 19m band and this may occur on paths that are mixed day and night. Tokio was logged on 15270 in English to North America at 2350, also Radio Peking in English to North America on 15060 at 0045. This is the occasion to use a good aerial and preselector, when the band is quiet and there is no danger of overloading the receiver with strong signals. **A. L. Herrick** of Leicester has also been trying 19 metres after dark. He reports hearing the Voice of Chile on 15120kHz at 2200 using an ex-Admiralty B40 receiver and a 60ft long wire.

BROADCAST BANDS

MEDIUM WAVE DX

by Charles Molloy G8BUS

Regular readers of *Practical Wireless* will have noticed an illustration (Fig. 10) of the *PW* Medium Wave Loop Aerial in the "Guide to Aerials" supplement within the March 1978 edition. Back issues are available from Post Sales Department (see page 18). The *PW* loop is a well-tried design. It appeared in my article *MW DXing* (*PW* April 1970) and in the *Aerial Wallchart* (Oct 1972). It has also been reproduced in *Electronics Australia* and in *Radio Communication* (RSGB).

Anyone taking up medium wave DXing should make this loop. If I had to choose, I would use a poor receiver plus loop rather than a good one with any other type of aerial, except of course the Beverage. During the past few years DXers making loops have written to me asking for help and this seems an opportune moment to mention some of the problems that were encountered.

It should be realised that the loop has two separate windings which are not connected to one another. The main winding, which should be wound on first, consists of seven turns and the two ends of the wire are connected to the tuning capacitor; one end to the fixed vanes and the other end to the moving vanes. The second winding is a single turn, wound beside the central (fourth) turn of the main winding. The ends of this single turn are connected to the coaxial cable which goes to the receiver. The single turn picks up signal by induction from the main winding and there is no metallic connection between the two. The same kind of wire is used for both windings.

"What kind of wire should be used?" is a question frequently asked. The answer is that almost any kind of wire will do. Plastic-covered "hook-up" wire of about 26 s.w.g. is readily available and is convenient to use. If very thick wire is chosen then it may be difficult to wind and bend. If fine wire is used it will not be rigid enough and may break easily. Stranded wire is not rigid enough. I once wound a loop with Litz wire but could detect no improvement in performance. Single copper wire with plastic insulation in the range 22-26 s.w.g. is ideal.

What sort of cable should be used between loop and receiver? Co-ax cable is shown in Fig. 10 and this is adequate when joined to a receiver which only has Aerial and Earth terminals. If the receiver has a balanced input (marked A and A1, or Dipole), then electrically balanced feeder will give better results. Ordinary twin plastic-covered lighting flex will do or, alternatively, use 75 ohm or 300 ohm ribbon feeder. The feeder also acts as an aerial! If it is balanced, then both wires pick up an equal amount of signal but as the signal from each wire passes through the receiver's aerial coil in opposite directions (from A to A1 for one wire and from A1 to A for the other), they will cancel out. The nett pick-up from the feeder will then be zero which means a deeper null.

Some readers have had difficulty in covering the whole of the medium wave band, which stretches from 1605kHz to 520kHz. If the loop will not tune to a high enough frequency then the residual capacitance when the tuning capacitor is at minimum, is too high. There are a number of possible reasons. The self capacitance of the main winding may be too high, caused by using thick wire or placing the turns too close together. The minimum capacitance of the tuning capacitor may be too high. Capacitance may be reflected from the single turn into the main winding, either from the receiver or feeder. The cure for all is to reduce the number of turns from seven to six.

If the loop will not tune to a low enough frequency then more capacitance is required. Fit a 220pF or 330pF fixed capacitor in parallel with the variable capacitor. This should solve the problem. In parallel, means connecting one side of the fixed capacitor to the moving vanes and the other side to the fixed vanes. Use a switch to do this and then the fixed capacitor can be switched IN for the l.f. end of the band and switched OUT when tuning to the h.f. end. If it is left IN all the time then the h.f. end will be affected.

The value of 500pF specified for the tuning capacitor is a nominal value only, 470pf will probably do just as well. A twin-gang 365pF with the two sections in parallel, giving 730pF in all, will certainly cover the whole band. Use one section for the h.f. end and switch in the second section when tuning the l.f. end of the band. A single-gang 365pF variable with a 220pF fixed and a switch is the set-up used by many DXers as it is a compromise between coverage, ease of tuning and availability of components.

Finally, in answer to a query received from **William Stevenson** of Swinton in Lancashire, a loop is unsuitable for use with a Vega 206 or any other receiver which has its own internal aerial. The reason is that the internal aerial will mask the loop's null. Even if the loop is rotated to null out QRM, this QRM will still be picked up by the aerial inside the receiver. The receiver could be rotated as well of course as its internal aerial is also directional. One way to do this is to mount the receiver, perhaps on a shelf, at the centre of the loop, so that the two nulls coincide. This means that the ferrite rod should point at right angles to the plane of the windings on the loop. The loop and receiver can then be rotated together. No need to join the feeder to the receiver as there will be direct pick-up from the loop by the internal aerial. Although this is rather clumsy it does work, but at best it is a makeshift. Portables usually work best with their own aerial which, incidentally, acts like a mini-loop. Tune in a station on the medium waves, rotate the receiver and two positions will be found where the station disappears.

In a letter to **Harold Emblem,** the Newfoundland Regional Engineer of the CBC lists stations that have received the most numerous reception reports from Europe. These are CBT Grand Falls 540kHz, CBNA St Anthony 600kHz (which relays CBY 990) CBN St John's on 640, CBNM Marystown on 740, CBGY Bonavista Bay on 750. All transmit with 10kW. Reports to CBC outlets in Newfoundland should go to PO Box 12010, Postal Station A, Kenmount Road, St John's, Newfoundland, A1B 3T8 and the CBC will issue a QSL card for each correct report.

Noel Cosgrave writes from Dublin to report reception of the BBC relay in Cyprus on 638kHz, WINS on 1010 and WNEW 1130 in New York City. Details of receiver and aerial were not given. Noel mentions an unauthorised station in his area but readers are reminded that it is illegal, in the UK at any rate, to listen to "pirates" and reports of such broadcasts cannot be included in this column. "Would a Codar CR70A plus PR40 preselector and aerial tuning unit (a.t.u.) be suitable for m.w. DXing, and could a loop be used with this receiver?" asks **R. P. Cruise** of Telford. Yes, the CR70 performs very well on the medium waves when used with a loop. Connect the loop direct to the receiver leaving out the preselector and a.t.u. The preselector might boost some signals but it is more likely to cause cross-modulation. An a.t.u. is not used with a loop, as it too (like the feeder) will act as an aerial and pick up signal.

VHF BANDS

by Ron Ham BRS15744

Congratulations to **John Branegan,** Saline, Fife, who has passed his RAE and by now will be sporting a GM8 call sign and using a Yaesu FT221R on 2 metres. Between 2000 and 2109 on January 31st, John heard tone-A c.w. signals, on 2m, from 5 GMs, 3 LAs and the Angus, GB3ANG, and Lerwick, GB3LER, beacons, all of which he thinks was due to a 27 day repeat of the auroral event he observed on the 4th.

Both the 27MHz Citizens and the 28MHz amateur bands were wide open, almost daily, from January 29th to February 19th when rock-crushing signals were received from Canada, north and south America and several European countries. **Cyril Fairchild,** G3YY, Brighton, reported that the 10m band opened up on January 29th between 1200 and 2100 when he heard very strong signals from LU, PY, PZ, VE, Ws, 1,2,3,4, 5,8,9, 0 and American CBers all working into Europe on both a.m. and s.s.b. At the same time, **Gordon Goodyer,** BRS 37345, Petworth, Sx, using an Eddystone 750 and a loft wire dipole, received 10m signals from Canada, Europe, the Middle-East and South Africa and at 1530, he says "it was armchair copy all the way" as the American stations pounded in. "The band had gone mad," said Gordon, a view supported by **Alan Baker,** G4GNX, Newhaven, who, like us all heard the Cyprus, 5B4CY, and TESSA, ZE2JV, beacons and at 1210 he had a c.w. contact with UY5VL using his FT101E with a Webster Bandspanner aerial stuck in his Black and Decker workbench outside the back door. The following day, using the Mid-Sussex ARS club station at Burgess Hill, he heard those powerful signals from a host of Russian stations on 10m.

On 17 of the 22 days from January 29th to February 19th I frequently received signals, averaging 549, from 5B4CY. On 13 of those days, signals averaging 539 were heard from ZE2JV, while on 3 days signals were 549 from A9XC, the Bahrain beacon. Almost daily, very strong signals came from the Russian stations before noon and from the American Continent in the afternoon, but what amazed us all was the fantastic strength of the American CB signals as they contacted their European counterparts. John Branegan now uses the Citizens band as a 10m propagation guide, because, as John says "A new pattern of DX, Europe to and from North and South

THERMOSTATS

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Limpet Stat must be mounted in close contact calibrated 90°–190°F 15 amp contacts **£1·62.**
Appliance Stat fix like a volume control—15 amp contact 30°–80°F **85p.**
ditto but for high temps **£1 25**
Over Stat—with Sarson and capillary **·85p**

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Model TT2 small but powerful 1in. pull—approx. size 1½ × 1¼ × 1¼in., **£2.00**
Model 4001/—½in. pull. Size 2¾ × 2 × 1¼in. **£2.50**
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Prices include VAT & postage.

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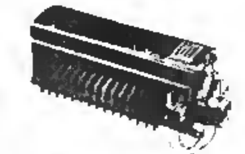
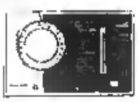
Mains operated—delay can be accurately set with pointers knob for periods of up to 2½ hrs. 2 contacts suitable to switch 10 amps—second contact opens few minutes after 1st contact 95p.

MOTORISED DISCO SWITCH



With six 10 amp changeover switches Multi adjustable switches are rated at 10 amp each so a total of 200w's can be controlled and this would provide a magnificent display For mains operating 8 switch model **£5.25**. 10 switch model **£5.75**. 12 switch model **£6.75.**

SMITHS CENTRAL HEATING CONTROLLER



Push button gives 10 variations as follows (1) continuous hot water and continuous central heating (2) continuous hot water but central heating off at night (3) continuous hot water but central heating on only for 2 periods during the day (4) hot water and central heating both on but day time only (5) hot water all day but central heating only for 2 periods during the day (6) hot water and central heating on for 2 periods during the day time only—then for summer time use with central heating off (7) hot water continuous (8) hot water day time only (9) hot water twice daily (10) everything off A handsome looking unit with 24 hour movement and the switches and other parts necessary to select the desired programme of heating Supplied complete with wiring diagram Originally sold we believe at over **£15.** We offer these while stocks last at **£6·95** each INCLUDING VAT and Postage.

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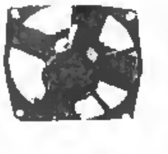
1 rev per day — 6 rev per day
1 rev per hour — 12 revs per hour
½ rev per min — 1 rev per min
2 rpm — 1½ rpm
5 rpm — 15 rpm — 20 rpm — 25 rpm — 30 rpm



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11 instant ranges measure:—
DC volts 10, 50, 250, 1000
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Continuity and resistance 0-150K ohms.
Complete with insulated probes, leads, battery, circuit diagram and instructions.

Unbelievable value only **£5·50** - 50p post and insurance.

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These are pulse operated switches as used in auto matic telephone switchboards etc. The pulse moves the switch arm through one position. Except where indicated the selectors are 25 position types and 50v Coil is standard 24v or 12v operation extra at **£2** per switch.

3 pole	**£4 80**	4 pole	**£5·84**
5 pole	**£7·02**	8 pole	**£9·72**
10 pole	**£10·80**	12 pole	**£12 96**
3 pole 50 way	**£10 58**	4 pole 50 way	**£12 74**

24 HOUR TIMERS

The one illustrated is E' controls this uses the Smiths mechanism as in their autoset. 2 On/off's per 24 hours, 13 amp contacts override switch **£6·60.** Smiths 100 amp model one on/off per 24 hours **£10·50,** extra contacts **£1·00** per set. AEG 60 amp model with clockwork standby, one on/off per 24 hours **£9 50,** extra contacts **£1·00** per set.

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One illustrated is our reference MM11 made for ITT ⅜' stack 1¼' spindle **£2 25.** ½' stack model **£1·75.**
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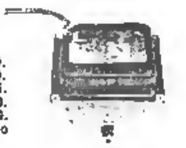

6v 1 amp £1·00. 12v ½ amp £1 00. 20v ½ amp 20w auto 230v £1·50. 18v ½ amp £1·75. 8·3v 2 amp £1·75. 25v 1½" amp £2·25. 24v 2 amp £2 50. 50v 2 amp £4·50. 9v 1 amp £1·50. 8·5v-0-8·5v ½ amp £1·50. 100w auto 230–115v £2·00. 8 5kv £8 50.
Many more, send for list.

WAFER SWITCHES

6 pole 2 way	12 pole 2 way	18 pole 2 way
5 pole 3 way	10 pole 3 way	15 pole 3 way
4 pole 4 way	8 pole 4 way	12 pole 4 way
3 pole 5 way	6 pole 5 way	9 pole 5 way
2 pole 6 way	4 pole 6 way	6 pole 6 way
2 pole 8 way	4 pole 8 way	6 pole 8 way
1 pole 10 way	4 pole 9 way	6 pole 9 way
1 pole 12 way	2 pole 10 way	3 pole 10 way
all **£1·32** each	all **£2·41** each	all **£3·12** each

Multi bank switches up to 72 pole 2 way—to 12 pole 12 way quickly made to special order.

THIS MONTH'S SNIP

Japanese made FM tuner and matching decoder. Two items for less than average price of the tuner only – **£11·20** the two Don't miss this stocks will not last long.

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12 volts, two 10 amp changeover plug in **95p.** 12v three 10 amp changeover plug in **£1·28.** 12v two changeover miniature wire ended **95p.** 12 volt open single screw fixing two 10 amp changeovers **85p.** 12 volt open three 10 amp changeovers **£1·25.** Latching relay mains operated 2 c/o contacts **£2 11.** Mains operated three 10 amp changeovers open type one screw fixing **£1 25.** Many other types with different coil voltages and contact arrangements are in stock, enquiries invited.

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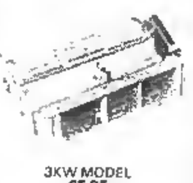

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IT'S FREE!

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived – often bargains which sell out before our advertisement can appear. – It's an interesting list and it's free – just send S.A.E. Below are a few of the Bargains still available from previous lists.

FM Tuner and decoder, 2 very well made (Japan) units, nice clear dial, excellent reproduction. **£11·20** the pair.
12 Volt Heavy Duty Relay, plug in type has three pairs of 10 amp changeover contacts. A transparent dust cover price **£1·08** suitable 11 pin base 45
4 Changeover Relay, upright mounting 4 sets of 10 amps changeover contacts, mains voltage coil **£1 72**
12 Volt Pump. Designed we believe as a bilge pump this is 12 volt AC/DC motor coupled by a long enclosed shaft to a submersible pump. Suitable for water or most any fluids. Price **£12·50.**
Just arrived. Fruit machines, working order, very impressive choice of several but very heavy so you must collect. **£60.**
High Load 24 Hour Clock Switch, made by the famous AEG Company for normal mains but with clockwork reserve has load capacity of 80 amps at 240V 50HZ. Therefore suitable for dealing with large loads of say shop lighting, water heating storage heaters etc. etc Has triggers for on and off once per 24 hours but extra triggers will be available, Price **£1·50** per pair. Size of clock approximately 8" x 5" x 5", totally encased but has lift up flap for ease of altering switching times Price **£7·50.**
Enclosed 24 Hour Clock, with contacts for breaking 10-12 amps at 240 volts. This one has two sets of on/off per 24 hours, price **£7·00.**
Light Dimmer, our timer module with small mods makes an excellent light dimmer Contains a 4 amp 400V SCR so it should be suitable for loads approaching 1KW. Price of module and instructions **£2.25**
Push Pull Solenoids, mains operated solenoids which will push as well as or instead of pull Very heavy duty estimate this at 20lbs push or pull. 1¾" x 3¼ x 4' made Magnetic Devices Co **£7·50**
Flashing Lights, chasing lights random flashes, strobe effects etc. etc. can easily be achieved using our disco switches. These switches are ex-equipment but guaranteed perfect and supplied suitable for mains working To get some idea of the loading number, each switch is 10 amp For the light pipe or Catherine Wheel effect order the 12 switch model with light pipe data model, interconnecting the switches to give fastest speed. 6 Switch model **£5.** 9 Switch Model **£9.75.** 12 Switch model **£8·20.**
Reed Switches, standard 60 watt glass type Normal open contacts glass lengths 2' diameter $\frac{1}{16}$', 10 for **£1** 100 for **£8,** 1000 for **£70.**
Flat Reed Switches, for stacking, greater quantity in confined space. Price **50p**
Single Ended Types for jobs where it is not easy to bring a lead to each end, **75p** each. All these switches are normally open but can be biased to a normally closed position by fitting a magnet adjacent. The reed switch would then be opened by a magnet of opposite polarity being bought up to it
Ceramic Magnets suitable for operating reed switches, central fixing hole 10 for **£1.**
Music Centre Transformer 12 0-12 at 1 amp and 9 volt at ½ amp Normal primary upnghting, impregnated and varnished for quiet operation. Price **£3 50.**
'W' Shaped Fluorescent Tubes for porch light, box signs or where you want light evenly spaced over a confined area of approx. 10" x 10" 30 watts, made by Philips price **£2·24.**
Extension Speakers 8 ohm 4 5 watts handling power. We have 5 or 6 different models in stock, cheapest being the Partytime at **£3·95** each again only really a bargain for callers as postage is **£1·50** per speaker,
T.V. Monitors, an item for callers believed to be in good working order switchable thro' 405 525 & 625. 21" tube line systems, normal controls volume, brightness, contrast width etc. Price **£18·20,** 12" models **£18,** suitable for conversion into special purpose scope, etc.
Auto Transformers for working American tools and equipment completely enclosed in sheet metal case with American type flat output socket made for computer so obviously first class 500 watts. With cang handle offered at about half price only **£15.** These may be a bit soiled but are fully guaranteed Similar but 1000 watt **£29·50.**
Car Starter Charger Kit. New version. We supply two 10 amp rectifiers, 250V transformer and the start charge switch with instructions, price **£9·75.** This is probably one of the most useful pieces of equipment you can have in your garage Sooner or later you or someone will leave something on and you will have a flat battery this starter will get you away usually in less than 5 minutes.
Resetter Counter by Veederoot Company, 230/240V mains operated. Intended for surface mounting has a fixing flange at the bottom Price **£2·16.**
12V Drip proof Relay. Specially designed for going under the bonnet of a car, made by one of our big manufacturers, this really has a removable semi-hard rubber cover. Contacts look suitable for up to 10 amps so this could be the right one if you are thinking about making an anti-thief device. Price **£1** + 8p
High Speed Uniselector. As many customers know, we have a very comprehensive stock of uniselectors as used in automatic telephone exchanges light flashing device etc., etc. Just arrived however is a high speed model made by famous Plessey, this is 2 pole 32 way with make before break wipers, overall size approx. 4" x 3 x 2½" price **£3·50** + 28p.
Pneumatic Ram for lifting, thrusting, pulling etc., etc. has 2¾" travel looks large enough to open doors, lift staircase, ventilators etc. Price **£7 00.**
Solder Gun Bargain. The ETP, this is 100 watt solder gun, a very well made tool with lamp to illuminate work, has double insulated mains transformer and is built into the shockproof thermoplastic case Comes complete with spare tips. Mains operated of course. Price **£4·50.**
Interested in Tape Control. American made tape punches really beautiful units full of sophisticated parts designed we believe to automatically operate typewriters, and they can of course be used to operate other punch tape controlled machines Reference number is NCR Class 461 2 reference 205 H8 R56, We believe these are 8 bit paper tape punches, powered from 115V 50HZ in very good condition with tape **£15·00,** carriage is £3·20.
Memories. The memory units which work with these tape punches again by NCR, are in very good condition and we believe in working order Price and details on request
Tangential Blowers. 12" long with powerful induction motor ideal for blowing heaters or general air extraction or circulation, offered at low price of **£2·70.** The motors are 110V so you will have to work them in pairs or through a dropper or mains transformer Post £1·08 for one or two.
Digital Panel made for the G.P.O. for incorporation, we understand in push button dialling units, this has the usual 10 digits, each of which when depressed operated a two pole changeover switch. Really beautifully made size approximately 4" square, price **£3·78.**

America has been discovered by the CBers". On the 7th, **Constance Hall**, G8LY, Lee-on-the-Solent, Hants, worked XYL operator, K2AGJ, New Jersey, whose husband was outside clearing some of that heavy American snow, and during the blizzards, John Branegan heard the local community-aid services using their CB sets.

Harold Brodribb, St. Leonards-on-Sea, Sussex, has greatly improved his 10m reception by removing the original KTW61 r.f. amplifying valves from his CR100, as suggested by our columnist, **Charles Molloy**, G8BUS, and fitted 6BA6 valves which has increased the gain and reduced the background noise. Harold also reports hearing the strong amateur and CB signals from America and on the 9th, he heard the harmonics of lower frequency broadcast stations around 29MHz. At 1410 on the 13th, **Nigel Golds**, BRS 36910, West Chiltington, Sx, tuned away from the Russian signals who were working into G and found the German beacon, DL0IGI. Both Gordon Goodyer and Harold Brodribb reported the extraordinary good conditions during the weekend of 4th and 5th when, like myself, they listened to the strong American contest stations.

On February 3rd, **Cmdr Henry Hatfield**, Sevenoaks, **John Smith**, Rudgwick, Sx, and myself, recorded a solar noise storm at 136-142MHz and although the Sun was "quieter" on the 4th, 5th and 6th, we all recorded a number of individual bursts of noise. During the afternoon of the 5th, I directed my pair of 8-element Yagis toward the Sun and heard the radio noise on 2m by using the converter in my FR101. Readers who may like to try this should tune their sets to a clear spot just below the 2m amateur band.

At 1000 on the 3rd, despite poor weather conditions, Henry got a brief glimpse of the Sun with his spectroheliscope and counted about 10 sunspots and something coming up on the east limb. On the 7th, an even bigger solar storm began and did not start to abate until the 18th. Although overcast skies continued to hamper visual observation Henry got another look at 1400 on the 9th and found the two largest sunspots he had ever seen.

The 11th was a cold clear day and Henry was able to make a detailed study of the Sun and take many photographs, in all he counted some 27 sunspots which accounted for the terrific radio noise we were receiving. At 1425 we all recorded a massive burst of radio noise which lasted for six minutes and stood out above the prevailing storm. My own recordings of the noise at 95 and 136MHz are shown in **Fig. 1**.

Ever since Henry Hatfield built his spectrohelioscope at his home in Sevenoaks he has longed for the day when he could see an actual solar event which caused a burst of radio noise on his 136MHz radio telescope. It was February 11th that brought his reward.

There is little doubt that the two large sunspots seen in his photographs (**Fig. 2**) were responsible for the bulk of the radio noise that both Henry and I had been recording for several days.

At 1426, in **Fig. 2(a)**, this special event is just visible at the bottom left of the upper sunspot. The full glory of the explosion manifested itself over the following few minutes, **Fig. 2(b)** and **(c)**, and by 1437 it had almost gone as shown in **Fig. 2(d)**.

Henry's chart recording of the period covering the event is shown in **Fig. 3**. The chart speed is 10in per hour, compared with 30in per hour in Fig. 1; hence the difference in scale.

Congratulations Henry, I feel sure that this is the first time that an amateur astronomer has pulled off such a feat.

Maybe it was this intense solar activity which caused the great 50MHz transequatorial opening on the 11th reported from Applecross, Western Australia, by **Anthony Mann**. The event started at 1220, local time, and finished at 1942 and the m.u.f. never fell below 45MHz the whole time. Russian Ch R1 video from Vladivostock was observed for 3 hours, several Korean Broadcast Service f.m. links were heard between 44 and 49MHz, dozens of signals from Japanese and South Korean amateurs were received between 50·04 and 50·22MHz and at the peak of the opening R1 sync pulses were received on a v.h.f. portable with just a 5ft whip aerial. "Without doubt" says Anthony, "this was the most prolonged transequatorial opening since February/March 1972, indicating the high level of solar activity". I've checked my records Anthony, and the Sun was very "active", from February 10th to March 15th, 1972.

Congratulations to **Arthur Bagnall**, Peacehaven, Sx, who having passed his RAE now has the call-sign G8OYC, and made his first contact on February 18th on 2m f.m. with local stations G8BTC, G8JFT, and G4GPX using a Hudson FM118 to a coaxial dipole. Congratulations are also due to **Eric Arnold**, Hove, Sx, who now has the call G8OUK, is using an IC240 on 2m and will be going for his G4 licence in due course; **Charles Brain**, Ferring, Sx, who has changed from G8LXT to G4GUO and **Alan Floyd**, G8KLN, who passed his Morse test at North Foreland on February 17th.

"Woody", **D. C. Woodhouse**, G3TWX, is now manager of the WAB v.h.f. contest. This event takes place on July 23rd from 0900-2100 GMT, on all bands, 30MHz upwards and any modes. All details from G3TWX, 13 Gannet Close, Haverhill, Suffolk, CB9 0JL accompanied by s.a.e. or one IRC. Don't forget the 2m c.w. and the 432/1296/2304MHz contests on April 22/23rd and May 6/7th respectively.

There was a brief tropospheric opening on February 15th/16th when, at 1620 on the 15th, Alan Baker heard ON1ON work G stations in Chelmsford and Colchester via the Kent repeater, GB3KR, and he could hear the Cambridge repeater, GB3PI, while driving in the Hastings area. Early on the 16th strong signals from GB3BM were interfering with GB3SN, both on R5. Although v.h.f. conditions were generally poor throughout the first half of February, G4GNX heard G4CJG, Durham, 2m s.s.b., at 2153 on the 5th, and around 1500 on the 19th he received a c.w. call from ON5EX but conditions deteriorated and they could not complete a QSO.

Thank you all for your interesting letters and reports and I look forward to hearing from you in the future.

Reports on the various bands are welcome and should be sent direct, by the 15th of the month, to:-

AMATEUR BANDS Eric Dowdeswell G4AR, Silver Firs, Leatherhead Road, Ashtead, Surrey KT21 2TW. Logs by bands, each in alphabetical order.

MEDIUM and SW BANDS Charles Molloy G8BUS, 132 Segars Lane, Southport, PR8 3JG. Reports for both bands **must** be kept separate.

VHF BANDS Ron Ham BRS15744, Faraday, Greyfriars, Storrington, Sussex RH20 4HE.

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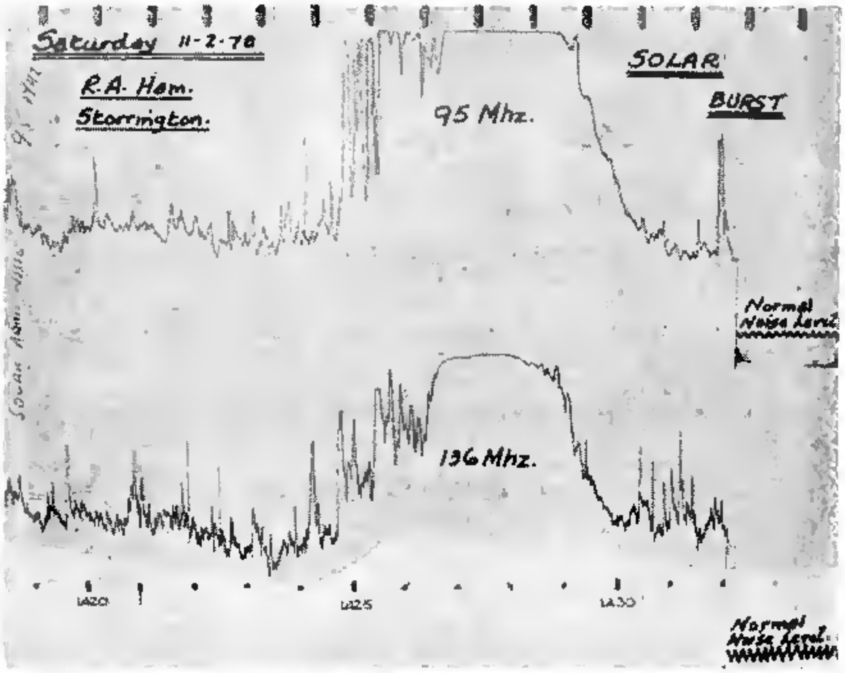

Fig. 1: Noise burst recorded at 30 in/hour

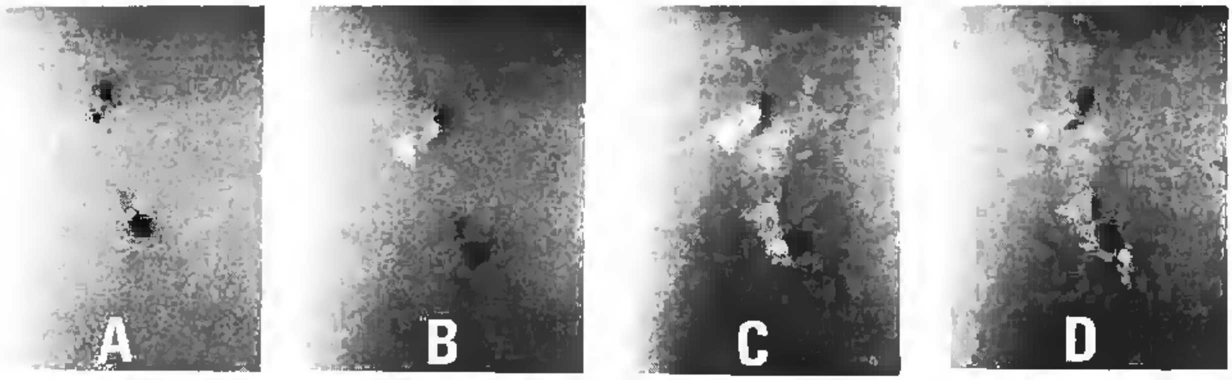

Fig. 2: Spectrohelioscope photographs of sunspots occurring at the time of the recorded noise burst

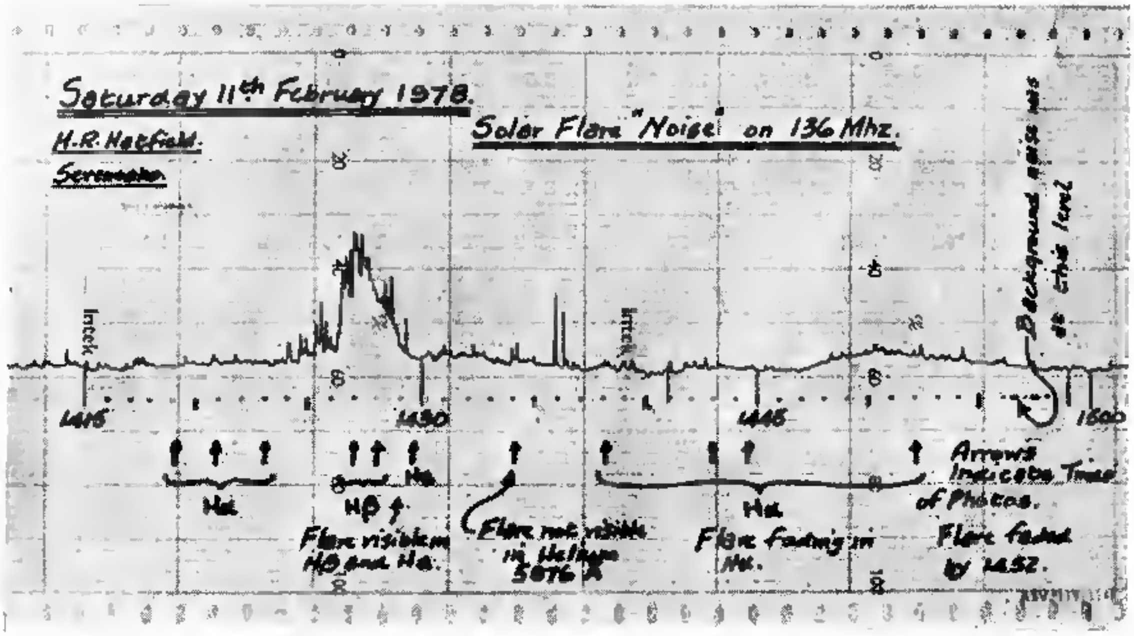

Fig. 3: Noise burst recorded at a chart speed of 10 in/hour

AMATEUR BANDS

by Eric Dowdeswell G4AR

Choosing a SW Receiver

Anyone buying anything of value will have some idea of the amount of money it is intended to spend. Whether they have the knowledge to spend the money wisely is another matter! On matters electronic, such as a communications receiver, the chances are that they will be sadly lacking in the necessary information to guide them to a good buy. So what is the first step?

The only worthwhile publication on the subject is the *Guide to Amateur Radio*, £1·38 inc. from the Radio Society of Great Britain, 35 Doughty Street, London WC1, which has one chapter devoted to reviewing the details of receivers which have become popular over the years, plus some more recent models. A lot of the sets are no longer in production and a number are valved, but don't let this deter you! Such sets can often outperform solid-state receivers.

You may be tempted to try your hand on the short wave bands with a cheap portable type receiver that probably includes the medium and long wave bands for which it is primarily intended. The dial will be found to be hopelessly small and inadequate for accurate tuning on the short wave bands. Even if you do find an interesting station there will be difficulty in holding it and it is doubtful whether you will ever find it again! So, in general, don't waste time and money on a set that is very inferior for this particular purpose. It will only give a mistaken impression of the amateur and broadcast bands.

The number of new communications receivers on the market that are likely to come within the budget of the average short wave listener (SWL) is very small nowadays, so recourse must be made to second-hand ones, but these are not to be despised. There are many ads in *Short Wave Magazine*, on the bookstalls at the end of every month, and in *Radio Communication*, the monthly journal for the members of the RSGB. When you send for your copy of their *Guide* why not ask for a specimen copy of Radcom, as it is familiarly known. You could do worse than become a member of the RSGB in due course. So here are a few points to watch, remembering that it is highly desirable for you to try to arrange an "air test" before buying any receiver, new or second-hand, although this may be difficult if the seller is at the other end of the country!

Don't forget that most amateurs use the single sideband (s.s.b.) technique for telephony which is best received on a stable receiver designed for the job. Cheap sets have a poor performance at the intermediate frequency (i.f.) in their ability to reject unwanted stations close in frequency to the wanted signal (adjacent channel selectivity) or to discriminate against stations that are operating at twice the i.f. away from the wanted station (image rejection). The latter effect relates to the r.f. tuned circuits, or lack of them, and results in many stations being found at two positions on the dial, particularly the more powerful ones. This may create an impression of great sensitivity but is, in fact, the opposite of what is required!

Some people believe in solving the image rejection problem by using double or even triple conversion techniques, but I have always used single conversion with a high i.f. (5·5 or 9MHz) using a crystal or mechanical i.f. filter to obtain the necessary adjacent channel selectivity. This system obviates the need for additional oscillators which can only add to the problem of spurious responses. For a very rough check on selectivity see if you can properly separate two fairly powerful stations located about 5kHz apart. Short wave broadcast stations are probably the best for this test.

Sensitivity is a feature which is almost impossible to check without a lot of test equipment although an experienced operator can express a fairly accurate opinion based on the "feel" of the set. However, if the set is a recognised communications receiver then its sensitivity ought to be adequate but if it is not then, hopefully, it may be a matter of re-alignment or possibly a new valve or transistor.

In addition to the main tuning dial there may be a bandspread dial of some kind, which greatly facilitates the tuning in of signals on a congested band. This dial may be marked in frequency for the principal amateur and broadcast bands. Watch out for excessive "backlash" on the dials, where a station comes in at slightly differing points on the dial depending upon whether the station is approached in an anti-clockwise or clockwise direction.

Next, tune into a station on any range and then operate the range switch from one end to the other then back to the original range. The station selected should still be there, in tune. Check with a station on each range. Any slight problems here can usually be solved with a switch contact aerosol spray. Don't worry too much if no noise limiter is fitted. Personally, I have never used one, on the theory that if the external noise is that bad then it's not worth listening! An "S" meter, too, is a much over-rated part of a communications receiver. It shows the relative levels of signals on your receiver, at your location and with your aerial and seldom bears any relationship to the same signals received elsewhere. The meter is desirable but not essential.

The average communications receiver covers about 3 to 30MHz (100 to 10m) and it will have several switched ranges which overlap to provide continuous coverage. The dedicated amateur bands enthusiast may prefer an "amateur bands only" set, although these are not so common, but the newcomer to short wave listening would be well advised to buy a general coverage receiver. Radio amateurs, by their very nature, will sometimes "modify" a receiver to improve its performance but a lot depends on how well the mod has been carried out as to whether one buys or rejects such a set. A disfigured front panel with several extra controls, generally unmarked, may mean that a lot of mods have been carried out and any resemblance between the old and new circuits will be quite accidental! Incidentally, always try and get a manual for the receiver from the seller, although manuals for the more popular sets are available from firms and individuals. Generally, the more mods in a set, the cheaper it should be! If cash is a bit short then such a set can still be a good bargain but it is not recommended if one is a complete newcomer to the hobby.

Don't rely absolutely upon the frequency calibration of the set's dial especially if the set is second-hand. It is surprising how many SWLs reckon that because a station comes in at, say, 5065kHz on the

dial then that is the frequency of the station. Not so! It could quite easily be 50 or 100kHz out; even more on the higher frequency ranges, especially if the set has been subjected to knocks or vibrations such as those encountered in a car journey. Some of the better class sets have a crystal calibrator incorporated which provides very accurate signals every 1MHz, sometimes divided down to 100kHz or even 10kHz steps. Then any dial errors can be corrected by re-alignment or simply by allowing for errors when reading the receiver dial.

The cost of a separate crystal calibrator is not excessive, alternatively one can be built up from scratch. It must, however, be considered as an essential piece of equipment that ought to be obtained at the same time as the receiver.

Having acquired a short-wave receiver it is worthwhile to look at its circuit diagram to see what you've got, how it works and what controls are fitted. The results achieved will largely depend upon how well the controls are handled. Some listeners seem to think that everything should be turned up and that the greater the output "noise", the better!

The very opposite applies, in fact, if one wants to be able to copy the real DX. Whatever we do to the original signal it is certain that we are going to spoil the signal-to-noise ratio by using amplification. Excluding the mixer stages over which we normally have no control, the three stages that introduce noise are the r.f., i.f. and audio stages. Since each stage has a different function it is imperative that each have its own gain control. Unfortunately, most controls marked "RF Gain" control r.f. and i.f. gain simultaneously! If you don't mind modifying your set fit a separate gain control, even if one is on the end of a bit of screened wire.

My old hobby-horse now rears its head again. Use **headphones!** Preferably high impedance ones connected to the output of the first or second audio stage via a capacitor of about 0·1µF. Avoid the low impedance hi-fi stereo jobs as they are far too good, reproducing all the hum and rubbish on the supply lines. Now to the controls. Short the aerial to earth and turn all gain controls to zero. Turn up the audio gain until the background hiss can just be heard, then back it off slightly. Do the same in turn to the i.f. and then the r.f. gain controls. Remove the short on the aerial and enjoy the 'hush' as signals rather that noise appear. Use the r.f. gain to control volume unless very strong signals are present when it should be backed off to reduce the risk of cross-modulation.

The Month's Reports

An appeal this month from **Jim Walker** of 12 Ansley Way, St. Ives, Hunts, Cambs PE17 5DA, who would like to hear from any readers in his area. Jim is with the USAF at Alconbury and very keen to get on the air. **Pete Cockerell** writes from Leigh-on-Sea, Essex, with a short log after noticing the paucity of logs in the March column. Good to hear from you Pete and trust that you will contribute regularly now. Pete began on the amateur bands in 1975 with a two-transistor regen on the Top band, by accident. The project was supposed to be for the medium wave band but somehow it got peaked up on the 160m band! Latest project is the 20m direct conversion set from the January *PW* with a 60ft wire, plus an a.t.u. and an F.G. Rayer 40673 r.f. amplifier.

I thought that our regular writer **Bernard Hughes** was a rather reticent character until he wrote to me with details of all his achievements as a listener. Bernard should really have been on the air a long time ago but being an essentially practical fellow doesn't seem to be able to put it all down on paper when it comes to the RAE. Let's hope that Bernard will succeed when the multiple-choice exam paper is introduced. He has 115 awards with 300 countries confirmed on 20m alone, with an all-time total of 325. At least you won't have any trouble hearing the DX when you do get your ticket OM!

The *PW* 20m set was also chosen by **Brian Smith** of Barry in Glamorgan to pull in the DX and, weather permitting, a dipole aerial is on its way up. For 80m Brian has stuck to his straight receiver. He finds the theory side of the hobby a bit difficult but intends to persevere and get the RAE in due course.

"NEWS" from the Wessex AR Group is really something now. Six pages of packed information for the 112 members of this go-ahead club. **Peter Preston,** an ex-VK9, of the *PW* staff at Poole is now a member and has been co-opted on to the committee. Usual venue, Dolphin Hotel, Holdenhurst Road, Bournemouth, at 1930 for 2000 start, Fridays.

Tom Hillier, of 23 Palace Avenue, Paignton, S. Devon, would probably take up amateur radio quite seriously if he could get hold of a manual for a rather ancient naval B40 receiver that he has acquired. If anyone can help please drop a line direct to Tom. More info on the activities of the Blackwood & District ARS (GW6GW) that meets every Friday at the Oakdale Community College, near Blackwood, Gwent, at 1930. On 14 April a film show on *'Communications in Air Traffic Control'*, followed by a 'Natter night' on the 21st and another film on April 28th on the construction and operation of the space/earth tracking station on Ascension Island, entitled *'Apollo in Ascension'*. Details from **Steve Cole** GW4BLE (not GLE as in March *PW*!) at 10 Llanthewy Road, Newport, Gwent.

A brief note on the WAB l.f. bands contest on Sunday, 7 May (phone), and Sunday, June 18th (c.w.), on 1·8, 3·5 and 7MHz from 0900 to 2100 GMT. Full rules etc. from Contest Manager G3FWX, 13 Gannet Close, Haverhill, Suffolk CB9 0TL, for an s.a.e. or one IRC. An interesting first report from **Peter Ramsey** (Stevenston, Ayrshire) who sports an FRDX400 plus an AR88 fed from four aerials ranging from dipoles to inverted Vee's. Pete does most of his listening at night to avoid the TV QRM! Glad to have a log from RTTY king **Dave Peck** BRS37621 of Cambridge. Thought you must have got your RAE or something OM! Dave enclosed a couple of feet of copy from his printer which almost induced me to take up the mode!

Log extracts

B. Smith:— 80m 3A2GX KP4CBH TF3TF VO1KG **20m** CT4YG VK6PM VK6DV **(all s.s.b.)**

P. Cockerell:— 20m EL2T OY6J TU2EZ VP2SZ VP8JE YB0ADI 3V8BZ 6W8MW **(all s.s.b.)**

P. Ramsey:—160m K2AF W9CF **80m** EP2TY ZF1MA ZS4PB 5H3KJ **40m** HI8TMR LU5OI **20m** KC4AAD KH6OR YB2SV 9N1NM **10m** W5QAW WA0BOE **(all s.s.b.)**

D. Peck:— 80m DM4JM OZ1BPU PA0GAY/SM6 **20m** EA8IY HA5KKC HV3SJ JA1DI OH6IK OD5AQ SM0ETZ VE2NL VK2SC YV5GU YB0ACB 4X4QG 9M2CR **(all RTTY)**

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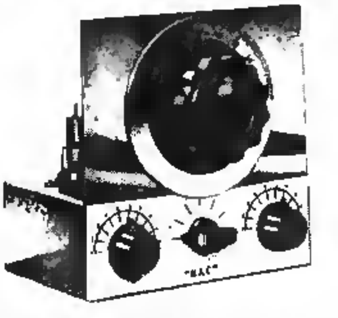

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AF115	0·20
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AF117	0·20
AF118	0·50
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AF125	0·25
AF126	0·25
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BC107	0·12
BC107B	0·12
BC108	0·12
BC108B	0·12
BC109	0·12
BC109B	0·12
BC109C	0·15
BC117	0·19*
BC119	0·25
BC125	0·15*
BC126	0·20*
BC140	0·32
BC141	0·28
BC142	0·23
BC143	0·23
BC147	0·08*
BC148	0·08*
BC149	0·08*
BC157	0·09*
BC158	0·09*
BC159	0·09*
BC160	0·32
BC161	0·38
BC168	0·09*
BC169	0·12*
BC169C	0·14*
BC182	0·11*
BC182L	0·12*
BC183	0·10*
BC183L	0·10*
BC184	0·11*
BC184L	0·12*
BC186	0·20*
BC187	0·24*
BC207B	0·12*
BC212	0·11*
BC212L	0·12*
BC213	0·12*
BC213L	0·14*
BC214	0·14*
BC214L	0·15*
BC237	0·16*
BC238	0·16*
BC300	0·34
BC301	0·32
BC302	0·40
BC303	0·48
BCY30	0·55
BCY31	0·55
BCY32	0·60
BCY33	0·55
BCY34	0·55
BCY38	0·58
BCY39	1·55
BCY40	0·75
BCY42	0·30
BCY54	1·40
BCY70	0·12
BCY71	0·18
BCY72	0·12
BD115	0·55
BD131	0·38
BD132	0·40
BD135	0·30*
BD136	0·39*
BD137	0·40*
BD138	0·48*
BD139	0·58*
BD144	2·20
BD187	0·80
BD181	0·88
BD182	0·92
BD183	0·97
BD184	1·20
BD232	0·60
BD233	0·48
BD237	0·55
BD238	0·60
BD410	0·60
BDX32	2·30
BDY10	1·50
BDY11	2·00
BDY20	0·80
BDY38	0·60
BDY60	1·70
BDY61	1·85
BDY62	1·15
BDY95	2·14
BDY96	4·30
BF179	0·30
BF180	0·30
BF181	0·30
BF182	0·30
BF183	0·30
BF184	0·20
BF185	0·20
BF194	0·10*
BF196	0·12*
BF197	0·12*
BF224J	0·18*
BF244	0·17*
BF257	0·30
BF336	0·35*
BF337	0·32*
BF338	0·45*
BFW30	1·25
BFW59	0·30
BFW60	0·38
BFX29	0·28
BFX30	0·38
BFX845	0·23
BFX8	0·25
BFX85	0·25
BFX87	0·20
BFX88	0·20
BFX89	0·90
BFY11	1·10
BFY18	0·50
BFY40	0·50
BFY41	0·60
BFY50	0·20
BFY51	0·18
BFY52	0·19
BFY53	0·25
BFY64	0·35
BFY90	0·90
BSX19	0·18
BSX20	0·18
BSX21	0·20
BSY62	0·28
BSY63	0·39
BSY64	0·33
BSY65	0·74
BSY66	0·30
BSY76	0·28
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BU105	1·80*
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OC43	0·95
OC44	0·32
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OC46	0·20
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OC71	0·35
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OC84	0·40
OC139	1·30
OC140	1·30
OC170	0·23
TIP29A	0·44*
TIP30A	0·52*
TIP41A	0·54
TIP32A	0·64
TIP41A	0·68
TIP42A	0·72
2N404	0·40
2N696	0·20
2N697	0·20
2N706	0·15
2N1131	0·15
2N1132	0·18
2N1302	0·40
2N1303	0·40
2N1304	0·45
2N1305	0·45
2N1306	0·50
2N1307	0·50
2N1308	0·60
2N1309	0·60
2N1711	0·24
2N2102	0·44
2N2217	0·30
2N2369	0·14
2N2369A	0·14
2N2483	0·20
2N2484	0·18
2N2646	0·50
2N2711	0·20
2N2712	0·15
2N2904A	0·20
2N2905	0·18
2N2905A	0·22
2N2906	0·18
2N2925	0·14*
2N2926O	0·09*
2N2926R	0·10*
2N2926Y	0·09*
2N2926G	0·10*
2N3053	0·20
2N3055	0·50
2N3137	1·10
2N3440	0·58
2N3442	1·20
2N3570	3·60
2N3702	0·10*
2N3703	0·10*
2N3704	0·10*
2N3705	0·10*
2N3706	0·10*
2N3707	0·10*
2N3708	0·09*
2N3709	0·09*
2N3710	0·10*
2N3711	0·10*
2N3715	1·70
2N3716	1·80
2N3771	1·80
2N3772	1·90
2N3773	2·10
2N3819	0·28*
2N4347	1·19
2N4348	1·20
2N4870	0·35*
2N4871	0·35*
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4011BE	0·20
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4013BE	0·50
4014BE	1·00
4015BE	0·95
4016BE	0·56
4017BE	1·06
4018BE	1·10
4019BE	0·59
4020BE	1·12
4021BE	1·03
4022BE	0·98
4023BE	0·20
4024BE	0·86
4025BE	0·20
4026BE	1·55
4027BE	0·62
4028BE	0·91
4029BE	1·10
4030BE	0·55
4041BE	0·80
4042BE	0·83
4034BE	1·90
4044BE	0·94
4046BE	1·32
4049BE	0·54
4050BE	0·54
4069BE	0·30
4070BE	0·50
4071BE	0·28
4072BE	0·26
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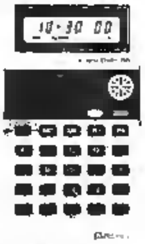

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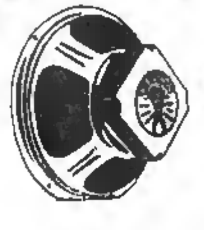

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MFC4000B	120p	ZN414	140p
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VOLTAGE REGULATORS — Fixed

1A +ve		**T0220**	**1A −ve**		**T0220**
5V	7805	115p	5V	7905	160p
6V	7806	115p	12V	7912	160p
8V	7808	115p	15V	7915	160p
12V	7812	115p	24V	7924	160p
15V	7815	115p	**Heat Sink**		
18V	7818	115p	17°/W		25p
24V	7824	115p	suitable for		T0220
0·1A +ve		**T092**	**0·1A −ve**		**T092**
5V	78L05	70p	5V	79L05	80p
6·25V	78L62	70p			
12V	78L12	70p	12V	79L12	80p
15V	78L15	70p	15V	79L15	80p
LM309K		150p	LM320-12		140p
LM323K		700p	TBA625B		120p
LM340T-5		115p	7805K		150p

VARIABLE

723	DIL	45p	LM317	T0220	325p
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2107	RAM	864p
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AC127/8	20p	BF195	11p	MPSA56	40p	2N2926RB	9p
AC176	20p	BF196	17p	MPSU05	72p	2N2926OG	11p
AC187/8	20p	BF197	18p	MPSU06	78p	2N3053	22p
AD149	80p	BF200	40p	MPSU55	90p	2N3054	65p
AD161	45p	BF244B	34p	MPSU56	98p	2N3055	65p
AD162	48p	BF256B	60p	OC28	140p	2N3442	151p
AF114/5	22p	BF257	34p	OC35/6	140p	2N3643	54p
AF116/7	22p	BF258	39p	OC71	32p	2N3644	54p
AF127	40p	BF259	43p	R2008B	225p	2N3702/3	14p
AF139	40p	BF336	32p	R2010B	225p	2N3704/5	14p
AF239	48p	BFR39	34p	TIP29A	50p	2N3706/7	14p
BC107/8	10p	BFR40/1	34p	TIP29C	62p	2N3708/9	14p
BC108/8	10p	BFR79	34p	TIP30A	60p	2N3773	320p
BC109	10p	BFR80/1	34p	TIP30C	72p	2N3819	27p
BC109C	11p	BFR88	37p	TIP31A	56p	2N3820	50p
BC147	9p	BFW10	90p	TIP31C	68p	2N3823	70p
BC148	8p	BFX29	30p	TIP32A	63p	2N3866	97p
BC157	11p	BFX30	34p	TIP32C	85p	2N3903/4	22p
BC158/9	13p	BFX84/5	30p	TIP33A	97p	2N3905/6	22p
BC169C	15p	BFX86/7	30p	TIP33C	129p	2N4058	19p
BC172	11p	BFY50	22p	TIP34A	124p	2N4060	19p
BC177	20p	BFY51	22p	TIP34C	180p	2N4123/4	22p
BC178	17p	BFY52	22p	TIP35A	243p	2N4125/6	22p
BC179	20p	BFY56	48p	TIP35C	290p	2N4401/3	34p
BC182/3	12p	BFY90	90p	TIP36A	297p	2N4427	97p
BC184	14p	BRY39	48p	TIP36C	360p	2N4871	60p
BC187	32p	BSX19/20	20p	TIP41A	70p	2N5179	75p
BC212	14p	MJE340	70p	TIP41C	84p	2N5245	40p
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BC214	16p	MJ491	216p	TIP42C	90p	2N5401	62p
BC461	40p	MJ2501	250p	TIP2955	76p	2N5457/8	40p
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BCY70	20p	MJE2955	130p	TIS43	40p	2N5460	65p
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BD124	146p	MJE3055	90p	2N698	43p	2N6107	70p
BD131/2	60p	MPF102/3	45p	2N706/8	22p	2N6027	40p
BD135/6	54p	MPF104/5	40p	2N918	43p	2N6247	200p
BD139	58p	MPSA06	37p	2N930	19p	2N6254	140p
BD140	60p			2N1131/2	25p	2N6292	70p
BDY56	225p			2N1304/5	75p	3N128	85p
BF115	24p			2N1306/7	75p	3N140	97p
BF167	25p			2N1613	22p	3N141	90p
BF170	25p			2N1711	22p	3N187	200p
BF173	27p			2N1893	32p	40360	43p
BF178	30p			2N2102	60p	40361/2	43p
BF179	35p			2N2160	120p	40409/10	75p
BF180/1	35p			2N2218A	25p	40411	325p
BF184/5	24p			2N2219	22p	40594	100p
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				2N2369	15p	40635	60p
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The CHROMA-CHIME is exclusively designed by

CHROMATRONICS River Way, Harlow, Essex.

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PW 5 78

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