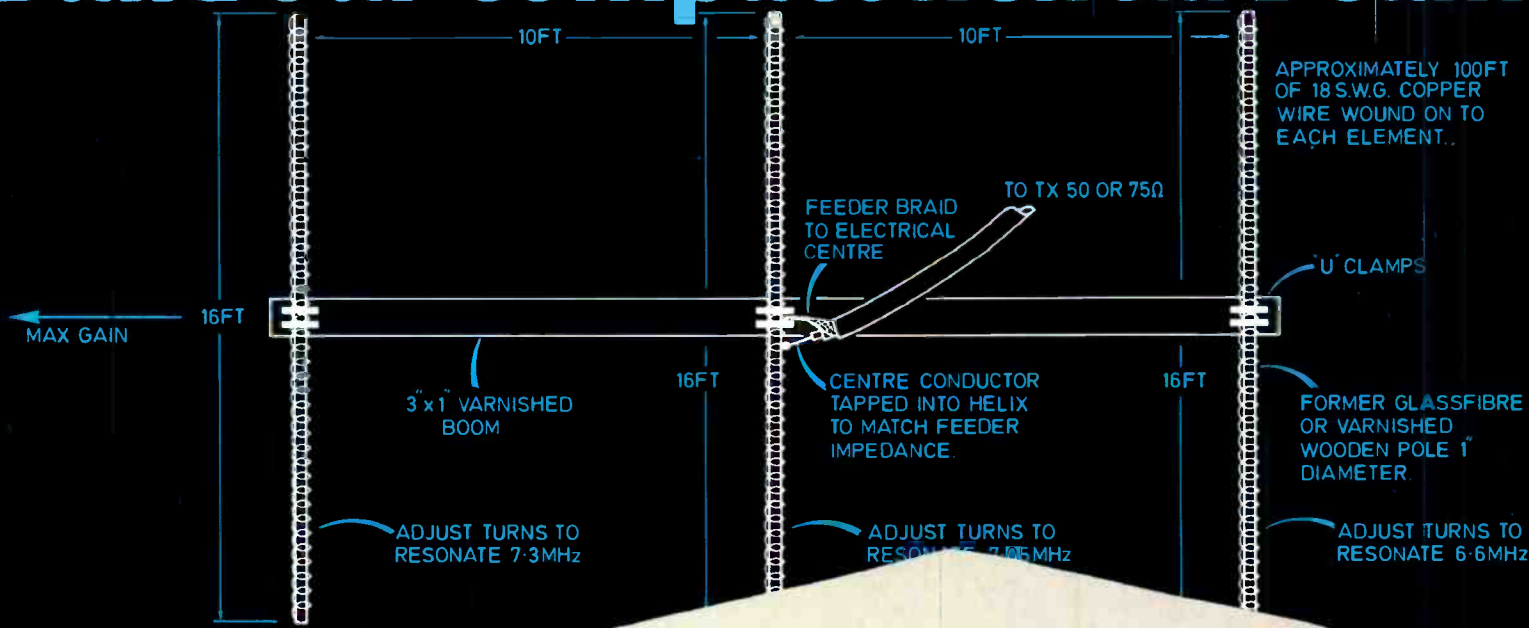


RADIO

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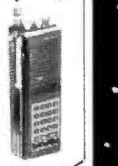
From the remarkable man in the north a pair of real SHOW STOPPERS... the SRB2 Auto Blanker for the nasty woodpecker... and it really works... the SRB2 locks on to the woodpecker as it appears and GETS RID OF IT just as fast. QRM GONE... QSO ON. The Automatic Notch Filter is really IMPRESSIVE... if you spend any time on the LF portion of 80mts you need to be a brave man to last the evening... with the ANF you'll lose a lot of sleep but your COUNTRIES SCORE WILL SOAR... You are sure to get one sometime why not now... Call 01-422 9585.

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Stop Press! Yaesu Lads on Nightshift!

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HAM RADIO TODAY

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VOLUME TWO NO.2 FEBRUARY 1984

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LETTERS

KW 2000 UPDATE

Sir, I was surprised to say the least, to see a 6577.5 kHz crystal recommended for conversion of the 30m band (10.1 MHz). My own 2000 has been in use on 10.1 since Jan 1, 1982, when the band first became available.

It is *certain* that the use of such a crystal, doubling, will give you disappointing results on that allocation. The fundamental frequency beats with the 9.5 to 9.9 MHz (31m) BC band and strong responses will appear in the 1st IF. Some of the broadcast stations put in 5 mV signals at least and whilst the majority, and perhaps stronger, will convert to fall between 3155 and 3055 kHz (10 to 10.1 MHz on the dial) they will none the less be a IM problem at the second mixer.

It should be noted that the BC signals are only 260 to 360 kHz LF of the 10.1 allocation. At 3% off resonance, the RF circuit response, even with a Q of 50, is only 8 dB down (16dB total for two circuits). The two KW2000 circuits cannot possibly cope with this situation.

After carrying out modifications using other 'off the air' signals for alignment, some modifiers might be quite shocked and assume, probably wrongly, that their wiring and procedures had been faulty.

With this particular IF, the area around 10 MHz is the very region of spectrum where the fundamental XTAL (13,155) should be used. The nearest unwanted beat is then around 16,200 kHz, which is 6MHz removed. A 3rd overtone is not possible with the design as it stands (3x4385).

Even on 14 MHz, the 2000 would benefit from the use of 17MHz fundamentals. In unfavourable conditions, the response from 11.7 MHz (approx) can be quite objectionable when using 8500x2 crystals, a 'general purpose' antenna and tuning unit. Using beam antennas of course this effect will be less noticeable.

The trouble with this oscillator circuit is that fundamental crystals in the higher range particularly, say above 15 MHz, tend to stop oscillating when the plate circuit is tuned to exact resonance, necessitating some slight detuning. However, this effect may not occur and, in any case, this detuned condition will be better than that described using the doubler. Also, I suggest that the fundamental arrangement will result in a purer spectrum for injection into the mixer.

Suppose you wanted a frequency of 9465 to be converted to 3155 kHz and chose the use crystal 6310 kHz x 2? In which case: $12620 - 9465 = 3155$

& (unsuppressed): $9465 - 6130 = 3150$ also!

This result would sound very odd indeed, but, given stability etc, might well serve to produce DSB from SSB (Hic!).

But seriously, this is not far away in frequency from 10 MHz in the band, nor from 6577.5 ref the crystal.

My example could be described as the 'Mixing Syndrome' for this particular receiver IF. Other arrangements will have their own. It would remain a hazard irrespective of the type of mixer used and could only become acceptable given a *very intensive* degree of selective tuning and filtering between the oscillator and the mixer.

John S Charles, G3KVG

PS. My general purpose antenna, eg consisting of 40m dipole with tuned centre-feed from ATU.

Malcolm Healey, G3TNO, replies:

1. We recommend the 6.5775 MHz crystal for use on 10 MHz because that is what Mr. Ray Charles and myself have used with *NONE* of the problems mentioned by G3KVG.

2. The use of a higher frequency crystals in this circuit, where the crystal and the anode circuit are at the same frequency will most definitely have undesirable side effects, namely as the anode circuit is tuned either side of the correct frequency, the oscillator will tend to stop and generally behave in an erratic manner; also, a certain amount of 'pulling' of the oscillator frequency will occur. The amount of 'pulling' will depend on the frequency concerned and will always be greater at higher frequencies.

3. Although dismissed very lightly by G3KVG, the anode circuit of the stage being tuned to a frequency of 2 or 3 times the amount of rejection of the 6.5775 MHz signal at the mixers.

4. The effects of pulling, as in 2, above, will also be affected by the loading of the oscillator by the *transmit* mixer. This loading will change with the drive applied to the mixer, ie SSB or CW. This changing loading will cause the conversion oscillator to be pulled around to an amount that will depend upon the drive level being applied to the mixer.

This will give pronounced chirp on CW and FM superimposed on SSB. I have, in fact, tried the higher frequency crystal recommended by G3KVG, and monitoring the outgoing CW signal using it, the note could only be described as T8C. The note normally with the modified KW2000 is T9X. De-tuning the anode circuit of the oscillator does

improve the note, *but* at the expense of Tx drive and linearity, so is *NOT* to be recommended.

Now to the heart of the comments by G3KVG regarding spurious responses on receive by virtue of the fundamental frequency from the oscillator beating with broadcast station in the 9.7 MHz band, also producing signals in the receiver. The truth is that they don't! I have used my version of the KW2000 with the 6.5775 MHz crystal on 10MHz and I can find *NO* evidence of this problem, using a variety of aerial systems ranging from a simple 10MHz ground plane to a 100 metres and end-fed aerial at 50 feet — always, of course, using an ATU.

Also, if comments from G3KVG were to hold *any* water, the Tx would, of course, produce an out-of-band signal. I have checked this using the station Racal RA17 Rx, transmitting on my normal 10MHz aerial, with the 100 metres end-fed connected to the Racal Rx. There is not a trace of *any* spurious in-band or out-of-band signals in the tuning range from 8MHz to 12MHz. I can't think of a more severe test as both Tx and Rx are next to each other.

I would ask G3KVG *how* changing the fundamental crystal in the oscillator stage can reduce the out-of-band IMD problems from the much-worried about (by G3KVG) broadcast signals he mentions. *Regardless* of LO frequency used, those signals will *still* be present at the input to the receiver and indeed probably up to the input of the first Rx mixer input, and will cause the same IMD problems. Changing LO crystal *WON'T* make them go away (or has someone re-written the theory books while we weren't looking?).

To G3KVG — I honestly think that you *must* have something wrong with your KW2000 if you get problems with it on 14 MHz and above, with, as you quote, problems from signals at 11.7 MHz when operating on 14 MHz! I have used my KW2000 on 14 MHz using a largish (500 feet per leg) vee-beam via a decent ATU with no such problems. There *MUST* be something very wrong with yours!

Malcolm Healey, G3TNO

Sir, my husband and I are enjoying the series 'Upgrading the KW2000 series of HF transceivers' and are keen to have to go at adding the new bands to our own '2000B' — as described in Part 6 of the series.

Therefore, could you or the authors advise me of a supply of the coil formers,

ferrite and iron dust cores for the new coils, please?

Rae Forth, G4JMT

Malcolm Healey, G3TNO, replies. The coil formers that we used in fact came originally from TV tuners; the former and slug being the IF output coil. These were obtained from an emporium in Tottenham Court Road. (Scrap UHF (and VHF/UHF) television sets are an excellent source of these components — Ed.)

Sir, in connection with the design of the antenna tuning unit for two metres described in the December edition of Ham Radio Today, can you please explain:

1. The purpose of sockets SK3 and SK4?

2. Why a simple length of coaxial cable connected in series in the signal path is described as a transformer?

3. Baluns?

Despite wide questioning and reading I have yet to find anyone, fellow amateur, lecturer, shop proprietor or author, who understands what a balun is or does and can explain it to me. Perhaps you can.

G.R. Gilbertson

If you wish to use the ATU with a balanced twin wire feed (100-200 ohms) then this must be fed in at SK3 and SK4. The ATU will match single wire antennas of 100-300 ohms impedance if they are fed in at SK3. Low impedance coaxial-fed antennas should be fed in at SK2. The 'simple length of coaxial cable' acts as a balanced step-down transformer when fed with a high impedance balanced feed at SK3 and SK4.

As far as I am concerned a 'balun' is any device that converts an unbalanced, or coaxial feed, to a balanced feed. When one wire of an aerial feeder is at earth potential (i.e. the braid of the coaxial cable) and the other (i.e. the inner of the coaxial cable) is at a potential above earth this may be termed an unbalanced feed. When both feeder wires are at an equal potential above earth this is termed a balanced feed. Unbalanced feeders are noisy, radiate, spoil the radiation pattern of your antenna and can lead to RFI. Balanced feed antennas should, if properly installed, be free of the above problems.

SAVE OUR CALLSIGNS!

It was recently announced that "all existing G5 + 3 letter callsigns will be phased out by the end of the year".

The majority of radio amateurs probably won't have paid much attention to this — "Oh yes, of course, they're going to let foreign visitors use their own callsigns — a much better idea, really". Few people seem to realise that this does not just affect a small handful of foreign holidaymakers, but about 600 (six hundred) foreign nationals permanently resident in Britain, some of whom have lived here and held their callsigns for a decade or more, and all of whom have

ordinary British amateur radio licenses which they renew on an annual basis just like everyone else.

Like most people, we are very attached to our callsigns — and not only that; losing them will also mean

— Piles of QSL cards will go to waste, and a fortune spent on having new ones printed

— We will have to start from scratch on many awards which have to be worked under one callsign

— Worst of all: WE WILL LOSE OUR IDENTITY both on the air and in amateur radio circles off-air.

I was told that the reason we have to give up our callsigns is that the Radio Regulatory Department has introduced a simplified way of listing licences to foreign tourists — which in itself is certainly not a bad thing. However, why this new regulation should affect us, people who have lived here and held British amateur radio licences for many years, I simply do not understand. TO ME, IT JUST LOOKS LIKE AN ACT OF BUREAUCRACY AND DISCRIMINATION AGAINST FOREIGN-BORN UK RADIO AMATEURS.

There does not appear to be any *plausible* reason why they should want to rob us of our callsigns. Do they want to re-issue them when the G1 and G0 series have run out? It's possible, but not very likely — after all, they *did* say, not long ago, that existing callsigns would not be re-issued (and just imagine the confusion it would cause if they did re-issue our callsigns, especially seeing that QSLs often arrive years after the actual contact).

However, if they do want to re-issue existing callsigns after all — WHY OURS? Of course they could 'nt really revoke all the G3, 4, 6 and 8 licences — there are just too many of them — but how about G2 + 3 letters . . . ? They are just as much of an 'anomaly' as our callsigns, but I am sure no one would dream of revoking them unless all other licences were revoked at the same time.

With the exception of the old TV licences (G6 + 3 letters), no one has ever lost their callsigns in this country — and I understand that those who had TV licences had their TV callsigns as secondary callsigns, so they only lost one of two calls. (Yes, OK, so you get a new callsign when you pass your morse test — but that is an entirely voluntary thing — also, you don't lose your old one, as you can always take it out again).

It will cost RRD hundreds of pounds in administrative costs to revoke all 600-odd G5 licences and issue an extra 600-odd G4, G0s, G1s. To me, this seems like an utter waste of money, especially in view of the recent 50% increase in our licence fees.

If all radio amateurs in this country were to be given new callsigns, then, obviously, I wouldn't mind losing mine. But it seems extremely unfair that a small group of radio amateurs should be signed out and discriminated against in this way. Angelika Voss G5CCI

G5 licences are currently in the process

of getting together to organise a 'save our callsigns' campaign. Unfortunately, they have been unable to get in touch with all the G5s, as the RSGB Callbook does not seem very accurate in this respect, possibly because many G5s are very mobile. G5s who have not yet received a letter about the campaign should write to the following address: 'Pannonia', Oxford Road, Manningtree, Essex Co11 1BN.

SILVER 70 REVIEW

Sir, I feel I must write in answer to some of Trevor Butler's remarks in his review of the 'Silver 70' antenna. After 9 months use and exposure to weather at 30 feet agl I have had no need of any maintenance of either the driven element or reflectors. As for birds perching on the elements and causing them to slip I have noted on several occasions upwards of 20 birds perched on my antenna. None have perched on the elements but they have at times completely filled the boom, with no ill effects.

I fail to see how a bird will or can perch on a 1/8 inch diameter element and even if it did, dislodge the clip.

Thanks for an interesting magazine, well worth the cover price each month and keep up the interesting reviews and constructional articles.

M. Howden, G6JKP

After a discussion with Trevor, we are of the conclusion that the birds in your area must have different roosting habits to his. Birds frequently and indiscriminately perch on his elements and on occasions have been completely successful in their efforts to unseat them. Trevor's 'Silver 70', as it happens is presently on the ground undergoing maintenance for 'weathering'. Trevor lives close to both Gatwick Airport and a brickworks; perhaps the corrosion is due to a mixture of aeroplane fuel and brick fumes? Come to think of it, he looks rather poorly these days. . . .

G5SO?

Sir, I read with interest the article 'Radio In India before World War 2' by George Metcalf, G6VS, in the December Issue of your Magazine.

I was particularly interested to see among the QSL cards one labelled G5SO whom I knew before the War. He was a member of the Blackpool and Fylde Shortwave Club. Unfortunately I have forgotten his name but I have often wondered what happened to him and I wondered if any of your readers knew him and could enlighten me.

Finally, may I say how much I enjoy reading your Magazine, keep up the good work.

DR MB Carson

Please address correspondence to:
Ham Radio Today,
1, Golden Square,
LONDON W1R 3AB

RADIO TODAY



Strike Up A Conversation With Sweden

The town of Jonkoping was founded in 1284, and as part of their 700th anniversary celebrations, the citizens of the town, and in particular, the town's radio club (SK7AX) is organising an award, which is called 'The Match Town Award' due to Jonkoping having been the place where the first ever match factory was built.

The principle is very simple — all you have to do is to make contact with a certain number of stations in the area. For each station you work in the Jonkoping county (= F6), you get one point; you get two points should you work the town's radio

club (SK7AX); however, how many points you need depends on where you are. SM stations, if we have any readers up there, require four points, European stations require three points, and DX stations require just two points.

You have the whole of 1984 to make contacts in, and when you've managed to get the points you need, all you have to do is to send a copy of your log with the information on the contacts — QSL cards are not necessary.

Send this to: Award Manager, SVARK, PO Box 2035, S-561 02 Huskvarna, SWEDEN, and you should receive a multi-coloured diploma and a silk streamer. So next time you hear an SM7 calling 'CQ', get in there, he or she could be from Jonkoping!

New Monolithic Microwave ICs

New cascaded silicon integrated circuits, which have an input and output impedance of 50 ohms, are now available from NEC Electronics (UK) Limited. The MM765 operates at 10V and can be supplied in 8-pin or TO-33 packages, whilst the MM 766 operates at 5V and is available in DISK-Mold, 8-pin MINI, 8-pin DIP and TO-72 packages.

Both series achieve a constant gain of 16 dB between 0 Hz and 1.2 GHz and built-in temperature compensation ensures stable bias within the working temperature range.

Both the MM 765 and 766 microwave IC's are suitable for use in a wide range of industrial applications, as well as in IF amplifiers, CATV and TVRO. NEC Electronics (UK) Limited, 116 Stevenson Street, New Stevenson, Motherwell ML1

Callsign Bandit

The callsign G6IBA belongs to the Crawley Court Amateur Radio Group, who operate from the home of the Independent Broadcasting Authority at Winchester. However, the same call-sign has apparently been heard being used in the Birmingham area.

Scopex Go Bust

We regret to say that the company Scopex, who made a number of oscilloscopes including what was possibly the first high-frequency LCD scope, the Voyager, have gone into receivership.

A new company will undertake repairs of Scopex instruments, and they offer free estimates on repairs. The company is called Mendascope Ltd, and it may be found at Otter House, Weston Underwood, Olney, Bucks, telephone Bedford (0234) 712445.

New Communications Receiver

We have received a press release from Cravenminister Limited, who have the trade mark Uniace, about their new Uniden CR 2021 communications receiver. Receiving a press release about a new product which is written up in glowing terms is not an unusual event around here, but the purple praise in this particular missive will take some beating. For example: "The CRC 2021 — a pathfinder for the new generation of compact, technologically advanced, highly portable RXs . . .".

Anyway, the main drift is that it is small (32 by 1557 by 65mm), has good sensitivity (claimed better than 0.4uV for 10dB S/N on SSB), and offers AM/SSB/CW coverage from 150kHz to 30MHz and FM VHF from 76 to 108MHz. Inevitably, it is microprocessor controlled.

The Rx costs £199.95 and is available from Uniace Telecommunications, Unit 8, Industrial Estate, Glan Conwy Corner, Llandudno Junction, Gwynedd, North Wales, telephone 0492-61 3232. Unfortunately, they neglected to send us a photograph of the beastie, so we can't show you how pretty (or otherwise) it is!



Richard Whitemore, well known BBC newscaster, opening the new Ambit Sales counter.

Ambit Moves

Things have been confusing over at Ambit International for some time, at least for us outsiders. First of all, they owned one of our rival publications (not that there are any real rivals to Ham Radio Today!) but they tended to get rather cross when you linked the two names together (they were, technically, separate companies). Next we get a letter from Ambit saying that they've sold off the mag to another publisher (Sovereign International), just when we'd all learnt not to say they had anything to do with one another (if that was the case, how could they sell it off anyway?).

Finally, we find that Ambit themselves have been bought up by Bulgin. Now, what the press release doesn't answer is, who owns Bulgin?

Anyway, Ambit are still operating as ever, and that means a continued expansion of the range of products they offer. In

particular, they tell us that they have extended their range of Toko standard helical filters to include coverage of the 800 to 1000 MHz band, and to provide lower profile versions of the 7H-W types, widely used in personal communications equipment.

Ambit also tell us that they have opened a new sales counter in Broxlea Building, Park Lane, Broxbourne, Hertfordshire. Ambit's main office is at 200, North Service Road, Brentwood, Essex CM14 4SG, telephone 0277-231616.

Oscar 10 Goes Well

The RSGB say that all appears to be well aboard the satellite Oscar 10, but there are problems with amateurs who do not observe the bandplans. The spectrum segment 145.8 to 146 MHz has been set aside for satellite working; however, many amateurs are still using this section for simplex FM contacts, including one net in west London that uses 145.975 MHz

'despite polite requests to change frequency'.

News bulletins are taking place via Oscar 10, under the callsign GB2RS. It is intended to make these transmissions a regular service, with two transmissions each Sunday. At the time of going to press, we were unable to discover details of times, but it seems that they will take place on 145.973 MHz. The RSGB would like reports on their transmissions (if they'd say when they were . . .).

Don't Set Fire To Your CB

Following reports in the press and on radio about the use of high-powered amplifiers ('burners') to disrupt the operation of petrol pumps at filling stations, Mr Alex Fletcher, Minister for corporate and consumer affairs in the Department of Trade and Industry, issued the following warning:

"All use of radio transmitters in petrol stations is potentially hazardous. The Code of Practice for Citizen's Band radio (available free at Post Offices) specifically draws attention to this. The use of high power transmitters such as a CB set coupled to an illegal 'burner' adds considerably to the risk of causing an electric spark close to the filling nozzle. An explosion could occur in some circumstances.

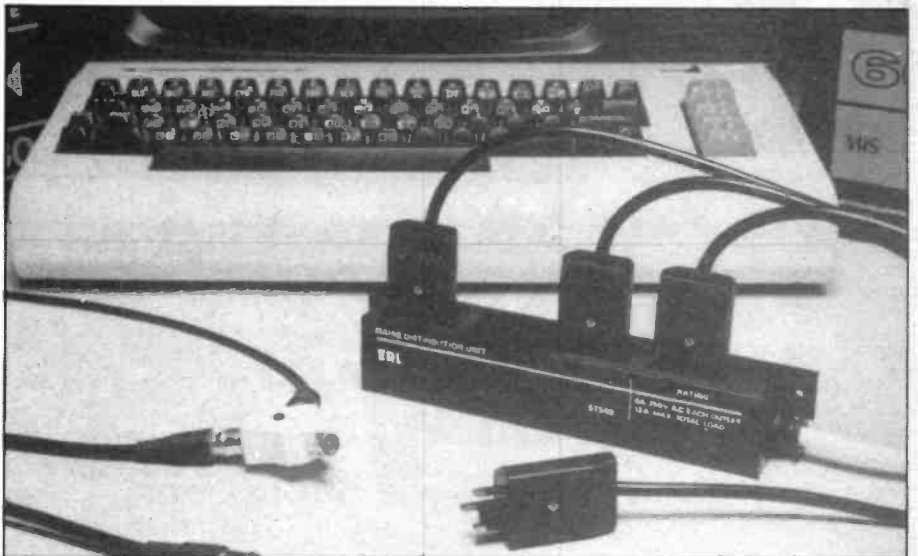
"The public are warned always to switch off transmitting equipment when entering a filling station forecourt and never to use CB 'burners' in a vehicle which is being filled with petrol.

"The use of a CB set with a 'burner' is in any case illegal because of the interference it causes to domestic radio and TV reception and to the emergency services; offenders may be imprisoned for up to three months and fined up to £1,000. The sale and possession of burners may be made illegal following the passage of the Telecommunications Bill at present before Parliament."

Don't say we didn't warn you.

A HRT First?

At the recent Breadboard electronics exhibition, Ham Radio Today ran a special event station, and we'll be giving further details of this in a forthcoming article in the next issue (giving ourselves a chance to recover first!). However, in the space of the three day conference, we made 200 contacts on VHF and HF. So far as we know, we are the first UK amateur radio magazine to run a special event station.



This new multiplug mains unit from ERL keeps the shack tidy

ZX Spectrum RTTY

Scarab Systems of 39, Stafford Street, Gillingham Kent, have recently introduced a new version of the SP-RTTY program written for the Sinclair Spectrum (48K version). The program features a type-head buffer, split screen operation (so that you can compile answers while still in the receive mode), seven memories with up to 255 characters each, and more. You can buy it either as a cassette tape with a bare PCB for the electronics, which costs £17.50, or as a cassette plus PCB and components for £29.10, or as a ready-assembled board with cassette for £37.50.

If you've already built the earlier version of the same system, you can get an update program for £7.50. Scarab also do a morse tutor program and a QTH locator program pack. They can be reached at the address above, or on 0634-570441.

STOP PRESS!

Trevor Butler, G6LPZ, reports that Dr Owen Garriot has been quite active on 2m FM from the space shuttle, Columbia, with his Motorola hand-held transceiver. However, as far as UK amateurs are concerned, it seems that making contact has proved somewhat difficult!

The first report of reception comes from a station in Jersey who heard W5LFL's signals on the morning of Friday 2nd December from his mobile set-up whilst travelling across the island. A desperate attempt to get home to his base station ensued - radio contact being possible for only a period of 6/7 minutes - but despite some nifty driving, his efforts were in vain.

On the morning of Sunday 4th December, Dr Garriot was scheduled to be on-air and it was expected that there would be a good signal in the UK, particularly in the South East, one of the passes being directly over Croydon. Unfortunately, in the event both passes occurred during one of W5LFL's sleep periods.

Many people have been replying to Dr Garriot's transmissions on his transmit frequency and causing severe interference. In an effort to cut down on the immense QRM generated by the interest in the shuttle, Angus McKenzie, G3OSS, erected a halo antenna 3m above his lawn. With this antenna, he was able to copy Dr Garriot's transmissions on the 4th at 1523 UTC for some 15 seconds and pass a recording over to BBC news.

G HAM 'Breadboard '83'
 AN ARGUS SPECIALIST PUBLICATION
 Cunard Hotel, Hammersmith
 LONDON W6

GB4 RADIO TODAY

73 Steve Ireland G3ZZD
 Dave Goodwin G4NXV
 Trevor Butler G6LPZ

| TO RADIO | DATE | GMT | MODE | MHz | RST |
|----------|----------|------|------|-------|-----|
| G8CHQ | 26/11/83 | 1530 | FM | 145.5 | 59+ |

Western

THANK YOU GENTLEMEN!

ALL SOLD ON ONE DAY RECENTLY!
 TS-530S KENWOOD TO MR. S. OF FIFE
 TS-530S KENWOOD TO MR. S. OF LIVERPOOL
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 R-2000 KENWOOD TO MR. W. OF GRIMSBY

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Since we first introduced the "Yaesu Musen" brand name to the UK market in 1970 and more recently the "Kenwood" name for Amateur Radio equipment, you can buy with confidence where experience counts. We maintain links with the factories for spares though we maintain stocks also. We also have extensively equipped service facilities with extensive (and expensive!) test equipment. It's gratifying to hear that more and more discerning prospective customers object to the "knocking and false rumours" put around by our competitors. Remember, Kenwood is THE brand name throughout the world. It's only for UK that Trios used. At 'WESTERN' we are not part of any illegal pricing ring and we are pleased to supply KENWOOD brand equipment known and recognised throughout the world.

"W.E." will not be under-cut! Prices forced down by "W.E." from the KENWOOD STABLE FOR . . . the discerning DX-OPERATOR . . . or . . . DX-SWL NOW ONLY £1099 for the TS-930s, . . . and . . . £279 for R-1000



Since, at 'WESTERN', we sell both Yaesu and Kenwood, we do not try to push a prospective purchaser into a particular brand of equipment... we have no "axe to grind" one way or the other. Our M.D. (He's spoilt! He just takes home what he fancies for a trial evaluation!) thought he'd try the top of ranges FT-1 and TS-930S. He promptly brought the FT-1 back to the stock room. Then he took the TS-930S up together but brought the FT-102 back. Said he'd got too old and lazy to bother with controls like PA Tune, PA Load, Pre-selection tuning, when the TS-930S does the same job with less knobs! The "Noise Blanker" really cuts old "Woody Woodpecker" down to size! UA's will have to find something new to annoy a TS-930S owner.

How often have you found a rare DX-station only to discover he has a good pile-up too! With the '930' you just press "M In" and store his frequency in the memory and carry on tuning round or QSO elsewhere. Then to come back smack onto the rare DX you just select 'Memory' instead of the VFO, and up pops your DX station. Since there are 8 memory channels there are more than enough for anyone!

The R-1000 is an un-cluttered simple to use and excellent general coverage receiver. It brings the world to your fingertips in seconds. With its PLL synthesised receiver you get excellent stability and accuracy.

Features are:-

- ★ Covers 200kHz to 300MHz continuously
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- ★ Terminal for external tape recorder

- ★ Built-in 12 hr. quartz digital clock with auto-timer facility to switch 'On' at pre-determined time
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- ★ Built-in 4" speaker
- ★ Built-in attenuator to prevent overloading
- ★ Digital readout to 1kHz and analogue dial

Special Bargain of the Month. Yaesu FT-980 £999 only. Special Guarantee

| KENWOOD PRICE LIST | | |
|--------------------|---|------------------------|
| Item | Description | Price £ Inc VAT+Carrr. |
| ST-1 | Base stand/charger for TR-2400 | 43 |
| KB-1 | Delux knob for TS-530/B30 series | 10.50 |
| PS-20 | DC PSU FOR TR-9000 | 49 |
| PBK-24K | Spare battery pack for TR-2400 | 16 |
| MC-30S | Hand microphone, 500 ohm | 13 |
| MC-50 | Desk microphone, 500 ohm/50k | 30 |
| MC-60 | Desk scanning microphone, dual impedance | 50 |
| MB-100 | Mobile mount for TS-130S | 18 |
| SP-100 | Speaker for R-1000 | 26 |
| TS-130S | HF Transceiver | 525 |
| DFC-230 | Digital remote frequency controller | 130 |
| TS-430S | HF transceiver with gen. cov. receiver | 705 |
| R-600 | Receiver | 240 |
| SP-930 | External speaker | 25 |
| TS-930S/ATU | HF transceiver with gen. cov. receiver & ATU | 1163 |
| TS-930S | HF transceiver with gen. cov. receiver | 1099 |
| R-1000 | General coverage receiver, digital | 279 |
| DCK-1 | DC operating kit for R-1000 | 8.26 |
| R-2000 | New general coverage receiver | 379 |
| TR-2400 | 2m FM hand portable transceiver | 195 |
| TR-9130 | 2m Multimode transceiver, 25W | 399 |
| TR-9500 | 70cm FM/SSB/CW mobile transceiver | 425 |
| TR-8400 | 70cm FM mobile transceiver, synthesised | 279 |
| DS-2 | DC converter for TS-830S | 42 |
| SP-430 | Speaker for TS-430S | 30.50 |
| AT-130 | Aerial tuning unit, 100W | 91 |
| MB-430 | Mobile mounting bracket for TS-430S | 12.50 |
| AT-230 | Aerial tuning unit, all band, matches TS-830S | 135 |
| TS-530S | HF Transceiver 160-10m with new bands | 560 |
| SP-230 | External speaker unit | 41.50 |
| FM-430 | FM option unit for TS-430S | 33.75 |
| TR-2500 | 2m FM handheld transceiver, synthesised | 227 |
| YG-455C-1 | 500Hz CW filter | 74.50 |
| YG-455CN | 250Hz CW filter | 75 |
| SMC-25 | Speaker/microphone for TR-2500 | 16 |
| PS-430 | Mains PSU for TS-430S (cooling fan built in) | 113 |
| YK-88CN | 270Hz CW filter | 36 |
| PB-25 | Spare Nicad battery pack for TR-2500 | 24.75 |
| SI-2 | Base stand and quick charger for TR-2500 | 52 |
| SC-4 | Soft case and belt hook | 13.50 |
| RA- | Antenna | 7.50 |
| MC-42S | Up/Down Mic. | 15 |
| TL-922 | 2KW HF Linear Amplifier | 719 |
| AT-930 | Auto ATU for TS-930S | 130 |

| YAESU PRICE LIST | | |
|------------------|---|------------------------|
| Item | Description | Price Inc VAT & Carrr. |
| SM-220 | Station Monitor Scope | 208 |
| PC-1A | Phone Patch | 48 |
| HC-10 | Digital World Clock | 64 |
| FT-102 | HF Transceiver | 670 |
| FC-102 | ATU for FT-102 | 195 |
| SP-102 | Speaker for FT-102 | 45 |
| FV-102DM | VFO Scanner for FT-102 | 225 |
| FAS-1-4R | Antenna Switch for FT-102 | 37 |
| FT-101Z | Transceiver | 499 |
| FT-101ZD | Transceiver, digital | 569 |
| FT-101Z/AM | FT-101Z plus AM unit | 515 |
| FT-101ZD/AM | FT-101ZD plus AM unit | 589 |
| FT-101Z/FM | FT-101Z plus FM unit | 530 |
| FT-101ZD/FM | FT-101ZD plus FM unit | 599 |
| FT-77 | Compact Transceiver (with FM unit + C24) | 430 |
| Marker Unit | for FT-77 | 8.50 |
| FP-700 | PSU for FT-77 | 105 |
| FC-700 | ATU for FT-77/707 | 80 |
| FV-707DM | Scanning VFO for FT-77/707 | 160 |
| SP-980 | Speaker for FT-980 | 50 |
| FL-2100Z | HF 1200W Linear | 460 |
| FRG-7700 | General Coverage Receiver | 319 |
| FRG-7700M | General Coverage Receiver with Memory | 379 |
| FRT-7700 | Antenna Tuner for FRG-7700 | 38 |
| FRA-7700 | Active Antenna for FRG-7700 | 36 |
| FRV-7700D | Converter 118/130, 140/150, 70/80MHz | 75 |
| FV-101 | Remote VFO for FT-101Z series | 109 |
| FT-1 | Transceiver 150kHz - 30MHz | 1350 |
| Fan B | Fan for FT-101Z series | 13 |
| DC Unit | 12V PSU for FT-101Z series | 44 |
| FT-757GX | HF All Mode Transceiver | 599 |
| FP-757GX | AC PSU for FT-757 | 129 |
| Accessories | | |
| QTR-24D | 24 hour quartz clock | 29 |
| YM-35 | Hand scanning mc. for FT-1/102/707 series | 14.35 |
| YM-36 | Noise cancelling mic, 4-pin, 50K | 13.95 |
| YH-25 | Lightweight headphones | 9.50 |
| E7-L | Remote cable for FT-720 | 14.50 |
| S72 | Switching box for FT-720 | 37 |
| YD-148 | Desk mic, 50K/500 ohms, 4 pin for FT-101 series | 21 |
| YM-49 | Speaker/mic for FT-290/230R | 15.85 |
| YM-38 | Desk scanning mc. for FT-1/102/707 series | 25.50 |

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RADIO Tomorrow

| | | | |
|---------|---|--------|--|
| 2nd Jan | Stourbridge ARS: informal | | |
| 3rd Jan | South Bristol ARC: <i>Early Radio by G2BAR</i> | 2 Feb | East Kent RS: Junk Sale |
| 4th Jan | Fareham RC: <i>Preamplifiers by G6BBS</i> | 3 Feb | Cambridge DARC: informal |
| | Three Counties ARC: Talk by the RSGB | 5 Feb | HAM FEAST! at the Mosses Centre, Cecil Street, Bury. Doors open 11 am. Bring and Buy. Food and drink available. Talk-in on S22. |
| 9th Jan | Exeter ARS: <i>HM Coastguard</i> | | |
| 10 Jan | Burt RS: <i>Fault Finding by G3RSM</i> | 6 Feb | Stourbridge ARS: informal |
| | South Bristol ARC: Demonstration of CW Operating | | Leighton Linslade RC: ring PRO for details |
| 11 Jan | Lincoln SWC: <i>Aurora by G2FKZ</i> | 8 Feb | Lincoln SWC: <i>Astrophotography by G4GZA</i> |
| | Fareham RC: natter night | | Fareham RC: natter night |
| | Nene Valley RC: natter night | 9 Feb | Edgeware DARC: ring PRO for details |
| 12 Jan | Colchester RA: <i>Deep Sea Diving</i> | | Colchester RA: Design and Production of PCBs |
| 13 Jan | Cambridge DARC: <i>Getting Going on 10 GHz by G8OFA</i> | 10 Feb | Cambridge DARC: <i>In Your Shack (Talk)</i> |
| | West Kent ARS: <i>DXpeditions to Andora by G4BIA</i> | 15 Feb | Lincoln SW: CW/RAE Class |
| 16 Jan | Stourbridge ARS: Annual Constructors Contest | | Fareham RC: <i>Did Morse get it right? by G3CCB</i> |
| | Leighton Linslade RC: ring PRO for details | | Three Counties ARC: Film Show from Shell |
| 17 Jan | West Kent ARS: informal | 16 Feb | East Kent RS: natter night |
| 18 Jan | Lincoln SWC: CW/RAE Class | 17 Feb | Cambridge DARC: informal |
| | Fareham RC: <i>Power Distribution by G8GNB</i> | 20 Feb | Lincoln SWC: activity night |
| | Three Counties ARC: Wine making | | Fareham RC: natter night |
| | Nene RC: RAF Communications | 23 Feb | Edgeware DARC: discussion on Contests |
| 20 Jan | Cambridge DARC: informal | | Colchester RA: <i>Making the Micro Work by Robbin Cobbold</i> |
| | Edgeware DARC: informal | 28 Feb | Dudley ARC: <i>TV outside Broadcasting by Joe Jacobs</i> |
| 24 Jan | Dudley ARC: <i>Running a Successful Cinema</i> | | |
| | South Bristol ARC: <i>Homebrew Equipment by G4KUQ</i> | 20 Feb | Lincoln SWC: CW/RAE Class |
| | West Kent ARS: Junk Sale | | Three Counties ARC: <i>Computers and RTTY</i> |
| 25 Jan | Lincoln SWC: activity night | 1 Mar | East Kent RS: <i>QRP Working by G3ROO</i> |
| | Fareham RC: AGM | 5 Mar | Stourbridge ARS: informal |
| | Nene Valley RC: AGM | | Leighton Linslade RC: ring PRO for details |
| | Colchester RA: <i>Amateur Radio Repeater Administration by the RSGB</i> | 7 Mar | Lincoln SWC: CW/RAE Class |
| 27 Jan | Cambridge DARC: <i>Satellites by G6AZI</i> | | |
| 1 Feb | Lincoln SWC: CW/RAE Class | | |
| | Fareham RC: Construction Techniques | | |
| | Three Counties ARC: <i>Practical Wireless</i> | | |

Will Club Secretaries please note that the deadline for the March segment of *Radio Tomorrow* (covering radio activities from 3rd March — 1st April '84) is 20th January.

Contacts

| | | |
|------------------------|------------------|---------------------|
| Abergavenny ARC | D. Ffestin Jones | 0495-79617 |
| Biggin Hill ARS | Ian Mitchell | 0959-75785 |
| Braintree DARC | Pat Penny | 0376-26487 |
| Bury RS | Brian Tydelsdale | Bury 25454 |
| Cambridge Repeater Grp | Chris Lorek | 0354-740672 |
| Cheshunt DARC | Roger Frisby | 0992-464795 |
| Colchester RA | G3FIJ | 0206-851189 |
| Dudley ARC | Mrs. C. Wilding | Codsall 5636 |
| Edgeware DARC | Roger Williams | 0792-404422 |
| Exeter ARS | Roger Tipper | Exeter 75858 |
| Leighton Linslade RC | Pete Brazier | Heath and Reach 270 |
| Lincoln SWC | Pam Rose | 0427-788356 |
| Maesteg ARC | MR Carey | Maesteg 734668 |
| South Bristol ARC | Len Baker | 0272-834282 |
| South East Kent ARC | Alan Moore | Dover 822738 |
| Swansea ARS | Roger Williams | 0792-404422 |
| West Kent ARS | Peter Reeve | 0892-24689 |

Rugged Low-cost 2m FM 'Talk-box'

For those newly licenced with a class B ticket, a cheap way of getting on the air is usually the first priority, and more often than not the band is 2 metres, and the Mode FM. This mode has gained a wide popularity for local nattering, mobile and repeater use,

teries — the photos and drawings show a case suitable for both purposes, which is easily made. PCB's and kits of parts are being made available for both the Transmitter and Receiver, with crystals readily available from any of the usual adver-

transmissions on the image frequency (around 124MHz) will also be present at high amplitude, and will cause interference. To achieve a high rejection of such signals, a 3-cavity pre-aligned High-Q helical filter has been placed following the RF amplifier, matched into the following Mosfet Mixer (Q2) via R28. This is an easy way of getting the needed rejection and flat in-band response, with no alignment required, as an alternative to using yet more tuned circuits all of which need alignment.

The first I.F. of this receiver is 10.7MHz, and conversion is via Q2 fed with oscillator injection from the oscillator/multiplier chain Q3/4. Signals in the range 134.3 — 135.3MHz are needed for coverage of 145-145.8MHz (the FM portion of 2 metres — although the receiver can be used down to 144.5MHz if needed). The crystal oscillator (Q3) uses series resonant 45MHz crystals, with the output then tripled to the required frequency by Q4. Exact adjustment of the crystal frequency is by means of the series trimmer provided for each of the six crystals.

Because of the availability of low current and versatile integrated circuits for use at 455kHz, plus cheaper filters for this frequency, we have used a second I.F. of 455 kHz for amplification and detection. However, prior to the second conver-

Perhaps you've recently passed the RAE but the idea of building your own 2m rig seems an impossible dream? Or you're an old hand with the soldering iron but VHF and Semiconductors seem rather a rich mix? Whoever you are, relax, lay back and let Tony Bailey, G3WPO, and Chris Gaston, G4KEI, take you step-by-step through the construction of a neat little FM transceiver — without blowing your mind or your bank account. Seriously!

with a phenomenal range of commercial equipment now available. Here is our alternative to going out and buying a Black Box. It features a crystal controlled Transmitter and Receiver, with up to 6 channels maximum, and uses readily available crystals.

The receiver is sensitive (better than 20dB quieting at 0.25uV input), and features a multiple helical filter at signal frequency for freedom from image response problems. *No coil winding is involved — all coils can be obtained pre-wound and alignment can be performed using only a multimeter.* The Transmitter, for which full constructional details will be supplied in next months HRT, runs 1 watt or so output, and features a dedicated speech processing chip to assist mobile communications. Where possible the construction has been simplified with only a few coils to wind. If you are reasonably competent with a soldering iron, and possess a multimeter, you should be able to build either unit following the comprehensive instructions given.

Once built, the Transceiver can be used as a base station rig (or just the receiver alone as a monitor), driven from a +12v power supply (14v max), or even used mobile. Alternatively, a portable rig can be constructed, with internal NiCad bat-

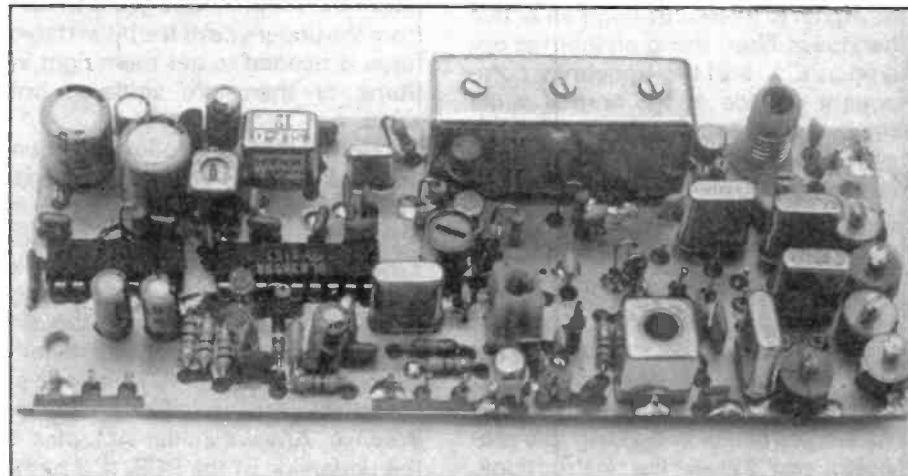
tisers (see parts list).

Description

We could have made the receiver simpler, but performance would have suffered, and with the crowded nature of the 2 metre FM at present this did not seem a good idea.

Signals at 2 metres are capacitively coupled via C1 and C2 (for a 50 ohm input match) to gate 1 of the dual gate RF amplifier Mosfest, Q1 (3SK51 or 3SK60), configured in grounded source mode. With only one tuned circuit present at this stage, unwanted signals such as adjacent PMR

The assembled receiver PCB



sion, a 'Roofing filter' has been used at 10.7MHz for initial selectivity. This has been the main advantage of reducing adjacent channel signals before further amplification, minimising the risks of 'bleedover' or adjacent channel interference. F1 is a two pole monolithic crystal filter with a bandwidth of 15kHz, and a skirt rejection of 18dB at +/- 25kHz — this adjacent channel rejection can then be added to that of the main filter at 455kHz.

Nearly all the remainder of the functions except audio power amplification are carried out by IC1, a ULN 3859 (or MC3359 which is equivalent) integrated circuit. This has on-board an oscillator, detector, I.F. amplification and squelch circuitry. It also has an output designed for use with a scanner, but this is unused here, as is the AFC function. Possibly the only function that IC1 does not provide is an S-Meter. However, for FM use these are not a great deal of use anyway — once you are fully limited that's it as far as perceived signal strength goes!

Conversion to 455kHz requires another local oscillator at 10.245MHz, and uses IC1 for this, with X1 (pins 1 and 2 of IC1 with output on pin 3) — this latter pin also has the correct impedance to match straight into F2, a 12kHz (-3dB) bandwidth ceramic filter, which provides the main selectivity prior to detection (narrower bandwidths than this will cause distortion of the received signal). Limiting amplification then follows, and quadrature detection with T4 as the quadrature coil. Low level audio output is then brought up to around the 1 watt level for driving a speaker by IC2, an LM380N.

For the squelch function, the high frequency noise present when there is no signal is filtered through an active bandpass filter, using an internal op-amp in IC1, and the frequency component outside of the normal audio range is used to drive the squelch circuit. The level at which the receiver mutes is controlled by RV1.

Construction

The receiver is built on one double sided printed circuit board, with the top plane used as an earth foil for good stability. Although the component layout is fairly compact, you should have no difficulty in building this providing you follow the instructions.

These instructions are comprehensive for the beginner, you can of course ignore them if you feel the need! You will need a soldering iron (tip size 1/8" maximum), multi-core solder (NEVER use anything else for this type of work!), and a pair of sidecutters as a basic minimum.

A few words on mounting the components for newcomers. Resistors mount either vertically or horizontally, using 10mm spacing for horizontal. Where one end is marked with a cross on the layout, this indicates that that end is soldered to the top foil where it goes through the hole, AND to the track underneath — this is important as some earth connections are made via tracks underneath and these components provide the link from one side to the other (this means some components may not appear earthed because they are not soldered to the top). In the case of vertical mounting resistors it is also important that the body of the resistor is in the position shown — this helps prevent signal radiation or pickup on the component.

Down To Specifics

With capacitors, keep them as close to the PCB as possible. Where one end is earthed with a cross, again it should be soldered both sides with the underneath of the capacitor body about 3mm above the PCB top surface. DON'T mount components more than 3-5mm above the PCB anyway as it can lead to all sorts of problems. Correct polarity of aluminium electrolytic and tantalum types must also be observed.

1. Insert and solder the 17 1mm dia. connection pins. If the receiver only is being built, and the case layout to be given next month is not to be used, then see instruction 9 below before putting them in. These are pushed in from the underside of the board (some force is needed to get them right in). Some of them are soldered both sides.

2. Solder in the following components — these will help locate the others and minimise problems with soldering iron access later. T1, T2, T3, T4, IC1, IC2, IC3, F1. Each of T1/24 has the can soldered to the top foil where shown. T3 has the side with a short shoulder located near the left hand side of R7. IC1 has one pin soldered to the top foil, and IC2 has 7 likewise. Always solder ALL pins on the underside of the PCB. IC3 has its

centre pin earthed to the top. F1 can go in either way round.

3. Now solder in the small gold plated cage jacks — these are used as sockets for the HC25/U crystals (X2-X7) which will be used for channel selection. It is easiest to do this by pushing a pair onto a surplus crystal then putting this through the PCB holes, soldering into place with the tops of the jacks resting against the PCB.

4. Solder in the trimmers CT2 — CT7 — one of the outermost leads on each is soldered to the top foil — be very careful when doing this so as not to melt the plastic body.

5. Solder in L1 (either way round), followed by C1,2,3,4,5,6,10,19,32,33,34,35,36, then R1,2,3,5,6,7,8,16,18 — 25, soldering earthed leads on both sides of the PCB where needed.

6. Now put a miniature ferrite bead on Q1 Drain lead where shown (the tab on the case should be positioned as drawn). Push the device down onto the bead, against the PCB, before soldering — again, one lead (Source) is soldered both sides. Repeat with Q2 (which doesn't have leads soldered to the top). Then push Q3 (getting the flat on the transistor case on the correct side) to within 3mm of the PCB, then solder. Now, add a ferrite bead to the collector lead of Q4, insert into the PCB and solder.

Helical Filter

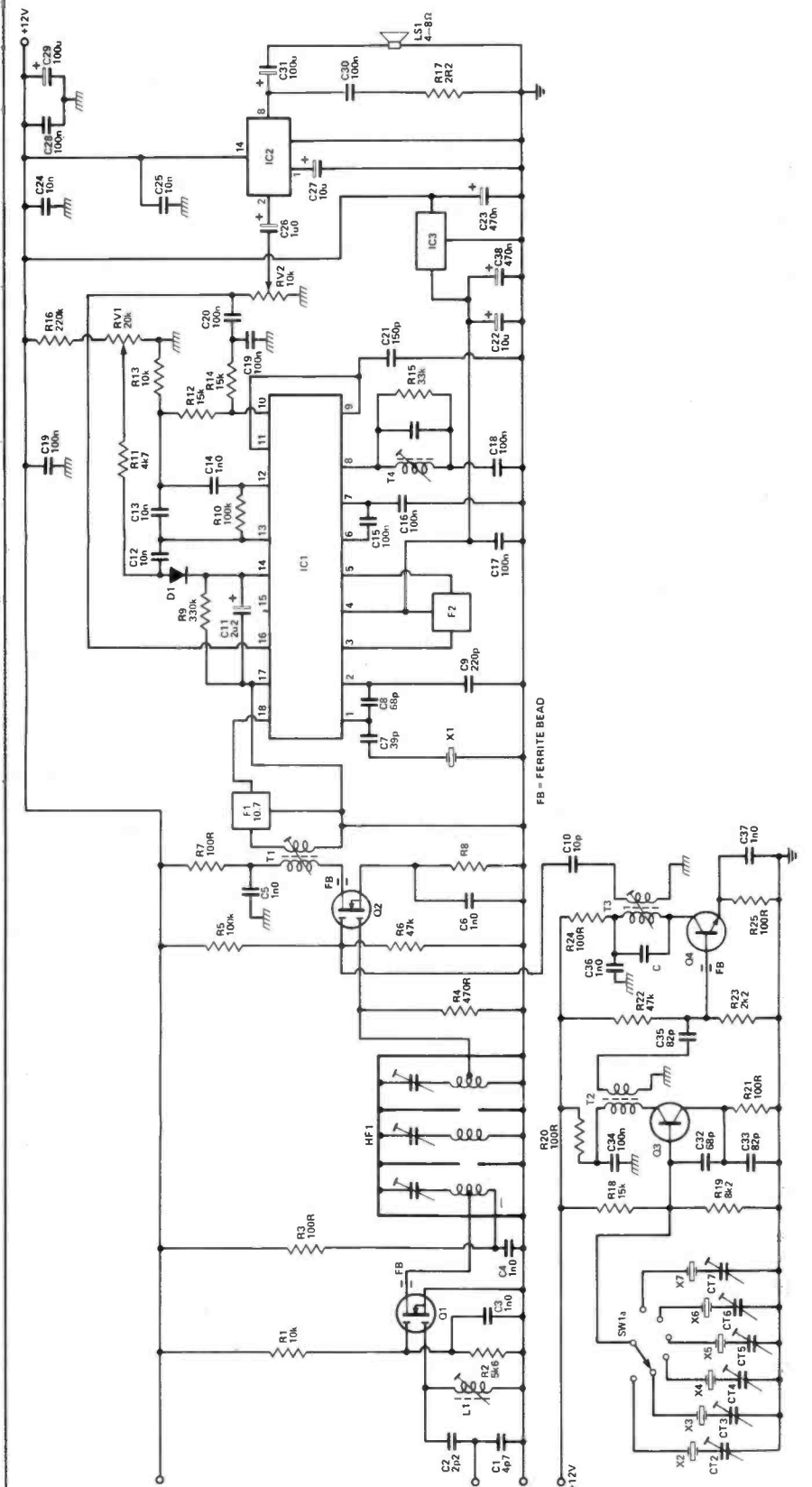
7. Put the helical filter (HF1) into the PCB (it will only go in one way round), solder all pins on the underside, and then solder the case to the top foil where shown. This needs a hot iron and it helps if you tip the PCB so that the solder runs against the case.

8. This leaves the right hand side of the PCB to finish. Start at the top and work down with each component, noting correct polarity of D1 and the electrolytic capacitors. C16 and C17 should be in before the filter F2.

9. If you are only building the receiver, it is possible to mount the two potentiometers directly onto the PCB in the holes provided instead of using connection pins when they are mounted remotely. If this is done, the earthed pin should be soldered both sides of the board.

With everything in place, *double check* that you have all the ic's and other orientation critical components correct (it saves heartache later), and that you haven't introduced any

Circuit of 2m FM Talkbox Receiver



solder bridges between tracks on the underside.

Alignment

To align the receiver, you will need a multimeter as a minimum, plus some off-air signals, or if you have them, a frequency counter and signal generator capable of operation at 2 metres.

1. Connect a power supply (switched off) with output voltage between 12 and 14V — positive to the pin marked + 12V, and the negative to the top foil — you should insert the multimeter in this circuit so that it can monitor the initial current taken (set to 100mA range). *Note that this receiver is designed for a negative earth power supply if used for mobile applications.* Connect a speaker, with one lead to the top foil, and the squelch and volume controls. If the latter are not PCB mounted, the volume control (RV2) must be wired in using screened audio cable, so that each of the wires to the pot (except the earthed lead which will be at the same potential — earth — as the screens themselves) ends up screened.

2. Connect point A on the PCB to one of the pins connecting to the crystals using a few inches of wire, and insert a crystal.

3. Turn both potentiometer controls fully anticlockwise.

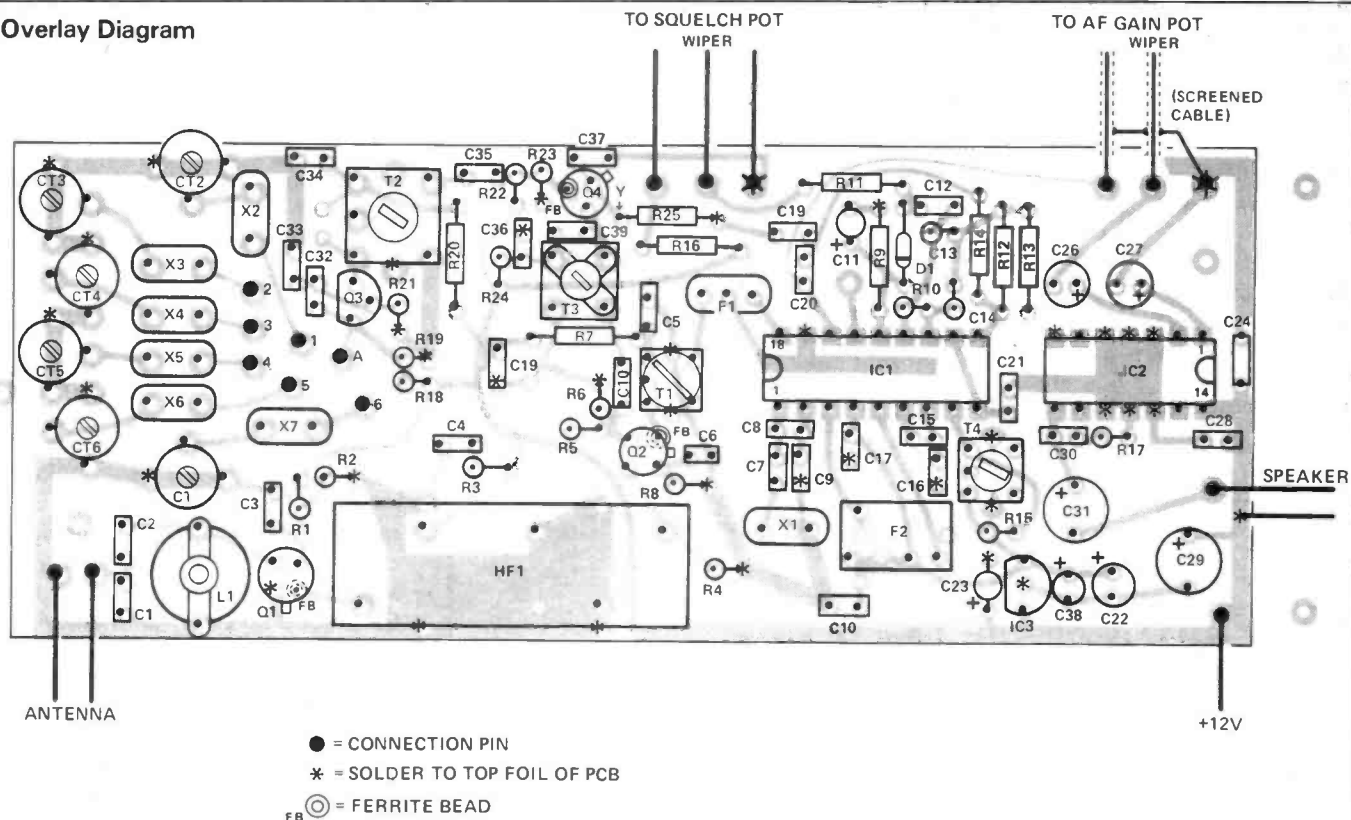
4. Apply power, and check that the current consumption is below 50mA. If a lot more current is drawn, then there is almost certainly a short circuit somewhere, probably between tracks on the PCB.

5. Turn RV2 volume clockwise and establish that there is some noise coming from the speaker. Adjust the core of T4 for maximum noise output. *Note that when adjusting cores, the correct trim tools should be used to avoid damage.*

6. Use your voltmeter probe (range 2.5 or 5V) at point Y (hot end of R25) and adjust the core of T2 for a peak in the reading (about 1.7-2V). When aligned the core of T2 will be approximately level with or slightly above the top of the former.

7. With the voltmeter still at point Y (hot end of R25) adjust the core of T3 also for a dip in the reading — this is not very noticeable and may be difficult to see — the core of T3 will be about 4mm below the top of the former when aligned) — alternatively you should be able to hear a peak in the noise output from the receiver

Overlay Diagram



when T3 is correctly adjusted.

8. Connect an aerial. If you have a frequency counter, adjust the channel trimmer for correct frequency output at three times the crystal frequency (connect to the counter at one end of C10). Alternatively, find a local signal, or use a signal generator, and adjust the trimmer for maximum perceived signal strength (maximum quieting of the receiver). If the signal is too strong to do this easily then use a shorter aerial — for less signal pickup. It is possible to swing the crystal over several different channels using the trimmer, so you may be able to find a signal on other than the correct frequency for this part of the alignment.

9. Adjust the cores of L1, T1 for maximum signal strength (again reducing the signal if needed so that it is not fully limited ie it is still noisy while peaking). **DO NOT ADJUST THE HELICAL FILTER** — this is supplied prealigned.

10. Adjust the core of T4 for best audio quality — this normally coincides with maximum high frequency hiss accompanying the signal.

11. Finally, carefully re-peak all the transformer cores, including T2 and T3, for best signal strength. If you have aligned the crystal frequency 'by ear' some slight adjustment may be needed to the trimmer for best results.

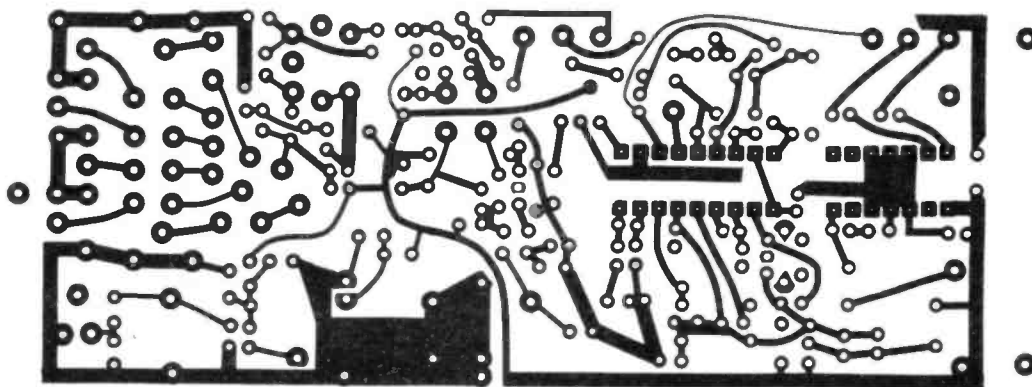
12. Check operation of the squelch control. This should silence the

receiver with no signal present at about one-quarter clockwise rotation, and then 'open' as soon as a signal is received. If the receiver stays muted (squelched) all the time, a very slight adjustment of T4 will cure this. The control should normally be set just past the muting point — it can be advanced to prevent weak signals from opening the muting, but then audio signals will tend to operate the squelch on some audio peaks if over-advanced.

Multi-channel

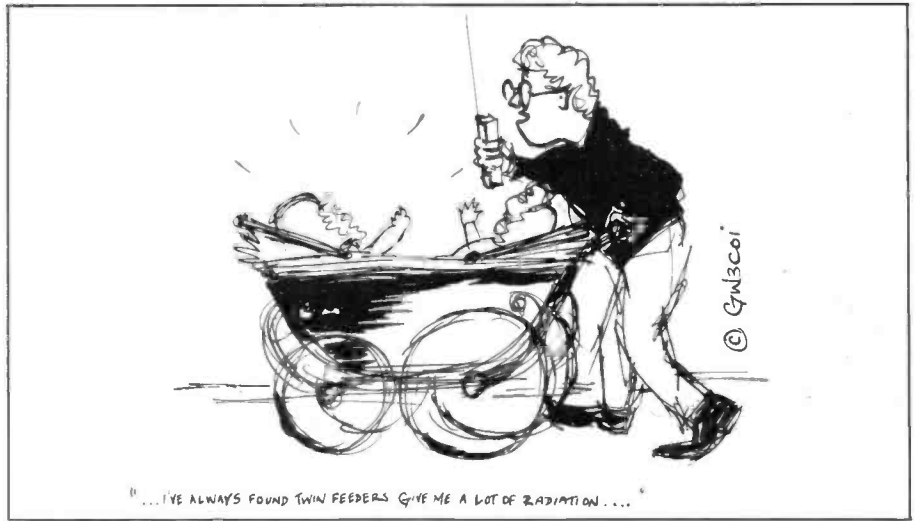
If you are using one crystal, then the link already connected can be left in place. For up to 6 channels, a rotary

Foil Pattern



1 pole 6 way switch is needed with point A going to the pole, and short leads (not more than about three or four inches) connecting each position to the PCB. If you are going to build the transmitter, then use a 2 pole 6 way switch, so that a spare set of contacts are available for the Tx.

NEXT MONTH we will describe the matching Transmitter, intended as a companion to this unit. This can also be used with almost any other 2 metre receiver, and is complete with an antenna switching relay. The case illustrated on the front cover will also be described, together with wiring and drilling instructions for the complete unit.



Resistors

| | |
|---------------|------|
| R1,13 | 10K |
| R2 | 5k6 |
| R3,7,20,21,24 | 100R |
| R4, 25 | 470R |
| R5,10 | 100K |
| R6,22 | 47K |
| R8 | 150R |
| R9 | 330K |
| R11 | 4K7 |
| R12,14,18 | 15K |
| R15 | 33K |
| R16 | 220K |
| R17 | 2R2 |
| R19 | 8K2 |
| R23 | 2K2 |

All 0.25W 5% carbon film types.

| | |
|-----|-------------------------------|
| RV1 | 20k (lin) TOKO VM10R pot |
| RV2 | 10k or 22k log TOKO VM10R pot |

Capacitors

| | |
|-----------------------------|-------------------------|
| C1 | 4p7 ceramic plate |
| C2 | 2p2 ceramic plate |
| C3,4,5,6,36,37 | 1n0 ceramic plate |
| C7 | 39p ceramic plate |
| C8,32 | 68p ceramic plate |
| C9 | 220p ceramic plate |
| C10 | 10p ceramic plate |
| C11 | 2u2 tantalum bead 16V |
| C12,24,25 | 10n ceramic disc |
| C13,14 | 1000p polystyrene |
| C15,16,17,18,19,20,28,30,34 | 100n monolithic ceramic |
| C21,33 | 150p ceramic plate |

| | |
|--------|--------------------------------------|
| C22 | 10uF electrolytic 16V |
| C23,38 | 0.47uF Tantalum bead 16V |
| C26 | 1uF electrolytic 16V |
| C27 | 10uF electrolytic 16V |
| C29,31 | 100uF electrolytic 16V |
| C33,39 | 47p ceramic plate |
| C35 | 22p ceramic plate |
| CT | 2-36p film trimmer 7.5mm dia (6 off) |

Semiconductors

| | |
|------|-------------------------|
| Q1,2 | 3SK51 or 3SK60 |
| Q3 | BF241 or BF273 or BF274 |
| Q4 | 2N2369A or BSX20 |

| | |
|-----|-------------------|
| IC1 | MC3359 or ULN3859 |
| IC2 | LM380N (14 pin) |
| IC3 | 78L05 |

| | |
|----|--------|
| D1 | IN4148 |
|----|--------|

Miscellaneous

| | |
|--|--|
| F1 | Nikko Denshi 10M15A |
| F2 | Ceramic filter LFH12S (12kHz) |
| X1 | 10.245MHz HC18/U 30p parallel |
| X2-X7 | 45MHz range series type for reqd frequency. HC25/U |
| (Frequency = $\frac{\text{Signal Freq} - 10.7}{3}$) | |

(i.e. 145.5MHz needs a 44.933MHz crystal.

| | |
|-----|---|
| L1 | TOKO S18-5.5 turns (green) |
| HF1 | TOKO Helical filter type 272MT-1006A |
| T1 | TOKO 119LC30099 |
| T2 | TOKO KXNK3335R |
| T3 | TOKO MC111 4.25/1.25 turns |
| T4 | TOKO LMC4200A or LMC4201A |
| S1 | 2 pole 6 way rotary switch (extra pole used for Tx) |

Also required: 3 Miniature ferrite beads; 12 CG1 Cage Jacks (AMBIT — for crystal sockets); 4 or 8 ohm speaker.

KITS — a complete kit of parts for this project, including drilled tinned PCB, all components, wire, pots, and rotary switch but excluding 45MHz crystals and speaker is available from WPO Communications for £39.65 inc VAT & p&p. PCB's alone are £3.80 each inc.

Crystals are available from Quartslab Marketing Ltd, PO Box 19, Erith, Kent at £1.96 each (1.74 for two or more) plus VAT. Please state HC25/U SR, and the actual crystal frequency required.

BOOKEND



This handbook is the hardy perennial of amateur equipment design. Published by the American Radio Relay League, the Stateside equivalent of the RSGB, it has become the standard reference manual for the

around the right way. The authors then go on to describe a few performance measurements that they made while using a diode ring in a DCR. To anyone with an interest in building radio gear, this is a delightful present-

SOLID STATE DESIGN FOR THE RADIO AMATEUR by **Wes Hayward W7ZOI** and **Doug DeMaw W1FB**. 256pp A4 format. Published by the **ARRL** and obtainable from the **Radio Society of Great Britain** at **Alma House, Cranbourne Road, Potters Bar, Herts EN6 3JU**. Price **£6.53**

HF build-it-yourself brigade. I've got a copy, a well thumbed edition purchased back in 1977. G3WPO has a copy — as does nearly every other builder that I know. It is a *very* useful book.

It is not the sort of text which offers a complete set of instructions on how to build an HF rig step-by-step, even though there are numerous circuit diagrams, drawings and photographs of the building blocks which make up the equipment. Rather, it offers a dissectioned view of what goes into an HF design and presumes a basic practical understanding of electronics on the part of the reader. Frankly, it's not a reference book for a complete beginner. Having said that, *just a little knowledge* will allow the lucid style of the text to throw up a succession of little golden nuggets of information. Despite the fact that I have owned the book for some five years I continue to glean further understanding of radio-type electronics from its pages.

Let me illustrate the usefulness of the book. You may wish to build a direct conversion receiver, for example. The knowledge that you will already probably have about this type of circuit tells you that a DCR requires a product detector. You may remember that diode detectors are the normal thing to use but you have forgotten the precise arrangement of transformers, diodes, etc to build a product detector. Turn to page 74 and all is revealed in both drawings and words. The text makes some general points about diode product detectors while the circuits should make sure that you get the things

tation whose effect is to fire the imagination with ideas of one's own.

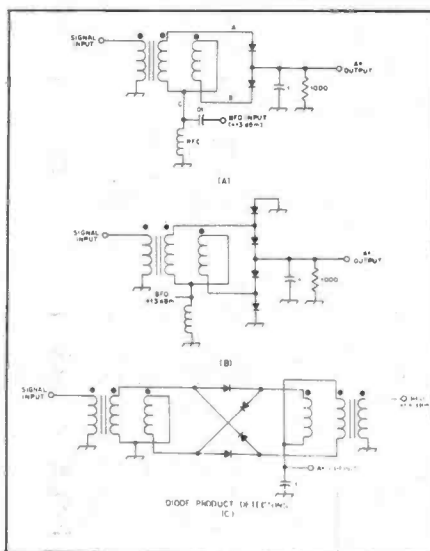
Almost every aspect of equipment design comes in for the same, practical treatment. You really get the impression that the joint authors are a pair of informed home-brew merchants who went to enormous trouble in order to document their own experiments for the benefit of others. Wideband amplifiers, low noise oscillators, specialist radio test gear (most useful) active mixers, crystal filters, power supplies — to list but a few. The book also offers a number of look-up tables for filter design together with detailed explanations of such things as dynamic range, reciprocal mixing and other of these 'buzz' word parameters which magazines so love to include in their articles and reviews.

Having said all these wonderful things about *Solid State Design*, it comes in for quite a bit of stick. First of

all, it's American. I've got nothing much against N's, W's and K's (except perhaps that they all seem to run more power than I do!) but the components shown in the book's circuits are not always easily available over here. This is particularly true of the toroid cores which are used in nearly all the illustrations. It is true that the authors meticulously provide winding details for inductors, but their instructions are not worth the printer's ink if you can't buy the right core. This is an instance where a degree of practical experience is necessary in order to 'adapt' the components shown in a US circuit diagram to those available from UK sources.

I have another gripe. This reference book was first published some seven years ago. Although the theory holds up excellently some of the practical circuit example are starting to look a bit dated. Many of the building blocks described could be better implemented by some of the multi-function radio ICs currently on offer. The circuits themselves seem rather old fashioned; no designer would dream of putting together a piece of amateur gear based purely on the designs shown in this book. (*Oh dear! I'm obviously not state of the art enough.* — Ed.) Specifically, the chapter on radio synthesizers was positively atavistic. You just wouldn't put something together based on SSI and MSI TTL.

However, there is another side to the coin; IC circuits make a very poor teaching aid. Too many electronics engineers these days are at the mercy of the semiconductor companies' applications labs. Discrete circuit examples allow a *much* greater understanding of the design process and are probably more instructive for the equipment building radio amateur. I have no complaints as an enquiring reader. **G4JST**



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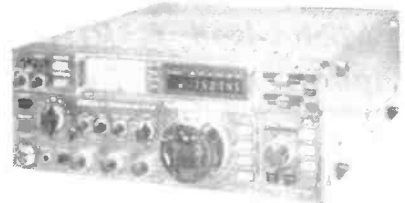
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RTTY with the BBC 'B' Computer and G3LIV Interface

Readers of my previous article on RTTY will remember that I discussed a Terminal Unit called the 'ST 5', which was designed to provide the necessary voltages to operate a mechanical teleprinter. This review describes a horse of a different colour, in fact, three horses of a different colour! I am going to discuss the G3LIV MODEM/interface for use between a

Ken Michaelson, G3RDG, investigates a 'state of the art' approach to RTTY — the long distance typewriter.

receiver or transceiver, the BBC model 'B' computer, and, not the least important, the program written by Peter Harris, G3WHO, to operate it.

The G3LIV interface arrived at my home QTH packed in a plastic bag, together with full instructions for assembling it. The PCB is roller-tinned and drilled but not screen printed with the component numbers etc. This in itself is not a disadvantage as a full-sized drawing of the PCB is provided giving all the positions and values of the various items. It measures 170mm by 120mm with 4 mounting holes, and is made of high quality glass fibre. A list of the components was also enclosed and a check showed that everything was in order. I set to with the soldering iron, and without undue strain, completed the job in two evenings quite easily.

Alignment

Having checked all the soldering and external wiring for short-circuits etc, the next thing to do was to apply power and align the active filters. They are designed to have switched centre frequencies to cover both the amateur 170Hz and commercial 425Hz shifts. In fact, the unit can be aligned to cover any two shifts required. However, in this case I was going to align them to cover 1275/1445Hz for amateur use and 1275/1700Hz for the commercial shift. The alignment instructions suggest that an oscilloscope be used to

set up the circuits, using an audio generator and a frequency counter. In my view it is essential that they be aligned using a scope. I think that it is impossible to do the job without one, but should any of you readers not be in possession of any of these units of test gear, do not despair. Johnny Melvin, the designer can arrange to do this for you for a small fee. The whole

operation of the unit is dependant upon the correct adjustment of the various circuits. There are nine potentiometers, but the unit is aligned in stages, and the end result should be a unit which is selective enough to operate in today's crowded band conditions without the frustration of losing the signal. Provided that care is taken in the alignment of the circuits, this objective is achieved.

Having got the unit electrically functional, the next step was to arrange to connect up the second board, the AFSK tone generator. This would not be required for those of you

who are only interested in receiving. In my case, a ready built AFSK board arrived from Johnny Melvin, and this only had to be connected to the proper points on the main board to make the unit operational both for receiving and transmitting.

Since all the operation of the transmitter etc, is controlled from the keyboard of the BBC computer, it was necessary to arrange some method of 'PTT' for the TRIO TS820S that I use. This was done by means of a DIL reed relay, the coil of which was connected between PB2 and the computer's 5 volt line, available on the ribbon cable coming from the computers USER PORT, PB2 switching on and off in response to 'CTRL TRANSMIT' and 'CTRL RECEIVE'. The 'DATA OUT', PB1, was connected to the switching point on the AFSK board and the 'DATA IN' came from the 4.7 volt logic output on the unit to PBO. Signal ground was, of course, '0 volts'. While on this point, I must tell you that there is available from the BBC computer itself, a perfectly good audio output from PB7 of the USER PORT. The only thing is that it is a



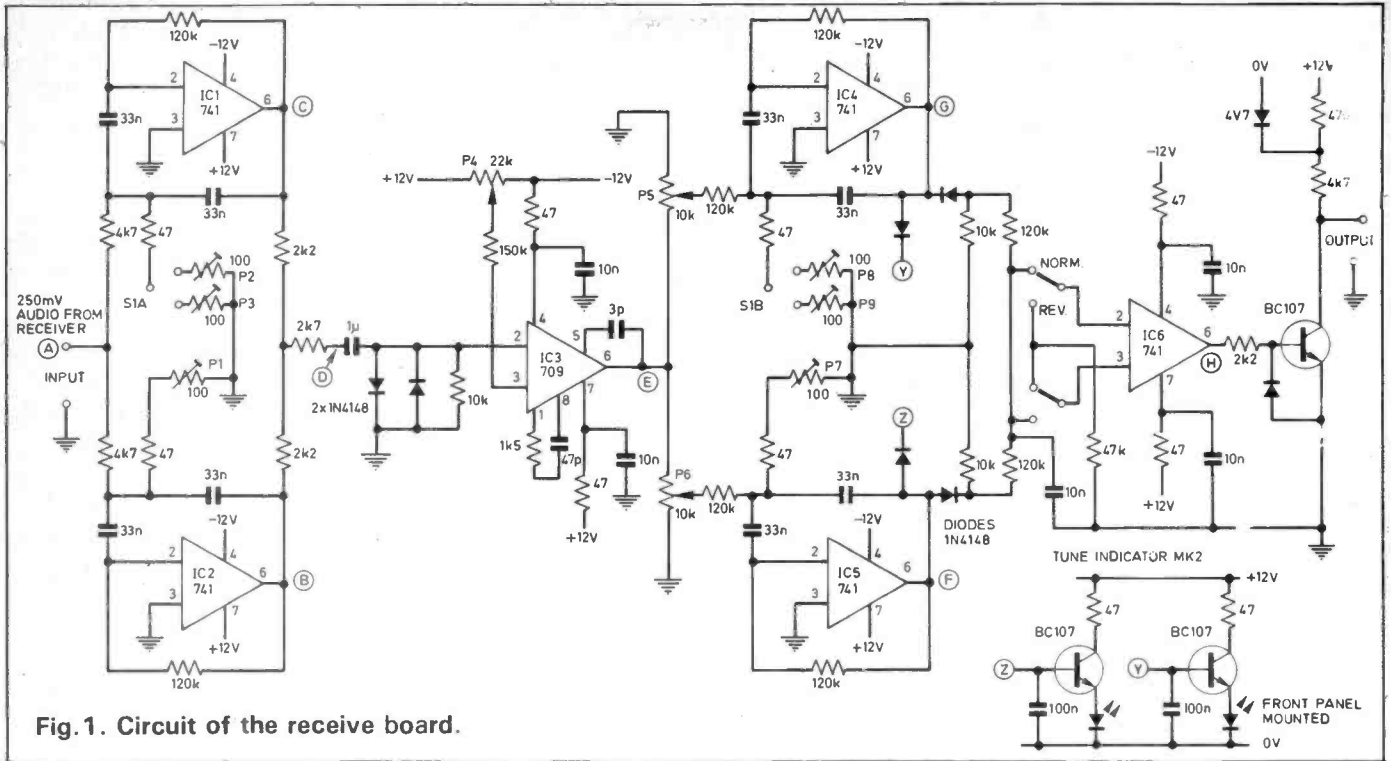


Fig. 1. Circuit of the receive board.

square wave output and requires filtering before it can be connected to the microphone socket of the transmitter. Johnny Melvin has also got this in hand and supplied me with a little board with the filtering resistors and capacitors on it. I have also tried this board instead of the AFSK tone generator board, and it works perfectly with no bother. Fig. 1 shows the circuit of the receive board and Fig. 2 that of the AFSK oscillator. Fig. 3 shows the appearance of the test set-up.

Loading the Program

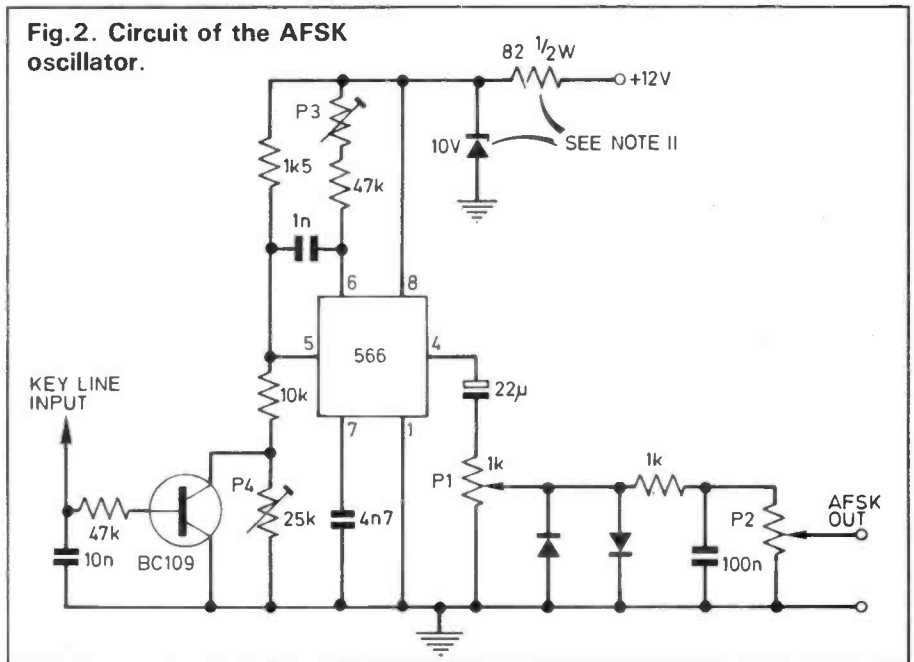
Now that the unit, together with the AFSK board, was functioning correctly and was being controlled from the keyboard of the computer, the time had come to load the G3WHO program. Peter Harris, who wrote this excellent program, has given a number of options or 'control codes' to use with it. Space does not permit the complete listing of the available commands, but, briefly, it will enable the BBC model B computer to send and receive RTTY when interfaced with a suitable Terminal Unit, in particular, the G3LIV unit reviewed here. It operates in the split screen mode, enabling the preparation of transmit text in the bottom half while received text is being printed in the upper half. The speed of transmission/reception is easily changed between 45.45 bauds and 50 bauds from within the program and any other speed (up to

about 100 bauds) can be selected. Audio tones are available from PB7 of the USER PORT (as mentioned above) as an alternative to using an AFSK oscillator. A CW identifier and real time clock are provided, and pre-programmed messages can be accessed for transmitting by a single key entry. There is also, to my mind, a very important extra facility. The program has the means of switching a printer on or off as desired. This can be driven by either the parallel or serial output from the computer, and can be very helpful in QSOs and is a necessity for contest working.

On the Air

I will now describe how the G3LIV interface using the G3WHO program actually operated when controlled from the BBC computer. The first thing to do was to tune up my transmitter, in this case, to 14MHz. The unit is intended to operate on Upper Sideband. I turned the dial to 14090KHz and, tuning carefully, found several stations working, and one who was calling 'CQ'. Slowly turning the dial so that the two tuning LEDs flashed on and off in sync with the tones of the received signal, the 'CQ' call was displayed on the upper

Fig. 2. Circuit of the AFSK oscillator.



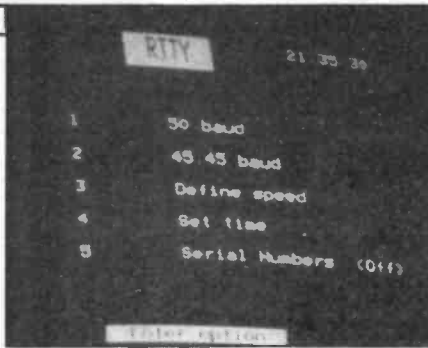


Fig.5. The menu that the program offers the user.

(that is if you are wanting to transmit). As soon as the 'CTRL T' is pressed, a tone is generated inside the BBC computer, and this is applied to the microphone socket. Since you have switched in the VOX, the transmitter immediately goes over to transmit. Pressing the 'CTRL R' again brings you back to 'receive'.

All this sounds very long-winded, but I was on the air within 10 minutes of unpacking the unit, and it performed beautifully. The only extra one has to buy is the 20 way IDC cable, which Johnny can supply.

The simplicity of using VOX made the operation very easy, and the first contact I had was with UT5RP in Odessa on the 80 metre band at about 2100 hours, I am sure that you have probably heard the QRM in the evenings on 80 metres, so I think you will agree that since I was able to have the QSO (my report was 569), the efficiency of the unit was most satisfactory.

All in all, this little marvel is perfect for the RTTYer who doesn't want to build or have any extra connections

Fig.6. The split-screen display when the program is in use.



Fig.7. The ready-made unit that is self-contained and derives power from the computer.

with the mains, but wants the simplest and most efficient method of getting on the air in the RTTY mode.

Conclusions

The units and computer, using the program, have been in frequent use during the last four or five weeks; with no trouble in working RTTY stations, and no snags. RTTY interest is growing, and the G3LIV INTERFACE/MODEM used with the BBC computer is most certainly the 'up to date' method of working the mode. I consider both units to be value-for-money purchases, either in kit form or ready cased with only the connections to the computer and transceiver to make. The performance of the units is very satisfactory under QRM conditions, with the qualification always, *that care is taken in the tuning of the signal*. A further point to emphasise to those of you who decide to build your own interface is the careful alignment of the tuned circuits. It is really upon these two points that the successful operation of the units depends.

Final Update

As one of the three items under review in this article was the BBC model B computer, it might be constructive to comment on the way it worked with G3WHO's program. Coming, as I did, straight from a VIC-20 computer, the BASIC dialect was quite different, and took some getting used to, particularly the programmable keys. I found that it was necessary to prompt my memory by having the list of the various functions placed on top of the red function keys. But apart from that, which would not happen after I became familiar with it, I have nothing but praise for the BBC micro. I like the keyboard, and the manual has plenty of information. Since this is the model 'B', there is memory of 32K, which means that there is no need to think about an extra motherboard to take 'plug-in' RAM cartridges etc. The facilities which are available in the machine make it unnecessary to think about outboard gadgetry, and the sockets on the underside of the computer cover all types of data input/output.

I hope that the above has whetted the appetite of some of you to have a go at working this mode, and for those of you who decide to do so, welcome to the world of RTTY.

The author would like to thank Johnny Melvin, G3LIV and Mick Payne, G4ITX, of SP Electronics for the loan of their equipment and all the help they gave. In return, SP asked if we might mention that they have a dealership for the BBC computer and software, and that they stock various other computers, a range of radio equipment and all of Johnny's range of equipment, including the pre-programmed EPROM containing the G3WHO program; of course, I told them that we couldn't possibly give them such a mention!

John Melvin, 2 Salters Court, Gosforth, NEWCASTLE, SP Electronics, 48 Linby Road, Hucknall, Notts. (0602 640377).

NEWCOMERS FORUM

By Tony Bailey, G3WPO

Since the inception of this magazine, one of the main features has been constructional projects, in an attempt to show that you can build it yourself, and don't have to go out and buy something to get on the air. You may not necessarily save money doing this, depending on the project, but the *will* get a very great sense of satisfaction from this approach when it is all finished and (hopefully) working. You will have also learnt something about the circuit that you have built.

sure what they all are. Perhaps you are contemplating buying some capacitors for a project or two but do not know which type to choose.

Most articles do attempt to point out how to identify any out-of-the-ordinary components, but this still leaves a large number of 'ordinary' items, particularly resistors and capacitors, that an experienced constructor would probably identify in 1 second flat but which will probably flummox the newcomer totally.

closer tolerance, better noise performance in certain applications, or a higher wattage rating.

Do you know how these carbon film resistors are made? The resistance is comprised of a thin carbon film deposited on to a ceramic or other tube. The final resistance is adjusted by cutting a spiral around the tube while monitoring the resistance, so that the effective resistance path is increased to the required value. All this is done automatically — and can be controlled to .01% accuracy. This process can increase the resistance of the uncut body by factors of several thousand times. All this is hidden under a protective outer covering, with the colour coding marked on top.

Resistors of ratings up to 2 watts are not difficult to obtain. They all have similar colour codings — just in case anyone is in doubt the standard table is given for reference. If you have difficulty in remembering this, you can get hold of little 'decoder cards' from some dealers — where you dial up the colour codes of an unknown resistor and read off the value.

In this NF special, Tony Bailey, G3WPO, gives a handy, up-to-the-minute guide to identifying components.

As I am sure many of you are aware, the writer is more than a little involved in such projects, and has always been an avid home constructor. The first major project I ever attempted was a single sideband transmitter for 160m, shortly after I became licenced. It worked very well (using those large seven legged transistors with heaters), but had a peculiar sounding transmit quality — a home made lattice filter for the SSB filter had been made, and the pass-band had a rather large dip in the middle. Consequently, the audio sounded "as though you are talking down a drain pipe".

However, it did work, and I reckon I got far more satisfaction out of using that little rig in my first few years on the air, than the KW Vespa which I subsequently acquired to replace it (then sold to build a VHF Transceiver!). If nothing else, the audio did start a few conversations off!

Home construction brings its own problems, and, for the relative newcomer, one of the biggest is that of identifying components, especially, say, when you are confronted with a large bagful of components to build a kit with, and this is your first attempt! You may have acquired a number of surplus bags of mixed "things" at a Rally, and are not really

So, this month's piece is a special edition, aimed at giving you a reference for as many components as we can cover. Particular attention is being paid to capacitors, special types of resistor, and some of the other components used within these pages. We suggest you keep it handy for future use — possibly more similiary aimed pieces of constructional information may follow if there is a demand. Also, some information on what type of component to use for what purpose has been included.

Resistors

Probably the most notable thing about the humble resistor is that it is now a lot smaller than it once was — but at least they nearly all carry similar colour coded bands these days — you don't have to fathom out one colour on the body and coloured circles etc anymore. The resistor may be small and cheap but it plays an essential part in almost *every* radio design.

There is a great number and variety of resistor types, but the great majority of solid state designs that the average constructor meets these days use the 0.25 watt, 5% tolerance **carbon film** variety, with PCB layouts standardised at 10mm lead spacing for horizontal mounting. You can probably get away with these for **most normal applications** unless you want

High Power

If you need a higher wattage resistor for RF use (carbon film types have appreciable capacitive reactance after spiralling), then **carbon composition** resistors are easily obtainable, slightly smaller for the same power rating, but not quite so stable in value over long periods. Colour coding is the same, (the fourth end band will generally be silver as 10% tolerance is normal with carbon composition). You may even find no fourth band — in which case the tolerance of the resistor is $\pm 20\%$ (20% tolerance resistors are fairly uncommon these days).

Of course, **wirewound resistors** are another possibility for high power applications (not RF — see further on) and come in many different packages, including some metal sheathed variants of very high wattage rating which can be bolted directly to a

chassis. Whilst OK for DC use, and at Audio frequencies, wirewound types are useless for RF work due to the fact that they are also nice inductors if you consider how they are wound!

Incidentally, there are some wirewound types that are encapsulated and look just like carbon composition resistors, complete with coloured band coding. However, they can be identified by the fact that the first band is always wider than the others. You might even find both ends have wide bands, in which case the resistor is flameproof (the right hand band will be blue).

Tolerances

A word about tolerances may be in order. If you have a 4.7K (4700 ohms) resistor of 5% tolerance, then you can expect its value to lie between 4935 and 4465 ohms (probably well within these limits). Depending on the application, this shouldn't be any problem, but if you were using two resistors as a divider chain to get a specific critical voltage, then pro-

bably a closer tolerance would be called for (you can always select resistors using a multimeter, and if this is a digital type, even better).

At one time, values under 10 ohms used to be referred to as 6.8 or 4.7 ohms. Like pounds, shillings and pence, this had to go for some reason or other to appease the great God of Standardisation. Now, these two values are 6R8 and 4R7, with the "R" replacing the decimal point. Likewise, under one ohm, we now have R47, rather than 0.47 ohm. Also, the "R" creeps under 1000 ohms, so that we have 470R for 470 ohms. You can now conclude that the "R" stands for ohms, and its position indicates the decimal point location.

Above 1000 ohms, we change to "K" (for times 1000), so that 68K is 68,000 ohms, and 6K8 is 6,800 ohms. Then up to "M" for times 1,000,000. 1M2 is then 1.2 megohm, or 1,200,000 ohms.

All the resistors we have referred to so far generally carry four colour coded bands — three for the actual

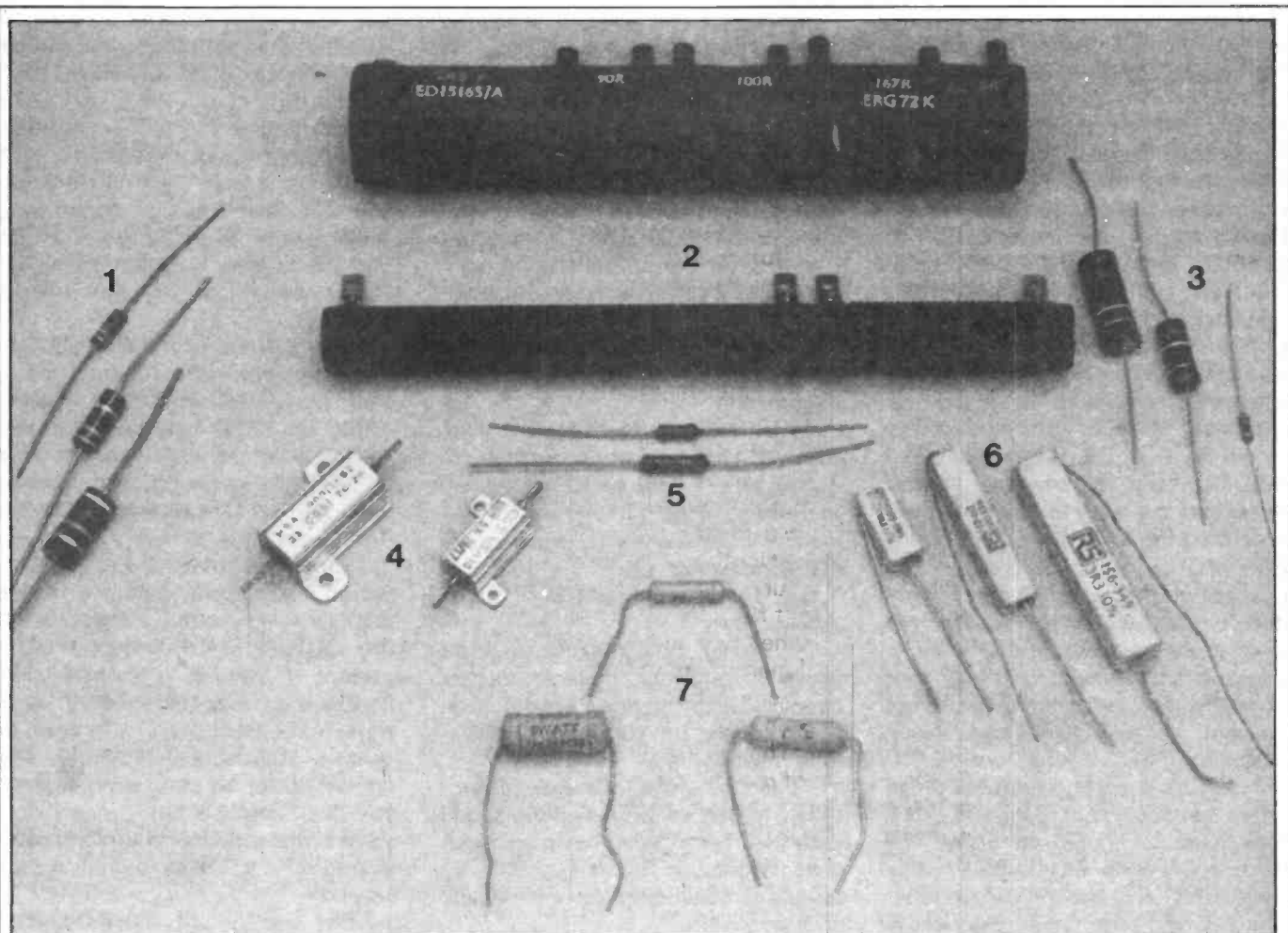
value, and one to indicate the tolerance.

Metal film

These are normally used where better tolerances are required, and 1 and 2% tolerance types are easily obtainable. Suitable applications are where the value has to be very close to a calculated value (say, in active filter circuits), and, also, where high long term stability, and low noise are important. They are made like carbon film types, but use a deposited metal oxide film (some types are often referred to as 'metox').

Most people find the bigger problem with metal film resistors is deciphering their coding and I won't be the first person to resort to a multimeter to find out a metox resistor value! Firstly, they have five (sometimes six) bands of coding, and secondly, they are obtainable in a much wider range of values, so the coding can be an unfamiliar combination of colours.

As an example, say we have a



A Regiment of Resistors

1. Carbon Composition

2. High Power Wirewound Dropper Resistors (TV Use)

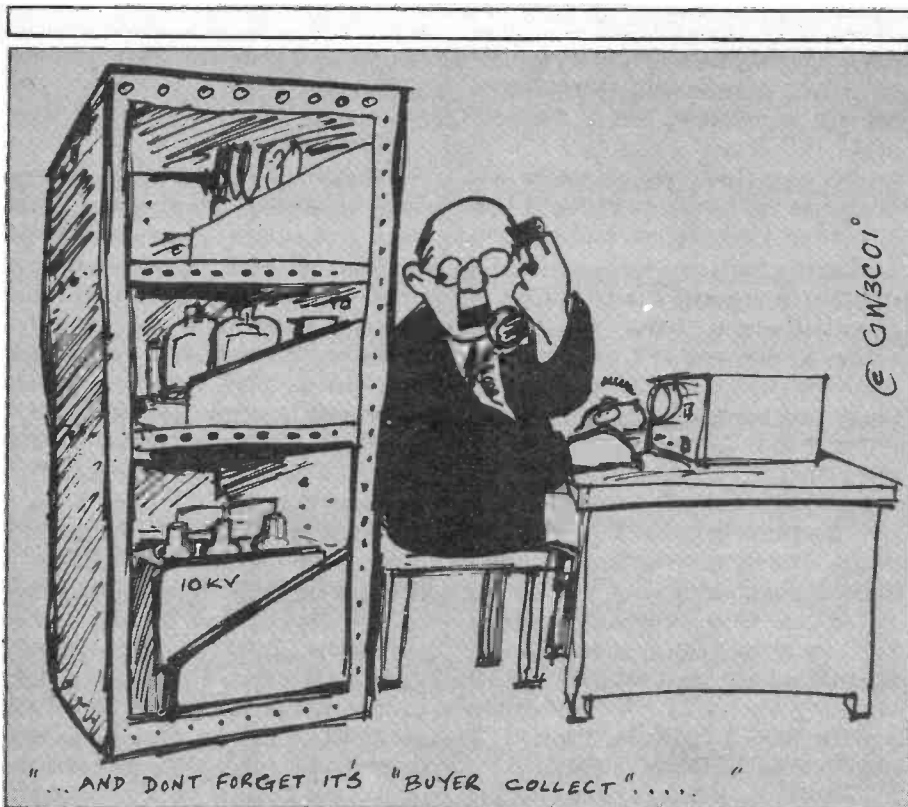
3. Carbon Film

4. Metal Cased Wirewound

5. Precision (0.1%) Metal Film

6. High Power Wirewound (Flame Proof)

7. Wirewound



There are large components . . .

coding of "brown, brown, black, red, red). What have we got. Well, starting at the beginning it reads ONE, ONE — then what? The third band is another figure, in this case black for zero — this enables the value of the resistor to be defined more accurately to 3 figures, rather than the two of normal resistors (you could have (12K5-12.5K for instance). The FOURTH band is then the normal multiplier, in this case red for $\times 100$. The final value is then 11,000 ohms, or 11K — actually 11K0 — to be accurate as the markings. This leaves us with one more band, which is the tolerance, referring to the table this would be $\pm 2\%$ (brown for $\pm 1\%$). Actually, to confuse things, there may be a sixth band, slightly separated from the other five, at the far end. If so, this is the temperature coefficient, (*the variation that will occur in the value of the resistor per degree change in its temperature — expressed in parts per million. Ed*) not normally of much concern to most of us, but red is 50ppm and brown 100ppm.

Just as a parting shot on these types, because most metal film types only need 2 figures to define the value, there are ones about with only four bands! Just like the carbon type. The tolerance band will then show either red or brown normally, with the resistor body normally a distinctive colour (blue seems to be the fashion).

Component decade values

Everyone who has ever done any constructing must have realised that resistors (and capacitors) come in a fixed set of values. The most common is referred to as the 'E12' series. This is 1, 1.2, 1.5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8, 8.2, and the multipliers (ie X100 or 1000) of these. I am not sure how these came about but suspect that it is because taking $\pm 10\%$ tolerances (which was the standard tolerance years ago) of each value gives the limits of the next value in the series when that is similarly toleranced.

With the arrival of today's electronics and higher accuracy requirements, a new set of values had to be established — these are the E24 series, and these are 12 more values in this series than the E12 — 1.2, 1.3, 1.6, 2.0, 2.4, 3.0, 3.6, 4.3, 5.1, 6.2, 7.5 and 9.1.

If you venture into the world of precision resistors, there is another set of values to increase the precision of the coding, but you are very unlikely to meet these.

There are lots of other resistor types, mainly variations on the above in terms of packaging or rating, even ones housed in what look like integrated circuit packages for space saving reasons.

Capacitors

It is here that the would be con-

structor is most likely to come adrift. Before reading on, which is the odd one out of the following markings? n10, 100K, 100p, 100pF, 100J, and a package devoid of markings other than a brown body with a red tip?

There seems to be very little standardisation in capacitor markings, as many people will testify. The Japanese and Russians seem particularly adept at using different markings for the same thing. Those listed above all indicate the same value — of 100pF!! You may be forgiven for thinking that at least one of them was 100,000pF or .1uF (actually, this would be marked 100n — or .1, 103n, 0u1, 103K and a few others . . .).

Identification

So, now a few basic principles to aid in capacitor deciphering. These notes are not infallible — sometimes the only answer is a capacitance meter.

For values below 100pF, there is very often only the figure, say 22 (for 22pF). It may be followed by a letter, but this will be a TOLERANCE, NOT a multiplier, i.e. 22K or 22J. Sometimes just the 'p' follows for pF, and like low value resistors, 2p2 would be 2.2pF. Very occasionally you will meet a colour coded body such as the example given at the beginning, with the body being the figure colour, and the tip the multiplier.

For values of 100pF-999pF, again, possibly three figures such as 150, maybe followed by a letter — 150K or 150J: all these indicate 150pF. Also, the addition of the letter 'n' PRECEDING the figures denotes a multiplier of 10 i.e. n15 is 150pF also, and n10 is 100pF.

For values of 1000pF to 9999pF, things start to change. Normally, 1000pF will be marked 1000p, .001 (for .001uF), or 1n. The latter is important — a small 'n' following the figures is a multiplier of 1000. Also, an actual FIGURE multiplier may be given — 102 indicates 1000pF — 10 times 100 (or 10 plus two noughts if you like). Another letter may follow some of these — this is a tolerance indication — 102z is common (see later).

For values of 10,000pf to 99,999pF. Similar to the last one, although you are unlikely to find 10,000 as a marking. The normal

codings are 10n, 103(n), 103z, and .01. Similarly, 22n or 223 are both .022uF.

For values of 100,000pF to .999uF. Again, 104 is a common marking for 0.1uF, but you will also find 100n equally as often. Just ".1" is found, or sometimes Ou1. The latter is a similar convention to resistors where the "u" symbol is like the "R" symbol, in this case showing the position of the decimal point in relation to 1uF. 220n would be the same as .22uF.

Above 1uF (more often an electrolytic type) the actual value is generally printed accurately, but often followed by the voltage, again usually with a "v" following it. You may sometimes find say, 10/16 — this would be 10uF at 16v working.

Capacitor voltages

The subject of 'working voltages' and electrolytic capacitors often seems to confuse people. Let us assume that the article you are following specifies a "16v working" device. Now, it doesn't matter one little bit if you put in a capacitor that has a working voltage of anything ABOVE this, say 25V, 50V or even 1000V (if you had one). The only possible problem is that the higher working voltage type will probably be physically larger, and

Short component lengths above the PCB are essential in RF construction to ensure stability and peak performance.

may not fit the layout. Again, although radial types (where both leads come out of one end of the can) are usually used on PCBs, you can use axial types (one lead at each end) by up-ending them and bringing the other lead round the body.

Types of capacitor

The most common workhorse of the lot is the ceramic type. For non-critical applications, such as decoupling of RF circuits and many interstage coupling and resonating purposes, these are fine, providing their limitations are borne in mind. The disc type (i.e. round in shape) are most common in the larger values (10n and above), and come in a variety of shapes! For 10n and above, except for some specifically marked as high voltage, their working voltages, because of their small size and high capacity, are limited to 20 to 63V. Capacity tolerance is usually +/- 10%, +/- 20%, or +80/-20% (usual codes for these are K, M or Z — often in lower case — following the figures). Such large tolerances don't really matter for decoupling purposes, but bear it in mind if you happen to need something fairly accurate. The reason for the large tolerances is the form of dielectric used to get the size/capacity relationship down.

Disc types also come in lower values down to 1pF — an additional tolerance letter of J (+/- 5%) is usual here, and you are unlikely to find a Z tolerance on these types.

With values of 1000pF and below, the ceramic plate or plaquette type are common. These are square in shape, and usually very small — a 2p2 capacitor can be very little different in size to a 1000pF, with a working voltage of 63V max. As these are so much more commonly used in RF tuned circuits, the temperature coefficient becomes more important. This is usually denoted by a coloured band across the top of the capacitor, or by a patch of colour on one corner. The usual colour code is:

| | |
|---------------|-------|
| RED/VIOLET | P100 |
| BLACK | NPO |
| ORANGE | N150 |
| YELLOW | N220 |
| GREEN | N330 |
| BLUE | N470 |
| VIOLET | N750 |
| ORANGE/ORANGE | N1500 |

N = Negative coefficient

P = Positive coefficient

Figure = capacitance change in ppm per deg/C.

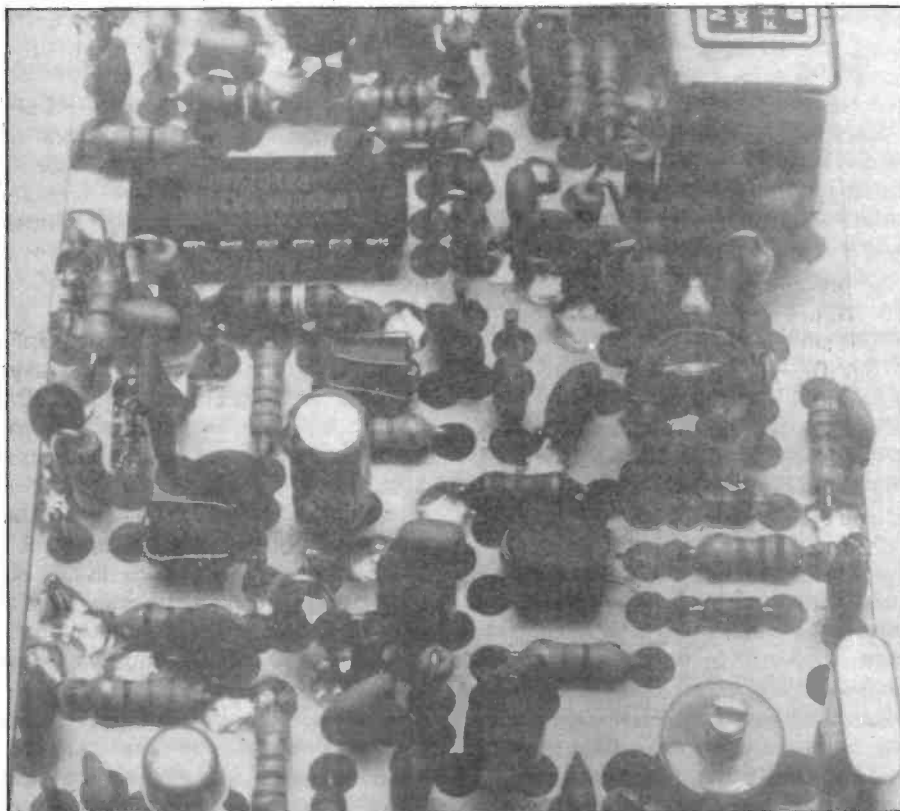
Capacitors without colour markings are not selected and may lie anywhere in this range. Using combinations of these marked types can give suitable temperature compensation to most circuits.

Again, different dielectrics are used for the higher capacities. The changeover point varies, but above 330pF Hi-K types are often found which aren't really suitable for use in tuned circuits.

Monolithics

One other type of ceramic often met, especially for decoupling purposes, are those of monolithic construction. They are made from alternating layers of ceramic dielectric materials — mixtures of fine ceramic powders and resins, together with silk-screened layers of metal paste electrodes. After further processing, stacking and compacting, they are cut into squares, and provided with wire ends and a tough encapsulation. This gives a lot of capacity in a small space, and although expensive by comparison to other ceramic types, are widely used in decoupling applications where space is limited.

Markings are usually limited to the





... and there are small components.

value in the form of a simple ".1", or 100n etc, normally on a blue or beige body, which may be almost square, or sometimes in the form of a bead like package. Working voltage is commonly 100V, with tolerances of ± 10 or 20%. The temperature coefficient can be very high.

Other types

Ceramics aren't always suitable for RF or even audio uses and some can be affected in their value by appreciable AC voltages flowing through them so other types are often needed. The ones you are most likely to meet are Mylar, Mica, Polystyrene, Polyester and Electrolytic/Tantalum types. Paper versions are rather out of vogue now, but are often found in older surplus equipment. Polyester types have now superseded them.

Mylar

These are quite useful in the 1000pF + range for audio and some RF applications as they are more stable than ceramic types. Generally found in green, red or yellow rectangular resin encapsulations with radial leads, their markings are similar

to the higher value ceramic types (i.e. 102 and 223 for 1n and 22n). Tolerances are normally $\pm 10\%$, but 5 and 2% values are also obtainable.

Mica

Usually found in the form of "Silvered Mica" capacitors from 2p2 to 10,000pF. They are popular for RF tuned circuits due to their stability and reasonably predictable temperature coefficient (positive at around +50ppm). Tolerances can be as low as $\pm 1\%$, or $\pm 0.5\text{pF}$ for low values, another reason for selection. They are usually in a red or beige, square or rectangular encapsulation and clearly marked with their value and tolerance. Working voltage is normally several hundred volts.

Polystyrene

Found in a tubular package with axial leads, you can see the internal construction through the clear outside, of a roll of metal film with a dielectric between. The point that often confuses people is the red marking at one end of the package. It is NOT a polarity marking, but simply indicates which lead is attached to the

outside of the foil winding. Tolerances are available down to $\pm 2.5\%$, and they are a popular choice for tuned circuits with good stability and low slightly positive temperature coefficient.

Capacity markings are usually quite clear in the form of the actual capacity, i.e. 220pF for low values or 1n5 or 1500pF for higher values, 10pF is about the lowest value found, with .01uF at the top end. If you need a fairly accurate .01uF capacitor this is about the only way to do it!

Polyester

The most common type is the Mullard "Lozenge" type, with striped colour coding. These are in fact metallised polyester, where the basic substrate has had a very thin layer of metal film deposited on it. This gives a much higher capacitance in a smaller case. Values of .01-2.2uF are common, with a tolerance of ± 10 or $\pm 20\%$.

Best used at audio frequencies for coupling and decoupling, they are not able to carry much AC current due to the very thin metallising film. They do have the ability to "self-heal" an internal short circuit, as the thin film is

burnt away by the arc, thus clearing the short!

Polycarbonate

Not so common, but very useful where a capacitor is needed for timing applications. They have a much lower temperature coefficient than polyester, and are much better suited to AC power applications. The actual value is normally printed clearly on the case. For a capacitor in the 1-10uF region with a close tolerance of 5%, they are ideal — except that one could set you back as much as £4!

Electrolytics

Virtually everyone will have come across these in one form or another. Values from 0.1uF up to one whole Farad, in every size, shape and form, for any application.

The most common type are aluminium electrolytic where two aluminium foils, separated by insulating papers, are wound into a roll. The roll is then impregnated with a liquid (the electrolyte), aged and stabilised, then sealed into an aluminium container.

Although useful, they do have serious limitations which must be borne in mind when selecting a capacitor for certain applications. Their leakage current is very high by

comparison with other types, and they cannot be used at high frequencies particularly well. They do not age well, and the tolerance can be as much as +200% on the high side. For AC power line filtering and audio decoupling this is not usually of much concern.

The voltage rating however is of prime concern. All such capacitors are marked with their "working voltage", and this should not be exceeded in any application. The results are often disastrous with leaking chemicals and explosion. During one HF Contest, I had an electrolytic in a Linear amplifier explode (it livened things up if nothing else early in the morning) but the Shack couldn't be used for ten minutes afterwards due to smoke and fumes.

A Few Guidelines

Temperature is also important (usually the maximum temperature is marked — often 85 deg C) — exceeding this can have the same effects as voltage overloads!

Identification is usually relatively easy in terms of value, although sometimes a marking may only be 10/25, which is 10uF at 25V working. Picking a type with a higher voltage rating than required is safer,

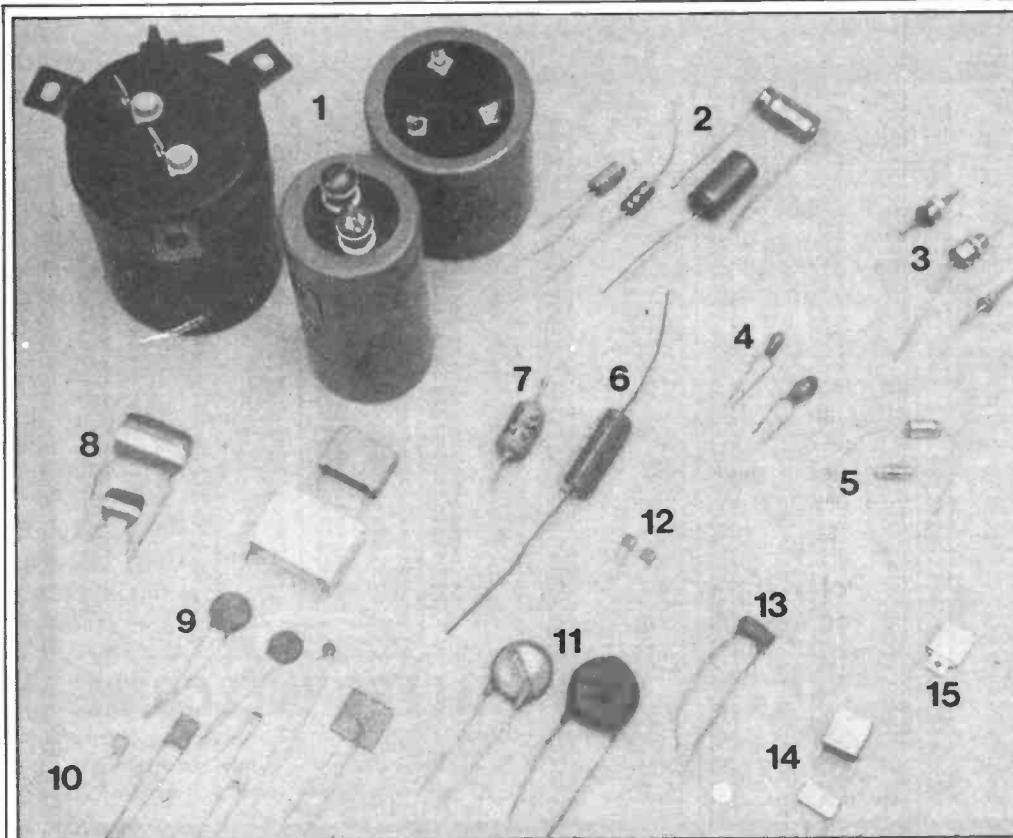
and will not usually cause any problems, other than physical size. In small values at low (50V) voltages, the cases are normally axial or radial. In the former, the leads come out each end of the package, and in the other, both out of end. Radials are a popular choice of PCBs.

In larger values, tags or even screw terminals are common, possibly with a mounting clip for chassis fixing. There are computer grade types in very high values which are ideal for smoothing PSUs. If you need a higher voltage rating capacitor for say a valve Linear PSU, then several values can be made into a series/parallel arrangement to get the required capacitance and voltage rating. However, it is important that each capacitor has a high value resistor across its terminals to level out the voltage across each unit (around 100K is usual, and of 1 watt rating, depending on the actual voltage in use).

Caution . . . NEVER discharge a capacitor with a metal object such as a screwdriver — the capacitor won't like it, and your screwdriver is liable to weld itself to the tag anyway. Use a resistor and discharge it gently.

Tantalum

For small physical size, and much



A Crowd of Capacitors

1. High Value Electrolytics
2. Small Value Electrolytics
3. Feedthrough
4. Tantalum Bead
5. Polystyrene
6. Polycarbonate
7. Paper
8. Mullard C280 Polyester
9. Ceramic Disc
10. Ceramic Plate
11. High Voltage Ceramic Discs
12. Monolithic Bead
13. Tubular Ceramic
14. Polyester (Siemens)
15. Unelco Mica

Taking apart the FT101 Part 4

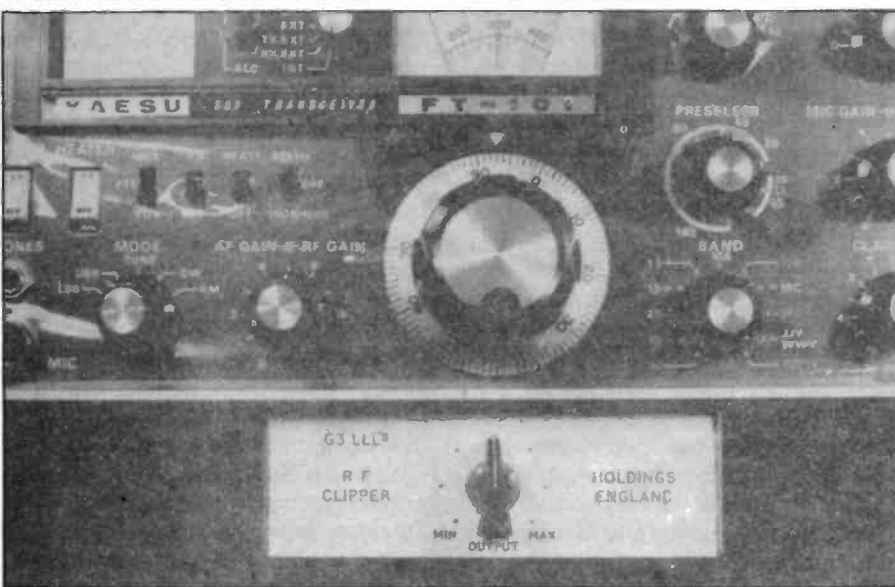
RF SPEECH PROCESSING

Initially the G3LLL RF Speech Clipper was developed to aid my own signals, but very encouraging results led to commercialisation. The circuit of the unit is shown in Fig.A. whilst Fig.B. (printed as Fig.2. in August issue) shows how RF speech processing functions in block diagram form. In

the signal eventually becomes strong enough for the peaks to be clipped by the second set of clipping diodes. Q3 has a gain of about 8-10dB so that if the mic gain is advanced to give a total of around 20dB of clipping this is shared by the two sets of diodes ensuring that neither of the stages can be overloaded. Q4 provides isolation from the clipping diodes, and passes

ping diodes are still in circuit on receive, but this is of no consequence as only a colossal local signal could cause them to conduct. In any case, as they are after the SSB filter, this would not matter. The extra gain provided by the clipper is within the automatic gain control loop, which results in better AGC action. The FT101 therefore has less tendency to overload on strong local signals when the Clipper is fitted. Leaving the Clipper in the circuit on receive produces a noticeable improvement in skirt selectivity. At the time I was told that cascading filters was something that "wasn't done". Now it is a common way of improving selectivity in commercial ham gear.

Harry Leeming, G3LLL, describes two methods of RF Speech Processing and gives simplified alignment details.



the case of the G3LLL Clipper, which is only made for the FT101, input and output connections are made by plugging the unit into the VFO socket, after attaching 3 jumper leads to spare pins.

Circuit Description

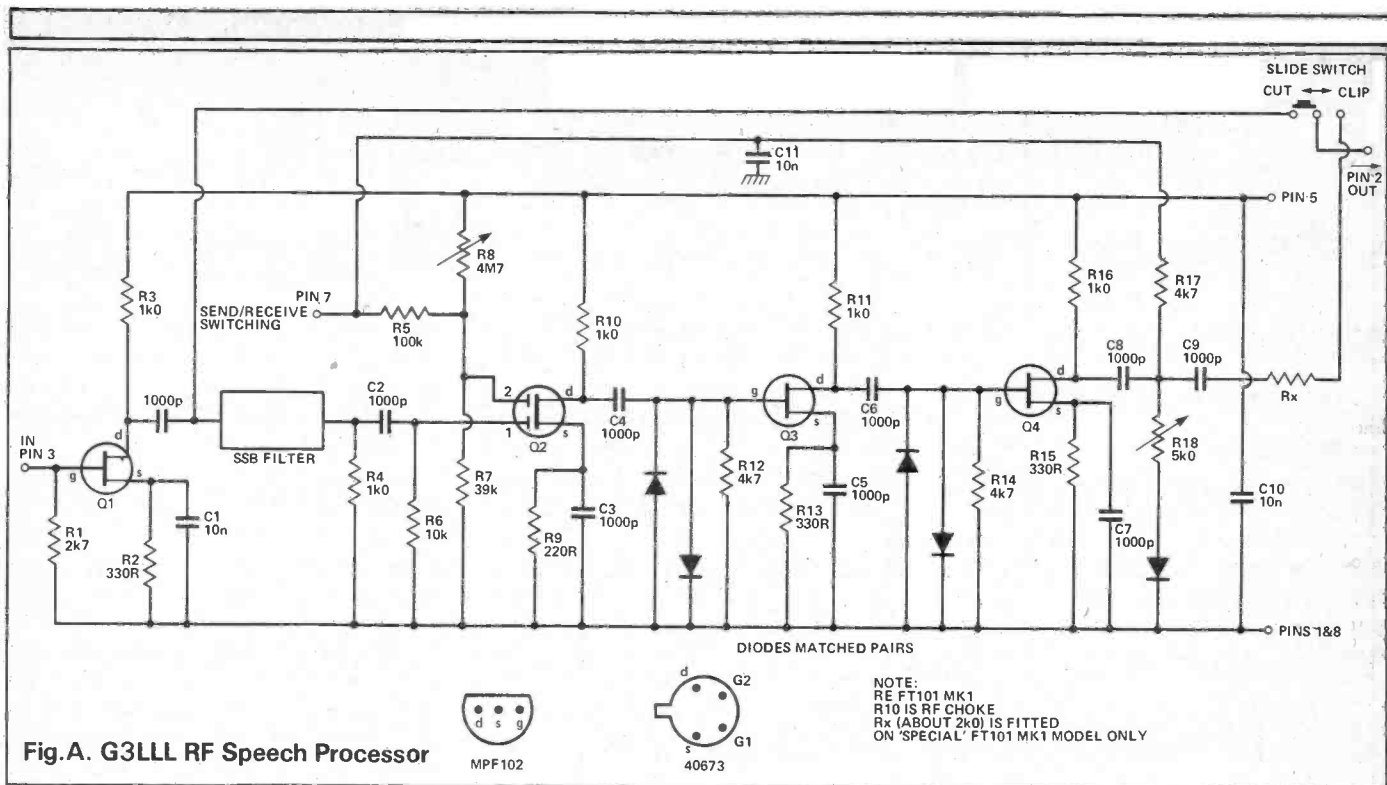
On transmit, the double band suppressed carrier signal from the FT101 is applied to Q1, amplified slightly, and then converted to SSB by the SSB filter. As with any SSB signal, each voice frequency then represents one (and only one) radio frequency, and this signal is further amplified by Q2 and Q3. As the mic gain is advanced

the signal back to the transmitter via the output control. The clipped signal is then processed by the transceiver's SSB filter, thus ensuring that any out-of-channel intermodulation products are removed, giving a clean signal free from splatter.

On receive, the signal path is the same, but the gain is reduced and the output control is disconnected. This is achieved by wiring the clipper to the FT101 Tx/Rx switching circuits, resulting in 13 volts being applied to pin 7 in the transmit mode only. R8 is available so that the receive gain can be adjusted to suit the operator's preference. Concern has been expressed in some quarters that the clip-

Yaesu's RF Processor

A few years' later with the FT101E came Yaesu's RF speech processor which was not a great success at first, particularly as it was necessary to open the lid and adjust an internal pre-set level control with a screwdriver every time a band change was made! The processor was quickly re-designed and a level control (concentric with the clarifier) fitted — the circuit is shown in Fig.C. Yaesu's processor takes the SSB signal after the IF unit, amplifies it by Q1, and clips it in the integrated circuit Q2. Q3 matches the clipped signal to the SSB filter, which removes out of channel intermodulation products. Then the clipped and filtered signal is returned to the transmit chain via Q6 and T3. Q5 acts as a variable resistor in the level control circuit and avoids RF having to be piped direct on the level control on the front panel. When the clipper is switched off, the signal is rerouted via Q4 instead of via the clipping and filtering circuits. Initially, some FT101E speech processors functioned better on one sideband than the other, depending upon the setting of a non-clipped pre-set gain control VR1. The writer traced this to unclipped signals leaking via the inter-



nal capacitance of Q4 and cured it by connecting a 200pF capacitor from the source of Q4 to chassis. This simple modification effectively shorts out any signal when Q4 is electrically off, but is not of low enough impedance to short out signals when Q4 is switched on and is acting as a source follower. From about 1977 onwards FT101Es are factory fitted with this capacitor on the reverse side of the processor circuit board, although it is not shown in the circuit in the manual.

Audio Quality

Properly adjusted, even 15 to 20 dbS of RF processing can sound quite reasonable; why then do some stations using the G3LLL or Yaesu clipper sound a muddy, muddled games? RF clipping does seem to 'amplify' any existing audio faults and the main trouble with almost all Japanese microphones is that they are short of treble. Recent correspondence with Yaesu has revealed that this is not so much because the difference in pitch between the orien-

tal and european voice, but because of different syllable emphasis in the languages. Yaesu are now deliberately 'brightening' the audio on their export equipment.

When using speech processing with older equipment much better results will be obtained if a 'bright' microphone is used together with a series capacitor (about 0.002 u for 50 Kohm input) to roll off the low frequencies. Even fitting this capacitor to the original mic makes quite a difference at the expense of a slight loss of mic gain. From experience, the Shure 444 plus a little extra LF roll off seems about the best mic to use with the FT101, but unfortunately it is getting rather pricey. Funnily enough, at the absolute opposite end of the price range, if you can find an original gold coloured Accos (Mic 43) crystal insert, fit it in the Yaesu hand mic without any matching transformer; you will find this comes a very close second.

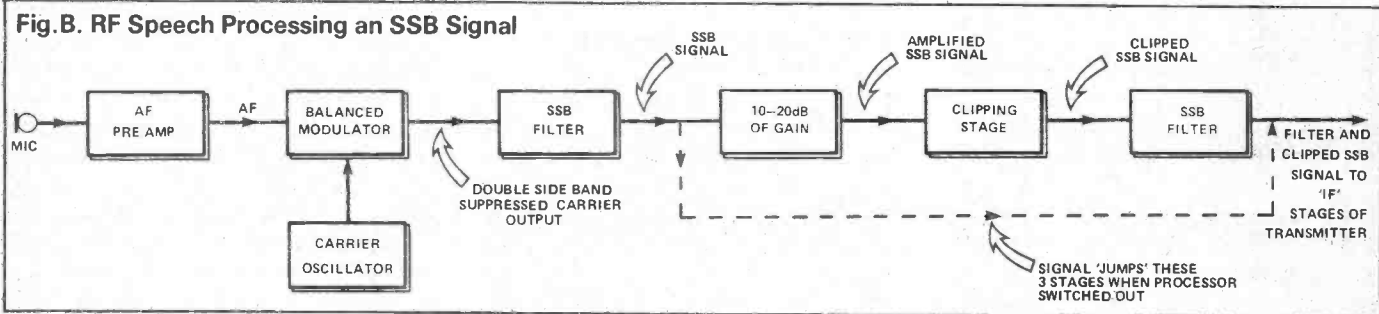
FT101 ALIGNMENT

Correct alignment makes the dif-

ference between mediocre and superb performance with the best equipment, and the FT101 is no exception. Alignment details are given in Yaesu's manual but experience has shown that the full procedure is only necessary if the alignment has been interfered with. In general it is advised that coil cores should be left alone unless there is clear evidence that they have need of adjustment. First, a couple of faults that come under the heading of 'alignment'.

PA and Driver oscillates or exhibits poor neutralization on the 40m band only FT101 MK2 - E. This is caused by misalignment of the extra coil L33 which is switched in on 40m to improve rejection of the transmit 'I.F.'. To cure, melt the wax holding L33 core with a hot iron and then trim until good transmit drive is obtained together with stability. The core is very easy to damage and difficult to obtain so use the correct trimming tool and *do not force it*.

'S' meter does not fall to zero. This effect sometimes only occurs on one side band, and is caused by RF from



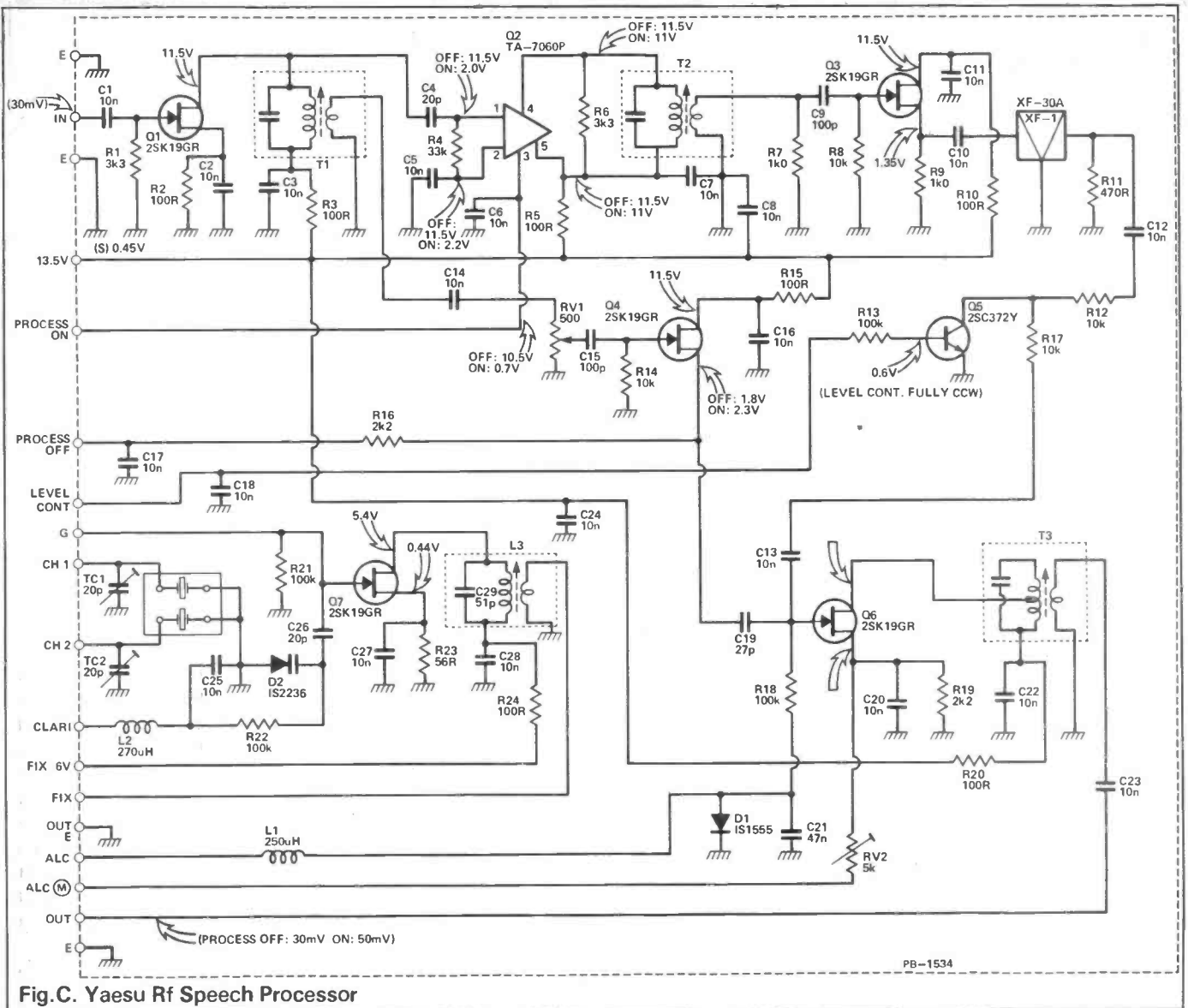
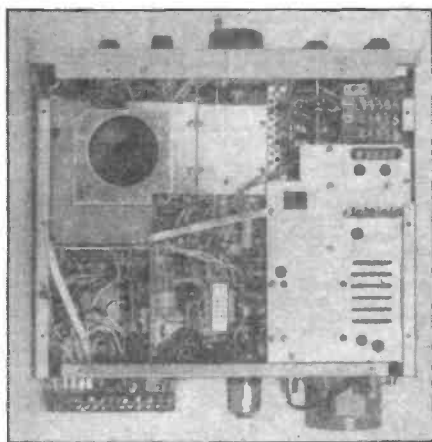


Fig. C. Yaesu Rf Speech Processor

the BFO getting into the AGC system. To cure, carefully adjust the balance pot VR1 in the product detector circuit on the low frequency IF board until the reading disappears. Note that if VR1 is badly out of alignment the receiver will be almost dead with the S meter reading S9 +.

Underside of FT101E



Location Of Adjustments

Yaesu have not done a particularly good job of indenting the various adjustments in the FT101 users manual (perhaps to discourage unnecessary fiddling!). The alignment and adjustment location chart published by the FT Club and printed by their permission as Figs. D and E helps no end, but please only adjust if you really know what you are doing, unless of course you wish to pay me £10 an hour to sort out the mess!

Simplified Alignment

If you are reasonably competent, and your rig is not badly out of alignment the following adjustment procedure is quite simple to follow through, and will normally considerably improve performance on the older rigs which have drifted a little. *Do not force trimmers if they are stiff.*

Try warming *slightly* with an iron but watch you don't melt the solder.

160-15 Metres

(1) . . . Tune to calibration point in centre of band and peak pre-selector for maximum on receive. (2) . . . Leave pre-selector set, switch to transmit, set carrier control to give about 70ma and tune load and PA for maximum RF output. (3) . . . Trim driver anode tuning capacitor on band in use (TC6-TC10) for maximum RF power out reducing drive control if PA current exceeds 100MA. Repeat above once or twice until pre-selector peaks on receive at same point as on transmit. *Compromise for MAX TX drive if necessary.* Note Some makes of 12BY7A will make Tx & Rx peaks differ.

An article describing the modification of the FT101 series for 10, 18 and 24MHz will follow shortly.

10 Metres

(1) . . . Tune to 28.6MHz (or wherever in the 10m band peak performance is required), and tune pre-selector for maximum on receive. (2) . . . Switch to transmit and with a small amount of carrier inserted, tune PA and load and *retune* pre-selector for maximum RF power output, noting as to whether it is necessary to tune pre-selector HF or LF. (3) . . . Set pre-selector half-way between points of peak performance on receive and transmit, and trim grid capacitor TC5 for maximum RF output, reducing drive if PA current exceeds 100ma. Repeat 1-3 a few times until points of peak performance in transmit and receive coincide. Compromise for MAX TX drive if necessary. **Note.** Some makes of 12BY7A will make Tx & Rx peaks differ.

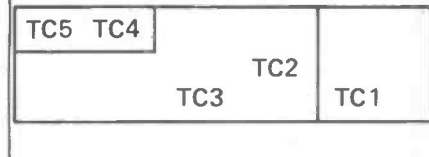
If desired, the aerial trimmer capacitors can be set on signal for maximum receive strength, but this is seldom needed, likewise, rarely will it be necessary to interfere with the coil settings.

Local Oscillator Trimmers If set sud-

denly goes dead on one band (usually 15 metres), slightly adjust oscillator trimmer until unit comes to life. Set trimmers for maximum Rx gain, but not too near point where oscillation ceases.

Band Pass Filter Adjustment — All Modes It is important that the band pass filter be correctly aligned. If it has been altered or if new boards have been fitted, it is important that filter be checked. Proceed as follows: Set transmitter for output on 14MHz into a 50 ohm dummy load. In TUNE position at 14000 KHz adjust PRE-SELECTOR, PLATE and LOADING for maximum power output. *Do NOT exceed IC reading of 200mA.* Adjust carrier control for 200mA. Use transmit mode for minimum time necessary to adjust controls (five seconds at intervals of 10-15 secs). Do not touch CARRIER control after setting. Adjust PRE-SELECTOR PLATE and LOADING for maximum output at 14250 KHz, note IC meter reading. Repeat at 14500 KHz. If readings are much different at these frequencies, 14000, 14250, and 14500 KHz, then alignment of band-pass is required.

TOP VIEW
2nd MIXER BOX BACK



In TUNE position at 14000 KHz adjust PRE-SELECTOR, PLATE and LOADING for maximum output with IC reading of 100mA. Adjust TC3 for maximum. Repeat at 14500 KHz, but adjust TC1 for maximum output. Repeat both at 14000 and 14500 KHz as adjustments will interact. Now check that maximum output at 14000 KHz and 14500 KHz are the same, If not, adjust TC2 as follows: If output is lower at 14500 KHz, increase TC2, if lower at 14000 KHz decrease TC2. After adjustment of TC2 repeat adjustments of TC1 and TC3, then re-check output.

Receive Band Pass Filter. Peak TC5 and TC4 for best signal using internal crystal calibrator of FT101.

PROP. A L BAILEY G3WPO 07918 6149

20 FARNHAM AVENUE HASSOCKS

WEST SUSSEX BN6 8NS

WPO COMMUNICATIONS

Again a full resume of our products — full catalogue on receipt of 50p in stamps, or shortform catalogue for s.a.e. Try one of our kits this Winter — the very best detailed instructions from an award winning design source.

NEW!! 2 METRE FM TRANSCEIVER — The February issue of this magazine contains an article on the 6 channel receiver. Full kit of parts (less channel crystals) priced at £39.50. The 6 Channel Transmitter (1 watt) appears next month at £32.90 (ex crystals). PCB's for either @ £3.80. TX available next month — both units £68 Inc.

CAPACITY-ADD-ON UNIT — What's this? A clever design which enables a Digital Frequency Meter to turn into a Digital Capacitance Meter. Measures from 1pF to lots of uF's. Only two connections needed to your DFM. Complete kit with case & pcb only £18.20. Works off +5 to +15v supply.

VHF PRESCALER — enhance your counter for £8.50! Divide by 10 prescaler which will raise the upper limit of your counter to 150MHz plus (typically 200MHz). Small, and comes with case.

ANTENNA MATCHING UNIT — the only kit on the market. Suitable for SWL's or QRP (up to 5/10 watts). Covers 1.5 - 30MHz, and intended for end-fed antennas or G5RV types. Match your aerial to your Rx and get more signals through. Easy to build and complete with case. £28.50

SIX METER CONVERTER — join in the 50MHz fun and listen with our 28MHz i.f. converter. It is very sensitive, 20dB gain (variable so as not to overload your Rx) and easy to align. +12v needed. All coils prewound. PCB and components mounted on it are £14.00, or complete with diecast box and BNC connectors £19.00

LOW COST TRANSCEIVERS — OUR MOST POPULAR kits with hundreds sold. Two versions — the DSB80 for 3.5 - 3.8MHz, and the DSB160 for 1.8-2.0MHz. Superb receiver (lots of people have been very complimentary about it) with on-board audio amplifier (1 watt). Double sideband (DSB) transmitter and CW with 3 watts or more output. VFO controlled and +12v operation. All built on one pcb and the kit is complete with slow motion drive, but no speaker or mic. Price for either kit is £37.45. We also have a punched case for the rig @ £23.35 including hardware, and if you want to go all the way, a Digital Readout (ready built and which will fit the case) @ £24.10 including mounting bezel. All three items for £79.00. **IDEAL FOR BEGINNERS or QRP enthusiasts or as relief from your Black Box.** Comprehensive instructions are included. DISCOUNTS for Club purchases of 5 or more. These rigs are easily capable of working Eu Dx as many people have proved.

NEW THIS MONTH — OMEGA BROADBAND HF PREAMP. High dynamic range and will suit any Rx lacking sensitivity. PIN Diode switched (not suitable RF Tx power) +15dB gain. +12v operation. Complete kit with diecast box £17.50.

GET ON TO HF WITH OUR TRANSVERTERS — if you have a 2 metre multimode transceiver, then you can use all its facilities (memories, scan etc) on the HF bands BOTH TRANSMIT AND RECEIVE. We have two versions, one for 160/80 & 40 metres, and the other for 20, 15 & 10 metres. Either version just plugs in to the VHF rig, and the unit converts to 2 metres on receive, and down to HF on transmit. Rf sensing for changeover avoids any mods to your rig. Very sensitive when used with any 2M rig and offers 2 watts minimum on Transmit — usually 3 watts (any mode your 2M rig has). Compact unit built on 2 printed circuit boards. It also offers direct frequency translation from your VHF rig dial i.e. 14.213 = 144.213MHz. Kits come complete with the 3 crystals required. Priced at £81.00 for either version (pcb pair only for either @ £8.50). A good example of saving money by building it yourself.

PROJECT OMEGA — we have had an overwhelming response to these kits for a HIGH PERFORMANCE HF TRANSCEIVER, as being described in this magazine, and over 150 people are well into constructing it with lots of complimentary reports on the receiver. Its a bit too complex to describe in full, but offers all HF bands in 1MHz segments, and most of the facilities found on far more expensive rigs. Intended for full break-in CW, but SSB also part of the design. If you would rather know what goes on in a Black Box, then try building it though! It is not cheap, but you should be proud of the result. Briefly, kits available so far are: Central IF Processing Unit (74.50), Preselector (14.85), Notch Filter (12.50), Active Filter (16.65), Synthesised VFO (109.00 inc crystals), Frequency Display (33.00), QRP PA (21.80), Logic/Antenna Switch (solid state 100W — 17.65) and Low Pass Filters (33.00), TX/RX SSB Adaptor/VOX (59.50), HF Preamp (13.50), 100W PA, FM and AM units, VHF transverter, In-Line SWR bridge, and a ready punched and screened case (Feb/Mar about £25). Diecast boxes for modules are supplied separately. PCB's can also be bought alone if wanted. Full instructions and corrections included. We have a MAILING LIST/NEWSLETTER for this project — ask to be put on it if you are interested in building it.

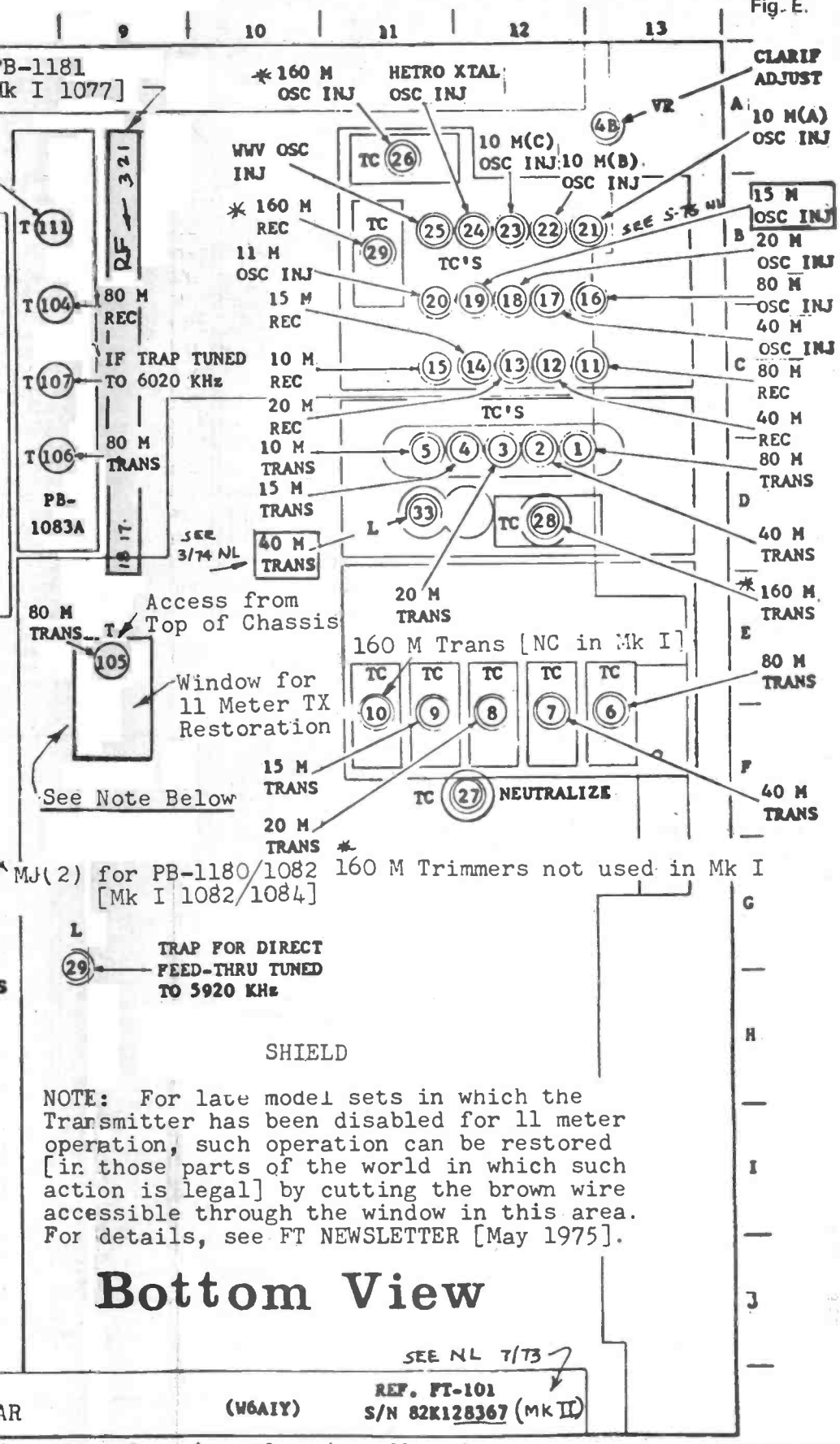
70CM PREAMP — a low noise, very small preamp which could be built into most rigs if needed. Either built @ £8.50 or a kit @ £6.50

2 METRE PREAMP — again, very small and low noise. Kits at £5.00 or ready built for £7.00. Ideal for Phase III satellite reception.

All prices include VAT. Post free over £10, otherwise +60p. Allow 1-4 weeks for delivery if not ex-stock. All kits are complete with components (including bolts etc), pcb's (drilled and tinned), wire and comprehensive instructions. Alignment/debug service available. EXPORT — please write for prices. **CASH WITH ORDER — MAIL ORDER ONLY. TELEPHONE MON - FRI 10am - 4pm.**

COMING SOON — More single band TRANSCEIVERS 160-10M. Watch this space for details.

Fig. E.



This service and alignment control layout is reprinted courtesy of the International Fox-Tango Club and Mily Lowens, N4ML.

NOTE: For late model sets in which the Transmitter has been disabled for 11 meter operation, such operation can be restored [in those parts of the world in which such action is legal] by cutting the brown wire accessible through the window in this area. For details, see FT NEWSLETTER [May 1975].

Bottom View

SEE NL 7/73
REF. FT-101
S/N 82K128367 (MK II)

For greater convenience in use, pull out this page.

1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9

A
B
C
D
E
F
G
H
I
J
K

YAESU
FT-101
Transceiver

ALL MODELS
[Mark I, II; B & E]

POWER TRANSFORMER

REAR

VR-6 PO ADJUST
ON REAR APRON

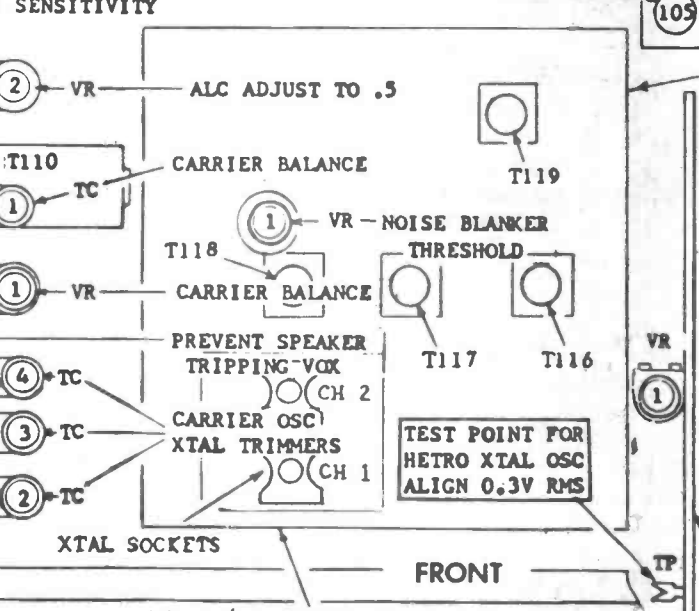
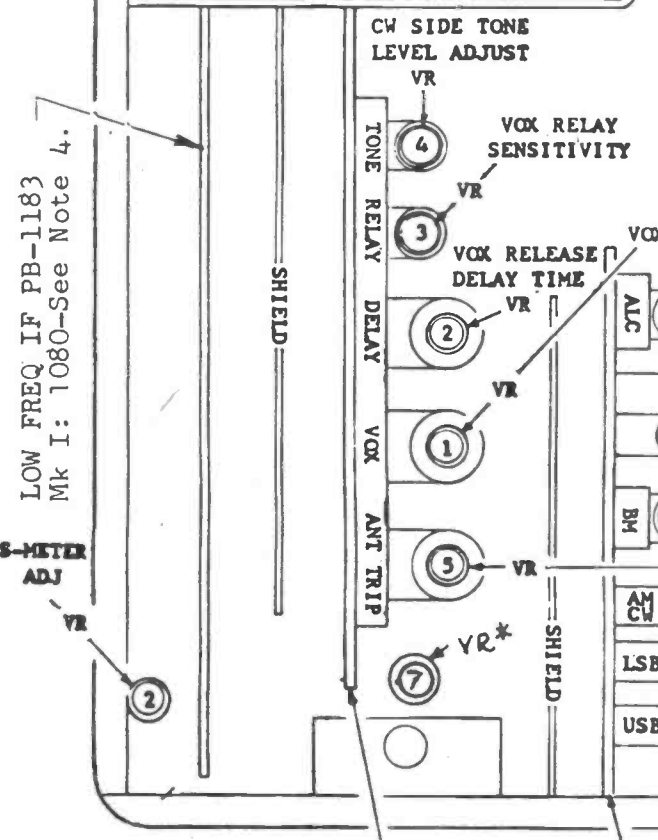
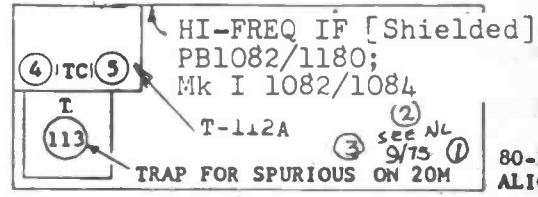
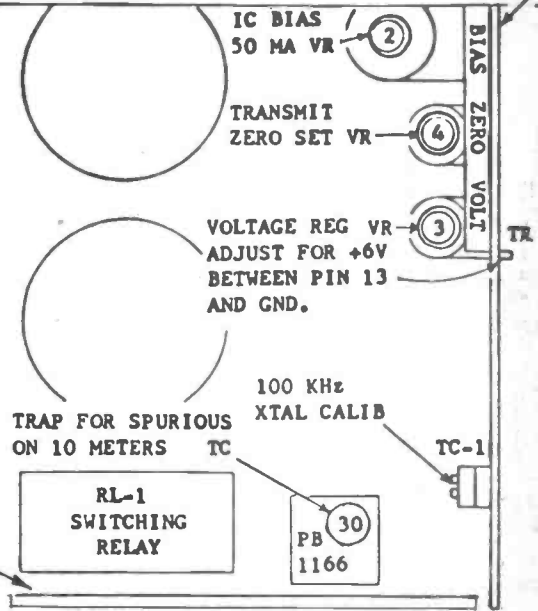
POWER RE
B 1314;

[RECTIFIER UNIT - PB-1076 Below]

B & E Only: NOISE BLANKER
PB-1292 [See Note 4]

RL-2
ANT Relay
[Below]

1. Mark I applies 24000; Mark II FT-101E in June
2. Unless otherwise circuit boards far as is known
3. With few except same in all FT-
4. The Noise Blank type board. The mounted above t board also cont The board in th B; the mark II above the VFO; was part of the
5. Adjustment contr will generally where functions various Noise B originally drawn 128367 - note th It was subsequen other series of



AUDIO UNIT: B PB-1315
Mk II 1189; Mk I 1081

MODULATOR PB-1184
Mk I 1078

NB &/or XTAL CONT &/or
PROCESS (see Note 4). Mk I
1070; Mk II 1182; B 1344;
E 1494 [incl. PROCESS].

* VR-7 [Mk I Only] Sets Mic Control Range

For grea

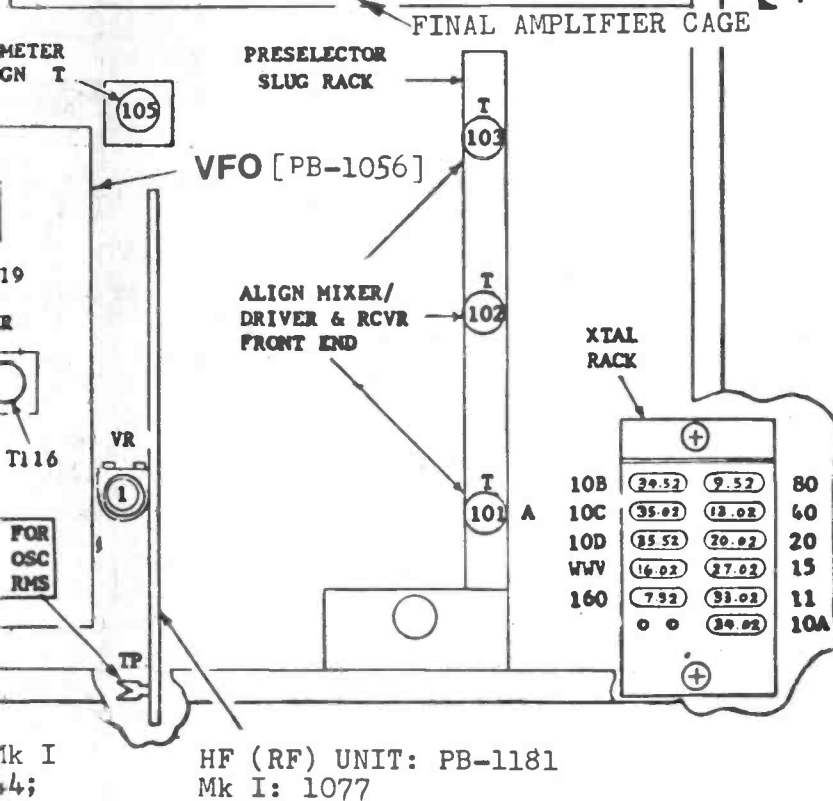
POWER REG UNIT: PB-1185;
B 1314; Mk I 1079

RL-2
ANT Relay
[Below]

NOTES

1. Mark I applies generally to Serial Numbers below 24000; Mark II above 25000, B to introduction of FT-101E in June 1975, E to date. [see NL 7/75]
2. Unless otherwise indicated, PB numbers apply to circuit boards in both Mark II and B series [as far as is known, E also]. Mark I numbers are given.
3. With few exceptions, alignment controls are the same in all FT-101s, early and late.
4. The Noise Blanker in the B and E series is a plug-type board. The separate crystal control board is mounted above the VFO box in the B; in the E, this board also contains the RF Processor unit. The board in the Mark I was similar to that in the B; the mark II board included the Noise Blanker above the VFO; in the Mark I, the Noise Blanker was part of the Low Frequency IF Unit.
5. Adjustment controls on individual circuit boards will generally be the same for all series except where functions are clearly different (as in the various Noise Blanker boards). The diagram was originally drawn for the FT-101 Mark II (S/N 82K-128367 - note that only the last five digits apply). It was subsequently adapted for use with the other series of FT-101s.

Top View



Service & Alignment Control Layout

Designed and Drawn by
Frank W. Sechrist W6AIY

Edited and Adapted by
Milton Lowens WA2AOQ

Published by the



Adjustment of Slugs, Trimmers, Pots, etc.

Slugs. These are adjusted by inserting the plastic trimmer tool into the hexagonal hole and rotating the tool. First, however, the wax used at the factory to lock the slug must be softened by carefully inserting a short length of heated bare No. 14 wire into the hole for a minute or two. To heat the wire, wrap one end around the tip of a small soldering iron. Slugs should turn easily—do not use force! The wax will lock the slug again as it cools.

Ceramic Trimmers. These are locked with unthinned enamel paint. The trimmers are mechanically delicate and easily broken. Use a tool that fits the screw slot well to avoid undue pressure; make adjustments slowly and gently. Usually very little angular rotation is required and the exact position for peaking requires much care.

Can Cores. These are like the ones used in the Preselector assembly: they have a thin threaded brass rod sticking out of the top. They are difficult to adjust except with jewelers tools because the slot in them is so narrow. Also the material used to lock the rods is quite tough—use a solvent like nail-polish remover—some recommend removing the entire assembly of 3 cores while removing the locking material. Use rubber cement after adjustments for locking. If slotted end of rod breaks, force a small brass nut on it and solder it in place—then use a suitable tool.

Circuit Board Potentiometers. These are quite rugged but a properly fitting screwdriver is recommended to avoid the need for undue pressure.

Small IF-type cans. If the hole is full of wax, use the same technique described above for slugs.

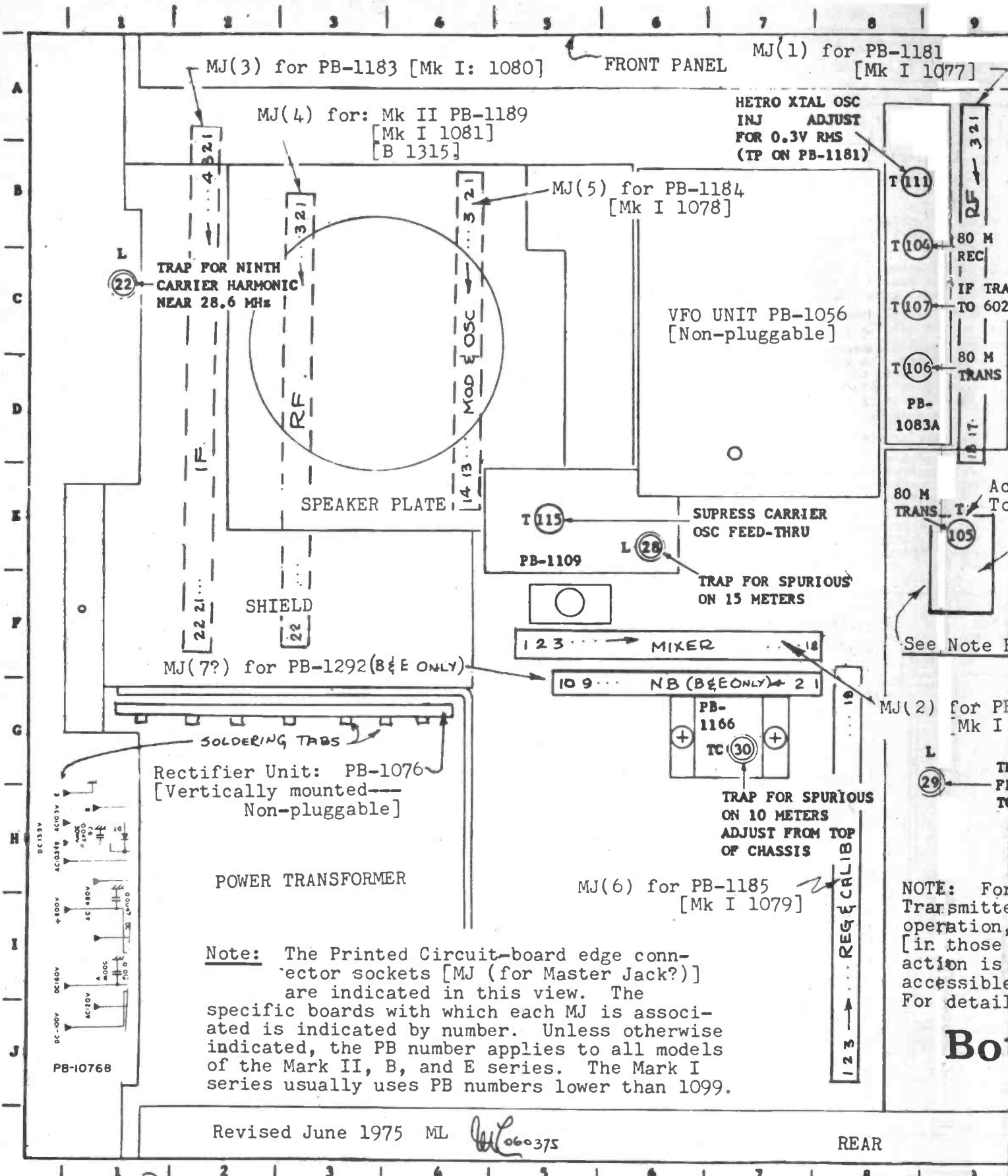
ALIGNMENT: See back of this page.

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3977-F Sedgwick Ave.
Bronx, New York 10463

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Note: The Printed Circuit-board edge connector sockets [MJ (for Master Jack?)] are indicated in this view. The specific boards with which each MJ is associated is indicated by number. Unless otherwise indicated, the PB number applies to all models of the Mark II, B, and E series. The Mark I series usually uses PB numbers lower than 1099.

NOTE: For Transmitter operation, [in those action is accessible For detail

Bo

Revised June 1975 ML *ML* 060375

REAR

Mobile Antenna Multiplexer

Many amateurs' cars are beginning to resemble porcupines; what with broadcast receivers, HF, 10m FM, 4m, 2m and 70cm all in regular mobile use, there comes a point when the car just cannot take another antenna.

The magic box described here helps to cut the number of 'whips' down to a very reasonable number; in

low capacitance coax cable to the vehicle broadcast receiver. Provision for VHF/FM broadcast was considered but, with poor coverage of the UK by VHF/FM for cars, coupled with the very few car radios that have VHF/FM, the author decided to dispense with the facility. C1 and C5 are important in that they act as LF blocking capacitors — so that the

thus having a high impedance elsewhere. C6/L4/C7 are a conventional pi-network to match the antenna to the CB/10m transceiver.

2m

Similarly to the CB/10m circuitry, L1/C1 are series resonant, this time at 145MHz. C2/L2/C3 may be dispensed with if only FM operation on 2m is required; these components act to broaden the bandwidth of the antenna (on 2m) considerably, permitting operation with reasonable matching from the SSB segment at the low end of 144MHz to the satellite band close to 146MHz.

Construction

Construction of the multiplexer is not particularly critical, but good VHF construction practice, short leads and well soldered joints, is necessary.

C1, C2, and C3 are screwdriver-adjusted trimmers, mounted on two 6BA short screws with the shaft 'floating' (ie, not connected to earth

Have you got more radio gear in your car than you've got room for antennas? Graham Packer, G3UUS, has the answer.

this case, all that is needed is a single 2m $\frac{5}{8}$ wave length for the bands listed above. ($\frac{1}{2}$ or $\frac{3}{4}$ will not do as they are usually DC grounded, a $\frac{1}{4}$ is too short).

LW/MW

In practice, a 2m $\frac{5}{8}$ whip will be found to work as well as any other car aerial on LW/MW. The low frequency signal is fed off via RFC1, 2 and 3 to a Belling Lee socket for taking through

signal is not 'lost' in the front ends of the VHF/HF radio equipment in the car. C9, C10 and C8 remove RF from the feed to the broadcast band receiver and C4 allows the internal antenna trimmer in the broadcast receiver to be set mid range.

CB/10m

The 2m $\frac{5}{8}$ -wave antenna acts as a base-loaded $\frac{1}{4}$ -wave for HF. C5/L3 are series resonant at CB/27MHz,

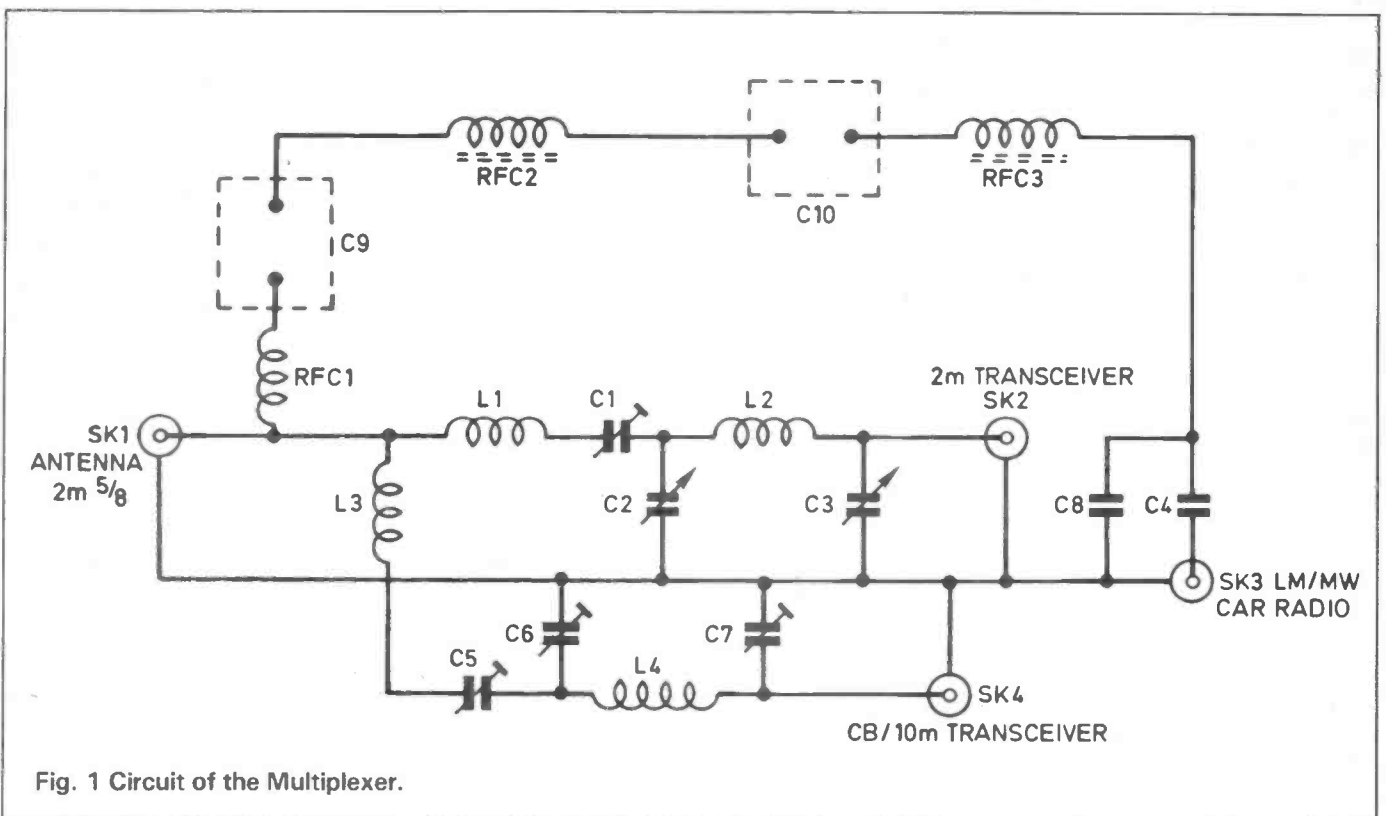


Fig. 1 Circuit of the Multiplexer.

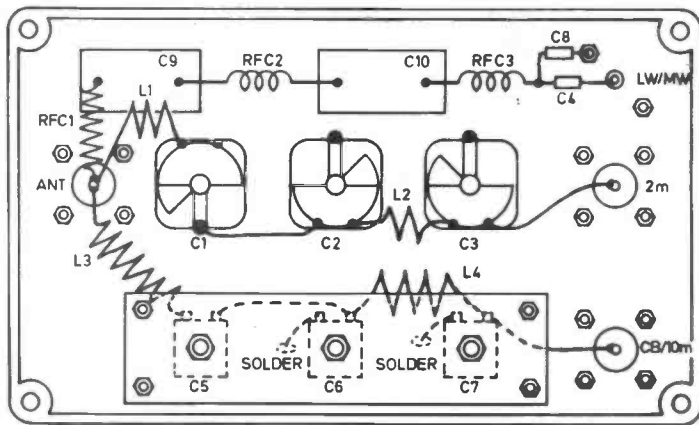


Fig. 2 The Multiplexer is ideally contained in a diecast box 17 x 12 x 5 cm with the circuit constructed on the underside of the box lid. Lower illustration shows mounting for C5, 6 and 7.

or anything else — floating at an undetermined voltage). This means that C2 and C3 have to have their rotor grounded via two M3 screws. Grounded rotor types could be used for C2 and C3, of course, but they are usually not so easily obtained at rallies, emporiums, etc.

C9 and C10 are cut from thin paxolin PCB material by scoring and snapping. Both are made using 1/16" -thick (or thinner) PCB and should be 20mm by 40mm; both are glued to the case. (see Fig. 2).

The edges of C9 and C10 should

be rounded with a file — so that there is no possibility of shorts to ground.

C5, C6 and C7 are 'postage stamp' compression trimmers mounted on a small piece of PCB material on pillars. Most trimmers of this type have the adjusting screw floating, but if it is connected to one side of the capacitor, C5 will need the PCB foil removing around its mounting thread.

Adjustment

Install the multiplexer in a conve-

nient location in the car, making sure that you can get at the adjustments *before* you finally fix the unit in place. The coax to the antenna should be as short as possible, at most 1.5m.

With VSWR meters in both CB/10m and 2m transmission lines, twiddle all trimmers for maximum received signals. The settings of C1 and C5 should be quite critical, resonating in their respective bands.

Switch the CB/10m set onto 'transmit' and adjust C6 and C7 for minimum VSWR on 2m.

Switch the 2m set onto 'transmit' and this time, using a plastic trimming tool for C1, adjust C1, C2 and C7 (then back, finally, to C1) for minimum VSWR.

There may well be slight interactions between all adjustments, so go back and forth over the above adjustments until you are satisfied you cannot improve on them.

Finally, re-peak the antenna trimmer on your car radio for the new coax.

It should now be possible to natter on 2m, listen to Radio 1 and let the kids use the CB, all at the same time!

COMPONENTS LIST

Capacitors

- C1 50 pF air-spaced trimmer
- C2,3 30 pF air-spaced trimmer
- C4 100 pF disc ceramic
- C5,6,7 500 pF compression trimmer
- C8 50 pF disc ceramic
- C9,10 see text

Inductors

- L1 3t 16 SWG*
- L2 2t 16 SWG*
- L3 10t 20 SWG*
- L4 4t 20 SWG*
- RFC1 12t 22 SWG*
- RFC2 5 uH
- RFC3 20 uH

*Note L1,2,3, and RFC1 are all 10mm diameter, with turns spaced by the wire diameter.

Miscellaneous

- SK1 To suit antenna; SO239 or BNC
- SK2 To suit 2m transceiver; SO239 or BNC
- SK3 To suit car radio; Belling Lee
- SK4 To suit CB/10m transceiver

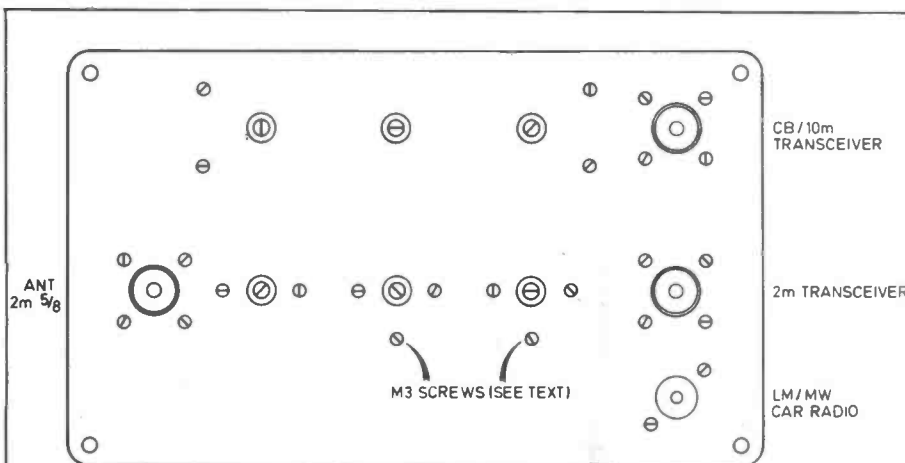


Fig. 3 Component layout as seen from top of box lid.



MOUNT LID IN BOX AND FIT ANGLE BRACKETS SO BOX CAN BE SCREWED IN TO CAR

The Datong SRB2 Auto Woodpecker

To recap, the "Woodpecker" interference which plagues most of the higher frequency bands emanates from 'over-the-horizon' radar based in Russia, but, now, also in the West as well. They are used for long range military warning purposes, such as the detection of moving objects in the shape of ICBM's etc, by reflection

communications receiver systems, as their inference suppression circuitry is usually designed for interference with totally different characteristics.

The other problem is the inconsistent nature of the pulses. By the time they reach your receiver they may be totally different to their original form when transmitted. Due to

The Solution

Conventional blankers are commonly designed to eliminate man-made interference, such as pulse-type ignition noise. This type of interference has a high amplitude, short rise time, and a short duration of 500 microseconds or less. Most blankers get rid of this by looking for this type of short duration, fast rise time pulse and then generate a control signal which shuts off a gate in the signal path. The problem is that Woodpecker signals often look more like conventional signals than interference pulses(!) so the blanker doesn't cope with them very well. The only way this type of blanker works is if it has very high gain, and even then it won't get at the remaining pulses which have lower amplitude.

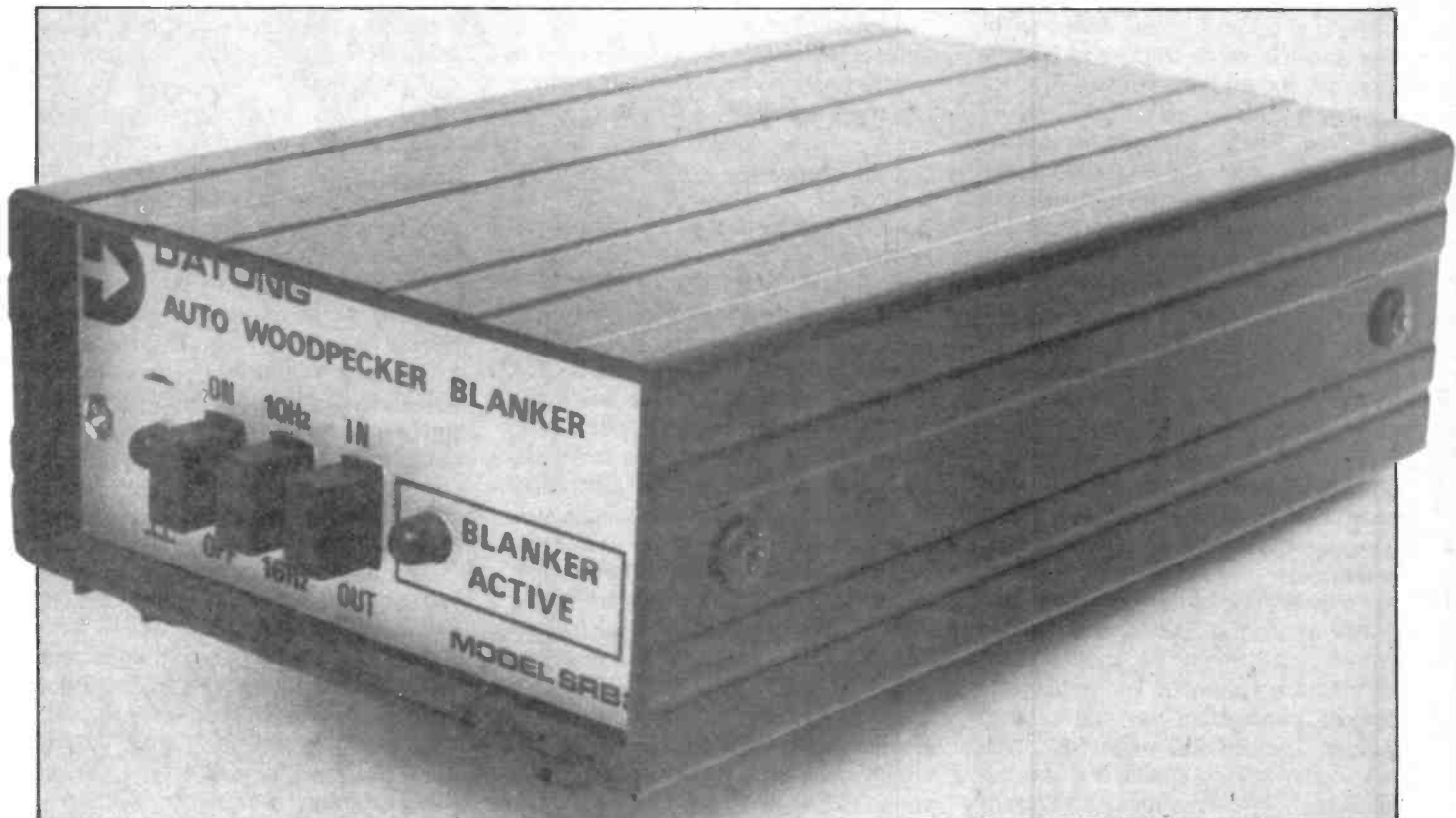
The AEA Moscow Muffler, reviewed previously, used the technique

We had a look at one Woodpecker blanker some months ago — here is another solution to the problem but which attacks the interference in a substantially different manner with better results.

By Tony Bailey, G3WPO.

from the ionosphere. The bandwidth is large, and a pulse repetition frequency of 10 or 16Hz is used, with a pulse width of typically 15uS. These characteristics make it extremely difficult to blank out with conventional

ionospheric reflection they may be stretched, or 'echoes' may be present. There may be multiple Woodpeckers going at the same time — and each pulse may be of different amplitude from the other(s)!!



of synchronising an internally generated 10 or 16Hz blanking signal with the actual Woodpecker signal. As the Woodpecker PRF (Pulse Repetition Frequency) is accurate to 10ppm, this meant that once synchronisation was achieved by means of a front panel control, the interference could be removed.

However, if the pulses were stretched, then the blanking pulse width had to be increased to cope — eventually resulting in audible loss of the desired signal. Also, with two Woodpeckers going at once, only one was likely to be blanked. Despite this, the unit was efficient most of the time — unfortunately even when the Woodpecker had gone if you forgot to switch the unit off!

The Datong Answer

Datong, not unreasonably, do not provide circuit diagrams with any of their products, desiring to protect their designs from being copied (the Woodpecker Blanker is the subject of a Patent), servicing their own products very quickly. However, it is a right pain for a reviewer! Mind you, AEA did not supply a circuit with their Woodpecker blanker either — so one gets used to it.

We will therefore have to limit ourselves to commenting on what they claim for the performance and what actually happens. As with most Datong products, these seem to be one and the same thing and Datong look set for another winner. Let me enlarge on this.

The SRB2 blanker is totally automatic, unlike the AEA model, and herein lies one of its main advantages. No synchronisation, pulse width, or other adjustments are needed in use. It connects into your system in two places — between the antenna and receiver (or transceiver — it copes with normal transceiver RF power outputs by RF sensing using an internal relay), and between the external speaker jack, and a speaker. Again, a difference to the AEA model which only blanked the receiver input, whereas the Datong blanks both RF and audio.

Power requirements are +11V to +16V at around 200mA and the unit comes with most of the required connectors (phono's for audio, DC coaxial connectors for the voltage supply, and SO239's for RF). It is housed in a very smart and durable black case, and as always with Datong



Rear view

products, is very neatly assembled and presented. The internal construction cannot be faulted, with two pcb's mounted back-to-back. A good set of instructions were supplied (although they looked temporary — this was an early release). Front panel controls are ON/OFF, 10 or 16Hz (usually left at 10Hz which is the more common), and IN/OUT (so that the unit can be left powered up, but not in circuit — as described later). A red LED shows when the unit is actually blanking.

Internally, the drop out time is adjustable, as is the threshold level of interference at which the blanker becomes active.

In Use

Datong claim that the blanker will remove virtually all forms of Woodpecker interference, including multiple Woodpeckers, stretched pulses, delayed pulses and even 'peckers that are the same strength as wanted signals. As I said, we don't have a circuit to analyse, but we do know that it compares an internally generated clock, running at either 10 or 16Hz (this is the only switch you might need to adjust), with the repetition rate of the interference. Once a match is found, the unit goes into action, tailoring the width, number and position of the blanking pulses to suit. In theory, this will be a great advantage over the AEA unit, which generates fixed width pulses which may have to be continuously varied manually by the user.

In practice, the Datong theory is upheld. With the unit connected in circuit, once the Woodpecker appeared it was a matter of a couple of seconds at the most before there was no sign of it. With "good" Woodpecker signals (i.e. not stretched or multiple) it was very difficult to even detect the blanking action of the device. With wider pulses, the blanking was still totally efficient, but you could hear a slight 'chuffing' noise as the holes of silence became apparent. Much more preferable than the Woodpecker signals though!

It even works on multiple Woodpecker signals, as claimed, and at near wanted-signal strength levels.

Datong do point out that it will also occasionally lock on to other forms of interference if the repetition rate looks 'right' to the internal circuitry — this isn't a disadvantage though, unless the interference happens to be extremely wide, when there will be so much blanking that the signal will suffer. In such cases, it is better to switch the unit out of circuit.

Conclusions

A marvellous product, well recommended if you have trouble with the Woodpecker — and who doesn't? It has a lot of advantages over other blankers, and the major extra that it is in essence, as claimed, automatic. At around £86 inc VAT it will probably save your frayed nerves when listening for that juicy DX.

QRM KILLERS



MODEL SRB2

is the definitive and long awaited answer to the Russian Woodpecker. Others claim to solve the problem of the distinctive RAT A - TAT TAT of the Russian radar system. **DATONG are the first to succeed with a fully automatic blanker.**

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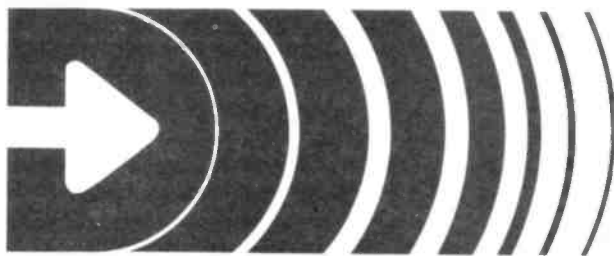
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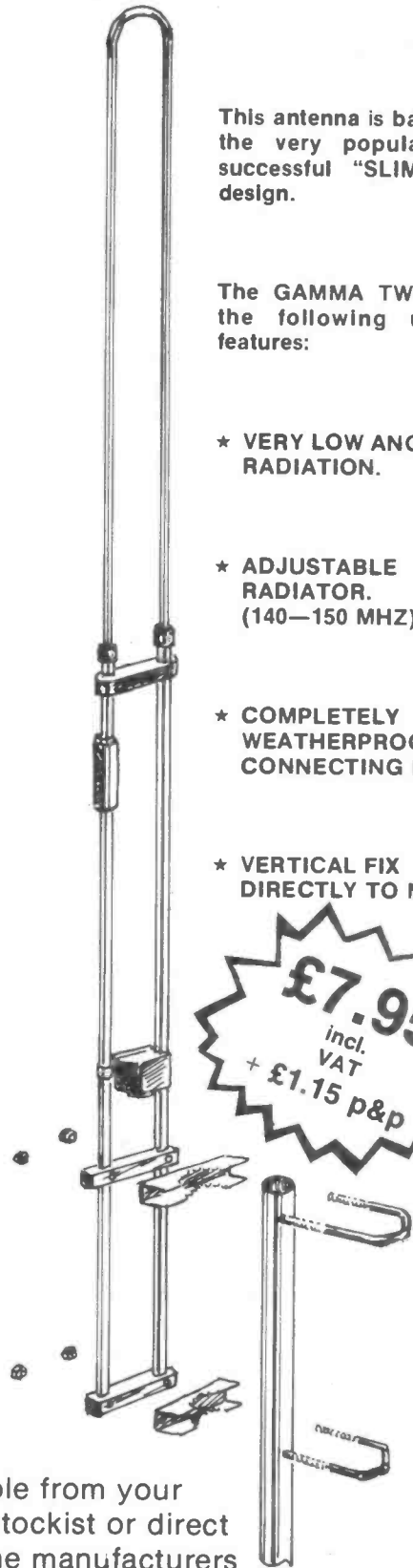


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Semiconductors Explained for the RAE

The word 'semiconductor' is used in two ways: to denote materials (such as germanium and silicon) that have properties intermediate between those of conductors and insulators; and to denote electronic devices (such as transistors and integrated circuits) that use specially treated pieces of semiconductor material.

Although this duality of meaning is technically wrong (the first meaning

required to remove an electron from a bond.

Thermal Excitation

In any crystal, there will be thermal vibrations, and these vibrations are grouped in packets called phonons that have a certain amount of energy associated with them. The average energy of all the packets of

(ie, infinite resistance). Germanium is a much bigger atom and the valence electrons are consequently that much further away from the nucleus, so a lower energy is needed to liberate valence electrons. This results in a slightly larger conductivity, particularly at higher temperatures, which is one of the reasons why germanium is falling out of favour as a material for making semiconducting devices with!

Note that light also travels around in packets of energy (photons) and these generally have much more energy than phonons; as a result, semiconductors can be used as detectors for light (visible, infra-red and ultra violet).

The RAE examination contains some questions on semiconductors – so here's a tutorial on them from Shirley Hesketh, G4HES. But old Gs need not turn the page – this would also be a good opportunity for a little brushing up on the subject!

is the only correct one), it is so widespread that even well-respected amateur radio magazines call the transistors, ICs, etc, needed for projects 'semiconductors'. Fortunately, in the vast majority of cases, which meaning is intended by 'semiconductor' is absolutely obvious from the context in which the word is used.

Semiconductor materials are crystalline – that is to say, they are made up of regular arrays of atoms all tightly bonded to their immediate neighbours (see Fig. 3). If you think of a box tightly packed with, for example, cricket balls, you can get some idea of the evenness of atomic structure.

The bonding between atoms in a crystal is through their valence electrons; as is shown in Figs 1 and 2, silicon and germanium each have four electrons in their outer, valence shell, and in their crystals each will have four nearest neighbours with which it will be sharing two electrons (one from each atom).

Figure 3 is very much a diagramatisation of this bonding, as the structure involved is three-dimensional, not two-dimensional. However, there is one important point which this diagram does show, and that is that the two electrons in each bond are pair-bonded to each other. This means that quite a lot of energy is

energy depends on the absolute temperature of the crystal, but within the average, there is quite a spread. At normal 'room temperature' a few – but only a very small few – have enough energy to break the bonding of the valence electrons, knocking an electron free to move about the crystal (at higher temperatures, there will be more energetic phonons).

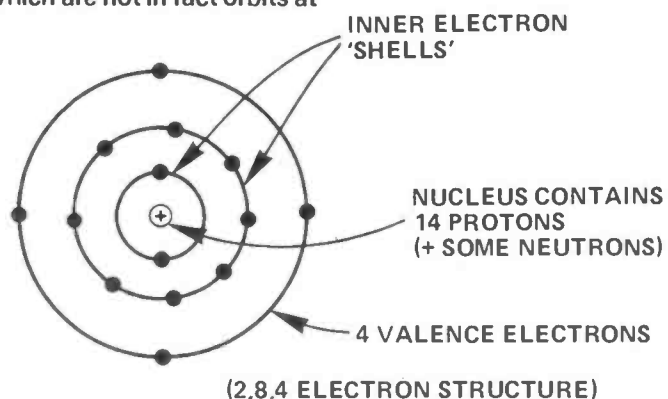
The result of this is that silicon and germanium have a small conductivity at room temperature; in the case of silicon, the conductivity is so small that it can usually be regarded as zero

Holes

When an electron is removed from its bond, by a phonon or a photon, the parent atom is left with a gap or hole, and hence a net positive electrical charge. There is already a certain amount of ambiguity about which of the two atoms involved in the now-broken bond 'owned' the electron – in fact, it is an important physical principle that all electrons are indistinguishable from one another – so the hole could belong to either atom. Additionally, with a little en-

Fig. 1 The atomic structure of silicon; note that this representation is highly diagrammatic; the current picture of the atomic structure of atoms is that the electrons all have different 'orbits', which are not in fact orbits at

all but probability fields; however, the diagram shown is rather easier to cope with, and shows the essential point, namely that there are four electrons on the outside.



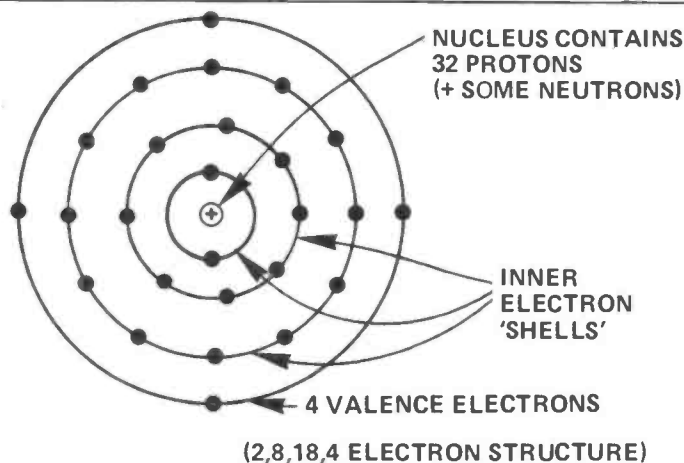


Fig. 2 The atomic structure of germanium, again highly diagrammatic.

couragement (say from an external electric field) one of the neighbouring atoms can give up an electron and become the one with an electron missing. This is possible because one atom will have gained exactly the same amount of energy as the other has lost, so there is no net loss or gain to the crystal. If the electric field persists, further swaps will occur, each of these moving an electron further in the positive field direction.

Rather than thinking of each electron involved in this swapping process as moving a little closer to the positive field, it is easier to think of one single hole moving towards the negative field. Nature is very helpful in this respect because the hole behaves almost exactly as if it were a positive electron.

However, this positive electron always runs the risk of meeting a free real negative electron travelling in the opposite direction. When this occurs, the two are attracted together with the result that the electron 'falls' into the hole; this is called **recombination**.

In semiconducting materials, electrons and holes are called current carriers or, more usually, just **carriers**. Pure semiconductors always have equal numbers of holes and free electrons; however, as will be shown shortly, it is possible to contrive situations where one or the other is very much in the majority.

Doping

Semiconductor devices use doped silicon and germanium. Doping

adds impurity atoms to the intrinsic material in such a way that they fit into the original crystalline pattern, but in so doing they increase either the number of free electrons or the number of holes – but not both! This reduces the resistivity of the material and increases its ability to conduct electricity.

Doping is carried out either with **acceptor impurities** – which have trivalent atoms (atoms with 3 valence electrons) or **donor impurities** which are pentavalent (atoms with 5 valence electrons). Trivalent impurities include aluminium, gallium, indium and boron; pentavalent impurities include antimony, arsenic and phosphorus.

P-type Semiconductor Material

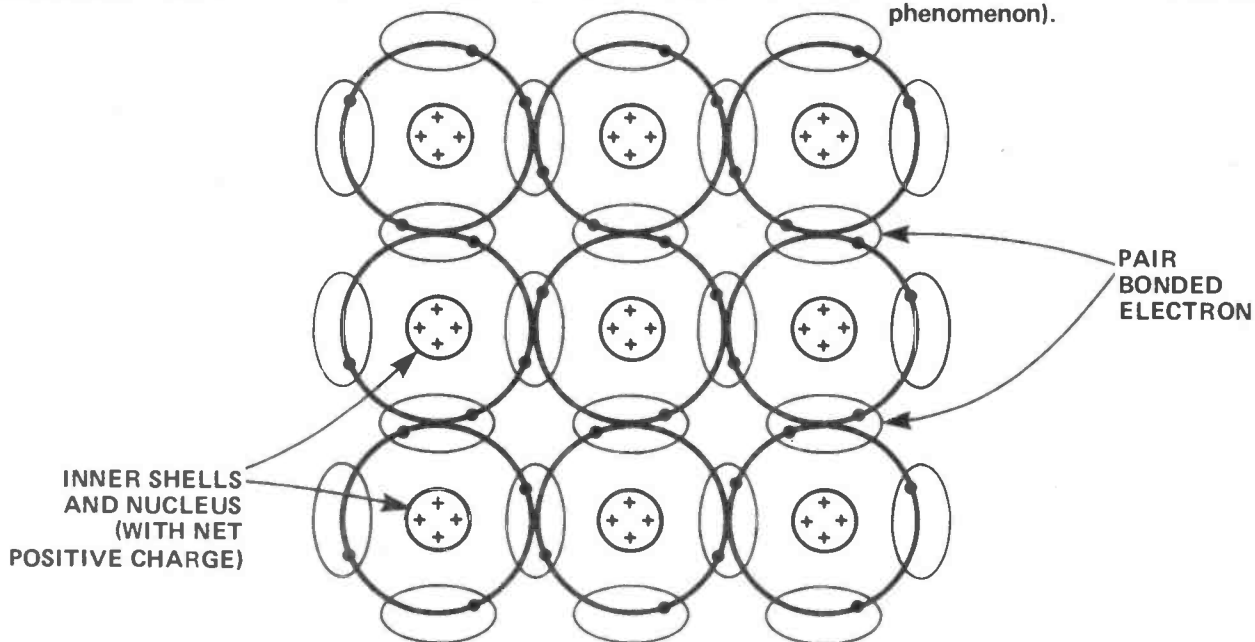
If a trivalent impurity is 'mixed' in with the basic germanium or silicon, the crystal structure begins to look like that shown in Fig. 4(a). Note, however, that the resulting material is still electrically neutral since the number of positive protons exactly balances the number of negative electrons.

Where atoms of the host (or intrinsic) material lie next to atoms of the impurity, there are intrinsic atoms whose valence electrons are not pair-bonded. Since the natural state is for the valence electrons to link in electron-pairs the 'lonely' electron

Fig. 3 A representation of the crystalline structure of a pure semiconductor material. Note that the

valence electrons are held in place by both the electrostatic attraction between them and the protons in the

atoms' nuclei, and the pair bonding with the other electron in the bond (this is a quantum-mechanical phenomenon).



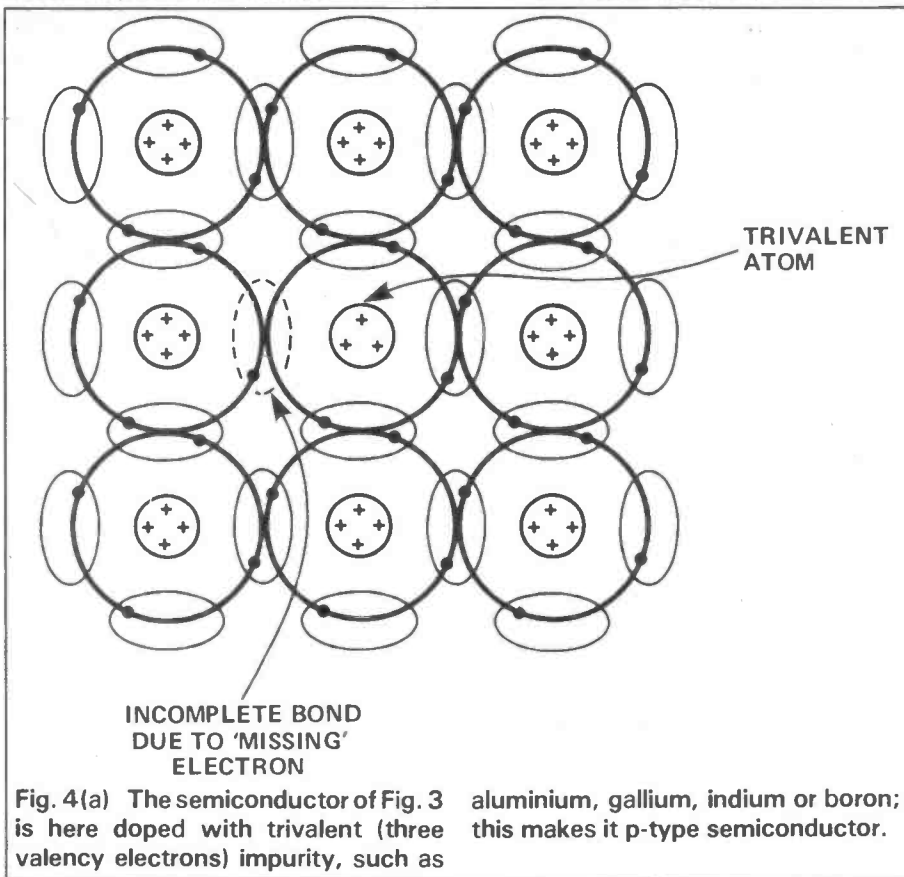


Fig. 4(a) The semiconductor of Fig. 3 is here doped with trivalent (three valency electrons) impurity, such as

aluminium, gallium, indium or boron; this makes it p-type semiconductor.

will try to attract a free electron to pair with. The apparently empty space is, in effect, an 'imitation' hole – it is not a true one in the sense that because it is there it does not mean the atom it is 'part of' has an overall positive charge. In fact if a neighbouring electron is attracted into that empty space the result will be an electron extra in the orbit of one atom (and hence an overall negative charge) while another atom will contain a real 'hole' and hence have an overall positive charge.

However, because the electron of the intrinsic atom requires an electron-pair, it will try to attract a free electron into the pseudo-hole – in other words there is a place ready to accept an electron. Hence the name for this type of impurity is acceptor impurity.

Because the impure material lacks electrons where it would normally expect to have them (in bonded pairs) and because the lack is a negatively charged particle which, if the holes were 'real' would lead to an overall positive charge, the name given to this type of impure material is p-type.

In summary: p-type semiconductor material, while remaining electrically neutral, possesses the ability to attract electrons by virtue of the incomplete electron-pairs appearing in

the intrinsic material where intrinsic atoms are adjacent to impurity atoms.

N-type Semiconductor Material

If a pentavalent impurity is 'mixed' in with the basic germanium or silicon, the crystal structure becomes

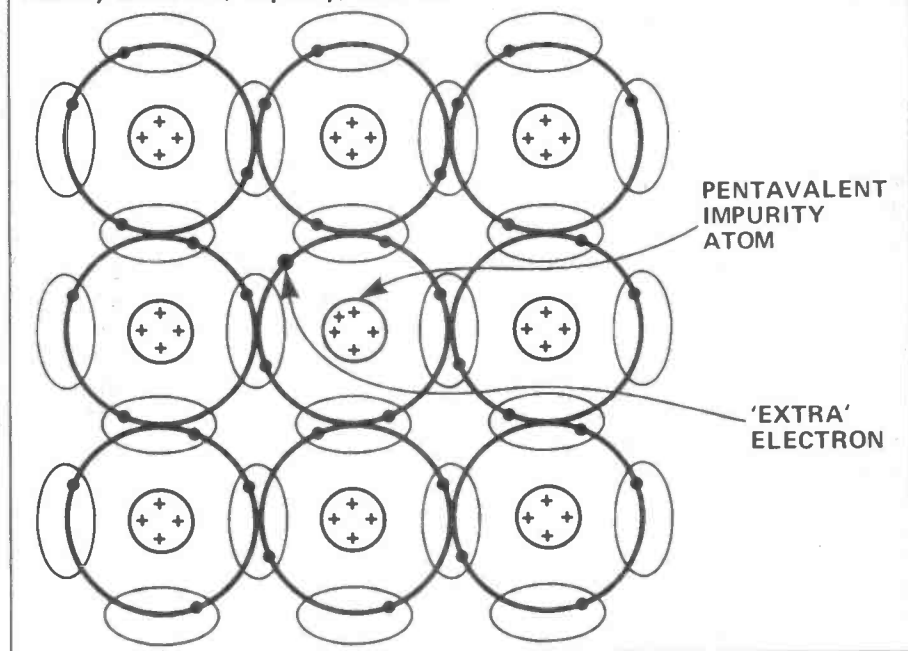
equivalent to that shown in Fig. 4(b). As with trivalent impurities the resulting material is still electrically neutral since the number of positive protons exactly balances the number of negative electrons.

In this type of crystal structure there are many 'lost sheep' electrons – that is, electrons that are not pair-bonded, for which there are no intrinsic electrons (i.e. electrons of the intrinsic atoms) requiring pairs, and which, because they belong to impurity atoms, are not as tightly bound to the nucleus as the intrinsic electrons. In fact these 'lost sheep' can be detached from their parent atoms even by the amount of thermal energy available at room temperature. They can then wander at will through the crystal lattice. Because of this, the n-type material appears to possess extra electrons, or apparently 'spare' electrons. Hence it appears to have an overall negative charge although it is, in fact, electrically neutral. Because it appears to have electrons to 'donate', it is known as a donor impurity. Because it appears to have an overall negative charge it is known as n-type.

In summary: n-type semiconductor material, while remaining electrically neutral, possesses the ability to 'give away' electrons by virtue of the fact that it contains easily detachable (by comparison with the electrons of the intrinsic material) electrons which are not needed for pair-bonding.

Fig. 4(b) Here, the semiconductor of Fig. 3 is doped with pentavalent (five valency electrons) impurity, such as

arsenic, antimony or phosphorus; this makes it n-type semiconductor.



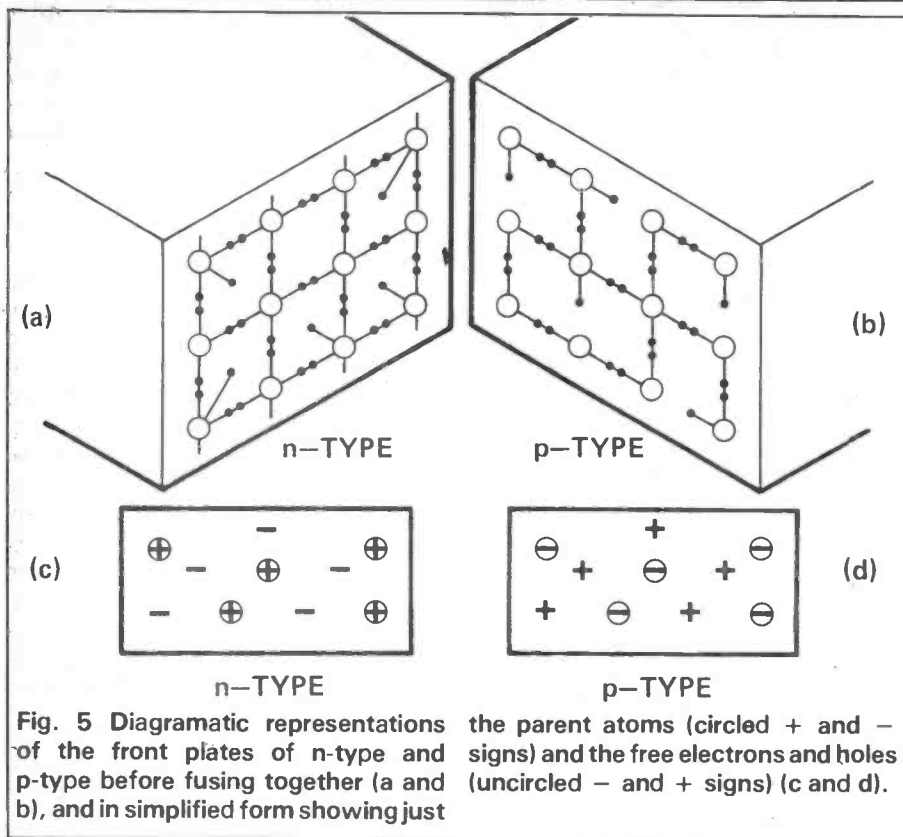


Fig. 5 Diagrammatic representations of the front plates of n-type and p-type before fusing together (a and b), and in simplified form showing just the parent atoms (circled + and - signs) and the free electrons and holes (uncircled - and + signs) (c and d).

The P-N Junction

So far we have only looked at a cross-section of crystalline material. If we consider it in a block, we consider it as a series of parallel plates of crystalline material such as that represented in Fig. 4. This is quite a reasonable hypothesis since coal is an example of crystalline material and coal tends to break up across flat plates!

Fig. 5(a) and Fig. 5(b) represent the front plates of n-type and p-type before they are fused together. The 'plates' behind will be similar throughout the material.

Fig. 5(c) is a diagrammatic representation of n-type material where 'free' electrons have become detached from their parent atoms leaving positively charged ions behind. Circled + symbol represents an ion with a positive charge, each - represents a 'wandering' electron. Similarly in Fig. 5(d) for the p-type material, the cases where electrons have managed to detach themselves from their parent atoms and their pair-bonds and have linked up with electrons in atoms next to impurity atoms, so giving some atoms an overall negative charge (represented by a circled - sign) while leaving genuine holes behind. These holes are represented by the + symbols.

Consider the result of fusing p-type material to n-type material. Fig. 6(a) represents the picture immediately the fusing takes place. At this point the free electrons in the n-type come under the attraction of the genuine holes in the p-type and will feel induced to move across the junction. A short while after fusion they will have done so and we will have the situation shown in Fig. 6(b). Here, the plates in the n-type nearest to the junction contain atoms with an overall positive charge but no spare electrons to cancel out this effect. Hence this layer in the n-type will have become positively charged.

Similarly the front plates of the p-type material will have had their genuine holes completed by electrons from the n-side and consequently will have gained a surplus of electrons and hence a negative charge overall. Because the force of attraction exerted by the 'holes' is limited, the 'holes' farther away from the junction are unable to attract electrons across this charged junction, the remaining free electrons being too far away.

Fig. 6(c) and Fig. 6(d) show the effect if the fused material is now broken open at the junction. In the n-type pentavalent impurities are an electron short and so have become positive ions. In the p-type the intrinsic atoms next to trivalent impurity

atoms have pair-bonded their 'lonely' electrons and consequently gained an extra electron and have become negative ions.

If we now look at diagram Fig. 6(e), the fused materials and the junction - known as the **p-n junction** - are represented. There is n-type material containing wandering electrons but balanced by the number of available holes; then n-type material with holes but no electrons to cancel them out - hence a positive electrical charge; then p-type material containing extra electrons, but no spare holes - hence a negative charge electrical; finally p-type material with 'overmanned' atoms but also enough spare holes to cancel these out.

The charged layer is known as the **depletion layer**. Electrons which cross the junction from the n-side are called **minority carriers**, when they reach the p-side. Holes that diffuse into the n-side are known as **minority carriers** in the n-side.

The depletion layer needs further investigation. It is void of free electrons on the n-side and of holes on the p-side. The resulting electric field set up acts as a barrier to further electron movement across the junction. The name given to the electric field is the **junction barrier**. Because one side has a positive charge and the other a negative charge we have a situation equivalent to that in a battery, where there is a potential difference across the terminals. The potential difference across the junction barrier is, in effect, measured as the sum of the excess electrons captured in the p-side of the junction and the holes left in the n-side of the junction. It is measured in volts and is called the **space charge** or **barrier voltage**. The actual value of the voltage (of the order of tenths of a volt) is also known as the **height** of the junction barrier. It should be noted that the depletion layer is extremely thin!

Conduction

When p-type and n-type materials are fused in this way we have what is known as a **junction diode**. If we now connect a battery across this junction diode with the **positive** terminal of the battery connected to the p-side of the diode, we have a situation where the action of the battery *adds* to the natural inclination of the holes in the p-side to attract electrons from the n-side. In other words there is now *extra pull* on the p-side. It's rather like

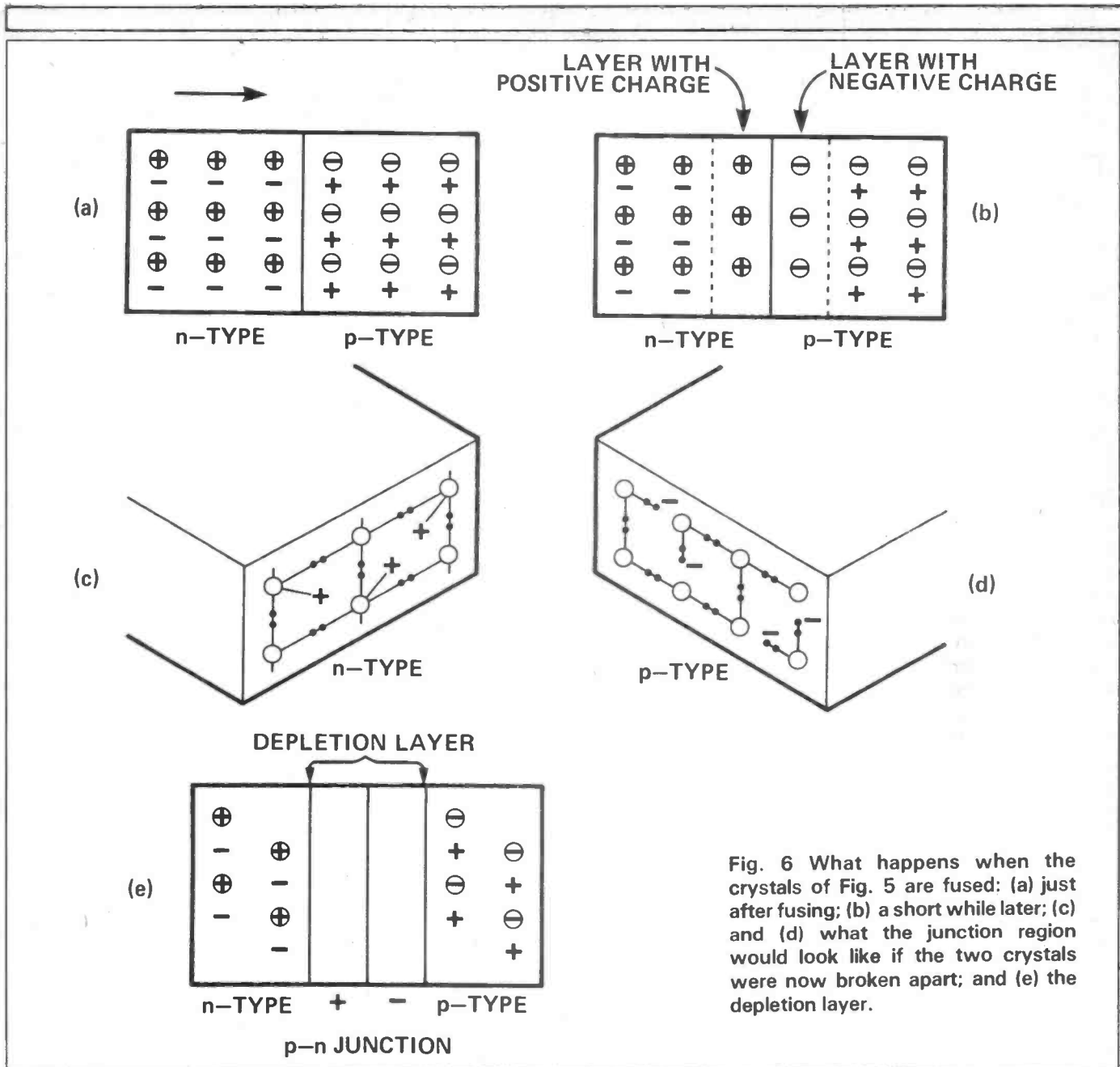


Fig. 6 What happens when the crystals of Fig. 5 are fused: (a) just after fusing; (b) a short while later; (c) and (d) what the junction region would look like if the two crystals were now broken apart; and (e) the depletion layer.

considering a tug-of-war team which isn't moving either way, i.e. at stalemate, so one team cheats by putting on an extra man, with the result that the 'short-staffed' team is pulled towards the overmanned team.

Connecting a battery positive to p-side across a junction diode (Fig. 7a) results in two reactions within the diode. One is that more free electrons are pulled out of the p-side (or you can think of it as more holes being made in the p-side), and the second is that additional free electrons are infused into the n-side. If the battery voltage is enough to overcome the space charge, then the electrons will be propelled into the n-side and pulled through the junction. And, if the pressure (from the battery voltage) is kept up, then, after an initial slow

start, a steady current will flow through the diode.

Having the battery connected with its positive to the p-side of the diode is said to **forward bias** the diode. The circuit diagram for this way of connecting the diode to the battery is shown again in Fig. 7(b), which introduces the circuit symbol for the diode. Fig. 7(c) shows an alternative symbol for the diode; in both cases, the 'arrowhead' of the symbol points in the direction of the conventional current (and also hole) flow.

For a steady current to flow through a forward biased diode, the (voltage) bias applied *must* be sufficient to overcome the space charge of the diode. The space charge for a germanium diode is about 0.25V and for a silicon diode about 0.65V. Hence

the forward bias voltage needed to overcome the space charge and so to give the carriers sufficient forward velocity to get into the opposite type of material is about 0.15 - 0.2V for germanium and about 0.6V for silicon. The reason the required forward bias is actually *less* than the space charge is because the carriers only need to get half-way through the depletion layer to 'cross over' into the opposite type of material.

For lower forward bias voltages, a small current will actually flow across the junction but this current is *very* much less than the current that can flow when the space charge is overcome. When the forward bias voltage just reaches the space charge voltage value there is a rapid (exponential to be technical) increase in current flow.

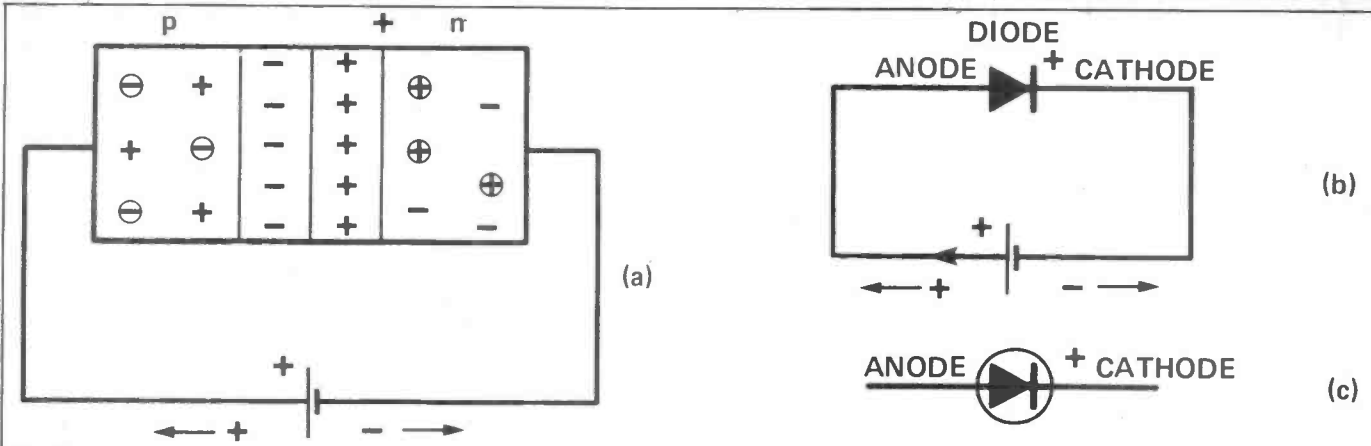


Fig. 7(a) Connecting a battery across the junction diode; (b) circuit diagram for this; (c) alternative symbol for the diode.

The diode is said to **turn on** when this value of forward bias is reached. When the diode is turned on the depth of the depletion layer decreases — though it does not disappear. Except for the **small region** near the junction where recombination is a continual process, the moving holes and electrons are **majority carriers**.

When forward biasing results in current flow through the diode, **conduction** is said to be taking place — but it is *essential* for the injection of electrons into the diode to occur, and for recombination to take place, before there can be conduction.

Non-Conduction

If we now reverse the polarity of the applied voltage (i.e. connect positive to n-side) we have the situation known as **reverse bias**. As shown

in Fig. 8(a), this has the effect of pulling 'free' electrons out of the n-side (hence resulting in a greater overall positive charge), and, in effect, pulling holes out of the p-side. In other words any electrons getting into the p-side (and they are pushed that way) are liable to be captured by the holes with the result that the holes start to disappear.

The overall effect is that the negative charge on the p-side increases. Free electrons will disappear near the depletion layer first — as will holes the other side. Hence the depletion layer will widen. Because the majority carriers are being pulled away from the junction on both sides, no current flow (of majority carriers) will cross the junction and the diode will not conduct. In fact all movement of majority carriers will cease quite quickly.

Fig. 8(b) shows the circuit diagram and Fig. 8(c) shows the effect on the depletion layer. When there is no current flow in the circuit the current is said to be **turned off**. Since the p-n junction diode permits conduction by majority carriers in one direction only it acts as a rectifier. The name diode comes because there are two separate elements.

Storage And Lifetime

If the forward bias on a diode is suddenly reduced to zero, minority carriers will remain on both sides of the junction. Counting in microseconds, a considerable length of time may elapse before these carriers recombine. The minority carriers are said to be **stored** under these conditions — and the length of time it takes for 63% of them to recombine is called

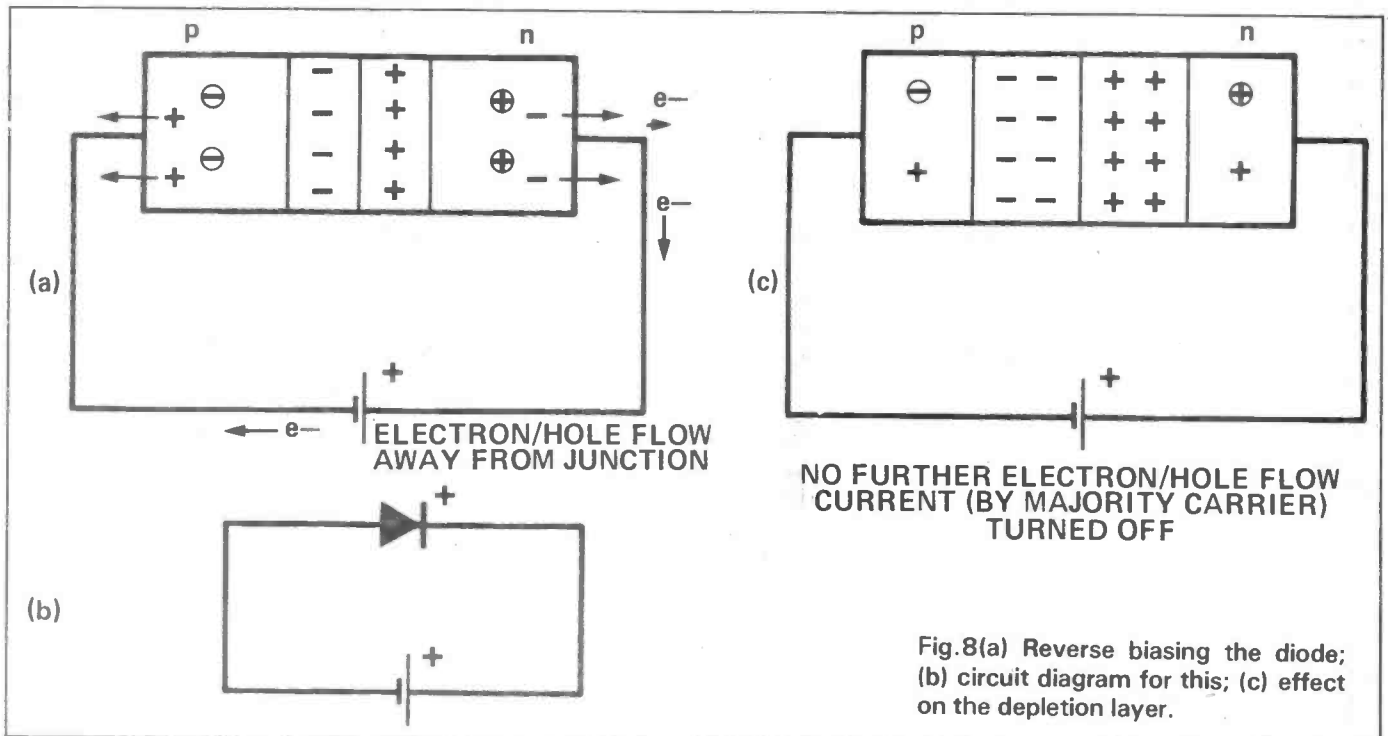


Fig. 8(a) Reverse biasing the diode; (b) circuit diagram for this; (c) effect on the depletion layer.

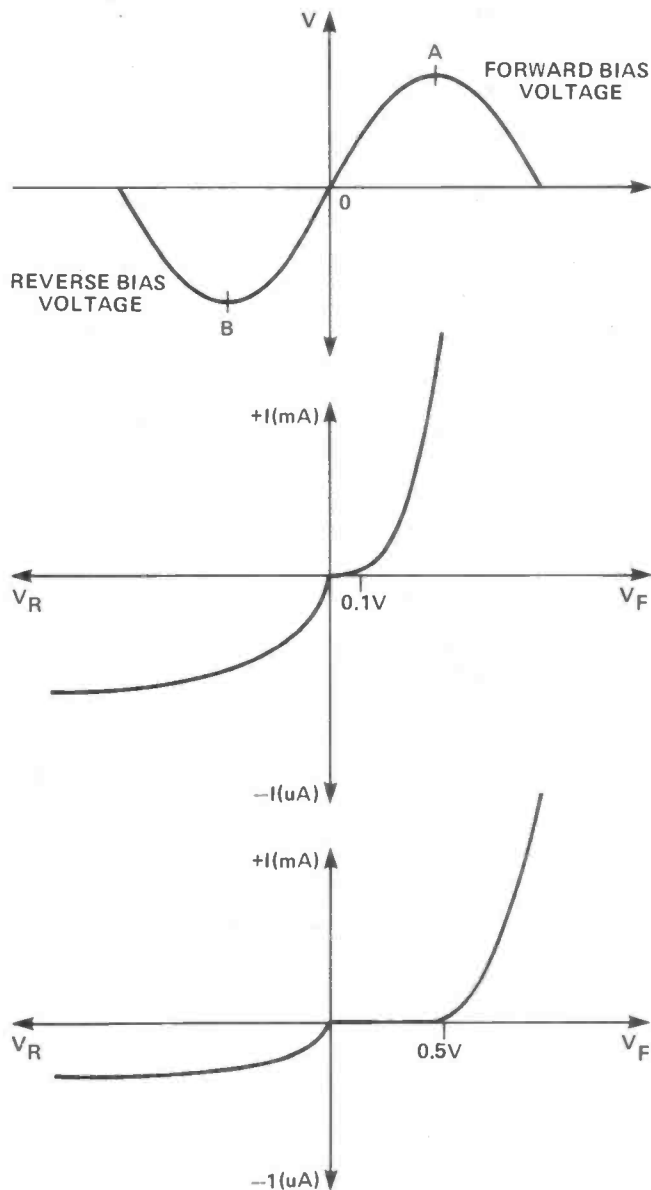


Fig. 9(a) Sinusoidal wave applied to a diode; (b) germanium diode characteristics and (c) silicon diode characteristics; note the different

scales for the positive and negative currents in both of the characteristic graphs.

ed their lifetime.

During their lifetime the stored minority allow current to continue flowing, so conduction actually ceases some time *after* the diode is no longer forward biased. In diodes for use at radio frequencies it is necessary to reduce storage time so that it will not cause circuit performance to deteriorate. It can be controlled by suitable processing of the semiconductor.

Reverse Or Leakage Current

Thermal generation of free electrons is a continuous process in a semiconductor, as we've already

seen. If a diode is reverse biased, so preventing conduction (or current flow across the junction by majority carriers), it will not prevent electrons thermally generated on the p-side (as minority carriers near the junction) being attracted over into the n-side – or prevent holes diffusing over from the n-side to the p-side of the junction. So a small minority carrier current will flow through the circuit. This current is variously known as the **leakage current**, the **reverse saturation current** or simply the **reverse current**.

This reverse current flows in the opposite direction to the majority carrier current of forward bias. Since it is caused by thermal effects, it is essentially constant in amplitude for any

given temperature, regardless of the reverse bias voltage applied.

The reverse current doubles approximately for each 10°C rise in temperature (slightly less in silicon but more in germanium). The leakage current at a fixed temperature is about 100 times as great in germanium than that in silicon. Hence the preference for silicon where small leakage (reverse) current is an important factor.

Diode Characteristics

To plot the characteristic graphs of the diodes we consider the effect on the current passing through the diodes of voltage increasing from zero as forward bias and decreasing from zero under reverse bias.

First we'll consider the effect of increasing the forward bias voltage from zero to the maximum (at A of the sinusoidal voltage waveform). For the germanium diode current won't start to flow until the voltage applied reaches about 0.1V, then it will gradually increase until the space charge voltage is reached – when it will start to increase very fast, and continue in this way.

For the silicon diode, current takes much longer (by comparison) to start flowing. The voltage required being about 0.5V, at which the current gradually starts to flow – increasing slowly until the space charge voltage is reached and then increasing rapidly.

Almost the opposite occurs when the diodes are reverse biased, during the section of the sinusoidal input cycle that has B as its low point. Here, as the voltage becomes more negative, the reverse current builds up rapidly towards its maximum value (although this maximum value is very small in comparison to the forward currents), then rises very slowly after this, in fact just edging closer and closer to this never-quite attained maximum.

If a very high voltage were applied to an ordinary diode, it would cause the diode to break down, and a very large reverse current would flow for the remaining few microseconds of the diode's life!

In the characteristic graphs of Fig 9(b) and Fig. 9(c), note that the larger current flow under forward bias voltage V_F is measured in mA, while the much smaller reverse current under reverse bias voltage V_R is measured in the much smaller measuring unit of μA .

The Fourth Most Important Document

Another year had receded into the millenium. Another amateur radio callbook, the 1982 version, had been consigned to the shelf in the radio room where sat 31 previous

it discloses, demonstrating the huge increase in the issue of amateur transmitting licences which has recently taken place in the UK.

A suggestion for the Christmas stocking by Hack Hum, G5UM.

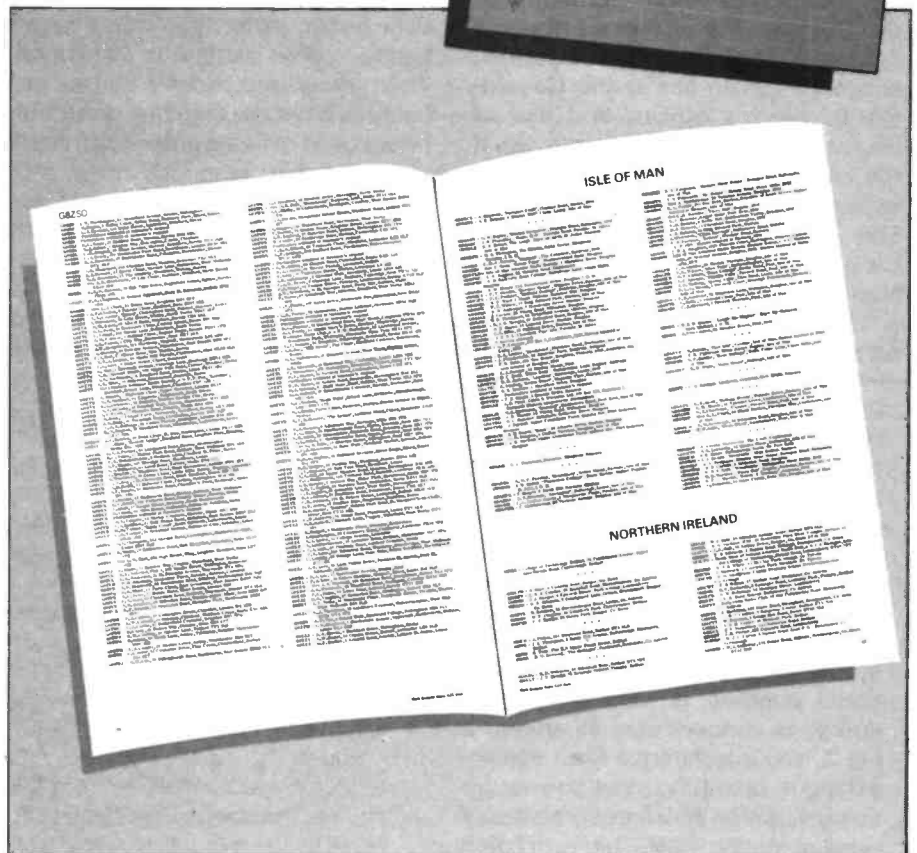
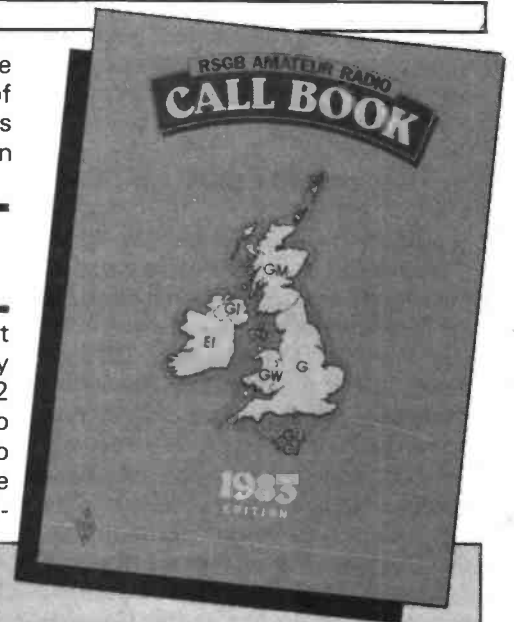
editions, silent sentinels to a small slice of communications history. Then came that day, at the end of 1982, when a shiny new 'Callbook', the 1983 version, was pressed into service as the indispensable adjunct to a metre-wave radioperson's operations. Soon it, too, will be filed but not forgotten in that bookshelf as the brand new 1984 edition supplants it.

To anybody who still happens to hold a prized copy of that tiny blue-covered First Edition of the *RSGB Callbook* of 1951 the contrast between then and now is so marked as to be almost incredible. With only 56 pages plus covers in a small format, plus a few pages of trade ads from firms mainly no longer in existence, the First Edition took in callsigns no farther than the G3I — (yes, I for item) block. The Class B licence was still more than a dozen years away into the future, and VHF was so different then from the way it is now that every contact was an event; valves reigned on two metres, and as for 70cm, it was regarded as almost a miracle if a flashlamp bulb could be persuaded to glow when touched across the output socket of the home built valve transmitters of those days.

Proliferation

In the sense that each edition of the *RSGB Callbook* is 'a slice of communications history' it is worth savouring a few of the facts which

The 1983 edition revealed that Class B licencees had increased by ten callsign blocks since the 1982 edition was published (ie. G6A-- to G6J--), compared with only two Class A blocks. This statistic alone tells the story of the great populari-



ty of the VHF-only 'ticket'.

This condition was maintained during 1983. Calculations which the writer made before the 1984

Callbook was due to appear, suggested that another 12,000-plus Class B licences were issued in the preceding twelve months and are

lined up ready to be taken into its columns – substantially exceeding the total numbers of Class A licences.

For the sake of historical accuracy it should be noted that although the little 1951 blue-cover *Callbook* was the First Edition of today's series, there was in fact, many decades ago, back in the 1930s, an RSGB *Callbook and Diary*, unfortunately just a little bit too pricey for the hard pressed 'hams' of the Depression years to afford in large enough numbers to make it viable. The commercial failure of this early forerunner of the *Callbook* may be due to the fact that there were only a bare 2,000 of us in those days!

'Document Four'

To this particular writer *The RSGB Callbook* has down the years become the second most important document in his radioperson's existence – after the coveted Transmitting Licence itself! – for, it establishes his (or increasingly these days her) identity as nothing else can.

But, wait a moment – there is another document that establishes one's identity even more firmly and indeed legally; the very proof of one's corporeal (as distinct from electronic) existence which lies in the Governmental records offices, and that of course is one's birth certificate. So, if the birth certificate may be regarded as Document No 1 in importance then The Transmitting Licence and *The Callbook* could well lay claim to being Numbers Two and Three.

"Haven't you forgotten something, dear?" came a still small

voice. Indeed one had – or nearly(!): the marriage lines. Remembering that many thousands of radio persons enjoy the blissful state of matrimony one should not fail to acknowledge that after the birth certificate "the next most important piece of paper" is without doubt the marriage document (ouch!). Other claimants might be the title deeds to the home QTH or perhaps the mortgage documents. But let us persuade ourselves, at least for the present, that they are superfluties. What better follower of the Marriage Licence than the Transmitting Licence? Each of them certifies that the holder is wedded for life (or should be!). This puts the Transmitting Licence at No 3 in order of importance closely followed at No 4 by *The Callbook*.

Effective Operation

If any of the foregoing seems like a mere plug for *The RSGB Callbook* perish the thought: it is intended to be a plug – in aid of more effective operating in the VHF/UHF bands, for, without some means of knowing where the other station lies, you have no idea in which direction to swing your beam. What, you don't have a beam, either vertical or horizontal? Then you are out of date! You are probably even worse than that: you could be accused of being anti-social! And if you think that language to be a bit strong, think on the following factor:

Why should any radio ham operating from his home site be so inconsiderate to his fellows that he uses an omni-directional antenna on 2m or 70cm and thereby inflicts his/her

signal on hundreds of others to whom it is not directed?

The answer to the question is often: "I've never thought of using a directional aerial when the thing I've got lets me talk to old Joe in the next suburb, and that's all I want most of the time"; or – "I can't afford a beam aerial" (but you *could* if you followed the simple-to-build diagram for a 4-element Yagi given here in HRT for May, 1983, page 55). Or –

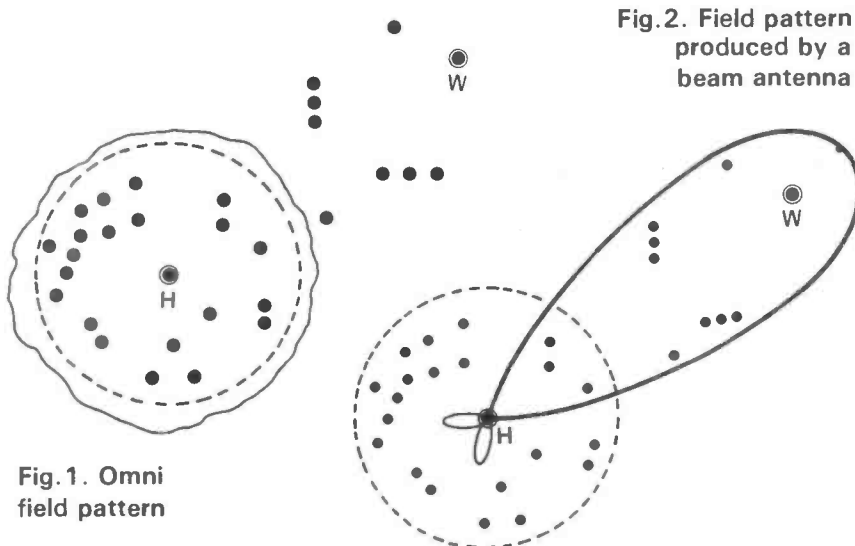
"I can't afford – or, I haven't got the skill to construct – a rotating mechanism for a directional beam". Have you ever tried a few lengths of piping, plastic or metal, stepped into a scaffold-pole base and the lot hauled round by means of a pulley-rope?

Some of these considerations were rehearsed in the May article. Since then the congestion problem on "Two" has become so acute for any reasonable person to declare that omnis *must* be out and beams in.

Which brings us neatly back to the primary purpose of this article: directly you build directivity and *gain* into the station antenna system you will be hearing people you didn't know were there before. You will need to check where they are. Only *The Callbook* can tell you this: the VHF person's best friend after his rig and his log. Definitely document Four in order of importance, say I.

Tailpiece coming up: a chap said over the air to G5UM the other day that he wasn't going to buy a *Callbook* until his own callsign was in it. He invited the riposte – but, of course, over the air, didn't get it – "It's not your callsign you want to look up, stupid, it's the other people's."

In a typical urban locale, there will probably be numerous amateur transmitting stations sited close by and at random (shown dotted) in relation to the home station, "H". When at "H" an omni directional antenna is employed, it produces the ragged-edged field strength pattern, shown in Fig 1, and expends much RF power in essentially unwanted directions. When a directional antenna is installed the RF energy is concentrated as shown at Fig 2, and interference from stations behind it, operating close to your frequency, will be enormously abated. A wanted station, "W", hitherto barely audible, will be detected free of interference from unwanted stations, its identity at once being established from the *Callbook*!



Ham Radio Holiday

If you're like me, each time you go on holiday you probably pack as much of the shack into the car as you can in order to ensure that you don't miss that exotic DX whilst away, to keep in touch with events at home, or just to be able to operate from a different location when the weather fails and there is nothing else to do.

he has in everyday use is new but he has certainly retained some very interesting radio-abilia and has been able to donate several items to the National Wireless Museum on the Isle of Wight.

Ernest first made radio contact on spark in about 1917 from within his school Cadet Corps (using his in-

tials as a call-sign), completing an initial distance of thirty feet: eventually DX was possible over two miles on 440m. Ernest has had a great deal of experience with radio, indeed his father, once a senior PO executive took out a licence as soon after the First World War as they could be obtained – a G2 'artificial aerial' call, with which Ern eventually worked America on 75 meters.

Ernest is possibly the only surviving person to be an honorary founder fellow of the London TV Club (the Royal Television Society) and a founder member of IERE, and he was president of the RSGB just after the last War although, as he admits, mainly because he happened to be about at the time.

The call-sign G6GR was taken out in 1932 and has been in use extensively ever since on many bands under many modes, and currently on all the HF bands, 2m and 70cm. It is surprising that there is any room left in the present shack for anything besides radio equipment, but Ern has other projects such as a fully working home-made electric organ and a computer.

Have you ever noticed that as soon as Christmas is over, tour companies immediately start trying to wheedle out what little money we have left? Trevor Butler, G6LPZ, has been looking at an alternative to those overcrowded Spanish beaches.

One holiday which I recently discovered, however, allows – in fact, positively encourages – you to be involved in amateur radio at your /A location. Listed by the ETB (apparently that's Japanese for English Tourist Board!) as an Activity Holiday Establishment, I found myself at a West Country hotel, the home of Maggie and Noel Tolkien (the latter a relative of *The Lord of the Rings* creator).

The Fairmount House Hotel (née The Fairmount Guest House) is a quiet, small hotel overlooking Chelston in Torquay, sunny Devonshire. Starting life as a Victorian family house, much renovation and decoration took place in order that by 1978 it could open its doors to accommodate guests, and it is now a comfortable eight-bedroomed hotel in the fashionable part of Torquay.

Last year, however, the number of available letting rooms was reduced to seven with the arrival of G6GR. Now there's an old call-sign worthy of further explanation. Its holder, Ernest Gardiner (Ern for short) is Maggie Tolkien's father. Having retired from the midlands where he was president of the Wolverhampton ARS and vice-president MARS for some years, he has now set up his modernised shack in the hotel. Much of the equipment



The Fairmount Hotel

Radio Shack

The shack at The Fairmount is freely open for use by any licensed amateur staying at the hotel and it is very well furnished. For HF, the popular FT101ZD Mark 3 is used, complete with FM adaptor, and, although plans for a cubical-quad would probably be quashed by the Local Planning Authority because of a Preservation Order, existing antennas work well. A trap-dipole at an advantageous height covers the UK on 3.5MHz and most of Europe on 7MHz with impressive results due to the splendid take-off across the Channel. 'Top-band' works well and proves very popular in the West Country on Sunday mornings.

For DX working on the 20, 15 and 10m bands, a trap vertical with



Ern, G6GR, in the well-equipped shack.

radials at about 60 feet is employed and offers many good contacts. For VHF/UHF operation, an FT225RD multimode is available with an FDK700E plus transverter for 70cms, and if my eyes did not deceive me, there is a rig for 11m in the corner.

The walls and numerous shelves of this very homely-from-home shack are crowded with memorable items from radio and television days past, including 200 pre-War QSL cards (some from the first stations

Some of Ern's collection of vintage QSLs.



licensed in various countries and many before prefixes were thought of) and a multitude of radio receivers, televisions and a 1918 SW tuner. The latter is described as a MkIII tuner and is in mint conditions; it was originally used by aircrews for spark contacts to their ground controls, and later by Ern and his father for their first amateur contacts in about 1922.

The morse key, often heard on the air, is a 1917 AT&C double current with reverse polarity and is in fine working order albeit slightly modified to meet today's requirements. An electronic 'el-bug' key is, however, available for those who prefer.



Spark Tx and Rx used by G6GR and his father for their first amateur contacts in 1922.

It transpires that G6GR was legally transmitting television before the BBC, and whilst working professionally in the early days of television, Ernest liaised closely with Messrs. Marconi and Baird. In fact, by 1933 Ernest had set up his first trading outlet, a retail shop in Conduit Street in London's West End, selling early television spares: do any of our readers remember the Radio Reconstruction Company?

Human Comforts

Away from the shack, the hotel is extremely comfortable, facilities excellent, and the food exquisite – not to say plentiful. In fact, one feels part of a large family home rather than a holiday-maker.

Torquay lends itself to be the perfect base for a touring holiday in south and mid Devonshire with an endless list of amenities and attractions within easy reach, both by car and public transport. I thoroughly enjoyed my time exploring all that Devonshire has to offer although I know there is still more to be seen.

Disabled visitors are catered for at the hotel; so too are babies, dogs and vegetarians by arrangement. There is ample parking on site adjacent to the south-facing walled garden, a patio and sloping lawns. Watch out for the picturesque 80 year old magnolia tree in April and May and for passion fruit (!) later in the year.

The Fairmount Hotel is in Herbert Road, Chelston, Torquay, Devon and Ernest may be contacted on Torquay 605446.

HAM

RADIO TODAY

NEXT MONTH

SPECIAL REVIEW!
Icom 271 + muTek – the ultimate 2m performer?
Angus McKenzie applies the magnifying glass to
this top combination!

PLUS

A visit to the National Wireless Museum

Miniaturising quad elements for HF

Belcom LS20/XE 2m hand-held reviewed

Polarisation changer to build – horizontal and
vertical polarisation from a single Yagi

WRITE FOR HAM RADIO TODAY!

We are always looking for new contributors to the magazine and we pay a competitive page rate. If you have built a project or you have some experience that you would like to pass on, or if you have a particular point of view that you would like to get across to others, drop us a line and describe what it is you'd like to write about. We'll get back to you to tell you if we're interested and to tell you all the boring details. Don't forget to tell us your address and telephone number (preferably a day-time telephone number too).

Note that as of the 20th December 1983, we shall be moving the magazine QTH to No.1 Golden Square, London W1R 3AB, tel-phone 01-437 0626.

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73's DAVID GADSDEN G4NXV
Advertising Manager

AERIAL VIEW:

a Helical Beam for 40 metres

There can be few people who are not familiar with the 'rubber duck' type of aerial, a helically wound structure which provides resonance in a

The aerial type is useful at higher frequencies where pocket portable equipment demands mini aerials. However, a much neglected use is at

for the construction of a helical quarter wave aerial for 2m so that scaling can be carried out for other bands. As a rule of thumb, a quarter wave helical element requires about a half wave length of wire wound into an element with a length ranging from between an eighth and a twelfth of a free space wavelength.

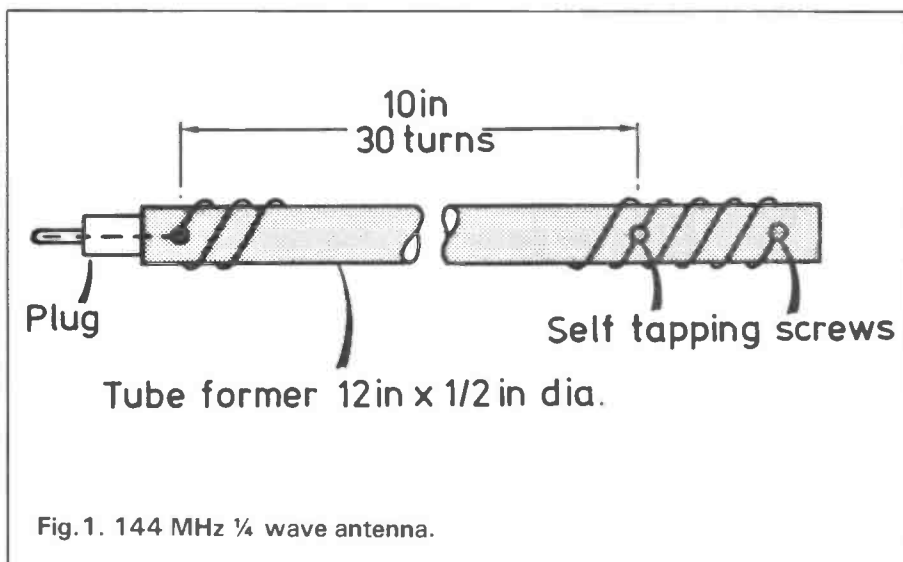
Two joined end to end produce a half wave element which can be coupled to an unbalanced feeder by joining the braid of the feeder to the electrical centre and tapping the centre conductor a few turns up to one side. Resonance can be achieved by coupling a GDO (grid dip oscillator, a device which detects the resonant frequency of a tuned circuit) to the centre turns of the aerial element. Needless to say, the resonant frequency of the element needs to be determined before the feeder is attached. Once resonance is found – the adjustment is carried out by adding or removing turns to the element ends – any feeder impedance can be matched by tapping the centre conductor of the feeder at the appropriate point on the element. This is best found with an SWR box connected in the feeder line and the application of a bit of RF.

Multi element yagis are manufactured by mounting several elements on a boom. The resonance of the

Do you live in a suburban semi? Frank Ogden shows that it is possible to get a couple of quarts worth of aerial into a pint plot.

physically 'short' element. At 144MHz the helical comprises little more than a self supporting steel spring in a plastic rubber sleeve.

lower frequencies where several helical elements can be combined to form a compressed yagi beam. With this in mind, we have provided details



lower frequencies where several reflector and director elements should be determined in isolation, before attaching to the boom. The same design rules apply to parasitic helical elements as pertain to full sized versions: the helical dipole should be constructed for resonance at the operating frequency; the director(s) for a frequency some five per cent higher and the reflector around five per cent lower.

Low Resistance

As a general point, the radiation resistance of an helical element is substantially lower than its full size equivalent. To keep losses within acceptable limits, the aerial should be wound with the heaviest gauge wire possible. Heavy gauge copper wire on a glass fibre pole is ideal. Resistive losses for elements resonating above 30MHz are negligible in most cases. At 7MHz this is not the case.

Element spacings are a bit of a problem. There is nothing which can be done to reduce these without sacrificing both gain and bandwidth. An helical element has markedly sharper tuning than a linear element and the characteristic is accentuated by very close element spacings. Furthermore, close spacing reduces the radiation resistance still further thus increasing resistive losses.

In spite of these shortcomings, very compact, worthwhile designs can be produced with superior characteristics to other aerial types for the same size. It is possible to build a 40m three element beam with excellent directional characteristics into the same size as a three element full size monoband array for 10m. Furthermore the practical gain in the forward direction is considerably higher than most of the standard designs for 40m. I've shown a design for such an aerial which uses varnished wooden poles for the supporting structure. From bitter experience I have found it is not a good idea to put more than about 100W up the spout because local heating causes the varnish to flake. Damp then gets into the wood and the aerial becomes useless! A 144MHz helically-wound antenna is easily made, and can be formed on a 12in length of plastic tubing ½in in diameter, as shown in the diagram, although fibre glass or PTFE tubing would be better and less lossy. A small hole is drilled near to one end of the tube, leaving a couple of inches to spare, eventually to be soldered to the centre pin of the coaxial plug. A second small hole is drilled 10in from the first hole and a self-tapping screw inserted.

Then 34 turns of the wire (18SWG or thereabouts) are close

wound at the lower end of the tube, leaving an extra couple of inches before cutting the wire. The turns will spring open a little but they are then slid along the former, which will tighten them up again, and the 30th turn anchored under the ST screw, the remaining turns being left for adjustment purposes.

Plug In And Tune Up

The coaxial plug can now be fitted by threading the wire through the centre pin, forcing the plug into the tube and then soldering the wire into the pin. If the wire is enamelled the end should be scraped clean, of course, before fitting the plug. It is a good idea to make sure the plug fits the tube before starting construction.

The top turns are adjusted by plugging the antenna into a rig via and SWR meter and adjusting them by pulling them along the tube or compressing them until the SWR is correct. This is best done at around 145MHz for general use unless there is a preference for a particular frequency.

If the tubing is slightly larger in diameter then fewer turns will be needed, and vice versa, and a matter of experiment. Finally, after adjustment, the top turns can be held fast by a spot or two of plastic cement or another ST screw.

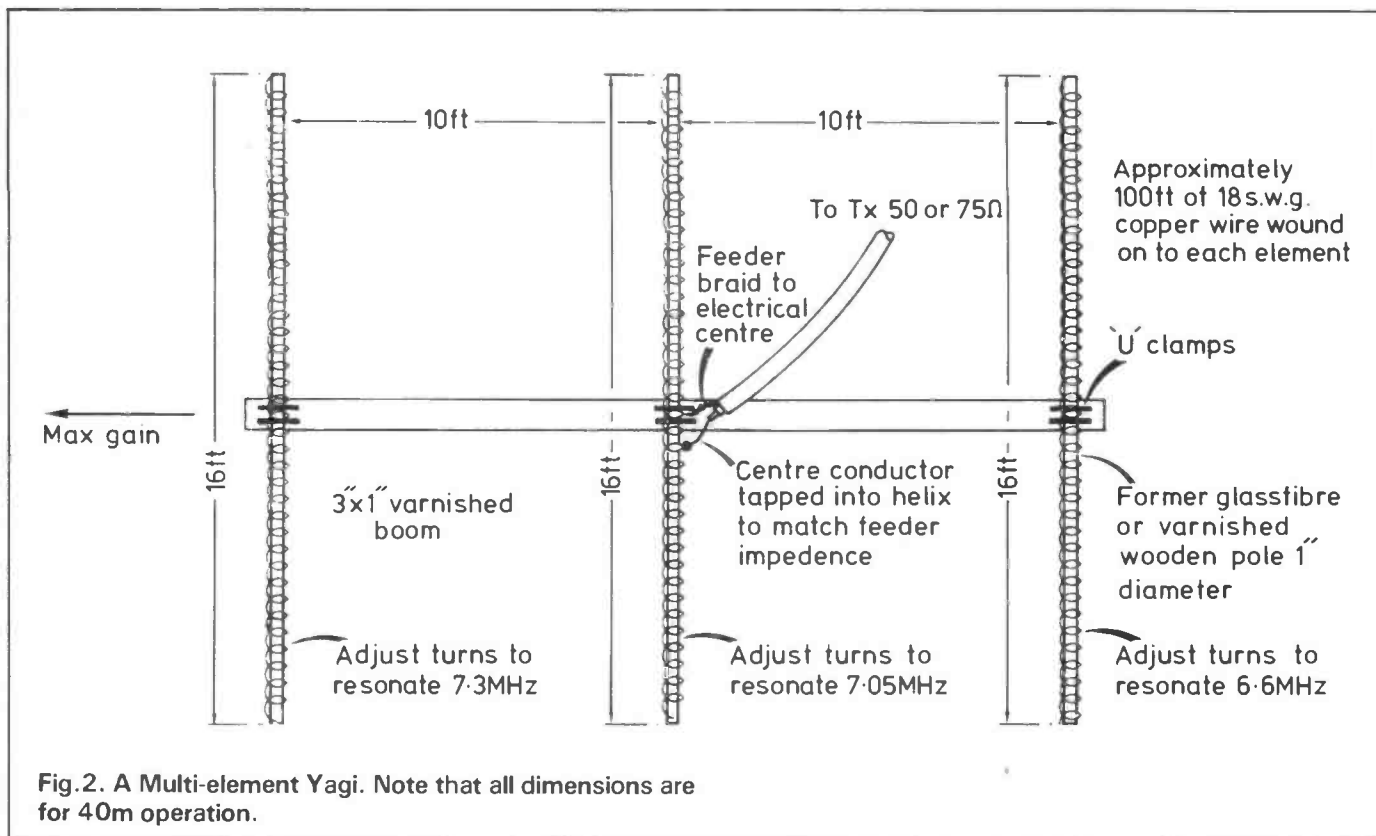


Fig.2. A Multi-element Yagi. Note that all dimensions are for 40m operation.

ALL MODE TRANSCEIVER Project

When Tony and I originally dreamt up the Project Omega transceiver concept, we didn't really think that an RF pre-amp ahead of the mixer circuit would be necessary. Anyway, here it is!

Let us explain a bit more. Omega, as it stands, reached our design expectations of 0.5uV useable sensitivity together with more than 105dB of dynamic range. More than this, the performance is real. Genuinely low local oscillator noise means that this wide signal handling ability is available close in. Other (synthesised) receiver systems claim massive signal handling range but only where the strong, interfering signal is spaced 100's of kHz away from where you are trying to listen. The real world isn't like that. The massively powerful SW broadcasting stations are more often than not just a few kHz away and, as designed, Omega copes with this situation very effectively.

Compromise

You don't willingly compromise this kind of attribute which is why we weren't too keen to add an unnecessary amplifier. The sensitivity may not have been as high as that found in many commercial units but, providing that the aerial system in use is large, then the received atmospheric noise from the aerial would be the limiting factor in determining the weakest signal that can be resolved by the overall systems. Adding further amplification to the set is of no value under these circumstances. It would merely serve to reduce the strong signal handling abilities of the transceiver. However, not everybody is using Omega with a high performance aerial system. Small beams and trapped verticals have been found not to provide enough signal-to-noise to limit the system. A high quality amplifier is very useful here. In practice it causes little deterioration, even with large aerials used on 40m at night.

PROJECT



Part 7

The broadband receive amplifier
by Frank Ogden, G4JST,
and Tony Bailey, G3WPO.

Broadband amplifier

Omega provides wide HF coverage and any amplifier system has to match this. The design chosen

uses a pair of J310 JFETs run in push-pull configuration. Like its hi-fi equivalent, distortion products generated on one side of the circuit tend to cancel on the other. Ideally, the two transistors used should be matched electrically. In practice, this is not too important. The common source resistor R2 tends to balance out electrical imperfections in the circuit.

Transistors Q1 and Q2 are run at around 20mA standing current each (40mA total) placing the operating point on a very linear portion of the slope. The heavy negative feedback provided by R1 and L1 from output to input terminal, combined with the high internal gain of the amplifier unit, largely removes any residual distortion products. The negative feedback circuit, which is of the virtual earth type, also defines the input impedance of the amplifier, but without adding the noise penalty of a resistor connected directly across the input transformer. It is worth noting that the amplifier input only represents a 50 ohm match while its output is terminated into a 50 ohm load. Choke L1 compensates for capacitive phase shift at high frequencies while C1 and C2 provide neutralisation. R3 and R4

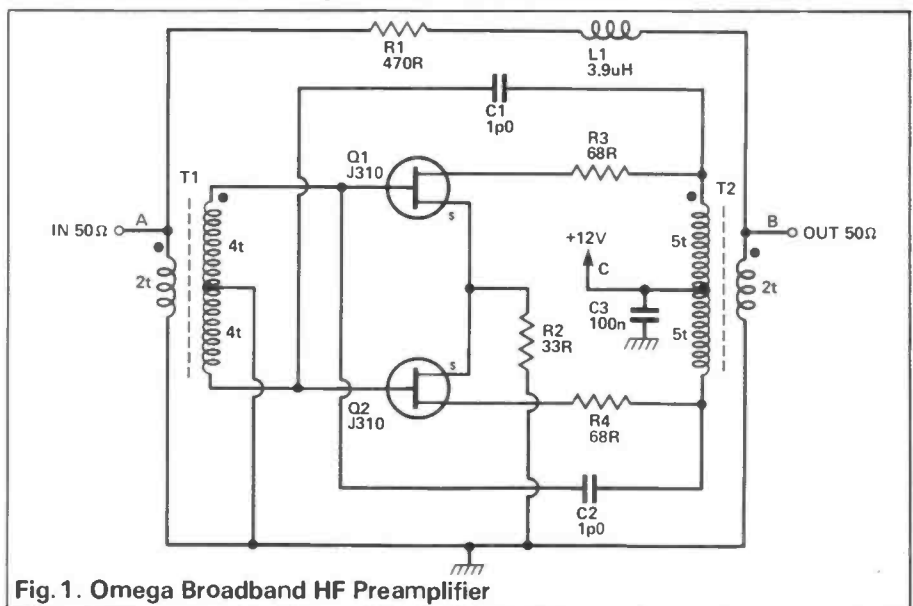
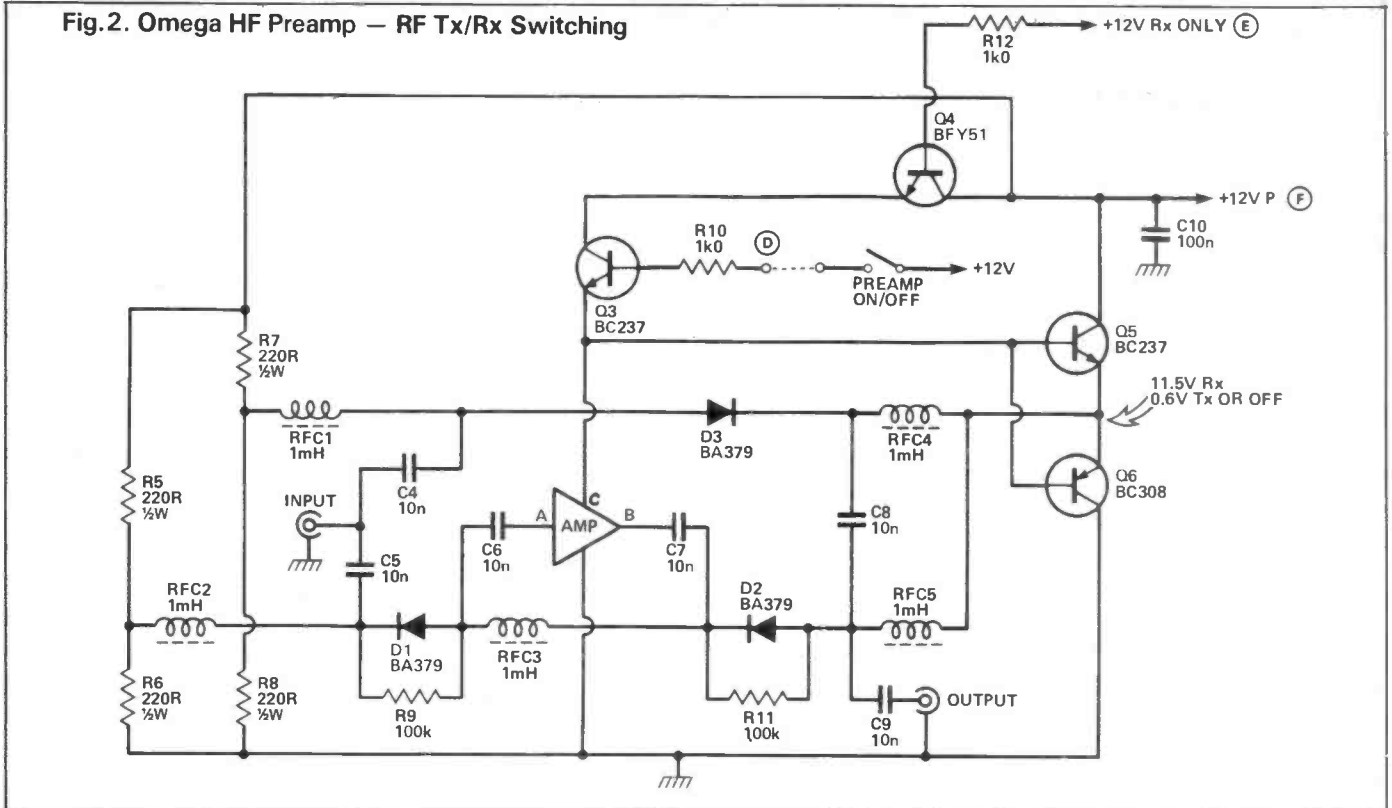


Fig. 1. Omega Broadband HF Pre-amplifier

Fig.2. Omega HF Preamp — RF Tx/Rx Switching



inhibit parasitics associated with the transformer leakage inductances. The amplifier provides a flat gain of 15dB across the HF spectrum when correctly terminated on both input and output into 50 ohms. It has an output capability of +15dBm (about 30mW).

Switching

The pre-amp appears to be rather complex. Well, it is a bit but you can't escape something like it if the RF pre-amp is to be used with full CW break-in. Like the aerial changeover board described in an earlier issue of HRT, all the diode switching could be usefully replaced with relays.* However, modern PIN diodes driven with large amounts of switching current do not appear to introduce either losses or intermodulation products.

In the receive mode (pre-amp on) supply voltage to the amplifier at the emitter of Q3 causes the emitters of the complementary pair, Q5, 6 to go positive. This causes the pair of PIN diodes, D1, 2 to conduct connecting the inputs of the amplifier to the inputs and outputs of the module. Note that the 'earthy' end of this diode chain (separated as far as RF goes by the choke RFC3) goes to a potential divider R5, 6. Current is diverted from R5 to the diode chain. Meanwhile PIN diode D3, isolated to RF by the usual

clutch of chokes, is reverse biased to around six volts by the potential divider action of R7, 8.

In transmit, or with the RF pre-amp switched off, the emitters of Q5, 6 are drawn down to ground causing D3 to conduct, coupling the input and output together i.e. through circuit, while reverse biasing D1,2. This disconnects the amplifier. **G4JST.**

Construction

Although the circuit is shown in two diagrams for clarity, the whole preamplifier and switching is built on one double sided PCB and housed in a small diecast box. If you want to build your own PCB for any reason, the track lengths between the J310 and outputs and the transformers must be kept as short as possible, if the design objectives are to be met and unconditional stability obtained.

As we keep repeating in this series, short lead lengths above the PCB are essential and this will help prevent any 'stability' problems from occurring. (1) Insert and solder the seven 1mm PCB connection pins. (2) Insert and solder the fixed resistors. It is important that R2 is orientated with the body in the position shown. (3) Now wind T1 and T2. These are both wound on two-hole balun cores, and constructed in a similar fashion to the

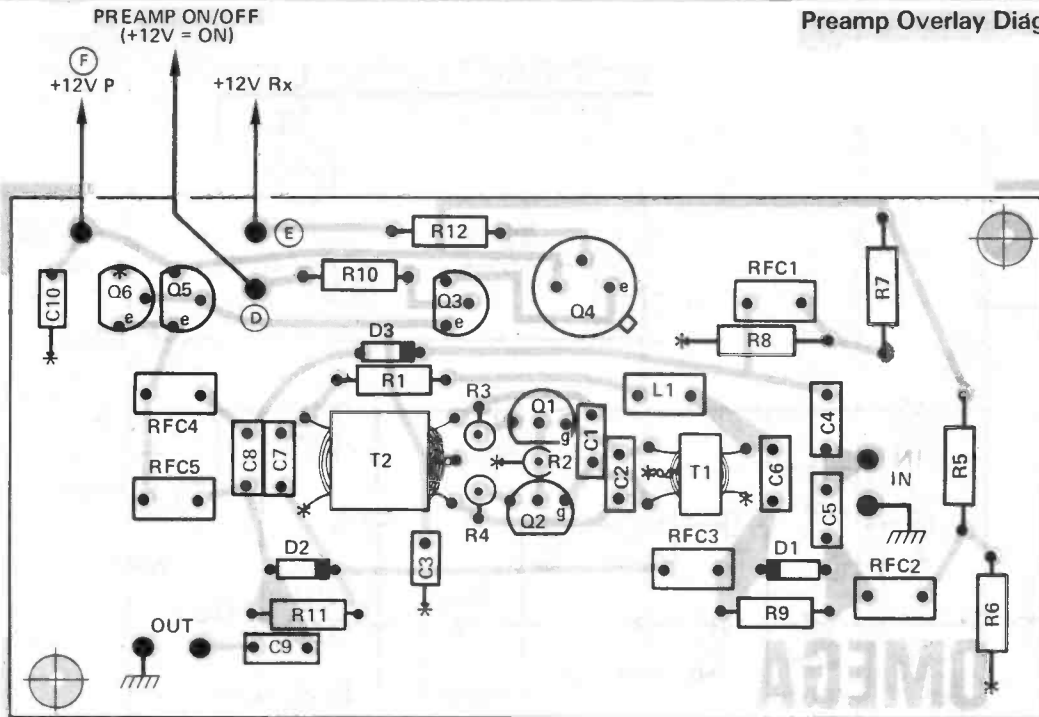
series. As for the rest, one turn is defined as a piece of wire down through one hole and back out the other — so that both leads end up at the *same* end. T1 is wound on a small Fair-Rite core, and T2 on a larger 10mm square core. Keep the earthed leads as short as possible when soldering to the PCB. T1 requires 9cm of wire for each half of the secondary, and 5cm for the primary. T2 uses two lengths of 20cm for the primary and 8cm for the secondary. (4) The remainder of the components can now be soldered into place. Take care that the orientation of the transistor cases is as shown — Q6 has one lead soldered to the top PCB foil. The three Pin diodes should lie flat against the PCB, whereas Q4 must clear the foil to avoid short circuiting (the case is at +12v).

Testing

Once assembled, the unit can be tested, if you have the equipment, using a scope or RF millivoltmeter, and a signal generator. The gain of the preamplifier should be flat between 1.8 & 30MHz at 15dB nominal. Both inputs and outputs must be terminated into 50 ohms for this measurement.

There is in fact little to go wrong, providing the instructions are followed. Some DC checks can be made as

Preamp Overlay Diagram



DOUBLE SIDED PCB, TOP FOIL IS GROUND

- = CONNECTION PIN
- * = SOLDERED TO TOP FOIL

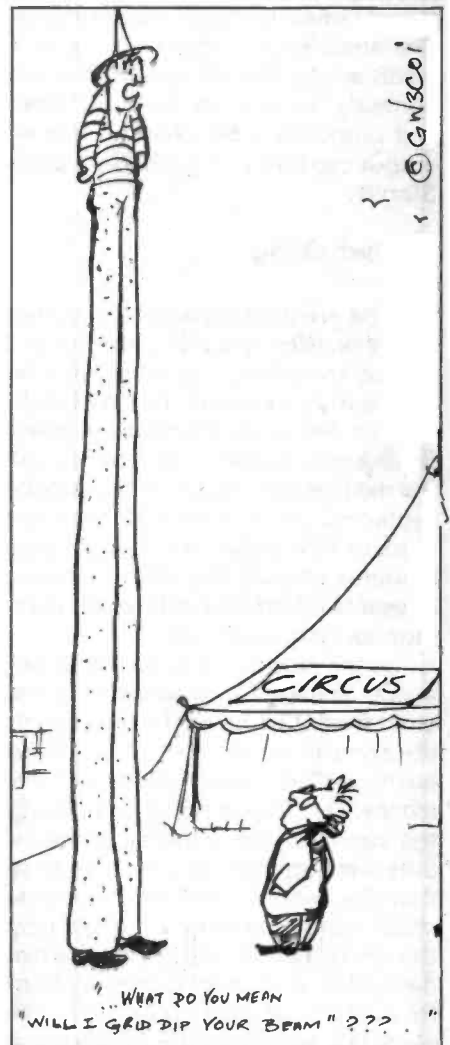
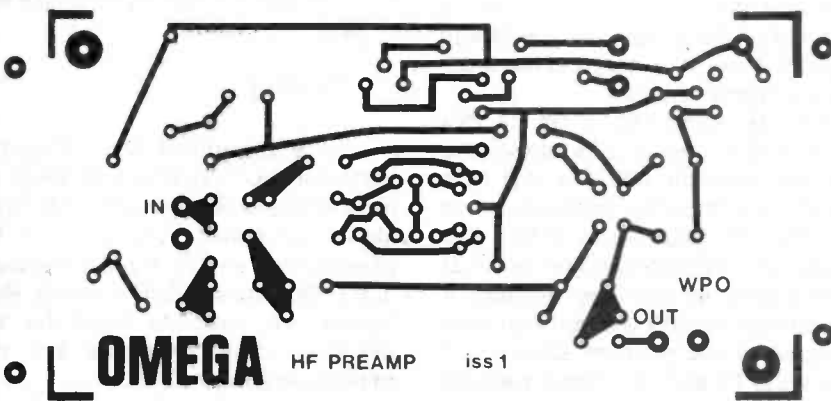
follows: 1. Apply +12v to points F and D. With no connection to E, the emitter of Q5 should be at around 0.6v. Apply +12v to E and this voltage should rise to near supply voltage. 2. The cathodes of D1 and D2 should all be at higher potential than the anodes (i.e. reverse biased) when no voltage is shown voltage is on point E, and D3's cathode should be at lower potential than the anode. Applying +12v to E should reverse this situation i.e. D3 should now be reversed biased and D1/2 conducting.

The preamplifier PCB is housed in a small diecast box, simply place the

finished PCB centrally in the box, mark the hole positions and drill out two x 3mm holes. The three +12v connections are made via 100pF feedthrough capacitors mounted on one side of the box (see diagram), and the coaxial inputs and outputs hard-wired (no connectors) through small grommets as shown in the photograph, using miniature 50 ohm coaxial cable.

The preamplifier must be located AFTER the preselector, and ahead of the CIFPU unit. If it is located before the preselector, then all the unwanted out-of-band signals will be amplified as well.

PCB Foil Pattern at size



Using The Preamp With Other Rigs

This preamplifier is ideal for use with almost any other receiver or

transceiver, providing space to mount it can be found. With most rigs, it is unlikely that the receive/transmit switching function will be required unless the preamp is located in a

signal path that provides a bi-directional low level RF signal path (as in Omega where the preselector handles both receive, and low level Tx signals). The normal place for the preamp would be immediately ahead of the receive RF amplifier (or mixer if no RF amplification) and after any filtering. In such a case, the Preamp on/off control (Q3) should be permanently wired ON (connect D to F) and ON/OFF control then obtained by switching point E to +12 on receive via a switch. **Note that UNDER NO CIRCUMSTANCES** should other than low-level Transmit power be passed through this unit.

Component Listing

| | |
|---|---|
| R1 | 470R |
| R2 | 33R |
| R3,4 | 68R |
| R5,6,7,8 | 220R 0.5 watt |
| R9,11 | 100K |
| R10,12 | 1K |
| All 0.25W 5% carbon film except R5 — R8 | |
| C1,2 | 1p0 ceramic |
| C3,10 | 100n monolithic ceramic |
| C4,5,6,7,8,9 | 10n ceramic |
| Q1,2 | J310 |
| Q3,5 | BC237 or 238 or 239 |
| Q4 | BFY51 |
| Q6 | BC307 or BC308 |
| D1,2,3 | BA379 |
| L1 | TOKO RF Choke type 7BA. 3.9uH (coded 3R9) |
| RFC1,2,3,4,5 | TOKO RF Choke type 7BA. 1mH (coded 102) |
| T1 | Wound on Fair-Rite Balun core Type 28-43002402. Primary 2 turns. Secondary 8 turns centre tapped. 0.2mm dia en Cu wire. |
| T2 | Wound on 10mm square block ferrite toroid. Primary 10 turns centre tapped. Secondary 2 turns. 0.2mm en Cu wire. |

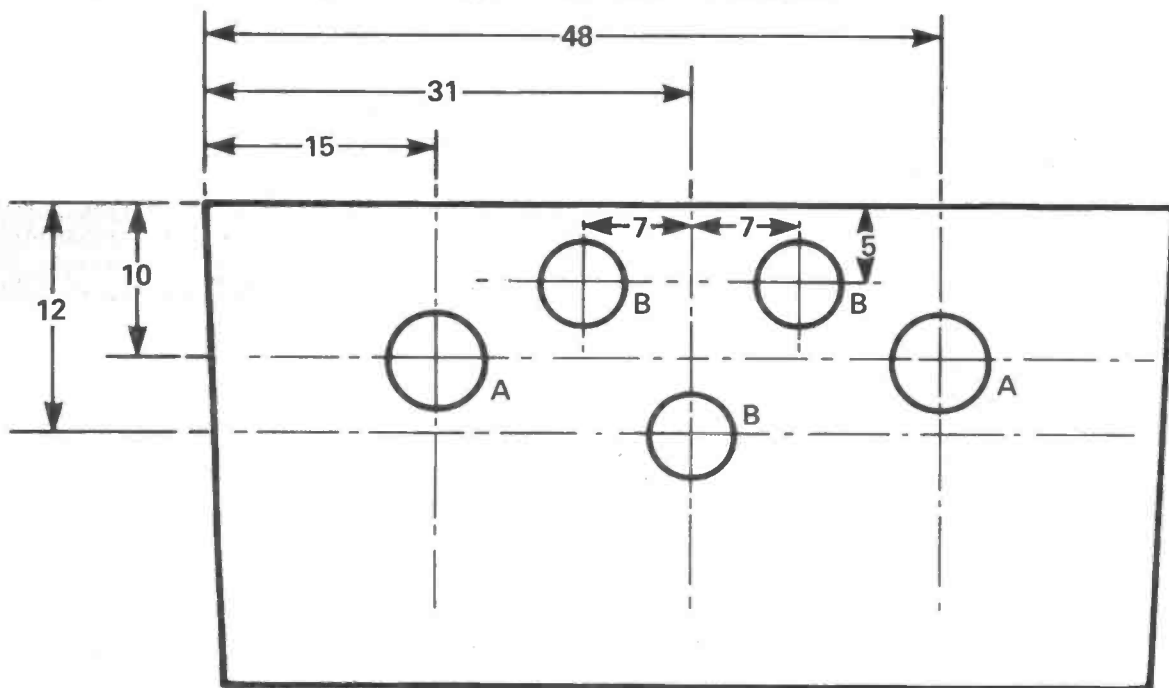
Also required: 7 x 1mm dia PCB connection pins; SPCO toggle switch; Min 50 ohm coaxial cable; Diecast Box RS type 509-939

Kits

A kit of parts for this project including a drilled tinned PCB, switch and all PCB mounted components is available from WPO Communications at £13.50 inc VAT & p&p. The PCB alone is £3.50. The diecast box is not included in this kit but is available at £3.50 inc.

* The diode switching of the preamplifier can be usefully replaced with relays if this facility is not required by the would-be constructor.

Fig.3. Preamp diecast box drilling detail Omega overlay diagram Foil Pattern



BOX: RS TYPE 509-939

A = HOLE TO SUIT GROMMET
B = 5mm Ø
MEASUREMENTS WITHOUT LID IN PLACE

Radio Yesterday

Way back in 1964 I felt that I wanted to extend my activities as a 'household ham' and go mobile. Now in those days this needed a great deal of scheming, shopping around and not least, physical strength. Not in those days the pocket size wizardry of today. No way. In 1964 it was the time of the 'heavy stuff'. Great bulky equipment that had to be coaxed and manoevered into any car before it rested comfortably.

Ken Michaelson, G3RDG, goes 'mobile' — old style.

The scheming consisted of coaxing the XYL that going mobile was a desirable adjunct to my already fairly unpopular hobby. This was achieved after a certain amount of justified blackmail, and the next step was to go shopping for the 'gear'. Almost all the equipment used for mobile operation at that time was ex-Armed Services, and consisted in the main of a series of transmitters and receivers called 'COMMAND' sets. These had been designed in 1938 and produced in prodigious quantities over a decade for the American Army, Navy and Air Force. There were nine separate models, all electrically and physically the same, apart from differences in the coil/capacitor values, and covering 500KHz to 9.1MHz, and 100-156MHz. As a matter of interest, Fig. 1 shows the basic circuit of the transmitter.

In addition to these two items, there was the modulator to consider, since at that time 90% of mobile operation took place in the 'AM' (amplitude modulation) mode.

20 years ago, one could go shopping for these goodies at electrical emporiums in Lisle Street, at the back of Leicester Square, and in Tottenham Court Road, both in London's West End. The R.S.G.B. used to hold their yearly exhibition at the Horticultural

Hall off Seymour Place, not far away from Lisle Street, and on the days of the exhibition one could meet old friends of the air all looking for various pieces of hard to get gear.

The physical size of the receiver was about 6 inches by 6 inches for the front panel by about 12 inches deep, and the transmitter was slightly larger, so it will be appreciated that it was no easy matter to get both these items into the car under the

dashboard and be able to drive the car at the same time, let alone accommodate the XYL in the front passenger seat. In my case I made a fearsome construction of 'Dexion' angle iron held together with nuts and bolts. This, of course, had to be inserted into the car, and having overcome that difficulty (by dismantling half of it!!!) the next thing was to arrange that the receiver and transmitter could be fitted in the racking.

Eventually, all was done, and the modulator unit and power supply had to be placed in the boot of the car, there being no more room in the front, although some enthusiastic

'mobileers' (if I can use the term) were not able to carry passengers when going mobile as they had all the gear in the car itself.

I operated on 160 metres (1.8 to 2.0MHz) and 80 metres (3.5MHz to 3.8MHz) and this necessitated two sets of transmitter/receiver assemblies. I arranged things so that it was possible to unplug one transmitter/receiver assembly and be able to plug in the other band assembly when I wanted to, but the cabling and plugs to do this had to be seen to believed. In addition to this, of course, there were the modulator and power supply in the boot, which also had to be wired into the system!

Mobile Whip

But I think the 'piece de resistance' was the antenna. My antenna was what is called a 'centre loaded' whip. That is to say, the loading coil was roughly in the centre of the aerial, and for those of you who have never seen a centre loaded top band mobile whip, there is a treat in store for you. It did not resemble the VHF quarter wave or even the five eights wave mobile antenna of today in the slightest degree. The whole

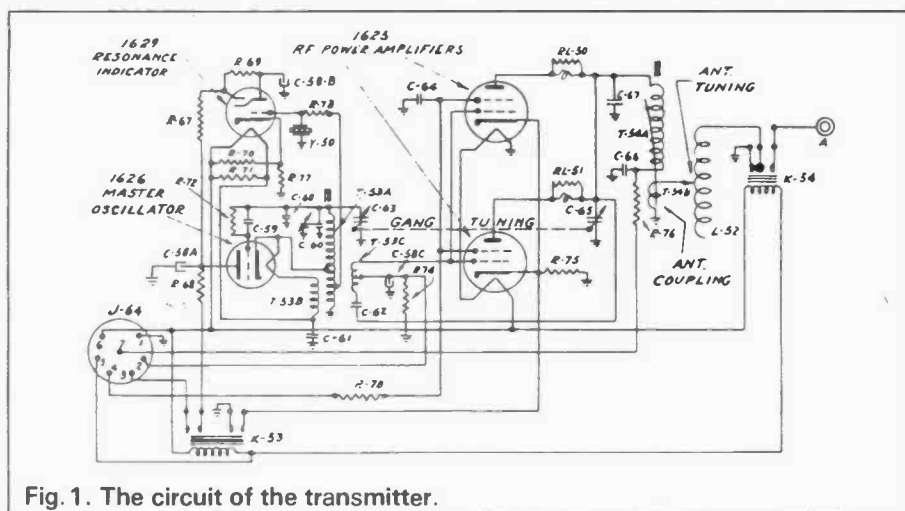
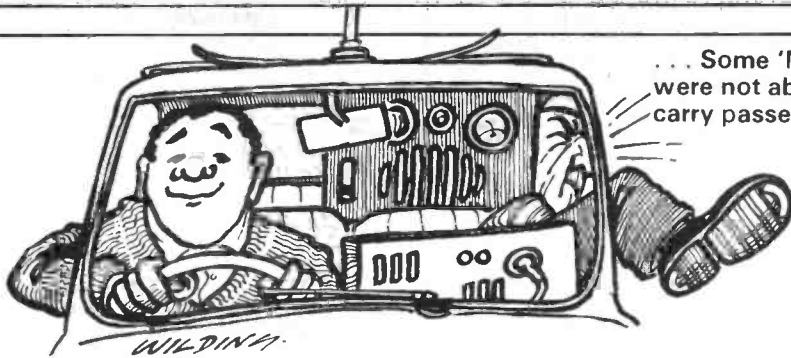


Fig. 1. The circuit of the transmitter.

thing was about 12 feet long, and the coil was in the middle, which, to make the antenna anything like efficient had to be about 10 inches long by about 3 inches in diameter! This was for 'top band', the loading coil for 80 metres was the same length but about two and a half inches in diameter.

I had this monstrosity (?) mounted on a half section of a ski rack on the car roof, and the total height from the top of the antenna to the ground was something like 20 feet. Apart from hitting the undersides of bridges on occasion, you can imagine the looks that I received, never mind the remarks, as I drove along. I have been mistaken for a BBC TV detector van, a secret type of policeman and other less polite descriptions. One made the antenna oneself, and wound the coil also, and the various hints and tips which went around at that time to help you wind the coil or tune the antenna would have filled a book.

The distance worked with top band mobile varied with the time of the day, as do the conditions for base station working today, but I well remember the thrill of working an amateur in Guildford when just outside Birmingham on the way home to London. That, to me, was mobile 'DX'. Another thrill that I recall was working a 'W' in New York from my car when driving round the North Circular Road in London. This, of course was at a later date, and with a mobile SSB rig. The controls of the 'COMMAND' sets were not engineered for adjustment when driving the car, and



as a rule, particularly on 80 metres, I had to draw into the side of the road to tune the transmitter up, before calling 'CQ CQ FROM G3RDG stroke MOBILE'. At that time and with the 'COMMAND' transmitters, a carbon microphone was necessary, and I have to this day the adapted telephone headset with the carbon mike projecting to curve round in front of my mouth. This was before the days of noise cancelling mikes.

Power Problems

Of course, current consumption of the rig was quite a consideration. Since the circuitry was all valve, there were the heaters of the valves to think about and some means of providing the high tension voltage of about 220 volts DC for the screens and anodes of the receiver valves and about 400 volts at 200mA for the pair of 1623 transmitting valves. In my case this was achieved by means of a rotary converter, a most inefficient means of doing it. Basically, it consisted of a motor running at 12 volts DC (from the car battery) attached to and driving a dynamo which generated the necessary voltages. Of course the

current drain from the car battery was considerable, and many a time I have stopped by the roadside so that I could keep the engine running at a good speed and keep the voltage up. A far cry from today when my Yaesu FT480R draws barely 3.5 amps on transmit with an input to the antenna of nearly 30 watts on high power. And that with a physical size no larger than a car radio.

Nevertheless, I feel, perhaps with nostalgia, that we had more fun 20 years ago than one gets today when operating mobile. To go and buy a 'black box' (and don't think, any of you, that I look down on the modern rigs), put it in the car, and get excellent transmission and reception without any trouble, seems to me to take away the excitement of the hobby. But perhaps I am wrong, and only looking at it from a point of view of 20 years ago.

At all event, all that I can do is to wish all you mobile operators more power to your elbow, whether using old-fashioned rigs with heavy current consumption and bulk, or the latest all singing all dancing box from Japan... 73's.



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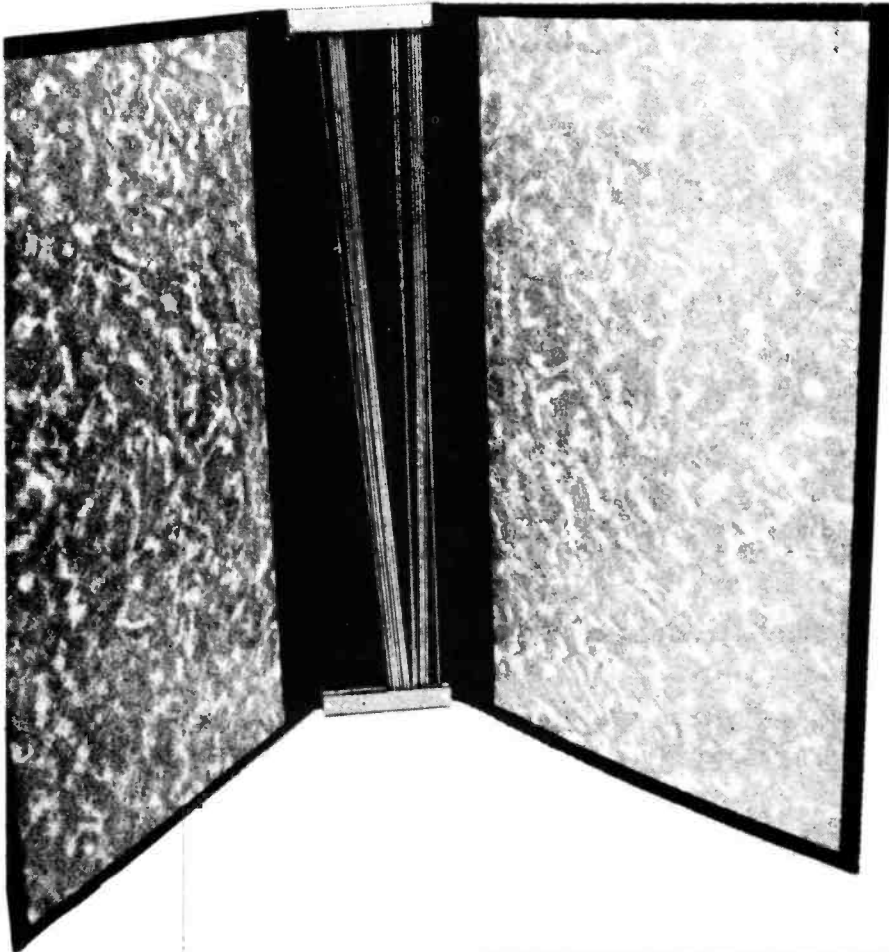


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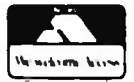
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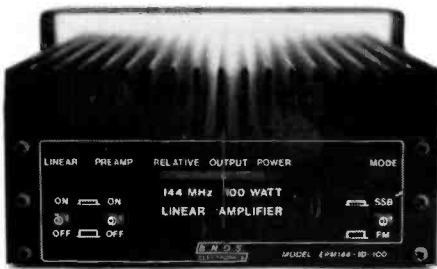
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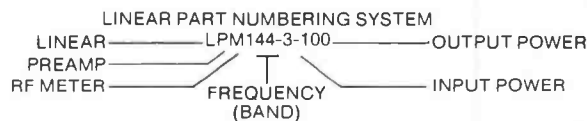
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