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NEW

HAM RADIO TODAY

MAY '83 85p

SPECIAL PROJECT:

THREE 4CX250's? Set fire to the ether with our new 400W HF design

LOADING: Towers and rotators to the limit

TESTING: Hand portable multimodes and the credibility gap

OPERATING: How to shoot a woodpecker

WORKING: 2m SSB for just £89

DESIGNING: An ultra-low noise synthesised VFO

PLUS: Teach yourself CW with your ZX81

HAM RADIO TODAY

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Published by:
Argus Specialist Publications Ltd.,
145 Charing Cross Road,
London WC2H 0EE.
Telephone: 01-437 1002.

Distributed by:
SM Distribution Ltd.

Printed by:
Q. B. Ltd.

Subscription Rate:
UK £12.80
O/Seas Sur: £13.25
O/Seas Air £25.80
Ham Radio Today,
Sub Dept.,
513 London Road,
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LETTERS

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COMMENT - RSGB REPLIES

It appears to be one of the trends of publishing today that people seem perfectly happy to rush into print with half truths and misinformation. We regret three things: first that HAM RADIO TODAY appears to subscribe to this practice; secondly that a few minutes of time was not taken to check some of the facts with the RSGB headquarters; and thirdly, the right of reply offered by the writer of the article (with or without the editor's approval) was not made at the time that such a reply could be seen alongside the original comments.

The general charge is that it is the RSGB's policy to downgrade the status of Class B licence holders. This is simply not the case. The RSGB welcomed the introduction of this licence and especially the often very talented people who are attracted into amateur radio for whom an ability in morse was irrelevant and perhaps previously a barrier. The only distinction is a technical one, the capacity to use morse is, and always will be, a major advantage when transmitting under marginal conditions. In that sense, Class B licence holders may be considered to be in a disadvantageous position. Since one of the things that the RSGB must stand for is more effective communication, it also must be RSGB policy to encourage the use of morse.

As regards the use of morse by Class B licence holders, there seem to be three different cases that people present, its value in practising under so-called real conditions (debatable - one can do as well by other methods), its value in demonstrating the power of CW to get through when other modes fail, and therefore an incentive to master the technique (a credible argument) and its value as a permitted means of contact for any purpose, but subject to the callsign being given in speech at the beginning and end of each transmission and at a stated intermediate time (also a credible argument). The RSGB VHF Committee cannot of itself recommend anything to the Home Office. At present, the question of Class B licencing conditions is being discussed by all the relevant RSGB committees, namely the VHF, microwave and licencing advisory committees. The recommendations, which may differ from committee to committee, since factors such as band occupancy will also differ, will be passed to the RSGB Council who will have the responsibility of making any final policy decision. Anything 'leaked' from a committee can only reflect an intermediate stage of deliberation or the view of an individual. The final decision regarding changes to the Class B licence would, of course, be made by the Home Office, not RSGB, although it is to be expected that RSGB's recommendations will carry great weight.

A similar argument applies to the 50 MHz experimental licences. The Society hopes that there will eventually be a permanent allocation in this most interesting part of the spectrum. The final decision about expermental licences again was made by the Home Office. In this case, RSGB recommendations clearly carried great weight.

In addressing this letter, I find it a little difficult to know who this reply actually is directed at. I feel that the editor of any magazine will always bear some responsibility for its editorial content. However, in the case of the above article, we have a problem, the writer is the editor, who in the letter claims that the opinions are his own and do not reflect those of the magazine he himself edits. It is called 'role conflict'.

DAVID A EVANS G3OUF
Secretary/General Manager, RSGB.

ASPECT OF DSB

Frank, A most interesting article about the low cost DSB/CW transceiver. I wonder if the two prototypes have been tried talking to one another on DSB. In theory some strange things might be expected to happen because the reference oscillator used to demodulate DSB must be in the correct phase. Under strong signal conditions the receiver VFO may lock on to the incoming signal through stray coupling. In the absence of locking, one would expect the audio output to be 100% modulated at the difference frequency between the far transmitter and receiver VFO's giving a flutter fading effect. Fortunately there are plenty of SSB and CW stations to work, so this effect is not really a drawback.

An intriguing property of DSB suppressed carrier (unlike SSB) is that the sidebands contain enough information to enable the RX injection oscillator to be locked in the correct phase, giving correct sounding audio without the need for careful adjustment (hence no "SSB sound"). Such a system has been described for broadcast reception, and a complete synchronous communication system using DSB was described in PROC.I.E.E. around 1960. However the need to conserve the frequency spectrum meant that SSB emerged as the universal voice modulation system for HF communications.

160m sounds a good place to try out a version of the DSB rig. There are usually plenty of empty channels even at night, particularly above 1.9MHz away from the Europeans and the DX.

JEREMY WHITFIELD G3IMW

I confess that I haven't actually tried the experiment that you suggest with DSB but I have noted an interesting "injection locking" phenomenon with an old fashioned TRF receiver of 1932 vintage. Naturally, this three valve set was designed for AM broadcast transmissions and, although sensitive, is lacking in selectivity when compared with a superhet design. However, if you wind up the regeneration until the set howls like a wounded dog and re-tune for a locked zero beat, adjacent, and seemingly co-channel interference vanishes while the demodulation bandwidth increases to almost Hi-Fi dimensions. Distortion induced by the grid leak detection system also disappears. I have a feeling that there is much mileage to be gained in re-visiting the early radio designs — Ed.

KW CORRECTION

Sir, This week I noticed your publication for the first time in our local WHS. I have found the one I have most interesting and wish you every success.

There is one item I wish to correct you upon and that is with reference to the HF RIG GUIDE, referring to the KW "ATLANTA" one of which I have been the proud owner since I purchased it new on 8th, May 1970. This model is very stable indeed, as are all of them, including the remote VFO. However the KW2000 series were very liable to drift and I only assume you have the two models confused. I think it only fair that you put a correction in an early issue.

Wishing you all the best for future issues.

FRANCIS MASON G4QU

Point noted. Instances of drift re. KW gear has always been associated solely with 500kHz versions of the KW2000. Atlanta models have never been implicated — Ed.

QRZ?

Sir, Who is this guy with the callsign QRZ whom I keep hearing other guys calling? If they would look up the Q-code they would find that QRZ means 'Who is calling me?' so it doesn't make much sense if guys come on an empty frequency and shout QRZ — or worse — if they come on an already occupied frequency and do the same thing, especially if the station which is already there has no interest in having a QSO with the QRZedder. So please — let's have a little less of the QRZ business and remember — we should only use it if we know that somebody is calling *us*.

SEAN SINEHAN E17CV

There is much room for improvement in operating etiquette on the HF bands and this is just one aspect. It is quite in order to call QRZ? de G4XYZ at END of a QSO but make *sure that it is the end. I would also like to see a little bit less of the CQ DX, CQ DX — Ed.*

GETTING THAT QSL!

Sir, The article on how to obtain QSL cards in 'Newcomers Forum' by Tony Bailey G3WPO (February issue), gave some excellent advice for anyone hunting those elusive bits of card. Might I add one small but vital point — always have the actual words "Confirming QSO" or "This is to confirm our QSO" printed on your own card, otherwise it will not qualify for many of the important international awards.

This could make all the difference as to whether you get a card in return or not.

DOUGLAS BYRNE G3KPO/GB3WM

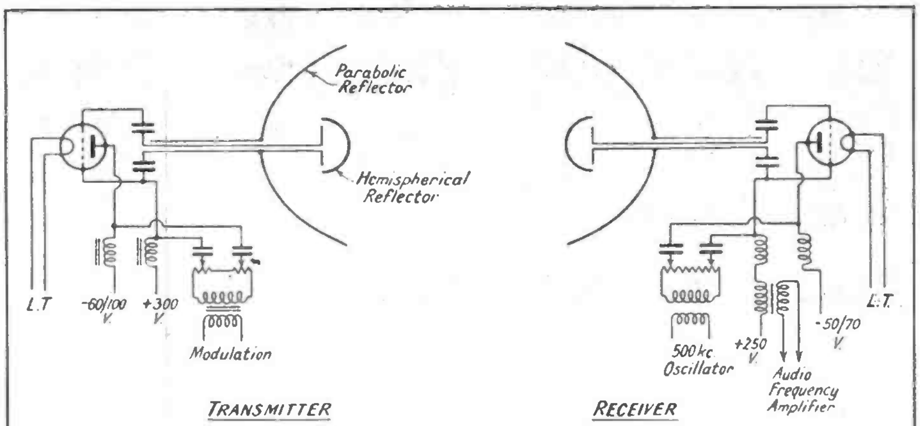


Diagram of English Channel Micro-wave Link

RADIO YESTERDAY

Sir, The oscillators at both ends of the cross-channel link appear to be an example of Barkhausen-Kurz oscillators (cf.e.g. E.C.S.Megaw, Jour.I.E.E. 72.313.1933 or F.B.Llewellyn,Bell Lab.Rec.13.354.1935). This type of oscillator employed a triode operating with grid held at a potential above that of the anode. The emitted electrons were oscillating in the space between cathode and anode for several periods before they were ultimately captured by the grid. The external resonant circuit was essential in maintaining the proper phase of oscillations, assuring that electrons with favourable phase of oscillations were kept in motion. The frequency was dictated by the dimension of the cathode-anode gap and depended on the grid voltage and on the tuning of the resonant circuit.

The front end of the receiver looks like a super-regenerative detector i.e. the receiving Barkhausen-Kurz oscillator has the build-up process of oscillation interrupted with a quenching frequency of 500 kHz. (cf. e.g. M. G. Scroggie, Wireless Eng.13.581.1936). This mode of reception was very sensitive and fairly broadband, which took care of relatively low frequency stability, and yet required a fairly simple installation.

I have tried B-K oscillators in the early forties, using some ancient Telefunken valves of REN series and easily reached frequencies up to about 2 GHz, which were measured with Lecher wavemeter.

Your comment that this type of oscillator is related to klystron is right: the phasing and bunching of electrons in the process of oscillations have been later further developed in a reflex klystron.

K V ETTINGER ex SP2HE

Thanks for your letter. For the benefit of readers who missed out on the January issue, I have included the simplified schematic of the 1934 17cms cross channel microwave link — Ed.

S-UNITS

Sir, Praise be to G3WPO for tackling the Great S-meter Myth. The S-code was intended as a subjective assessment made in the light of experience with given equipment.

Nowhere in the technical literature can I find a definition of an S-point. One might expect it to represent 6dB., but my KW2000E manual says the meter represents 4dB. per S-point approximately. A peculiar figure to choose. Perhaps it just turned out that way rather than by design. Other receivers yield equally arbitrary figures.

Operators overdo S9 reports, not only during contests. I seldom give more than S8, reserving S9 for the amateur next door. After all, S6 "good signals" is pretty complimentary, but is sometimes taken as a slight on the recipients personal potency.

The addition of an objective assessment onto what is by definition a subjective one makes nonsense. A report of "S9 plus 10dB." means less than the weatherman saying "It will be very hot plus 10°C". If pressed he might be able to give an actual figure in °C.

S-meters are useful for peaking a signal or making comparisons when, for example, the chap at the other end wants to compare performances of two antennas. An ungraduated meter would suffice. Maybe the designers of military receivers of the past were wise when they chose "magic eye" indicators instead of meters.

So to the crunch question, question 1 in the competition on page 62 of the January issue. This implies that there is a specific value ascribed to an S-point. Why isn't "nonsense" one of the possibilities? Can anyone find a definite figure quoted in the accepted literature? Bear in mind that once you define an S-point you also have to define the datum, e.g. S9 = so many microvolts at the aerial terminals. That leads on to aerial and feeder efficiency . . .

RAY BURGESS G3RXG

If no-one else is going to say it, then I shall. Let one S point = 6dB; Let OdB = 0.5 microvolt PD across antenna socket. End of conversation — Ed.

TYPE APPROVAL

Sir, I have some points to make along the lines of the "changing the rules" letter sent in by Peter G6NSU. I understand that the main reason for amateur station logkeeping is to assist interference tracing by the radio interference service. Does this therefore mean that a typical commercial 2M "black box" is much more likely to cause interference than a commercial CB transceiver? Considering the price of the average 2M FM rig compared with the price of the average CB rig I would have thought that the chance of the 2M FM rig going faulty and producing spurious transmissions was no greater than a CB rig developing a similar fault. The Home Office must think that commercial amateur equipment is very unreliable in terms of frequency of operation and spectral purity because an amateur must have an absorbtion wavemeter for checking these things. I assume that all CB transceivers are 100% reliable, otherwise the CB licence would have stated the need for a wavemeter. Perhaps the amateur licence rules on wavemeters were written when most amateur equipment was "home brew" which suggests to me that the licence is out of date.

The Home Office must also think that legal CB causes no TVI whatsoever, as a legal CB operator cannot be closed down as long as his equipment is OK but an amateur can be closed down for one month by the radio interference service on the basis of an interference complaint. Surely this is nothing short of "CRAZY".

Did the Home Office overlook these points when they drew up the CB licence or is it true as stated in G6NSU's letter that class B amateurs are "second class citizens with third class allocations". I have taken the RAE and was thinking about taking out a class B amateur licence but now I'm not so sure as it would seem from G6NSU's letter that 27MHz FM offers much greater working range than 2 metres ever can. Therefore I assume that in terms of DX, the class 'B' amateur licence has nothing to offer.

Surely there are a lot of amateur licence rules that need changing.

PS. I would be most interested in other readers comments. Thanks for an interesting new magazine.

P SHORT

Amateur radio gear does not have to meet specific type approval unlike just about every other kind of R/T equipment. You are supposed to have the necessary facilities to make sure that it doesn't interfere with other wireless telegraphy (sic) users. And it occasionally does.

Two metres has much to offer, DX wise. Trans equatorial propagation is just one, albeit rare, phenomenon. There are quite a few other modes of extended VHF propagation. The class B licence offers considerable scope for exploration, rather more than is possible with the HF bands. Worked anyone on 100GHz lately? — Ed.

RADIO TODAY

RADIO AMATEUR SAVES LONE SAILOR

Radio amateurs in the USA, New Zealand and on board a yacht saved the life of a lone yachtsman after 100 mile-an-hour winds and 70 foot waves wrecked his boat, snapping the mast and filling her with water.

The yachtsman, Frenchman Jacques de Roux, was eventually picked up by fellow single-hander Richard Broadhead, who is licensed as OD5KW/MM. Both men were contestants in the single-handed *Round the World Challenge Race* sponsored by British Oxygen. De Roux, 43, was sailing his 43ft cutter *Skoiern III*. Richard Broadhead, 29, was sailing the 52ft yacht *Perseverance of Medina*.

All the yachts in the race were fitted with a gadget called *Argos*, a small device used to transmit meteorological information to the four weather satellites that orbit the Earth every two hours. The satellites relay the data to a computer near Paris, which helps compile NATO weather maps. However, the system can also give the location of each *Argos* transmitter – or, to be precise, the position of the *Argos* when the satellite was last in range.

Each *Argos* was also fitted with a 'panic button' to be used in case of dire emergency. De Roux pushed the button. The system told race officials in Newport, Rhode Island, that he was in trouble some 2,000 miles West of Cape Horn, at a latitude of 55 degrees South, drifting Eastwards at a speed of 1.8 knots.

The nearest ship was the Australian yacht *Pier One*, about 165 miles North-West of De Roux. However, the hurricane-force winds and huge waves had smashed the Australian ship's aerials, putting the radio out of action.

The second nearest ship was Richard Broadhead's, 300 miles ahead in the race. When the race organisers realised this, they appealed to local amateur Robert Koziokowski KA1SR. He contacted ZL4-- in Owaka, New Zealand, on 14.347MHz. (We have been asked not to reveal the ZL4's identity because New Zealand law, like British law, bans amateurs from carrying third-party messages.) ZL4-- was able to reach the *Perseverance* on the same frequency. For 59 hours, race officials fed computer readouts of the two yachts' positions over the 14MHz amateur link to Broadhead, and 'talked him in' to within 17 miles of the drifting *Skoirn III*. Navigational experts in Newport calculated the likely drift of each vessel, and eventually brought OD5KW/MM alongside the stricken craft.

He was just in time. He found de Roux exhausted by his ordeal in the appalling conditions, and his boat sinking.

50MHz—THE FULL STORY

Forty UK amateurs have now received the coveted 50MHz research licences from the Home Office, valid from February 1st. They are allowed to operate between 50 and 52MHz outside BBC1 transmission hours, with the same power and mode restrictions as for 70MHz. Breakfast television is not transmitted on Band I (41-68 MHz), so operation is normally possible until 0830, when the 405-line transmitters are powered up.

If this first stage of 50MHz operation is considered satisfactory by the Home Office and the BBC then more people may be allowed to transmit. The forty stations and their locations shown on the map.

Consultation

The RSGB's General Manager, David Evans G3OUF, says the forty were chosen by the Home Office in consultation with the Society. "We recommended people who should have these licences, and the final choice was up to the Home Office." He says they were chosen to be evenly distributed throughout the country, and that they gave preference to people with a past record of 50MHz activity and the capability to transmit at short notice. However the RSGB's former VHF Manager, Tom Douglas G3BA, says the forty people were chosen to "make the experiment worthwhile, because it's only a political thing." He sees the experiment as "a foot in the door" to getting a full 50MHz band. Tom is one of a number of 'prominent' amateurs who refrained from applying for tickets themselves because they realised it would expose the RSGB to allegations of nepotism. Some others say they didn't apply because they disapproved of the selection method.

About 500 amateurs expressed interest in transmitting on the band, and 126 returned an RSGB questionnaire detailing both past activities and future plans for work in this part of the spectrum.

Protests

Some amateurs complained that the RSGB had no business to ask some of the questions on the form – for instance the one about the applicant's Morse speed. The RSGB's VHF Manager, Keith Fisher G3WSN, says they put this question in because they wanted to pick people who would be capable of doing propagation research such as auroral and meteor-scatter work. (However, speed is not essential for auroral work, and SSB can be used with less Doppler distortion on 50MHz than on 144MHz. For meteor-scatter, it is usual to tape the incoming Morse signals and slow them down on playback.)

The questionnaire is not the only thing people are complaining about. Hardly surprisingly, there have been bitter protests from some of the 86 people who filled in the form but were turned down. One such is audio and radio consultant Angus McKenzie G3OSS. He's been active working crossband to 50MHz from the 28 and 70MHz bands. In 1979 he hit the (RSGB) headlines when he worked a Canadian station who reduced his power to 10mW, yet still being heard (and recorded) by G30SS. He recalls "I called him on about 28.88MHz. He was coming in on about 50.1MHz. He was a right thumping signal. I asked him to turn his signal down because it was distorting. At 10 Watts it was beginning to get comfortable."

He complains "there are an awful lot of people who should have been given tickets in view of their experience and facilities, many of them holding awards for VHF working.

"If the RSGB was responsible for choosing the callsigns to go before the Home Office in the first instance, thus rejecting the large majority, this is wrong. The RSGB should have been a clearing house, leaving the Home Office the responsibility of deciding who gets the tickets. There would have been no harm in the RSGB rubber-stamping forms that they know are correct and from people they know are experienced."

In March 1981 the RSGB's then Telecommunications Liaison Officer, the late Roy Stevens G2BVN, sent a confidential letter to 25 amateurs known to be interested in 50MHz operation, inviting them to apply for the out-of-TV-hours licences. Apparently it's taken from then until now because the BBC, which is the primary user of the band, called a halt. The BBC will remain the primary user of Band I until 1986, with six CH2 405-line TV transmitters still on the air until at least 1984, including the high power ones at North Hessary Tor, Holme Moss and Rosemarkie. However the Merriman Committee's report on the future of TV bands I and III has recommended that the 405-line transmitters be closed down at the end of 1984. As reported in the January issue of *Ham Radio Today,* the committee also supported the RSGB's request for an amateur band in the 50-54MHz range. The Secretary of State William Whitelaw recently promised Parliament a statement on the Merriman proposals "as soon as possible." All things considered it looks as though 50MHz could be clear for full amateur use by the end of next year. There is, however, a snag.

50MHz stations in the UK

Broadcast Ancillaries

The BBC also uses 50MHz for a variety of systems used in television programme production – radio microphones, talkback systems and so on. The idea of the limit of 40 stations is that BBC engineers could pinpoint any interference to these systems from an amateur station quickly. The official view is that this would not be possible with more people on the band.

Keith Fisher says that he realises that having only 40 permits is unsatisfactory, but that the choice is either 40 or none at all. While the band is BBC territory, the Home Office attitude is that what the BBC says sticks.

There do appear to be some oddities about the distribution of the 40 stations – there are none in London, yet two in Dunfermline! There are also no stations in the North of England. Keith Fisher says there were not any "suitable" applicants from the North of England, and although London is densely populated it is geographically small compared to Scotland, which has ten licensees.

The RSGB is seeking reception reports of six-metre activity, including reports of the GB3SIX beacon at Anglesey on 50.02MHz. Reports should be addressed to the VHF Committee, RSGB, Alma House, Cranborne Road, Potters Bar, Herts. EN6 3JW.

There is a 50MHz users' net on 3.718MHz at 0830 daily.

MORSE TEST CENTRE CHANGES

British Telecom says there will not be any change in the list of test centres used for amateur morse tests for about two years.

A question mark over the future of the test was raised by BT's proposal to automate its coastal HF radio stations, (which are used as test centres) and concentrate operational staff in two central complexes. ●

G4DYA

400W HF Linear Amplifer

This new design features a power grid, broadband input circuit yet only requires a meagre 10W of drive for full output. It displays all the advantages of the grounded grid configuration without any of the drawbacks.

By Frank Ogden G4JST
Editor, Ham Radio Today

There is virtually no limit to the number of ways in which it is possible to put together a linear amplifier for the HF bands. The method that most people use will be largely dictated by whatever they happen to have to hand in the junk box.

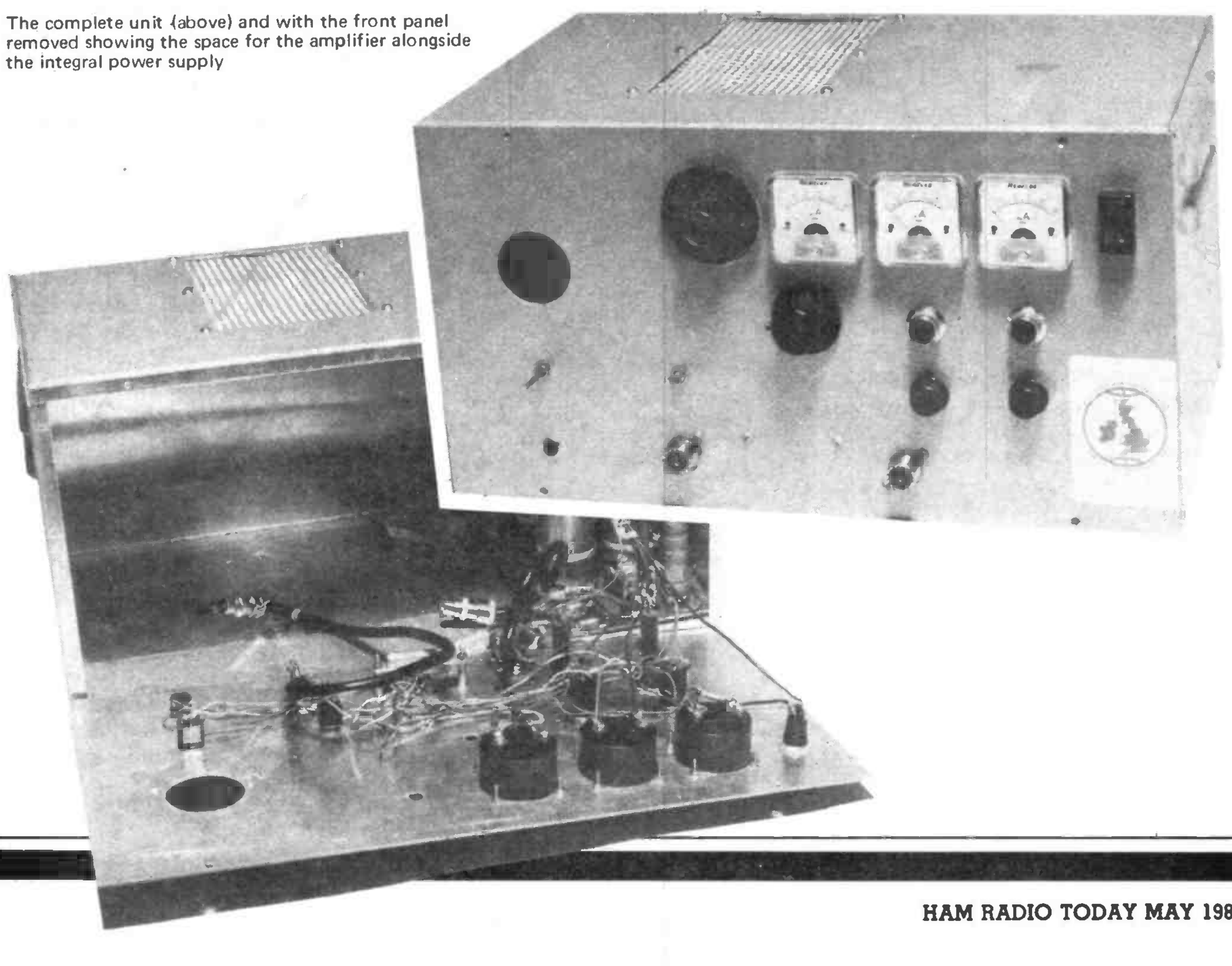
For instance, if a pair of 813 bottles are lying about gathering dust, the most sensible course is to keep an eye out for a 5V @ 20A transformer (for the heaters) and another transformer capable of stepping the mains back up to a level in keeping with the super-grid. You keep the requirement for a box of electrolytics at the back of your mind and, when such an item crops up at the local junk sale, snap it up for a song. The same goes for HV tuning capacitors, fuse holders, cases, etc.

If you're patient, it is possible to build a first rate linear amplifier for no more than a few pounds. It might not look either too pretty or compact when it is finished but it will probably work and save you £100's. This is the way I go about most home construction projects. I keep a permanent shopping list for about half a dozen projects at the back of my mind and, when I see something at the right price, I buy it even though I know that I shall not be able to use it for a considerable time to come.

That was the way I came to build this particular project. It took around four months of evenings to complete but the preparation lasted most the previous year, albeit at a very low level of consciousness.

As it happened, I had 4CX250B valves kicking around the house. I had already used such a bottle in a 2m linear amplifier and I had purchased more gear than I needed for that project. Here is a truth about building this type of equipment. It would be prohibitively expensive to purchase all the parts necessary for a high power valve

The complete unit (above) and with the front panel removed showing the space for the amplifier alongside the integral power supply



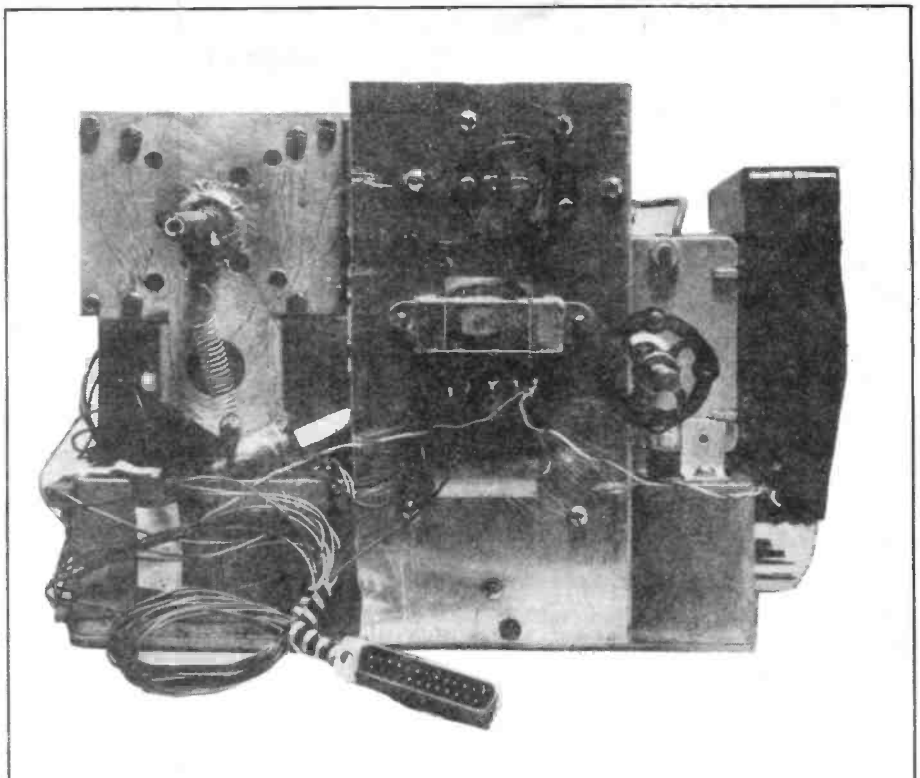
linear amplifier off the shelf as new. The valves themselves would cost £37 each or more while the roller-coaster tuning components and high voltage capacitors would total several hundred pounds. For this reason, I have not given a parts list; the only reasonable way to build QRO designs from new components is to use modern ones: transistors. Even so, the bill would probably come to around £500 and there would be no guarantee that the finished design would work . . .

In the event the complete project, a 400W + HF amplifier cost me around £20 plus a ZX81 exchanged for the rollercoaster. The end product has been closely tailored to my requirements: that it should be compact, quiet, reliable, safe and should produce the full output with the 10W of RF available from my homebrew transceiver.

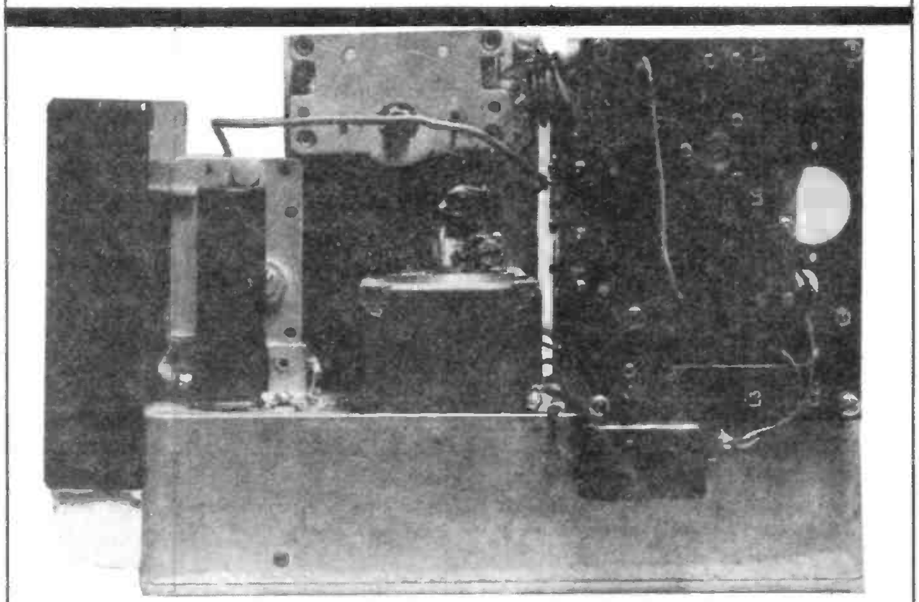
Three 4CX250Bs?

People are often surprised when I tell them what the design requires three of these valves to produce the full legal output; they point out that a single bottle on its own is quite capable of breaking the licence conditions. They are quite right of course. A single valve will produce nearly 500W providing the power supply can deliver some 2.5kV. Going to such a high anode voltage produces all sorts of circuit complications. While it is possible to buy 1kV capacitors off the shelf the same is not true of 2kV+ parts. Similarly, the strings of electrolytics in the power supply are very unreliable. Furthermore, 2.5kV is bad for the health in much the same way as exploding capacitors are bad for the nerves.

Three valves, producing 400W with a supply rail of just 1300V lope along with consummate ease. Their operation is demonstrably linear as received reports indicate. Wishing to ditch the massive HT transformer from the design, I settled upon quadrupling the mains supply to provide the DC HT rail. Thus, the decision to use 1300V came before the decision to use three 4CX250's. It follows that three bottles are necessary to produce a linear 400W of RF at this supply voltage and everything followed from there. My direct rectification system has been entirely satisfactory in use although, on public safety grounds, I have indicated the use of an isolating transformer for the HT supply.



Front view of amplifier proper. The unit connects with the power supply through an umbilical cord. This allows easy removal of the amplifier from the cabinet for servicing, etc.



Rear view. Note the cowling connecting the end mounted cooling fan with the airtight die-cast box. The three valve chimney was made from etched PCB material

Grounded cathodes

There is a lot to be said for grounded grid power amplifiers. They provide a stable easily matched load to the exciter (transceiver) but the drive power requirements are high and the relative gain low, particularly at low HT voltages. The only way to obtain the required gain, some 16dB, is to drive the three paralleled 4CX250 valves in the grounded cathode configuration with the RF drive applied to the grids. At 1300V HT, 300V on the screen and the quiescent anode current set at 150mA (three valves) the control grids require an RF drive voltage of around 90V peak-to-peak. This corresponds to about 20W of RF dissipated across a 50 ohm non-inductive load. **Fig. 1** shows the amplifier schematic. The RF input is stepped up by a ferrite autotransformer in the ratio of two to three. Thus if 20V of drive is applied to the input, then 30V is delivered to the control grids. The impedance is also raised from 50 to 100 ohms. The three valves present a capacitive load of

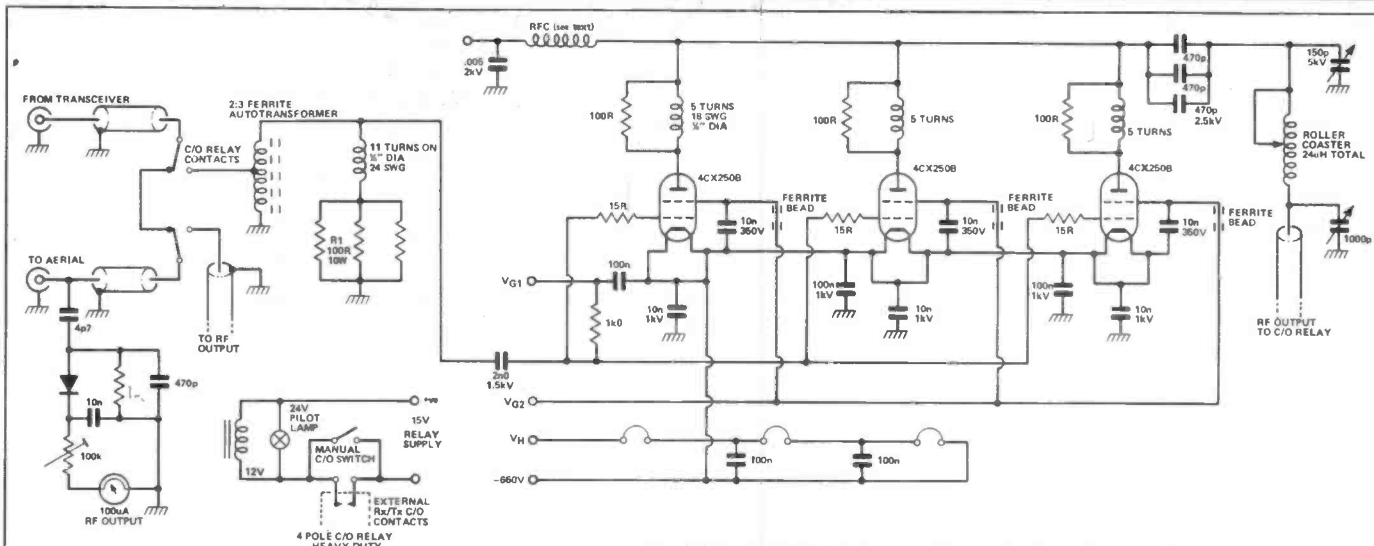


Fig. 1 The scematic of the amplifier unit. Note the broadband input circuitry.

around 80pF total. This equates to a reactive impedance in the order of 70 ohms on the 10m band.

A simple 100 ohm resistive load connected across the input transformer works fine up to about 20MHz. Above that, the input capacitance of the valves leads to an unacceptably high SWR on the input circuit. The input resistor assembly R1 therefore includes a series inductor made up of 11 turns, 24swg wire on a ¼ inch diameter high value resistor. This brings the input VSWR comfortably below 2:1 across the entire span of 1.8 to 30MHz without any other form of input tuning. This allows broadband input operation causing the amplifier to load fully with just 10W of drive at any frequency. Furthermore the amplifier is unconditionally stable.

And the output circuitry ...

This part of the design is absolutely conventional. The three bottles (or perhaps one should say cans) offer a combined load impedance of around 800 ohms at their anodes. The component values shown for the Pi-matching network are not necessarily optimum. They represent those which were available at the time of building. For instance, better matching, and hence power transfer could be obtained on 80m if the anode tuning capacitor had a larger swing. Ideally, the maximum capacity should be in the region of 300pF. The circuit Q is rather low on the lowest frequency bands. However 400W is available whatever the precise matching situation.

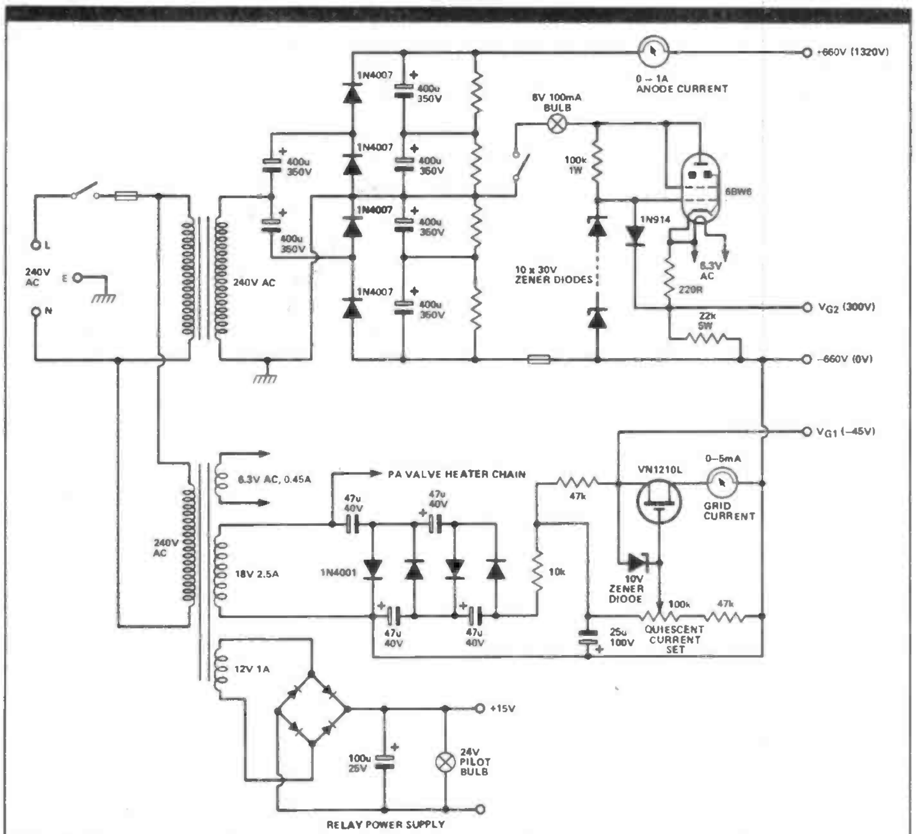


Fig. 2 The power supply. The original used direct rectification of the mains, via a quadrupler to provide the 1300V of HT as two 650V rails above and below chassis.

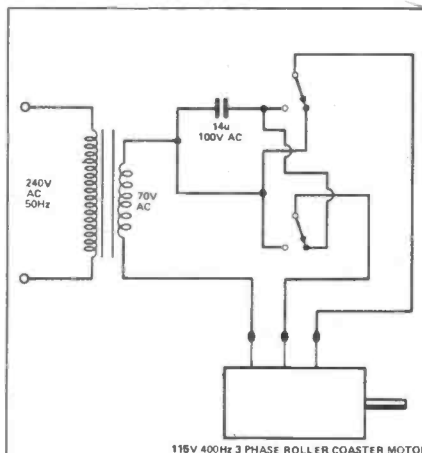


Fig. 3 400Hz 115V AC rollercoaster motors can be made to function of 70V 50Hz AC although at one eighth speed!

The anode choke used in the prototype presents another area for improvement. That, and the rollercoaster tuning assembly were pulled out of an HF aircraft transmitter covering up to 18MHz. Unfortuantely the choke has an unpleasant little resonance around 28 to 29MHz which reduces efficiency while producing a smell of burning varnish. The original component has now almost completely carbonised.

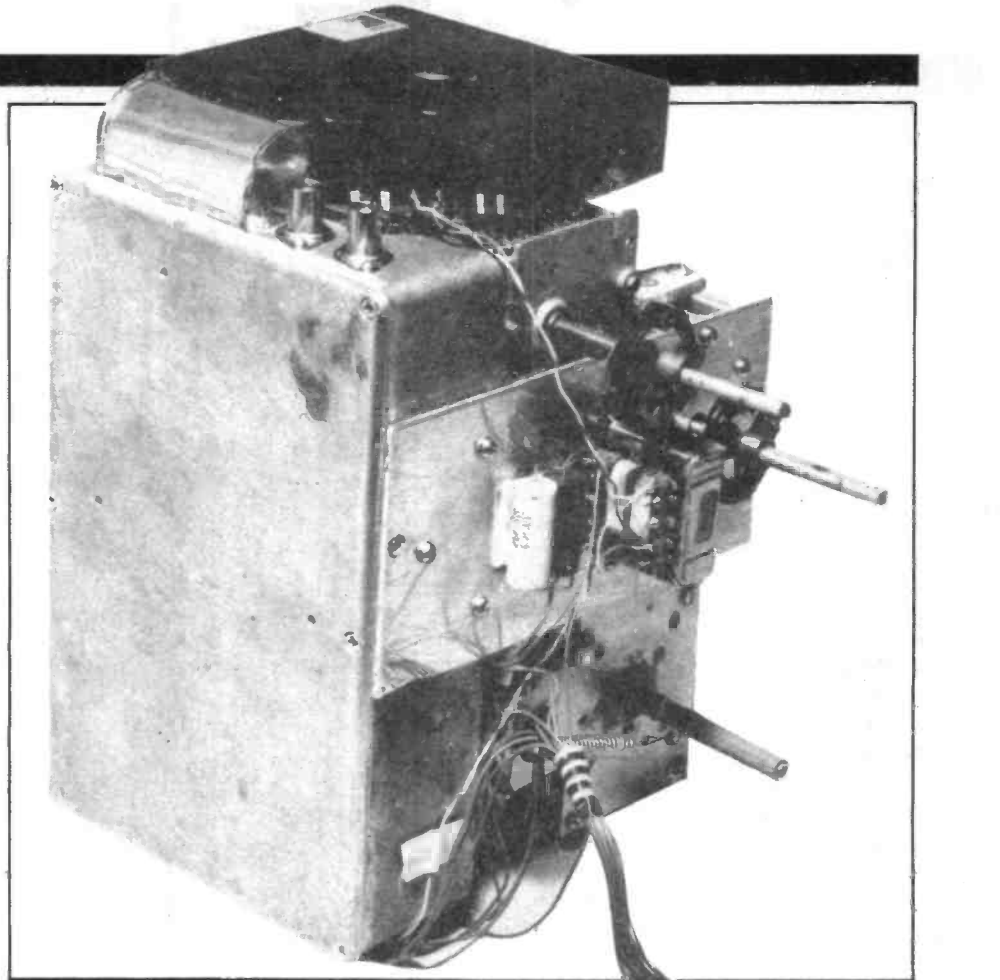
Power supply

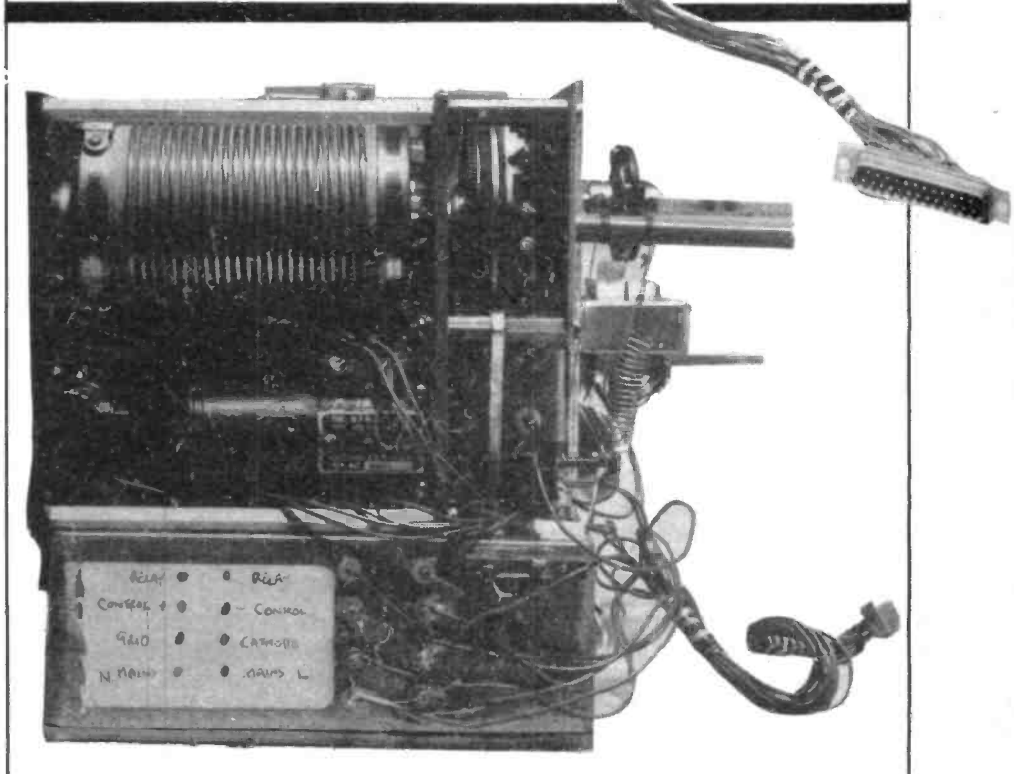
The original power supply is more or less as per **Fig. 2** but without the 1:1 transformer in the HT circuitry. Frankly, the transformer is included for those people who are a bit squeamish about playing around with mains level voltages. However, any kind of power supply running at the kV + level should be treated with the greatest respect regardless of how the voltage is generated.

The quadrupler circuit produces a bipolar supply of +660 volts for the anodes and −660 volts for the cathodes. The screen supply is drawn from the OV rail (which is effectively 660V above the cathodes.) My thoughts on safety are these. 660V DC is not nearly as dangerous as 1.3kV DC which is itself less dangerous than 1kV AC, regardless of the original voltage source. If you can guarantee that the external instrument case will not become live regardless of the polarisation of the mains plug, then the equipment can be called safe. In the original design, there are no direct connections made to the chassis although the chassis itself is used as an RF ground. This achieved by making all connections between the circuitry and chasses via high voltage, high reliability capacitors. Note that in both **Fig. 1** and **Fig. 2** the only direct connection of circuitry to chassis is in **Fig. 2** at the secondary of the HT transformer. In the direct rectification scheme, the strap is replaced by a high value fixed resistor. In either case, the chassis is securely earthed to the earth terminal of the incoming mains supply.

NOTE: When rectifying the mains directly, it is necessary to include a 2.5 ohm current limiting resistor in series with the connection to the capacitor/diode bridge. Furthermore, a 'soft start' type of circuit is recommended.

The grid bias supply is derived from the heater transformer. The valve heaters were wired in series because transformers delivering 18V at 2.5A are a lot more easy to come by than those delivering 6V and 7.5A. The quadrupler provides nearly 100V of bias. The supply provides a standing voltage to set the quiescent current on the PA valves (150mA). The impedance of the supply is reduced by using an enhancement MOSFET as a voltage follower. This device transforms the high impedance of the bias supply to a low impedance required by the PA valves. If the valves start to draw grid current because of excessive drive, the extra current is 'reflected back' through the MOSFET to be displayed on the grid current meter.



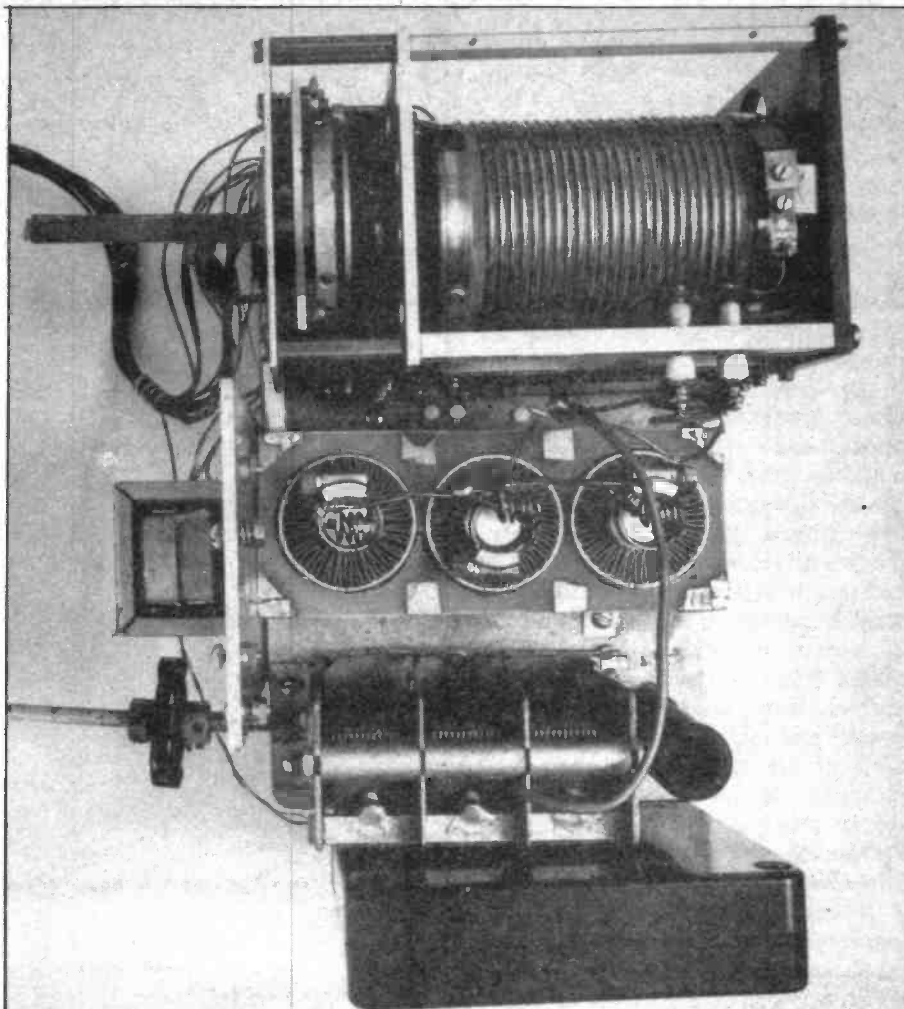


Side view showing rollercoaster

The screen supply

A lot of care has been put into this part of the circuit. The 4CX250, in common with many other high performance tetrode valves, has strange screen current characteristics. Under light loading and heavy drive, grid 2 draws a fairly heavy current: up to 25mA per valve. Under high loading or heavy static DC anode current, the screen grid current reduces very sharply to the point where it can actually go negative, that is, the screen electrode emits electrons just as if it were a cathode. Under these conditions, the screen has a tendency to shoot up in voltage in an attempt to reach anode potential. The power supply must prevent this by being able to sink current as well as source it. That is the function of the 22k resistor connected between the screen grid and cathode circuits. The amplifier should never be operated without this component.

Furthermore, the screen grid structure is of delicate mechanical construction and easily damaged by excessive current. If the valve anode supply should fail for any reason, the entire electron stream inside the valve diverts to the screen causing a burnout in milliseconds. Therefore, the circuit contains a current limiting valve, a 6BW6, and a 100mA fuse in the shape of a small pilot bulb. Most designs for 4CX250 based amplifiers have totally inadequate screen power supply protection.



Note the chimney for the 4CX250B valves. It is an airtight box with three holes in the top, slightly larger than the anode diameters, made from PCB material. The bottom of the box connects with a succession of holes drilled around the B8B type valveholders

Construction

I used modular construction for their prototype. All electrical connections, with the exception of the RF input/output, were made through an 'umbilical cord' fitted with a multiway plug and socket. The complete unit separates into two halves: the amplifier proper, and the external case which houses the integral power supply.

A single diecast box, roughly. 2×4×7 inches features as the main chassis for the amplifier since it is both RF-proof and airtight. Good use is made of this last property. The amplifier valves need to be blown with air supplied from below, up through a chimney to the anode finning. A powerful but quiet snail blower pushes air into the box through a slot, via a custom made tinplate cowling. The valve holders, standard B8B loctal parts salvaged from an old WW2 US R/T set, are mounted in a row across the width of the diecast box. Slots and holes are cut around the valve holders, large enough to allow an unhindered, airflow yet maintaining enough mechanical strength to support the valve holders securely. A box structure, made from selectively etched PCB material, is constructed over the valve holders and associated air slots. Three holes are cut in the top of the box for the valve anodes. This arrangement forces air through the anode structures.

The box system of valve chimneys has proved rather more effective than the standard Eimac bases. In fact, the whole business of valve bases for the 4CX250 has become something of a bogey. Up to 30MHz any sort of valve base will suffice and mechanical and thermal considerations will have more significance than any electrical problem likely to be encountered. In this design electrical stability is ensured by the use of 15 ohm grid stopper resistors. The anode anti-parasitic components are probably superfluous. A ferrite bead in the screen supply to each valve prevents instability caused by coupling between the valves. Whatever the precise electrics, the main thing is to make sure that plenty of air passes up through the valve anode finning.

All grid and screen grid circuitry is mounted within the diecast box and there must be no direct path to the outside. All connections into the box should be either screened or decoupled with capacitors at the point of entry. The anode tuning components are mounted directly on top of the box. The sequence of photographs show the methods of construction quite clearly.

Operation

Using the finished unit is quite straightforward. Connect up, plug in the control lines and fire away. The input drive should be adjusted so that the grid current meter shows a slight positive upswing on voice peaks. The anode circuitry should then be tuned for maximum indication on the RF output meter. The anode current should 'whistle-up' to 700mA when the valves are correctly loaded, corresponding to a DC input of some 850W. Linearity tends to be better with 'heavy' rather than 'light' loading. ●

PRACTICE RAE PRACTICE PRACTICE

Try your hand at the Ham Radio Today RAE practice papers. Using our special facilities, we have provided questions which very closely parallel those set by the City and Guilds Institute.

The full exam requires the candidate to answer 95 questions in three hours. The 25 questions given here should be completed in about 50 minutes.

1) A mobile station must enter in his log book the following information:

a) the date, area of operation, frequency band(s) used, times of establishing and ending contact with each station.

b) the date, area of operation, frequency band(s) used, times of establishing and ending contact with each station including all CQ calls.

c) the date, frequency band(s) used, time of commencement and end of journey.

d) the date, area of operation, frequency band(s) used, time of commencement and end of journey.

2) The apparatus at the station shall be designed so that:

a) the levels of spurious emissions shall be at least 20dB below the fundamental frequency.

b) it is capable of receiving messages sent on the frequency or frequencies, and in the same class or classes of emission, which are in current use at the station for the purpose of sending.

c) the operator may continuously monitor the transmission.

d) the levels of spurious emission be less than 5V when measured with a good quality oscilloscope.

3) The Secretary of State may vary the terms, limitations or provisions of amateurs licences A and B by placing a general notice:

a) in the London, Edinburgh and Belfast Gazettes.

b) in a newspaper published in London, Manchester, Edinburgh and Belfast.

c) in the London, Edinburgh, Cardiff and Belfast Gazettes.

d) in a newspaper published in London, Edinburgh, Cardiff and Belfast.

4) The licensee with callsign G12JKL must not sign himself:

a) G2JKL/A when at a temporary location in England.

b) G12JKL/M when driving his car in Wales.

c) GM2JKL/M when driving his car in Scotland.

d) G12JKL/A when at a temporary location in Ireland.

5) The maximum carrier power supplied to the antenna of an amateur 1.81-2.00MHz transmitter is limited to:

a) 32W (15dBW)

b) 400W (26dBW)

c) 40W (16dBW)

d) 8W (9dBW)

6) The symbol J3E is applied to classes of transmission to mean:

a) amplitude modulated, telephony, single sideband, reduced carrier.

b) frequency modulated telephony.

c) amplitude modulated, telephony, single sideband, suppressed carrier.

d) frequency modulated facsimile transmission.

7) Drift in frequency must be avoided to ensure:

a) the transmission frequency does not interfere with users on adjacent frequencies and go outside the amateur band.

b) the transmission can be received by the listening station.

c) the transmission frequency does not go outside the amateur band.

d) the transmission frequency remains absolutely constant.

8) "Splatter" on an amplitude modulated transmission (telephony) could be caused by:

a) excessive bandwidth.

b) a very high power of transmission.

c) not using directional aerials.

d) talking too close to the microphone.

9) Poor design of an HF transmitter could cause VHF or UHF oscillations due to:

a) the natural tendency of transistors or valves to oscillate at these frequencies.

b) stray inductance and capacitance causing resonance at these frequencies.

c) the use of both transistors and valves in one unit.

d) the choice of an active device with a too high cut-off frequency.

Answers on page 55

10) To cure "chirp" on CW transmissions you should ensure that:

a) the key contacts are cleaned.

b) the aerial is well matched to the feeder cable.

c) an a.f. choke is placed in series with the key.

d) the oscillator circuit is adequately screened.

PAPER 2.

1) The international Q-code to ask "Who is calling me?" is:

a) QSP.

b) QRM.

c) QSL.

d) QRZ.

2) The signal report for an extremely strong CW signal modulated with a slight trace of whistle, but which is readable with practically no difficulty may be given as:

a) 496.

b) 946.

c) 446.

d) 469.

3) If a transmitter's output power is increased from 10dBW to 20dBW the new output power will be:

a) 10 Watts.

b) 20 Watts.

c) 50 Watts.

d) 100 Watts.

4) A particular radio frequency amplifier is quoted as having a power gain of 20dB. If the maximum output power is to be 200W, the maximum power which can be fed into the device is:

a) 100W.

b) 2W.

c) 10W.

d) 20W

5) In *Fig. 2* the voltage across the capacitor will be about:

a) 3.5V

b) 5V

c) 7V

d) 14V

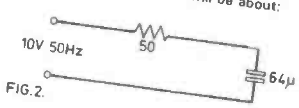


FIG.2.

6) In the design of a transistorised class B amplifier, as shown in *Fig. 3*, the cause of the distortion shown in the output diagram is:

a) I_c being too high.

b) insufficient supply decoupling by the capacitor C.

c) incorrect bias of Tr_2/Tr_3.

d) omitting an emitter resistor for Tr_3.

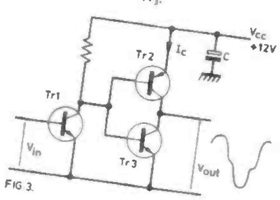


FIG 3.

7) *Fig. 4* shows the main parts of a typical superheterodyne receiver. The main purpose of the box marked 'Y' is:

a) phase locked loop (PLL).

b) beat frequency oscillator (BFO).

c) automatic gain control (AGC).

d) voltage controlled oscillator (VCO).

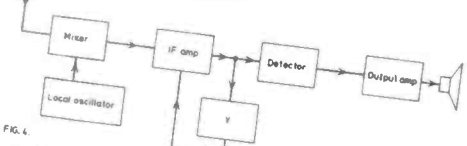


FIG. 4.

8) In the design of a transmitter, the frequency determining oscillator is usually followed by a class A amplifier stage. The main reason for this is:

a) to reduce the loading on the oscillator by subsequent stages.

b) to ensure that the output is rich in harmonics for the multiplier stages.

c) to ensure that the output is a pure sine-wave.

d) to reduce drift due to temperature effects.

9) It is inadvisable to attempt to design a transmitter for amateur use which broadcasts high quality speech (up to eg. 15kHz) because:

a) the components to construct such a device would be expensive.

b) the design is liable to cause TVI.

c) the band width of the signal would mean that only frequency modulation could be used and this would cause excessive distortion.

d) the bandwidth of the signal would be excessive and cause interference to other band users.

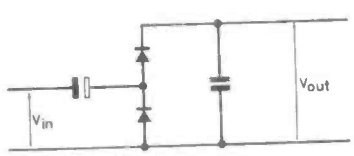


FIG.5.

10) The function of *Fig. 5* is:

a) a frequency discriminator.

b) a voltage multiplier.

c) a product detector.

d) a voltage regulator.

11) Vertical antennae offer the advantage of:

a) low angle, omnidirectional radiation.

b) low angle, directional radiation.

c) the antenna ned not be matched to the transmitter.

d) reduced co-channel interference.

12) The natural impedance of a folded dipole halfwave antenna at the centre point is approximately:

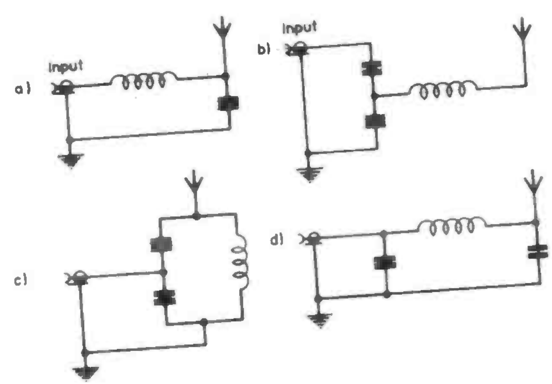
a) 75 ohm

b) 300 ohm

c) 70 ohm

d) 50 ohm

13) Which of the following tuning networks would not match a halfwave antenna?



14) Very long distance communication onthe HF bands (eg. England to Australia) is achieved by:

a) E layer reflection.

b) ground wave propagation.

c) F2 layer reflection.

d) multiple F2 layer reflections.

15) A standing-wave ratio meter is used to:

a) see if an aerial is radiating properly.

b) check the radiation efficiency of an aerial.

c) check the matching of a transmission line on a transmitter.

d) count standing waves in a transmitter.

A PLAIN MAN'S GUIDE TO MASTS & TOWERS

part 4

Loading

by A. S. Barraclough G3UDO *

So far we have looked at a number of factors related to selecting a suitable aerial mast or tower, such as the effect of height on aerial performance, losses in the feeder cable, aerial rotators, some aspects of getting planning permission and a selection of the various types of tower or mast that can be used for amateur radio aerials.

Well, assuming that you have managed to convince the XYL/OM, the neighbours and the local planning officer of your need to erect a mast, we should have a look at some of the 'nitty gritties' that are essential when selecting and finally installing your mast or tower.

The most important of these is probably wind loading; that is, what size of aerial or how many can be safely installed on a mast or tower and in what sort of wind conditions.

When the wind acts on the surface of the aerial, rotator and the mast itself, it generates a force which depends on the speed of the wind. This force must be allowed for when selecting a mast or tower to carry a particular aerial.

Most aerial manufacturers specify wind loading, but these may not be true values because sometimes they contain safety margins. This can sometimes lead to the selection of a rotator or tower that is too large, and more expensive, than it needs to be. It is quite a simple matter to calculate the wind loads on an aerial and it is worth doing as a check — if nothing else.

Horizontal aerials

The first thing then, is to work out the maximum surface area of the aerial. This is not the same as the area of the aerial viewed from the side or the end. To find the maximum area, area A, of a typical horizontally polarised aerial such as the Yagi shown in **Fig. 1** the first thing to do is find the area of the aerial as viewed from the end, area C; and from the side, area B.

Area B is the area of the boom **(Fig. 1)** which is found by multiplying its length L1 by its diameter D1. The ends of the element can be ignored unless there are traps fitted. In this case find the area of a circle equal to the diameter of the trap, multiply by the number of traps, and add this figure to the area of the boom.

Area C is the average area of a single element, including traps if fitted, as viewed from the end multiplied by the number of elements in the aerial. If the driven element is a folded dipole it counts as two. The average area of a single element is found by multiplying the average length of the element L2 by the diameter D2. The average length of element L2 $= \frac{L_1 + L_s}{2}$ **(Fig. 1)**.

Fig. 2 shows a right-angled triangle whose sides AB and AC are drawn to represent areas C and B. The side BC then represents the maximum area A. This can be obtained by using Pythagoras (that Greek chap — remember?) Thus:

Area A = (area C)^2 + (area B)^2.

Alternatively, if you can draw the triangle to some suitable scale that represents area B and C, then a close approximation of area A can be got simply by measuring the side (hypotenuse) BC. So far all the areas have been worked out as if they were flat plates of equivalent size set at right angles to the air flow. However,

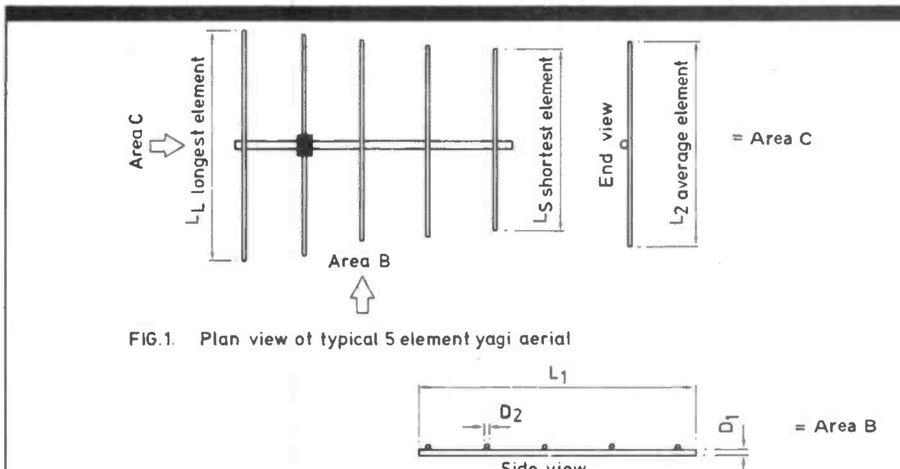


FIG.1. Plan view of typical 5 element yagi aerial

* Allweld Engineering

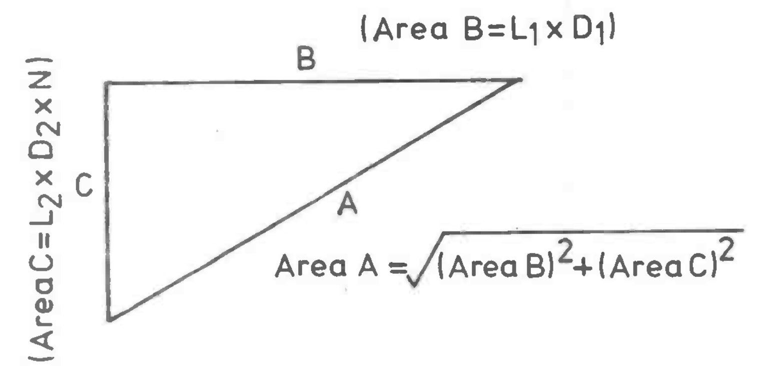


FIG.2. Wind diagram

if the aerial is made of round tube or rods, they present a much better aerodynamic shape to the airflow (see **Fig. 3**) and so any resulting wind pressures would be less than that on the equivalent flat plate. An allowance is made for this by multiplying the maximum area A by a factor of 0.6. Having got the maximum effective area of the aerial, corrected by 0.6 if round tube is used, the wind pressure or 'windage' is obtained by multiplying by the wind pressure relative to a given wind speed.

Wind pressure

There are a number of variables to be taken into account when considering wind pressure in relation to its speed, but so as not to confuse the issue we have simplified matters by using values applicable to aerials at a height of 15m above ground, situated in open country with scattered wind breaks. These values of wind speed have been derived on a statistical basis from continuous records for the whole of the UK and are given as being the estimated gust speeds that are likely to be exceeded, on average, only once in 50 years in open country and 15m above ground. These values are given in a British Standards Code of Practice, CP3 Chapter V: Part 2 1972 and some of these are reproduced below in simplified form:

Vertical aerials

With aerials that are mounted vertically as in **Fig. 4**, the maximum surface area appears when the aerial is viewed from the side. Therefore, the maximum windforce will occur when the wind is at right angles to the side of the aerial. The effective area can be worked out as follows: multiply the area of the longest element, (including any traps) by the total number of elements. Add the area of the supporting boom.
Effective area =

$$AE = (L_2 \times D_2 \times N) + (L_1 \times D_1)$$

As with the horizontal aerials, if the elements and boom are made of round tube, then the result must be corrected by multiplying by a factor of 0.6.

Extensions and rotators

Like the aerial, the rotator and any extension tube (see **Fig. 6**) will also offer some wind resistance that has to be taken into account. The total area and wind pressure can be worked out in the same way as for aerials made of round tube. If, however, the rotator has a rectangular profile then find the greatest area, and consider it as a flat surface. When dealing with rotators and extension tubes (see **Fig. 6**) two factors have to be considered:

1. The sideways load due to the wind load of the aerial.
2. The sideways load due to the wind load of the extension tube itself.

These two loads cause a bending load to be applied to the rotator and mast top as well as the extension tube. The bending load on the rotator is found by multiplying the windage of the aerial at point A by its distance (B2) above the bottom of the extension tube. Working in units of pounds (weight!) and inches, the load is given in lb.in. The wind load of the extension mast is found by multiplying its height H above the rotator by its diameter D. Because it is generally of round tube, the answer is

Wind Speed (Miles/Hour)	50	60	70	80	90	100	110	120
Dynamic Pressure (lb/ft^2)	6.4	9.2	12.5	16.4	20.7	25.6	31.0	36.9

CORRECTION – APRIL

In the April issue of this magazine we carried an error in the previous part of this series 'A Plain Man's Guide to Masts and Towers - Pt 3' which has caused much annoyance to all concerned.

We stated that the name 'Versatower' was attributed Western Electronics Ltd. This is not so. This well known brand-name belongs to Strumech, a company which has been making Versatowers and other forms of aerial masts for the last 15 years.

The error originated in the editorial offices of this magazine and was in no part due to the author of this otherwise excellent series, Alan Barraclough G3UDO. Profuse apologies and red faces.

Frank Ogden G4JST
Editor, Ham Radio Today

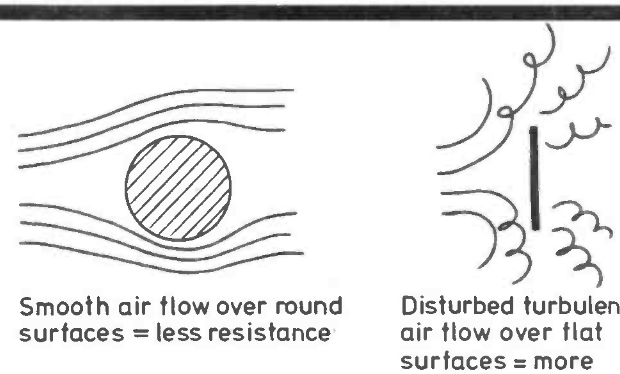


FIG. 3.

multiplied by the correcting factor 0.6 to give the true effective area, and from this the wind pressure can be found. This wind pressure on the extension mast is taken as acting at a point E that is at the middle of the exposed length H. (i.e. half the amount sticking up above the rotator or mast). The bending load caused by the extension tube loading is found by multiplying the effective wind load on the extension at point E by its distance B_1 above the bottom of the tube: ie. half the exposed length plus the part in the rotator clamp. These two bending loads are added together to give the whole bending load or sideways load on the rotator and extension tube. Using these figures, the bending load in the mast or tower can also be found. Note that the extension tube should have a factor of safety of 2; i.e. it should be able to carry twice the maximum bending load.

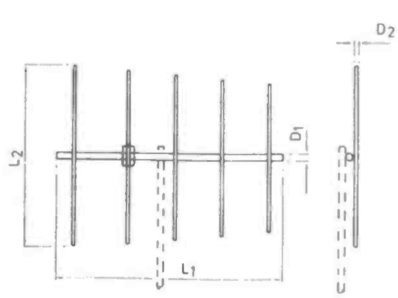


FIG. 4. Vertically polarised aerial

Ice

In the UK, ice is very unpredictable factor, but an aerial with layer of ice on it will offer a greater resistance to any wind than an aerial of the same size with no ice. There are no firm guidelines to go by here, so for practical purposes, applicable to average icing conditions in the UK, adding 25% to the final value of wind resistance should be adequate. The method of calculating wind resistance shown is not intended to be precise but merely to enable the average amateur to get some idea of the kind of forces that are acting on the aerial system and mast. Where there are any special local wind conditions due to high rise buildings etc., these must be taken into account individually.

The structure

In addition to any wind load

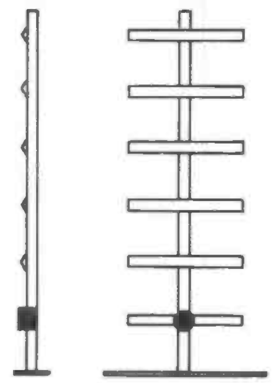


FIG.5.
Flat aerial elements induce a substantially higher wind loading than round ones.

imposed by the aerial system, the mast or tower must also withstand the wind load induced by the structure itself. In general, the structure of the mast or tower must be capable of withstanding twice the maximum load imposed on it, including its own wind load. When commercially made structures are concerned, the manufacturer would have taken all these loads into account and included a suitable safety factor when specifying the maximum horizontal head load that a particular mast or tower can carry. Usually a safety factor of between 2 and 3 is applied.

Fig. 7 shows a typical self-supporting post-mounted structure with the basic wind loads indicated. The combined effect of the two wind loads FA (for the aerial system) and FM (for the mast structure) is to try and tip the whole lot over about a fulcrum, point 0, at the base; this is the overturning force F_T. Counteracting this is the force due to

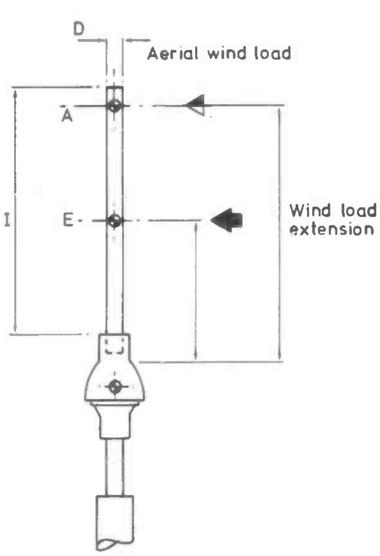


FIG. 6. Rotator loading

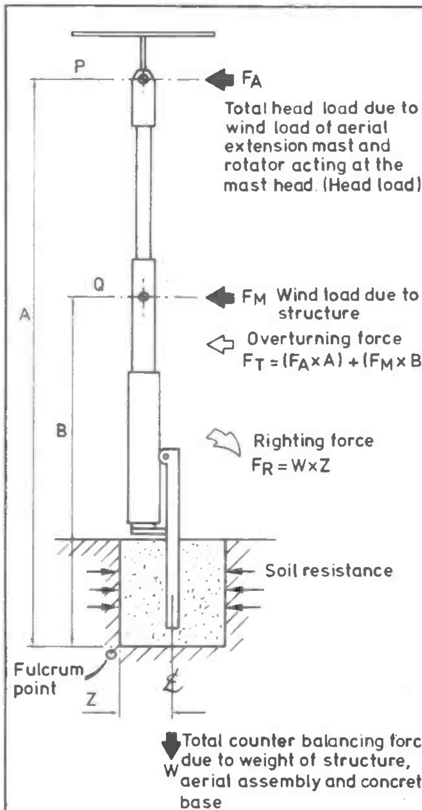


FIG.7. Effect of wind loads on self supporting masts or towers.

the combined weight of the aerial system, the structure and the foundation base. All of these act in the direction of arrow W, trying to right the structure; this is the righting force F_2. In addition there is a certain amount of resistance from the ground, which, depending on soil conditions is acting in favour of the righting force. So long as the whole of the righting force F_R is equal to or greater than the overturning force F_O, the structure will remain upright. The overturning force F_T is a combination of the wind load F_A effectively acting at the mast head P, multiplied by its height A above the fulcrum point 0; plus, the wind load F_M at point Q, multiplied by its height B above point 0, thus:

$$F_T = (F_A \times A) + (F_M \times B).$$

Similarly the righting force F_R is equal to the combined heights W multiplied by the distance Z from point 0, plus any resistance due to the soil, thus:

$$F_R = (W \times Z) + \text{soil resistance}.$$

In addition to the overturning force F_T imposed by the combined wind loads, there is also a certain amount of bending taking place in

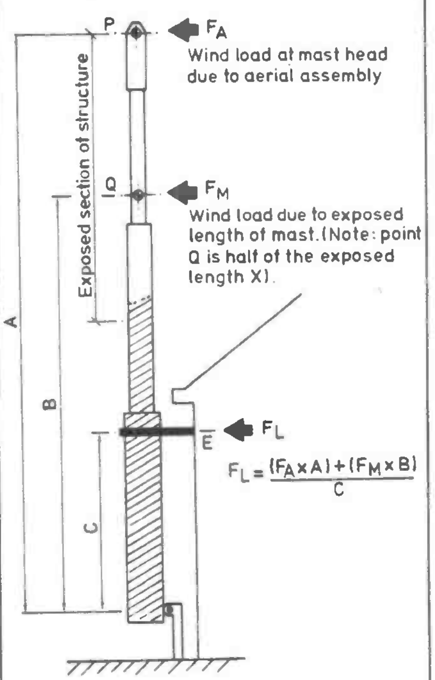


FIG. 8. Wall supported tower.

the structure due to the wind loads. This would have been taken into account and a suitable safety factor allowed by the manufacturer. However, as long as the specified head loads etc., are not exceeded and the correct procedure followed

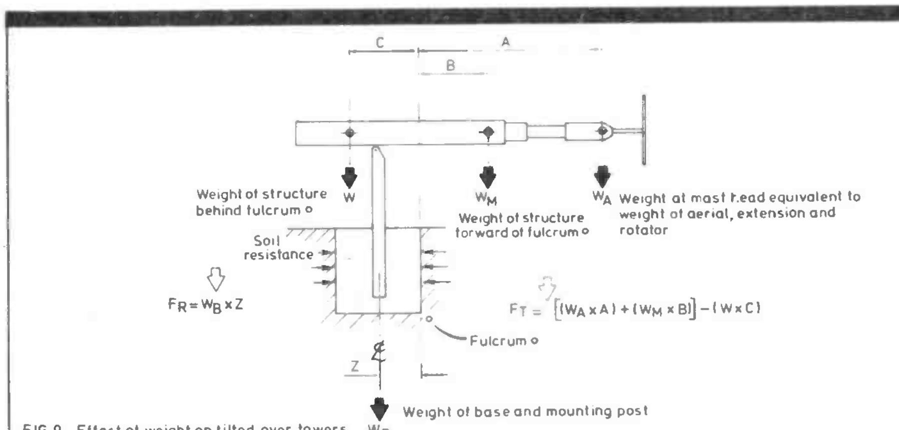


FIG. 9 Effect of weight on tilted over towers

during installation, no difficulties should arise. (Excluding unforseen soil or wind conditions.)

Masts or towers that are supported by a wall, (see **Fig. 8**) differ in that the supporting wall must carry some of the load. In certain conditions, the wall will shield parts of the structure (shown shaded) from the full effect of the wind and so reduce the wind load on the structure. Bear in mind that the wind force will still affect the wall. The simplified formula:

$$F_L = (F_A \times A) + (F_M \times B)$$

can be used to obtain a useful estimate of the load that could be imposed on the wall and support bracket at point E. If the wind was blowing along the wall face, i.e. at 90% to the direction indicated in **Fig. 7**, then the circulations are a little more complex. However, with the wind in the direction of the arrows in **Fig. 8**, this is the worst condition and presents the maximum load on the wall. You will notice that the higher up the wall the bracket is anchored, the lower will be the load at point E. Bear in mind also, the taller the tower and larger the aerial, then greater will be the load at point E. Towers with an extended height of over 50 ft are not recommended for installation on the average house wall. However, there can be exceptions so get some advice from your local builder as to the strength and condition of the wall. If necessary, reinforce it.

When a post-mounted mast or tower is fitted, as in **Fig. 9**, then the weight of the aerial and tower begins to affect the stability of the installation. The weight on one side of the fulcrum (point O) tries to overturn it, in this case those to the right of point O. A weight on the other side, i.e. to the left of point O, tries to right it. These are the overturning load F_T and the righting load F_R. To ensure the installation is stable F_T should be less than F_R. Bear in mind that as before, the ground will resist any over-loading load depending on soil conditions and so can form part of F_R. F_T is equal to the total weight of the structure to the right of the fulcrum point O, minus the weight of the structure to the left of point O.

$$F_T = [W_A \times A) + (W_M \times B)] - (W \times C)$$

The righting force F_R is equal to the total weight of the concrete base and the mounting post acting through a centre that is to the left of the fulcrum point O.

$$F_R = W_B \times Z.$$

The effect of ground resistance, depending on soil conditions, can be added to this to give a final righting load.

Data

Concrete: Suitable mix for foundations:
1 part cement, 2% parts sharp sand, 4 parts coarse aggregate.
Average weight: 140 lb/cu.ft., 2240 kg/cu.m.
Aluminium tube:
The weight of aluminium tube can be found by the following.
Metric: 0.003823t (D — t) = kg/m
Imperial: 3.68t (D — t) = lb/ft.
t = wall thickness in mm or inches.
D = overall (outside) diameter: in mm or inches.
Grades of Aluminium tubing:
HE9, General purpose. Tensile strength 9-10 tons/sq.in.
HE30 Structural Grade tensile strength 25-30 tons/sq.in.

CONVERSION FACTORS
1 lb = .454 kg*
1 kg = 2.2046 lb
1" = 25.4mm
1 metre = 3.281 FT
($39\frac{3}{8}$" approximately)
1 sq. ft. = 0.1524 sq. metre
1 sq. metre = 6.562 sq. ft.
1 cubic ft. = 0.0283 cu. metre*
1 cu. metre = 35.315 cu. ft.*
1 lb. f = 4.448 Newtons*
1 kgf = 9.80665 Newtons

TUBE WALL THICKNESS
STANDARD WIRE GAUGE

swg	inches	mm
7	.176	4.470
10	.128	3.251
12	.104	2.642
14	.080	2.032
16	.064	1.626
18	.048	1.219
20	.036	0.914

*APPROXIMATE VALUE
NOTE: All data etc. given is for guidance only, and where necessary it is recommended that expert advice is sought.

NEWCOMER'S

There is a vociferous section of the amateur community which maintains that the two metre band is now no more than an extension of 27MHz (legal or illegal) CB. Some of the reasons given are that the majority of operators are black box users, that they have little technical knowledge of the equipment they use, the use of channelised frequencies, simple ('inefficient') aerial systems, pointless conversations with no technical content, plus "ever since the Class B's got the band...." (I am quoting from letters in various magazines, not expressing my opinion!).

There is no doubt that the past 15 years have seen a bigger change in the 'modus operandi' of this band than any other VHF/UHF allocation. I doubt that many of the newer licencees have any knowledge of what changes have taken place, and for what reasons. On the other hand, many older licencees probably don't stop to think of why it all has gone the way it has, and forget that their lack of use of the band partly prompted the Class B licence in the first place. (Letters on the subject to the Editor!)

Having a look at the background to all this may give you some clue as to why these comments are made, and why some of the practices that have now fallen into obscurity may be worth reviving for practical reasons.

Self-training?

Firstly, one of the arguments advanced against black box operators is that there is no element of self-training involved in pushing the PTT switch on a piece of commercial gear. Well, that is true if taken out of context. You will no doubt experiment with aerials and feeders, learning about their types and characteristics, using power and SWR meters, learning by experience about propagation, building some accessories for the station, and a multitude of lesser items. All this *is* self-training — the licence doesn't require that you pass an MSc in Electronics/Electrical Engineering after a given period!

I feel that those who rabbit on about this lack of self-training are confusing the technical aspect of the hobby with the operating part. They are forgetting that both are important to the hobby and that it couldn't exist without both. Because of the things I mentioned in the preceding paragraph, I doubt that even the inveterate appliance operator has no technical knowledge at all. On the other hand, even the person who builds and designs everything himself, and who revels in the technical side of the hobby, will go on the air sometime to try it all out, and thus fulfil the other aspect.

Incentive licencing

Where I would agree that the system falls down is in the method of selecting Class A and Class B Licensees. The Morse Test should *not* be the vehicle by which this is achieved — the acquisition of the skill to use the code is a purely mechanical process and does not demonstrate an inherent ability to be let loose on HF. What is needed, is some form of incentive licencing, as adopted in the USA. With this, you can demonstrate to the satisfaction of your fellow amateurs that because of your technical and operating knowledge, you have more right to certain facilities than someone who does not have these attributes.

At present, we have a form of incentive licencing where with no technical or operating knowledge — you can get a CB licence, and with some technical but still no operating experience you get everything else going!

Enjoy yourself

However, as things stand amateur radio is still, and always will be, a hobby, and like most hobbies the idea is that you enjoy it. If you get your enjoyment by just chattering about the weather, or what you worked in the last lift, rather than propagation delays in CMOS circuits, so what? We still live in a democratic society, with freedom of choice, providing our activities are not against the interests of the rest of the community. So, like the television set, there is a channel/on-off switch/ the HF bands/RTTY/satellites/data/ SSB/TV/SSTV/CW/contests (more letters!)/the local pub if you don't like what you hear.

In the beginning...

Well, not quite, but prior to the introduction of the mass produced Japanese transceiver, which is the heart of the problem as you will see, two metre operation was a totally different thing, with no channels (other than the one on your favourite 2m crystal), and a bandplan totally different in concept to today's. There were also a lot less stations, mainly due to the fact that with little commercial gear around, everyone had to build their own equipment. As constructing for VHF is a bit more demanding than HF, there was a natural limitation on the number of active stations. Possibly, if a lot more people had built their own and got on the band, the changes which occurred may not have been as devasting as they appeared to some eyes.

Prior to February 1974, the two metre band would have caused today's operator to puzzle at how stations contacted each other. If you look at **Fig. 1**, you will see that before 1974 the band was split into a number of Zones, with each county in the Country allocated a specific Zone, with adjacent counties in the same Zone. Depending on whether you wanted to work local stations or DX, you would transmit on a frequency within your own Zone (often crystal controlled) and look for a reply. If the other station was local, you would be called on either your own channel or elsewhere within the part of the band for your Zone. If you were called by a DX station it would be in the section of the band for his Zone. If you were

FORUM

By Tony Bailey G3WPO

VFO controlled then you could opt to move to the calling station's frequency, or carry on split working.

This naturally resulted in much split-frequency operation as SSB was the exception, with FM and AM dominating the band. It was only in 1966 that a specific national calling frequency was adopted for SSB, 145.41MHz. Alternatively you could use SSB within any of the regional Zone sub-bands. 1966 was also the first year that the CW-only portion was fixed, then at 144.0-144.1MHz.

Any advantage in zoning?

I personally think that this method of working has distinct advantages over todays channelised operation, certainly for DX working. For one, both ends of the QSO knew where to look for each other, and you were more likely to hear each other spread out over a range of frequencies, than on a small number of individual numbered channels. You could also tune the band from low to high (or the other way round) look for contacts and decide which station you were going to reply to. All of this would be announced during your CQ for the benefit of the listening stations.

So many people forget nowadays to state where they are located, when calling CQ on FM. It is to your own advantage — if you are in Sussex and hear G6ZZZ (apologies to the eventual owner) calling CQ, you may ignore him during a lift. If he says G6ZZZ located in Cumbria, your reaction may change. So, always give your location, even if it is only a brief call on S20 — you never know who is listening, or what the state of propagation is at any moment.

Goodbye zoning

This geographical zoning was eventually abandoned in February 1974, in favour of a bandplan very similar to that which exists today. This came about as a result of the changing uses of the band, and to fall in line with European practices.

In 1968, the Class B licensees were given access to the two metre band — prior to this they were permitted only to use 427MHz and above (yes — 70cm was even wider then). This in itself brought more use to a quiet band, but the real changes started in 1970 with the appearance of the FT2-F from Bill Lowe, retailing at around £80. For the first time, a reasonably cheap commercial FM mobile/fixed station rig was available, and a lot of those who didn't want to face construction opted for purchasing one of these. They came with Japanese FM channels fitted, including 144.48, 144.6 and 145MHz — this might explain why you get some odd frequencies in older fixed channel rigs.

More black boxes started appearing over the next few years with a consequent dramatic increase in the level of activity on FM.

Some say the start of the end...

In 1972, an experiment started which was to result in more controversy than possibly any other aspect of the hobby. The first repeater station, GB3PI, was commissioned on a short term licence for a feasibility study. This was a success, and in the ensuing years more followed, to the present level using all 8 repeater channels.

As the number of repeaters grew, so did the number of operators, and the available commercial equipment. By 1974 it was already obvious that the bandplan needed some sort of alteration to cope with this new phenomena, and also the growing use of SSB. Zoning was totally abandoned as unsuitable, in favour of a mode-oriented bandplan. A national calling frequency of 145.5MHz (S20) was adopted together with 3 other simplex channels (S21-S23). As you all know, more were added later. Use of 145.0MHz as a mobile calling frequency in the UK was deprecated by the Europeans as it interfered with R0 operations — needless to say, many people carried on using it rather than buy a new set of crystals!

Fig. 1. 2m band plan until 1974

Zone 1	144.0 — 144.1 MHz	CW only Nationwide
Zone 2	144.1 — 144.25MHz	Cornwall, Devon, Somerset, Berkshire, Dorset, Hampshire, Wiltshire, Channel Is.
Zone 3	144.25 — 144.5 MHz	Brecon, Cardiganshire, Carmarthenshire, Glamorganshire, Gloucestershire, Herefordshire, Monmouthshire, Pembrokeshire, Radnorshire, Worcestershire.
Zone 4	144.5 — 144.7 MHz	Kent, Surrey, Sussex.
Zone 5	144.7 — 145.1 MHz	Bedfordshire, Buckinghamshire, Essex, Hertfordshire, London, Middlesex.
Zone 6	145.1 — 145.3 MHz	Cambridgeshire, Huntingdonshire, Leicestershire, Norfolk, Northamptonshire, Oxfordshire, Rutland, Suffolk, Warwickshire.
Spot Frequency	Single Sideband	145.41MHz
Zone 7	145.3 — 145.5 MHz	Anglesey, Caernarvonshire, Cheshire, Denbighshire, Flintshire, Merionethshire, Montgomeryshire, Shropshire, Staffordshire.
Zone 8	145.5 — 145.8 MHz	Derbyshire, Lancashire, Lincolnshire, Nottinghamshire, Yorkshire.
Zone 9	145.8 — 146.0 MHz	All Scotland, Isle of Man, N. Ireland, Cumberland, Co. Durham, Northumberland, Westmorland.

Prior to 1966, Zone 1 was allocated to Cornwall, Devon and Somerset.
CW was allowed in any Zone as well as the exclusive Zone.

Today

We are now in the situation where 65% of the available 2 metre band is exclusively allocated to FM, AM having been nearly totally abandoned, and CW little used by comparison. The operation of the repeater network is a shambles in many parts of the country, and their original intended prime use for mobile working is often dropped in favour of 'DX' contacts during lifts (the actual QSO distance being that between your station and the repeater), and use by fixed stations who can perfectly well hear each other on the input.

Even the newer licensees can probably now see why criticisms are levelled at today's users along the lines of "where is the experimentation and self-training?". Whether it is justified or not I will leave up to you to decide. On the credit side, I have a serious doubt that if (a) the Class B's had been denied access, (b) the repeater experiment had been abandoned, and (c) the Japanese had stuck to making cars, we would not have 2 metres today, it long ago having been forfeited to the PMR service. There are those who would say that was the better option.

As I said earlier, if you don't like it, there are many alternatives. However, I would urge those newer licensees who use the band purely for nattering, to try to get a better antenna system up (if possible) and see how far it is possible to work under even flat conditions — you may get a surprise.

Phone patch?

Someone asked me what on earth the above was all about — was it something to do with computer programming? Well, not quite, it is the American term for linking the telephone system to your transceiver for relay purposes. I should hasten to add that it is *not* legal over here (needless to say) but is so in the USA and a number of other countries with which they have agreements.

You can very often hear it in action up the top end of the 20 metre band (14MHz) normally with one end located on board a ship (Maritime Mobile) carrying an amateur operator, linking passengers back to the States (you can hear similar traffic being conducted over here on the maritime bands using ship-to-shore links). Unfortunately for us anything along these lines, unless it is an emergency, is verboten because it takes revenue away from Buzby's coffers.

Careless talk...

And, just in case you don't think that the bands are monitored for this sort of thing, some months after I was licensed, two City looking gentlemen turned up on my doorstep, asking to have a word with me. They produced a complete transcript of a CW QSO I had had on 160M some weeks earlier, complete with all the mistakes. During this QSO, I had agreed to ring the parents of one of the other station's operators (he was at university) to say that he would be home at the weekend. All this was faithfully recorded, and shoved under my nose with appropriate warnings.

The annoying thing was that I never actually passed the message — one of the other stations in the net had already done it and popped up to say so — they didn't hear that!

RTTY The Long Distance Typewriter

By Ken Michaelson G3RDG

To some people, swimming the channel or climbing a mountain is their idea of a hobby but mine is somewhat more leisurely and a lot less energetic. By just sitting down at my teleprinter and typing a few words I can be in touch with another enthusiast on the other side of the world watching his machine print out almost instaneously what I am typing in my shack.

It was largely due to the research and hard work of one Frederick Creed (who worked for the Central & South American Telegraph and Cable Company in Peru) and who became frustrated with the then used method of sending messages by telegraph. In 1890 he developed from an old typewriter a machine which enabled complete Morse signals to be punched into paper tape.

Creed's system formed the embryo teleprinter of today, but the first teleprinter as we know it, came from the USA — the Morkrum teletype machine which operated on a 5-unit start-stop signalling code and was a direct printer, that is to say, it printed messages directly from incoming signals instead of a punched tape.

The first experimental teleprinter service to be used commercially was operated by the press in 1915, and in 1917 the 'United Press' completed a contract for three private lines. From this small beginning grew the worldwide use of 'Telex' as the commercial version is called. It only really got under way after the last world war, but amateurs became interested and started to use ex British Post Office machines in the early 1950's. Radio amateurs, of course, do not use landlines and so naturally their messages are sent and received by radio. When I first saw this in operation at a radio society exhibition on the stand of the British Amateur Radio Teleprinter Group (known to all as BARTG), I was hooked. The idea of watching a piece of machinery actually printing a message in front of my eyes uncontrolled by human hands was simply magic to me. I immediately scoured the classified advertisement columns of the radio magazines for a secondhand teleprinter. In due course I was able to obtain a machine together with a 'terminal unit' or 'demodulator' (which is necessary to change the incoming signals into a means of operating the teleprinter, which I shall refer to later on), and risked at least a slipped disc carrying it to my shack.

What it is

No doubt many of you, licenced amateurs and shortwave listeners alike have tuned into something that sounds like 'jingle bells' in various parts of the band and wondered what it was..That is RTTY or Radio Teletype, and it is a method of communication where the sender types a message on a keyboard and the distant operator sees it appear in print, on a roll of paper or a length of paper tape.

Where to find amateur RTTY

Amateur RTTY operates on the 6 HF bands as follows: 3.6; 7.04; 10.145; 14.1; 21.1; and 28.1 MHz, all frequencies plus or minus a few kHz. Although most of the long distance contacts seem to be on the 14MHz band, you will also find RTTY operation on VHF and UHF, that is 144 MHz and 432 MHz. These are usually short distance contacts working on 'autostart'. I shall discuss this later. The arrangement of the RTTY segments of our amateur frequencies is shown in **Fig. 1.**

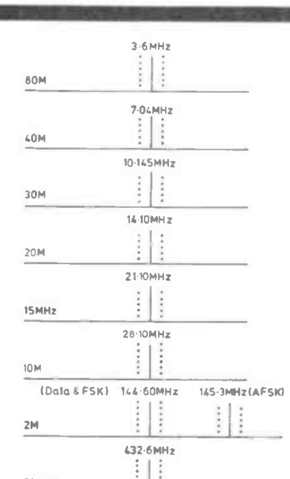


FIG. 1 RTTY calling frequencies

How it works

A teleprinter is an extremely complicated piece of machinery, but to understand the basic principles the following explanation should be sufficient. The coding used by radio teletype machines (and incidentally worldwide commercial 'Telex') is the Murray code, also called 'Baudot', and the 'CCITT No 2 International 5-unit Start-Stop Teleprinter Code'. The complete code (letters, numerals and operational functions) is shown in **Fig. 2.** The letters of the alphabet are transmitted prefaced by a start pulse and followed by a stop pulse. You will note that there are 32 possible combinations of which 31 are used. The exception is the character containing all spaces. The 32 possible combinations available from the 5 unit code are not sufficient for practical use as there are 26 combinations required for the alphabet alone, leaving insufficient for numerals, let alone punctuation marks. The solution is to use the code twice, that is, to make a given combination print either a letter or a number. Two of the 32 combinations are used as 'shift' signals, the function of which is to operate a mechanical changeover device on the machine and so allow the mechanism to print either letters, or numbers and punctuation only. The shift signals are also known as 'case shift' signals. One 'case' is letter shift and the other 'case' is figure shift. The marks and spaces which transmit the particular letter, numeral or punctuation mark are known as 'elements' and are numbered from 1 to 5 in sequence. A start signal is transmitted at the commencement of each character formation and a stop signal at the end. Teleprinter signals, as far as the amateur is concerned, are generally transmitted and received at speeds of 45.45 or 50 'bauds' (more of that later), although there are exceptions. To keep things as simple as possible, if we consider a speed of 50 bauds, the time taken to transmit a complete character including the start and stop pulses, is 150ms and this is divided up as shown in **Fig. 3.**

Combination numbers		5	4	3	Feed holes	2	1	Letters
1	–				·	●	●	A
2	?	●	●		·		●	B
3	:		●	●	·	●		C
4	Who are you		●		·		●	D
5	3				·		●	E
6			●	●	·		●	F
7	Optionals	●	●		·	●		G
8		●		●	·			H
9	8			●	·	●		I
10	Bell		●		·	●	●	J
11	(		●	●	·	●	●	K
12	)	●			·	●		L
13	.	●	●	●	·			M
14	.		●	●	·			N
15	9	●	●		·			O
16	0	●		●	·	●		P
17	1	●		●	·	●	●	Q
18	4		●		·	●		R
19	·			●	·		●	S
20	5	●			·			T
21	7			●	·	●	●	U
22	–	●	●	●	·	●		V
23	2	●			·	●	●	W
24	/	●	●	●	·		●	X
25	6	●		●	·		●	Y
26	+	●			·		●	Z
27	Carriage return		●		·			
28	Line feed				·	●		
29	Letters	●	●	●	·	●	●	
30	Figures	●	●		·	●	●	
31	Space			●	·			
32	All space				·			

FIG. 2. The full Teleprinter code

Transmitting a character

When a key of a teleprinter is pressed it causes a moving contact inside the machine to switch between two fixed contacts at a rate and sequence dependent on the telegraph speed. In this case we are thinking of 50 bauds. Machinery inside the teleprinter selects the letter keyed, and operates the transmitting contacts. If a positive voltage is applied to one fixed contact and a negative voltage to the other, as the moving contact changes from one side to the other, a positive or negative voltage appears on it. This voltage, when fed to a audio generator produces the two tones sounding like the 'jingle bells' mentioned above. The two tones used by amateurs today are 1275Hz and 1445Hz. The difference between the two is 170Hz and this is termed the 'shift'. These shifting tones are then applied to the microphone socket of a tranceiver or transmitter and radiated as a signal. The signal contains the start pulse, the 5 elements of the letter and the stop pulse as described earlier. The signal is received by the distant end and decoded in the reverse manner.

Receiving a signal

When the varying tones are received at the distant end, tuned carefully so that both tones have equal amplitude, and applied to that item of equipment that I shall discuss later, the 'demodulator' or 'terminal unit', the circuitry of the TU will change the two tones received over the air into a fluctuating voltage, having the same plus-and-minus variation as the original signal sent out by the transmitter. This varying voltage, when connected to the magnet of the receiving teleprinter (also designed to operate in the 'double current' mode) and which is running at the same speed as the sending teleprinter, will then print the signal which has been sent.

What is this thing called a "baud"?

I talked about two amateur speeds earlier, 45.45 and 50, and I called them 45.45 bauds and 50 bauds. The 'baud' is a term used for the 'signalling speed'. If we talk about a speed of 50 bauds, a character takes 150 milliseconds to send including the start and stop pulses (see **Fig. 3**). The signalling speed is equal to 1000 divided by the time taken to send 1 element of the character (in milliseconds). In the case of 50 bauds, dividing 1000 by 20 = 50 (bauds). Machines operating at 50 bauds generate 7½ units of 20ms length = 150ms. Since a word is defined as having 5 characters plus a character space, a word = 6 x 150ms = 0.90 seconds length. Because there are 60 seconds in a minute, a machine operating at 7½ units 50 bauds can send or receive 60 divided by 0.90 = 66.6 words per minute. The other amateur speed, 45.45 bauds, takes 22ms to send 1 element and when worked out with the same formula gives a speed of 60 words per minute. There is no need to get too concerned about this matter of speed though. There are some quite simple methods of checking the speed of a teleprinter that I shall discuss in a later article. ●

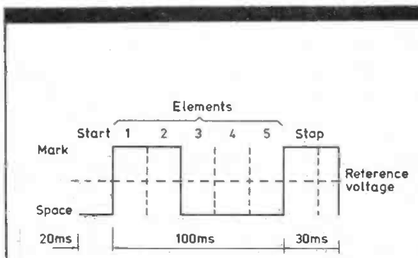


FIG. 3. The letter 'A' a typical character construction

Upgrading the KW2000 series of HF transceivers

Part 4

Modifications

By M.T. Healey, G3TNO, and R. Charles

If you have followed the procedure given in previous articles your *KW2000* should now be working reasonably well. You may well now feel that it is worth while making some improvements to the rig, and adding some features that it does not possess in its standard form. A possible list of 'things that would be nice to do' might be as follows:

1. Stop the VFO drifting with changing mains voltage, due to the heater voltage of the VFO changing.
2. Improve the receive sensitivity on the 21 and 28MHz bands, which is not as good as more modern designs.
3. Improve the selectivity on CW, since the passband, which is designed for SSB, is uncomfortably wide for CW, particularly under contest or crowded band conditions.
4. Improve the note on CW transmit. The *KW2000* has a very distinctive sound on CW that is less than perfect to the CW purist.
5. There are no facilities for any of the WARC bands, and on 21 and 28MHz the whole of the band is not covered.
6. Cross-modulation performance is poor, particularly on 7MHz.
7. It would be useful to be able to vary the transmit power on SSB and CW properly, i.e. by some other means than using the MIC GAIN control.

The methods by which the writers have improved the above features are described below. However, there are many alternative ways of tackling all of them, and the way in which any individual tackles them will, of course, depend on his personal preference, and the contents of his junk box!

VFO drift

Whilst most sections of the *KW2000* are comparatively insensitive to supply voltage variations, the VFO V11 and HF crystal oscillator V10 tend to change in frequency as their heater voltage, and hence cathode temperature, is varied. Because of this their heaters are not connected to the main 12V heater system of the transceiver, but are brought out to a separate pin, pin 12, on the multiway connector, and the mobile PSU was designed to provide a stabilised 6.3V supply for this so that the frequency did not vary with engine speed. However, the manufacturers did not consider such a refinement necessary for base station operation and, as can be seen from **Fig. 101**, the supply to pin 12 is simply derived from the main 13V heater supply via a dropping resistor R9. This means that variations in mains voltage can cause variations in frequency, which can be annoying especially if using the rig with a narrow CW filter as described later.

It is comparatively easy to modify the power supply to provide the necessary stabilised 6.3V supply for V10 and V11, and one way of doing this is shown in **Fig. 102.** This has the additional advantage of providing an unstabilised +18V supply which can be used to derive stabilised supply voltages for various bits of additional circuitry, such as the preamplifier associated with the CW filter described later. It can be seen from **Fig. 101** that the LT supply is derived from a 13V 5A winding on

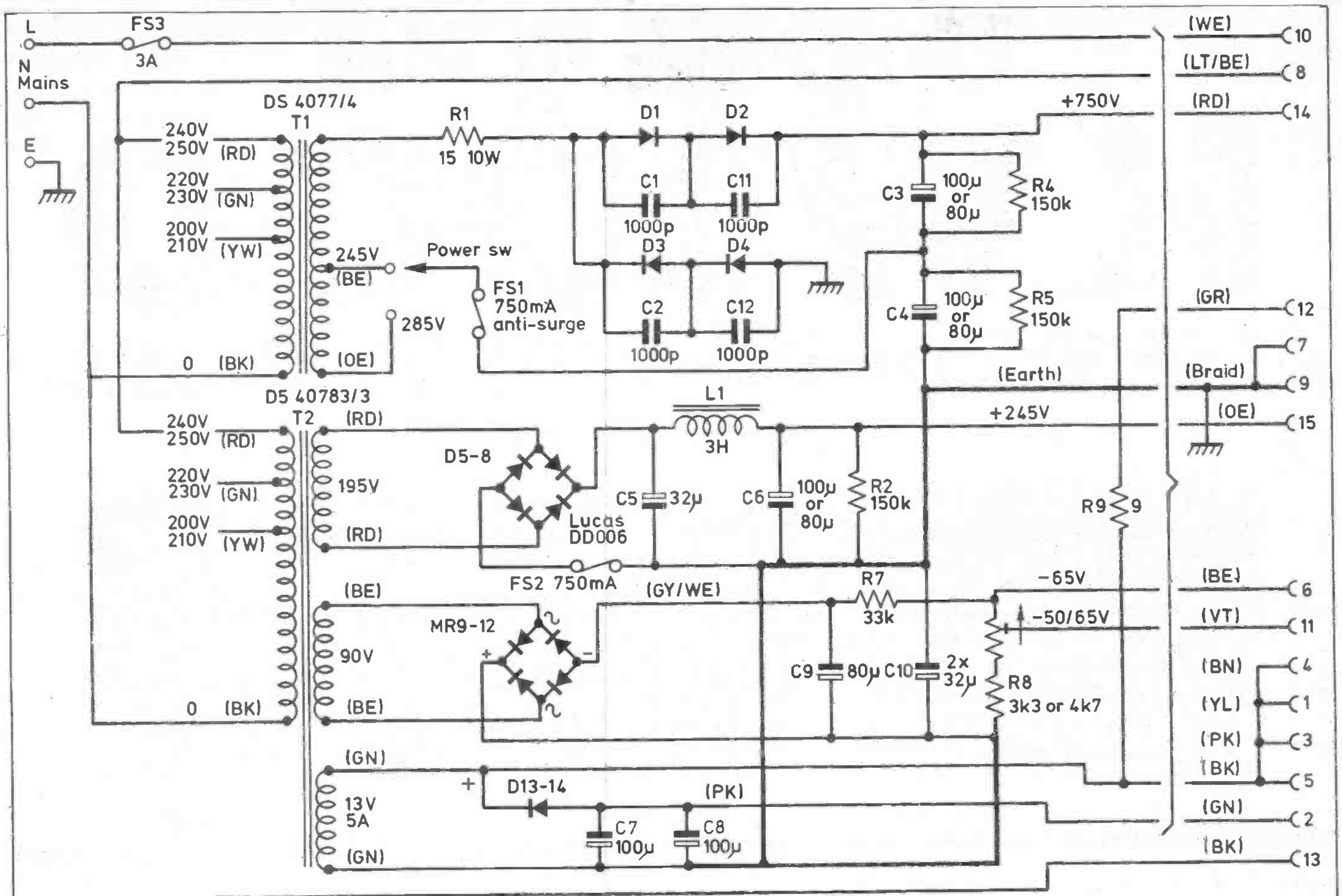


FIG. 101. Circuit of KW2000A power supply.

T2. The voltage from this winding is also half-wave rectified by D13/14, and smoothed by C7/8 to provide a DC supply for the relays. The first step in the modification process is to reverse the rectifier and remove C7/8. The current rating of the diodes should be checked and, if they are not 2 Amp types, they should be replaced by a single 2 Amp diode such as a 1N5401. In the case of one of the writers it was found that the rectifier was in fact a single 40266, which is quite adequate. C7 and C8 are now replaced by a single 5000 F 25V capacitor, mounted horizontally between T1 and T2 under the chassis. R9, which is a large ceramic disc resistor mounted on the side of the chassis, is removed and the hole in the chasis used to mount a tagstrip which will carry most of the circuitry of the new regulator. The 7805 integrated circuit is mounted alongside the tagstrip; a mica washer and insulating bush must be used since the earth tag of the IC, which is internally connected to the cooling tab, is not connected to earth in this case. The circuit is wired up as shown in **Fig. 102.**

As a result of this modification the heaters of V10 now receive a stabilised 6.3V supply, and 18V DC is available from pin 2 of the multiway connector for operating other circuits. In practical terms, the frequency of the transceiver should now remain stable once the warm-up period of about 20 minutes has been completed.

Improving receive sensitivity

The simplest way to improve receive performance on 21 and 28MHz is to fit a 3-30pF trimmer across the un-decoupled cathode bias resistor in the RF amplifier stage V6 (see **Fig. 103**). A small value has been suggested for this capacitor since, with a more normal 10 or 100nF, the gain of this stage will become excessive on the lower bands, leading to poorer cross-modulation performance. The small trimmer can be set so that it only affects the higher bands. A further

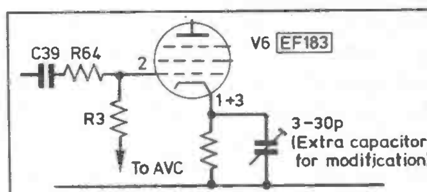


FIG.103.

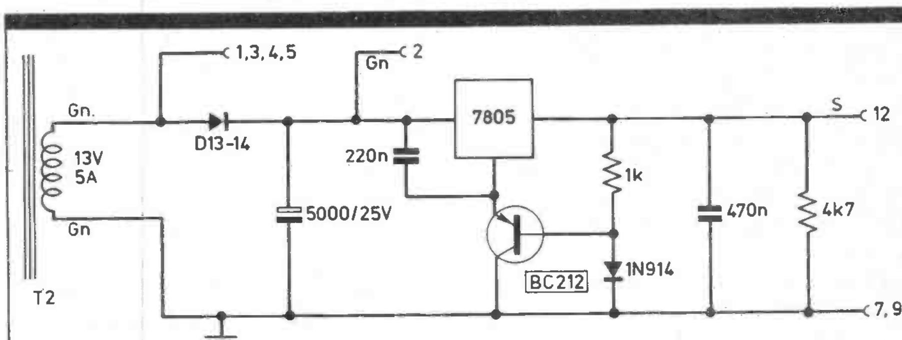


FIG. 102. Modification for stabilisation of heater supply to V10 and V11

snag is that a larger value may lead to the RF stage becoming unstable on 28MHz. A suitable component for this purpose is a Philips 'Beehive' trimmer, the central part being soldered to the earth tag adjacent to V6 on the side of the screen across the valveholder adjacent to pins 1 and 3. These two pins should be linked with a short piece of tinned copper wire and joined to the remaining terminal of the Beehive trimmer. To adjust after modification, tune up on transmit on 28MHz in the normal way, and do not touch the pre-selector after this. Switch to receive, tune to a steady incoming signal or inject a weak signal into the receiver, and set the trimmer to about half value. Adjust L5 for maximum signal as in the alignment procedure, and then check the operation of the preselector control to see whether its adjustment on receive seems to be unduly sharp. If so, reduce the capacitance of the Beehive trimmer, readjust L5 and try again. If, on the other hand, there seems to be little improvement in RF gain, increase the value of the trimmer, readjust L5 and try again. Note that the preselector peaks on receive and transmit should coincide. A convenient signal to use for these tests, particularly in the South of England where the writers live, is the GB3SX beacon. After finding the correct setting for the trimmer the operation of the receiver on 21 and 14MHz should be checked, adjusting the appropriate coils as described in the alignment section. The modification should have little or no effect on the performance on the other bands.

Improving the selectivity on CW

Two methods of improving the CW selectivity have been tried. The first, which is relatively cheap and simple, uses a single crystal and two miniature DIL relays, and despite its simplicity is fairly effective in use. To carry out this modification the coupling capacitor C21 between the mechanical filter and the grid of the first receive IF amplifier V13 is disconnected at the valveholder, and the circuit of **Fig. 104** is inserted. A convenient method of construction is to assemble the components on a piece of *Lektrokit* board and mount this board on a small bracket adjacent to the mechanical filter. It is also necessary to provide a switch on the front panel of the *KW2000* to switch the filter in and out of circuit. Since this switch only has to carry DC to the coils of RLA and RLB its position is not critical, and a convenient way of avoiding the necessity of drilling extra holes in the panel is to replace the calibrator push-button by a miniature three position toggle switch. This is wired so that the 'up' position activates the calibrator and the 'down' position switches in the CW filter, the centre position being for SSB operation. The relays RLA and RLB should be separate, rather than a single double-pole relay, in order to minimise signal leakage around the filter. The type used by the writers was RS Components type 349-399 in form C. No mechanical layout is given, since this will, to a large extent, depend on the components available, but it is advisable to keep all leads as short as possible, and to separate the input and output connections.

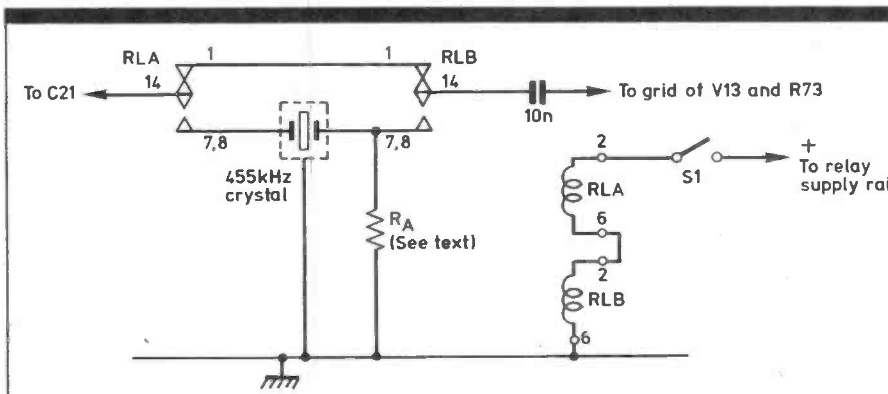
Once the filter has been installed, a temporary resistor of 4.7k ohms should be wired into the R_A position, the rig switched on and allowed to warm up. Tune to a CW signal of reasonable strength and switch the filter into circuit. A definite peak in signal strength should be found as the receiver tuning is varied. The width of this peak will depend on the value of R_A. Reducing the value narrows the peak and increasing the value widens it. There is, however, a tradeoff between selectivity and sensitivity, since reducing the value of R_A increases the insertion loss of the filter. The best value will usually lie in the range 1k to 10k, and will depend on the activity of the crystal, so some experimentation will be necessary. It is as well to note that some use of the IRT control may be necessary in practice since the filter peak may not be at quite the same frequency as the transmitted signal. Until the modification to improve the keying characteristics (described later) is carried out, the exact transmitted frequency is dependent on the frequency of the sidetone oscillator since, as mentioned in part 1 of this series, CW is generated by keying this oscillator and feeding the resultant audio into the transmitter AF section.

The filter as just described was used for about a year by one of the authors and, whilst not perfect, it was found to be a vast improvement over having no filter at all. If CW is not your main mode you may find that it is adequate; however, if like both authors, you operate mainly on the key, you may well wish for something better, as is now described.

Fitting a mechanical filter for CW

The second, more complex method of improving the CW selectivity uses a Collins 455kHz mechanical filter of 500Hz bandwidth, and is definitely the better method of the two. The drawback is that the insertion loss of this type of filter is about 10dB, and some method of replacing this lost gain must be found. The writers used a dual gate MOSFET amplifier for this purpose; **Fig. 105** shows a block diagram of the final set-up, and the circuit details are shown in **Fig. 106.**

A short note on the design philosophy behind this filter system may be of help at this point for the



S1 = Extra cw/ssb switch on front panel (see text)
XTAL = 455kHz HC6U etc. but preferably in metal can. (Earthed)
Note: Numbers adjacent to RLA, RLB on circuit diagram refer to pin numbers of RS. DIL relay, do not reverse pins 2 and 6 as a diode is mounted across the coil in the DIL package.

FIG.104.

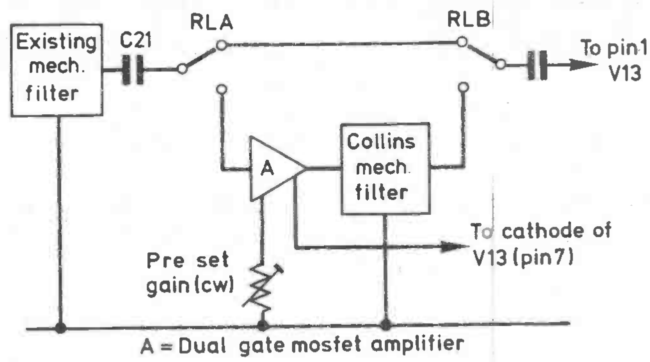


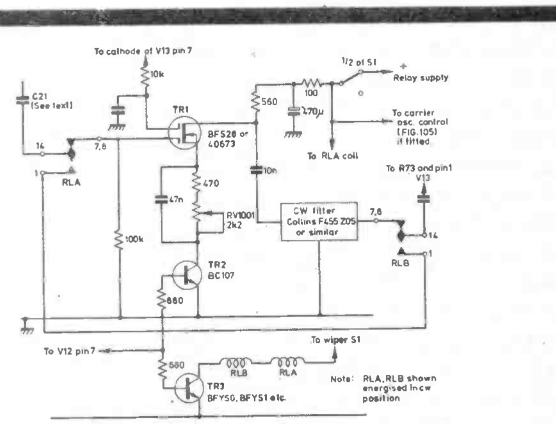
FIG.105. Block diagram of the improved cw filter

benefit of those who wish to modify the writers' system for their own requirements. It was considered that problems might arise if the original SSB filter was switched out of circuit on CW and replaced by a narrower filter, since out-of-passband signals might leak around the original SSB filter due to the extra wiring of the switching system. This would affect both transmit and receive operation. So it was decided to leave the SSB filter in the signal path on both SSB and CW, inserting the extra filter *as well* when required. At first the narrower filter was simply put in series with the receive final IF path, and although selectivity was much improved the receive gain was drastically reduced. So the amplifier of **Fig. 106** was constructed and inserted between the existing filter and the extra filter. This worked well, but it was found that the AGC behaved in a rather odd fashion on CW. This was found to be due to there being no AGC on the extra MOSFET stage. This problem was very simply cured by deriving the Gate 2 voltage for the MOSFET from the cathode of one of the existing AGC controlled IF stages in the *KW2000*. Because of the AGC action, this voltage varies with signal level, dropping as the increasing signal causes the AGC to move the valves towards cut-off and thus reduces the current through the cathode resistor. This is just what is needed, since reducing the Gate 2 voltage reduces the gain of the MOSFET. Most of the components for the amplifer can be mounted on a small piece of *Veroboard* positioned adjacent to the main filter. The new filter, which is rectangular in shape, can conveniently be mounted on the top of the existing filter on top of the chassis, using a large capacitor clamp and an aluminium strap to hold the old and new filters respectively, and making the connections to the new filter with miniature co-ax. The capacitance of this co-ax must be taken into account in determining the terminating capacitance required for the filter, which was found to be approximately 130pF in parallel with the input and output connections for this type of filter. If a different type of filter is used, the required value of terminating capacitance should be obtained from the manufacturer's data sheet. RLB was mounted adjacent to pin 1 of V13. The two transistors TR2 and TR3 in **Fig. 104** are used to remove the CW filter from circuit during transmit. These transistors obtain their base bias from the cathode of V12, one of the receive IF stages. During transmit V12 is biased off, which means that its cathode voltage is zero, so there is no forward bias on TR2 and TR3. On receive V12 is turned on, producing a voltage drop across its cathode resistor and thus supplying forward bias to TR2 and TR3. The values of the base resistors for these transistors are chosen to ensure that both devices are turned on hard despite the variation of V12's cathode voltage caused by the AGC action. Turning off S1 removes the supply from the amplifier and the relays, preventing the filter from being switched into circuit on receive, and this is the condition used for SSB operation.

Setting up the filter system is very simple, merely involving the adjustment of the amplifier gain control RV1001, and the selection of the correct value of terminating capacitance for the filter. The procedure is to set RV1001 to minimum resistance, switch S1 to on and tune in a steady carrier of about S5. Now try various values of capacitor a little above and below the maker's specified value across the input terminals of the filter, using the value which is found to give the maximum S-meter reading. Then repeat the procedure for the output terminals. The exact value seems not to be all that critical and a few pF either way will make little or no difference. To set RV1001 the same S5 signal should be tuned in with the switch S1 set to ON, and S1 then switched off. Note the S-meter reading, switch S1 back on again, and adjust RV1001 to obtain the same reading.

Again it may be found that it is necessary to use the IRT control when operating since the transmit frequency may not coincide with the centre frequency of the filter until the keying modification has been carried out. **Part 5 of this series in our July issue will describe this modification as well as others.**

Fig. 106. CW filter, amplifier control and AGC



Evaluating the FT290R against the C58 Practical Report

There have been a number of recent reviews covering two metre multimodes — the range of portable equipment is evidently becoming more popular. Trio, Icom and FDK do not seem to have catered for this market although they and other manufacturers do produce hand-held equipment. This therefore leaves us with just two multimode portables for 2m — the Standard C58 and the Yaesu FT290R. They are claimed to be multipurpose pieces of equipment — suitable for portable, mobile and base station use. But are they?

By Trevor Butler G6LPZ

Turning first to the Yaesu *FT290R*, the first ever (just) two metre multimode, one would expect the design to be tried and tested and any small problems found on earlier production models to have been rectified. It looks as a portable should look (not to be confused with hand-held equipment) with a compact 58(h) 150(w) and 209(d)mm overall and weighing some 1.79kg complete with batteries. It utilises PLL synthesisers, dual VFOs as well as receiver incremental tuning, switchable 2.5W/500mW output plus split memory/VFO working and priority channel facilities. It certainly has all the extras, but are they all necessary? Do they hide a good, basic transceiver or a load of drawbacks?

FT290R

As supplied the frequency coverage on the UK version of the *FT290R* is 144.0 to 145.999MHz, although by cutting the wire link between pin 38 of the micro-processor and earth (it's the pin nearest the bottom of the micro's pcb) the range is extended to 147.999MHz. This link is one of four controlling frequency coverage and steps. I found the step shifts as supplied — 25kHz/12.5kHz FM and 100Hz/1kHz SSB — to be the most convenient. An option available is a 10kHz/5kHz stepping on FM achieved by joining another two link wires.

Batteries

8 'C' dry cells or similar size Nickel-Cadmium rechargeable batteries supply power. Alternatively a regulated DC power supply of 11 to 15V may be connected. Full memory back-up is obtained via a long lasting lithium cell (supplied with the rig!) and switchable through an internal switch to conserve its life if the rig is to be out of use for long periods. Access to both the charging socket (3.5mm) and external DC socket (2.1mm) is via the rear panel. Ni-Cads may be charged in situ even if the rig is being driven from an external supply.

Control layout

The front panel is compact, perhaps even rather crowded, although generally well designed in its layout. It is of neat appearance and has most of the controls located upon it. The 1750Hz tone burst is generated when a small front panel metal button is depressed regardless of whether the PTT button is pressed. This button stands as one in a group of eight similar buttons. The other seven control various functions: clarifier (rit), memory operation, VFO selection, priority and split frequency working. Under mobile operation it was not always easy to hit the tone burst button and I often committed the VFO frequency to the memory by mistake — there being no safeguard to prevent accidental re-writing of the memory input. A small modification to give switchable automatic tone burst when in repeater mode would make life easier all round. Having the volume and squelch controls on the same spindle also proved to be interesting at times and care had to be taken to adjust the correct control — I was sometimes deafened when trying to squelch out background noise! The squelch control is only operative when FM modes are selected.

The microphone, connected by a six core coiled screened cable was pleasant to use and very easy in operation with a positive PTT switch — large enough to handle even in the most awkward of situations. Two buttons, inset into the top of the mic unit, control the up and down frequency tuning and scanning. A lock switch is located to the rear of the mic behind a metal hanging clip to disable these two buttons. The high sensitivity of the mic sometimes gave rise to background noises entering the transmission.

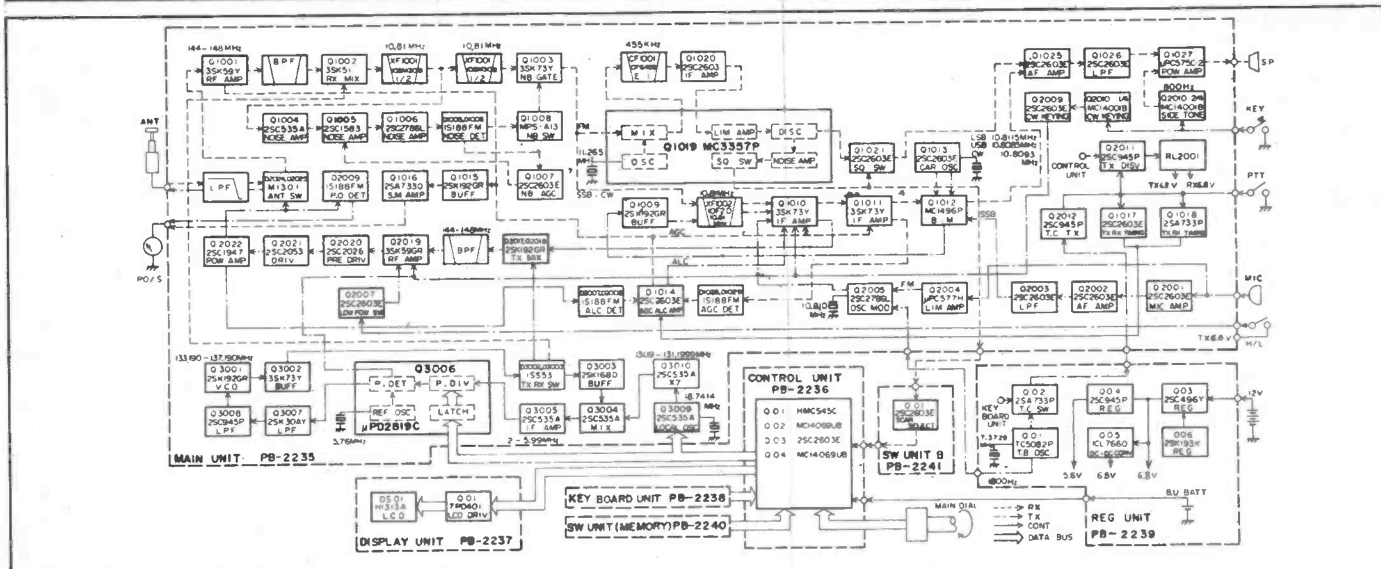
There is an LCD display indicating the last five digits of the operating frequency (whether TX or RX) with resolution to 0.1kHz. Being of the LCD type this does not draw a large current and can be viewed even under bright sunlight. Indicators showing operation of the various functions are also shown on the display. A single light illuminates this display as well as the adjacent meter and, if appearing bright under night-time mobile operation, lights adequately at all times. A rear mounted switch is provided to extinguish the light when not required, and certainly saves on battery drain when portable. The meter can only be described as barely adequate — half calibrated and requiring a magnifying glass to read it — it lets down the whole appearance of the rig. As well as showing incoming signal strength (relative voltage and not S-points), the meter serves as an indication of output power, showing either high or low output, and the state of the internal batteries if fitted.

Left: Yaesu FT-290R costs about £265

Below: Standard C58, £239 from Lee Electronics

Facilities

An antenna option is present on the set; a telescopic quarter wave terminating in a Yaesu screw thread on the front panel, and an S0239 UHF style socket on the rear. Besides the S0239, other sockets to the rear of the rig include a 3.5mm socket for the addition of a morse key, and a similar socket for charging the Ni-Cads, and one for connection of the external DC supply. It is unfortunate that this is wired such that the external surface of the plug is positive and, when this touches the chassis under mobile operation, the in-line fuse blows. However if the additional mobile mounting bracket is used this should not occur. This bracket costs some £22 and tends to gouge lumps out of the rig's case and reduce its



Yaesu FT290R block diagram

appearance and value.

An external speaker jack (3.5mm) is located on the side of the rig and when in use cuts the internal speaker. This internal speaker tended to produce generally good audio if lacking in 'top', and coped with high audio output levels well. A very useful feature is the 'Stand By' jack which is hard wired as a parallel PTT line and may be used in conjunction with attached linear amplifiers to prevent them dropping out of transmit due to a lack of RF. This socket would also allow the use of an independent PTT such as a footswitch.

The bottom plate of the *FT290R* is removed by undoing a latch. This plate conceals the battery compartment as well as internal switches. The first, labelled "T Squelch", is unused on British models — although it can be utilised for a reverse repeater modification (see later). The second internal switch selects the VFO and memory scanning to halt on either clear or occupied frequencies, while a third position gives totally manual scanning. It is a pity that this switch is not easily accessible. A better idea might have been to have utilised the spare position on the memory select control (there are two identical settings) and thus give front panel operation of this facility. One certain plus about the *290* over some equipment is the main tuning knob. This is very smooth in operation giving a positive response with ratchet positions to aid the operator.

Operation

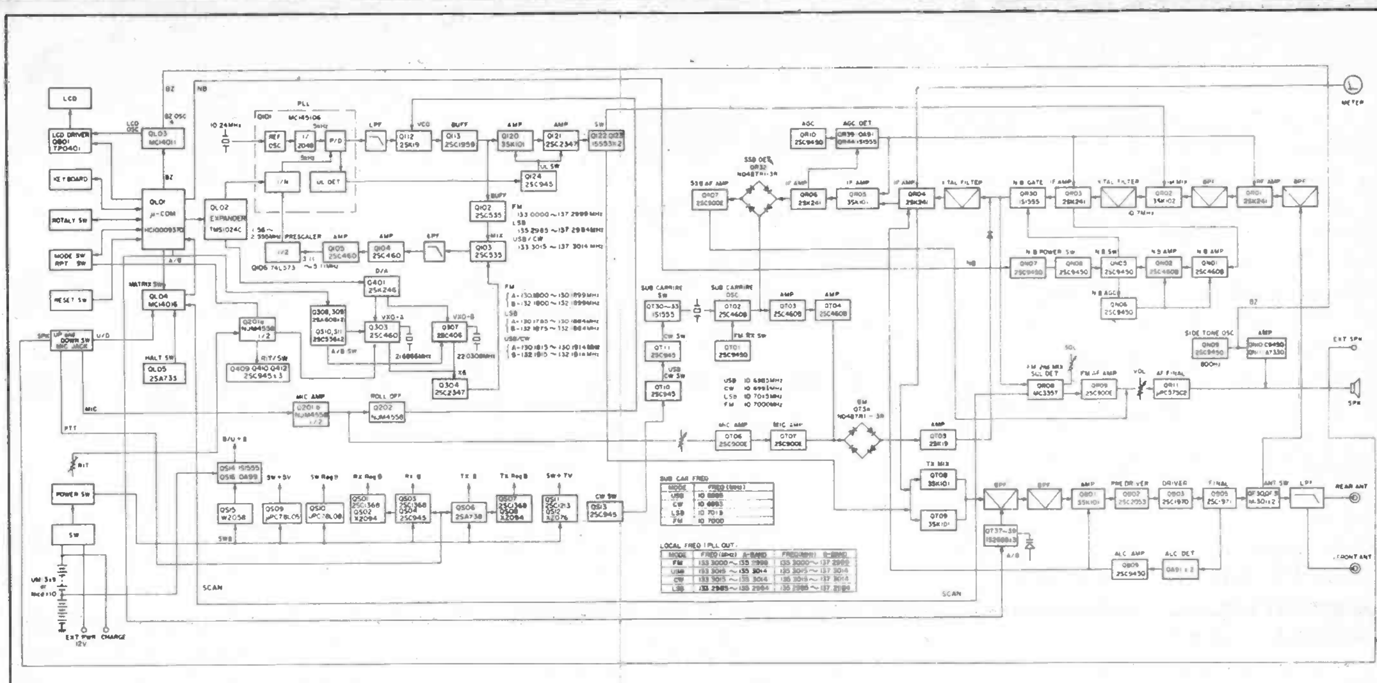
Repeater operation is simply a matter of dialling the repeater output frequency in any of the FM positions and then selecting the negative shift to move the transmit frequency down by 600kHz. The display will show the transmit frequency when the PTT or tone burst keys are activated. Having established a repeater contact it is not possible to listen on the input frequency without either dialling down on the VFO or storing all the repeater inputs in the memory channels. It is however possible, providing that the second VFO is on a frequency below 144.600, to press the PTT & VFO control button simultaneously to hear the input frequency. An 'E' will appear on the display as the rig is out of range and hence will not transmit despite the PTT being pressed.

Reports through local repeaters were favourable; even the fussy ones didn't give deviation pips, and it was very easy to use as a portable unit with the shoulder strap supplied as well as in the car without the mounting bracket. Similarly simplex contacts indicated good audio. When a linear was used, however, there were reports of the *290* 'hooting' slightly despite efforts to prevent this. This could be due to RF feedback into the audio circuitry.

Sideband operation from my location has never been easy despite lots of time and money on a reasonable antenna set-up. The majority of SSB signals seemed to be lost in the noise and I turned to a 9 dB pre-amp which improved matters considerably. I suspect that, because of the vast difference the pre-amp made, the sensitivity of the rig could perhaps have been a little better. I was told by local stations that there were 'DX' stations responding to my calls although I could not receive them. A much advertised addition to the *FT290R* is to replace the Q1001 front end MOSFET with a 3SK88. During these tests I recalled various FM and SSB frequencies from the ten memories only to find that I couldn't re-tune away from them by using the VFO tuning. The memory recall facility allows direct access to any one memory using a memory select control located on the front panel. The clarifier facility allows independent receive tuning but only in 100Hz steps up to 10Hz either side of the VFO frequency, and sideband signals could not always be properly resolved. One word of warning is that the 'micro' seems to be easily confused. For instance if whilst in transmit power is lost and restored, the transmit LED remains alight and the meter suggests that transmission continues but in fact there is no RF produced. To re-set the machine the rig must be turned off and then on by its switch. A similar condition occurs when replacing the internal batteries after either servicing or replacement. After replacement the internal memory back up switch and then the on-off switch must be switched. There exists on the *290* very versatile scanning facilities, controlled from the microphone unit and selectable to stop for a few seconds before continuing to scan on either a busy or clear frequency. Total manual scanning can also be achieved.

Documentation

A very important aspect when



Standard C58 block diagram

considering a piece of equipment is the handbook. The 64 page A5 size manual supplied with the *FT290R* was invaluable. Printed in black and white on glossy paper, it includes many photographs and illustrations with a clear description of the user functions. Page 24 contains a very useful if rather small block diagram of the internal workings — backed by a full description of the receive transmit, and PLL circuitry as well as a comprehensive measurement and alignment section. The type and make of recommended test equipment is also mentioned — strangely enough it's either Yaesu or Hewlett-Packard!

Clear photographs locate important adjustment points and individual board layouts. The handbook concludes with a complete list of components and parts included in the rig. A loose leaf circuit diagram opens out and looks typically 'Yaesu' with eye strain developing when trying to follow one in a group of parallel lines. Labelling of these is barely sufficient as not all lines are labelled at both ends. Test voltages at given points are not included on the diagram. It must be said that Yaesu has incorporated a vast number of facilities into the *FT290R,* many of which are not present on much more expensive pieces of equipment. Having said this, there are several modifications needed to justify the initial outlay in my opinion. After all what is the point of spending £250 on a piece of equipment if it can be so easily improved? A few design changes would not go amiss.

Standard C58

The other two metre portable multi-mode on the market is the Standard *C58*. The range of equipment from Standard is increasing rapidly with new designs being produced all the time. First impressions of the rig are that it is considerably smaller than the Yaesu being 55(h) 141(w) and 214(d)mm weighing in at just 1.44kg complete with batteries. Although seeming perhaps to lack a number of features present on the *FT290* such as that second VFO, 10 memories and split working facilities, there are more essential facilities on the *C58* such as superior RIT, reverse repeater working option, and tone burst facility from the mic. More about these features . . .

Positive assets

Two buttons control the mode of operation — one selects USB/CW/LSB/FM, the other for simplex, repeater and reverse repeater working. Having two buttons can cause problems as you have to remember to select 'simplex' when working sideband, otherwise the repeater shifts remains operative.

Standard like many other manufacturers save space on the front panel by using one switch position for many function controls. Volume and squelch levels and the noise blanker (ssb only) are all on the same spindle — make sure the right part is adjusted!!

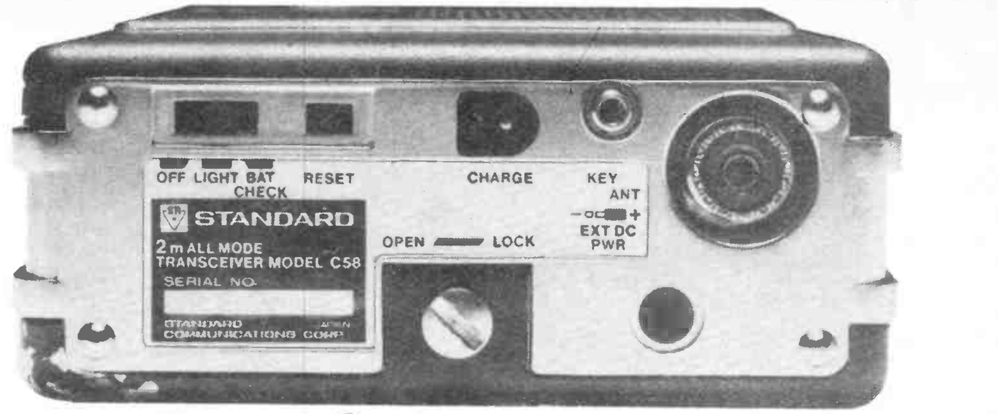
Tuning is achieved by turning a rather nasty VFO control knob — very stiff in operation with an unpleasant feel; leaving a rubbery deposit on the fingers, it is not at all comfortable to use. Perhaps removing the ratchet would help here. An interesting control is that labelled 'MHz' and is one of a group of eight similar metal buttons. Selecting a 1 MHz sequence in the frequency bands 144, 145, 146 and 147 MHz, saves on rapid turning of the tuning knob. The feature is a virtual necessity since the *C58* has just one VFO.

Operation

I never really grasped the memory operation properly, or at least if I did it did not live up to expectation. There are five independent memories, although access is strictly sequential. The memories store not only a frequency but also a mode of operation and a frequency stepping interval. Before data can be stored, the appropriate memory must first be recalled, thus preventing accidental re-writing. If an empty memory is selected an 'M' will flash until the memory is filled. When recalling memory frequencies, the rig will indicate if the mode selected when the frequency was memorised is different to the mode chosen when recalling the memory. Indeed, the simplex/repeater shift key will change the recalled frequency since it is operative upon the displayed frequency. Tuning away from the recalled frequency is possible and does not disturb the stored data. Scanning is ingenious in that only frequencies within the megahertz band selected will be scanned in accordance with the step pre-selected. The display will indicate that this facility is in use. The FM mode uses a system whereby scanning will cease when an occupied frequency is found, whereas in the SSB modes, scanning continues regardless of a signal because such signals do not lift the squelch. Scanning is not possible from the microphone unit, and once scanning is halted it must be re-started manually. FM scanning for 'clear' frequencies is not possible. Repeater operation using the *C58* took some learning and seems unique in that the repeater input frequency must be selected and then the repeater shift installed. This is OK once the operator has become accustomed to it. The repeater shift is selected and the output frequency tuned. If scanning the band in simplex and a repeater output is heard, it is necessary to retune to the input frequency as the introduction of a direct repeater shift will simply move the receive frequency and not the transmit frequency.

A rather useful feature for repeater operation is a tone burst controllable from the microphone. A second push to the PTT button will generate a one second tone burst at 1750Hz. An aspect which seems to require a lengthy and detailed explanation is the LCD readout (certainly according to the manual supplied). I had great problems during darkness to read the display at all. The internal light is inadequate and while just illuminating the 'S' meter, it does little for the display. I used a torch to overcome the problem!!

This readout consists of four seven segment figures as well as some symbols to identify the use of various facilities. Being just a four figure display it is necessary for some



figures to be taken for granted. For example, 144.1234 MHz under the 5/25 kHz step setting is shown as '4.123' — yet under the 1 kHz setting as '.1234'. The operating frequency is immediately obvious, just by looking at the front panel.

Quality

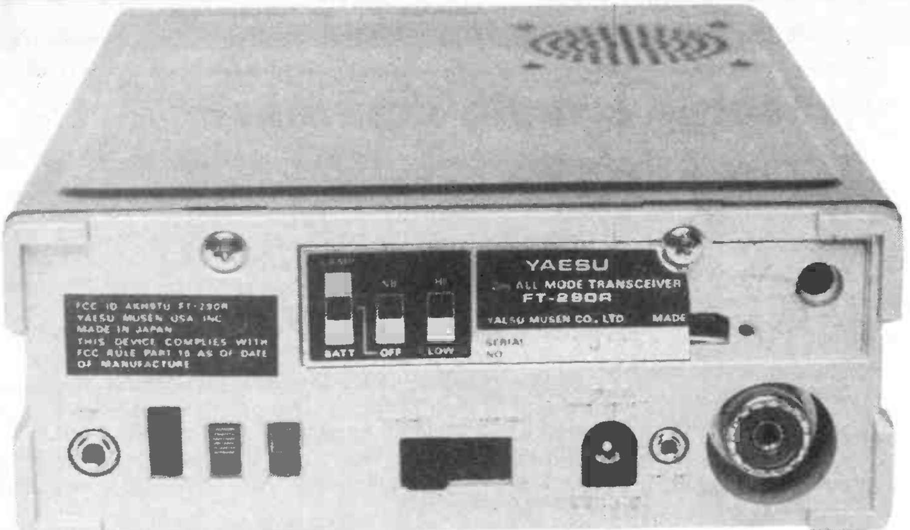
The microphone supplied is attached via a coiled flex to a seven-pin plug. Although producing good audio — in fact excellent audio reports were obtained when using SSB, the microphone is not very easy to operate. The PTT switch is located off centre to the top of the unit and had a strong spring. On several occasions I experienced difficulty in depressing the switch for long periods as constant downward pressure is required.

The up-down frequency control button on the front of the mic stands proud of its inset, meaning that it could be accidentally touched thus changing the operating frequency during a QSO. Continuous depression of this switch will cause a continual increase or decrease of the display frequency within the MHz selected. The *C58* will run on either internal batteries or from an external regulated DC power source of 13.8V, according to the manual. The equipment worked quite satisfactorily on my 12V supply and produced 900mW drawing a current of 560mA on FM TX and 90mA RX. The internal batteries (10 Ni-Cads or 9 dry cells) are split into two groups. The first of four (3 if Ni-Cads used) powers the memory and 'switch off' back-up, while the others drive the rig. Because the back-up power comes from the internal batteries, there is a real danger of losing the memory frequencies should the battery compartment be removed for replacement or maintenance, or should Ni-Cads become 'flat'. The equipment ran well from its batteries although they seemed to run down rapidly.

Certainly they did not last as long as a fully charged battery pack on an *IC2E* would last. While portable, I used the rubber helical aerial supplied which fits the BNC socket on the top of the set. There is an S0239 socket on the rear panel like the *290R*. It was not possible to access the local repeater with just the 1W, and the higher output power from the *290R* was advantageous in this particular case. A number of

CORRECTION - APRIL

We would like to apologise for a mix-up over an advertisment on page 16 of our April issue. The name is wrongly shown as AH Supplies; it should have read AJH Electronics, 20 Barby Lane, Hillmorton, Rugby, Warks CV22 5QJ. Our sincere apologies to both companies for the inconvenience caused.



passers-by were startled by the exceptionally loud 'bleep' the equipment produced every time I selected a function.

Other features

Apart from the S0239, the rear panel allows access to the battery compartment inside which, apart from the battery holders, there is a frequency-step switch mounted to the PCB. Other sockets to the rear include a 3.5mm jack for a morse key and similar shielded socket for DC connection, and another for the Ni Cad charger. A power lead was supplied with the rig, complete with in-line fuse; this is just as well, for the plug is a non-standard 3.5mm type with extra shrouding to prevent accidental shorting. With the positive side of the plug exposed to the world, care must be taken not to allow this to touch the chassis or aerial plug! When using the *C58* from home, I attached a separate 25W linear, although Standard does manufacture a slim-line amplifier together with a mobile mount. All three then fit together with a very neat appearance. The rig seemed very sensitive and the pre-amp combined with my linear made little or no difference to the readability of most incoming signals. The only impression was to move the 'S' meter needle. For SSB use, tuning (down to 1kHz) plus the infinite tuning 'rit' facility meant that I was able to resolve all those distant signals. There seemed to be a delay in the noise decay when trying to squelch-out FM signals but otherwise once I had mastered the memory operation and the ability to read the display accurately, I had no real problems apart from the received audio.

Audio

The quality of the incoming audio was poor seemingly because of a rather cheap and nasty 'wafer thin' speaker inside the rig. The audio lacks resemblance to the peoples' actual voices, even on FM. An external speaker cured the problem though. It is interesting to note, and in fact the case seems to be so with the *FT290R* as well, that if CW is being used, the PTT switch must be continually depressed while keying to keep the rig in transmit. With the *290* the PTT line socket could be used with a foot-switch. There seems to be no convenient answer as far as the *C58* is concerned, unless you get a friend to help.

Documentation

The 69 page handbook complete with idiot-pictures on operating the various facilities is very handy. The service section, complete with circuit descriptions and detailed explanation of the micro's working, the PLL system and alignment charts. With dis-assembly guidelines and component and board locations, it's virtually all one needs to rebuild the rig. A complete list of component parts and values is included for easy reference. At the end of the manual is a loose circuit diagram, the tracks on which are quite easy to follow, although the component symbols are rather small and the writing unreadable without '20-20' vision. A useful feature, even if they are hard to read, is the inclusion of test voltages at key points in the circuitry. Indeed this circuitry, being that of a synthesized multimode is by definition rather complex, and a look at the block diagram may help the reader follow it. The receiver section is a double superheterodyne system with a quadrature FM detector. The incoming signal is amplified by a 2SK241 and coupled to the 1st mixer before being combined with the local PLL frequency down to the 1st IF of 10.7MHz. This then passes through a crystal filter before a second mixer, IF amp, quadrature detector, squelch switching amp and the second local oscillator with a frequency of 10.245 MHz, which is mixed, to be converted to the second IF of 455kHz. The signal passes through two ceramic filters and is amplified and demodulated before the final amplifier, audio amp and loudspeaker. The SSB receiver has an IF of 10.7 MHz and the signal is amplified much as the FM signal and appears at the output of the first IF amp. This output is coupled to another MOSFET and to an SSB detector. The demodulated AF signal is then amplified by an exclusive SSB AF amplifier. Looking at the transmit side of the rig, the FM signal is generated by amplifying the microphone audio, and after a limiter and roll-off filter to prevent harmonics out of the audio range, the signal is coupled to a varicap diode to provide direct frequency modulation on the VCO output. The PLL output is connected to the gate of a balanced mixer where it is combined with the FM sub-carrier to give a carrier frequency signal which passes through a linear amplifier stage, transmit amplifier which is then coupled to the antenna. The RF output power is kept constant with the aid of an AGC amplifier which picks up a rectified carrier signal. The SSB transmitted signal is generated differently for obvious reasons.

Conclusion:

While it is obvious that the *FT290R* hosts an impressive range of features, certain aspects of the *C58* together with its superior 'RIT' and sensitivity seem to suggest that perhaps this is the rig for the SSB man. However, as I tend to operate mainly on FM. I know I'm boring *(I don't think you're boring, Trevor — Ed)* but there is FM DX to be had and accessing distant repeaters can be fun. I utilise the 10 memories offered by the FT290R. I also like its clear readout and that second VFO comes in handy as well. As there is virtually no price difference between the two its really a case of 'you pays your money and takes your choice'. ●

Technicalities

In last month's column, we showed the way to a better IF system. We built it and can report that the performance is outstanding. We hope to have achieved the same with this design for a low noise, all band VFO. By Frank Ogden G4JST. Editor Ham Radio Today

The theme for the column this month is 'successful RF design', the art of designing and making things which not only work but hopefully outperform the generally available commercial equivalents.

I started the series last month with a design example for a high performance CW IF strip. I am going to continue the theme with an all-band synthesised VFO suitably complementing last month's strip. The two together form the basis for a really first rate CW transceiver. We anticipate that the complete transceiver could take on something like a TS930 and win. Eventually the whole project will be offered as a constructional project in Ham Radio Today complete with PCB designs produced by Tony Bailey G3WPO. I must emphasise though that, like the IF strip described last month, the circuits given here are original, have been computed from first principles, but have yet to be tried. There will almost certainly be bugs in them but hopefully not too many!

What to look for in a VFO

The VFO, along with the mixer circuit, is probably the most important and critical area of any HF transceiver design. As can be seen from **Fig. 1**, it is central to the equipment for both transmit and receive. Since the transmit signal, derived by mixing the IF signal with the VFO output, will not pass through any narrow band filters, it is essential that the VFO signal has very low noise sidebands. Noisy circuits can cause substantial interference to other users. Likewise, the receive path requires the purest of signals otherwise adjacent, powerful stations will interfere with reception of weak ones regardless of how good the main crystal filter may be.

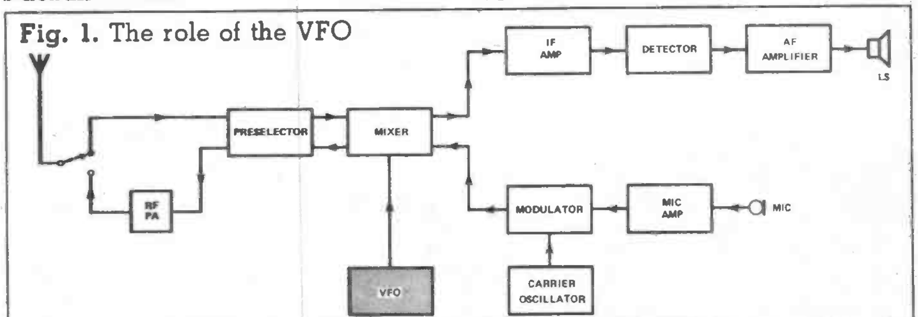
Digitally synthesised LO/VFO circuits offer absolute stability but are virtually all a step backwards when it comes to sideband noise. I cannot think of a single piece of synthesised HF amateur gear, including my own homebrew design described in the January and following issues of HRT, which comes near the purity of free running VFO equipment. Furthermore, most black box synthesised HF gear is so convoluted in design that the equipment displays all sorts of image responses as well as high levels of sideband noise.

Simply put a VFO should produce a pure, single frequency signal with a stability of Hertz/minute. The single band arrangements of **Fig. 2** (circuitry of VFO shown in **Fig. 3**) come very close to this. The disadvantage of course is that the VFO output will only act as an LO signal on one or perhaps two bands only, unless it is mixed with fixed frequency crystal oscillators. However, anyone who has ever listened to any directly coupled gear of this kind will testify to the 'clean' sound of the resulting signal.

Complex VFO systems

The system shown in **Fig. 4** is typical of much of the equipment

Fig. 1. The role of the VFO



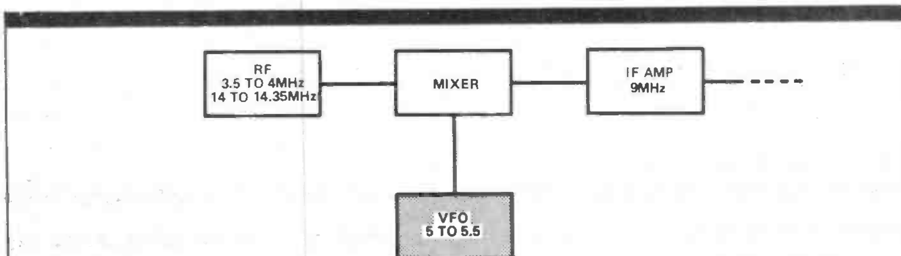


Fig. 2. A typical single or dual band system based on a 5MHz VFO

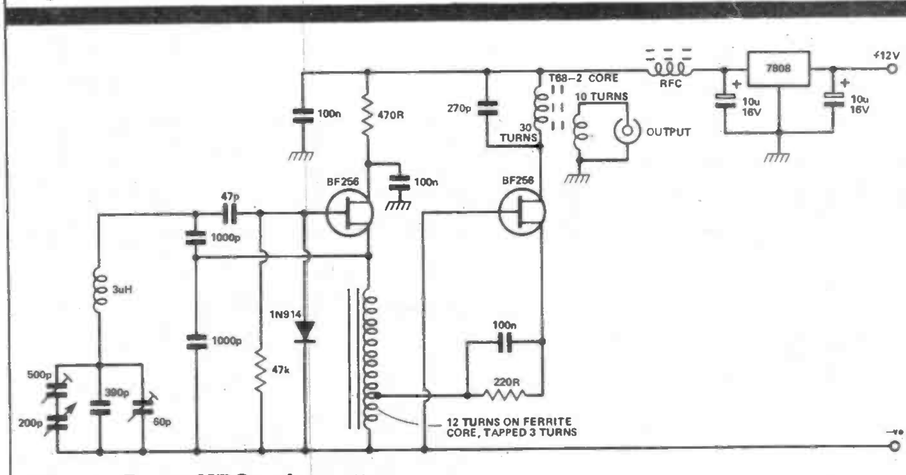


Fig. 3. Basic VFO schematic

TABLE 1

VFO characteristics required for all band operation 160m through to 10m. 10.7 MHz if assumed.

Band	Signal frequency MHz	LO frequency MHz	% Swing
160m	1.8 to 2.0	12.5 to 12.7	1.6
80m	3.5 to 4.0	14.2 to 14.7	3.5
40m	7.0 to 7.3	17.7 to 18.0	1.7
30m	10.1. to 10.15	20.8 to 20.95	0.3
20m	14.0 to 14.35	24.7 to 25.05	1.4
17m	18.67 to 18.77	29.37 to 29.47	0.4
15m	21.0 to 21.45	31.7 to 32.15	1.4
10m	28 to 29.7	38.7 to 40.4	4.3

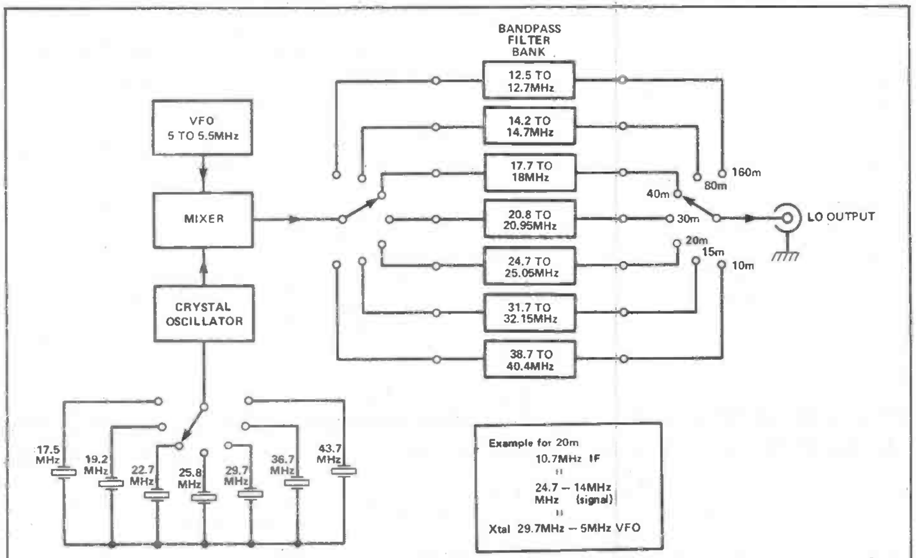


Fig. 4. The traditional method of generating the local oscillator signal from a VFO and crystal bank

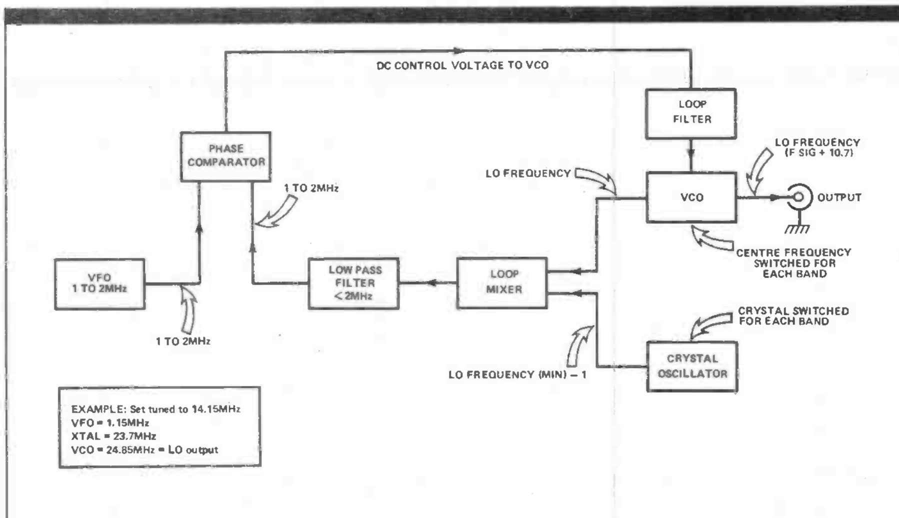


Fig. 5. Block diagram of the proposed single loop synthesised VFO

manufactured during the mid-Seventies. It often works demonstrably better than the latest gear although it has its own problems. In particular, this type of *direct synthesis* system is prone to spurious signals because of the image products formed during the mixing process. It is also noisier than the basic VFO but not nearly as noisy as digital circuits. Furthermore the bandpass filter bank required to filter out the unwanted mixing products is a fairly cumbersome piece of circuitry. However the stability (from a frequency point of view) is virtually that of the basic VFO.

The design pursued as the basis for the HRT transceiver combines the best aspects of direct and digital synthesis to produce a VFO with little compromise between the two. I confess that the concept is not original, but very few these days are. **Fig. 5** shows how the system fits together. The main tuning control – the box marked VFO/1 to 2MHz – is analogue and represents a free running oscillator operating over this range.

I don't propose to offer a discourse on closed loop synthesisers. You must therefore take me at my word when I say that the VFO subsystem, schematic **Fig. 6**, operates as the reference oscillator of a conventional PLL system. Anything it does makes everything else do the same. Therefore the LO output to the TX/RX mixer will be shifted by a constant increment proportional to the crystal oscillator depicted in **Fig. 5**, added to the frequency of the VFO. If the VFO shifts by 100kHz, then the LO output, driven from the VCO, will do the same. If the VFO drifts by 100Hz, then the output will do the same.

The advantages of the system should be apparent. It is a relatively easy task to design a VFO which will provide a stable output in the region of 1 to 2MHz. It should be possible to obtain rather higher stability over a complete MHz of coverage than is possible from the standard 5MHz system covering just half that span. The VCO runs at the output frequency so that it should contain virtually nothing in the way of sproggies provided that the loop filter does its job satisfactorily.

Noise

But what about VCO and synthesiser noise ... wasn't there something about these devices being impossibly dreadful and fit only for use

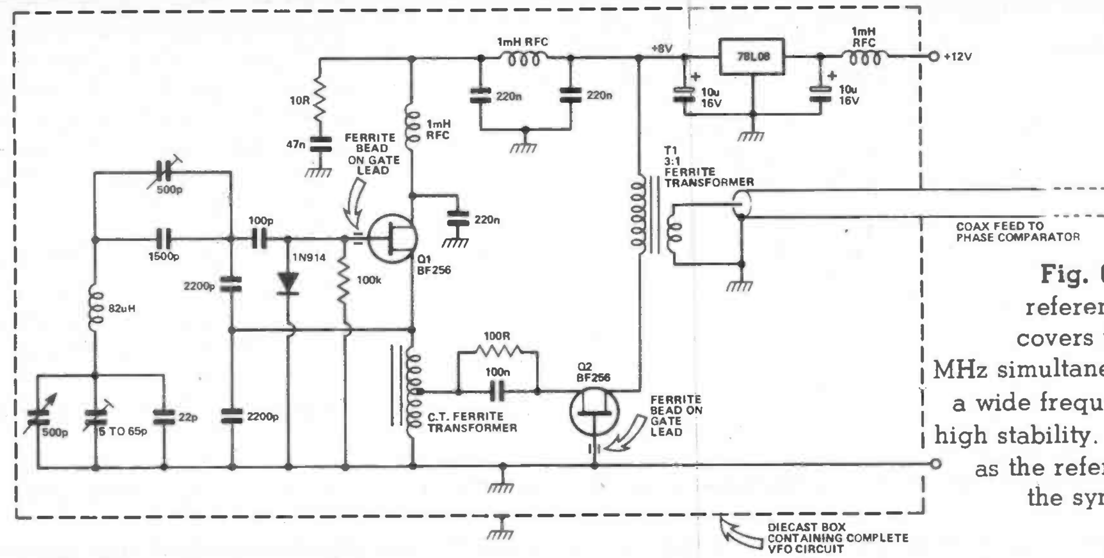


Fig. 6. The analogue reference oscillator. It covers the range 1 to 2 MHz simultaneously providing a wide frequency swing and high stability. The circuit acts as the reference source for the synthesiser system.

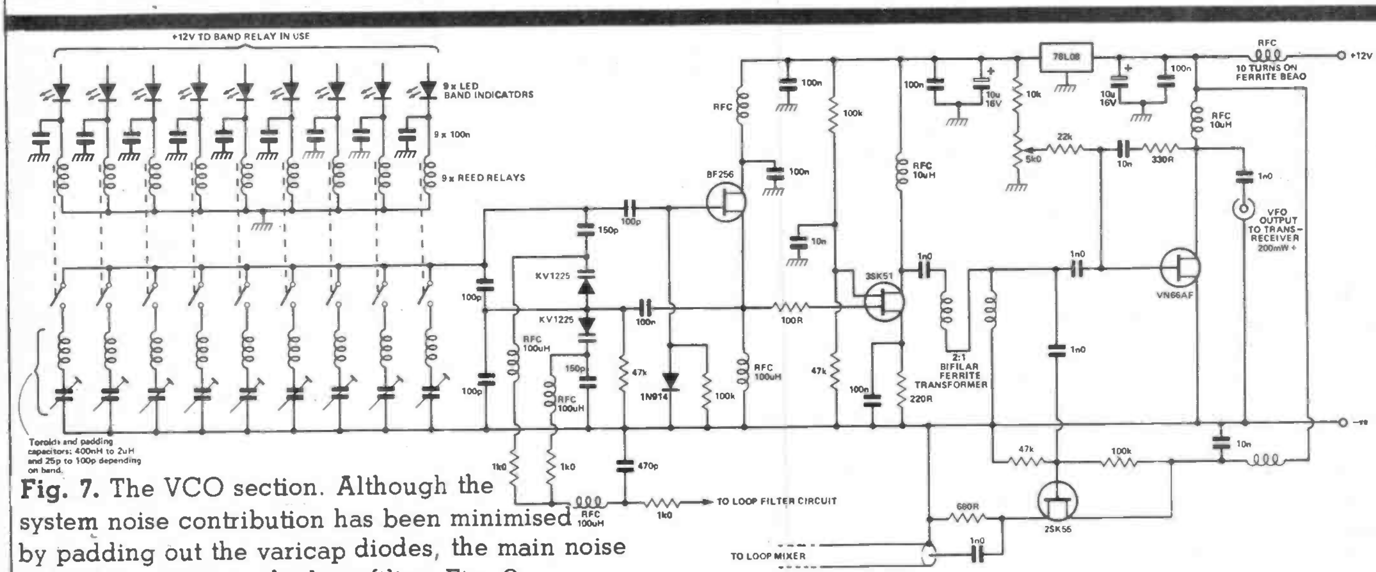
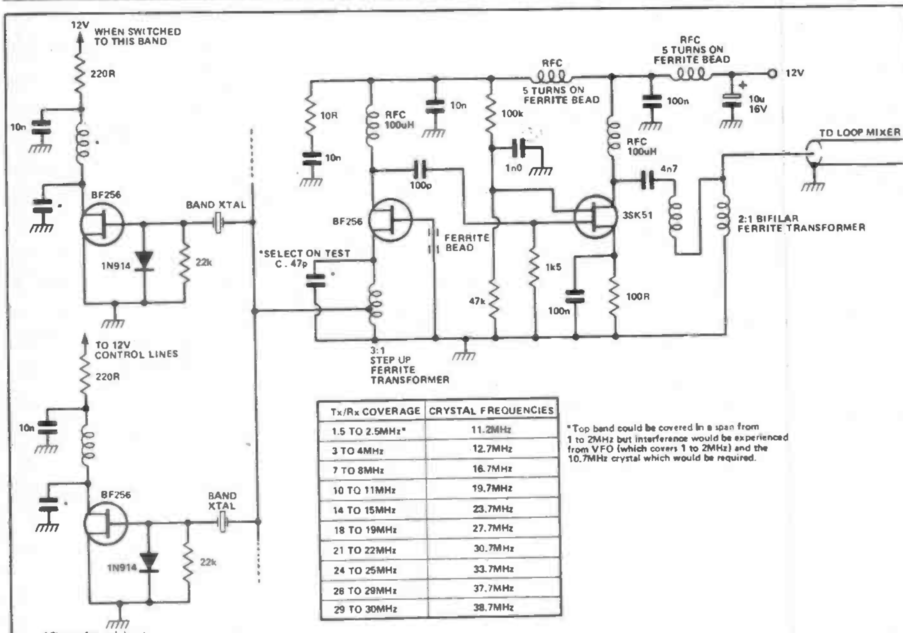


Fig. 7. The VCO section. Although the system noise contribution has been minimised by padding out the varicap diodes, the main noise reduction occurs in the loop filter, Fig. 9



Tx/Rx COVERAGE	CRYSTAL FREQUENCIES
1.5 TO 2.5MHz*	11.2MHz
3 TO 4MHz	12.7MHz
7 TO 8MHz	16.7MHz
10 TO 11MHz	19.7MHz
14 TO 15MHz	23.7MHz
18 TO 19MHz	27.7MHz
21 TO 22MHz	30.7MHz
24 TO 25MHz	33.7MHz
28 TO 29MHz	37.7MHz
29 TO 30MHz	38.7MHz

*Top band could be covered in a span from 1 to 2MHz but interference would be experienced from VFO (which covers 1 to 2MHz) and the 10.7MHz crystal which would be required.

*Chosen for each band to resonate at the required crystal frequency/overtone. For instance the 20m band crystal would require 82p and 560nH but the values are not critical

Fig. 8. The crystal oscillator bank. There is one crystal and one FET sub-circuit for each band

as a noise generator? True, if you do not allow for it.

The biggest noise contribution comes from the VCO circuit, particularly if it is one using varicap diodes. Varicaps are awful things and should never be used seriously in free running oscillators. Oscillators using them tend to have noise sidebands stretching out to 100's of kHz at significant levels. They can be cleaned up somewhat if the VCO is only required to operate over a limited range as in the design for this VFO system. The noise contribution is roughly proportional to the percentage of resonated capacitance supplied by the varicap. If all you require is a few hundreds of kHz swing at, say, 20MHz, then the diodes can be swamped by fixed capacitors to the point where 95 per cent of the total capacity is made up externally. **Fig. 7**, the VCO schematic, shows how the capacity swing of the diodes, normally 25 to 400pF is reduced to the range 60

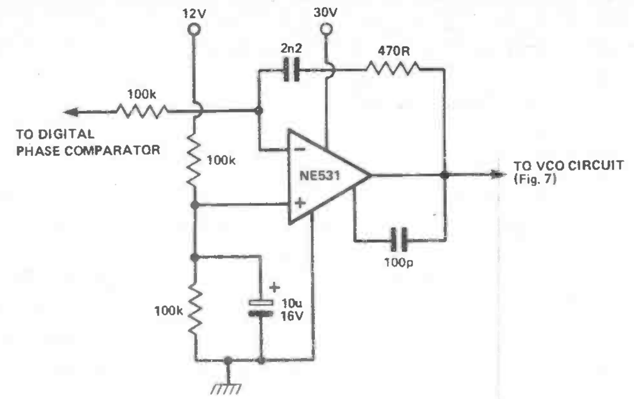


Fig. 9. The loop filter. The wide bandwidth cuts the noise contribution a long way out from the nominal carrier frequency

to 100pF. The padding capacitors (which allow adjustment of the VCO band centre frequencies) reduce this swing even further. FETs and MOSFETs are used throughout to keep added noise to a minimum. As a practical observation, this and the other circuit modules should be manufactured separately and housed separately in RF-tight enclosures. Although the VCO noise has been reduced as far as possible, the real noise killer resides elsewhere.

Wideband, low noise

A reference frequency (in conventional synthesiser terms) in the order of MHz or more is very high. It

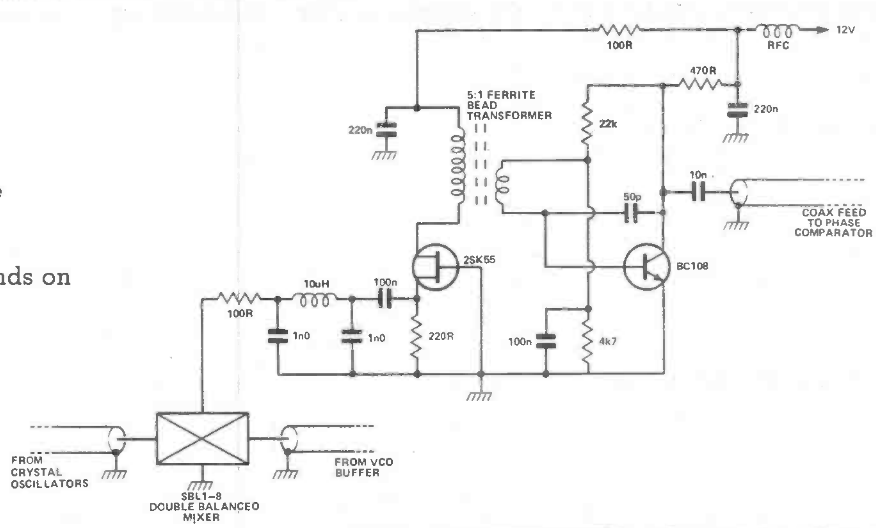


Fig. 10. The loop mixer. The lowpass filter removes image responses above 2MHz. The wideband 'cleanliness' depends on this section

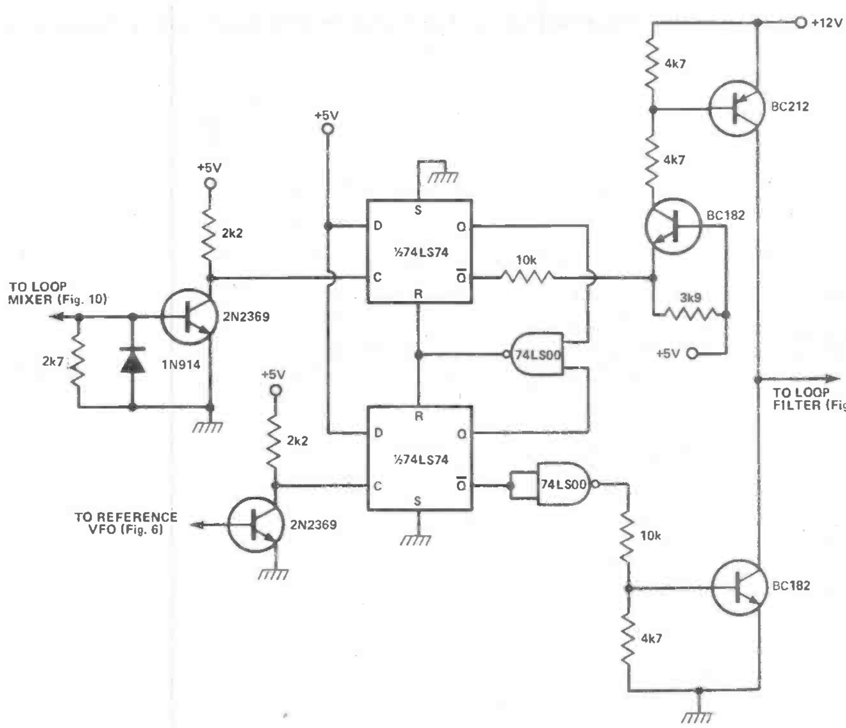


Fig. 11. The digital phase comparator provides both frequency and phase comparison up to the 2MHz maximum loop reference frequency

allows the creation of error signals approaching 500kHz (the Nyquist point, etc). These error signals can be used to counteract the VCO noise sidebands right from close in to the nominal carrier frequency to several hundred kHz out. In an ideal circuit, the noise present in the VCO/LO output would be purely that of the crystal oscillator and the low frequency VFO, regardless of how noisy the VCO circuit was to start with.

Fig. 8 shows the circuit diagram of the band-switched crystal oscillator. Complete sub-circuits, rather than individual crystals, are switched by the DC control lines which activate the reed relays in the VCO circuit. This type of crystal oscillator is inherently low noise and thanks go to Richard Davis G3TDL for pointing it out to me. The circuit functions both on fundamental and overtone crystals. The actual mode is selected by the components in the drain circuit. The low noise aspect comes about because the buffer circuit is fed through the crystal rather than directly from the oscillating device. As well as providing a resonant circuit, the crystal acts as a filter unit reducing the sideband noise even further. Theory suggests that this type of oscillator circuit should show a 10 to 20 dB improvement on conventional designs.

The capacitor shown in the source circuit of the first buffer transistor controls the coupling between the oscillators and buffer circuitry. Its value should be chosen so that every crystal sub-circuit – especially the ones operating in the overtone mode above 20MHz – oscillates robustly. Precise frequency trimming is not necessary since calibration can be provided at the VFO level.

The phase comparator

The circuit for this is shown in **Fig. 11.** The circuit is entirely conventional except that discrete logic gates are used to allow the phase detector to operate up to 2MHz. The edge triggered flip-flop arrangement, which is effectively open-circuit in the phase-locked condition, has the distinct advantage that is frequency as well as phase sensitive. No matter how far the reference and input signals are out of lock, the comparator circuit will always pull the VCO back into line provided that the tuning range had not been exceeded.

The other advantage of digital edge triggered phase comparators is the absence of significant 2f terms in the output. This makes for much easier design of a loop filter since, when the system is in lock, the only output from the phase comparator will be 50nS (or thereabouts) glitches. These are easily removed with a simple lowpass filter.

The loop filter, **Fig. 9**, acts as an error amplifier and also increases the available varicap swing from the 12V of the comparator logic to the 30V of the NE531 supply rail. A high speed wide bandwidth op-amp is essential in this position, to keep the VCO output noise-free a long way from the centre frequency.

The loop mixer mixes the VCO and crystal signals together to provide a difference output for frequency and phase comparison with the VFO in the digital phase comparator. There is an f1 + f2 term with this type of mixer which is removed by the lowpass filter following the double balanced mixer. Note that it is essential to provide isolation between the various circuit modules. Transformers, coax and screening will all be necessary to obtain the desired spectral purity at the VCO output. Watch carefully for signal earth loops. ●

CLUB NET

by Cyril Young, G8KHH

I have to apologise for the Gremlins that chewed up the March Club Net, however, after burning a few gallons of midnight oil we're back with a bumper edition. What better way to start the month than to introduce some new and welcome clubs.

Showing no favouritism the first new club off the pile is **SOUTH EAST KENT (YMCA) AMATEUR RADIO CLUB** or may be better known as the **DOVER AMATEUR RADIO CLUB**, anyway they have the call signs G3YND and G8YND. The Club has over 170 members and meets on Wednesday evenings at 1945 local time at the Dover YMCA, Godwynehurst, Leyburn Rd, Dover. Their programme of diverse activities is intriguing to say the least. (The things they get up to!). More information from Alan Moore G3VSU, 168 Lewisham Rd, River, Dover or phone 03047 2738.

Our next newcomer is **THE CRAY VALLEY RADIO SOCIETY** who hold their meetings on 1st and 3rd Thursday of every month in the Christ Church Centre, Eltham High St, London, (opposite the Fire Station). The Club Secretary, Jon Postlethwaite, G8DYN, says that all our readers are welcome to the Club and for further information contact him at 94, Algernon Rd, London, SE 13.

Let's now move over to Wales to the **BARRY COLLEGE OF FURTHER EDUCATION RADIO SOCIETY.** They meet at 1945 local time in the Annex, Weycock Cross, Barry on Thursday evenings. Their Secretary, Simon, tells me that the Welsh Amateur Mobile Rally is taking place on Sunday 22nd May in the Barry Memorial Hall, doors open at 10am, with talk-in on S22. For further information on the Rally contact R. Rowles GW4FOM, 4 Cowbridge Road West, Cardiff, or give any of the members a shout on GW4BRS, GW6BRC, GW3BKL.

Moving along the coast a bit to **SWANSEA AMATEUR RADIO SOCIETY** who can be found in Lecture Room 'N' (4th floor) Applied Sciences Building, Swansea University, at 7.30pm on the first and third Thursday of every month, where they get up to all sorts of things, including talks, demos and films, when they're not playing with the Club HF rig. Roger Williams GW4HSH on Swansea 404422 will tell you what they have in store, apart from the Trade Rally to be held on Sunday 10th April in the Patti Pavilion (next to St. Helens County Cricket Ground) on the Swansea-Mumbles Coast Road. In case you get lost there's talk-in on S22!

G3SAD and G8SAD are the call signs of the **STEVENAGE & DISTRICT AMATEUR RADIO SOCIETY.** Club members meet at 'T.S.Andromeda' Shephall View, Stevenage at 8pm on 1st and 3rd Tuesdays of each month. From their attractive Newsletter I gather that Terry Bailey G6CRF is the Club Secretary, 187 Archer Rd, Stevenage and the Publicity Secretary is Les Mather G8OKI, 68 Woodhall Lane, Welwyn Garden City. Contact either Terry or Les for a list of future events (and don't forget the SAE).

Now we come to the 'Boffins Club', better known as the **FARNBOROUGH & DISTRICT RADIO SOCIETY,** who let themselves down by meeting at the Railway Enthusiasts' Club, Access Rd, off Hawley Lane, Farnborough, Surrey, at 7.30 on the 2nd and 4th Wednesday of each month. Arriving just in time for me to re-write the page, I received the one and only 'Programme for the Year' from any club. From this I see that on April 13th they are holding a 'Bring & Buy Sale'. The programme for April 27th says 'TBA' ("Transmit by and", I wonder? Must be a new sort of morse class). It's obviously a good programme, because they are holding it again on May 5th (Hi). Beam into Christopher French G8ZAJ, 26 Wood Street, Ash Vale, Nr. Aldershot or phone him on Aldershot 29469 for any further info.

In New Cross London you'll find the **CLIFTON AMATEUR RADIO SOCIETY** meeting every Friday at 8pm in the New Cross Inn, Clifton Rise. On the 8th April a lecture on 'OSCAR' by G4RFC is being given. The Secretary is R. W. Hammond G4DBW, 43 Durant Rd, Hextable, Swanley, Kent. (enclosing SAE).

At the top of St. Alban's Hill is the location of the **VERULAM AMATEUR RADIO CLUB.** W. G. Thompson G6EQO, Publicity Secretary has kindly given me details of the new Secretary, Ed Balley G4KLQ and goes on to mention the Club Memorial Lecture on 'Microwaves', given by Dr. D. S. Evans G3RPE, at the Charles Morris Memorial Hall, Tyttenhanger Green, Nr. St. Albans, which I know is an interesting lecture. I'm not sure if this is the Club QTH, but no doubt further information can be obtained from Ed on Redborn 3291 or Bill at St. Albans 58132.

For a man who admits to his sins and gets landed with the job of Publicity Officer for the **CAMBRIDGE AND DISTRICT AMATEUR RADIO CLUB,** I think it's a bit much, never mind David, you're doing well. The Club meets each Friday during term time in the Visual Aids Room of the Coleridge Community College, Radegund Rd, Cambridge at 7.30pm. On 8th April the College is closed, so A Grand Junk Sale is to be held at Comberton Village Hall. On 15th April is a 2m Fox Hunt and 22nd An Exciting Evening with John Hall G3WLD. For more information contact David Wilcock G2FKS, 6 Lyles Rd, Cottenham, Cambridge, or phone 0954 50597.

Apart from the Floodgates working, there is another great event in the Thames Valley; the Golden Jubilee of the **THAMES VALLEY AMATEUR RADIO TRANSMITTER SOCIETY.** Celebrations include — 5th April Constructional Competition for the Caernarvon Trophy, held at Thames Ditton Library Meeting Rooms, Watts Road, Giggs Hill, Thames Ditton, Surrey at 8pm. Their next meeting on 3rd May is an NFD Briefing and a talk by Bill Hall G4FRN on Maritime Mobile

Both 1981 and 1982 were a success in the SSB HF field days for the Windy Net group using a TS 830S and double inverted V antenna. Club call is GM3NEQ/P.

From Left to Right — GM8NJG, GM3ZDH, GM3NIG, GM4KBR, GM3UTQ, GM4LFA, GM4JMU and GM3NEQ. Photo by GM3AXX.

Net Operation. More info from Julian Axe G4EHN 65, Ridgeway Place, Wimbledon, phone 01-946 5669. Here's wishing you well chaps for the next 50 years from *Ham Radio Today*.

Our next newcomer to the net is not exactly a club, but never the less well worth a mention — the National Wireless Museum at Arreton Manor on the Isle of Wight. I, like thousands of others have had the good fortune to visit the museum GB3WM, spending considerable time reminiscing, being fascinated with the equipment of yesteryear. Just gazing at the bright emitter valves one can hear 2LO calling — and what an imagination Logie Baird had to dream up that 30-line mechanical TV! Douglas Byrne, G3KPO, Curator, tells me he has a large collection of old service sheets. If any reader is looking for information for their radio gear the National Wireless Museum may be able to help. Ring Douglas on 0983 62513 or write (enclosing an SAE) to Arlington House, 34 Pellhurst Rd, Ryde, Isle of Wight.

Yes Colin, I'm pleased to mention the up and coming **BATH & DISTRICT AMATEUR RADIO CLUB.** The Club Secretary, Colin Rose G8YCV tells me the Club has been going for about a year and has 30 members, who meet at the Englishcombe Inn, Englishcombe Lane, Bath, every other Wednesday at 7.45. The next meeting on April 6th is the Club's AGM which must be a good time to join. If you are interested contact Colin on 0225 311687.

The **MID-ULSTER AMATEUR RADIO CLUB** were one of the first to send me a photograph of one of their activities. The Club meets at 3pm at GI4BAC QTH in Bambridge, County Down on the first Sunday of the month. Their Secretary Danny Campbell GI4NKD tells me their annual mobile rally will be held as usual in Parkanaur House, Nr. Dungannon, Co. Tyrone, on Sunday 8th May. Danny will be pleased to bring you right up to date with the Club's activities by calling him on 0762 42620.

Members of the **LEYLAND HUNDRED AMATEUR RADIO GROUP** meet on the 2nd Monday of each month at 7.30pm in the Astley Park Social Club, Chorley, where Secretary Arthur Jolly G4JCO says new members are always welcome and further information can be obtained from him at 20, Crawford Ave, Chorley, Lancs. (Don't forget the SAE).

THE FLIGHT REFUELLING AMATEUR RADIO SOCIETY. I don't know about you, but I remember reading about these guys during the recent South Atlantic squabble, I guess they didn't have much time for radio then, although I hear there are several new *FT ONEs* among the members, Hi! They meet every Sunday at 7pm in the Flight Refuelling Sports and Social Club at Merley, Wimborne. All are welcome to help the Club's 50 members to construct a 12 metre dish for EME on 2.3GHz and a 23 meter tower. If you can lend a hand contact Richard Ayley, 20 Milne Rd, Waterloo Estate, Poole, Dorset.

My next letter carries a large heading saying **"WELCOME TO THE CHESHUNT AND DISTRICT AMATEUR RADIO CLUB"** and "welcome to the Net". From Roger Frisby's letter (G40AA) I find the club meets every Wednesday evening in the Church Room, Church Lane, Wormley, Nr. Cheshunt, Herts. Their next meeting on April 6th is concerned with the BBC Micro and Amateur Radio. On 13th is a Natter Night, on 20th A Showing of Rude Pictures (members shacks) and on 27th is RAE Revision. If you want to know more the Club call signs are G4ECT and G6CRC, or contact Roger on 099 24 64795.

Next is another club from my favourite part of the country, Cornwall, **THE BRITISH CHINA CLAY'S RADIO CLUB G6ECC**, situated in St. Austell, is only the 2nd club from the Duchy to report in! It's nice to have you chaps. They meet every other Monday at 7.30 in the Pentewan Road Labs, but it looks like the club will have to be on the lookout for a new QTH soon. Jack Redfern G8HSZ, the PRO, says all holiday visitors are welcome to 'the Shack' Treverbyn, up in the 'clay hills'. The Club holds a net on Fridays at 7pm on S22 and on Sundays at 1100 on 3.70MHz$\pm$QRM.

Jack emphasises a point I constantly seem to be making, that is that on the GB3NC repeater, the NC stands for Newquay Club and not North Cornwall. My cousin G3DCJ regularly monitors the repeater, someone say 73 to him for me!

Having just held their AGM, it would be a good time to introduce the **SALISBURY RADIO AND ELECTRONIC SOCIETY.** Their Secretary Bert Newman G2FIX tells me the programme for 1983 will include numerous demonstrations at Fetes, DF Competitions and lots of other goodies. Club meetings are every Tuesday at 7.30pm in the Grosvenor House, Salisbury. For more details ring Bert on Salisbury 743837, who will 'fix' it for you!

Still introducing new clubs to the Net, we now have the **BURY RADIO SOCIETY**, who hold meetings at the Moses Community Centre, Cecil St. Bury, every Tuesday evening at 8pm. Their next meeting on April 12th is an evening on "23cm and Repeaters". Newcomers are invited to contact Brian Tyldsley G60KE, 4 Colne Rd, Burnley (tel. Burnley 24254)

Thank you for the few kind words on the magazine, Roger, Secretary of the **NEWARK AND DISTRICT AMATEUR RADIO CLUB.** He says in his letter that the Club meets at The Palace Theatre, Appleton Gate, Newark (curtains up at 7.30pm on the first Thursday of each month, where in April G4MDV performs with a 'Workshop Construction Project'. On April 2nd, 3rd and 4th the Club holds a special event station at the Newark Air Museum. Further enquiries to Roger Hiscock G4MDV at 17, The Green, Elston, Nr. Newark (with an SAE).

Our next recipe comes from **DENBY DALE (PIE HALL) & DISTRICT AMATEUR RADIO SOCIETY**, who according to their Secretary have just held their 10th AGM. Meetings are held at Denby Dale, Pie Hall, every Wednesday at 8pm. On April 13th there is a visit from Lowe Electronics, 20th a Rally Committee and on 24th Drayton Manor Rally. Come along, Mr. Secretary don't be shy, *Ham Radio Today* will be pleased to have your criticisms as well as the compliments we have been getting. Sorry to be so formal but I have no first names. For those who want to know more about the club, write to J. Clegg G3QH, 8 Hillside, Leak Hall Lane, Denby Dale, Huddersfield.

THE EDGWARE & DISTRICT AMATEUR RADIO SOCIETY G3ASR are the next club to sign in. They meet on 2nd and 4th Thursdays of each month at 8pm at 145 Orange Hill Rd, Burnt Oak, Edgware. From the Club's interesting Newsletter they admit that they have a Society photograph album. Come along, Mr. Custodian, let's be having some of them to liven up these pages! On 14th April the Club make a visit to the Lowe Emporium, Kings Cross, (with big bags). The Secretary is Howard Drury G4HMD, 11 Batchworth Lane, Northwood, on Northwood 22776.

Bob Kugler G8VQS, Secretary of the **SHEFFIELD AMATEUR RADIO CLUB** has very kindly sent me the Club's Newsletter Q BIT, generously marked with green blobs drawing my attention to things like the Club's new premises. How many Societies can boast of two club houses? It appears they meet on the 1st and 2nd Mondays of each month at First Park Pavilion (Clock Tower) and on the 3rd Monday of the month at the Sheaf House Hotel, Bramall Lane. As the programme of meetings only goes up to February, I'm unable to give you news of the club activities in the future, therefore contact Bob by telephone on 0246 31696.

This seems to be a good time to bring to the attention of all Club Secretaries that these pages are compiled some 2 to 3 months ahead of publication. Therefore it would be much appreciated if details of Clubs' forthcoming events for at least this period could be sent in time to make the column of practical use.

One other point I'd like to make, which has been brought to light by Secretary Bob Brown GM8UIZ of the **INVERNESS AMATEUR RADIO CLUB**, who asks if kits of parts are going to be available for projects described in the magazine. The simple answer is 'not yet', due to staff limitations. Maybe in the future we can look at this possibility. Bob tells me his club is a very new one with limited funds and only about 20 members. As he omitted to give me any details on the club if you're interested I suggest you contact him at The Flat, 21 High St, Dingwall, Rosshire, Scotland, and I'm sure he will fill you in with all the details.

Now back to some of the clubs that have appeared in this column before. **GLENROTHES & DISTRICT AMATEUR RADIO CLUB GM4GRC.** From their Newsletter I see that they have resolved their problem with Raynet that I mentioned last month. They have decided to disband the group due to lack of interest and commitment by members. As I write this column there are reports of heavy snow in the Fife district. It would have been comforting to know that there would have been a skilled and reliable team to back up the emergency services that may be required in this kind of weather. In a brighter vein, I see everyone's going to roll their sleeves up (it's hoped) to refurbish the club room, for which planning permission has just been granted. The forthcoming meeting on May 15th is blank on my calendar, so if you're interested contact Gavin Lucas GM4EJI.

The **BIGGIN HILL AMATEUR RADIO CLUB** who meet at 8pm in the Biggin Hill Memorial Library, are organising a visit to the Kent Police HQ on Tuesday 10th May (that's goodbye to half the club members) Hi. On May 17th those left will be following up the April meeting on Home Construction Techniques and on May 24th the other half will be going to the 'Nick'. Full details can be obtained from Ian Mitchell G4NSD, 37b The Grove, Biggin Hill, Westerham, Kent.

There appears to be the usual activity this month with the **IPSWICH RADIO CLUB.** On the 4th and 18th May morse classes are being held and on the 25th they're planning for the East Suffolk Wireless Revival (three very suitable programmes to be held at the Rose & Crown, Norwich Rd). On 11th May a DF Hunt (ending of course in the club room) and on 29th May the East Suffolk Wireless Revival is being held at the Civil

Service Sports Ground, Bucklesham — a radio rally for the family. Jack Tootill G4IFF can fill you in on all details and he can be found at 76 Fircroft Rd, Ipswich or on 0473 44047.

I hope the Component Fair organised by the **PONTEFRACT & DISTRICT AMATEUR RADIO SOCIETY** was a great success and no doubt they are looking forward to the forthcoming Mobile Rally calendar. Call Niall Whittingham G4ISU or go along to the club rooms at the Carleton Community Centre, Pontefract on any Thursday evening and you will be made most welcome.

From **AMSAT-UK** comes the usual bumper magazine in which there is a very nice article by Dave Lane G3VOM, trying to persuade those members of the organisation that haven't operated through a satellite to have a go! Also the truth about ARIANE 5. To those of you who are waiting for hard covers for OSCAR NEWS, these are now available, says Ron Broadbent G3AAJ. For those who are not members of AMSAT-UK, I'll just say "Why not?". You can apply for your membership to Ron Broadbent, 94 Herongate Rd, Wanstead Park, London. (With an SAE)

Like AMSAT the **G-QRP CLUB** cram so much information into the Winter edition of their journal SPRAT that it is difficult for me to select something to tell you about. Just to wet your appetite how about a 'Tuned Balun ATU' or 'TTL TX' or '160m Convertor' and lots more besides. If you're a QRP type drop a line to the Rev. George Dobbs G3RJB at 17 Aspen Drive, Chelmsley Wood, Birmingham (with an SAE if you want a reply).

From the **BROMSGROVE & DISTRICT AMATEUR RADIO CLUB** I understand from the Secretary A. Kelly G4LVK (How about some first names) the club meets on the 2nd Friday in the month at the Avoncroft Art Centre, at 8pm and on 4th Friday of the month the quiet part of the club meets (QRP meeting) at the same time and venue. This month the 'Constructors Contest' is to be judged so don't forget to take your goodies with you to the next meeting. With snow on the ground as I write it's nice to see the club looking forward to their annual picnic, which I'm sure the Secretary will tell you about if you drop him a line at 8 Greenslade Cres., Marlbrook, Bromsgrove.

In a short letter from **THE CLIFTON AMATEUR RADIO SOCIETY** I see their next meeting is on OSCAR by G4RFC. They meet at the New Cross Inn, Clifton Rise, New Cross, London every Friday at 8pm. Their Secretary is R. W. Hammond G4DBW, 43 Durrant Rd, Hextable, Swanley, Kent.

Just creeping in with the last couple of meetings on the list of programmes **THE CHICHESTER AMATEUR RADIO CLUB** have a club meeting on 5th April and their AGM on the 21st. The Club meets at the Green Room, Fernleigh Centre, 40 North St, Chichester on 1st and 3rd Tuesdays of each month at 7.30pm. For up to the minute information there is a club net on Wednesdays at 1900 local time on S11, or ring the Secretary T. M. Allen G4ETU on West Ashling 463.

With the ever increasing costs of our hobby it's not surprising that sooner or later someone would look into the expense of the certificates and awards that abound. It has fallen the lot of the **FYLDE AMATEUR RADIO SOCIETY** to do just this at their May 10th meeting. It will be most interesting to learn the result of the discussion! The club meets at the Queens Hotel, Central Beach Lytham, at 8pm on 2nd and 4th Tuesday of each month. Secretary Harold Fenton G8GG will be pleased to give you up to the minute information. Contact him at 5 Cromer Rd, St. Annes, Lytham St. Annes. (With an SAE)

Everybody's making a beeline for the **HASTINGS ELECTRONICS AND RADIO CLUB**, on 20th April for the Club's 'Junk Sale'. As I haven't heard from them lately I'm not certain of the Club's new QTH, it may be in Downey Rd, St. Leonards. However, if you're travelling any distance or taking a big van with you (Hi) I should contact George North G2LL on Cooden 4645. On May 18th there is a lecture on 'QRP' by 'low power' Chris Page.

LINCOLN SHORT WAVE RADIO CLUB, who are on the air with call signs G5FZ and G6COL, meet at the City Engineers' Club, Lincoln, at 8pm. They are meeting on April 13th for a talk on 'Contest Preparation and Operation' by G8ZHP Contest Group, and on 27th April for a talk about the RSGB by G3SZJ. Their big day is on 8th May when they hold the '1983 Ham Fest' at the Lincolnshire Show Ground just north of the city on the A15. Talk-in on S22 and SU8. This family day out plus all the usual trade stands etc., starts at 11am. If you don't believe me when I say how good it will be, ask Pam Rose G8VRJ (the Club Secretary), at the club address.

Steve Thompson G4RCH, Secretary of the **NORTH WAKEFIELD RADIO CLUB**, admits in his second Newsletter that he hasn't a great deal to say. Going along with that, all I can tell you is that the club meets at Carr Gate WMC (wherever this is) and on 14th April they're having a visit from G4DAX who is the RSGB Regional Rep. (I hope he finds them OK). If you want to know more contact Steve at 3 Harlington Court, Morley, LS27 0RT.

THE READING & DISTRICT AMATEUR RADIO CLUB meet at the White Horse, Emmer Green, Reading, at 8pm each Tuesday. At their meeting on April 12th, they've delving into the workings of the VHF Contest Committee (dig deep fellas). On April 26th they will all be struggling to the meeting loaded with antique equipment and pockets bulging with pound notes, to witness a demonstration by South Midland Communications (the best salesmen in the land). On May 5th they're having a 'Quiz' played against the Maidenhead Club in the Red Cross Hall, The Crescent, Maidenhead. Further info from Chris Young, G4CCC, Reading 471761.

The **RHYL & DISTRICT AMATEUR RADIO CLUB** meet at the 1st Rhyl Scout Headquarters, Tynewydd Rd, Rhyl, on the 2nd and 4th Thursday each month. On April 28th they're delving into 'Propagation' by G3LEQ and on May 12th they have an Activity Night. If you want to know what

Using a special event call sign, GB8CFC the CHESHAM & DISTRICT AMATEUR RADIO SOCIETY gave a demonstration on amateur radio to the local physically handicapped and able bodied club, where over 35 contacts were made in the evening.
Peter Cabbin G4OST persuades a club member to talk into the mike.

they get up to then you had better ask B. N. Jones at 6 Rhodfa Maes Hir, Rhyl, Clwyd.

There will be a packed club room at the **SOUTH DORSET RADIO SOCIETY**'s next meeting on April 5th when they hold their AGM where they will know if they've raised enough money to pay for the generator they so badly need. The club meets at the Wyke Regis Army Bridging Camp, Weymouth on the 1st Tuesday of each month at 7.30pm. This is the last date given on their calendar so contact Andrew Prior G6HEL at 3 Greenways, Dewlish, Dorchester, Dorset.

At the Control Tower, Bearley Radio Station, Nr. Stratford, the **STRATFORD-UPON-AVON DISTRICT AMATEUR RADIO CLUB** on 14th April ask that all important question 'could you still pass the RAE?' and on 25th April they will be discussing 'Your First Radio Station' and on May 9th they are teaching the 'Techniques of Home Construction'. All meetings start at 7.30 and in case you're a stranger in town 'talk-in' is on S22. Programme Secretary (Ian Hopwood G6CWK) will tell you more about their events, call him on Stratford-upon-Avon 68863.

In a very short letter, Ray James GM4CXM tells me the **WEST OF SCOTLAND AMATEUR RADIO SOCIETY** meets every Friday in its own clubroom, at 22 Robertson Street, Glasgow at 8pm. For a programme of forthcoming events you will have to get on the air and call Ray or GM4LGM or GM4HYF.

From the **WIRRAL & DISTRICT AMATEUR RADIO CLUB** I have received a long letter and the January edition of their magazine 'Airwave'. From their Secretary Gerry Scott G8TRY I hear they've recently held their AGM and they are probably one of the first clubs to have a husband and wife team as Chairman and Treasurer. Gordon Nichols G8MMM is no newcomer to chairmanship and he was a founder member of the Club. XYL Susan G6ADO, normally works in a bank, but at the moment is spending her time looking after their new 'oscillation'. Just one other item from their magazine for this month, Ian Brooks, Wirral Raynet Controller, has been forced to resign due to pressure of work and in the hot seat now is Mike Hampson G8RXB with John Fogg G8UZZ as his assistant, doing their best to keep the Raynet group up to scratch. Gerry Scott bemoans the lack of articles for the magazine, but on page 19 they publish an instant 'buzz word' generator. Now if you've played Bingo using the generator you could write a 5,000 word article in 10 minutes. For the Club's forthcoming events April 13th they have a 'SOTA Communications Ltd. demonstration'. April 27th is 'Passive DF'. Their drinking and waffling nights! are on April 6th at the Railway Hotel, Meols; April 20th 'The Harp', Neston and May 4th 'The Primrose' Liscard. Club meetings are held at 8pm on 2nd and 4th Wednesday each month at Irby Cricket Club. If in doubt call Gerry G8TRY on channel S13.

Finally, three new clubs to the net have just dropped through the letter box in time to be included in this month.

One is the **BRISTOL AMATEUR RADIO CLUB** whose call is G3TAD. Meetings are held at YMCA, Park Rd, Kingswood, Bristol, every Tuesday at 7.30pm. On April 5th — 'A quarterly business meeting'. April 12th — Projects Night. April 19th 'RTTY' night by G4REH. April 26th the Computer Club meets and May 3rd is an 'On the Air Night'. If you want to know more about this very active club check with Mark Goodfellow G4KUQ on 0272 716093 or on the club net 1.919MHz Sunday 11pm.

Next we have **THE SEFTON AMATEUR RADIO CLUB** who meet alternate Wednesdays at the Liverpool Prison Officers Social Club, Hornby Place, Hornby Rd, Walton, Liverpool. Mike Webb G6ICR, says in his letter 'the club is holding a Junk Sale in the near future and there is to be a demonstration on the 'use of the Micro Computer in amateur radio! The Club has its own call sign G4RAQ and hopes to be on the air shortly. For up to the minute news call Mike on 051-487 0756. Thanks for the letter Mike, let's be having some more details from you soon.

The **PRO of the SOUTH COTSWOLD AMATEUR RADIO SOCIETY** has written asking me if I would mention their club. Of course I am delighted to do just that. Formed in October 1982 by 10 members it has now grown to 30. The Club's QTH is Scout Headquarters, Dr. Brown's Rd, Minchinhampton, where they meet on 2nd and 4th Wednesdays of each month. For further information on club activities contact the Chairman R. J. Burnett G4RJB on Nailsworth 2874.

We welcome the last three clubs to the net, but let's be a little less formal, what about some first names, this is a *Club Net*.

That completes our bumper issue for this month. Thank you to everyone who has participated. There are still a lot of clubs we haven't heard from. There's no excuse, it's only a short walk to the local post box and the Net's still wide open! Best 73s to all.

Cyril Young G8KHH.

Morse Tutor on the ZX81

By Paul Newman G4INP

The coming of the cheap micro-computer into ham radio opens up many avenues of fun and education. One of the first and most obvious uses is that of morse tutor. The *ZX81* however, is not blessed with a sound facility such as the BEEP-command of the Spectrum. The *ZX81* will, however, produce a sound of sorts and the tutor described here uses this fact. Facilities available with this program are as follows:—

a) Speed variable from around 6 to 35 wpm in practical terms.
b) Delay between characters can be varied to aid learning.
c) Teach-mode; characters can be selected from the RSGB-recommended groupings and can be demonstrated at low speed.
d) Exam mode; the program selects a random grouping and sends 20 characters at the selected speed.
e) On-screen checking of received copy.
f) Save; the program can be saved with the last lesson set, to resume where you left off.

The morse is sent out of the *ZX81's* 'mic' line and may be monitored by a small earpiece or amplifier. Alternatively the TV sound may be turned up (the video may require slight detuning) and the morse heard that way. The picture collapses when CW is sent since it will only work in FAST mode. Don't try SLOW — it simply won't work. The program has been kept as simple as possible but should contain all you need for an effective tutor.

Program construction

The data storage in line 0 is made first as follows:
enter 1 **REM** followed by the comments up to and including **PEEK TO TAN** — which are tokens. Add 36 dots to the **REM** at this point. Use the program below to **POKE** the data in table 1 into the space reserved by the dots.

Table 1: Data Values

16556	2	16557	4
16558	6	16559	16
16560	3	16561	7
16562	15	16563	6
16564	12	16565	24
16566	5	16567	9
16568	17	16569	14
16570	30	16571	21
16572	13	16573	22
16574	11	16575	10
16576	18	16577	27
16578	19	16579	20
16580	25	16581	29
16582	62	16583	60
16584	56	16585	46
16586	32	16587	33
16588	35	16589	39
16590	47	16591	63

```
2 FOR J = 16556 TO 16591
3 PRINT J,
4 INPUT N
5 POKE J, N
6 PRINT N
7 SCROLL
8 NEXT J
```

Enter one value (viz 2 is the first) and press **NEWLINE.** Enter each value in turn from the table. When complete, check thoroughly. Next add using **EDIT** the characters at the end of the **REM** (viz EISH . . . etc), ending with 5 dots. Then **POKE** in directly the last five values as follows: **POKE 16628,12; POKE 16629,1; POKE 16630,1; POKE 16631,4; POKE 16632,1.** Check the **REM** thoroughly and when satisfied enter **POKE 16510,0** as a direct command. Save the line for safety. It now appears as line zero to prevent accidental erasure.

Next, enter the rest of the program as given. **Table 2** gives the **CODES** of the characters in the string **'O'**, line 1365. Read across the table. **Fig. 2** shows the screen display for option selection, the black square shows the group selected. **Fig. 3** shows the screen checking.

Table 2: Characters in 0$

1	4
5	7
8	10
139	13
14	17
18	21
22	26
27	31
32	36
1	36
1	26
27	36
26	

The program

Some lines in the program require a little explanation and this follows:

lines 1-19. Array **'P'** is for the CW character data. Array **'A'** is for character data in checking output. The variables **S,D,F,LS** are speed, delay, first in group and last in group.

lines 20-280 form the sending sequence. **line 30** — a random number between the first and last pointers to the group (1 and 4 indicate E I S H for example) is generated and line **40** loads the character data into array **'P'. Line 50** loads the corresponding characters for printing.

line 70 onwards perform the sending. Morse characters are held as decimal numbers with bits set according to the dot/dash pattern. **Lines 90 and 100** divide the value by 2 and find the remainder, ie the bit value. **Line 120** is the loop-control which will vary according to the value of **'E3'.** It will either be 10 or 10 + 20 = 30 ie. dot or dash. The construction of this line is correct despite its odd appearance. Your ZX81 manual will explain its operation.

line 130 is the **USR** call to the three machine code bytes **'PEEK TO TAN'** which are simply a way of making a click at the 'mic' socket. Repeated calls to this generate the buzz.

lines 155-160. This is a 'do-nothing'

Fig. 2.

```
      ERROR CHECKING

INPUT YOUR COPY AS A STRING
<NEWLINE> ONLY IF NO COPY
USE<SPACE>AS DONT KNOW

DEATO9RSSPEADCIHE75L RECEIVED

DATO9RSSPTADCIHE75LX SENT

ERRORS IN INVERSE VIDEO

   SCORE 2/20

 >>ANY KEY FOR MAIN OPTION<<
```

Fig. 3.

```
      G4INB MORSE TRAINER

         SPEED  :12
         DELAY  :1

      MORSE LEARNING GROUPS

    1-E I S H      2-T M O
    3-A U V        4-N D B
    5-W J C K      6-P G R L
    7-Q Z F X Y    8-1 2 3 4 5
    9-6 7 8 9 0    A-ALL CODE
    B-LETTERS      C-NUMBERS

    PROGRAM OPTIONS
    T-TEACH    S-SPEED
    E-TEST     D-DELAY
    B-SAVE

    >>PRESS OPTION KEY<<
```

loop to give a suitable gap between characters.

line 240 generates a short pause between groups of five characters. It gives a smoother pause than the rather 'jumpy' **PAUSE** in BASIC.

line 1365. This is a table that gives the pointer values for the code data in the **REM.** Don't confuse zero with the letter 'O'.

lines 1390 and 95 calculate the row and column numbers on which to print the black square. Save the program several times before checking.

Program operation

Run the program. The screen should appear as **Fig. 2** — group 1 will be selected with speed 12 delay 1.

Press 'S' - select a new speed which should be printed on screen.

Press 'D' - select a delay between 1 and 9. I prefer to keep a short delay of 1. At any rate a delay of 5 should be long enough even for a rank beginner.

Press 'T' - the prompt will ask you to enter the group you want. The square will reposition accordingly. 'Z' will return you to option level.

The prompt will change and ask you if you want the group demonstrated. After all are demonstrated, or refused, pressing any key except **BREAK** will cause the group to be sent at the chosen speed. If you want the demonstration to be at the selected speed rather than 6 wpm, delete **line 890.**

On-screen checking is done as **Fig. 3.** Enter your copy as a single string with 'space' as 'don't know'. Your score will be displayed with errors in inverse video.

Pressing 'R' here (only in Teach mode) will repeat the lesson. Any other key will go back to main option level.

Press 'E' - program will select a grouping at random and square will reposition. Pressing any key starts the test and screen checking is as before. Any key return the program to option level.

Press 'B' - the program is saved with current options stored and is autorun on loading.

Learning morse

Remembers that morse is best learned in short daily sessions until reading it is instinctive at around 16 wpm. The PO test should then present no problem. Sending is best left until receiving is well instilled since the 'feel' helps sending. I prefer to teach morse at fast speeds (8 to 10 wpm) and vary the gaps between letters.

Notes

This program uses techniques dictated by the limitations of *ZX81 BASIC*. Adaptation to other micros should present no problems provided this is borne in mind.

```
   0 REM C G NEWMAN 1982 DO NOT
ALTER THIS LINE PEEK TO TAN
?£/ ) :2+$-"">.<=: 1YWSK457R,
EISHTMOAUVNDBWJCKPGRLQZFXY123456
7890£
   1 LET M$=""
   2 LET B$="
"
   3 LET V$="
"
   4 LET T$="G4INB MORSE TRAINER
"
   5 LET S=PEEK 16628
   6 LET D=PEEK 16629
   7 LET F=PEEK 16630
   8 LET LS=PEEK 16631
   9 DIM P(20)
  10 DIM A(20)
  11 LET RET=0
  12 LET O=PEEK 16632
  13 LET OLDS=S
  14 LET OLDLINE=1
  15 LET OLDCOL=9
  16 GOSUB 1390
  19 GOTO 300
  20 RAND
  25 FAST
  30 FOR X=1 TO 20
  35 LET Q=F+(INT (RND*(LS-F+1))

  40 LET P(X)=PEEK (16555+Q)
  50 LET A(X)=PEEK (16591+Q)
  55 FAST
  60 NEXT X
  70 LET A=1
  75 LET B=5
  80 FOR C=A TO B
  85 LET E=P(C)
  90 LET E2=INT (E/2)
 100 LET E3=E-(E2*2)
 120 FOR X=1 TO 10+(20*(E3=1))
 130 LET G=USR 16553
 150 NEXT X
 155 FOR X=1 TO INT (120-240*(E<
2))/S
 160 NEXT X
 170 LET E=E2
 180 IF E>1 THEN GOTO 90
 190 IF RET=1 THEN RETURN
 200 FOR X=1 TO 50*D
 210 NEXT X
 220 NEXT C
```

Fig. 1: Program listing

Contd. next page

```
230 IF B=20 THEN GOTO 500
240 LET X=RND**RND**RND
250 LET A=A+5
270 LET B=B+5
280 GOTO 80
300 CLS
305 PRINT AT 1,6;T$;AT 2,6;V$;A
T 4,11;"SPEED :";S;AT 5,11;"DELA
Y :";D
310 PRINT AT 7,6;"MORSE LEARNIN
G GROUPS";AT 8,6;V$;""
315 PRINT AT 9,4;"1-E I S H","2
-T M O","        3-A U V","4-N D B",
"      5-W J C K","6-P G R L","
  7-Q Z F X Y","8-1 2 3 4 5","
  9-6 7 8 9 0","A-ALL CODE","
B-LETTERS","C-NUMBERS"
316 GOSUB 1390
320 PRINT AT 16,4;"PROGRAM OPTI
ONS";AT 17,4;"T-TEACH   S-SPEED";
AT 18,4;"E-TEST     D-DELAY";AT 19
,4;"B-SAVE"
325 PRINT AT 21,0;B$;AT 21,4;">
>PRESS OPTION KEY<<"
330 LET A$=INKEY$
335 GOTO 330+470*(A$="T")+630*(
A$="E")+70*(A$="B")+40*(A$="D")+
10*(A$="S")
340 PRINT AT 21,0;B$;AT 21,4;">
>ENTER NEW SPEED<<"
345 INPUT A$
350 IF A$="" OR A$<"1" OR A$(1)
>"9" THEN GOTO 345
355 LET S=VAL A$
360 PRINT AT 4,18;"  ";AT 4,18;
S
365 GOTO 325
370 PRINT AT 21,0;B$;AT 21,4;">
>ENTER NEW DELAY<<"
375 INPUT A$
380 IF A$="" OR A$<"1" OR A$>"9
" THEN GOTO 375
385 LET D=VAL A$
390 PRINT AT 5,18;D
395 GOTO 325
400 PRINT AT 21,4;">>SAVE CURRE
NT LESSON<<"
405 POKE 16628,S
410 POKE 16629,D
415 POKE 16630,F
420 POKE 16631,LS
425 LET WAIT=RND**RND**RND
430 PRINT AT 21,0;B$;AT 21,4;">
>START TAPE,ANY KEY<<"
435 LET A$=INKEY$
440 IF A$="" THEN GOTO 435
445 SAVE "LESSON"
450 RUN
500 CLS
510 SLOW
520 PRINT AT 1,5;"ERROR CHECKIN
G"
525 PRINT ,,"INPUT YOUR COPY AS
A STRING"
530 PRINT "<NEWLINE> ONLY IF NO
COPY"
535 PRINT "USE<SPACE>AS DONT KN
OW";AT 11,0;"ERRORS IN INVERSE V
IDEO"
540 INPUT A$
545 LET R=0
547 IF A$="" THEN LET A$="[illegible]
[illegible]"
548 PRINT AT 7,0;A$;AT 7,20;" [illegible]
[illegible]",,,
550 FOR X=1 TO 20
555 IF X>LEN A$ THEN GOTO 590
560 IF A$(X)=" " OR NOT CODE A$
(X)=A(X) THEN GOTO 590
570 PRINT A$(X);
575 LET R=R+1
580 GOTO 600
590 PRINT CHR$ (A(X)+128);
600 NEXT X
605 PRINT " [illegible]"
610 PRINT AT 13,0;"[illegible] SCORE ";R
"/20 [illegible]"
615 IF M$="E" THEN GOTO 635
620 PRINT AT 16,0;"""R"" REPEAT
GROUP (TEACH MODE)"
625 LET Q$=INKEY$
630 GOTO 635+295*(Q$="R")-10*(Q
$="")
635 PRINT AT 21,0;">>ANY KEY FO
R MAIN OPTION<<"
640 LET A$=INKEY$
670 IF A$="" THEN GOTO 640
680 GOTO 300
800 PRINT AT 21,0;">>TEACH-WHIC
H GROUP? (Z=QUIT)<<"
801 LET M$="T"
802 LET Q$=""
805 INPUT A$
807 IF A$="Z" THEN GOTO 325
810 IF CODE A$<29 OR CODE A$>40
THEN GOTO 805
815 GOSUB 1360
820 PRINT AT 21,0;B$;AT 21,4;">
>DEMONSTRATE? Y/N<<"
825 INPUT A$
830 IF A$="Y" THEN GOTO 845
835 IF A$<>"N" THEN GOTO 825
840 GOTO 930
845 LET Y=F
850 LET P(1)=PEEK (16555+Y)
855 LET A(1)=PEEK (16591+Y)
860 LET RET=1
865 LET C=1
870 LET OLDS=S
875 PRINT AT 21,2;">>THIS IS ";
CHR$ (A(1)+128);" ANY KEY TO HEA
R<<"
880 LET A$=INKEY$
885 GOTO 890-10*(A$="")
890 LET S=6
894 FAST
895 GOSUB 85
896 SLOW
900 PRINT AT 21,0;B$;AT 21,4;">
>AGAIN? Y/N<<"
905 INPUT A$
910 IF A$="Y" THEN GOTO 875
915 LET Y=Y+1
920 IF Y>LS THEN GOTO 930
925 GOTO 850
930 PRINT AT 21,0;B$;AT 21,4;">
>ANY KEY FOR LESSON<<"
935 LET A$=INKEY$
940 IF A$="" THEN GOTO 935
945 LET S=OLDS
950 LET RET=0
955 GOTO 20+35*(Q$="R")
960 RAND
962 LET Q$=""
965 LET M$="E"
970 PRINT AT 21,0;B$;AT 21,4;">
>EXAM MODE<<"
975 LET A=(INT (RND*12)+1)
980 LET A$=CHR$ (A+28)
985 GOSUB 1360
990 LET WAIT=RND**RND**RND
995 PRINT AT 21,0;B$;AT 21,4;">
>ANY KEY FOR TEST<<"
1000 LET A$=INKEY$
1005 IF A$="" THEN GOTO 1000
1010 LET RET=0
1015 GOTO 20
1360 LET O=CODE A$-28
1365 LET O$="[illegible]$:)>+-,.34£
8,.8,"
1370 LET F=CODE O$(2*O-1)
1375 LET LS=CODE O$(2*O)
1380 IF F=139 THEN LET F=11
1385 POKE 16632,O
1390 LET LINE=8+1*(O<3)+2*(O=3 O
R O=4)+3*(O=5 OR O=6)+4*(O=7 OR
O=8)+5*(O=9 OR O=10)+6*(O>10)
1395 LET COL=3+12*(2*(INT (O/2))
=O)
1397 PRINT AT OLDLINE,OLDCOL;" "
1400 PRINT AT LINE,COL;"■"
1405 LET OLDLINE=LINE
1410 LET OLDCOL=COL
1415 RETURN
```

Metrewave

Our regular VHF column

By Jack Hum G5UM

Cast your mind back to a couple of phrases which appeared in the last *METRE WAVE*.

One of those talked about today's "...enormous aggregate of VHF and UHF operators". The other invited the reader to "...look at a half-wave aerial rod" for UHF and went on to suggest that it was so apparently insignificant a thing that it would never but never on its own get you places on the air. Although *dis*connected from one another by several intervening paragraphs of typematter they were by no means *un*connected. It is the purpose of the present instalment to show you why.

Well, then, what *is* the connection? Let us take a more detailed look. In the last article we analysed the tremendous proliferation of Class B licences which had occurred over the last year or two or three, and we made the observation that more than a third of the pages in the current *RSGB Callbook* are now taken up with them. That is a very sizeable proportion of the totality of today's UK ham fraternity — and here's the rub: every bone of them is a metre-wave person (you need to be careful not to say "metre-wave man": there are a lot of metre-wave YFs and YLs around these days).

What we see today, then, is a vastly increased and increasing body of enthusiastic VHF/UHF people attempting to cram themselves into a by no means increasing amount of frequency space on 2m (and to a lesser extent on 70cm). Our bands, prescribed by international edict, are finite in size, but the number of licensed amateurs wishing to use them certainly is not. Does the future hold the prospect of insupportable over-crowding in the metre-wave spectrum? To answer this question we need to traverse some of the past history of that spectrum.

Way back, before the arrival of today's "black box" era with its plenitude of rigs, to choose from a plenitude of suppliers, you were compelled to build everything yourself if you wished to get going on the metre-wavebands. Valves were *de rigeur*. What few transistors that were around were essentially 'HF devices', if even that. Then came two highly significant and related developments in the Sixties that slowly but irrevocably changed the face of the metre-wave scene as it had been perceived up to that time.

One of these developments was the enthusiasm with which mobile operating was taken up. The other — a few years later — was the arrival of Britain's first 145MHz repeater station.

Enter verticality

Mobile operation was slow to develop for the one practical reason that it was rather thirsty! The transceivers of the Fifties and early Sixties were perforce 'valvular' ones: transistor development had not at that time taken in the 'very highs'. And of course all-valve rigs were thirsty rigs, requiring a supply of several amperes from the vehicle battery as their power source. It was not unknown for the well-heeled radio ham to buy a small AC generator to carry about in the vehicle, generally in the boot — with adequate exhaust facilities! — to obviate his reliance on the car battery as a power source for his transceiver.

Needless to say, the arrival of transistors with VHF capability — at first receiving ones, but transmitting ones not long after — effected a revolution in the convenience (and consumption) of 'going mobile'. Out went the big bulky uneconomic valve transceivers: in came their transistor successors, modest in their square footage and peak amperage — and of course in their weight, by contrast to the old valve equipments with their call on well developed biceps when they were lifted in or out of motor cars, not to mention their call on the capacity of car battery.

Even before the transistor revolution the concept of VHF mobile operation had so caught the imagination of the metre-wave fraternity that by the mid-Sixties something like 2,000 British hams were active in this mode — and their numbers are known for the good reason that separate "Stroke M" licence was required in those days before The transmitting licence was consolidated into its present form that allows home based or mobile or portable operation at no extra charge.

Recognising that all metre-wave antennas at that time were disposed in the horizontal plane, mobile operators at first arranged their vehicle antennas to be compatible, generally by means of a halo horizontally orientated. It did not take long to discover that mechanical convenience in fitting an antenna to a vehicle was better served if the device were vertical rather than horizontal. Thus began the trend twoards 'verticality for vehicles' which is with us today.

That, then, was the first of the two related developments of the Sixties that so changed the metre-wave scene.

The second was the evolution of the repeater station concept from the pioneer work done by several 'professional hams' at the Pye establishment at Cambridge. From their prototype came the proliferation of repeater stations which now cover the country on both 2m and 70cm.

A repeater's *raison d'etre* is to enable disadvantaged operators like those in motor cars to talk with their fellows on VHF when otherwise they could not do so. And because repeaters were (are) vehicle-directed it was natural that their antennas should be polarization-compatible with the antennas on the vehicles they were intended to talk to. That meant vertical.

Today tens of thousands of

mobile operators on the metre-waves bless the day when repeaters were invented ("invented" in a manner of speaking: they were developed slowly but deliberately if only on account of the entirely new ground they were breaking and the entirely new technology they were deploying).

But those tens of thousands of *fixed*-station operators on the metre-waves detected (if they were at all observant) a deleterious trend behind all this. Because the mobiles and the repeaters went vertical, very many fixed stations did so too, installing at their home stations vertical omni-directional antennas either on grounds of cost, or "it's the thing to do... everybody else does", or for sheer failure to take thought of the consequences.

...and the consequence was

It is as well to spend a few moments considering what these consequences are. In the first place an omni-directional antenna at the home site radiates its power in all directions instead of solely in the wanted one. Secondly, the operator in the wanted direction receives a poorer signal from an omni than he would from a directional skyhook: any reader of any VHF textbook will know that the ERP (effective radiated power) from a directional antenna must be immensely greater than from an omni (postulating the same amount of RF applied at the base of each respective feeder).

But thirdly, and probably most important of all, the use of an omni on the 2m band may be regarded in today's conditions of increasing congestion as being positively anti-social. Granted that if you use a simple beam the man in the next suburb or the next village will still be able to detect your signal; but it will be much attenuated to him by contrast with how it would sound if it were coming off an omnidirectional system. And you will contributing to the orderliness of the band — and adding to the pleasure of others who wish to use — by reducing the size of your signal in all *un*wanted directions and increasing it in the *wanted* ones.

There is one circumstance where omni-verticals come into their own at a fixed site (if readers can think of any others your scribe will print them here). This circumstance is *net operation*, where a scatter of stations at random QRBs (remember?) and bearings from one another wish to talk together. Then the use of an omni is inescapable. What might be added is that nets should preferably conducted in a clear part of the 2m band, say below 144.9MHz, and never but never through repeaters.

Getting oneself directional

The reader who accepts the thesis that it is a good thing to put one's signal where one wants it to go, rather than to scatter it wastefully, will by now be cogitating how best to go about achieving this desirable condition.

To riffle through the numerous antenna designs offered by the media and the ham radio textbooks may throw him into a state of such confusion that he will end up by thinking "Oh, it's all too difficult...let's stick to the omni with all its faults". Understandable — but unforgivable, because (a) he is abrogating his responsibilities to his amateur community by inflicting on them a QRM level that would be abated if he 'went directional', and (b) the world's simplest but most effective directional antenna may be his for the asking — or at least for the making, should he so choose. It is ... guess, wait for it, *a common or garden Yagi.*

Didn't Mister Yagi evolve his first antenna way back in the Twenties when its possibilities for metre-wave applications went unrealised simply because the state of the electronic art was too rudimentary in those days (come to that, there was no electronic art: the word 'electronics' hadn't been born)? Answer to question. Yes, he did. And hasn't the Yagi design proved itself to be easily the most popular of any, despite fashionable upstarts that attempt to deny its virtues from time to time? Answer to that one: Again, yes.

How do we know? What support can we offer for what many may read as a somewhat dogmatic utterance? Answer: Look at any housetop, spot the colour-television antenna, remind yourself that the TV aerial industry with its task of catching uhf signals for twelve million homes, almost overwhelmingly uses the

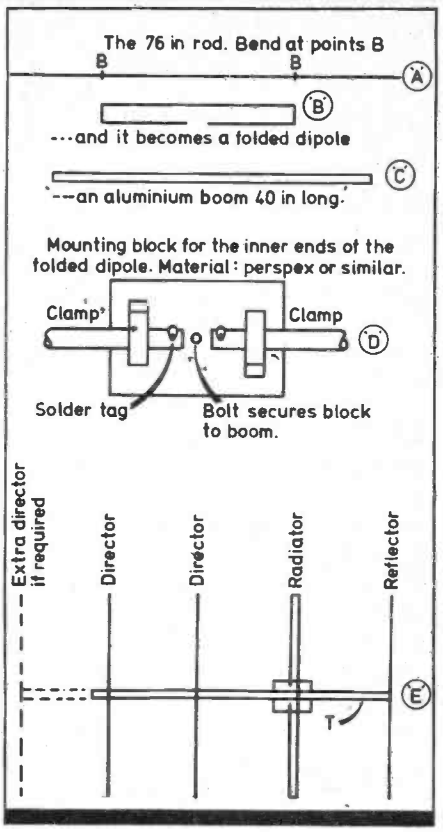


Fig 1 showing the construction of a basic Yagi antenna for 145MHz.

At "A" the 76" aluminium rod, its ends to be bend inwards at Points B.

At "B", how the single rod becomes a folded dipole.

At "C", an aluminium boom 1", diameter will be 40" long for a three-element Yagi 58" for a four-element, or 76" for a five-element, spacing between each element 19".

At "D", a flat block of insulant such as perspex or similar accepts each of the bent back ends of the folded dipole. It is firmly bolted to the main boom. The inner conductor and the outer braid of the coaxial feeder cable are soldered to the tags mounted at the inner ends of the folded dipole; the cable is then taped to the main boom.

At "E", the finished antenna. The feeder cable is to be taped to the main boom at "T" to avoid pulling stresses.

Answers to Practice RAE

Paper 1

1 d, 2 b, 3 a, 4 b, 5 d, 6 c, 7 a, 8 a, 9 b, 10 c.

Paper 2

1 d, 2 a, 3 d, 4 b, 5 c, 6 c, 7 c, 8 a, 9 d, 10 g, 11 a, 12 b, 13 b, 14 d, 15 c.

Yagi design for its products. So it ought to be good enough for those of us in the ham radio fraternity.

Assuming it is (and write in and say if it isn't!) let us address ourselves in more detail to the above mentioned "...world's simplest directional antenna" to see what service it is capable of giving on the 2m and the 70cm bands.

First of all we shall need some dimensions. Let us start with those for the 144-146MHz band, accepting that this is where most home-built Yagis will be required. These dimensions lodge in the brain like one's motor car number or telephone number — or even like those dimensions you see displayed on a fashion page (if you ever read a fashion page) and they go like this: 36-38-40 inches. If that sounds a strange contour for a fashion page it is the ideal contour for a ham-built aerial.

"But there must be more to it than that?" you the reader may be excused for asking. There is, of course. The dimension of 38″ is basic to 2m. It is the length of a half wave dipole. Double it to 76″ and you have the dimensions of a folded dipole: to fashion it into one you simply bend it so that the top section is 38″ long and the two other half sections come round to meet one another below it... well, not quite to meet one another; the two remote ends, now bent round almost to touch one another, are the feed point for you coaxial cable. **Figure 1** makes this clear. An insulated connection block is provided at this point.

The reader's next intelligent question will be: But what impedance of feeder cable? Fifty ohms, 75 ohms or what? Answer: whatever you like! By narrowing or widening space between the two limbs of your folded dipole you can persuade it to match into a variety of impedances.

In practice, almost certainly the constructor will be wishing to connect a length of the popular 50-ohm coaxial into his intended design of antenna. He will find that the folded dipole on its own will not like it; feed it in to a VHF transmitter and the latter will promptly shut itself down via the protection devices at its antenna output, simply because it is looking at an anomalous impedance.

'Electronic searchlight'

This, though, is but the first stage. The object of the exercise is to evolve a directional antenna, and **Stage 1** in this process is the bending up job. **Stage 2** is to mount the folded dipole at the centre point of an aluminium boom 40″ long and to bolt a solder-tag to each of its inner ends to accept the feeder cable connection. **Stage 3** is to mount a single unbroken rod 40″ long at one end of the boom and an unbroken rod of 36″ at the other end. Space all three elements by 19″ apart, and hey presto, the thing is beginning to look like one of those familiar rooftop TV aerials, only a bit bigger.

You now have a three-element Yagi ready to radiate just as soon as you have connected your feeder run to those two solder tags.

It is all so easy as to persuade the sceptical reader to ask: "There must be a catch in it somewhere". There is — but only a mild one. It is the final matching of the assembly to the transceiver into which it is to work. You already know how to do this: you were told above. You simply compress or strech the space between the folded dipole rods until the transceiver feeding the assembly delivers power into it without shutting down.

To perform this operation mount the antenna in the clear on, say, a temporary lowdown mast in the backyard where it will be accessible for adjustment. It should not fire into nearby obstructions: these can produce anomalous results. It would be somewhat frustrating to have adjusted the dipole element for what looked like optimum results at head height only to find that it was far from optimum at house height!

What we have talked about up to this point is the most basic three-element Yagi of all. To secure more gain from it, add another 36″ rod ahead of your existing 36″ director, or even a 35″ rod ahead of that, to make it into a 5-element Yagi. Spacing each time will be 19″, which means that you need to provide a boom 76″ long, ie, a quarter wavelength spacing between each element, if you go for the 'five elly'.

You will notice that from these tapering dimensions directors get smaller the further away they are from the active folded dipole element, where it all starts. Visualise the whole structure as an electronic searchlight with the folded dipole at the focus of the 'mirror'. The 'reflector' of the mirror is our 40″ rod reflector of the assembly.

Rods, rods... where to get them from? Aluminium curtain rail from your D-I-Y shop works excellently. Much cheaper is redundant TV aerial stock which may be bought (or even cadged) from television aerial installers whose names are to be found in any Yellow Pages or Thomson's Local Trade Directory. They often have a lot of it in their backyards recovered from ancient Band 1 and Band 3 405-line antennas.

If you *do* obtain your antenna materials other than new, be sure to give them a thorough furbishing, for two reasons: first, that RF power skates more readily along a smooth surface than along a corroded one; and secondly that if electrical contact between the various metallic surfaces of your aerial is not perfect then you are in effect interposing a small resistor between the joints. Remember, aluminium corrodes rapidly. Particularly at the point where you have affixed those solder tags to the radiating element do not fail to file and to polish clean before you bolt them finally to the inner ends of the folded dipole.

And so to the eventual evaluation of your electronic searchlight. The first thing you will need to ask yourself is: "Shall I mount it vertically or horizontally?". The question virtually answers itself: if the antenna is to be used for the FM traffic that dominates the 2m scene today then mount it vertically to render it reciprocal with the polarization employed by mobiles and by the 2m repeater chain.

But suppose you wish to try your arm at DX working in the lower half of the 2m band? In that area you will require horizontal polarization for long distance communication on both FM and on SSB — and indeed to CW if you are a Class A licensee who enjoys the winkling-out which may be done below 144.15MHz.

If, then, you wish to have the best of both worlds — and they *are* two worlds on 'Two' these days — you will need to build yourself two antennas, one disposed vertically and the other horizontally. If that represents too forbidding an undertaking, and if the pocket will stretch to it, purchase one of the excellent professionally-designed crossed

Yagis which advertisers in this journal can offer you.

Straight up, then...

An important factor to emphasize to those constructors who propose to erect a vertical Yagi for VHF/UHF is: Do not mount it on a metal mast. Remember that its own elements are vertical. Any unrelated vertical object in its vicinity will affect its field strength lobe and probably its performance.

Here are practical solutions to this problem:

Obtain a length of non-conducting material such as a plastic waterpipe. Clamp its lower end to the station mast. Clamp the new-built antenna to its upper end. If the non-conducting section can be 4 to 5' long, so much the better, to clear the antenna limbs from any metal vertically.

By now, having mated up Yagi with non-metallic sub-mast into main mast the constructor will next turn his attention to methods of rotating that little lot. It is not difficult. As with professionally made antennas, there are professionally made rotating systems advertised in this magazine in profusion. Choose one that best suits your station circumstances. You may prefer to place the rotator at the base of the mast to keep it accessible in case it should go wrong: it will need to be strong enough to turn the mast and all that on it dwells.

But you may prefer to site the rotator up the mast. If you do, be sure that mast and fittings (and any chimney stack related thereto) will withstand the worst likely windage to be expected on the site.

Please do not think that your scribe has dismissed the subject of rotation in too summary a fashion. It is of great importance; but because it introduces mechanical complexities (by constrast with the relatively 'easy' electronic complexities of the antenna itself) there may be many readers who at this point say: "I don't think I can tackle this one".

If this should be the case why not offer up "antennas, directional, and their rotation" as a continuing project to be tackled by the local club? (And if there is not a local club then form one! Where twelve good men and true are gathered together, plus a few YL/YF operators, a club may readily be distilled from the combined enthusiasm).

Club antenna projects can embrace not only the solving of mechanical problems but also the provisioning of motors and of course the metal rod and tubing that makes up the member's own individual antenna system. Even planning permission aspects may be better tackled with a dozen heads bent towards them than with a single one . . . "in the silence of my lonely room".

Three times down

All of the foregoing applies as much to ' the next band up' , meaning 70cm, as it does to 'Two'. All you need to do to build yourself an antenna for 433MHz is to divide the dimensions given above by a factor of three, and lo, you are go on a band which to many is more fascinating in a variety of ways than 'Two' — and much less crowded (at present!).

One of the many charms of 433MHz is that an antenna built for it, being three times smaller than its 2m counterpart, is that much lighter to turn, and that much less conspicous. (If this consideration should be relevant, as it is in some urban localities). But never forget to fit good low loss coaxial cable to your 70cm antenna, eg, UR67 or equivalent. Television coaxial gives results — but good coaxial is a great improvement upon it.

But does a 70cm antenna *need* to be three times smaller than a 2m one? Consider these figures.

A boom length of 57" will accommodate four elements for a 145MHz Yagi, at the conventional spacing of 19" element-to-element; but — A boom length of 52" will accommodate nine elements for a 433MHz Yagi, at the conventional spacing of 6½ in element-to-element.

Clearly, for a given length of antenna the 70cm design will provide much greater gain than the 2m one, assuming constant power fed to the base of the feeder and identical feeder losses. We refuse to be drawn into *how much* more gain would be obtained (even some well respected textbooks refuse to dogmatise about antenna gains in actual figures, at VHF and UHF!). It is evident from the electrical size of the two designs under discussion that 70cm version shows up very well.

Yes, there are others

Should the reader think from the foregoing that there is rather too much concentration on Yagi designs and none at all on others, he would be quite right. The Yagi has been chosen as the subject of this piece simply because it is cheap, cheerful and chockful of easily-to-be-got gain. Equally important, it is almost self-matching (if built reasonably well).

Of the profusion of other designs of metre-wave antenna there is much in the current textbooks. Chapter 7 of the RSGB **VHF/ UHF Manual** is especially informative on the subject. Readers can (and should) pick and choose what design of 'skyhook' suits them best — and tell your contributor so that *your* findings may be reported here, for the benefit of others.

How's your SWR today?

Something else it is not proposed to discuss here in any detail is standing wave ratios. Since the advent of Japanese black boxes and (in the vernacular) the 'swer bridges" which are often sold with them, many a metre-wave user appears to have developed either an obsession or a nervous tick about ". . .my SWR".

Certainly it is desirable to reduce to a minimum the voltage reflected back down the feeder to the RF source. In practice, much worse standing wave ratios may be tolerated than many operators believe. Often, the station transceiver continues blithely to function without shutting itself down (as it would if the SWR were unacceptable), yet the operator views with alarm the apparent poor reading on his external 'swer meter'.

The true criterion of performance is the report offered up by one's distant QSO-partner. If your SWR goes up when the antenna is wet, and your signal at the other end goes down, there may be absolutely no connection between the two phenomena. When it's wet VHF conditions are usually poor — and that, rather than your SWR, could be the cause of the signal reduction way out at Point X.

No, let us not be too traumatic about 'old man swer'. He may not always be telling you the truth. Let him be your servant, not your master!

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NEW PRODUCTS

Datong v Woodpecker

Datong Electronics Ltd. is developing a self-synchronising noise blanker to remove 'Woodpecker' interference pulses.

Dr. David Tong told *Ham Radio Today* that he got the idea when he first saw the AEA *Moscow Muffler* (reviewed in this issue) and decided there was a market for an automatic 'Muffler'.

Dr. Tong has a working prototype, and hopes to have the unit in full production in a few weeks.

The device connects in series with both the aerial and loudspeaker of a receiver or transceiver and is completely automatic. Not only does the unit synchronise itself to the Woodpecker pulses, but adjusts its own blanking width to match that of the particular Woodpecker. What's more, it can deal with more than one Woodpecker at a time!

The only adjustment needed by the operator is to select the pulse repetition frequency (10 or 16Hz).

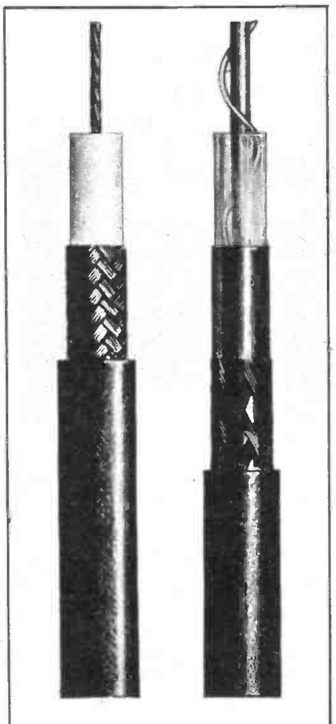
The unit is housed in an extruded aluminium case, size 150 × 90 × 42mm. Further details from Datong Ltd., Spence Mills, Mill Lane, Bramley, Leeds LS13 3HE. Tel 0532 552461

Cheap UHF coax

A new 50 ohm cable looks like being good news for microwave enthusiasts, offering low loss at a reasonable price. The new cable, made by the Pope company in Holland, is called *H100*, and is designed to bridge the gap between braided types such as RG213/UR67 and the more expensive solid-copper types such as Andrew *LDF4/50*.

Originally designed for the 934MHz Citizens' Band, the supplier claims it is useful for all bands between 144 and 1296MHz. The attenuation figures per 100 metres are: 2.2dB at 28MHz; 5.5dB at 144MHz; 9.1dB at 432MHz and 15dB at 1296MHz. Comparable figures for RG213 are 3.6dB; 8.5dB; 15.8dB; and 31dB respectively. The cable is slightly lighter in weight than RG213 yet will handle more power, and fits ordinary PL259 or N type plugs.

The importer, W.H. Westlake of Devon, says the only disadvantage of *H100* is a bending radius of 150mm, compared to RG213's radius of 100mm. They charge 80



RG213 H100

pence per metre, with discounts for lengths of 50m or more, compared to 50 pence per metre for small quantities of UR67. W.H. Westlake, Clawton, Holsworthy, Devon.

Trapped dipoles

There are several new trapped dipoles being added to the range of 'Anti-TVI' aerials produced by G2DYM Aerials of Tiverton, Devon. At the top of the range is a dipole with no less than four pairs of traps, providing half-wave resonance on the 3.5, 7, 14, 21 and 28MHz bands. As the aerial is fed with 75 ohm *balanced* feeder, it can also easily be matched to 50 ohms on the 10, 18 and 24MHz amateur bands with an ATU. The aerial can also be used as a Marconi-T vertical, fed against earth, on the 1.81MHz band. This aerial has a power rating of 1000 Watts.

Other aerials in the range offer a combination of various bands, and the ability to fit into a reduced space by using 'tails', ie. vertical sections hanging from each end insulator.

Also in the range is a new *trapped unipole,* with various combinations of bands and numbers of traps available. These are trapped end-fed wires, designed to be loaded against earth or (preferably) radials.

Details from G2DYM Aerials, Cobhamden Castle, Uplowman, Nr. Tiverton, Devon. Tel 03986 215

Stick-on screening

Adding internal screens to homebrew equipment can be a bit difficult if the equipment has already been built and extra screening is then found necessary! RFI Shielding Limited have brought out a self-adhesive foil that could solve this and many other problems. *Alumashield* consists of a 0.04mm thick aluminium foil which is laminated to a 1.5mm thick layer of PVC foam. The self-adhesive glue is protected by backing paper.

The maker claims that as well as screening otherwise unprotected enclosures, *Alumashield* can be used with printed circuit boards to provide a mounting pressure pad as well as shielding.

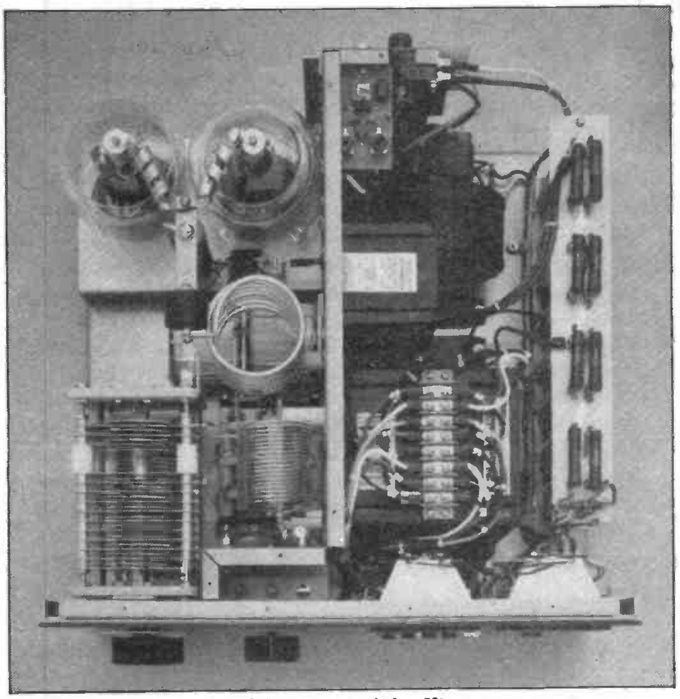
RFI Shielding Ltd. says another application is lining the inside of inspection covers of individually screened modular equipment. "In this application *Alumashield* provides a good electrical contact between the cover and the inter-stage screening dividers within each compartment. When the cover is screwed down the dividers sink into the material and the resilience of the foam takes up any distortion in either the cover or the dividers."

Alumashield is also available with copper or tinned copper foil. The tinned copper variety looks like being the most useful to amateurs because it can be soldered easily, and because it is available in 300 × 900mm sheets for approximately £5, whereas the smallest sheet of the aluminium sort is 1m square, costing about £14. RFI Ltd. says it's willing to supply amateurs with single sheets. More details are available from John Collins of RFI Shielding Ltd., Warner Drive, Springwood Industrial Estate, Rayne Road, Braintree, Essex CM7 7YW. Tel Braintree (STD 0376) 42626

Luxuries

This gadget would look good on the licence application form – you know, the bit where they ask you how you intend to check you're not churning out horrible sproggies. The Ando *AC-8211* RF spectrum analyser will measure anything between 100kHz and 1700MHz, from −110 to +20dBm. It will display signals with a bandwidth of between 100MHz and 20kHz per horizontal division.

Here's the rub. It costs £4,350. And here's another rub. The VAT is an extra £652.50! Don't ring us, ring Aspen Electronics Ltd., 2/3 Kildare Close, Eastcote, Ruislip, Middlesex HA4 9UR. Tel 01-868 1188. Better ring your bank manager as well.



PT2000A HF linear amplifier, part of the Viewstar range

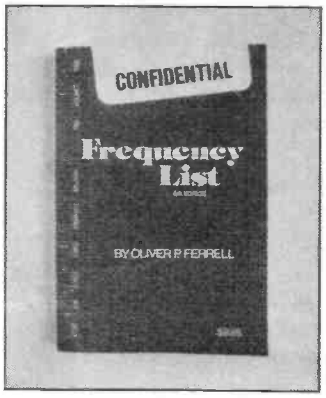
Dealers' chance

Viewstar Inc. is a Canadian company which manufactures amateur radio equipment for the North American market, and is now looking for distributors in the UK and Western Europe. Viewstar products include HF linear amplifiers, ATUs and filters.

Interested emporiums (emporia?) can contact Viewstar's Marketing Representative, Harold M. Stevens, at 705 Progress Ave., Unit 53, Scarborough, Ont. M1H 2X1, Canada. Telex (21) 065-26242 VIEWSTAR TOR

BOOKS

Spies' bible



The *Confidential Frequency List* is a fascinating catalogue of all those signals between the HF amateur and broadcasting bands that you're not supposed to listen to.

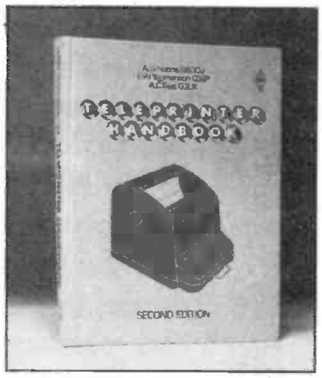
The book is based on the list of transmitters notified to the ITU's International Frequency Registration Board by individual governments, with the gaps filled in by a lot of less orthodox sources. The author and his 'collaborators' claim to regularly listen in to aeronautical, maritime, diplomatic and military channels. These operate in CW, SSB, AM, RTTY, FAX and TOR (coded Telex On Radio) modes, amongst others.

As well as listing everything heard in frequency order, this edition (5th) includes a *Confidential Callsign List*. By making intelligent guesses at likely callsigns, it's possible to find the frequency of almost anything. For instance, the callsign of the US President's plane, Air Force One, is, believe it or not, AF1! Another source of endless fascination is the HF telephone links to the Falkland Islands. Amateur stations there use the prefix VP8. By working on the principle that 'official' stations use similar prefixes to amateur ones, it doesn't take long to discover that the callsigns of the Falklands' links are VPC and VPC24. The list then gives the frequencies as 13.482, 19.950 and 24.145MHz. Great fun.

The Home Office points out that it is an offence under Section 5 of the Wireless Telegraphy Act 1949 to listen in to such transmissions deliberately, or to divulge any information gained if you do.

The book is imported by Amateur Radio Exchange and costs £7.80. I wonder how much that is in Roubles.

Teleprinter Handbook



This book, now available in its 2nd edition, is a comprehensive guide to the theory and practice of amateur RTTY, and is very valuable for anyone seriously interested in this mode of operation.

The book includes a 156-page chapter on teleprinters, which gives system descriptions and maintenance information for several commercial European and American machines. Other useful RTTY equipment, including test gear is described in detail elsewhere in the book, and there are designs for home-constructed equipment.

This book is a hardback, and contains hundreds of diagrams and close-up pictures.

The chapter titles are: Basic telegraph transmission theory (based on a British Telecom training pamphlet of the same name); Teleprinters; Other RTTY machines; Power supplies; Demodulators; Polarised relays; Keying methods; Filters; Test equipment; A video display unit; The Hellschreiber system; Control systems; The RTTY station; Operating procedures. There are also three appendices giving a glossary of commercial equipment, terminology and data.

The book concentrates on the more traditional Baudot RTTY techniques – there is little on more modern systems involving home computers, dot-matrix printers, ASCII or AMTOR for example. There is, however, a new chapter featuring a DIY video display unit designed by Peter Martinez G3PLX. This circuit, based on 74-series TTL, was featured in *Radio Communication* in 1977.

The *Teleprinter Handbook* is available from the RSGB and costs £12.00, or £13.84 by post.

The Moscow Muffler Reviewed

No, this isn't a device for squelching out Radio Moscow on 7MHz, or even an ICBM complex description. It is Advanced Electronic Application's (AEA) latest box of tricks for dealing with the phenomena which has earned the nickname of the 'Woodpecker', and which causes so much aggravation on the higher frequency bands. It fits in the antenna lead of your transceiver, so doesn't need any modification to the circuitry. And it works!

by Tony Bailey G3WPO

The characteristic rattle of pulses from the over-the-horizon radar system sounding like a woodpecker at work, is now familiar to all HF operators, especially those who inhabit 20 & 15 metres. At times the strength can be well over S9, which prevents virtually any reception while it lasts, especially if your AGC has a fairly long time constant.

The origin of these signals is primarily from two sources — one in European USSR (Kiev region) and at least one other further East somewhere near Siberia. They are used for long range military purposes, to obtain early warning of moving objects in the shape of ICBM's, by reflection from the ionosphere — all this is denied of course, but they are there all the same. With reputed power outputs of 4 Megawatts it is not difficult to see why so much havoc is caused.

The frequency coverage of the transmissions is around 10-30MHz, and the signals appear to follow the MUF (Maximum Usable Frequency) up and down the spectrum — there is also quite often more than one transmission being radiated at a time. With a bandwidth of around 50kHz and the pulse repetition frequency usually 10Hz (although sometimes 16Hz or even higher), and the pulse width typically 15 S, the interference is difficult to blank on a communications receiver, as it is very different to the type of interference that most noise blankers were designed to overcome.

Conventional noise blankers

Most modern transceivers have a noise blanker facility, sometimes with adjustable threshold, or, in the latest models, with adjustable blanking width. These are primarily designed to eliminate man-made interference, typically pulse-type ignition noise. This type of interference has high amplitude, with a very short rise time and fairly short duration — around 500 microseconds or less.

These pulses are amplified early on in the receiver chain, typically straight after the first mixer and before any filtering, by an amplifier which looks for these fast rising, short duration pulses. They are used to generate a control signal which is applied to a gate that shuts off the signal path, which has had a slight delay applied to it, for the duration of the pulse. With most modern blankers, the elimination of the interference is very effective; for most of the time it is practically inaudible to the user, because the ear ignores the very short silenced periods.

However, the normal noise blanker cannot cope effectively with the Woodpecker, as the pulses are very much longer, and the received pulses do not look much different to a strong signal as far as the detecting circuitry is concerned (they don't have a very fast rise time). The individual pulses are also themselves composed of further pulses of varying amplitude, and some of these may not be of sufficient strength to actuate the blanking amplifier unless it is of very high gain. Hence, although some of the interference will be suppressed, a lot will still be left.

The AEA solution

A number of different answers have appeared over the past few years in efforts to get over this problem, some of which have proved very effective. Unfortunately, one of the best requires significant alterations to existing receiver circuitry which may not appeal to everyone. The AEA *Moscow Muffler* is an attempt at providing the solution as an in-line device between the receiver (or transceiver) and the antenna, thus removing the need for any modifications.

The only paperwork supplied by AEA is a three-page instruction sheet on how to use the device, but with no circuit details, so the following notes are derived from a delve inside the box. The principle behind it is that of the 'Synchronous Blanker', described a while back by VK1DN in the American magazine, *Ham Radio*.

All previously described blankers aimed at getting rid of this phenomena use the fact that the Woodpecker signal consists of very strong, evenly spaced pulses, and these are used to generate blanking pulses in the normal way, but of much longer duration than before. Some of the latest transceivers have variable width blanking controls (such as the FT102, reviewed in the February issue) for this very purpose.

The *Moscow Muffler* uses another principle — the pulse repetition frequency (PRF) is very accurate, to a tolerance in the region of 10ppm, as is the duration for any given Woodpecker signal. Hence, if we generate a crystal derived 10Hz (or 16Hz) signal, and then phase-shift it to synchronise with the received Woodpecker signal, after introducing a delay in the received signal path, we should have an excellent control signal for the blanking gate. All this is done at signal frequency, with the gate being an SRA-1 Shottky wideband double balanced mixer.

This has considerable advantages over trying to do it all at AF, which is the alternative for an add-on unit. At AF the Woodpecker signal will still actuate the AGC, and if it is very strong the blanker may not be of much help as a result.

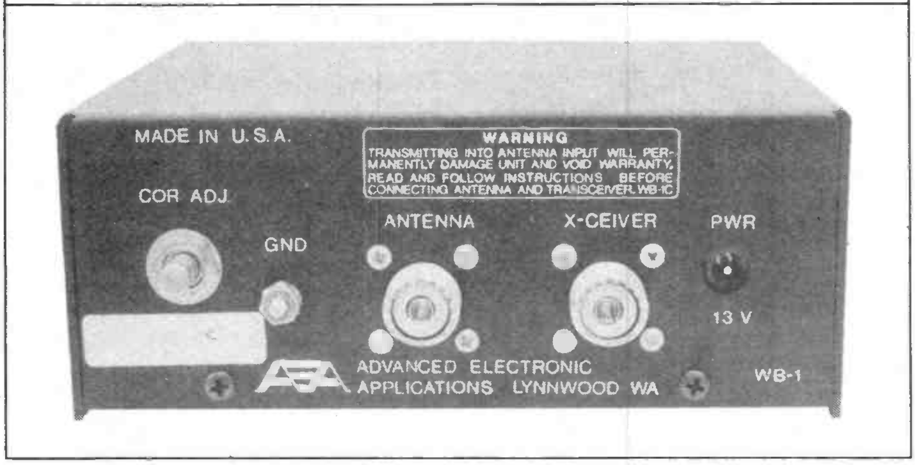
Controls

The synchronisation is carried out manually from a front panel control, in conjunction with a blanking width control. Four other pushbuttons are provided, for Power on/off, Blanker ON, or Standby, and 10Hz or 16Hz repetition rate. The last pushbutton provides an additional wideband preamplifier for 6dB gain when on, or 0dB when off. A red LED indicates when power is applied to the device. It is supplied from an external 12V source, at approximately 600mA, most of which is used to power the changeover relay which bypasses the circuitry on transmit — this uses RF sensing so it does not need any PTT-line connection to the transceiver. The relay is normally energised on receive.

The model reviewed is the *WB-1C,* which has the COR (carrier operated relay) facility, but there is also a *WB-1* which has no relay and is intended for receive applications only, or transmit applications with external transmit bypassing. The instructions do warn that serious damage will result if the transmitter is connected to the wrong socket on the back, so do read these carefully!

The rear panel carries the two SO239 sockets (antenna and transceiver), a variable pot to set the COR drop-out time, and the coaxial DC power connector.

Inside, the unit is well made, with a screened double-sided, through-plated PCB, with the component numbers screened on (useful if only we had the circuit!) A 74LS divider chain running from a 4MHz crystal provides the 10 or 16Hz signals. The case is very robust, and should withstand rough handling.



In use

The instructions are fairly comprehensive on how to set up and use the unit, but as is often the case, actually using it is easier than trying to describe it! When the Woodpecker appears, the blanker is switched on, with the WIDTH control set to about the two o'clock position. The SYNCH control is then adjusted until the interference disappears. The WIDTH is then reduced to the minimum possible, while re-adjusting the SYNCH control. The PRF control, marked 'RATE', should normally be at 10Hz, but if blanking is only taking out a few of the pulses, then it probably needs to be set at 16Hz.

All this works just as described, used with a KW2000A transceiver, and the unit is capable of reducing the Woodpecker to inaudibility. The manual states 45-50dB of blanking is obtainable most of the time — in theory, this should reduce an S9 signal just to inaudability. There are conditions under which the degree of blanking will be reduced, such as when multi-path propagation is taking place. This results in delayed pulses arriving — the same effect will occur if two Woodpeckers are transmitting at the same time. Under these conditions the unit will only blank the set of pulses to which it is synchronise, although this can be overcome by increasing the blanking width.

Blanking the signal

Bear in mind though that the longer the blanking pulse, the less audio there will be available from the non-blanked period, and there rapidly comes a point when there is insufficient audio left to pass intelligence (at above roughly 25% blanked).

Of course, all the time we are blanking the fairly wide Woodpecker signal (10-20mS every 100mS) we are also removing 15% or so of the received signal. With SSB stations, the effect is that of very rapid flutter (at 10Hz) which doesn't make the signal unreadable, and is preferable to trying to listen with the Woodpecker pulses present. The overall result is usually a terrific increase in readability especially when the interference is very strong, with the unit completely killing the Woodpecker pulses, except with very weak signals, where readability does suffer somewhat.

On CW, things are rather worse. Depending on the width setting, the unit can have a disastrous effect on Morse signals, to the point of making them completely unreadable most of the time. The problem is of course that the unit makes no attempt at distinguishing between the Woodpecker pulses and CW, with the result that if the blanking width is at all high, the dots start to become blanked as well! At faster CW speeds, or wider settings, both dots and dashes become blanked. Of course, you have a choice — try to copy the whole signal with the Woodpecker blasting away, or try to copy less of the signal but with no Woodpecker.

It should be emphasised that most of the time, the blanking width can be reduced to its theoretical minimum, and under these conditions there is just a slight 10Hz 'pinging' effect on the signal which most people could cope with. If the incoming pulses are long and distorted, then the width has to be increased.

The other point is that you cannot really have the unit turned on while there is no interference present, unless you are prepared to listen to the 10Hz pulses modulating both the background noise and the wanted signal. The unit is of course running continuously, and this is the disadvantage of the *Moscow Muffler* over those blankers which use the incoming received pulses to generate the blanking pulse. The ear will respond much more favourably to periods of missing signal, than high intensity Woodpecker pulses, but this is only a practical advantage as long as the gaps are limited to the periods when the Woodpecker pulses would have been present.

Once the SYNC and WIDTH settings have been established at any point in time, the blanking is maintained over longish periods — as long as the Woodpecker signal doesn't change. Occasionally slight readjustment of the sync control is needed. During the period of the review, there were a fair number of transmissions at 16Hz as well as 10Hz.

The unit is well screened, and none of the digital signals present inside the unit got into the receiver. The COR system only needs a few watts of RF to switch correctly.

Summary

The *Moscow Muffler* is certainly a very effective unit and works as claimed by the manufacturer. If your existing transceiver or receiver has no effective facility for dealing specifically with the Woodpecker (it won't handle random type interference), then this AEA unit can be highly recommended, especially as it does not entail any adjustments or modifications to your existing rig.

It will eliminate the interfering pulses under nearly all conditions, but inevitably it has some blanking effect on the wanted signal as well. Unless the received pulses are very wide, this effect is tolerable — the overall result is usually a vast improvement in copy. Some care in adjusting the controls is needed for optimum results.

Thanks to ICS for loan of the unit. It costs £126 including VAT.

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144.4 (433.2)	b	e	b	e	e	b	e	e	e	e	e
144.800	e	e	e	e	e	c	c	c	e	c	e
144.825	e	e	e	e	e	e	e	e	e	e	e
144.850	e	e	e	e	e	e	e	e	e	e	e
145.000/R0T	a	c	a	c	c	b	e	b	e	a	c
145.025/R1T	a	c	a	e	e	b	e	b	e	e	e
145.050/R2T	a	c	a	e	e	b	e	b	e	e	e
145.075/R3T	a	c	a	e	e	b	e	b	e	e	e
145.100/R4T	a	c	a	e	e	b	e	b	e	e	e
145.125/R5T	a	c	a	e	e	b	e	b	e	e	e
145.150/R6T	a	c	a	e	e	b	e	b	e	e	e
145.175/R7T	a	c	a	e	e	b	e	b	e	e	e
145.200/R8R	a	c	a	e	e	b	b	b	a	e	c
145.300/S12	e	e	e	e	e	e	e	e	e	e	e
145.350/S14	e	e	e	e	e	e	e	e	e	e	e
145.400/S16	e	e	e	e	e	e	e	e	e	e	e
145.425/S17	e	e	e	e	e	e	e	e	e	e	e
145.450/S18	a	e	a	e	e	b	b	b	a	a	e
145.475/S19	a	e	a	e	e	b	b	b	a	a	e
145.500/S20	a	c	a	c	c	b	b	b	a	a	c
145.525/S21	a	c	a	c	c	b	b	b	a	a	c
145.550/S22	a	c	a	c	c	b	b	b	a	a	c
145.575/S23	a	c	a	c	c	b	b	b	a	a	c
145.600/R0R	a	c	a	c	c	e	b	b	a	a	c
145.625/R1R	e	e	e	c	c	e	b	e	a	a	c
145.650/R2R	e	e	e	c	c	e	b	e	a	a	c
145.675/R3R	e	e	e	c	c	e	b	e	a	a	c
145.700/R4R	e	e	e	c	c	e	b	e	a	a	c
145.725/R5R	e	e	e	e	c	e	b	e	a	a	c
145.750/R6R	e	e	e	c	c	e	b	e	a	a	c
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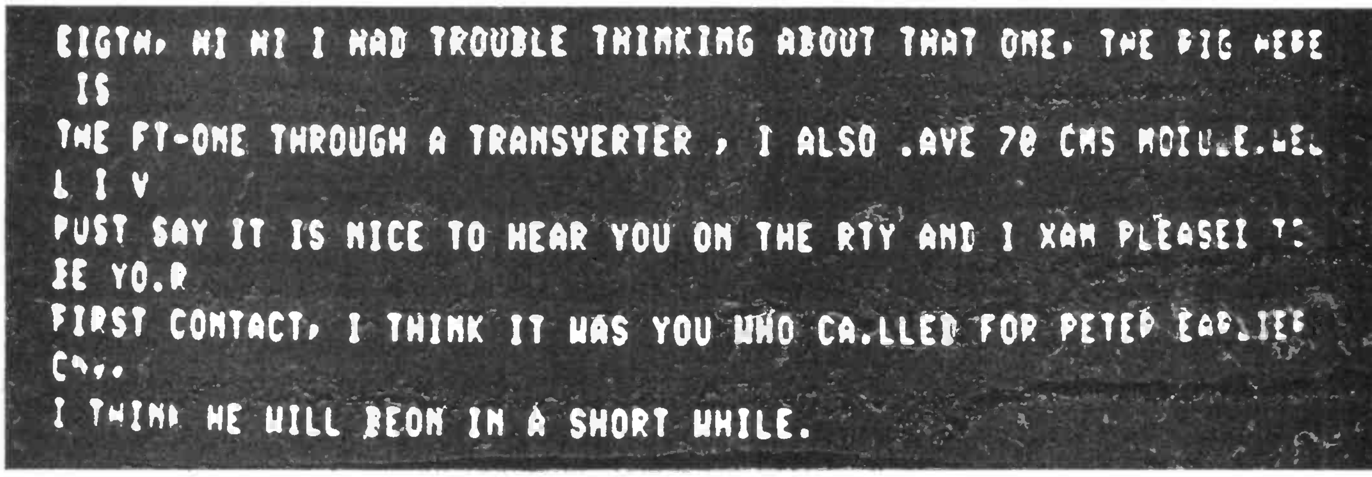
MM2001 RTTY Converter Review

By Peter Metcalfe G8DCZ



One cannot help but notice that over the past few years RTTY has increased in popularity, especially among newly licensed amateurs on the 2m band. Basically there are three ways to 'get going' in this mode, all three requiring some form of terminal unit (TU) to convert the signal into two separate tones. The difference comes with the display device:

1. The old tried and tested teleprinter, of which the most popular tends to be the Creed models *7B* and *7E*. This method has the advantage that the hardware is fairly cheap and readily available. However, there are problems in that teleprinters are very noisy and space consuming and therefore, this method is usually confined to the 'bottom of the garden' shack.

2. Microcomputer decoding and display, which is a most attractive method gaining in popularity over the past few years due to the availability of cheap 'personal' computers eg. *ZX81, UK101, PET* etc. As more and more of these machines find their way into the radio shack, amateurs are beginning to see their TU and some form of interface is available, all that is needed is a software package. This could be self-written (cost £0 but the time taken could be expensive!) or bought for many of the more popular machines. Another offshoot of this method is the use of ASCII code rather than BAUDOT or AMTOR and experimentation with higher data rates than the usual 45.5 baud. (Incidentally, the term 'BAUDOT' or sometimes 'MURRAY' are normally used, but strictly speaking it should be 'CCITT No. 2' — I think I'll stick to BAUDOT!')

3. As a result of (2), many manufacturers are now producing self-contained microprocessor-controlled devices which contain the TU and software (usually in an EPROM). All that is needed to complete the station is a rig, a conventional TV (or a VDU for better results) and a power supply. This

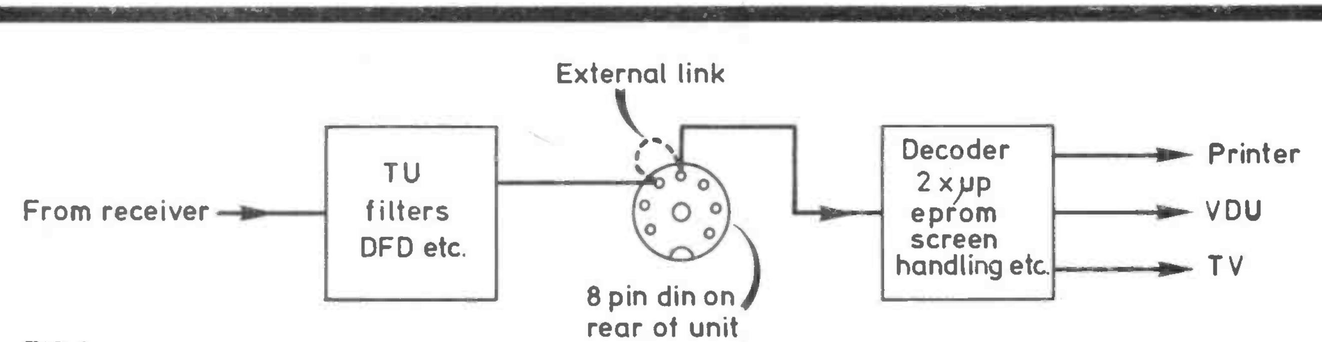


FIG. 1.

The Microwave Modules *MM2001* RTTY receive converter can cope with most standards, but carries a price tag of £189.

method gives all the advantages of the second method without the programming or construction problems although it does tend to be rather expensive. (Up comes the old argument of 'black box' versus home construction!)

One such device in the third category is the Microwave Modules *MM2001* which is a receive only RTTY to TV converter at just under £200. (The companion *MM4001* at around £300 gives transmit capabilities also, when coupled to a suitable keyboard.

What you get for your money

The *2001* is constructed in a very rugged-looking 7¾" by 4¾" by 2" by 2" die-cast box and caters for virtually all the speeds likely to be encountered on the air ie. BAUDOT 45.5, 50, 75 and 100 baud and ASCII 110, 300, 600 and 1200 baud. The different speeds are selected by a single push button on the front panel, which steps sequentially through the modes, and are displayed by a group of five LEDs. Tone frequencies and shifts are selected by a pair of toggle switches and the options available are shown in Table 1. A 'clear' button does as its name suggests and it is recommended that this be pressed on initial switch-on. The front panel is completed by a pair of 'tuning' LEDs which indicate 'mark' and 'space' tones.

On the rear panel are three phono sockets for connection to a TV (UHF out on channel 35), composite video (labelled VIDEO OUT) and 'audio in' from the receiver. A five pin DIN socket accepts 9-12.5V DC at around 700mA along with a second audio input paralleled with the phone socket. A 25 pin 'D' connector is provided for connection to Centronics-compatible parallel ASCII printers (ie. 7 data bits, positive acknowledge and negative strobe lines). The rear panel socket line-up is completed by an eight pin DIN socket which, for normal operation, must have the supplied plug inserted. This socket makes it possible to separate the two main parts of the unit so that one can try out homebrew TU's or decoders (see **Fig. 1**).

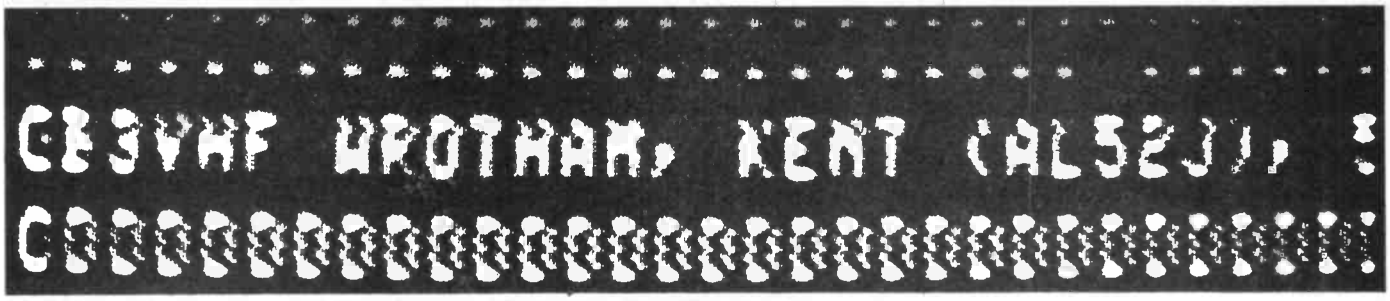
Black characters on a white background or the reverse are available from the unit. Also a 'case control' switch, when 'on' and the unit is receiving BAUDOT code, forces a letter shift after fifteen consecutive figure shifted characters (useful when decoding noisy signals where a letter shift code could be easily missed). Some rather crafty software ensures that overprinting, e.g. due to missing carriage return or line feed in BAUDOT, never occurs.

Open the box

Disappointingly, on opening the box, one is confronted by a single socketed EPROM mounted on the solder side of a printed circuit board. However, the removal of four nuts gives access to the works and very nice it looks too! Two high quality plated-through-hole fibreglass boards, mounted with component sides facing, contain an impressive mixture of linear, TTL and CMOS ICs.

The top board contains two processors, a 6802 (forerunner to the 6502 and a very powerful device) and a 96821 (presumably for screen control etc?). Five LM348's (quad op-amps) along with a sprinkling of digital ICs form the frequency discriminator. Also there are 74LS244's (octal tri-state buffers) for the printer output.

The bottom board boasts a standard UHF modulator, two 2114's (ie. 1K by 4 bit memory chips) for the screen memory, providing 16 lines of 64 characters, and a host of



RTTY identification from GB3VHF beacon. Photo from UHF TV receiver.

associated logic. Throughout the design there is scope for expansion ie. space and decoding exists for 2732 EPROMS instead of the current 2716 and there are many vacant IC pads. The same boards are obviously used in the *4001* transmit/ receive version.

Operating impressions

One word of warning when using this unit is that it is not designed for the quick 'lash up'. As the information sheets advise, all leads must be very thoroughly screened and the box lid screwed down tightly or else excessive QRM is experienced. This also means that the TV/VDU should be situated well away from the rig/aerial feeder. However bearing this in mind, the picture quality is acceptable on a standard UHF set and is perfectly readable even when using a 6" portable (although the black on white option did produce some rather distracting vertical dark lines between character slots). For the best results a VDU should be used and then the picture produced is excellent.

On 2m FM the unit performed very well, although one or two minor irritations were found. A good noise-free signal of at least S2 is needed, otherwise rubbish is generated, and the audio input required to drive the unit is rather high. If you want to monitor the tones while decoding, the level is ear shattering! Initially a little trouble was experienced with selecting the mode and speeds, but with practice this becomes second nature. However, I found that the speed select push button could have done with a little more 'de-bouncing', as it occasionally stepped twice. With so much going on when initialising a contact, especially on HF or 2m SSB, this can lead to confusion and frayed tempers! I also feel that rather more band pass or even lowpass filtering of the signal would be helpful as any noise (eg. FM hiss or more notably HF noise) on the signal causes rubbish to be displayed. On the subject of 'rubbish' in the BAUDOT mode, noise or an unrecognised code produces a stream of full stops or commas. This can be confusing as many RTTY operators punctuate QSOs with a string of full stops. Perhaps some more appropriate character could be programmed as the 'invalid' code eg. ■ or an inverse 'E'. A better solution might be to have software error traps and not display anything.

Tuning

When trying to decode HF RTTY considerable practice and patience is needed. The points mentioned above together with problems in tuning the receiver to produce the correct tones make it a very difficult task. Eventually one becomes accustomed to the correct sound and can tune in by ear approximately. The so-called tuning LEDs (one for mark and one for space) are practically useless and it becomes more of a hit and miss process. For HF reception I was using an old *KW2000 (without the mods — I really must read that series!)* and found that its stability, while being what I would consider adequate for the reception of SSB, was not really good enough for this unit. Speeds higher than 45.5 baud and high speed ASCII were practically impossible to resolve consistently. *I found exactly the same tuning difficulty experienced by Peter Metcalfe when using the unit with my synthesised transceiver, stability 10's of Hz/hour. — Ed.* To be fair to Microwave Modules, they do warn you of this albeit for a different reason!

"At 300,600 and 1200 baud ASCII the purity of the received tones becomes more and more critical. Therefore it is essential that the receiver in use is of sufficient quality so as not to alter the audio quality which could result in corrupt copy".

Generally the unit, although having a few drawbacks, provides a quick and easy (if not cheap) way of listening to RTTY. For VHF work, especially FM, it is quite adequate for beginners. However, I feel that one would soon want to dabble in a homebrew TU for better results and here the unit can provide a ready-built decoder of excellent quality. The construction is sound and the information sheets, while being a little skimpy, do provide sufficient information to get going. ●

Table 1

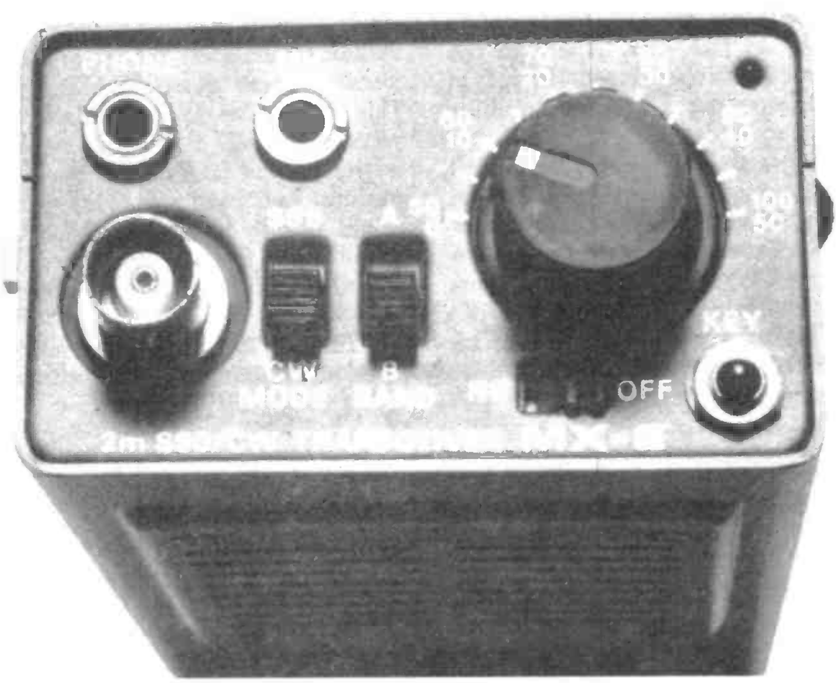
Digital frequency discriminator settings

MARK TONE (Hz)	*SPACE TONE (Hz)*	*SHIFT (Hz)*
1445	1275	170
1275	1445	170
1700	1275	425
1275	1700	425
2125	1275	850
1275	2125	850
2400	1200	1200
1200	2400	1200

MIZUHO MX-2 Review

SSB for £89

By Frank Ogden G4JST, Editor



I was looking through a stack of amateur radio magazines, attempting to seek out an interesting subject for review. I turned page after page of glossy ads all showing a succession of archetypal Japanese black boxes which mostly did the same thing.

There they were. Everyone a multimode/two VFOs/scanning/ten memories/10W PEP+/advanced PLL circuitry/latest GaAsFET front ends and all the rest. I was bored.

I turned a few pages to the Waters & Stanton ad which prominently depicted the FDK series of gear including, of course, the 750E multimode. Yes, we are going to review it because I'm told that this sort of thing is very popular. However, what took my interest was a little SSB/CW handitalkie that cost just £89. Can you believe it? A piece of amateur radio gear which left some change out of £100. Incredible. Furthermore this little box had neither dual VFOs nor a PLL synthesiser which was enough to make me want to do the review personally.

What you get for £89

The MX-2, as delivered, covers the frequency range from 144.25 to 144.35MHz in two bands selected by slide switch on the front panel. A similar sized slide switch selects SSB/CW operation while a third, rather smaller, switches the internal noise blanking circuitry. A single 15mm wide knob provides the 50kHz VFO swing over its 180 degrees of rotation. Finally, a miniature push-to-make switch acts as an integral Morse key. The front panel also carries a BNC aerial socket which accepts a ¼ wave rubber duck (supplied) together with external microphone and earphone sockets. The PTT (push-to-talk) switch and edgewise volume/on/off control are mounted on the side of the sturdy metal case, the 1½" internal speaker to the front, and the external key jack socket and power supply socket at the bottom.

The battery carrier, designed to accept six AAA size 1.5V dry cells, fits into a recess at the bottom of the set reached by removing a sliding cover. The innards of the MX-2 comprise two boards mounted on top of each other, offering reasonable access for servicing and modifications. The VFO crystals are of the plug-in variety and are easily replaced to alter the set's frequency coverage.

Circuit description

I must say at the outset that the circuitry design meets with my full approval on pure performance criteria. It is a single conversion superhet, entirely conventional (mostly not a bad thing) which has, at its heart, a variable crystal oscillator for LO injection.

VXOs, as they are known, may seem to be rather limiting with their inherent narrow frequency span – just 50kHz/crystal in the case of the MX-2. However, when it comes to pure performance, they are streets ahead of any synthesised VFO system. Even the simple one transistor VXO circuit of the MX-2 offers a lower noise performance – the characteristic which enables you to operate in the presence of adjacent frequency high power 2m stations – than the best of the synthesised multimodes. There is another payoff. The low local oscillator noise results in 'cleaner' single sideband and CW reception. More of this later.

On the receive side, the front end

comprises a dual-gate MOSFET RF amplifier followed by a JFET mixer: good RF practise but heavy in current consumption. The output from the JFET mixer is passed through a crystal filter (centred on the 7.8MHz IF) and then on to a two stage, dual-gate MOSFET IF amplifier. This is followed by a four-diode product detector and an integrated circuit audio amplifier.

The AGC is carrier derived; and the receiver circuit also incorporates a noise blanker. Aerial switching, like most of the other circuits which need to be switched on changeover from receive to transmit, is achieved by diodes.

The transmit path is similarly simple. A VOGAD (voice operated gain adjusting device) microphone amplifier passes audio to a balanced mixer together with a signal from the carrier insertion oscillator. The unwanted sideband is removed by the crystal filter. The wanted sideband is subsequently mixed with a 137MHz signal derived from the VXO to produce SSB or CW at 144MHz. A succession of buffers and bandpass filters remove unwanted mixer products. The PA final amplifies the SSB signal to the 200mW PEP level. CW keying is achieved by unbalancing the first transmit mixer.

Operation

You should be aware of the limitations of a little set such as this. At about half an inch shorter than an IC2-E (fitted with the smallest battery pack) it is undeniably small and handy. The manufacturer and importer (Waters & Stanton) would have you believe that the place for this set is in the pocket, with the owner at the top of a mountain somewhere. "You would be surprised at the DX which can be worked from a hilltop, even with just 200mW".

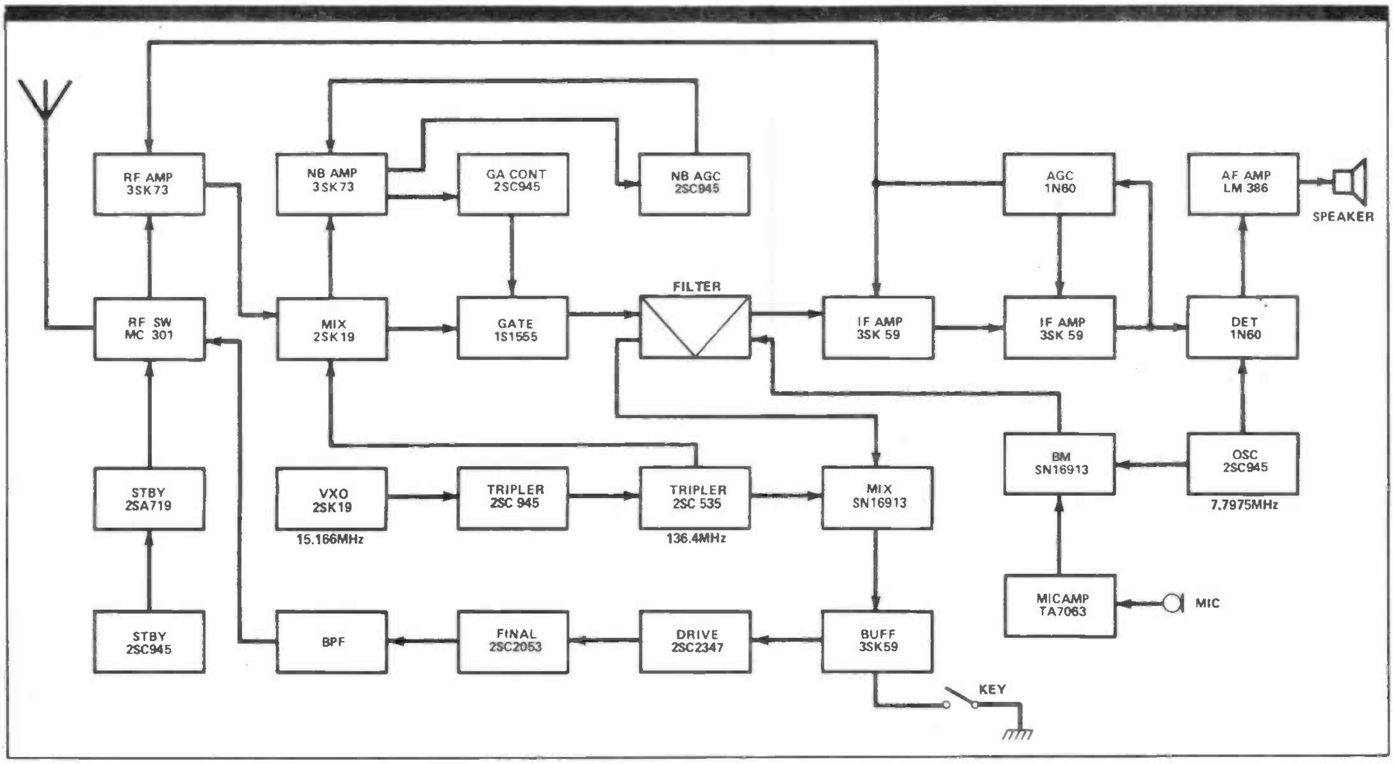
That is how the publicity blurb goes, or at least something like it. Although the importer supplies a short set of instructions in English, I suspect there is considerably more information in the original Japanese which has been left untranslated. The reality is yes, the MX-2 works extremely well on both receive and transmit and lots of contacts can be made with its 200mW. However you have to complete your QSOs very rapidly as the battery life is, quite frankly, a joke.

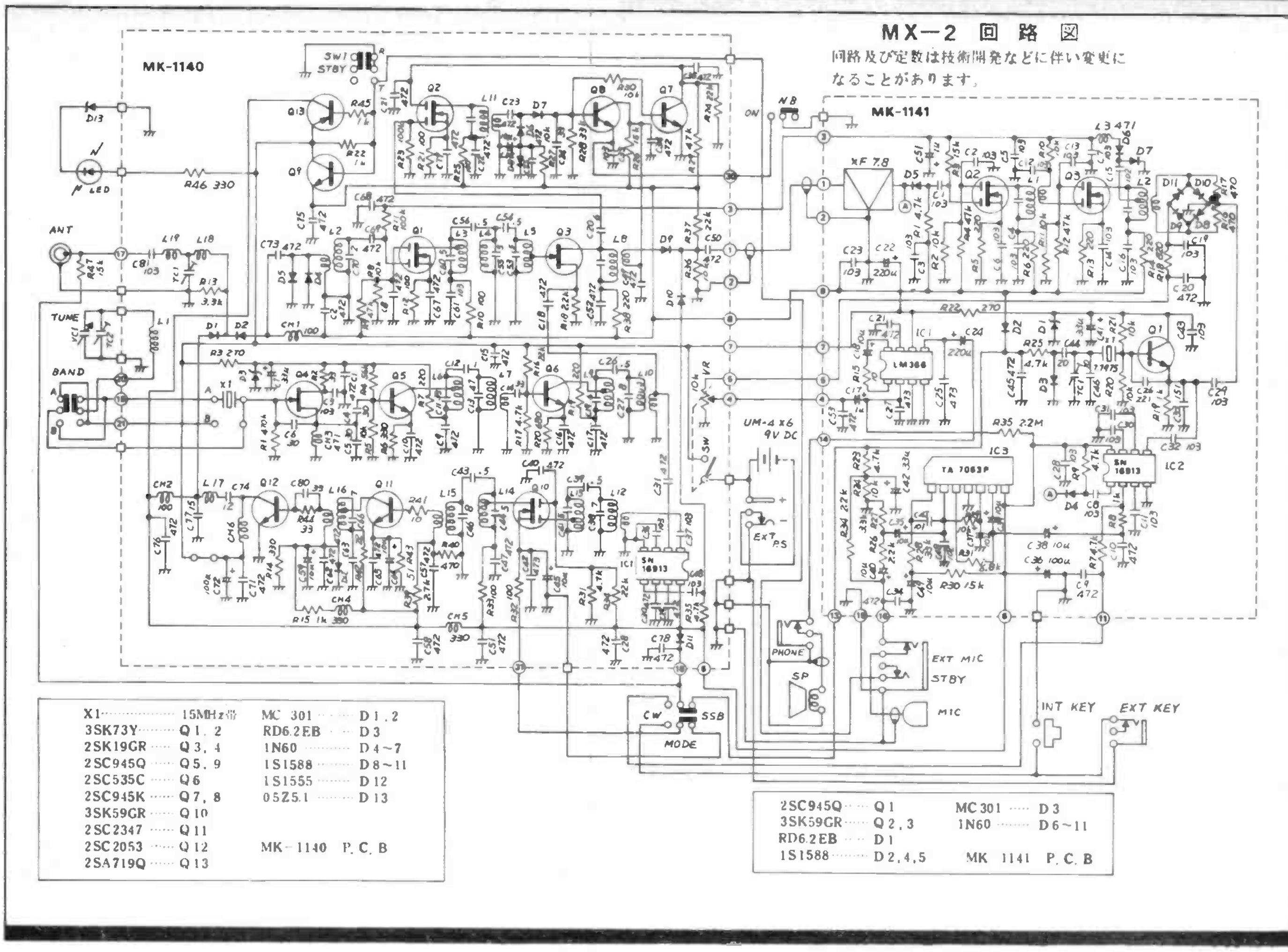
As supplied, the battery carrier takes six AAA dry cells to produce the 9V supply which the set requires. Unfortunately these cannot be replaced directly with Ni-Cd rechargeable batteries (capacity 180mA/hour) because the terminal voltage would be reduced to just 7.2V. Although the receiver would operate satisfactorily at this voltage the TX would produce something under 100mW which isn't really enough. The set requires the full 9V to produce 200mW output. A similarly sized PP3 Ni-Cd battery will fit into the battery compartment but the capacity of these is only 100mA/hour although the terminal voltage is 8.4V.

This is the heart of the matter. The battery consumption of the MX-2 is excessive for the size of battery which the unit is able to accommodate internally. On standby receive, the manufacturer quotes a supply current of 40mA (review sample 50mA) which rises according to volume. The transmit current consumption is 160mA (review sample 180mA) maximum reducing to 100mA with no modulation. Even when using expensive manganese alkaline cells, the set's endurance is no more than about six hours; a PP3 type Ni-Cd pack would offer less than two hours. The only way that the set can match the battery endurance of other models is by using an external battery pack together with the DC power cord (supplied). I, for one, would have preferred the MX-2 to have been housed in a larger case accommodating much bigger batteries.

This major criticism aside, I have unreserved praise for every other aspect of the set's operation bar the internal CW key. It's not the fact that the button on the front panel has absolutely nothing in common with a conventional Morse key, but rather that the circuit doesn't generate a sidetone. This means that you can't hear what you're sending. I guess it wouldn't matter for the majority of two metre working but there are times when I would like to have sent clean CW. When there is only 200mW coming out, CW offers a distinct advantage over SSB.

The audio, both received and





transmitted, was excellent. I attribute this to two factors. The first is the VXO circuitry. The phase noise of the LO is obviously very low indeed combined with a complete absence of FMing of the suppressed carrier. The second aspect contributing to good audio can be attributed to the crystal filter characteristics. The passband is distinctly wider than the filter types normally associated with HF SSB gear. This results in a wider audio spectrum. The perceived quality of the transmissions has more in common with good, solid FM copy than with typical SSB reception. The same applies in receive providing that the originating station is capable of sending good quality audio in the first place.

It might be argued that slightly wider band transmissions are antisocial. However, while this may be true on HF, it hardly matters one way or the other on VHF and the results are certainly a lot more pleasant to listen to.

The noise blanker was not particularly effective. It went some way to reducing high level impulse noise but it certainly could not 'blank' it. Similarly, the AGC required a fairly strong signal present at the aerial socket before this part of the circuitry started to operate.

In use

I operated the review unit from an external power supply for most of the time for reasons outlined earlier. One might think that the rather primitive tuning arrangements – a single 15mm knob rotating just half a turn – might make it difficult to use. Well, I suppose that it was a bit fiddly to tune accurately, but it was certainly possible. On the plus side, the half-turn rotation made it possible to scan the band very rapidly. Furthermore, if you think that 100kHz of coverage doesn't sound like much, then it should be pointed out that about 90 per cent of SSB contacts are made in this segment.

I didn't particularly like the latching PTT; why a *latching* variety was fitted, I shall never know. It was all too easy to leave the unit in transmit shortening even further the already inadequate battery life. However, these things aside, the unit was great fun to use and exhibited a performance comparable with gear costing around five times the price. I made numerous local contacts using the MX-2 with just the helical aerial. '200mW can't be much use' I can hear people saying. But it can. I received a 5 by 2 report from a station some 20 miles distant using the set as a handitalkie in the kitchen while doing the washing up with the other.

Summary

Although it's a great little set which I personally love, it misses its role as a hand portable. Greater justice would be done by taking the guts out of the case supplied and transferring them to a much larger one. I would then fit a bank of crystals, possibly enough to cover the beacon (which I rather missed) and satellite subbands and fit a more sophisticated mechanical tuning mechanism

Having done that, I would add a decent PA strip to raise the power to the 10W level. That modification package, which would bring the total price tag to the £150 level, should provide a dedicated two metre SSB/CW transceiver capable of outperforming any multimode you care to name.

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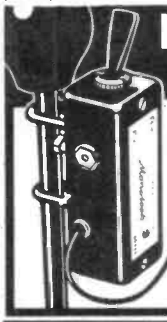

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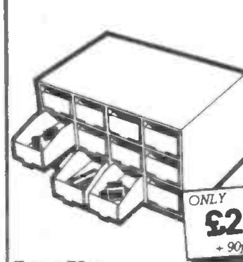

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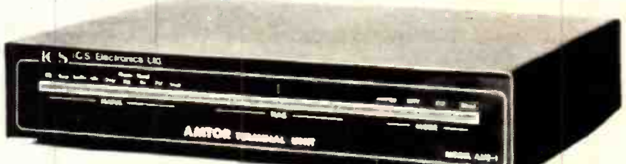

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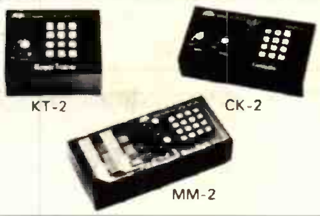
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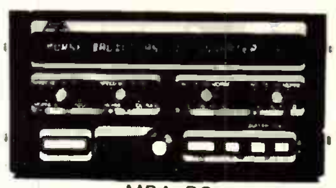
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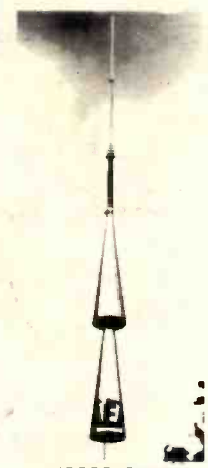
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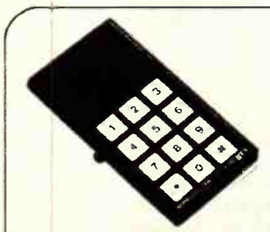

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