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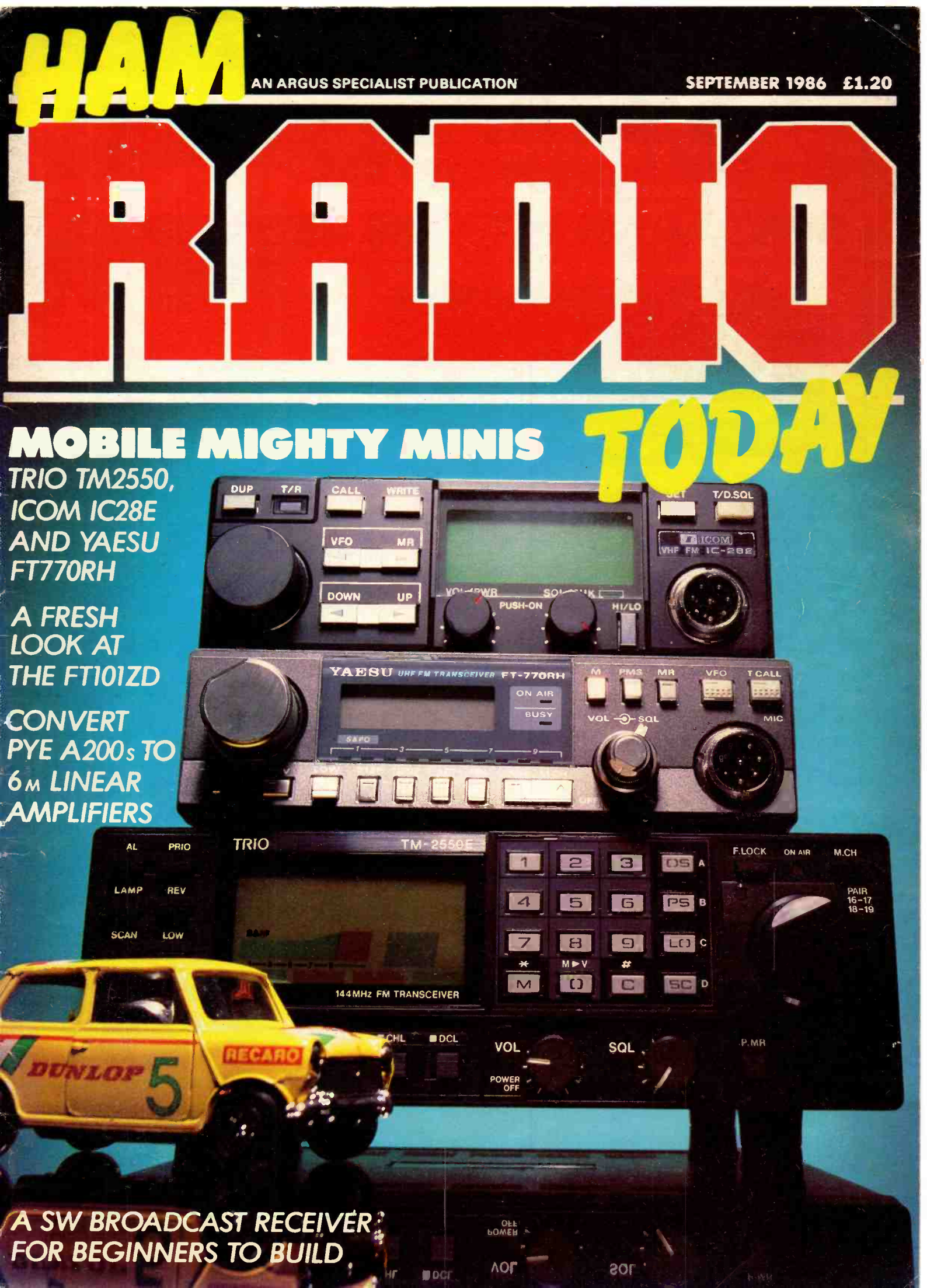

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REGULAR COLUMNS

CONSTRUCTION

FEATURES

REVIEWS

TWO FOR THE ROAD.

The very latest IC-28E 2m. FM mini-mobile from ICOM.

This new 2 metre band transceiver is just 140mm (W) x 50mm (H) x 133mm (D) and will fit nearly anywhere in your vehicle or shack. Power output is 25 watts or 5 watts low power and is supplied complete with an internal loudspeaker.

The large front panel LCD readout is designed for wide angle viewing with an automatic dimmer circuit to control the back lighting of the display for day or night operation.

The front layout is very simple, all the controls are easy to select making mobile operation safe. The IC-28E contains 21 memory channels with duplex and memory skip functions. All memories and frequencies can be scanned by using the HM-15 microphone provided. Also available is the IC-28H with the same features but with a 45 watt output power.

Options include IC-PS45 13.8v 8A power supply, SP8 and SP10 external speakers, HS15 flexible mobile microphone and PTT switchbox.

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F1	Select Mode	↑ V	Up/Down (arrows)
F2	Freq/Memory Scan	M	Memory Channel
F3	Mode Scan	, .	Memory Up/Down
F4	VFO → Memory	/	VFO/Memory
F5	Memory Write	B	Bargraph Select
F6	Memory Clear	@	Occupancy On/Off
F7	Set 'SIG' Level	:	Scan Stop Off/On
F8	Memory File Read	S	Change Set
F9	Memory File Write	DEL	Speech (If fitted)
		Q	Quit

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The new ICOM IC-735 is ideal for mobile portable or base station operation. It has a general coverage receiver from 0.1MHz to 30MHz and transmits on all amateur bands from 160m to 10m. SSB, CW, AM and FM modes are included as standard. RTTY and Amtor are also possible. The IC-735 has a built-in receiver attenuator, pre-amp, noise blanker and RIT to enhance receiver performance. A 105dB dynamic range with pass band tuning and a sharp I.F. notch filter for superior reception. The twin VFO's and 12 memories can store mode and frequency. The HM12 scanning mic is supplied. Scanning functions include programme scan, memory scan and frequency scan.
The IC-735 is one of the first H.F. transceivers to use a liquid crystal display which is easily visible under difficult conditions. Controls that require rare adjustment are placed behind the front panel hatch cover but are immediately accessible. Computer remote control is possible via the RS-232 jack. Output power can be adjusted from 10 to 100 watts with 100% duty cycle. A new line of accessories are available, including the AT150 electronic automatic antenna tuner and the PS55 AC power supply. The IC-735 is also compatible with most of ICOM's existing line of HF accessories. See the IC-735 at your authorised ICOM dealer or contact Thanet Electronics Limited.

LETTERS

EXPERIENCE DISAGREES

Sir, In response to the letter by John Butcher, DA1DC/G4CWJ, as an older and more experienced reader, call sign G3UDO, with some knowledge of running something, I feel that perhaps like many of the 'old guard', G4CWJ is living in RSGB cuckoo land.

There are a large number of amateurs like myself who, after many years of membership of the RSGB, have resigned in disillusionment. In an organisation that purports to democratically represent radio amateur interest, there should be no such thing as an 'established order'. Unfortunately, it is all to evident that this is in fact the case, where an established clique has perpetuated.

Some may claim that this body represents all licensed radio amateurs and their interests in the UK. If they do, they do by default. The fact remains that very many licensed amateurs are not members of the RSGB and that a fair proportion of the members they have are not licensed amateurs.

It is true that the RSGB, through its membership of licensed amateurs, has a wealth of experience and expertise going back to the days when 'radio was wireless' and no doubt coherers were coherent. Unfortunately, the opinions, egos and attitudes of many of the established order and their supporters are dogmatically entrenched in the same past from whence comes their experiences. Contrary to the belief of some who blindly support it, the RSGB is not a learned institution, the membership of which sets them apart from the rest of us mortals. It is only a limited company! And we non-members are not inexperienced idiots.

If the RSGB were really interested in recruitment and in improving non-commercial radio communication, then they should have taken some positive steps to encourage and educate other non-professional users of the radio spectrum and encourage them within its organisation.

By treating the CB fraternity with contempt, they have failed to grasp the opportunity to considerably increase membership, generate more funds and increase tenfold the amount of *real* clout they have with the authorities. In addition, their experience and expertise would have a beneficial and positive influence on a fraternity from whence many of today's amateurs emanate, particularly where operating standards are concerned. I would suggest that their own dogmatic, egocentric and entrenched attitude over the years has done much more to reduce recruitment, encourage discontent and fragment membership than anything I or any other critic may write, or your magazine print.

Keep up the good work, HRT. It is time fellow amateurs put pen to paper on these and other issues and that magazines like HRT had the guts to publish it.

A S Barraclough, G3UDO.

WANTED: CONSTRUCTIVE PROPOSALS

Sir, I was pleased to note your refreshing impartiality in publishing (July '86 issue) the letter from John Butcher, G4GWJ. I feel sure that many fair-minded responsible adherents of our hobby think as he does, even if they do not think it of sufficient importance to write and tell you so.

In this age of "free speech", "armchair critics", and "barrack-room lawyers", it is easy for a person, without any real grasp of the situation or experience in the matter under discussion, to sieze on some half-truth or imaginary grievance (probably out of date by the time any letter is published anyway) and write in with the implication that their ideas represent the majority opinion.

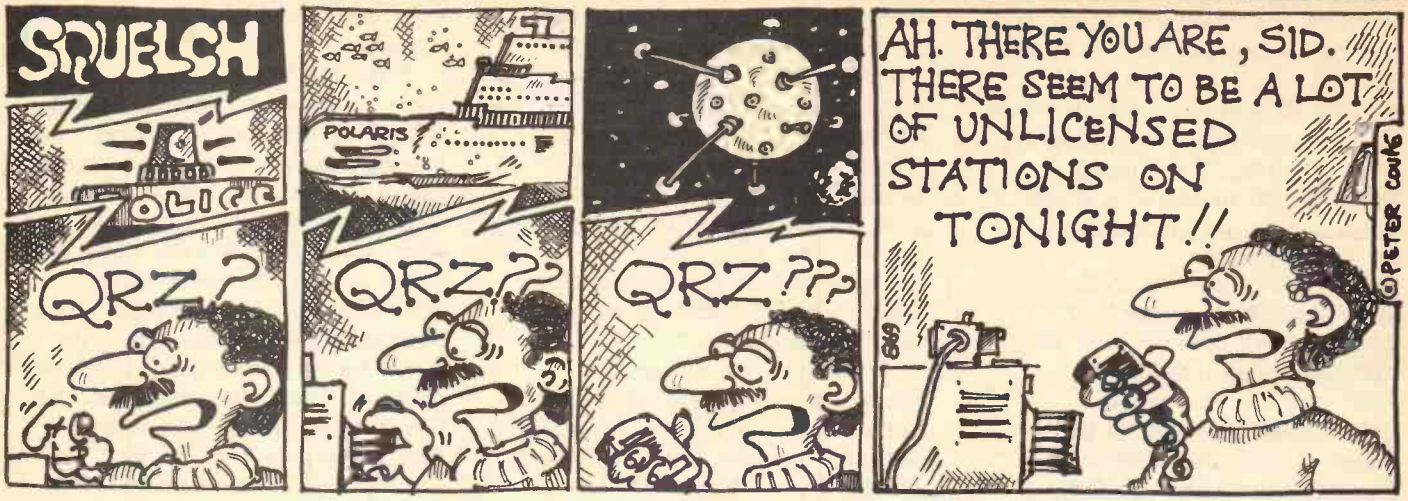
Amateur radio has a small number of vociferous malcontents who write to all the magazines upon various topics anti-RSGB. Free speech is fine, but it would be nice to read some constructive proposals from these people and, if they care for the hobby as much as they claim, even offers of help.

I think readers are by now entitled to ask these would-be agitators what executive experience they have had in a concern with world-wide ramifications and over 30,000 members/shareholders/customers. We could then judge their organising ability. Nothing in this life is perfect, and our National Society is no exception. Only a fool would suggest this and, conversely, any fool can find faults.

Senseless carping criticism does nothing to enhance one's case, although it may help in cases where circulation figures of a periodical are falling. There must be many like me who turn to the "letters" pages to see which "bee" is in someone's over-sized "bonnet" this month. Rather like when, as children, we looked forward to next week's exploit of our favourite character in "Comic Cuts"!

Rather a pity that you do not tell two or three people that they have exceeded their quota of critical letters, with the suggestion that they address them to the Body for whom they are intended. Alternatively, if they disagree with the rules and regulations, either try to change things from within or have the courage of their convictions and, with their supporters, resign and form a rival organisation. It would not get off the ground!

P J Wadham.



UNDERGROUND ANTENNAS

Sir, After reading the letter from John Heys, G3BDQ, about the April spoof on underground antennas, I just had to write to you on the subject. You see these antennas are fact not fiction. Anyone who worked me on Top Band from the middle to late fifties would have been talking to a station using an underground antenna. Perhaps some of your readers may remember me if they were Top Banders in those years around the Wiltshire/ Gloucestershire/Bristol areas etc.

This antenna although tuned for Top Band, was once used on 40m. While chatting to a GI station this subject cropped up and he persuaded me to give it a try. Much to my surprise, I only dropped an 'S' point and the antenna I had been using was 270 feet long about 40 feet high. So the comparison was fantastic, had the underground been tailored for 40m — who knows?

Whilst there is no 'window' for these antennas, they cannot be used as all band devices without an ATU in the system. With my antenna connected to a receiver — albeit tuned on 160m — as the receiver was tuned up frequency, the effect of attenuation could be almost 'felt' — around 10-11MHz the antenna was to all intents not there.

Why not run an article on Underground Antennas, but this time don't publish it in April. They are a system to be taken seriously.

John Cooper, G3CXI

THE "Q" CODE

Sir, The "Q" code as we know it today came into force on 1st January 1929, the same date which saw the introduction of the new audibility scale of from R1 to R5. (It was formerly from R1 to R9).

However, can anyone tell when the *original* "Q" code was first used, and who invented it?

Douglas Byrne, G3KPO.

MORSE EXAMINATION SERVICE

Sir, This is the first time I have been roused enough to write to any magazine but a letter from my old friend and tutor G3ZQS did it. We can all sit back and criticise the RSGB at some time and we all have the right to voice our opinions, but on this occasion I feel a word on behalf of the Examination Service is called for.

In order to satisfy people like G3ZQS, great care must be taken in the setting up of the service and examiners are very carefully interviewed and tested. The fact that an applicant is in possession of a PMG certificate does not infer that he or she would make a satisfactory examiner and since all eyes will be on the service in its initial stages every precaution is being taken to ensure that examiners meet a very rigid standard. The Chief Examiner Mr A N Ianson GW3GDO (soon to drop the W) has taken on the task and is not prepared to be rushed into appointing anyone just to get the show on the road. I feel it is very unfair at this early stage to criticise the RSGB who are doing their best to get the test examiners and venues organised as quickly as possible.

Three of us in the Strathclyde area were interviewed at the Kelso Rally on the 4th May and all arrangements have now been made for the examinations to take place in Glasgow starting in July and every four weeks after that until the backlog is cleared.

So come on George, give us a chance and please allow us to get off the ground before you begin using words like "untouchable authority" and "kneeling at the feet of those chosen by the RSGB" etc. We are aiming at a well organised examination service for radio amateurs run by radio amateurs and constructive criticism will be welcomed but we haven't even started yet. Morse examinations at rallies are only a stop gap and distances may be long but in the past test centres have been relatively few and it is intended to set these up in at least 74 places this year and next year should see one in every major populated area when travelling will be of no major concern. Most will be held between 7 and 9 pm in the evenings which was impossible in the past so people will not need to take time off from work to attend. If at the end of the day any of George's premature remarks are justified I will publicly eat his morse key.

Jack Dixon, GM4RSJ

ARE YOU EX-CALLBOOK?

Sir, When the 1985 Callbook first became available, I was most surprised to learn that I had

become "ex-directory" without having ever asked for it. I soon learned that I was not the only one. 1985 was the first year that the callbook had been prepared from the RALU's computer records, and to say that these were somewhat inaccurate is putting it mildly.

Comparing the 1985 Callbook with the previous year's, it became very obvious that the number of "ex-directory" amateurs had increased dramatically. In most of these cases, it appeared that the amateurs who had suddenly become "particulars withheld" were stations whose station location differed from their correspondence address (as does mine).

Telephone conversations and correspondence with both the RALU and the RSGB confirmed that this was indeed the case and was due to an omission in the RALU's software which meant that in these cases the RALU had simply transferred a blank record to the RSGB who printed this as "Particulars withheld at licensee's request".

In the light of this, the RSGB promised to set up a system where you could inform them directly of the address which you wanted to have appear in the Callbook. I wrote to them, giving this information, and confidently expected that everything would be correct in the 1986 Callbook.

Yesterday, I was able to check my entry in the 1986 Callbook. There it was — "Particulars withheld at licensee's request". So, I would like to take the opportunity, through the pages of your letters column, to let everyone know that my particulars are correct in the 1984 Callbook. For those who have thrown away their old callbook, the correct details are:
G4IJF, Nigel Roberts, PO Box 49, Colchester, Essex, CO4 3SF.
Station located at Manningtree, Essex.

Nigel Roberts, G4IJF.

CONTEST COMPLAINANT

Sir, I wish, via your correspondence column, to query the mentality of contest organisers. With total disregard for non-participants, they all to frequently release their hordes of overlineared and selfish minions edge to edge across the bands uncaringly to the detriment of others. For 48 hour non-stop periods over at least three of the past six weekends, these bigoted cretins have completely commandeered the frequencies supposedly available to all and sundry licensees.

It can only be assumed therefore that governing watchdog bodies, such as RSGB and ARRL actually condone the continuance of this inconsiderate and lunatic practice; they've made no move whatsoever to apply frequency limits per band portion, within which these event should be permitted to function.

To refer to these events as contests must be Hamworld's most FB misnomer. Contests they would be were inputs restricted to 100W and antennas to 1/2 wave dipoles. The sheep and the goats would then readily become segregated and winners' call signs would be much more indicative of operative skills. Currently it's predominantly appears a battle of the fan-assisted black boxes. What a farce!

Fortunately, training at Bletchley and similar hotspots of learning, coerced its inmates into ignoring QRM in the furtherance of weak signal receipt. As an ex-graduate, I can claim some degree of built-in immunity to contest cacophony in CW mode — but why should such futile and seemingly uncontrollable hassle be inflicted upon non-contesters? They feel obliged to keep off the air for fear of ruining a genuine operator's multiplier. Admittedly, I was blessed with an upper band limit QSO early on the Sunday morning of the last WW. I managed a UA9 on about 14070. He was, however, intermittently being blown to pieces by an east European lid calling "CQ contest" smack on our frequency and threatening to damage my 'S' meter indicator. No way could it have been an oversight on his part, otherwise slim indeed would have been his chances of contest multiplier acquisition were he not capable from eastern Europe of hearing either a UA9 or a G4 prior to his CQ call. (Obviously the courtesy of QRL imi is not applicable in contest working).

I frequently muse over letters from indignant amateurs slating CBers for their behaviour on air. Having been associated with as many ardent and fine CBers as with members of our amateur sect, I can emphatically state that never during lifts on 27MHz channels 31-39 have I ever heard such acts of blatant piggery as those being perpetrated under the guise of 'competitiveness' on the CW only portion of 20 metres during the last WW... Not exactly a glowing accolade relative to certified gentry — normally regarded as trend setters by the uninitiated but would-be amateurs.

In fairness to all, let there be portions of each band segment reserved for contests, with automatic disqualification for out of frequency working. Agreed, their level of QRM would be much greater, but virtually self-inflicted — being instigated by like minded morons engaged in the same charade.

Rave notices having already been posted in sundry journals re numerous contests pending, the average and (from choice) unobtrusive amateurs will be debarred or most certainly discouraged from pursuing their hobby at peak leisure hours. Like me, they will be relegated to other spare-time occupations for which neither enthusiasm, study, examination, certificate of competence nor callsign will be prerequisites. Included in the RAE curriculum should be propagation (of plants), resonance (of piano strings), maintenance (of Aldis lamps) etc — thereby ensuring that all radio persons of the non-contestant ilk may derive at least some pleasure from their relaxation periods via enforced weekend diversification. Meanwhile, let's have some democratic and fairminded contest organisation relative to other band users' entitlements.

G4WRV.

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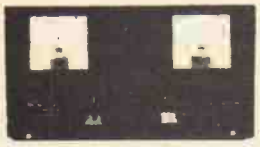

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RADIO TODAY

Tested For Life

The Department of Trade and Industry has announced that a pass in the Radio Amateur Morse Test will now be regarded as valid for life. Previously, where a break of over 12 months had occurred in licensed operation, or where a licence had not been obtained within 12 months of having passed a Morse Test, a further test was required.

This change of policy brings into line the currency of the Morse Test with that of the Radio Amateur Examination, where a pass is already valid for life.

Spreading The Word

If you've bought a legal CB set and want to convert it to 10m, but don't know how, you could try a product from Spectrum Communications. Their SC29 conversion board fits just about every type of FM UK rig, they claim — they know of 73 different named rigs that do work.

It will put channel 1 on 29.31MHz through to channel 40 onto 29.70 which is just on the band edge. First designed for rigs containing the LC7136 and LC7137 ICs, the board can also now convert those using the MC145106, TC9119P and MM55108 chips. The only exceptions that Spectrum openly admit defeats their board is the Maxcom 20 and 21E which is too small unless you remove the loudspeaker.

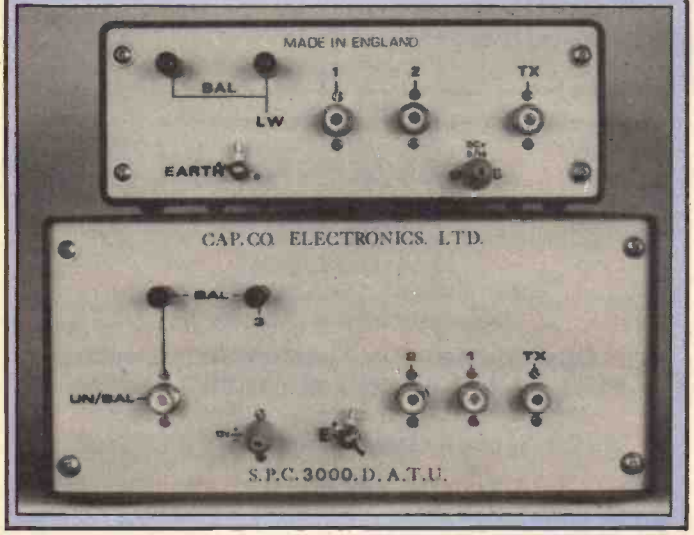
The SC29 conversion board costs £15 fully built and aligned and comes with all the fitting instructions.

If you have a multimode CB rig that you want to convert to 10m, Spectrum have conversions for over 20 rigs. Contact them on 0305 622350 for further details.

Static Protection For ATUs

The SPC300D and SPC3000D are developments of the Cap Co SPC300C that include a safety device for lightning protection. Although they will not stop a direct hit, they will limit damage from secondary or large static discharges if the aerials are connected up as normal.

All antennas that are connected to the ATU are automatically grounded because the new design uses electro mechanical switching via relays and control switches. There are also three sockets for connecting up antennas, plus a direct or through position and a 1kW balun.



On the first hot day of summer, Chesham DARS again staged a demonstration station for Chesham's Carnival day on June 14th, with a special call sign of GB2SCC (Schools of Chesham Carnival). The station created a lot of interest with well over 100 contacts made during the afternoon. Visiting the stand is Jeremy Hands, an ITN reporter who officially opened the Carnival, and Chesham Town Mayor Cllr Mrs Jo Franks, on the microphone is club member Chris Dunn, G8KVI.

Events

Sunday 10th August sees the staging of the 4th Hamfest '86 rally at the Flight Refuelling Sports and Social Club, Merley Park Road, Merley, Wimborne. The rally which raises funds for the Radio Amateurs Invalid and Blind Club (RAIBC) will have all the usual amateur radio attractions, plus a craft fair and lots of entertainment for children. There is free car parking nearby, with handicapped visitors welcome to park on site.

The following Sunday (17th) is the date for the Salisbury RES 2m contest. Starting at 0900GMT on SSB and CW only below 144.295MHz, you score a point for each contact, ten for each new county and country and ten for contacting G3FKF/P. There is a maximum power limit of 250W ERP to give lower power stations a chance. Give your callsign, report, serial number and county and send logs plus details of your station to G4RLF QTHR (enclosing an SAE) before 17th September. The contest will finish at 1500GMT.

August Bank Holiday weekend seems to be a busy time for several groups of amateurs. From 22-25th, the Towersey Village Festival group will be operating the callsigns GB2TVF and, hopefully, GITVF to publicise the 22nd Village Festival. They are intending using 80, 20 and 2m (SSB and CW only) at least with other bands used if there's space for the antennas.

Barry College of Further Education RS are making their annual pilgrimage to Flat Holme Island in the Bristol Channel, where Marconi conducted some historic experiments in May 1897. Despite the "spartan conditions" *(or perhaps because of — Dep Ed)* they will be transmitting on HF, VHF and UHF using the callsign GB2FHI.

N Wakefield RC are publicising the Harewood Steam Rally for the whole weekend and for the Sunday and Monday, Worksop ARS will be using GB2BTF at the Bassettlaw Show, Kitton, Worksop.

And finally, the 1986 BARTG rally is on the Sunday (24th) at Sandown Park Racecourse, Esher, Surrey (talk in on S22). The rally opens at 10.30 am and there will be BARTG kits and components, a car boot sale, many trade stands and all manner of info for the RTTY enthusiast. For further details contact Peter Nicol, G8VXY, on 021 453 2676.

Howes and Scarab Stockist

Ward Electronics have just become a stockist of C M Howes Communications. They also have a range of Scarab Systems software and hardware including stuff for satellite operation and RTTY terminal units.

On The Move

South Midlands Communications Ltd (SMC) has moved to larger premises at SM House, School Close, Chandlers Ford Industrial Estate, Chandlers Ford (phone 04215 55111). They are promising more demonstration space for amateur radio equipment including a permanent, complete weather satellite receiving station. The nice chaps have also ensured that visitors will no longer be greeted by the friendly traffic warden giving their cars tickets as there is ample free car parking.

YLOM Results

The YL-OM Midwinter contest results have just been published by BYLARA — the association of 'young lady' radio amateurs. In the YL SSB class the winner was G4YLO with 11 more multipliers than the second placed GW4SUE, OHBYL was third with a 1000 less points. In the YL CW class OHBYL was first, LZ2AU second, DL0JK third with half the QSOs of first and second places. In the OM CW category the winner was SM6FPC. The only G entrant came seventh. On SSB the winner was SM3CER, OH5OJ was second and DL1RA third. In the SWL class, NL8818 was well ahead of all the rest with 0H1-100 second and SM3-5384 third.

Ten's Taking Off Again!

Telecomms of Portsmouth are about to announce a major launch into the 10m band to coincide with the release of their new Nevada TC35 DX power amplifier designed for 29MHz FM operation. As their Managing Director Mike Devereux explained, "Traditionally 29MHz operators have used amplifiers converted from 27MHz CB which are usually poorly designed and transmit very strong 2nd and 3rd harmonic radiation. The TC35 DX has a built-in harmonic filter which drastically reduces 2nd and 3rd harmonic output from the amplifier, and includes a built-in polarity protection, in line fuse and on/off switch".

There is also going to be a range of equipment for 10 FM including converted 27MHz transceivers, antennas, PAs. If you would like a catalogue or further information Telecomms are at 189 London Road, North End, Portsmouth PO2 9AE (phone 0705 698113).

COURSES FOR THE RAE

BIRMINGHAM

Fox Hollies Leisure Centre, Acocks Green (phone course tutor, Keith Frettsome, G4ABV, on 021 778 1311 during school hours or 021 743 5104 evenings) on Mondays at 7.15pm. Enrolment is at the Leisure Centre from 6pm on Wednesday 10th September. Ring G4ABV for details of the fee and date. Facilities include a fully equipped HF station and satellite tracking equipment. A morse course is also available on Thursday evenings from 7.15pm at the same venue.

BRIGHTON

Brighton College of Technology, Pelham Street (phone 0273 685971). Details of commencing dates, times and cost of course from Mr Bravery, G3SKI, at the college. Enrolment is on the 8th and 9th September between 4 and 8pm at the above address. Course lecturer G3XUS. A morse class will be available if sufficient demand.

BRISTOL

Twyford House, High Street, Shirehampton (phone 0272 822400) from Wednesday 1st October at 7pm. Enrol by post to the Director of Education, Stoke Lodge, Shirehampton BS9 1BN. The fee is £30.60 (reductions available).

FAREHAM

Adult Education Centre, Wickham Road (phone 0329 28079) from Friday 26th September for the 27 week course (exam in May '87) or Monday 15th September for the 11 week course which assumes some previous knowledge (exam December '86) at 7pm on both nights. Enrolment by post to the centre or in person from 8th September. The fees are £25.50 for the 27 week one, £10.40 for the 11 week course (reductions available). Course tutor G3CCB.

FARNBOROUGH

Wavell School, Lynchford Road (phone 0252 540084) from Thursday 25th September at 7.30pm. Enrolment should be by post to NE Hants Adult Education Institute, St Albans Hall, Lynchford Road, North Camp, Aldershot. The fee is £28.35.

There is also two morse courses: the first is a 20 week course to take beginners to the level of the Home Office Certificate at the same address but starting Monday 22nd September and costing £39.20. The second course is for 10 weeks and is for advanced operators. This runs at the same time as the RAE course and costs £19.60.

GUILDFORD

Guildford College of Technology, Stoke Park (phone 0483 31251) from Monday 15th September at 6.30pm. Enrolment will take place at the college on the 8th and 9th September between 2 and 4pm and 6-9.30pm. The fee for the course is £23.05. Course tutor G1RNV.

ISLINGTON, LONDON

Islington Institute, Rising Hill Street from Monday 22nd September at 6.30pm. Enrolment is on Monday 15th September at 6pm. For details of the fee, ring the course tutor, Brian Bond, G3ZKE, on 01 485 7065. The institute also runs a morse course on Wednesday evenings from 7pm.

PADDINGTON, LONDON

Paddington College, 25 Paddington Green (phone 01 402 6221). This course is a little different from others available in that it covers the syllabus and the college facilities are available for practical experiments in electronic theory. This means that attendance is required on two evenings: the main one being Friday with the choice of either Tuesday or Thursday for the practicals. Enrolment will take place on the 8th, 9th and 10th September at Paddington College between 1 and 4pm and 6-8pm or during the first few weeks of the course. The course tutors are David Peace, G4KKM, and David Hunt, G6MFR. Further details of cost, etc are available from the college.

Hamvention Report

After the RSGB's National Convention at Birmingham earlier in April, a visit to the American equivalent was an experience not to be missed. Myself and three colleagues from Thanet Electronics arranged a trip to the Dayton Hamvention hoping to learn from our Stateside counterparts on improving our approach to amateur radio.

The 1986 Hamvention took place on 25th-27th April, a total of 2½ days, at the Hara Arena Exhibition Centre, Dayton, Ohio. This involved a seven hour flight to New York — made very palatable by a letter of introduction which ensured free drinks all the way — and a short interval flight.

Dayton covers a vast area of 'real estate' as they call it in the States. 'Downtown' is covered by overhead wires, electric bus cables and traffic lights. The streets virtually clean from litter and 20th Century rubbish. Whilst waiting for the exhibition to open, we visited the USAF museum nearby, which is the oldest and largest military aviation museum in the world with exhibits including the Kittyhawk and Apollo 15 moon module. A continuous flow of free buses feed the show from all the surrounding areas and we took advantage of the one that stopped outside our hotel.

As we approached the Hara Arena, the traffic build up was immense but was well organised by traffic marshalls. Surely, it could only happen in America, where a car was spotted with a CQ DX registration plate, a motorcycle had RTTY and many more cars and campers had owners callsigns.

The vast area in front of the main building provides free parking and was almost full. The entrance fee was $10 (about £6.50) but this did cover all three days.

A 70 page catalogue in full colour was given to each entrant and this contained details of stand locations, lecture programmes, facilities available plus the usual trade advertising.

In the main hall were the major exhibitors — such as Icom and Kenwood — were located. These stands drew large crowds with several new pieces of equipment being on display. The other internal traders were housed in four large halls, with lectures held virtually non stop in a further seven annexed rooms. These lectures were well attended and covered nearly every aspect of amateur radio. Outside and towards the rear of the main complex was situated the flea market. This was estimated to cover about 10 acres.

All in all, the exhibition was far too large to absorb in just a few hours, even the 2½ days duration was not long enough to really experience all that was going on. Returning to our hotel that evening, it was obvious from the TV that the hotel was full of amateurs — the video was subject to heavy QRM!

The flea market starts at 6 am although those who need a little more sleep can lie in as the main halls don't open until 8 am! During the day, there was a small fire in one of the halls that was cleared in a couple of minutes. The local fire brigade traced the problem to an overheated extension mains lead. The show was just as crowded as before and the tremendous hustle and bustle adding to the atmosphere. No empty stands could be seen in either the main buildings or the flea market.

The American amateur is an interesting bird of paradise. All of them seem to wear the peaked hats with trade names, callsigns or comic remarks about the habits of seagulls printed on them. A considerable number of VHF portables were also part of the plumage complete with headsets and boom microphones. Aerials included the usual helicals, flexi 1/4 waves and even some mounted on safety helmets. It seemed as if every channel of the 2m band was in use and the US band covers an extra 2MHz!

These strange animals would tend to congregate around the large VDUs strategically placed which displayed the winning numbers of a variety of raffles. Hourly prizes included Icom IC2ATs and Yaesu FT203s with the main raffle including a Yaesu FT1, Trio TS940 and Icom IC751A with IC2K1 amp.

Outside in the flea market, the temperature had soared to the mid 90s, and the snack bars and beer stalls were in constant demand. The main catering area was always full though nobody had to queue longer than a few minutes anywhere.

The flea market contained almost every conceivable aspect of amateur radio with brand new and second hand transceivers, satellite TV systems and a lot of computer hardware to be purchased. The amount of non amateur or electronic equipment was very small.

The evenings are spent in one of the many 'hospitality' suites. These are hotel rooms taken by various traders, clubs and magazines to bring together socially those attending the exhibition. Food and drinks were supplied and in one suite we were able to see video recordings of the exhibition.

The exhibition was very well organised and attended. It was estimated at 30,000 people would attend the Hamvention, and although unconfirmed there were certainly a lot of people. It was pleasing to see family groups and a large number of youngsters proudly displaying their callsigns — a sign not often seen in the UK.

Amateur radio in the USA is alive and kicking and the enthusiasm for the hobby is obvious. This enthusiasm appears to be lacking in the UK and ought to be restored. This should be the responsibility of our national society, local clubs, traders to promote the hobby and not be out of reach with existing amateurs and newcomers alike.

Dennis Goodwin, G4SOT

Want To Get Into Satellite TV?

Comex Systems have announced their TVRO receiver kit which they claim "takes the risk out of awkward RF construction" *(where have I heard that before? — Dep Ed)*. The kit comprises of a mother board and components for mounting the RF and IF modules, video, control and sound IF circuits. The first module is a tunable converter covering the 950 to 1450MHz range and the second is an IF processor and WBFM quadrature detector.

They also have a range of accessories and will be making two further kits available for a tuning display and "stereo" sound IF. The TVRO receiver costs £35 with all the components plus "very detailed paperwork" or the board alone costs £11.75. For more information Comex Systems Ltd are at Comet House, Unit 4, Bath Lane, Leicester (phone 0533 25084).

Milton Keynes Morse

The Milton Keynes DARS are holding morse classes in two grades. The first is for novices to take them up to the required RSGB morse test speed of 12 words/minute. The second is an advanced course of QSO type CW and higher speeds of up to 20 wpm will be used.

Both courses are tutored by officially appointed RSGB morse examiners and run for 20 weeks. Whilst the tutors give their services free of charge, to cover the cost of the hall a fee of 60p per week is payable in advance (ie £12.00). Both courses are open to anyone wishing to learn of become more proficient in CW and are held each Monday, commencing 19.30, at the Society's HQ 'The Meeting Place', Hodge Lea Lane, North Milton Keynes. During the evening light refreshments are available at reasonable cost.

For enrolment details contact Alan, G0AXF, on Milton Keynes 78804.

Convert The Pye A200 For 6m Use

Modifying Pye gear isn't just about retuning transmitters to amateur frequencies, it's also about boosting your signals on 2, 4 and especially 6m for as little as £15 as Chris Lorek, G4HCL, explains.

Wandering around the surplus Pye gear at rallies — there were six stands with them at Drayton Manor this year — one sometimes sees the A200 on sale. It is often covered in dirt, as it is used as a 'stick it in the boot and forget it' add-on linear amplifier. People turn their noses up at them and walk away, not realising that even past professional radiotelephones could sometimes do with a few extra watts for maximum range.

Improvements in base station receiver design coupled with the ever increasing need for spectrum re-usage has meant that more of these units are finding their way onto the amateur market. Last year at an East Anglian rally, a large pile of these were offered for sale by one trader, but many were left unsold because people were very wary of what was inside them. Well inside these sturdy weatherproof boxes you will find a piece of mint-looking board with a 50W plus linear amplifier, complete with automatic RF sensing and changeover switching! Just the job for 2m, 4m, or — with some modes — 6m.

Identifying The Beast

This is very easy once you know what you're looking for, the only similar looking beast around has the same outer case but with two thick DC leads coming out of the side — this is a type VR200 24V to 12V converter. The most common amplifier has a single thick DC cable together with a coax socket mounted on either side of the cable exit, although you may sometimes find a later model, with one SO239 output socket and flying coax lead for the RF input. Internally they are virtually the same, but you may find the newer arrangement easier to install.

The DC cable is actually a very heavy current AC one with brown, blue, and green/yellow leads; brown is used as the positive 13.8V supply, blue as negative, and green/yellow as a switching lead. Please **don't** wire it up to your mains plug — the capacitors make a lovely exploding noise!

On the side of the case, you will find a riveted plate with "Cat No. A200" marked, below this is space for the aligned frequency of operation. Unfortunately this is often blank, but if you look at the section marked "Code", you will see something like "01 E0", which instantly gives you all the information you need. The first two numbers are the market code which is irrelevant for our purposes, the final letter/number combination gives the frequency range: E0=68–88 MHz, M1=105–108 MHz, B0=132–156 MHz, and A0=148–174 MHz. The E0 is useful for 4m, and both the B0 and A0 models will tune to 2m. 6m buffs should look for an E0 model.

Inside the E0 model are a pair of MPX085P or BLW60 transistor. These have forward bias applied via a wirewound resistor and two forward biased diodes. The RF path involves input and output printed circuit inductors, compression trimmers and a three stage low pass filter. A further capacitor and plate resistor on the input form a gain control to ensure the amplifier is operating in the linear portion of its input/output curve. RF sensing circuitry detects input drive and switches in the amplifier if DC power is supplied. The unit is extremely rugged both physically and electrically, and even incorporates an over-temperature cutout to stop the transistors overheating in use.

6m Modifications

Many amateurs are coming onto 6m with gear such as the FT690 or IC505, both reviewed in the May '86 issue. The output power of these, even with a reasonably large aerial system, will still not offer the legal maximum ERP on SSB. Commercially available transverters — such as the muTek and Microwave Modules units — give a greater power in general; even so an increase in power is always useful on initial CQ calls prior to final beam alignment.

At this stage I must point out that we should not use high power just for the sake of it. We are 'on trial' on 6m so remember to go back to

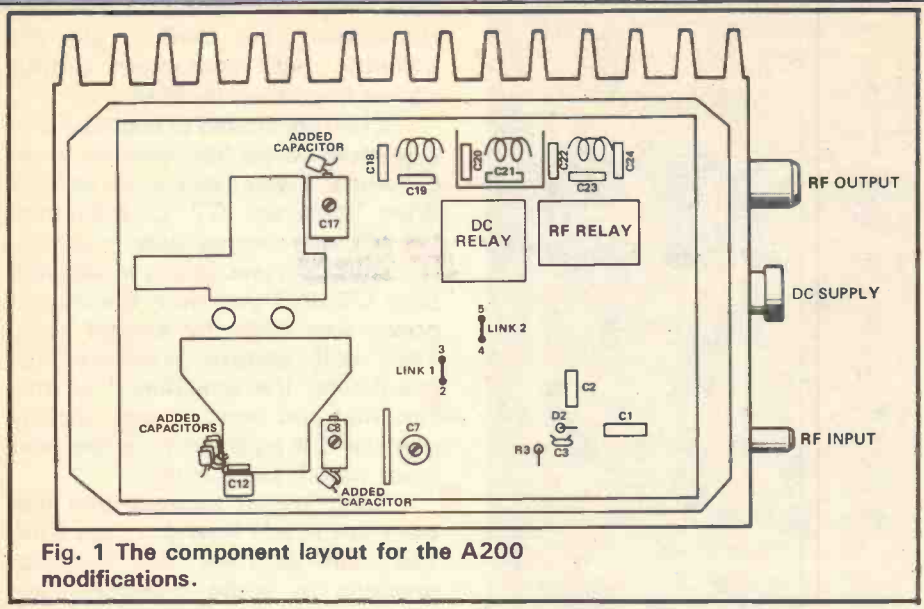


Fig. 1 The component layout for the A200 modifications.

low power when working your mate on the other side of town! Another problem is that of the second harmonic falling right in the middle of Band II broadcast frequencies. Many 50MHz sets fail in this respect and it could easily lead to a visit from the local RI man plus an angry neighbour deprived of £21.

The conversion was tackled in three stages, the low pass filter, then the amplifier itself, finally the switching circuitry.

Low Pass Filtering

Fig. 1 shows the layout of the unit. The low pass filter is made up in three sections and employs accurately made coils and tubular capacitors of close tolerance. It was decided to retain the original coils if possible and only modify capacitor values.

The existing filter was designed to pass 68-88MHz whilst attenuating the harmonics of these, which means that it probably would not offer too much rejection of 100MHz. A Hewlett Packard Network Analyser was used to check the attenuation and return loss characteristics of the existing filter circuit — the response being shown in **Fig. 2**. A set of capacitor values were calculated which would hopefully give the desired response, with maximum attenuation at 2nd harmonic and low loss of fundamental frequency. The network analyser was again connected to check that the response was just as required, see **Fig. 3**. Other units were modified with identical results.

Capacitor	Modification to be made
C8	Add 120pF across existing trimmer
C12	Add 750pF across, (see text)
C17	Add 68pF across
C18	Replace with 56pF
C19	Replace with 39pF
C20	Add 68pF across
C21	Replace with 18pF
C22	Add 68pF across
C23	Replace with 5.6pF
C24	Add 39pF across

Table 1 The component changes for adjusting the low pass filtering.

Table 1 gives the modification in capacitor values required. Please **don't** be tempted to use 'near' values depending on what your junk box holds, use close tolerance silver mica or ceramic plate capacitors of the exact value unless of course you use tubular ceramics as originally fitted. Note that some capacitors require changing, where others require an extra capacitor added across the original one.

You will need to remove the internal board to carry out the changes. When removing the three central screws securing the main heatsink block to the chassis, take care not to break the 1nF decoupling capacitors fitted on the solder tags. You will also have to disconnect the RF input and output leads, but the board may still be hinged out if you leave the DC power wiring connected. Watch out for the heatsink compound smeared on the underside, it's terrible stuff to get off your clothes. After these capacitor changes, all further work may be performed from the component side of the board so you can do the screws back up to keep the compound away from fingers etc. Don't forget to resolder the RF input and output links.

Amplifier Mods

The Smith Chart came out at this point, and the delights of j-notation were yet again contemplated together with the transistor manufacturer's data. Then came the soldering iron and the inevitable 'final touches' (fiddles?) were added — why couldn't it be like the low pass filter?

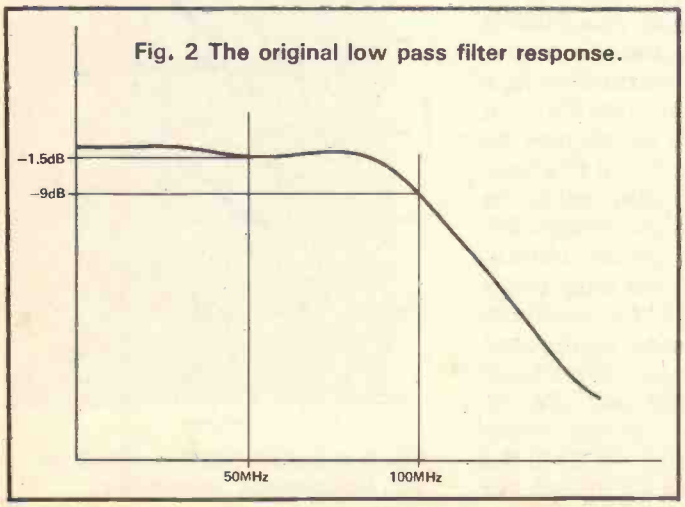


Fig. 2 The original low pass filter response.

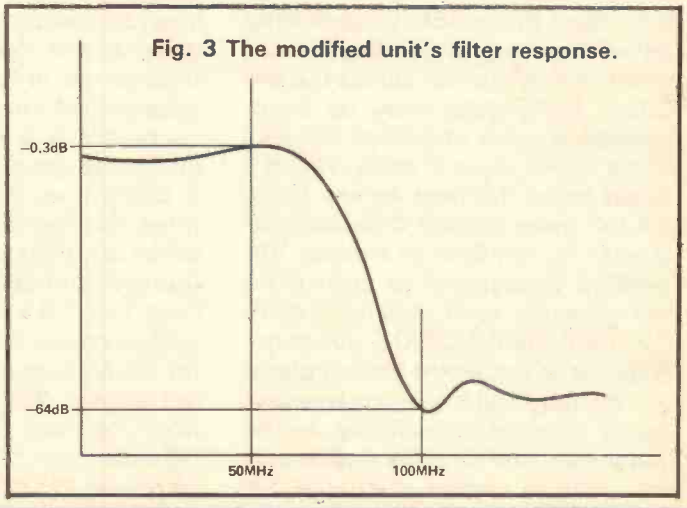


Fig. 3 The modified unit's filter response.

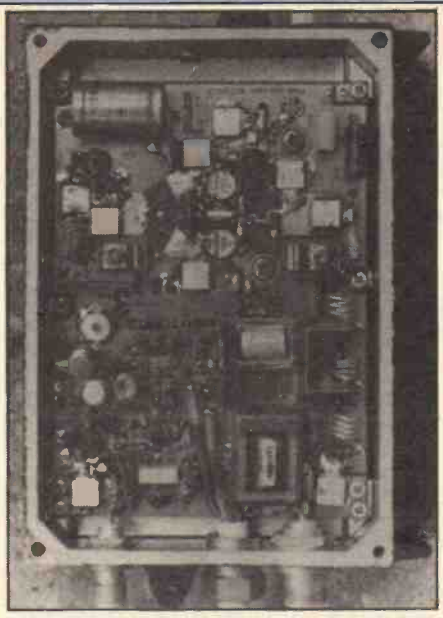
Both input and output impedances were more inductive with a decrease in frequency, so more capacitance to earth was required if I wished again to keep the existing inductors. This time, most types of capacitors may be used, values not being too critical, but ensure you use the shortest lead lengths possible. This is particularly true in the case of the added capacitors across C12, I found several in parallel to be the best. If you are feeling extravagant, Cirkit supply Semco mica-wrapped capacitors that are ideal for this use — you will see this type of capacitor already used on the input and output stages.

Across C12 you may see a silver mica 180pF capacitor added. This is used on manufacture when the amplifier is tuned below 78MHz. On later models with a flying input lead as opposed to input chassis-mounted socket, you will see a variable capacitance trimmer of 30-140pF. You will need a total of around 750pF extra, if the 180pF capacitor is fitted then subtract that, and if the trimmer is fitted set that to maximum (adjuster screwed tight) and subtract 140pF. Otherwise, four 180pF capacitors in parallel are ideal, soldered between the board earth plane and the input matching network board as shown in Fig. 1. The two other capacitors required are soldered between the 'hot' side connections of the trimmers and the board earth plane. Make sure you use a hot soldering iron to avoid dry joints here.

Switching Changes

As the amplifier is made for two-way AM/FM use, immediately the RF input power falls, the relays go back to their 'straight through' positions. If we want to use SSB, this would be rather annoying. By adding a small electrolytic capacitor across C2 and C3, a Tx/Rx delay may be incorporated. A value of 0.68uF will give about 0.75 second delay which I found to be the best for my taste, 0.47uF gives around 0.5s and 1uF around 1s. Any type of at least 10V working voltage will be suffice. Fit the capacitor with positive lead to D2 cathode/R3/C2/C3 junction, negative to the board ground plane.

You may find it useful to increase the RF switching sensitivity. As the unit stands, the amplifier switches in only with in excess of around 1W



drive power which could cause the loss of the first syllable or so of speech. Fit a small capacitor of around 4.7pF in parallel with the C1 (1pF) capacitor as this will increase the sensitivity to allow switching with about 50mW of 50MHz. Both of these capacitors may easily be fitted on the component side of the board.

Check that link 1 between pins 2 and 3, and link 2 between pins 4 and 5 are in place. You may then switch the amplifier in and out of circuit simply by switching the supply on and off. Alternatively, if you prefer to use a smaller toggle switch, connect it between the green/yellow supply lead and negative supply and unsolder both links 1 and 2.

Tune for Maximum Smoke

All that now remains to be done is a quick tune-up. Initially set C7 for minimum capacitance (vanes fully apart). Connect 13.8V DC and RF input and output leads, your 50MHz driver to the input, and the output through an in-line wattmeter to a suitable load. On early units the input connector is a TNC which may be difficult to get plugs for, in this case a flying coax lead may easily be fitted. Set your rig to give around 2W or so of constant power output, transmit and check the relay clicks over. Tune C8 and C17 for maximum output power, retuning as required for absolute maximum. You should get around 35W out with 2W in. Now connect your in-line meter between the 50MHz rig and the amplifier, and retune C8 slightly for the lowest input SWR — this will coincide with maximum output power from the amplifier.

If you are limited to less than 3W maximum power from your rig, leave C7 alone. If you can run up to 10W drive, then set C7 to maximum capacitance (vanes fully meshed), transmit your maximum power and tune C7 until you note the output power has fallen by around 10%. This will ensure you are not overdriving the amplifier. You may find that you need to very slightly readjust C8 again to give the best input match to your rig.

Don't try to squeeze the last watt out if you intend to use SSB, you will degrade the linearity resulting in audio distortion and splattering of your signal. For FM and CW use however, you will be safe with around 60W or so output with 10W input. I would not recommend using more than 10W drive power. If your set or transverter gives more, reduce the input level to 10W PEP maximum by applying suitable ALC, or by reducing the 28MHz or 144MHz drive when using a transverter.

Results

A number of A200s, of both new and old models, have been modified by myself and typical results and graphs are shown in **Table 2** and **Figs. 4** and **5** of the performance achieved. The output two tone intermodulation distortion with 2.5W PEP applied from a high

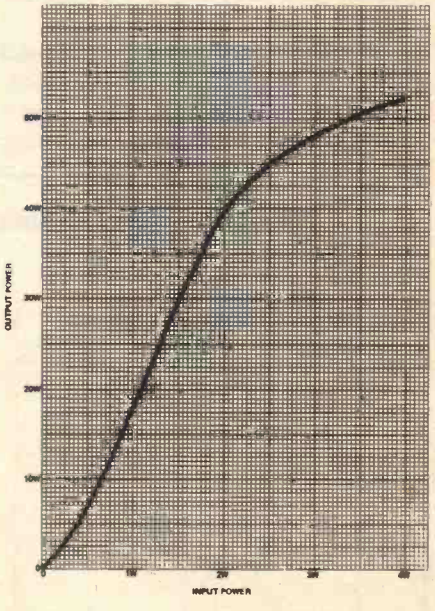


Fig. 4 A typical A200 modified for 6m, input/output relationship.

Table 2 The typical results achieved from a converted amplifier.

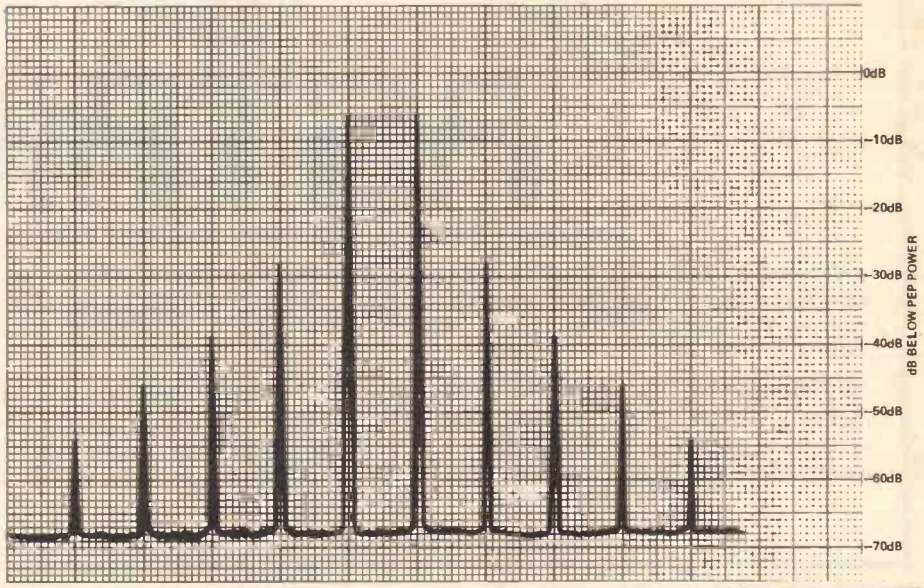
All tests performed at 50.25MHz unless stated.

Input/Output Relationship, sensitivity at maximum		
Power Input	Power Output	DC Current Drawn
0.5W	6.5W	2.1A
1.0W	17.5W	3.5A
1.5W	29.0W	4.3A
2.0W	39.5W	5.0A
2.5W	44.5W	5.6A
3.0W	48.0W	6.3A

Harmonic Output with 2.5W in, 44.5W out	
2nd Harmonic	−81dBc
3rd Harmonic	−90dBc
All others	<−90dBc

Straight Through Insertion Loss	Less than 0.5dB
RF Switching Sensitivity	Less than 100mW

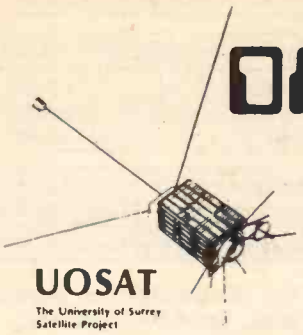
Fig. 5 The intermodulation distortion of a typical, 6m A200 with two signals at 50.2 and 50.3MHz.



quality laboratory source is better than that from a typical drive signal such as the FT690, or IC505 on mid power so you should not get any degradation in signal quality in these cases. Conversely, the output 2nd harmonic level will be substantially better than that of a typical drive source even though you are putting out more 50MHz signal, due to the good low pass filtering in the amplifier.

You now have a good 6m amplifier to get your signal heard. Make sure that your power supply can stand the extra current demand. Finally, if you can't find an EO band unit, remember when rummaging on the rally stand that an AO or BO one will work just as well on 2m!

DATA FROM SPACE!



ASTRID receives from UOSAT satellites:-
- ★ News Bulletins on spacecraft matters.
- ★ Operating schedule of UOSAT.
- ★ Satellite Status.
- ★ Experimental Data.
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- ★ Orbit Information.
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ASTRID

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ASTRID is only available from the manufacturers. Please send cheque or postal order (or use your Barclaycard or Access number) for £144.00 + £5.00 carriage to MM Microwave Ltd., Kirkby Moorside, Yorks. Y06 6DW. Tel: 0571-31620 Factory. Tel: 0653-7513 Design Engineer.

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160 TO	999 kHZ	£11.90	7th OVT	125.00	TO 175.0	MHZ	£10.00
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MICRO'NET

Reception of satellite signals requires a judicious mix of radio and computers. Dave Bobbett, G4IRQ, looks at ASTRID — a ready built receiver and decoder for the UOSAT series — and reveals more on RFI screening techniques.

From listening to the bands and reading the amateur press you might think that the amateur radio world can be divided neatly into two parts: those who only operate black boxes and develop nervous twitches at the thought of taking the covers off; and those who reckon that anything with less than 50 BC108s and half a mile of Veroboard inside is just kids stuff.

The fact is that it is not just the availability of sophisticated electronic 'take-aways' but also the time and resources involved in even fairly simple projects which dissuades aspiring constructors. Modern components require modern construction techniques and these in turn necessitate access to specialised facilities such as draughting and photo-etching equipment. Ordering components from several suppliers (and the cost of minimum charges and P&P); the non-availability of obsolete devices and the "Out-Of-Stock" syndrome — no wonder the newcomer opts out. There's no guarantee that the thing will work anyway!

For Micro' Netters (or Micro' Nutters as somebody suggested to me recently) the situation is, if anything, more difficult. Most other computer hobbyists tend to be software orientated and have been known to pass out at the sight of a naked soldering iron! So apart from the odd feature on how to get your VAX mainframe to control your train set, there isn't much DIY hardware around for data comms people. For the next few columns, we will be looking at both ready built and kit form data comms accessories so that you'll know what to look for and where to find it.

Introducing 'ASTRID'

As I've just mentioned, we will be taking a look at some of these kits in more detail later, but for this issue we will start off with a ready built unit which is designed for the reception of UOSAT1 and UOSAT2 signals. The Automatic Satellite Telemetry Receiver and Information Decoder (ASTRID) is intended to offer a 'plug in and go' solution to the reception and decoding of the UOSAT space vehicle 145.825MHz downlinks.

The system arrived packed inside a corrugated cardboard box and was

further protected by a substantial polystyrene moulding — a fairly abuse proof piece of packaging. The system, as can be seen in the photo nearby, comprises of the ASTRID receiver/decoder itself, a separate power supply, a set of connecting leads, an aerial, a test tape and a 16 page A5 manual.

First Impressions

The one thing which immediately struck me was the size of the ASTRID unit. As it was generally BBC micro shaped, I had fallen into the trap of assuming that the thing would also be about the same size. In practice, it measures only 6.5"(W)×6.5"(D)×1.75"(H) (ie 16.5 × 16.5 × 4.5 cm), which is small enough to sit comfortably on the top of the machine without getting in the way of the keyboard.

ASTRID is, however, a good bit heavier than it looks, it actually weighs 2lb 4oz (just over 1kg). This is due to the *steel* case — a feature which should endear the unit to the educational market where battleship engineering is always welcome. As well as making the unit extremely rugged, it also provides very effective screening against the RF garbage which virtually all micros throw out. The unit is nicely finished in a cream colour with a red screen printer central logo and clear labelling on all input and output sockets and controls.

The power supply is of the 'transformer in a plug' variety, with the rectifiers and smoothing capacitor fitted inside the 'plug' housing. I was a little surprised by the apparent lack of fusing but closer investigation showed that this is taken care of by a temperature sensing cut-out fitted to the transformer's primary winding. I left the system on overnight on a number of occasions and the PSU only gets slightly warm to the touch. The voltage regulators needed for the TTL circuitry of the decoder and the receiver section are fitted on ASTRID's main circuit board where there is plenty of ventilation and heat sinking provided by the PCB itself. As for those mere mortals who leave things on all night, there is a bright red LED on the front panel which will remind/confirm that the unit is connected.

The connecting leads and software supplied with the review unit were for use with the BBC micro's RS423 serial port. There is also a Spectrum version of the software which is accompanied by the appropriate leads for the Spectrum's Interface 1 expansion option. If your Spectrum doesn't have an Interface 1 fitted, ASTRID can be used with an unexpanded Spectrum Plus or Spectrum 48K by means of a suitable software package — details of one such package arrived with the review unit which enables direct input to be made into the micro's audio cassette port. The program is written by N Taylor, G4HLX, and is called the 'Spectrum UoSAT Data Demodulator' (SUDD) — further details in the 'Address Box'.

Assuming that your Spectrum does have the Interface 1 fitted, the software supplied with ASTRID can be used in either of two ways. Option 1 simply displays any 'live' or pre-recorded data on the screen whereas Option 2 allows the data to be stored in a user-defined chunk of memory and permits printing of the down-loaded text on a ZX type printer. For a change, Spectrum owners can take heart in the fact that their software package is less basic than that which is supplied for the BBC machine, however, for the purposes of this review my comments are confined to the BBC version.

The introductory manual supplied with ASTRID was a welcome relief from the photo-reduced dot-matrix nasties. The 16 page booklet is clearly and professionally printed and competently achieves its goal of explaining how ASTRID works, how to connect everything up and what can be done with the

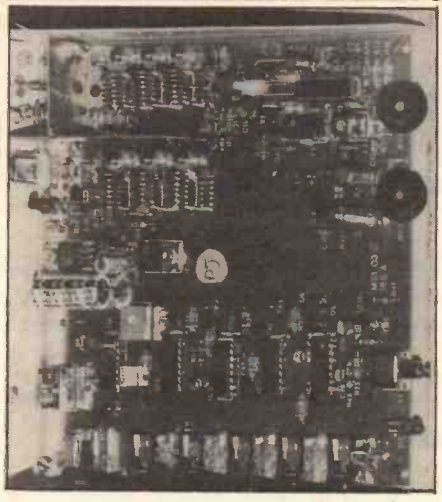
satellite data when it is received. For people who already know satellites inside out, it can be skimmed through for the essentials. As an introduction to space data reception for newcomers it doesn't baffle the uninitiated with mumbo-jumbo. Useful contact addresses for more advanced information and program sources are incorporated — so overall the manual is pretty good.

I did encounter one problem in setting-up because my BBC machine is solely disc based. Whilst it is not necessary to have a cassette-to-micro connecting cable for sending *data* to the computer (the data is fed into the serial port) it *is* needed to load the short program which is eventually used to check and display the resulting text. My cable went walkies years ago so I had to be baled out by the program listing supplied with the review unit.

I had a bit of trouble at first with the usual printer quirk of all the '£' (pound) signs shown on the printout meaning '£' (hash). The only other thing which I would recommend would be to set up one of the red programmable function keys so that one key press will 'RUN' the program. With a marginal signal, the program will exit every time it finds an error in the data so a single key re-start can save an awful lot of typing.

The test tape contains a selection of down-link signals of varying quality ranging from the 100% copyable to the virtually unreadable — an honest reflection of the sort of span one gets from satellites. However, it does mean that you have to be a bit careful to select a 'good' part of the tape when initially setting things up. It also helps to have a reasonable quality tape machine which doesn't distort or overload easily. The cables supplied are plugged to suit the 3.5mm type sockets for input and output (2.5mm for the remote control facility) so recorders having DIN type sockets would have to be rewired. Incidentally some cheap tape machines can get themselves into feedback loop problems if both EAR and MIC lines are connected simultaneously so if nothing seems to work properly pull one of the plugs.

The antenna supplied with ASTRID is quite a rugged affair but for the sake of newcomers and especially the educational market I do feel that a crossed dipole (instead of a single dipole) would have been a better choice. There are two reasons for this; the satellites would be well into the null of a single dipole at the extremes of their orbit if the aerial ran North/South reducing the maximum receiving time, and a non-rotatable dipole detracts from the overall efficiency of the receiving system. In fairness it should be said that *all* the data shown here was acquired off-air using the aerial supplied. Still it would have been nice to have had the extra time between the acquisition and loss of signal that a crossed dipole would have given.



Finally, as supplied, ASTRID has TV type aerial plugs and sockets which is ideal for the educational market being cheap and easily obtained. However, most radio amateurs will probably be using BNC connectors at VHF. . .

Probably the cleverest part of the ASTRID system is the idea of using the receiver's squelch line to operate the remote control function on a cassette recorder. As soon as the squelch is opened by a satellite signal, a relay switches on the tape machine. The pass is recorded and the machine is switched off again as soon as the signal is lost — a simple idea saving time, tape and tempers!

Open The Box!

I've always found that the inside of a piece of equipment invariably gives a much better idea of the overall quality than the outside ever can. I've already commented upon the substantial nature of the housing and one of the first tasks with ASTRID was to open it up and take a look at the 'clockwork' within. The circuitry is built on a double sided glass-fibre PCB and consists of two main sections: decoding, which is located on the left of the board adjacent to the row of input/output sockets; and receiver, which is on the opposite side of the board running back from the front panel volume and squelch controls.

Beginning with the aerial socket (which is a 75 ohm TV type), the signal passes through a tuned circuit to a BF981 dual gate MOSFET RF amplifier stage. The output from this is sent through further band pass filtering to the BF981 mixer where it is mixed with the local oscillator signal. The local oscillator is derived from the 3rd harmonic of a 45MHz crystal oscillator which is buffered and filtered before reaching the mixer stage. The resulting 10.7MHz 1st IF is fed through a 10.7MHz two pole crystal filter into an MC3359 IC, a mixer/limiter/FM detector package. Here the signal is converted to the 2nd IF of 455kHz by mixing with a 10.245MHz crystal source, passed through a 455kHz ceramic filter and finally resolved and sent to an LM380 audio amplifier IC.

The schematic diagram shown in **Fig. 1** reveals the overall design of the Rx is essentially a standard dual conversion 2m design, having none of the doppler-tracking PLL circuitry of other satellite receivers on the market. The only departure from the norm is, of course, that the squelch line is also used to operate a relay which allows remote control of a suitable tape recorder. With one of the passes used for this review being at 06:45 UTC unattended operation was not just possible but absolutely essential!

The Decoder Section

Once the data has been collected by the receiver and saved on tape, the decoder section of ASTRID comes into its own. It is possible to use the unit in real time, ie pick up the satellite and instead of feeding the audio to a tape recorder send it directly to the integral decoding section and on to the computer. The snag with this approach is that even if you are one of the lucky few who don't suffer from interference problems, you only get one chance of getting it right. Frankly, reading text at 1200 baud just isn't a viable proposition. If you have disc-drives then you could save the data immediately by using the *SPOOL command but overall I would recommend following the manual's advice and record the data tones on tape.

UOSAT2 (Oscar-11) uses audio tones which are directly compatible with the cassette port on the BBC micro and a number of other machines. This means that, in theory, it should be possible to play the recording directly into the micro and get data out. However, when you add the fading and other general pops and bangs which accompany satellite down-links, this approach is not too successful.

Another point is that the tones used on UOSAT1 are the other way round to those on UOSAT2 so there is a need for the signal to be cleaned up and the sense of the data to be inverted. The decoder section takes care of this by means of the "1 DATA 2" switch on the front panel. This connects an inverter chip into circuit when required so that the TTL data stream is the 'correct' way up. In practice, if you are not sure which of the satellites you are receiving flipping this switch will change garbage text into readable copy if the signal is good enough.

A small selection of the sort of information which can be down-loaded directly from these satellites is shown in **Fig. 2, 3** and **4.** Fig. 2 shows part of the news bulletin and updates concerning both UOSAT and other space vehicles which are available on UOSAT1, whilst Fig. 3 shows a newsflash carried by

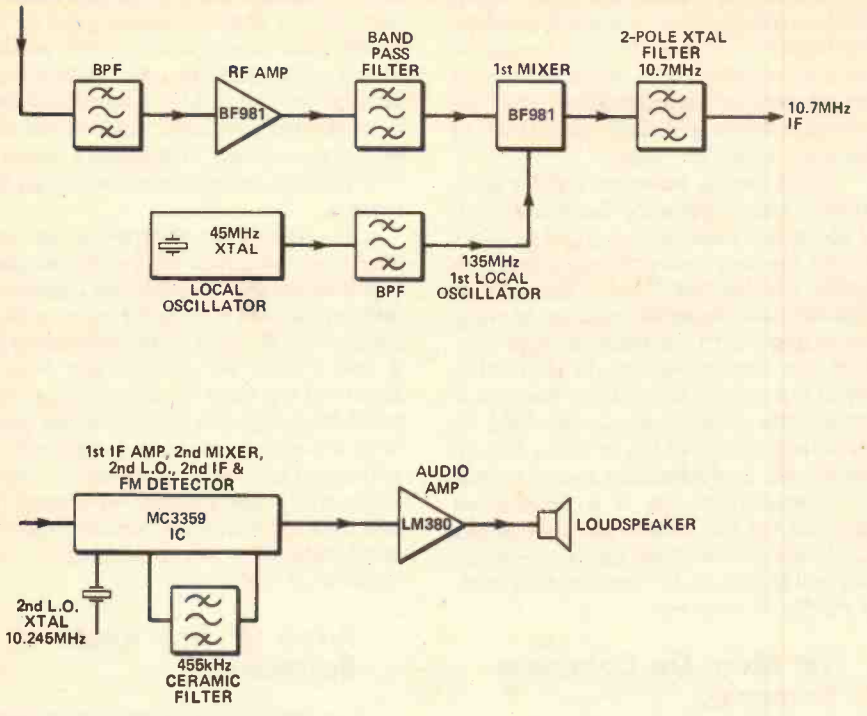


Fig. 1 The block diagram of the receiver section of ASTRID.

UOSAT2 telling users that UOSAT1 was back in action! In addition, both satellites transmit blocks of telemetry which are received in the format shown in Fig. 4(a) and 4(b). The data carries a header containing the satellite's name followed by the date (in year/month/day format), the number of the week in the current month and the time in UTC. As well as this the telemetry block contains data on 70 different channels on the space-craft. Fig. 4(c) shows the block split up into the various channels and programs can be obtained (for example from AMSAT UK) which will translate this into a complete satellite status report, showing everything from the output power of the 2m beacon to the temperatures of each face of the space-craft.

Conclusions

ASTRID is solidly built and well engineered and offers all the essentials for a basic minimum fuss UOSAT reception facility. I have my reservations both about the type of aerial supplied and the suitability of the aerial connectors for the amateur radio market. At a total price of £149 the package offers fairly good value for money considering that it is a ready built unit — better software and/or a slightly lower price would make the package more attractive.

The Radio Hackers Code Book

It must be said that this 240 page book by George Sassoon is a little difficult to categorise. The first 90 or so pages deal with an introduction to the theory and practice of data comms in the shape of morse, RTTY and AMTOR type systems. It goes on to briefly cover some of the other non-verbal communications systems both past and present, including what must now be one of the best known code machines, Enigma, dating back to World War II.

A brief mention is also given to the

```
***UOSAT 1 COMPUTER STATUS INFORMATION***
COMMAND DIARY V0.4 IN OPERATION
UNIVERSAL TIME IS 06:43:05
DATE 09/06/86
AUTO MODE IS SELECTED
LAST CMD SENT BY COMPUTER WAS XXH TO 0
LAST CMD RECD BY COMPUTER WAS 7DH TO 0 WITH DATA 16H
CURRENT WOD COMMENCED AT 00:00:00
DATE 09/06/86
SURVEY INCLUDES CHANS 03,22,30,

 ****    UOSAT-OSCAR-9 Bulletin-180A  05 June 1986        ****

** UO-9 OPERATIONS STATUS **

Rather than following the usual experiment schedule on 145 MHz,
UO-9 has been transmitting on 435 MHz for the last two weeks.
This is due to a subtle problem being experienced with the DIARY
software and an OBC data port.  It is important that we
understand the nature of the problem and further diagnostics are
being prepared.  A modified version of the DIARY software is now
in operation.  This should restore UO-9 operations to normal,
although we wish to pursue the source of the problem and this
may interrupt the operations schedule whilst tests are carried
out.  During this time, UO-9 will transmit on 435 MHz rather than
145 MHz.

Sorry for any inconvenience to users.  Take this opportunity to
get data on 70cms!  Reports are of great interest to UoS Group.
Operating Schedule:

The DIARY will run until 1230 gmt on 12066 when the VHF beacon
will be switched off and OBC re-loading will commence.

The Radiation detector will be switched ON this week.

This week's WOD schedule:  (All surveys start at 0000 UTC)

          Date        Chs

        090686    3,22,30
        100686    3
        110686    3,53,54
        120686    3,23,43

NOTE:  The VHF downlink will be turned OFF at 1430 gMt each day
starting 090686 to allow for possible OBC diagnostics which
would then replace the DIARY and operations revert to 435 MHz.
If the diagnostics are not required, the downlink will be
switched back on each day.
```

Fig. 2 A UOSAT1 status report and update which was down-loaded from the satellite using ASTRID.

```
***UOSAT 2 COMPUTER STATUS INFORMATION***
COMMAND DIARY V3.2 IN OPERATION
UNIVERSAL TIME IS 21:53:45
DATE 08/06/86
AUTO MODE IS SELECTED
SPACECRAFT SPIN PERIOD IS -0182H SECONDS
LAST CMD SENT BY COMPUTER WAS 40H TO 1
LAST CMD RECD BY COMPUTER WAS 00H TO 1 WITH DATA 00H
CURRENT WOD COMMENCED AT 00:00:00
DATE 08/06/86
SURVEY INCLUDES CHANS 02,03,30,52,
****!!!!NEWSFLASH!!!!****
DE  G3YJO  -  UOSAT-1  NOW  BACK IN OPERATION
060686.
```

Fig. 3 UOSAT2 status information and a newsflash on UOSAT1.

```
UOSAT-1          8606090064314 COMPUTER GENERATED TELEMETRY
00110001150502687B03001204001505717406338E073343084633093956
10120211140512273513365214309F15496F16714517331718476C19523C
20160521020122639C23013324009F2541462643302729862847182943 2E
30140631050732665433290B34666135311536364437410138473B39541A
40110441160242727443181F44017645000146004647469848469749 5008
50110551100552278A5308975465205535065644305746885848545 9456B

                    Fig 4a

UOSAT-2          8606080215522
00519D0140140225360360720405670504010602730705570804950903 82
10313011348F1200031306151414441544 9D16191E175982185639195937
20708F21187D22699A2300012400172530072609 7A27587F285791295428
30523731037632285E3358OD340007352576363126374 49D384906395197
40766341122242640443064544164345000146000247509F485229494922
50536551103652658C532774546645550000560003575160585118595 15D
60830D615FD0621F4E6333416444026 51E0C6647ED67700668000E69000F

                    Fig 4b

UOSAT-2          86/06/08 0 21:55:22
00519D 014014 022536 036072 040567 050401 060273 070557 080495 090382
103130 11348F 120003 130615 141444 15449D 16191E 175982 185639 195937
20708F 21187D 22699A 230001 240017 253007 26097A 27587F 285791 295428
305237 310376 32285E 33580D 340007 352576 363126 37449D 384906 395197
407663 411222 426404 430645 441643 450001 460002 47509F 485229 494922
505365 511036 52658C 532774 546645 550000 560003 575160 585118 59515D
60830D 615FD0 621F4E 633341 644402 651E0C 6647ED 677006 68000E 69000F

                    Fig 4c
```

Fig. 4(a) and (b) Typical UOSAT1 and UOSAT2 telemetry blocks down-loaded from the satellites.
Fig. 4(c) An edited telemetry block showing the heading detail and individual data channels.

'Hellschreiber' system of the same era which has recently enjoyed something of a small-scale renaissance on an experimental basis amongst European amateurs. This was not a coding machine, but is considered by some to be a superior form of RTTY system being far more tolerant of speed fluctuations than the latter since it is (for want of a better description) a hybrid of RTTY and FAX technology.

One interesting point was that after 40 or so years of dormancy, Hellschreiber-type signals have been picked up from the People's Republic of China. The author suggests that the most likely explanation for this is that the system is admirably suited to the idiogrammatic form of Chinese writing where the same character represents the same word or concept but is pronounced in entirely different ways by the various language groups within the country. The FAX aspect of the Hellschreiber system allows any of the 20000 or so idiograms to be drawn easily so communication via a common written language is made more straightforward.

At the back of the book, there are some interesting programs such as an RTTY receive program for the ZX Spectrum and circuit details of a Phase Lock Loop based interface for transceive operation. But the main thrust of the book isn't really about the practical side of data comms at all. It is aimed at those who are interested in the world of secret codes and the mathematical challenge of cracking them. It details the different 'families' of code systems such as simple Encryption, Substitution and Transposition Ciphers and Public Key Ciphers. The book includes an 'Enigma Emulator' program which mimics the operation of the electro-mechanical original and I am sure that some will find that aspect of the book quite intriguing.

Most people however will be quite content just to get a feel for the subject of codes and code-cracking and to relate to the obvious enthusiasm which the author has for this area — the level of mathematical expertise required to really get to grips with the book is quite considerable. I need hardly add that using any of the ciphers on amateur bands will not exactly endear you to the folks at GCHQ and of course the amateur licence **specifically prohibits** such secret codes.

Overall then this is a publication intended for the mathematically adept puzzle-solvers amongst us and no doubt they will love it. As for mere mortals such as myself — beware!

Yet More On Computer Screening

I hope no-one has resorted to using those 3g bottles of silver conductive paint at £5 a throw in an effort to solve their computer RFI problems. However, I have recently come across a couple of slightly saner solutions which have appeared on the market — presumably in response to the howls of despair emanating from the amateur radio community.

The first approach is simply a DIY version of a service mentioned in the past whereby the computer's case is sent off to a specialist spray plant for the inside to be treated with a nickel powder based paint. A similar paint is now available from Cirkit Holdings in aerosol form consisting of powdered nickel mixed with an acrylic carrier. This gives a conductive coating which also acts as an RFI screen.

By way of an alternative for situations where direct solder connections to the screening are required, Copperfoil Enterprises can supply 33 metre rolls of copper foil in three different widths (4, 6 and 8 mm) or you can get 1 sq ft sheets of the stuff for those 'larger' RFI problems! Both the sheet and the tapes have an adhesive backing designed to withstand high temperatures. It occurs to me that a combination of copper foil and zinc spray coating should make for fairly effective RFI screening in the majority of instances.

Know Of Any Apple Software?

I've had a letter from Simon Creasy (G4PKQ, VS6CX and ZL1BH) in Hong Kong recently bemoaning the fact that amateur radio programs are impossible to get hold of over there. If you know of a source of disc based Apple IIe radio related software perhaps you'd like to either drop him a line directly or let me know and I'll pass the information on. Simon's address is: S Creasy, CPA, PO Box 1, Hong Kong, and I am sure that he would appreciate any information readers were able to give.

Address Box

Note all prices shown here include VAT and postage and packing charges. Please remember to send SAEs with any enquiries.

ASTRID Satellite Receiver/Decoder System currently for BBC Model 'B', Electron (with official serial port), Spectrum Plus and Spectrum 48K (with Interface 1 fitted). Amstrad 464, Commodore 64, Apple IIc and IIe, Versions for Sinclair QL, and Tandy TRS80 are under development.
Price: £149
Available from:
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Ings Lane
Kirkbymoorside
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Tel: (0751) 31620

SUDD UOSAT data demodulator program for Spectrum Plus and Spectrum 48K (does not require Interface 1). Cassette and 7 page instruction booklet.
Price: £4.50
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Stanford in the Vale
FARINGDON
Oxon SN7 8ND

The source for satellite related information is:
AMSAT-UK
94 Herongate Road
Wanstead Park
LONDON E12 5EQ

UOSAT data sheets giving full details of these vehicles can be obtained from:
University of Surrey (UOSAT)
GUILDFORD
Surrey GU2 5XH

Adhesive backed copper foil tape and sheets:

33 metre rolls	4mm wide	£3.70
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Tel: (04024) 56697

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200gm aerosol
Stock No 51-11123 £8.07
Available from:
Cirkit Holdings PLC
Park Lane
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Tel: (0992) 444111

'The Radio Hackers Handbook' by George Sassoon. Published 1986 by Duckworth, London.
Price: £6.95

To contact Micro' Net:
Ham Radio Today
No 1 Golden Square
LONDON W1R 3AB
or:
DG Bobbett
PO Box 49
COLCHESTER
Essex
or via Prestel
Prestel Mailbox No: 01-999 9045

ASTRID's Man Replies

The designer of ASTRID, Steve Webb, G3TPW saw a copy of Dave's review and has made these comments.

The aerial supplied with ASTRID was chosen after considerable thought and experiment. Crossed dipoles were tried but overall they did not give a significant increase in copy time. Presumably, when the satellites are low on the horizon to the east or west (ie with a long path distance) the 3dB loss of the crossed dipole reduces copy time. Remember that at low angles the crossed dipole will be horizontally polarised and will be 3dB down on a broadside simple dipole. Of course, the crossed dipole gives better signals when the satellite is overhead. On balance, I could not decide which aerial was the best so I opted for the cheapest.

Other 2m aerials can always be used. A 50 ohm system works equally as well as a 75 ohm one. A handheld four element Yagi can be used to demonstrate satellite tracking quite effectively.

I am sorry about the 75 ohm TV connectors. I decided to use a 75 ohm system with TV plugs and sockets because of the availability of back to back connectors and standard 75 ohm coaxial cable from TV shops.

The software is crude and simple. I did not have any more complex software developed as I did not want to compete with AMSAT UK. Their profits from UoSAT software are used to fund new satellites.

Finally, the price. Well I still haven't got my tower to get the 2m 10 xy and 70cm helix back up since my move to North Yorkshire to design and produce ASTRID. I aimed at £125 on a selling price and it is only £129.57 before the VAT man gets his cut!

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The Cheap And Easy Way
Ted Nield, GW3ARP, describes a veroboard design to give flexible Rx (Tx the following month) operation on popular surplus PMR gear.

SCANNERS
Tony Bailey, G3WPO, looks at the Regency 7000, AOR2002 and Icom ICR7000.

Ad Index

A Fresh Look At The Yaesu FT101ZD

Harry Leeming, G3LLL, turns his attention to HF and the FT101ZD — the last in the long and very popular line of the Yaesu FT101 models. A two part article covering all the marks, what they have, how they work and how to service and repair them.

The Yaesu FT101 series was probably the most popular line of amateur radio equipment ever made and worldwide sales ran into many hundreds of thousands. In my previous series of articles (which ran in April, June and August '83 and February and June '84), we followed the FT101 from its inception in 1972 to the last of the original series — the FT101E taken out of production in 1978 to be replaced by the FT101ZD.

The FT101ZD differs from its predecessor, the FT101E, in design concept and appears to have been developed as a simplified economy version of the FT901 which in 1978 was the top of the line. It has also been very popular despite not containing a general coverage receiver, memories or built in bread slicer! It does have an extremely good receiver and contains most of the facilities that most amateurs want together with an enviable reputation for reliability.

Variations On A Theme

The FT101ZD Mk 1 was introduced in 1978 and differs from later versions in that only the SSB and CW modes are provided for. The Mark II is identical to the Mk I except that AM operation has been added together with a few minor modifications. Later production models of the Mk II, known as the Mk IIA, are fitted with the new 12, 17 and 30 metre bands and have the "FT 902" type RF board together with an improved frequency counter. This frequency counter can be identified by the 40 pin IC which replaced 15 separate ICs used in the older counter.

The Mk III version was the last and most popular unit. It is fitted with a peak and notch filter and has either AM or FM capability. Units were supplied either fitted with AM, FM, or even no board at all in the AM/FM position. Check what is or is not fitted before presuming that you are buying an FM model and parting with your money. The simplest way to find out is to switch to the AM/FM position and note that the squelch control will only function if an FM board is fitted.

Finally if you have come across the Yaesu FT101Z, you will find it is identical to the FT101ZD except that the latter includes a digital frequency display, whilst the former has a mechanical analogue dial. It can be converted to a "ZD" by removing the analogue dial and fitting a counter. Unfortunately, the conversion kit is very expensive and difficult to obtain.

A range of extras was marketed by Yaesu, some of these being fitted by certain importers as standard, although not all are still available.

CW Filter The FT101ZD provides positions for wide and narrow CW reception on the mode switch, but the facility only works if a CW filter is fitted. Two filters are available at 600 and 300Hz bandwidth. In the writer's view it is better to fit a 300Hz filter as a bandwidth of not much more than 600Hz can be achieved in the CW wide position using the width control, thus reserving the CW narrow position for when things get really rough. Some users, however, object to the slight ringing on the narrow filter and prefer the 600 wide filter. Unfortunately, you cannot fit both.

Cooling Fan With 6146B valves rapidly approaching £30 a pair, a cooling fan is a must. At the time of writing this item is still available.

DC-DC Converter. This is a square unit with a perforated black metal cover that screws on to the back of the FT101ZD. In conjunction with windings on the mains trans-

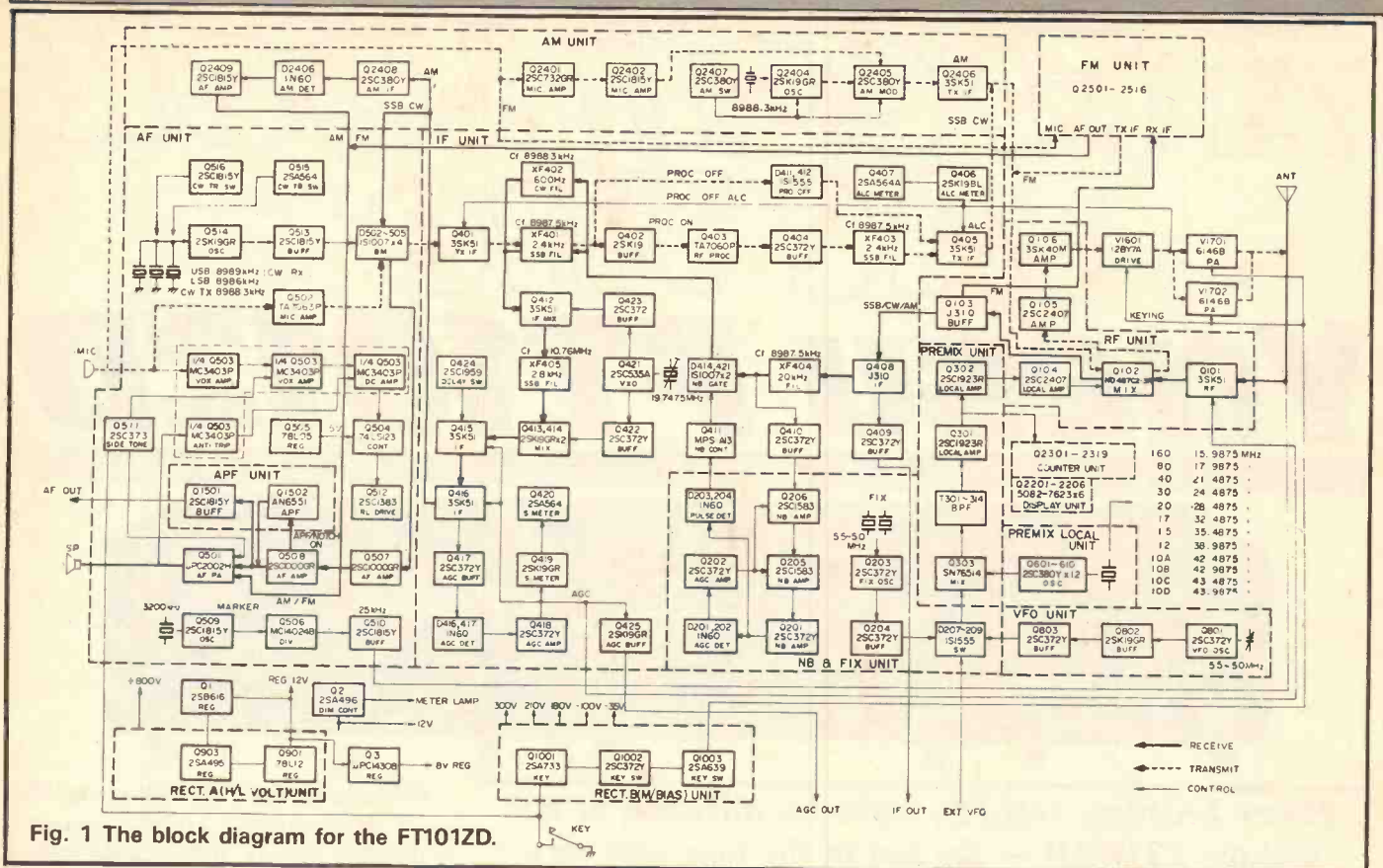

Fig. 1 The block diagram for the FT101ZD.

former, the DC-DC converter functions as a power oscillator at around 50Hz to enable the transceiver to be operated from a 12V supply. The current drain at 12V is 5-6 amps on stand-by and about 25 amps peak on transmit. When equipped with the DC-DC converter, the FT101ZD makes a very nice mobile rig *if* your car and battery are big enough!

AM Unit This PCB will fit any FT101ZD from the Mk II onwards and transmits good quality AM. Reception is a bit of a compromise as the signal passes through the SSB filter resulting in a receiver audio response which is rather short of treble.

FM Unit This alternative PCB can be fitted in place of the AM unit in the FT101ZD Mk III. It can also be made to work with the FT101ZD, Mk II if the dim control is disconnected and re-wired as a squelch control. If you do this, fit a preset 5k ohm pot inside the FT101ZD to enable the correct counter brightness to be set.

Monitor Scope YO901/P If you come across one of these accessories secondhand remember that there are two versions only one of which has the band scope "panoramic adaptor" parts fitted. This version besides providing transmit monitor facilities also spectrum analyses the band you are listening to on receive.

FC901/FC902 Aerial Tuning Unit These are first class ATUs, the only difference being that the latter version is fitted with the new WARC bands. The units are rated at 500 watts, but the coils and tuning capacitors are larger than some rated twice this power. The only weak link found is that the diodes in the SWR bridge are rather under rated, and the writer usually swops these for OA91's in the event of any trouble.

FTV901R VHF/UHF Tranverter This can be obtained secondhand fitted with various combinations of 2m, 6m, or 70cm modules, and is extremely attractive and convenient to use with the FT101ZD. It can be left in circuit permanently, and lead swopping is not necessary when moving from HF to VHF or UHF. Do note, however, that the 70cm module does not have fitted the standard UK repeater shift, and that modification is not always possible to enable this to be fitted. The FTV901 if bought secondhand at a good price can be an attractive proposition, as it enables all the features of the FT101ZD to be used at VHF/UHF.

SP901 Speaker will enhance the appearance of your station, but if you only want results, I must be honest and say that I prefer the

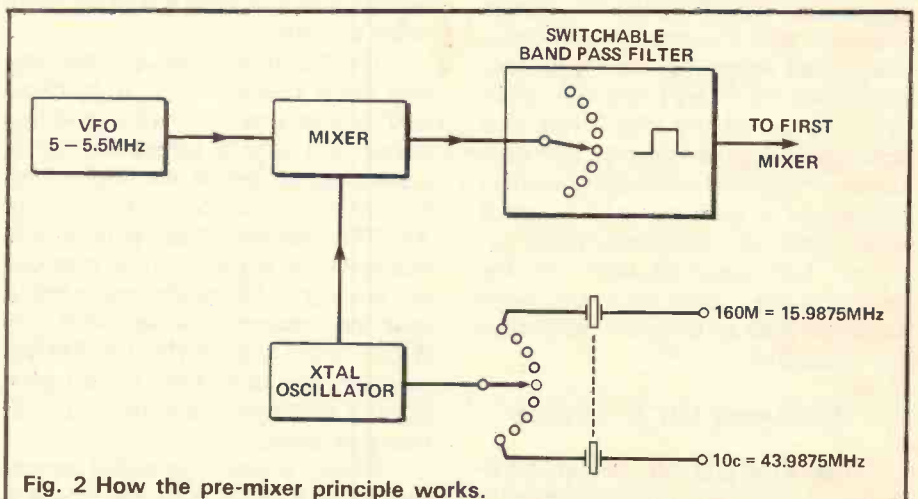

Fig. 2 How the pre-mixer principle works.

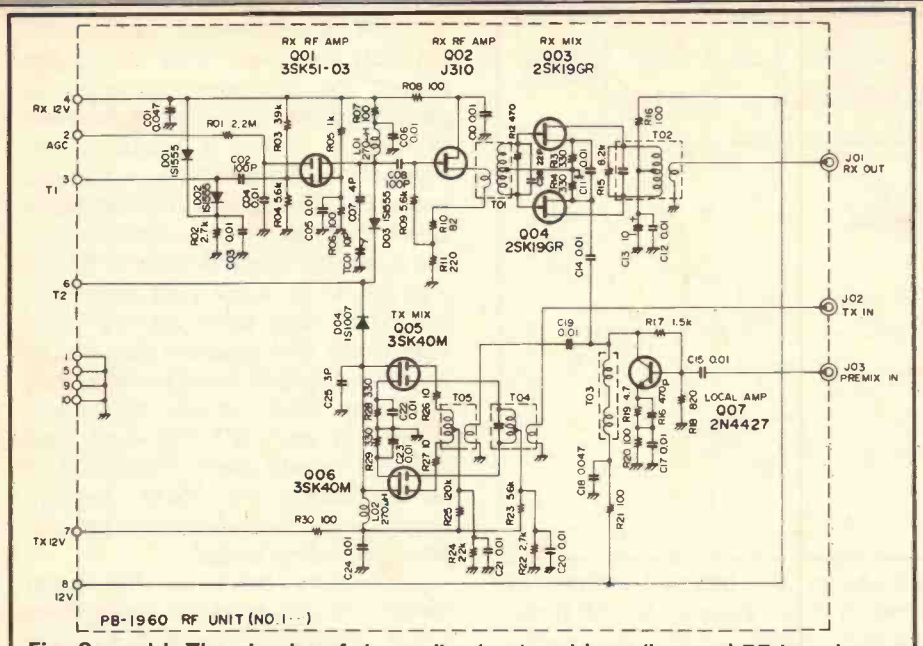

Fig. 3a and b The circuits of the earlier (top) and later (bottom) RF boards.

internal speaker on the FT101ZD or a pair of headphones for DX operation. Note that the SP901/P is fitted with phone patch connections.

External VFOs The VFO made for use with the FT901 and FT902 — FV901DM — is suitable for use with the FT101ZD, but not with the FT101Z since no frequency readout is provided on the VFO — it utilises the digital display on the transceiver. The analogue read-out FV101Z can be used with any FT101Z/ZD, or better still Mk III FT101Zs or ZDs can be used with the FV101DM which includes it's own digital read-out (it will not work with earlier FT101ZDs). A secondhand FV101DM obtained at "the right price" is probably the most cost effective way of digitalising an FT101Z, Mk III. A new internal digital display — if it can be obtained — costs well over £100 and does not, of course, provide for the possibility of split frequency or memory operation.

How It Works

Looking at the block diagram shown in **Fig. 1**, we can trace how the system works. Like the FT107, FT200, FT707 and several other Yaesu models, the FT101ZD uses the pre-mixer principle to obtain single conversion super HET operation with only one stage of conversion before the stages of high selectivity. This gives good rejection of cross modulation but requires that the VFO injection to the first mixer be always 8.9875MHz higher than the signal frequency, as this is the IF.

Other manufacturers have tried switching the frequency of the VFO itself when changing bands, but this is very difficult in practice and commercial amateur transceivers which have been made this way have sometimes ended up with horrendous drift problems. Yaesu's approach can be seen in **Fig. 2.** If we set the VFO to give an output of 5.1MHz and switch to 160m on the bandswitch, the VFO will mix with the output of a 15.9875 crystal oscillator and the difference frequency (15.9875−5.1=10.8875) of 10.8875MHz will be selected by the switchable band pass filter. 10.8875MHz is the correct injection frequency required for receiving 1.9MHz and mixing this with a signal frequency of 1.9MHz (10.8875−1.9 =8.9875) will produce the correct IF of 8.985MHz.

The same idea is used on all the other bands; so that by selecting the correct crystal oscillator and band pass filter, the band switch provides an oscillator injection signal for the first mixer whose stability is mainly dependent on the quality of the 5-5.5MHz VFO. This gives accuracy and stability of the transmit and receive frequencies without the complication — or noise — of a digital synthesised arrangement.

Moving on to the SSB receive path, the RF stage uses a dual gate FET followed by a double balanced mixer. The circuits of the early and later versions of the RF board are shown in **Figs 3a** and **3b.** Just how much better the diode ring mixer performs compared with the earlier balanced FET's is debatable and in practice either RF board seems pretty effective. As Fig. 1 shows the output of the RF board goes via a couple of J310 FETs (a large signal handling low cross modulation device) to the 20kHz "roofing" filter.

Following the roofing filter, comes the noise blanker. Noise blankers are funny devices. Some are deviously spectacular in design concept but operationally useless, others are very simple and work well. The FT101ZD noise blanker falls into the latter class and works much better than that fitted to the more expensive FT902.

The variable selectivity (*not* band pass tuning) arrangement is shown in **Figs. 4a, b** and **c** where the frequencies have been "rounded off" for simplicity. The receive signal is passed through XF1, centred 1.2kHz either side of 9MHz — the total

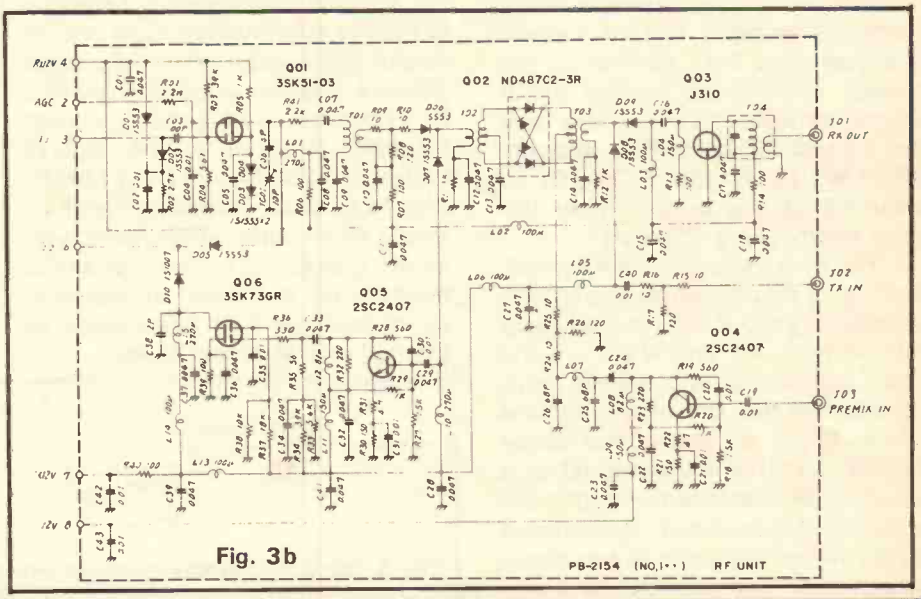

Fig. 3b

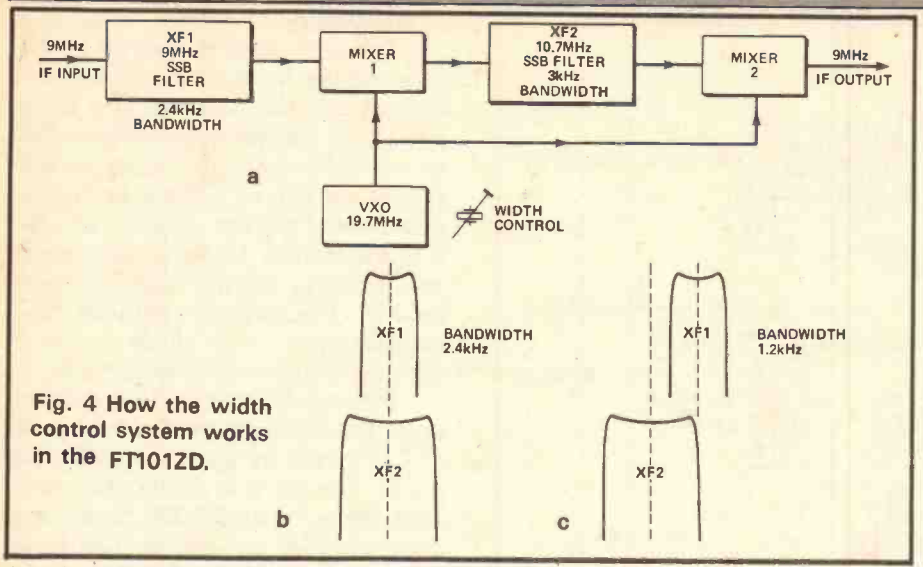

Fig. 4 How the width control system works in the FT101ZD.

bandwidth being 2.4kHz. This signal is mixed with the 19.7MHz VXO oscillator (19.7−9=10.7) to produce a signal of 2.4kHz bandwidth centred on 10.7MHz. This passes through the centre of the band pass of XF2. Mixing this signal with the VXO again in mixer 2 (19.7−10.7=9) produces a 9MHz signal identical with that which left XF1 except that having passed through two filters, the skirt selectivity is rather better.

Now note what happens if we adjust the frequency of VXO by the width control to say 19.7015MHz. 19.7015−9=10.7015MHz so that the IF going to XF2 is centred on 10.7015MHz and not 10.7MHz. The signal will still extend 1.2kHz either side of 10.7015, but only the half of the signal below 10.7015 will be able to pass through XF2. Hence the receive bandwidth is reduced to 1.2kHz. Adjusting the width control "chops" off either the HF or LF side band depending on which way it is turned — giving continuously variable selectivity. The VXO signal is delivered to both mixers; so the change of IF made by the width control cancels itself out and only the correct IF of 9MHz (actually 8.987.5MHz in the FT101ZD) is delivered at the output, only the band width being adjusted.

The demodulation and AF amplification is pretty conventional with a diode ring mixer SSB demodulator followed by AF amplification and filter stages. Some users have commented that the receive audio is not as bright as that of the earlier FT101E, but this is intentional as a low pass filter is incorporated in the amplifier stages to reduce HF noise. To the writer's ear, this is just about optimum if communications headphones or the internal speaker is used. A larger speaker or hi-fi headphones made sound somewhat bassy and although the components around the filter could, no doubt, be altered to compensate, a swap of speakers or phones is simpler.

The Transmission Path

The AF signal from the microphone is amplified by an IC and applied to the receiver ring mixer — which is "thrown into reverse" — to act as a balanced modulator giving a double side band (DSB) suppressed carrier signal at its output. On transmit, the variable selectivity circuit is switched out and SSB is generated in the conventional way by applying the DSB signal to the crystal filter. If the RF speech clipper is brought into circuit, the SSB signal is then clipped and applied to a second SSB filter before going on to the transmit mixer which is on the plug in RF board.

The transmit mixer is balanced to reduce spurious products and its output is applied to the driver valve. This is a 12BY7A, originally intended by its makers to be used as a video amplifier. Because of this, not all makes of 12BY7A suit the FT101ZD and NEC was originally fitted by Yaesu. Some alternatives work well, others give low drive and cause the pre-selector to peak at different points on Tx and Rx particularly on the higher frequency bands.

Like Trio/Kenwood, Yaesu presumably designed their PA stages around the Japanese equivalent to the 6146B, the S2001, and were left in mid air when it went out of production. Fortunately, whilst the voltages applied are considerably above the makers recommendations, the American General Electric 6146B was found to work well and most FT101ZDs have been factory fitted with these. One problem that occurs with the General Electric valve was flashover from anode to screen which on early FT101s (and also FT901s) caused nearly 1000 volts to be applied to the 350V working screen supply de-coupling capacitors, exploding them!

In later models, flashover damage is prevented by connecting a high voltage rectifier diode in series with the screen supply so that current can go into the screen but cannot come out of it. If your rig is not fitted with this diode (in series with L04 on the circuit) you are strongly advised to fit it. Details are shown in **Figs. 5a and 5b.** The same applies to *any other rig* which uses 6146Bs and has a final voltage of 900-1000 volts against the recommended 600 volts. This modification can save a lot of trouble and expense as new GE 6146Bs tend to flash over until the dust has cleared from their electrode system.

Other makes of 6146B? RCA work well in the FT101ZD but now seem to have disappeared from the market. Others I have tried are noisy on receive. This is a peculiar effect in that the background hiss increases particularly on 10m once the PA valves get hot. Some alleviation to this problem can be obtained by wiring the antenna relay spare contacts to short out the earthy end of the PA coil on receive, but the only real cure is to remove the 900 volts supply, or fit GE or RCA 6146Bs.

In next month's part, G3LLL will take a look at the servicing and repairing of the FT101ZD. If you intend writing to G3LLL, please send it to Amateur Electronics/Holdings, 45 Johnston Street, Blackburn BB2 1EF enclosing an SAE.

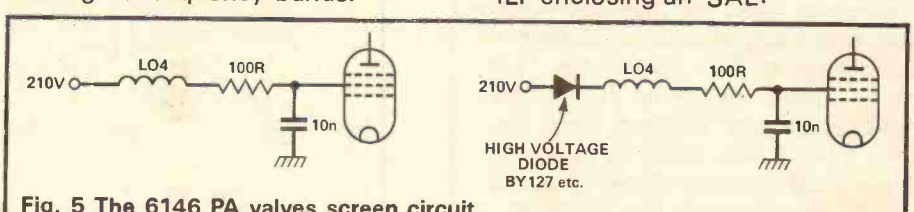

Fig. 5 The 6146 PA valves screen circuit.

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HOWES QRP TRANSMITTERS. We have three QRP CW transmitters in our range at the moment. The **CTX** transmitters are available for 40 or 80M bands, and the **MTX20** is for 20M. All three feature adjustable outpur power, up to about 5W on 80, 3W on 40 and 10W on 20M. The heatsinking for the output stage is onboard, and one crystal is included. There is space for two more crystals on the PCB, and provision is made for connecting a VFO. The CVF VFOs are available for 40 and 80M at the moment, the 20M version is under development. The VFOs have dual buffered outputs, so that not only will they drive the transmitter, they can also drive the DcRx receiver as well, for full transceive operation. Voltage regulation, and IRT (clarifier) facilities are included.

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HOWES 2M to HF TRANSVERTERS

If you have a 2M SSB/CW transceiver (an FT290 for example) you can get on to 20 or 80M without having to spend a fortune on an HF transceiver. These transverters also make HF Mobile operation much more practical, as a small 2M rig is all that has to be mounted within reach of the operator. These units deliver about 10W output from mismatch proof transistors, and do not require any fancy test equipment to set them up. A high proportion of fixed value filter components keeps alignment simple, and the output spectrum clean.

HC220 20M Kit £48.90	**Assembled PCB Module £79.90**
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The CTU30 is a "T" match type ATU for use with receivers and transmitters of up to 30W output on all bands from 1.8 to 30MHz. It uses two air-spaced capacitors, and 12 switched inductance settings. An unusual feature in a small ATU is the provision of a balun for feeding balanced antennas in addition to the more common unbalanced types. All the parts are PCB mounted in this novel design. Simply add a case and connectors to fit in with your station, even the knobs are included in this kit!

HOWES CTU30 Kit £24.90 **Assembled PCB Module £29.90**

HOWES TRF3 SHORTWAVE BROADCAST RECEIVER

The TRF principle was developed 80 years ago. Here it is brought up to date with modern silicon devices. The receiver tunes from about 5.7 to 12.8MHz in three bands, if you wind the coil as suggested in the instructions, although you can easily experiment with the coverage if you wish. The TRF3 has switchable input impedance and attenuator, so it can be used with large or small antennas. This is an excellent educational project for the "junior op", as well as providing a bit of fun for the old timer as well! You should be able to read all about building it in the September issue of Ham Radio Today.

A suitable tuning capacitor is available at £1.50

HOWES TRF3 Kit £13.90 **Assembled PCB Module £18.90**

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73 from Dave G4KQH

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- ALL COAX + NECESSARY PLUGS.

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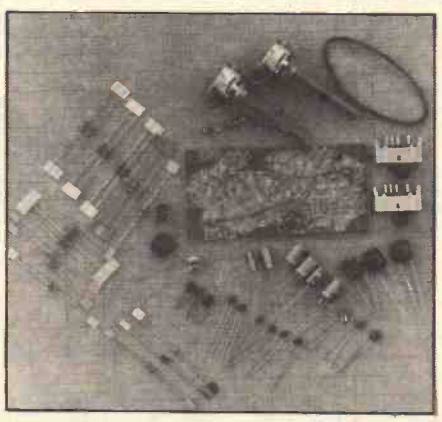
The TRF3 SW Broadcast Receiver



To celebrate the 80th birthday of the regenerative receiver, David Howes, G4KQH, describes this TRF' receiver which as well as an improved performance, offers the old thrill of hearing far away stations on a simple, home built set.

Radio — as in long distance point to point communication — started towards the end of the last century. However, it was in 1906 that Edwin Howard Armstrong 'invented' the regenerative receiver which in a variety of forms was to become the mainstay of broadcast reception into the middle of this century.

These sets used thermionic valves and tended to be much bigger and heavier than our modern receivers. They also suffered from several shortcomings in their performance — power consumption not being the least of them! Another was the large amount of RF radiated from the receiver as the listener advanced the "regen" control to tune into a station — you could tell if your neighbours were tuning in to listen to the same programme by the loud whistling noises emanating from your receiver. Needless to say, the modern design described here does not suffer from these shortcomings in quite the same way!

The Design Concept

My very first shortwave receiver was a simple one valve TRF design that I bought as a kit from a magazine advert at the age of 12. It worked all right but not as well as I would have liked. In a way, this was very valuable, because it set me thinking about how to improve matters and I learnt a lot from the subsequent experiments.

The receiver described here does not suffer from the problems I encountered with my one valve set, but there is still plenty of room for experimentation by anyone wishing to extend the frequency coverage, and add extra facilities if they wish. The basic design requirements that I decided to work to are:—

1. Audio output/power consumption The receiver should be capable of being battery powered — and hence have a low quiescent current — but should also be able to provide a good output power if needed. A TBA820M audio output chip was selected to meet these requirements. This device gives up to 2W of output from a 12V supply, but needs only a small current at lower volume settings. The quiescent current consumption of the receiver is around 15mA, depending on the exact supply voltage used. The receiver should be able to operate from anything between 9 and 14V DC.

2. Sensitivity and antenna requirements It is not always possible to use a large antenna in many locations, especially if the receiver is to be built as a portable set operating from a whip type antenna. An RF amplifier stage having a high input impedance would enable short antennas to be used, this amplifier stage would also help prevent the oscillations from the detector stage radiating to the annoyance of nearby listeners. A field effect transistor would do the job nicely. Larger antennas could be used if a low impedance input could be selected, and an attenuator provided for strong signal conditions, to prevent overloading. A switched input network was therefore designed to give this versatility.

3. Frequency coverage As the TRF principle is at its best for AM reception, it was decided that coverage of a number of shortwave

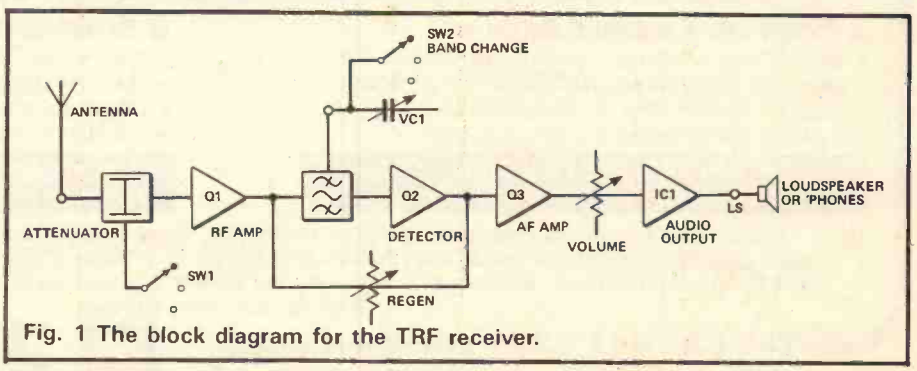


Fig. 1 The block diagram for the TRF receiver.

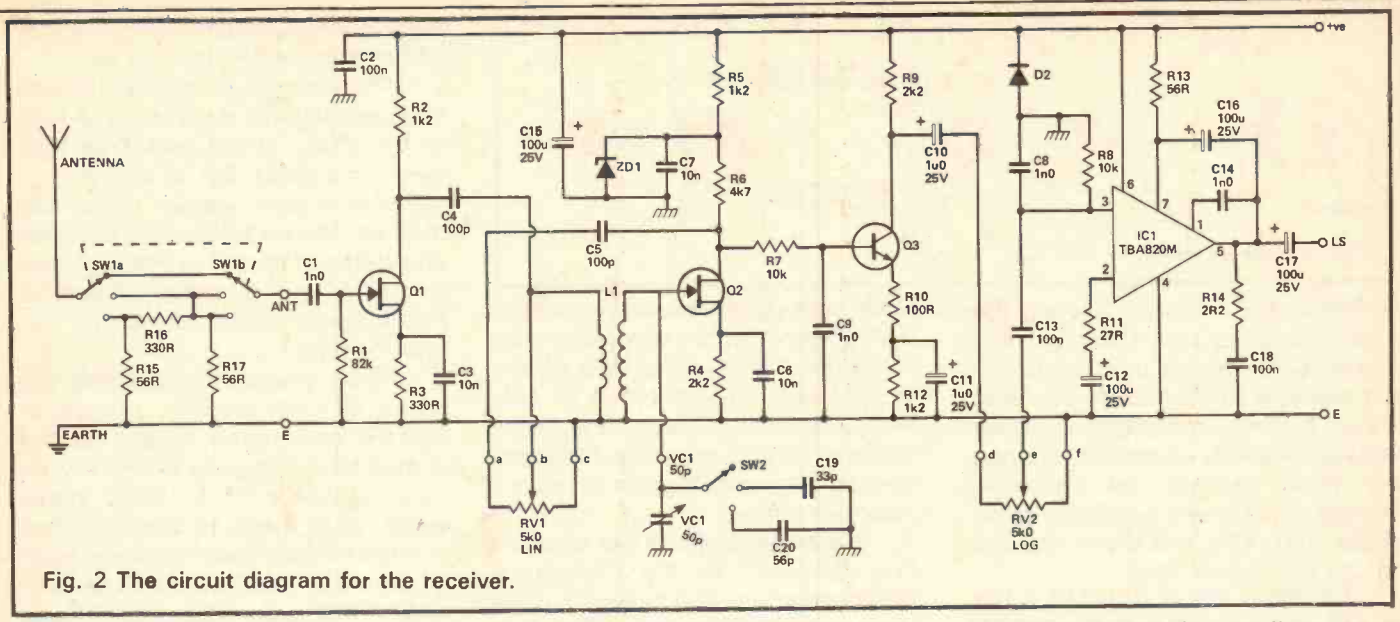


Fig. 2 The circuit diagram for the receiver.

broadcast bands would be the best starting point for this design. With the coil wound as specified, the tuning range will be from about 5.7 to 12.8MHz with a 50pF tuning capacitor. This coverage is in three ranges selected by a switch, SW2. This gives coverage of several broadcast bands, plus the 7 and 10MHz amateur allocations. Modification of the tuning range is very straightforward and you can build a version for Top Band, or other frequencies if you wish.

4. Physical size The circuitry for a simple solid state TRF should not need to take up very much room, but there is no point in squeezing the components together too tightly. This allows for construction by those without previous constructional experience, after all, this type of receiver could well provide a first project for a beginner. You can see from the photo nearby that the finished PCB is neat and compact, without being fiddly to work on.

These design objectives led to a simple circuit, shown in **Fig. 1**, that uses three transistors and one chip and offers good performance compared to my old valve set. The HT battery for that receiver cost about £1 20 years ago — with inflation that's about £10 now. The full 90 volts was fed to the valve via the headphones, which in my case had exposed terminals. This led to some interesting experiences if you forgot this fact while adjusting their position on your head! Modern circuitry has brought some advances.

Circuit Description

The signals from the antenna are first fed to a selector switch, SW1 (see **Fig. 2**), which has three positions. The first allows the signals to pass straight through to the input of the TRF3 circuit board. No. 2 is as in position 1, but the signals are also connected to one end of the attenuator network (R15, R16 and R17) to provide a low impedance termination for the antenna. No. 3 allows the signal to be routed through the attenuator to reduce its level by about 20dB to help with strong signal handling.

The output of the selector switch, SW1, is fed to the "ANT" input of the TRF3 board. From here the signal is coupled by C1 into the gate terminal of the first transistor (an FET, Q1), where the signal is amplified at RF. R1 and R3 set the correct DC operating conditions for the FET, and R2 provides a load on its output. The signals are then coupled by C4 into L1.

The secondary winding of L1 is tuned to the operating frequency by the tuning capacitor (VC1) and any band change capacitor (C19 or C20) switched into play by SW2. It is the combination of these capacitances and the inductance of L1 that form the only tuned circuit in the receiver. Any change to either L1 or the associated capacitors will result in a frequency change, thus making modification to the coverage of the receiver a doddle for the experimenter.

If you fancy building, say, a receiver for your local medium wave station, or dare I say it, Radio 1 — you simply change a few components. However, you will need to use a larger toroid core to wind a big enough coil for medium wave frequencies. You should use a powdered iron type toroid for this, ferrite types do not provide a high enough Q and the selectivity will not be very good if you use them.

Q2 is the active device that forms the regenerative detector stage, the heart of any TRF design. This stage can be considered to have two functions. The first is amplification of the RF signal selected by the tuned circuit. This is maximised by feeding some of the amplified signal back into the tuned circuit again via RV1 (the "regeneration" control). This causes a sort of "howl-round" situation. If RV1 is advanced beyond a certain point, then the stage oscillates, producing a signal at the tuned frequency itself — this beats with the incoming signal to give the whistles you hear on tuning through the stations (this also enables SSB and CW signals to be resolved after a fashion).

The effect of feeding some signal back to be reamplified, by passing it through the tuned circuit again, not only greatly increases the sensitivity, but also the selectivity by a very significant amount. This enables a single tuned circuit to offer a far higher level of performance than would be possible without feedback. This is the genius of the TRF principle — lots of gain and high selectivity from a single stage! But that's not all folks. Q2 also performs another task.

The voltages set up by the various resistors around Q2 cause the FET to operate on a rather nonlinear part of its transfer characteristic. This results in some of the signal being

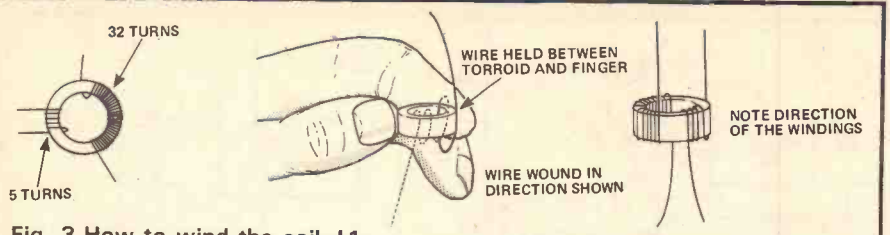


Fig. 3 How to wind the coil, L1.

rectified, and so demodulating the audio frequency signal from its radio carrier. Q2's work is now done, and the signal is passed on to the next stage. To prevent changes in supply voltage, or battery condition altering the regen. settings, the operating voltage of Q2 is stabilised by a zener diode, ZD1. This is a luxury the old valves sets never had!

The audio signal from Q2 is fed to Q3 via R7, C9 being used to remove any RF component and so prevent it upsetting the operation of the output stages. Q3's output is fed to the TBA820M output chip, IC1, via the volume control, RV2. The output of IC1 is in turn fed to the loudspeaker, or headphones. D2 is provided as an "idiot diode", just in case the power supply is connected the wrong way round by mistake! It is only effective though, if a fuse of about 500mA is used in the DC supply feed. The "6 Inch Nailer, universal fuse replacement device" I saw advertised in an American catalogue is not recommended for this application!

Building the TRF3

The TRF3 can be built from a kit (see box for details), or you can make your own PCB using the foil pattern shown nearby. An important point to note is that the correct device *must* be used for Q2. Substituting a different part will require alteration to other component values to obtain correct operation of the regenerative detector. Most other parts are not too critical. Miniature 3 way slide switches are provided for SW1 and SW2 in the kit, but you can use rotary or toggle switches if you prefer.

It is important to wind the toroid correctly as shown in **Fig. 3**, including ensuring that the windings are wound in the correct direction. If not, the feed back signal could be in the wrong phase and there will be no regeneration. The toroid's primary winding has five turns, the secondary 32 turns, of 0.315mm diameter enamelled copper wire. Make sure you scrape the insulation from the ends of the wire before you solder the leads to the PCB tracks. Dry joints on these types of connection are one of the most common soldering errors made by constructors, so take extra trouble to make a clean joint here.

It is easier to fit all the resistors first, followed by the capacitors, semiconductors, and finally, L1, using the component overlay in **Fig. 4** as a guide. When the PCB is complete, hold the board up to a bright light, and look at the underside of the board so that the tracks are in silhouette. Inspect for light coming through a "joint", or for any solder "bridges' between tracks, and make good any doubtful looking connections. Solder joints should look shiny when viewed under a bright light. If they have a matt appearance, then the problem is probably due to insufficient power in the soldering iron, poor quality solder, or the solder being kept molten for too long.

The completed receiver module can be housed in many ways. A look at the photo of the prototype may give you a guide, but as long as you observe a few simple rules, the module can be housed in any size and shape of case you like, provided it is a screened, metal enclosure. Plastic cases are not suitable for this type of project.

When you are considering the layout of your receiver, remember that the leads to the "regen" control should be reasonably short, say up to a maximum of 4". Keep these wires, plus those to the switches and the tuning capacitor, away from all the other leads as much as possible. They can cross other leads without problem, but they should not be run close side by side with other wiring. When the module and its controls are installed in the case, give the wiring a double check, and then you are ready to connect up the power. There is no alignment to carry out, so your receiver is ready to use straight away.

Operating The TRF3

Perhaps a few comments on the operation of a TRF receiver are in

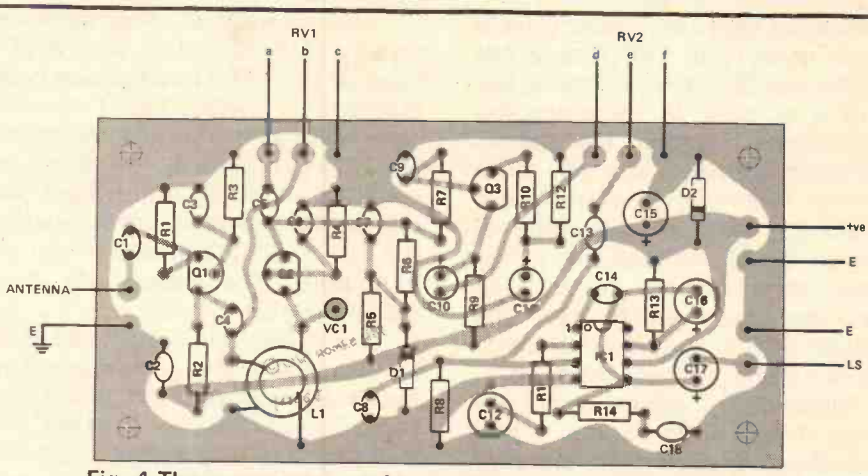
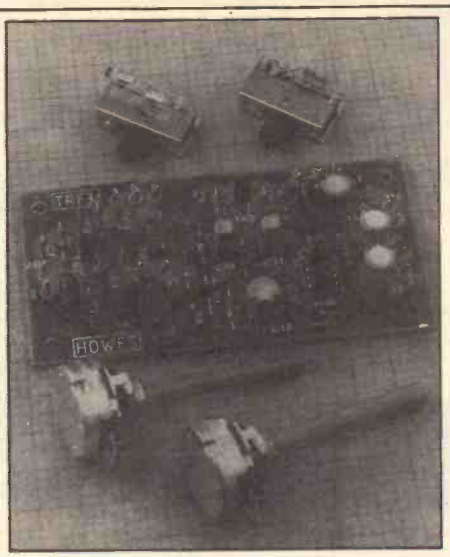


Fig. 4 The component overlay and foil pattern of the PCB.

order at this point. Set the volume control to about half way and advance the regen control until the onset of oscillation by listening for the rushing noise. Then back the control off a fraction until the oscillation just stops. The receiver is now operating at its most sensitive and selective point. As you tune VC1 across the band, you will have to make slight adjustments to the regen control to keep it at its optimum setting. If you advance the regen control so that oscillation just starts, then you will hear whistles as you tune through the various stations. This is a good way of finding signals, you then back off the regen control to listen to them — VC1 will require slight retuning when you adjust the regen setting.

To listen to CW and SSB signals, you need to keep the set just oscillating, and tune very carefully to resolve them. You will find that a different conversion receiver offers much better performance for these modes, but the TRF gives a remarkable account of itself for AM broadcast reception.

I hope you find this little project as fascinating as many people who



have played with the prototype have.

Kits

The TRF3 kit is available by post from CM Howes Communications Ltd at 139, Highview, Vigo, Meopham, Kent DA13 0UT telephone (0732) 823129, at a price of £13.90 inclusive, or as a built and tested PCB module, £18.90 inc. Tuning capacitors are available at £1.50 while stocks last. Post and packing charge is 80p.

Components List

RESISTORS

R1	82k
R2, 5, 12	1k2
R3, 16	330R
R4, 9	2k2
R6	4k7
R7, 8	10k
R10	100R
R11	27R
R13, 15, 17	56R
R14	2R2
All 0.25W carbon film	
RV1	5k linear pot.
RV2	5k log pot.
Both carbon track type	

CAPACITORS

C1, 8, 9, 14	1n 50V disc cer.
C2, 13, 18	0.1u 50V 10% mylar
C3, 6, 7	0.01u 50V disc cer
C4, 5	100p 50V disc cer
C10, 11	1u 25V radial electrolytic
C12, 15, 16, 17	100u 25V radial electrolytic
C19	33p 2.5% polystyrene
C20	56p 2.5% polystyrene
VC1	50pf

SEMICONDUCTORS

ZD1	6V8 BZY88
D2	1N4001
Q1, 2	BF245A
Q3	BC237
IC1	TBA820M

MISCELLANEOUS

SW1, 2	2 pole, 3 way switches
L1	T50-2 dust iron toroid
PCB, metal case, wire, etc.	

Sideswipes

William, G8QRM, reminds us not to take ourselves — or what we hear on the air — too seriously.

I'm often asked, "What will you do when you grow up?" Perhaps I shall take my morse test and use special emetic sounding CW along with my close relative G3QRM on HF. Lots to do there.

In the mean time, 2m is quite useful. It's sometimes tempting to wake up the low end of the band with a bit of FM from time to time. There often seems nothing but the odd carrier going on and off below point one five. Very few CW QSOs seem to be going on. For a chat there's the local repeater, GB3QR, which is sometimes short for GB3QRM. Some unkind soul once said it was a right queer repeater. Why? This can having nothing to do with the after midnight gay counselling service run by Dave.

Now radio amateurs are over the technical novelty phase and repeaters are a fact of life, their social uses have come to the fore. In these days of isolation and aberration, there is a real need for an understanding ear. Dave provides this, after all what is discussed is 'matters of a personal nature' — quite within licence regulations.

It is good to hear the ensuing hiccups of outrage from some radio enthusiasts. Trouble is, someone has gone a bit too far of late and shopped a fellow local to the authorities for 'encouraging' a pirate. I have encouraged lots of pirates. Out of spite they have been urged to become radio amateurs.

My own licence arrived courtesy of a great administrative cock-up. Not being able to do the wrong thing and pay someone to take the exam, I entered, but forgot to turn up. A yellow pass slip arrived anyway and to this day no-one has noticed the slight difference in the name on the

licence and my own.

The DTI doesn't seem too interested in piracy unless people cause trouble. They do get rather snotty about me chatting to aircraft on HF. It all started when my mother, who is stone deaf and a devout ignoramus, wandered by chance into the local radio emporium. She was sold a new 'trannie' by the 'very nice young man'. She is still paying the HP on the TS940S, even though it was presented to me for Christmas, as she thought it useless though ornamental.

Listening On...

With the holiday season in full swing, what's there to listen out for on a basic 'trannie' shoved as an afterthought into the suitcase? Our resident 'earwig' takes a look at the 'World Services'.

Although many readers of this column probably have highly sophisticated short wave receivers or transceivers with general coverage receive capability, many amateurs have amateur band only transceivers and maybe only a transistor portable receiver covering the short wave broadcast bands. This month we look at a few stations which should be well received on just such a simple receiver, using only its built-in telescopic antenna. For those of you who have not yet been on your summer holidays and plan to go abroad, we give you some suggestions of stations to tune into if you are thinking of taking a shortwave receiver with you.

London Calling

One of the best ways of keeping in touch with what's happening at home when you are abroad is to tune in to the BBC World Service. It can also be heard in many parts of Britain much of the day and night on 648kHz medium wave, a frequency really intended for northern France and Germany as well as Belgium, Holland, Luxembourg and Denmark.

For those of you unfamiliar with BBC World Service programmes, here is a brief run-down. The main-stay of World Service programmes is their nine minute World News, around which all other programmes are slotted. It is highly regarded for its accuracy and impartiality — world leaders and politicians of all political persuasions are known to tune in regularly often to find out what is really happening in their own country! These World News bulletins are broadcast on the hour, 17 hours out of the 24. At 1200 and 1500 GMT "Radio Newsreel", a 15 minute programme of correspondents' reports from around the world, is broadcast instead, while at 0400, 0600 and 1800 "Newsdesk" (starting with the World News) is a full thirty minute programme. On the other hours is a one minute news summary.

One criticism a lot of British people have when tuning in to BBC World Service for the first time is that there always seems to be more news about disturbances in Sri Lanka, or the results of the Bolivian general elections, than there is about Britain. This is a valid criticism, although since it is a *World* service, they do try to include important news stories from wherever they may take place, even if they would never feature in a Radio 4 or a TV news bulletin. To compensate for this there are special "News About Britain" bulletins at 0009, 0309 and 1109 GMT, and British news is also broadcast within the "Newsdesk" programmes at the times mentioned above.

BBC World Service is broadcast 24 hours a day, on a bewildering variety of frequencies, some for almost the whole day, others for just half an hour at a time, between other BBC foreign language services. It would be impossible to give the full schedule but some good old favourites that the BBC has been using for decades are: 5975, 7325, 9410, 12095, 15070, 17705 and 21710 kHz. You should be able to hear something on one or other of these frequencies at some time of the day or night, more or less anywhere in the world.

If you are using a transistor portable receiver without any accurate frequency calibration, it is worth noting that several of these frequencies, particulary 9410, 12095 and 15070 kHz are right on the edge of the broadcast bands. In fact, officially, they are outside the limits of the bands, but many stations operate outside the official bands, and the BBC has been on these frequencies for so long it has acquired "squatters rights". When tuning through the 31, 25 or 19 metre bands, therefore, the BBC World Service should be found immediately beyond most of the other stations which are all jammed together in a narrow frequency band.

If you're feeling homesick, there's always the Beeb to listen out for.

A fairly typical QSL card from Radio Moscow, showing the flags of the constituent republics of the USSR.

All the frequencies mentioned above emanate from transmitter sites in Britain, but the BBC also has relay stations on Ascension Island, Cyprus, Masirah Island (Oman), Singapore, Antigua and in Lesotho. As if this were not enough, BBC programmes are relayed by Voice of America and Radio Canada International transmitters on a reciprocal basis, so wherever you are in the world there is a chance you should be able to hear World Service programmes with reasonable reception. One relay station frequency is worth mentioning for those of you lucky enough to be holidaying in the east Mediterranean area, (the Greek islands, Turkey, Cyprus, Israel etc). This is 1323 kHz, which comes from a 200 kilowatt transmitter on Cyprus and carries BBC World Service programmes for over 20 hours per day.

Apart from their up-to-the-minute news bulletins, the BBC World Service broadcasts a wide variety of feature and music programmes. At present, for example, is a series of recordings made at this year's promenade concerts, called "Saturday Night at the Proms" and broadcast at 1830 GMT on Saturday evenings. If new wave music is more your scene, a new series called "New Waves on the Short Wave" and presented by Tom Robinson, began in July and is broadcast first on Saturdays at 0130, then repeated on Tuesdays at 2315, Thursdays at 0730 and again on Fridays at 1000. What sounds like an intriguing series of programmes to be broadcast throughout August and the early part of September, is called "Eccentric Travellers" in which dramatised reconstructions tell the true stories of 18th and 19th century explorers and travellers who were in some way extraordinary or unusual. "Eccentric Travellers" is broadcast on Mondays at 0100, repeated on Fridays at 1515.

One regular BBC World Service programme which may be of interest especially to SWLs and radio amateurs is called "Waveguide". It tries to explain, in totally non-technical language, how BBC World Service reception can be improved. For example, if there have been any propagation problems during the week, they try to explain what happened, or if new frequencies are in use for any particular part of the world, listeners are advised of them. There are also regular receiver reviews, although again these are presented in a totally non-technical manner (ie there is as much concern as to the size or even the colour of a new radio as to the frequencies covered or what the selectivity is like). However, this can be an interesting programme broadcast on Sundays at 0750, with repeats on Mondays at 0450, Tuesdays at 1115 and Thursdays at 0130 GMT.

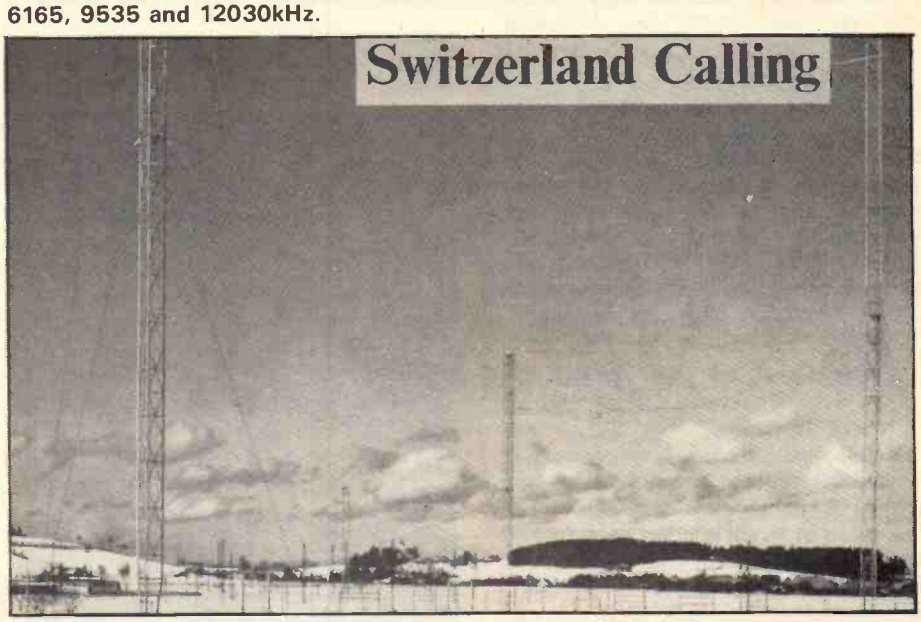
Other European "World Services"

There is really only one other World Service, and that is Radio Moscow World Service. Like the BBC's, it broadcasts 24 hours a day in English, and has news on the hour, every hour, but there any similarity ends. Listening to Radio Moscow World Service, you certainly get a different perspective on world events, and contrary to most people's expectations, their programming is not all 'hard sell' propaganda. There are several good music programmes, usually broadcast at 31 minutes past the hour (following a one minute news summary), featuring Soviet jazz, pop and middle-of-the-road music, as well as programmes specialising in the music and culture of the Soviet nationalities, such as the Uzbeks, Kazakhs etc.

There is no problem hearing Radio Moscow World Service: they utilise up to 40 short wave frequencies simultaneously (less in the evenings when the transmitters are required for other Radio Moscow transmissions). At times, Radio Moscow World Service is also carried on some medium wave frequencies. These include 1143, 1323, 1386 and 1494 kHz.

In addition to their World Service, Radio Moscow also broadcasts a one hour programme every day specially for listeners in Britain. This is at 1900 GMT and at present is on 7330, 7370, 9470, 9520 and 9770 kHz. Programming is very similar to the World Service, but there are often interviews with visiting British politicians or trade union officials and other items of specific interest to British listeners. Incidentally, if you're trying to find Radio Moscow World

Swiss Radio International broadcasts in English between 1200 and 1230 on 6165, 9535 and 12030kHz.



A QSL card from the Israel Broadcasting Authority.

Service on your radio, try tuning in one or two minutes before the hour, when they broadcast an orchestral version of the tune "Midnight in Moscow" (much as BBC World Servie puts out "Lillibulero" before each news bulletin) followed by the Kremlin clock chimes on the hour.

In the last two "Listening On . . ." columns I have mentioned the programmes of Radio Netherlands and Radio Sweden International. Both these stations are generally well enough received to be heard on a transistor portable receiver using just its built-in telescopic antenna. Another station that is very well heard is Swiss Radio International, which broadcasts from Berne. Their programmes are very much news-orientated and — being Switzerland - economic news is well to the fore, as are stories connected with the various United Nations organisations which have their headquarters in Geneva, and the Red Cross. SRI's English programmes are heard — at present — at 1200-1230 on 6165, 9535 and 12030 kHz and at 1700-1730 on 3985 and 6165 kHz. SRI is one of those stations that changes the time of their programmes depending on whether they are on summer time or winter time; the times mentioned are the current, summer times, but will change when Switzerland reverts to winter time.

The Rest of the World

From outside Europe (just!) the Voice of Israel is perhaps one of the best received stations and they have several English language broadcasts every day. The Voice of Israel is quite easy to find on the dial because it also uses several frequencies just outside the official limits of the broadcast bands: at 1900 they can be heard on 9009, 9435, 11605, 13725 kHz, at 2130 they are on 7410, 9009 (a long time favourite for Israel), 9435, 9815, 9860 and 13725. Finally, at 2300 just three frequencies are in use: 7410, 9435 and 9860 kHz. The Voice of Israel also has a home service in English which cannot normally be heard much outside Israel. It is, however, relayed on short wave at 1000, when their midday news programme is carried. It makes interesting listening as it is a commercial service and sometimes Hebrew advertisements are broadcast after the news. This programme is on 13725, 15640, 15650, 17565 and 17685 kHz, and is followed at 1030 by the same sort of programme in French. (This is presumably a service for new immigrants who have not yet learned Hebrew). One of the Voice of Israel's most enjoyable programmes is "Thank Goodness it's Friday", broadcast every Friday evening — a celebration of the beginning of the Sabbath.

Listen out for Radio Japan which comes via satellite and Gabon, West Africa.

One final tip for those interested in hearing what is normally quite a "DX" station on just a simple receiver — Radio Japan. Japan is a notoriously difficult country to hear in Europe, because signals have to pass through the arctic polar region. However, Radio Japan does broadcast three hour long programmes in English every day via a relay station in Moyabi, Gabon, in West Africa, and these are generally quite well received here. Signals are sent from Japan to Gabon by satellite, and sometimes the audio quality of the signal received from the relay station is none too good because of this. However, Radio Japan's programmes are most interesting and this makes up for it. These relayed programmes are at 0700 on 15230 kHz (sometimes a signal can be heard direct from Japan on the "parallel" frequency of 17810 as well), at 1500 on 21625 kHz and at 2300 on 9645 kHz. One of Radio Japan's most interesting programmes is called "One in a Hundred Million" which looks at the day-to-day life of an ordinary Japanese citizen, be he a car worker, Kobe beef farmer or director of a multi-million pounds electronics company — it gives a fascinating insight into this little understood country.

Oops! Psychic Failings

One of the difficulties in writing a column like this is that you have to be psychic, in as much as deadlines necessitate the article being written more than a month before the magazine appears in the bookstalls. In this time radio stations often decide to change their operating times or frequencies, so I have to write about not just what is on the air, but what I expect will still be on the air in four or six weeks time! Unfortunately my crystal ball is not always accurate.

In July's "Listening On . . .", I mentioned the test transmissions from Omani Radi on 17795 kHz — these now seem to have moved elsewhere. Radio Tanzania Zanzibar, Radio Riyadh and Radio Maputo, though still around, are by no means as well received as they were when I wrote about them in May (although by the time this appears they may have improved once again!). Radio Monte-Carlo has now settled down into a daily schedule of 0500-0645 on 9795 kHz and 0645-1500 on 15465 kHz. Finally, due to a printing mistake, the callsigns of the Australian short wave domestic services were shown incorrectly as VLSA and VLSK. The actual callsigns are VL8A and VL8K. A third such station in the Northern Territories, at Tennant Creek, should by now be on the air. Its callsign is VL8T, but I have still not heard of any of these stations being audible in Europe. . .

Exploding Antenna Myths

Back in 1939, advertisements appeared in the mail order sections of the Saturday newspapers that expounded the advantages of the "Jiffy Aerial". According to these adverts, an outside antenna was no longer necessary for good broadcast band reception — indeed the piece of wire around the room was equally obsolete. The "Jiffy" sold for the sum of 3s/6d which was about 10% of the average wage packet in those days. It consisted of a cardboard container with three wires protruding. One went to the aerial socket of the broadcast set, one to the earth socket and the other to an external earth. The container was filled with sand and a 0.001 mF mica capacitor that simply connected the external earth to the aerial socket of the receiver, thus using the earth wire as an antenna. The point of this story is that it illustrates the fact that since the earliest days of radio the broadcast listener, TV viewer and indeed the radio amateur have been trying to beat the basic laws of antenna engineer in trying to get something for nothing — in most cases not having much success.

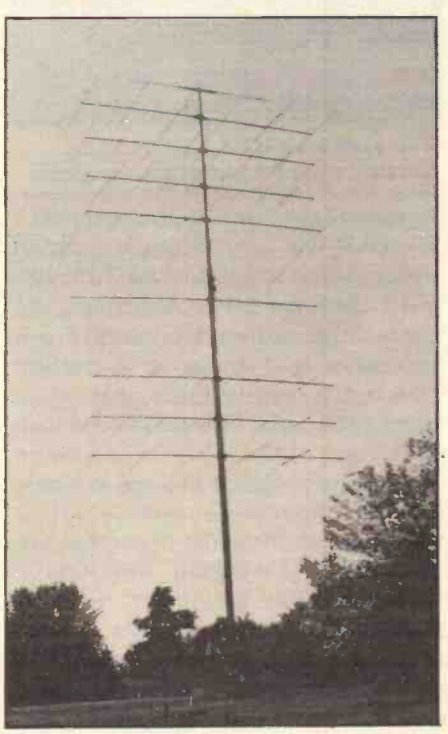
The purpose of this article is not to describe or illustrate any of the various types of antenna in use today. This is done very effectively by the various handbooks available — in particular "The ARRL Antenna Handbook". Rather the object is to deliver some plain talking based on 35 years of experimentation with them. This experimentation has resulted in a top placing on the DXCC Honour Roll, high placings in many DX contests and countless friends throughout the world.

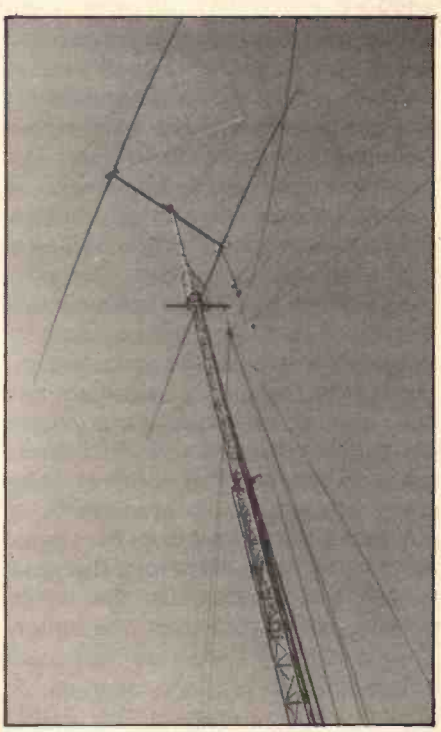
Simply put, the fact is that for an average performance on the HF bands there has to be a certain amount of anxiety, aggravation and cost in any antenna installation. The anxiety concerns the forces of nature. Sam Harris, W1BU, came up with a simple theory many years ago that if your antenna had withstood the winter storms it was probably not big enough! The aggravation concerns planning problems and the reactions of neighbours whilst cost is inevitable in any installation which is going to stay up and be effective.

There are many myths passed around about antennas, feeders and the like. Al Slater, G3FXB, reveals the facts and cuts the fantasies down to size.

It is probably true to say that the most effective antenna on any band is a rotary *monoband* yagi. It is capable of excellent gain and discrimination which can be directed exactly where required. Three elements are a very satisfactory compromise between performance on the one hand and mechanical consideration on the other. Whilst extra elements will give greater gain, it is very much a question of diminishing returns! Improved performance is achieved only at the expense of a big increase in size and weight. However we are tending to put the cart before the horse for monoband yagis are often outside the realms of possibility for the average radio amateur. Consideration initially should be given to the more basic and simple types of antenna.

On the left: Almost the ultimate aerial array — the 'Christmas Tree' at the station of the late Jim Lawson, W2PV. The rotating structure boasts a 2m antenna at the top (115'). The next antenna down is a 6 ele 14MHz beam which can be phased with the other 6 ele at the lower level. The same is applicable to the 8 ele on 21MHz and the 10 ele on 28MHz. Each beam can also be operated independently ensuring the optimum propagation angle at all times. Between the HF beams can be seen the 3 ele full sized beam for 7MHz and an 11 ele 'long John' for 50MHz. On the right: The author's own original 2 ele quad on a 60' crank up tower also supporting inverted V dipoles for the LF bands. It is still in use but the inverted V dipoles have been replaced by wire beams and slopers.



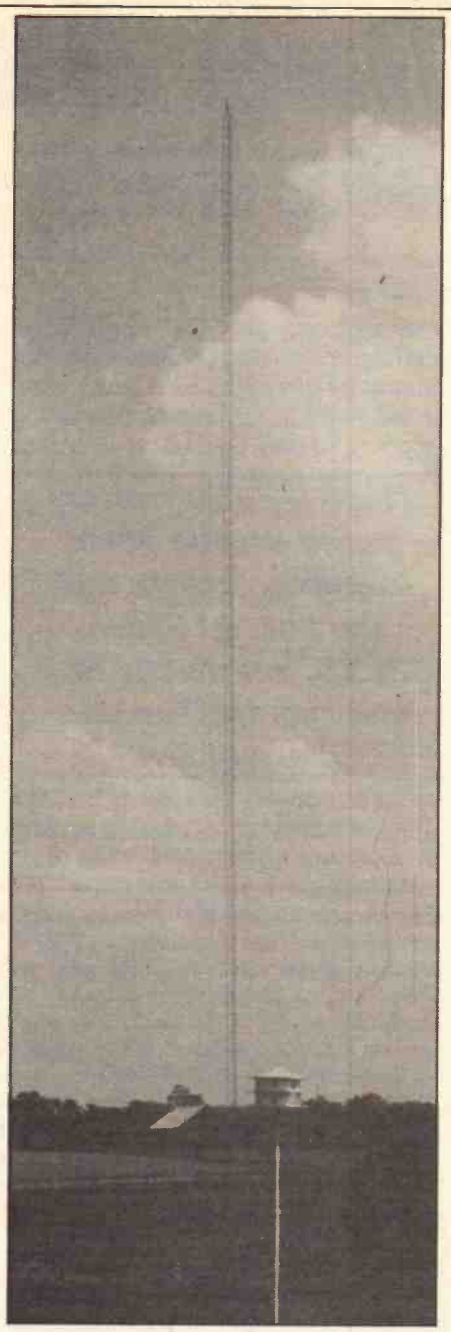


Half Wave Antenna

The half wave dipole or doublet is the basic building block of the majority of antennas. Even in the case of the quarter wave vertical or ground plane, the radial system functions as the mirror or the other half of the antenna. It is used as a reference in measuring the gain of larger arrays. Its performance is perfectly predictable when used in its basic form without traps or any other loading devices. The method of feed has little bearing on the performance assuming there is an efficient transfer of power. This can be by low impedance feeder or if multi-band operation is required by open wire line with an ATU which need not be an expensive commercial tuner. Tuning capacitors and coil forms can still be found on the surplus market and there are a variety of ATU designs in the handbooks.

The use of open wire line and an ATU will ensure balanced feed to the antenna. If coaxial cable is used, the feed will be unbalanced and a lot is written in the technical press concerning the use of baluns. It is probably true to say that with the antenna length/conductor diameter ratios found on the HF bands, the balance to unbalance condition is not a serious problem. Indeed a poor quality balun could introduce losses into the whole system as well as the mechanical sag at the centre of the antenna where the bulk of the radiation takes place. On the other hand the use of a reasonable quality balun will ensure that the radiation pattern is correct, that there is no feedline radiation giving rise to RFI and TVI problems and that the bandwidth of the antenna is satisfactory. Where the half wave dipole forms part of a directional array as in the case of a yagi, the use of a balun is even more important to ensure the rejection of the sides and back is at an optimum.

Finally the use of non-resonant lines such as coaxial cable provides the current neurosis SWR. Admittedly, in the case of modern solid state equipment a low SWR is required if the output from the transmitter is to be satisfactory. But that apart it is fairly safe to say that levels quite a bit higher than the much sought after 1:1 can be tolerated before losses become serious. A glance at the chart in the ARRL



A ¼ wave vertical for 160m at N4AR. Currently there are two of them in phase.

Antenna Handbook will reveal that a 2:1 SWR will only increase existing transmission line losses by 20% and a 3:1 SWR by 50%. Assuming the line is of fair quality, the length is not excessive and there is a perfect match, the loss will probably be no more than 2dB. The additional loss as a result of the 3:1 SWR would be 1dB; or the smallest change in signal level the human ear can detect. It should be appreciated that reflected power is not all lost. Although a thesis on this particular point is outside the scope of this article, there have been a number of excellent articles published in recent years about this popular misconception. A good match is of course desirable to ensure optimum power transfer and an acceptable load for the transmitter or amplifier. However, it is fair to say that with the exception of solid state gear already referred to, it is not necessary to go to great and, perhaps, hazardous lengths to achieve that perfect 1:1.

On the subject of misconceptions, there are a number concerning the type of material used in antenna construction. There are many for instance that always associate yagi beams with the use of tubing for elements. In fact whilst tubing improves the bandwidth of the array, its use is primarily for mechanical reasons in the construction of rotary arrays. Fixed beams with wire elements will in fact deliver just as much gain as their counterparts with tubing — the drawback being that they cannot be rotated. Another myth is that bare antenna wire is more effective than covered wire. At HF, this is not the case. There is also a certain amount of uncertainty over the use of single or stranded wire. In this case one does have to exercise caution. Whilst much stranded wire is perfectly satisfactory, in particular 7/22 — 7 strands of 22swg — some PVC covered wire employing a substantial number of thin strands is very suspect giving rise to quite pronounced inductive effects. In one case when a quad was constructed of this material, the resonant frequency came out over 2% below the design frequency.

A further misconception exists concerning the inverted 'V' antenna, at least in the conventional half wave form. Exaggerated claims have been made concerning its DX performance, pointing to the effective radiation at low angles off the ends. In fact any horizontal half wave antenna used at modest heights will exhibit these characteristics. The inverted V half wave antenna results in a lower average height plus some cancellation of radiation, thus giving rise to an inferior performance compared to the horizontal. Against this, the inverted V needs only one support and the ends can easily be trimmed for resonance. Nevertheless for optimum performance, the 'flat top' is to be preferred and after all the inverted V is a convenience antenna.

A half wave antenna configuration with distinct advantages, particularly for DX on the lower

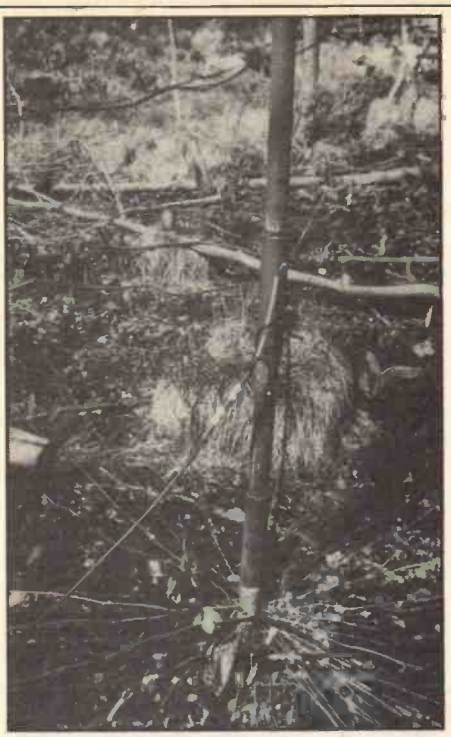
frequencies, is the sloper. This should be suspended from a tower, mast or even a tree and angled at 45 degrees or so in the desired direction. It is capable of some 4 or 5dB enhancement coupled with rejection in the opposite direction giving a 'front to back ratio' of some 10dB. If more than one sloper can be erected, put in a relay box for changing over. Furthermore by selecting a suitable length and type of coaxial cable, the unused antennas can be resonated as reflectors giving a considerable increase in discrimination.

As mentioned, slopers are normally of the half wave type. Indeed even on 3.5MHz the writer has used them suspended from a 60' tower and with the feed point but 8' off the ground. In this case the remaining half of the antenna is run out just above ground like a Beverage antenna or a ground plane radial, and results have been very satisfactory. Excellent results have also been reported with the 'half sloper'. Here the feed point is at the top of the support which should be metal since it provides the other half of the antenna. The braid of the coaxial cable is clamped to the support at the top and the good performance is attributed to the fact that the area of maximum current — and therefore maximum radiation — is in the clear rather than being near the ground.

Whilst many reports of good performance have been received, there have also been reports of poor results and failure to establish proper resonance. Success seems to depend on what other antennas are on the support. In the case of a tower with a beam this would provide some degree of top loading with an attendant effect on resonance. Finally the performance of slopers is markedly affected by different propagation conditions. On some evenings during low sunspot years, the performance will be quite outstanding and on others noticeably less so. Indeed during the years of high solar activity slopers will be generally less effective especially on 3.5MHz than in the corresponding low years.

Multiband Antennas

The most popular, convenient and inefficient way of multiband operating with a wire antenna is with the trap dipole. To ensure a half wave resonance and low impedance feed, traps are introduced. Inevitably these introduce losses into the system, although it is fair to say that if they are of good quality, those losses will not be serious. The main point is that this antenna, by establishing a half wave resonance with traps, negates the gain resulting from longer lengths. For example a full wave centre fed becomes two half waves in phase giving a gain of 1.8dB. If the length is optimised to 1.28 wavelenths an 'Extended Double Zepp' results having some 3dB of gain.



The radial system at the base of a vertical used in a 4 ele vertical array at W1CF illustrates good engineering practice for such a system. In addition, the array is located in a swamp further enhancing ground conductivity.

It makes little sense to throw away the gain that antennas in excess of a half wave possess in return for the convenience of low impedance feed often accompanied by quite high values of SWR. A far better plan is to use a length of antenna which will exhibit gain on certain bands and achieve multiband operation by the use of an open wire feedline and an ATU. There seems to be an aversion to such techniques today as they seem to be regarded as outdated and complicated. This is not the case. Open wire line can be fabricated quite easily with 14 or 16 swg wire and plastic spreaders.

If the antenna feedpoint is at a current maximum then one half wave down the feeder this condition will repeat itself requiring series tuning. On the other hand if the feedpoint is at a voltage maximum then parallel tuning will be required at that half wave point. Of course an antenna length may be such that the feedpoint is neither at a point of a current or voltage maximum. Furthermore, it may not be physically possible to accommodate a specific length of feeder to give purely voltage or current feed at the ATU. There are two points to bear in mind here. One is that the overall length of the antenna and feedline establishes the resonance and the second is that awkward terminations at the ATU can invariably be accommodated by parallel tuning with the feeder being tapped down the coil. The use of an SWR bridge between the transmitter and the ATU is mandatory in securing the correct adjustment and aerial current meters installed in each feeder will give an indication of the optimum power transfer and also line balance.

One of the writer's favourite antennas in the above catagory is indeed the Extended Double Zepp for 14MHz only an 85 foot top is required. As mentioned earlier the gain is 3dB with maximum radiation being at right angles to the antenna. In addition there are four minor lobes that give a certain amount of radiation off the ends. On 7MHz this antenna becomes an extended half wave giving a very satisfactory performance whilst on 21 and 28MHz the pattern splits into several lobes that exhibit a modest amount of gain. On 3.5MHz it can be fed as a shortened half wave but in the writer's case one feeder only was used as an inverted L tuned against ground. In this case of course, the feeder radiates and being vertical provides a useful amount of low angle radiation for DX work. Using nothing more than this antenna, the writer achieved second place in the UK during the Commonwealth Contest some years ago: certainly evidence that for those with limited facilities it should be given serious consideration.

Verticals

If the trap dipole has the honour of being the most popular, convenient and inefficient way of securing multiband operation then

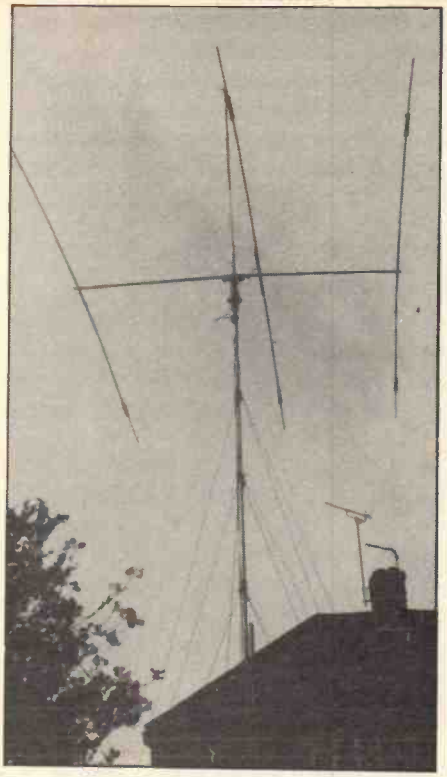
the trap vertical is a close rival. The writer recalls reading, many years ago, that the vertical was an excellent antenna for DX work conferring a long angle of radiation, which enhanced long distance signals and attenuated the higher angle Europeans. It has been my experience that providing a conventional horizontal antenna can be erected in excess of a quarter wave in height, its performance will be superior to the vertical. In practical terms this means a height of at least 40 feet on 7MHz and 80ft on 3.5MHz. Obviously, there is a case for the vertical on the latter band and also 1.8MHz. However, the vertical will have directivity whilst a sloping dipole will provide enhancement and discrimination.

As far as the HF bands are concerned, a normal quarter wave vertical will radiate equally poorly in all directions and even more so if it incorporates traps and merely an earth spike for a ground system. Remember too that the very low angle of radiation from the vertical will aggravate EMC and TVI problems and in reverse the reception of local man made noise.

If space considerations preclude the erection of a horizontal antenna, then one has little choice. In that event, attention should be paid to the ground system as a means of optimising performance. Commercial practice calls for no less than 120 radials and whilst this figure may be somewhat ambitious for an amateur installation, as many as possible should be put down. Relying on an earth spike is simply not good enough. If space is not a premium, the use of two or more verticals in a phased array may well be worthy of consideration, particularly on the LF bands, and has the makings of a reasonable DX antenna system.

Loops

The conventional full wave loop has things to commend it in the diamond, square or delta configuration. For one thing, it exhibits some 1.4dB gain over a half wave antenna. For another, it displays a very acceptable bandwidth. In addition, it provides a reasonable match to coaxial cable with the option of vertical or horizontal polarisation depending on the point of feed. Furthermore the addition of



A popular trap 3 ele for the HF bands as often found in the average surburban garden.

a parasitic reflector results in a very effective beam antenna with gain approaching that of a three element full-sized monoband yagi and discrimination that probably exceeds it. Another advantage compared to a yagi is the reduced response to precipitation static.

An excellent reference on the subject of loop antennas as used in quad arrays is the book by Bill Orr, W6SAI, entitled "All About Cubical Quad Antennas". The information contained in this book is very accurate and useful. However there are a number of points that should be stressed and which will lead to the optimum performance of a loop antenna:

1. In the case of a loop antenna suspended from a support, it should be remembered that the effective height of the antenna is less than if that support is used for a conventional horizontal antenna. For example, a 7MHz square loop suspended from a 60' support has an effective height of only some 43 feet, or the middle of the loop. In the case of the low frequency bands where a self supporting array may not be practical, this will result in a deterioration in performance unless a high support is available. In a self supporting array, the effective height in the case of a square loop is the boom. In the case of the delta loop where the bulk of the antenna is higher, the effective height is of course also greater.
2. There is no truth in the suggestion that the diamond configuration is more effective than the square. This comes from the misguided theory that as a loop is in fact two half wave antennas stacked with their tips joined, a diamond design will provide a greater stacking distance between the current maximas. Whilst this theory can be disproved mathematically, the writer has also tried it in the field with absolutely no measurable difference between the two configurations.
3. There is little point in using stubs to tune the reflector. Lengths cut from the book are quite satisfactory providing conventional wire is used. Slightly higher gain is achieved by dispensing with the stub and pattern skew eliminated.

Full wave loops are very efficient antennas either on their own or in the form of a parasitic array. Their radiation efficiency is high with good bandwidth and on reception their performance is also excellent possibly due in some measure to the larger "capture effect". On the other side of the coin it has been the writer's experience that increasing the size of a quad array beyond two elements does result in only small improvements in gain that are out of proportion to the much larger mechanical structure required. It would appear that better performance is obtained by adding yagi elements rather than loops resulting in the Quagi array.

In any event the basic two element quad for 20, 15 and 10 metres will give a performance superior to anything but the big tri-band yagis by virture of the absence of traps and other loading devices and the efficiency of the system in its own right.

As pointed out previously, the purpose of this article has been to attempt to clarify the position concerning a few of the misconceptions that surround antennas. If the result is some improved communications ability, a change from the use of some convenience antennas and the acceptance of the basic laws of antenna engineering, then putting pen to paper will not have been a wasted exercise.

RADIO Tomorrow

Your at-a-glance guide to what's happening around the clubs, on the air and in general radio-wise.

1 Aug Borders ARS: Tynemouth Coastguard visit or lecture.
Clifton ARS: meeting.
Coventry ARS: mini lectures.
Dunstable Downs RC: The Spark Transmitter video.
Harrow RS: activity night.
N Bristol ARC: natter night.

2 Aug Worksop ARS: barbeque at Clumber Park.

3 Aug Wolverhampton ARS: DF hunt on 2m starting from Tettenhall Rock at 11 am.

4 Aug Basingstoke ARC: natter night.
Pontefract DARS: informal.
Southdown ARS: meeting.
Welwyn Hatfield ARC: Model Radio Controlled Aircraft by G0AII.

5 Aug Dartford Heath DFC: pre hunt meeting.
Delyn RC: meets at the Daniel Owen Centre, Mold, at 8pm.
Kidderminster DARS: meeting.
Warrington ARC: open forum at the Grappenhall Community Centre, Bellhouse Lane.
Wolverhampton ARS: visit.
308 ARC: meets every Tuesday at the Coach House, Church Hill Road, Surbiton.

6 Aug Chesham DARS: meets every Wednesday at Bury Farm, Pednor Road, Chesham.
Cheshunt DARC: natter night.
Fareham DARC: portable operation.
Havering DARC: informal.
Three Counties ARC: HF and VHF stations on the air.

7 Aug Douglas Valley ARS: meeting at the Standish Conservative Club, School Lane, Standish, near Wigan.
Horndean DARC: Special Stations — Another Angle by G4RLE.
N Wakefield RC: natter night.
Salop ARS: discussion night.
SE Kent (YMCA) ARC: QRP outside operating practice.
Vale of Evesham RAC: meets at the 'Round of Gras', Badsey, near Evesham. All visitors welcome.

8 Aug Clifton ARS: meeting.
Coventry ARS: night on the air.
Harrow RS: Automatic Vehicle Location by Mike Hoyle of BT Radio Tracking.
N Bristol ARC: G3TCO.
Wimbledon DARS: briefing for summer camp.

10 Aug **Hamfest '86 organised by Flight Refuelling ARS and the RAIBC at the Flight Refuelling Sports and Social Club, Merley, Wimborne. Interests for all the family as well as the radio amateur.**
Dartford Heath DFC: DF hunt.

11 Aug Felixstowe DARS: social.
Milton Keynes DARC: Lundy Island DXpedition by G5LP.
Sheffield ARC: one hour club contest and social.

12-13 Aug **Holyhead DARS: special event station at the Anglesey Show, Mona, near Gwalchmai, Anglesey.**

12 Aug Bury RS: fox hunt.
Dorking DRS: informal at the Star and Garter.
Harpenden ARC: The 62 Set by G0CXP.
Keighley ARS: informal.
Newbury DARS: DF hunt.
Verulam ARC: activity evening.
Warrington ARC: barbeque.
Wolverhampton ARS: Black Box or Homebrew? A Discussion.
Worksop ARS: darts and dominoes evening.

13 Aug Cheshunt DARC: equipment night.
Fareham DARC: portable operation.
SE Kent (YMCA) ARC: DF hunt on 2m.
Stockport RS: official natter night.

14 Aug N Wakefield RC: on the air.
Southgate ARC: open evening.

15 Aug Borders ARC: Safety In The Shack.
Clifton ARS: meeting.
Coventry ARS: DF hunt on 2m.
Dunstable Downs RC: on the air tonight.
N Bristol ARC: VHF activity night.

17 Aug **Aberdeen ARS operating GB4BGG from Beechgrove Gardens open day.**

18 Aug Welwyn Hatfield ARC: RTTY station and informal.

19 Aug Biggin Hill ARC: evening DF hunt.
Dartford Heath DFC: DF night hunt starting at 7.30pm.
Delyn RC: meeting.
Kidderminster DARS: meeting.
Midland ARS: club outing.
Warrington ARC: Winter Hill Station by G4YZE from the IBA.
Wolverhampton ARS: visit to the Wireless School at RAF Cosford.

20 Aug Cheshunt DARC: natter night.
Fareham DARC: portable operation.
Hastings ERC: HF DX by G3BDQ.

	SE Kent (YMCA) ARC: barbeque.
	Stockport RS: informal natter night.
	Three Counties ARC: 50MHz Operation by G3TCV.
21 Aug	Douglas Valley ARS: meeting. New members welcome with further details from Chairman, G4CWG.
	Edgware DRS: SSB FD briefing.
	N Wakefield RC: History of Amateur Radio by G3VTD.
	Pontefract DARS: on the air tonight.
	Vale of Evesham RAC: meeting at the Anchor, Fladbury.
22 Aug	Clifton ARS: meeting.
	Coventry ARS: night on the air.
	N Bristol ARC: natter night.
23-25 Aug	**Harewood Steam Rally special event station run by N Wakefield RC.**
23-25 Aug	**Barry College of FE RS will be establishing a station on Flat Holm Island in the Bristol Channel, to commemorate Marconi's achievements. All bands will be worked. Skeds available.**
	308 ARC: DXpedition to Charmouth in Dorset.
24-25 Aug	**Bassetlaw Show, Kitton, Worksop with GB2BTF special event station.**
24 Aug	Borders ARS: Galashiels open day.
25 Aug	Felixstowe DARS: projects evening.
26 Aug	Chester DRS: pre SSB field day meeting.
	Dorking DRS: social evening, barbeque at the Fox Revived pub.
	Harpenden ARC: informal natter night.
	Keighley ARS: lecture.
	Verulam ARC: bring and buy sale.
	Warrington ARC: Melbourne RC video.
	Wolverhampton ARS: night on the air.
	Worksop ARS: DF hunt.
27 Aug	Cheshunt DARC: Wulfrath, West Germany.
	Crawley ARC: pub hunt.
	Fareham DARC: portable operation.
	Farnborough DRS: Propagation by G3LTP.
	SE Kent (YMCA) ARC: visit.
	Stockport RS: Use and Abuse of VHF Antennas by G4HK.
28 Aug	Edgware DRS: informal.
	Felixstowe DARS: visit to Radio Orwell.
	Glossop DARG: Japanese Morse by Norman Kendrick.
	G Peterborough ARC: social.
	Salop ARS: final arrangements for the Telford rally.
	Southgate ARC: informal.
29 Aug	Clifton ARS: meeting.
	Coventry ARS: Using Oscilloscopes.
	Dunstable Downs RC: The Lundy Expedition.
	N Bristol ARC: talk.
30 Aug	Dunstable Downs RC: club summer barbeque.
31 Aug	**Telford Mobile Rally at the Racquet and Fitness Centre, Telford.**
	Wolverhampton ARS: DF hunt.
1 Sept	Basingstoke ARC: Surface Mounted Devices by G4OXK.
	Sheffield ARC: SSTV demonstration and discussion by G8RWV.
	Southdown ARS: meeting.
	Stourbridge DARS: informal.
	Welwyn Hatfield ARC: meeting.
2 Sept	Delyn RC: meeting.
	Kidderminster DARS: AGM.
	Warrington ARC: open forum.
	308 ARC: meets every Tuesday.
3 Sept	Chesham DARS: meets every Wednesday.
	SE Kent (YMCA) ARC: natter night.
	Stroud ARS: meeting.
	Three Counties ARC: Propagation by G3LTP.
4 Sept	Cheshunt DARC: home construction.
	Douglas Valley ARS: meeting.
	Horndean DARC: another junk sale.
	N Wakefield RC: AGM.
	Salop ARS: natter night.
	Vale of Evesham RAC: meeting at the 'Round of Gras', with G5UM talking about 'VHF Then and Now'.
5 Sept	Borders ARS: field day preparations.
	Coventry ARS: night on the air.
	N Bristol ARC: natter night.
6-7 Sept	**SSB National Field Day.**
8 Sept	Felixstowe DARS: social.
	Milton Keynes DARC: American Scientists and Discoveries.
	Sheffield ARC: Iceland on Foot by G3PHO.
	Southdown ARS: meeting.
9 Sept	**Bury RS: Hamfest '86 at the Mosses Youth and Community Centre, Cecil Street, Bury.**
	Chester DRS: An Introduction to Microwaves by G3PFR.
	Dartford Heath DFC: pre hunt meeting.
	Dorking DRS: informal at the Star and Garter.
	Harpenden ARC: The GB3HN Repeater by G8OPE.
	Keighley ARS: informal.
	Newbury ARC: junk sale.
	Warrington ARC: junk sale.
	Worksop ARS: Sheffield brewery visit.
10 Sept	Crawley ARC: informal.
	Farnborough DRS: pre AGM discussion.
	SE Kent (YMCA) ARC: How Raynet Works.
11 Sept	Edgware DRS: Relays by G3GC.
	N Wakefield RC: junk sale.
	Pontefract DARS: visiting N Wakefield.
	Salop ARS: fox hunt.
	Southgate ARC: The Quick and Easy Way to Learn CW by G3ZVW.
12 Sept	Coventry ARS: treasure hunt and barbeque.
	N Bristol ARC: bring and buy sale.
13-14 Sept	**BATC International ATV contest from Sat 1800 to Sun 1200 BST. On 70cm, 23cm and 3cm FSTV. Details from G6IQM.**
13 Sept	**Scottish Amateur Radio Convention organised by Glenrothes DARC. Contact Ken, GM3ZSP, on 0334 53336.**
14 Sept	Dartford Heath DFC: DF hunt.
	Dunstable Downs RC: visit to Alton Towers.
	Edgware DRS: Top Band DF hunt.
15 Sept	Stourbridge DARS: meeting.
	Welwyn Hatfield ARC: meeting.
	Rugby ATS: auction of amateur radio goodies plus trade and club stands, refreshments available and admission free. Doors open at 7.30 pm at the Cricket Pavilion, B Building Entrance, BTI Radio Station, A5 Trunk Road, Hillmorton.
	Biggin Hill ARC: The Work of the RIS.
	Chester DRS: video tapes — Satellite Communications and Packet Radio.
	Delyn RC: meeting.
	Kidderminster DARS: VHF Propagation by G8BKL.
	Midland ARS: surplus sale.
17 Sept	Hastings ERC: G4KYQ.
	SE Kent (YMCA) ARC: natter night.

Stroud ARS: meeting.
Three Counties ARC: Amateur Television by G8LES.

18 Sept Douglas Valley ARS: meeting.
N Wakefield RC: Contest Operating by G3ZXZ, G4IAU, G4RCG.
Salop ARS: natter night.
Vale of Evesham RAC: meeting at the Anchor.

19 Sept Borders ARS: Top Band Working by G3YOG.
Coventry ARS: night on the air.
N Bristol ARC: GWR by Ron Gardner.

20 Sept Pontefract DARS: Went Valley Hike — Raynet exercise.

21 Sept **The National Amateur Radio Car Boot Sale at the Shuttleworth Collection, Old Warden, near Biggleswade. Admission 50p though parking is free. Open from 10am till 5pm.**

22 Sept Felixstowe DARS: Talk by G3NYK.

23 Sept Chester DRS: How Marcher Sound Radio Station Works.
Dorking DRS: Raynet at Ashcombe School.
Harpenden ARC: informal natter night.

24 Sept Crawley ARC: The RSGB by G4VEC.
SE Kent (YMCA) ARC: meeting.

25 Sept Edgware DRS: informal.
Glossop DARG: equipment display.
G Peterborough ARC: video.
Pontefract DARS: Raynet by G3PSM.
Salop ARS: slow scan TV by G4IUT.
Southgate ARC: informal.

26 Sept Coventry ARS: visit.
N Bristol ARC: QSL card display.
Worksop ARS: quiz night vs Maltby club.

30 Sept Chester DRS: Lowe Electronics visit.
Delyn RC: meeting.
Keighley ARS: Mr Fleet, senior transmitter area manager for the BBC.
Kidderminster DARS: an Evening With G3PGQ.

1 Oct SE Kent (YMCA) ARC: natter night.
Stroud ARS: meeting.
Three Counties ARC: HF Antennas and Feeders by G5RV.

Will club secretaries please note that the deadline for the November segment of Radio Tomorrow (covering radio activities from 1st October to 1st December) is 22nd August.

Contacts

Aberdeen ARS	Don	04676251
Abergavenny & NH ARC	GW4XQH	0873 4655
Aberporth ARC	GW0DPR	023987 274
Alyn and Deeside ARS	GW4RKX	0244 660066
Amateur Radio & CC	Trevor	04895 81032
Atherstone ARC	Roy	0203 393518
Axe Vale ARC	Bob	029 74 5282
Ayr ARG	GM3THI	Ayr 42313
Barking RES	R. Woodberry	01 594 4009
Barry College RS	John	065679 710
Basingstoke ARC	Dave	07356 5185
Bath DARC	G4UMN	Frome 63939
Biggin Hill ARC	G0AMP	0689 57848
Borehamwood Elstree ARS	Tony	01 207 3809
Braintree ARS	G6CJA	0376 45058
Bredhurst RTS	Kelvin	Medway 376991
Brighton DARS	Peter	0273 607737
Bristol ARC	G4YOC	Bitton 4116
Bristol (Shirehampton) ARC	Ron Ford	0272 770504
BT (Reading) ARC	G4MUT	0734 693766
Bury RS	Allan	0204 706191
Cambridge DARC	D. Wilcox	0954 50597
Chesham DARS	Sec	09278 3911
Cheshunt DARC	G4VMR/G4VSL	092084 250
Chester DRS	Dave	0244 336639
Chichester DARC	C. Bryan	0243 789587
Clifton ARS	RA Hinton	01 301 1864
Conwy Valley ARC	G4VVW	0492 636376
Coulsdon ATS	Alan	01 684 0610
Coventry ARS	Robin	0203 73999
Darenth Valley RC	Sec	0322 63368
Dartford Heath DFC	Pete	0322 844467
Denby Dale DARC	G3SDY	0484 602905
Derwentside ARC	G1AAJ	0207 520477
Donegal ARC	EI3BOB	074 57155
Dorking DRS	John	0306 77236
Douglas Valley ARS	G4GWG	0942 211397
Droitwich DARC	G4HFP	0299 33818
Dudley ARC	John	0384 278300
Dunstable Downs RC	Phill Morris	0582 607623
East Kent ARS	Stuart	0227 68913
East Lancashire ARC	Stuart	0254 887385
Edgware DRS	John	Hatfield 64342
Exeter ARS	Roger Tipper	0392 68065
Fareham DARC	Alan	0329 288139
Farnborough DRS	Mr Taylor	0252 837581
Felixstowe DARS	G4YQC	0473 642595
Fishguard DARS	Bernard	0348 872671
Fylde ARS	PRO	0253 737680
Galashiels DARS	GM3DAR	0896 56027
G. Peterborough ARC	Frank	0733 231848
Halifax DARS	D. Moss	0422 202306
Harrow RS	Tony	01 861 0419
Hastings ERC	Dave Shirley	0424 420608
Haverhill DARS	Rob Proctor	0787 281359
Havering DARC	G0BOI	04024 41532
Hornsea ARC	Norman	0262 73635
Horsham ARC	Pete Head	0403 64580
Inverness ARC	Brian	0463 242463
Keighley ARS	G1IGH	0274 496222
Kidderminster DARS	Tony	0562 751584
Kingston DARS	G3ODH	Epsom 26005
Lagan Valley ARS	Jim	0846 682474
Leeds DARS	G1EBS	0274 665355
Leighton Linslade RC	Pete Brazier	052 523 270
Lothians RS	Robin	0506 890177
Loughborough ARC	Philip	0509 412043
Loughton DARS	G6FWT	01 508 7190
Maidenhead DARC	John	0628 28463
Maidstone YMCA S/C ARS	G4AYD	0622 29462
Maltby ARS	Ian Abel	0709 814911
Medway ARTS	Tony	0634 578647
Midland ARS	G8BHE	021382 0086
Mid Sussex ARS	G1FRF	0791 82937
Mid Ulster ARC	Sam	0762 22855
Mid Warwickshire ARS	G4TIL	Southam 4765
Milton Keynes DARS	Dave	0908 501310
Morecambe Bay ARS	G3PER	Heysham 52659
N. Cornwall RS	J. West	0288 4916
N. Staffs ARS	G6MLI	0782 332657
N. Wakefield RC	Steve	0532 536633
Newbury DARS	G3VOW	0635 43048
Nunsfield House ARG	G4PZY	0332 767994
Oswestry DARC	Brian	0691 831023
Plymouth ARC	G4SCA	0752 337980
Pontefract DARS	G0AAO	0977 43101
Preston ARS	George	0772 718175
Rhyl DARC	GW1AKT	Nantglyn 469
Rugby ATS	Kevin	0788 77986
Salisbury RES	Neil	0980 22809
Salop ARS	Simon	0743 67799
Sheffield ARC	John	Sheffield 581766
Sandwell ARC	G4UMY	021 422 1554
Shefford DRS	G4PSO	Hitchin 57946
S. Bristol ARS	Len Baker	0272 834282
S. Cheshire	Chris	07816 73185
S. Lakeland ARS	Dave	0229 54982
S. Manchester RC	Dave Holland	061 973 1837
S. Tyneside ARS	G4XWR	S. Shields 543955
S. E. Kent (YMCA) ARC	John	0304 211638
Southdown ARS	P. Henly	0323 763123
Southgate ARC	Dave	0992 30051
Stevenage DARS	G4ISO	0462 892765
Stirling DARS	GM0BFS	0259 217702
Stockton DARS	John Walker	0642 582578
Stockport RS	Mel	061 224 7880
Stourbridge DARS	G3ZOM	K/ford 288900
Stowmarket DARS	M. Goodrum	0449 676288
Stroud ARS	G0DZM	045 3832773
St Helens DARC	A. Riley	051 430 9227
Swale ARC	B. Hancock	0795 873147

Amateur Transmitters 1925-1930

After the 'DX Revolution' of the first half of the decade, John Heys, G3BDQ, notes that the second half was no less exciting.

The first part of this article covered the years 1920 to 1925 and attempted to show how the 'DX Revolution' and the migration down to shorter wavelengths after 1923 had influenced amateur transmitter design. The unstable, chirpy and drifting T1 signals of the earlier days slowly disappeared and the trend was towards the generation of clean and stable emissions.

Power became almost an irrelevance. Experience had shown that a low powered rig having an excellent frequency stability and a good note could easily out-perform the drifting monsters using their football-sized triodes and fed from either raw or at best poorly smoothed and rectified HT supplies. Fantastic DX on the shorter wavelengths which went down to around 20 metres was being worked by low powered stations. Early in 1926, Loren G Windom, American 8GZ (of antenna fame) contacted Capetown when he was using only 0.493 of a watt input. This represented a range of 17,250 miles per watt which must have seemed almost unbelievable at that date, especially to the older generation of amateurs who had been reared on spark, high power and long wavelengths.

Austrian EACM in his shack in 1927. Top left is his 400W single valve self-excited transmitter. The receiver on the desk was an early superhet.

The Multi-stage Concept

The adverse effects caused by a direct aerial connection to a free running oscillator were well known. Even when the HT supply was well smoothed, any aerial movements could 'pull' the transmit frequency alarmingly. An obvious answer to this problem was the isolation of the oscillator from the aerial circuit and its connection instead to a following amplifier valve. This system was known as the MOPA (Master oscillator-power amplifier) circuit which remained in use during the 1940s — the British 1154 Aircraft transmitter being a typical example. Unfortunately the triode valves in use in the 1920s were very difficult to neutralise so many amateurs resorted to using power doubler stages instead of power amplifiers.

Birmingham amateur C H Green, 6YD, built a 10W MOPA rig in 1926 which was designed to work on 45 metres. This transmitter circuit shown in **Fig. 1** was described by 6YD in 'Amateur Wireless' early in 1927 but an examination of its circuit reveals that it did not have any neutralisation. This means that it probably operated (unintentionally) in the 'locked oscillation' mode. The DET.1 output stage would behave as a TPTG (tuned plate-tuned grid) oscillator; its grid coil being coupled to the oscillator anode circuit. The latter would determine the final output frequency. So long as the two valves were oscillating on close frequencies the oscillator proper (V2), which had a better 'Q' or goodness in its circuit, would

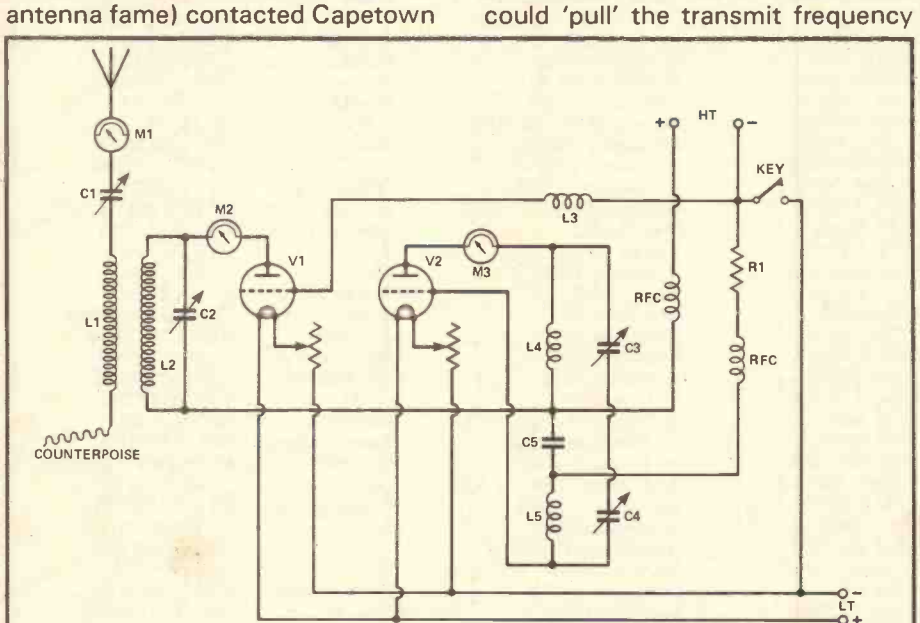
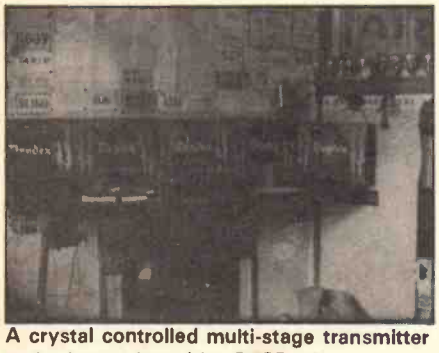


Fig. 1 Circuit of an early MOPA transmitter designed by 6YD in 1926. The PA valve V1 was not neutralised so was probably working as a power oscillator 'locked' to the frequency of V2's oscillatory circuit. The anode current meter M2 in the 'hot' part of the V1 tank circuit was poor practice!

determine the operating frequency and 'pull' V1 to that frequency. This 'locking' principle is an important one and will be discussed again in a different context later.

6YD had fine results from his little transmitter and mentioned working five continents and also keeping a weekly and successful 'sked' with American station U-1AFF (the Americans then did not use the W prefix). In the first paragraph of Green's article he wrote " . . . if the note is very pure DC and absolutely steady it is far easier to read a weak steady DC note than some of the AC stuff sent out by a large number of Continental transmitters . . ."

The output valve of 6YD's transmitter was a Marconi LS5, a valve type which became the workhorse for hundreds of low powered amateur stations in this country. The LS5 used 5.25V on its filament and could take a maximum anode potential of 400V. At this voltage and a current of 25mA, the LS5 ran comfortably within the 10 watt licence condition then the norm. 6YD used grid-block keying of both valves and he claimed that this method eliminated key clicks and — most importantly — prevented the radiation of a spacing wave. He wrote, ". . . at the present time there is quite enough QRM on this band without stations having two notes when one is sufficient."



A crystal controlled multi-stage transmitter built along a board by G5CP of Manchester around 1930.

Quartz Crystal Control

The piezoelectric property of Brazilian quartz crystals was probably first noticed by Dr W G Cady of the American Wesleyan University who published a paper concerning it in 1922. A little later Dr G W Pierce of Harvard University developed their use in oscillators and in 1924 he used quartz crystals to control amateur transmitters. The first mention of crystal control for amateur use appeared in the ARRL publication 'QST' in July 1924 and after this article (which had been written by H S Shaw) appeared several amateurs experimented with crystals. Through the year 1926 the number of amateur stations using crystal control mushroomed as operators were quick to realise its advantages. A frequency stability of an order unattainable by the contemporary free-running oscillators and a very pure DC note were factors which made crystal controlled oscillators so attractive.

The British magazine 'Experimental Wireless' carried articles by 2SZ, Cecil Goyder and his co-worker Hinderlich in 1926 and also early in 1927 which explained the theory relating to the use of quartz crystals for frequency control and also provided some practical working details of oscillators and transmitters. Quartz crystals were then very expensive and it was soon noted that if they were used to control high power oscillators they would fracture.

Fig. 2a shows part of the circuit for a typical crystal oscillator at that time. It was a normal TPTG oscillator but with a crystal in parallel with the tuned grid circuit. To set up this arrangement the oscillator would first be tuned up without the crystal to a frequency close to that of the crystal. Then when the crystal was put in circuit it would 'take over' from the tuned circuit. The crystal had a much higher 'Q' thanthe grid coil and its capacitor and so it captured the frequency of oscillation.

To enable the frequency stabilisation of high power oscillators which often had their grid currents

A QSL card from Polish SP1AG in 1930 which shows his MOPA rig neatly built on a metal faced board and with inter-stage screening.

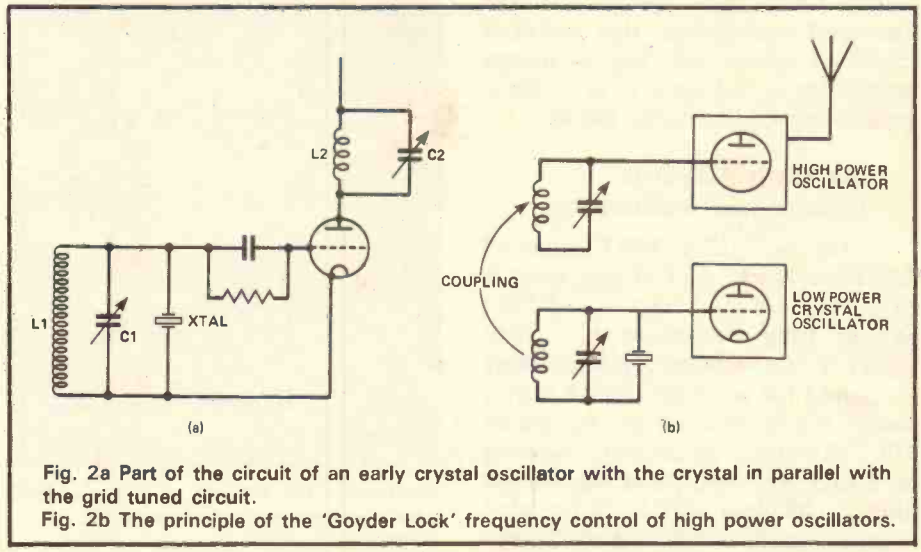


Fig. 2a Part of the circuit of an early crystal oscillator with the crystal in parallel with the grid tuned circuit.
Fig. 2b The principle of the 'Goyder Lock' frequency control of high power oscillators.

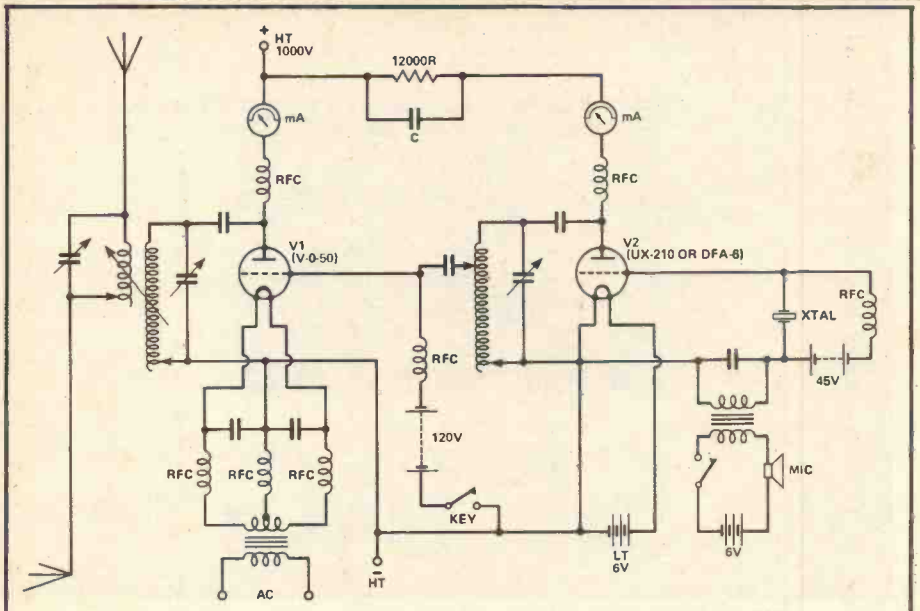


Fig. 3 A two stage crystal controlled transmitter which could be used for CW or telephony on 45 metres. The output stage V1 worked as a power doubler.

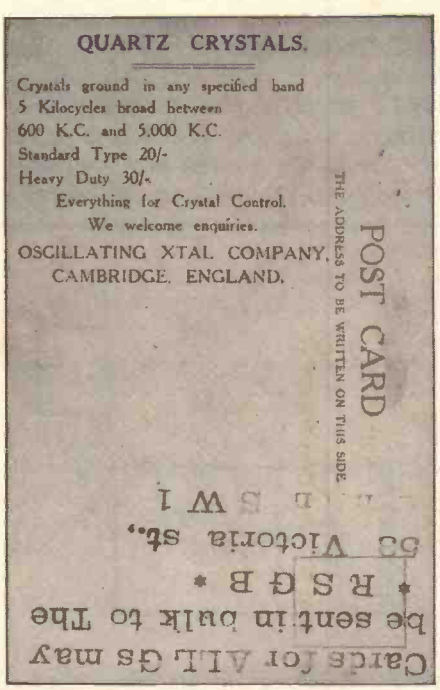
running at such high levels that no crystal could be used safely, Goyder employed a crafty system which became known as the 'Goyder Lock'. This technique is shown in **Fig. 2b.** A low powered crystal oscillator had its frequency controlled grid circuit very loosely coupled to the grid circuit of a free-running high power oscillator which had been tuned close to the crystal frequency. The superior 'Q' of the crystal circuit then could 'capture' the grid circuit of the big 'bottle' and enable it to oscillate with great stability at the crystal frequency.

Another way to use crystal control and achieve higher power levels was by doubling in the transmitter output stage. This was not so efficient as using a straight PA but no neutralisation was required. The 'Goyder Lock' became obsolete when transmitter design instead favoured multi-stage rigs using a chain of valves working as buffer amplifiers or doublers after a lower power crystal oscillator stage.

An Early Crystal Controlled Transmitter

The April 13th 1927 issue of 'Wireless World' had an article by R W H Bloxham (who had the call 5LS) which fully described his 50W crystal controlled transmitter designed for work on the 45 metre band. Bloxham used an American UX-210 valve as an oscillator running at about 8W input, but mentioned that a Mullard DFA6 valve also worked well in this circuit. His crystal had a fundamental *wavelength* of 91.6 metres (work that out in kHz!) and it rested between two steel plates which had been ground dead flat. Each plate was 1¼" square and ¼" thick.

The transmitter output valve was a Mullard type VO.50 which worked as a power doubler at an input of 54W when 1000V HT was applied to its anode. This valve also had 120V of grid bias so it was working in class C mode and could therefore double fairly well. The HT voltage supply came from the AC mains using a high voltage transformer, valve rectification and smoothing. This 1000V HT was dropped through a 12000 ohm resistor to supply the crystal oscillator with its 400V HT. The resistor was wirewound, had inductance, and until shunted by the capacitor C (a 0.002uF) to detune it had given instability problems. AC was applied to the filament of the VO.50 valve and batteries supplied suitable bias voltages.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THE ADDRESS TO BE WRITTEN ON THIS SIDE.

The back of G5YK's QSL card sent in 1929 which advertises quartz crystals for amateurs.

Grid-block keying of the output stage removed the 45 metre 'spacer' but there must have remained a considerable amount of signal on the fundamental crystal frequency both under key up and key down conditions. Rigs then had no screening whatever. The crystal oscillator could also be grid modulated, something which would give serious FM with a free running oscillator. The output stage was loosely coupled to the antenna and counterpoise.

5LS was an enthusiastic and early convert to crystal control and he mentioned that even when using an unsmoothed rectified HT supply a practically pure CW note could still be obtained. Bloxham concluded his article be remarking that no matter how much his aerial was swinging and even when the operator's hands were near the transmitter coils (at 1000V very dodgy!) the frequency shift was no more than a few hundred cycles (Hz). He added that so long as the crystal oscillator was set up properly ". . . it is impossible to be the perpetrator of those chirpy notes which are dreadful to copy!"

Getting Crystals

Throughout the period 1926 to 1930, quartz crystals were very expensive. In 1929 the Oscillating Xtal Company in Cambridge could supply standard type crystals for working between 600 Kc (kHz) and 5000 Kc (kHz) for £1 each. Their heavy duty types were 30/- (£1.10s). At that time in the United States, the Scientific Radio Service Company offered crystals for the 80 metre band at 25 Dollars and for the 40 metre band at 45 Dollars. These crystals were unmounted.

British amateurs soon discovered that there was a much cheaper source of oscillating quartz crystals. They might be found in the junk boxes of the longer established opticians around the country! During the 19th century, rock crystal was

used for high quality spectacle lenses and these were often ground to prescription by the opticians themselves. The use of such lenses discontinued during the early years of this century but many opticians 60 years ago still retained their old stock of quartz blanks and unwanted lenses.

Amateurs visited friendly opticians to borrow their stocks of old lenses to test them for activity and frequency. Many could be induced to oscillate, but finding specimens suitable for working on the amateur bands was not easy. I still have a few of these lenses which were passed over to me by a deceased old timer and two of them can be coaxed into oscillation; one on the old Top Band which began a little above 1700kHz and the other on the 200 metre band. The crystal holders in the early days were not enclosed but just consisted of a very flat polished metal plate upon which the crystal rested and on top lay another similar steel plate. My late friend once told me that over-excitation of crystals in these holders often resulted in the crystal leaving its mount and shooting off across the room!

An American Transmitter

The circuit in **Fig. 4** of W1AOZ's crystal controlled telephony transmitter shows just how far transmitter design had advanced in the USA by 1929. This transmitter had a Miller type crystal oscillator working on the 80 metre band which was used to drive a neutralised triode PA. An unusual variety of choke modulation which used a pair of 30H chokes and a 2uF capacitor (C) together with a resistor to drop the voltage on the PA anode would allow almost 100% modulation. Neutralisation was accomplished through the use of a small feedback inductor (L2) and an adjustable capacitor (NC). The antenna coupling arrangement was suitable for an open wire feeder to a Hertz antenna, possibly a Zepp.

This 1929 circuit is little different from many circuits in general amateur use when the writer entered the transmitting scene in 1946. It was a very advanced design for its date. The use of directly heated valve filaments dictated the employment of balance resistors and capacitors when AC was used. It is interesting to note that the oscillator valve was

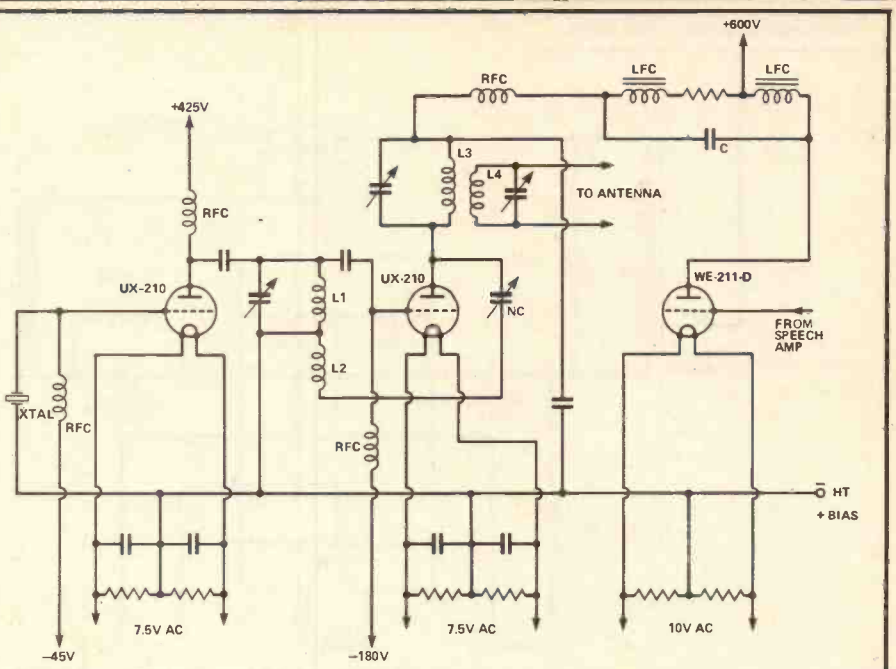


Fig. 4 A sophisticated 1929 American transmitter used for telephony on 80 metres (a band then not available to British amateurs). This rig had proper PA neutralisation and effective anode modulation.

biased from a 45V source; the concept of grid leak bias was not then in general use with crystal oscillators. This little transmitter which could run at inputs between 25 and 50 watts was used during an unusual 'Long Distance Talking Marathon' when W1AOZ worked 71 stations in twelve States and also Canada during a non-stop 13 hours on the air!

It was possible to buy a three stage crystal controlled 10V CW transmitter kit for 56 Dollars in the USA in 1929. The Radio Engineering Laboratories No 215 Transmitter fitted into a smart metal case and it employed a screen grid (tetrode) buffer valve between the crystal oscillator and the type UX-245 PA valve. Additional sets of plug-in coils for any of three bands could be purchased for just 7 Dollars per set. I doubt if there was anything similar available on the amateur radio market anywhere in Europe to that date. American radio technology was by 1929 far ahead of anything to be found in the rest of the world and the very large amateur population in the 'States offered a fine potential market to manufacturers of gear for amateur use.

A Return to the Primitive!

'QST' magazine had a long and detailed constructional article in its December 1929 issue. This was at the very end of the period under review in this article and, surprisingly, despite the advances in transmitter design involving multi-stage rigs and crystal control. The 'QST' piece was a description of 'The Single Control Transmitter' which was in fact nothing more than a bread-boarded single valve, self-excited TPTG oscillator running at up to 50W input on 80, 40 and 20 metres.

The author of the article was George Grammer, a member of the ARRL staff who later became well known for his transmitter and receiver designs for 'QST'. Grammer offered a simple but effective transmitter which used the then ubiquitous American UX-210 valve in a circuit **(Fig. 5)** which was a little unusual in that the grid coil was tuned by just the valve's grid/filament capacitance.

The grid coils for each band were low 'Q' devices and were wound with thin cotton covered wire on 1" diameter tube or wood dowel. In sharp contrast, the anode coils were made from hefty ¼" diameter soft copper tube and were self supporting. The anode tuned circuit determined the operating frequency which in a TPTG was higher than the self resonant grid frequency. The anode and grid coils were not coupled and the feedback needed to sustain oscillation was through the valve inter-electrode capacitance.

Grammer stressed the importance of the aerial which he said, was a part of the transmitter design. His

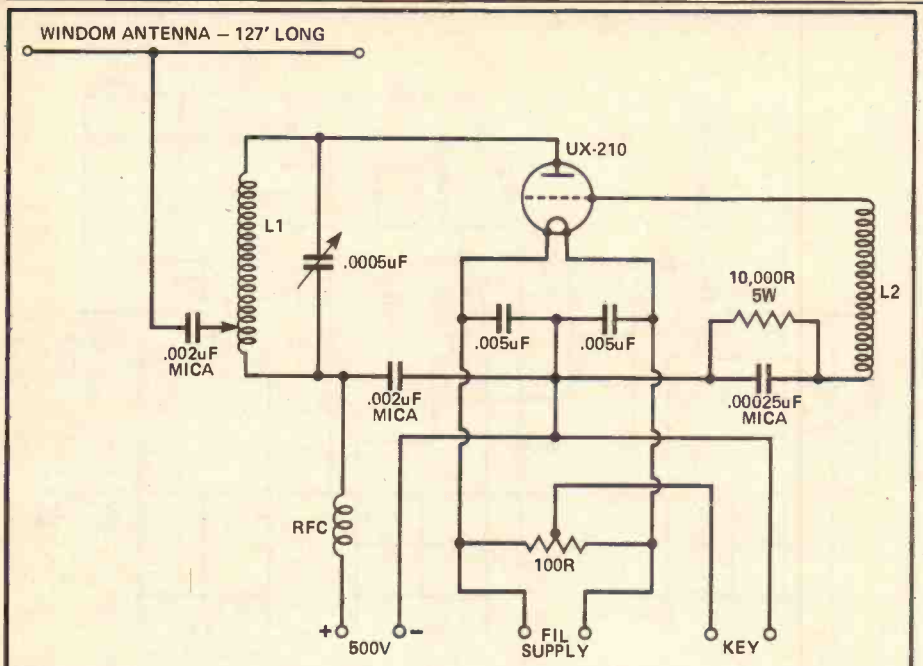


Fig. 5 Almost the last of the 'dinosaurs'! A self-excited single valve TPTG transmitter described in 'QST' at the end of 1929. The Windom antenna was an important part of the circuit.

aerial was a Windom or resonant Hertz with a single wire feeder terminating at the transmitter anode coil via a mica isolating capacitor. The tune-up instructions are interesting for they involved the use of a small bulb across a single turn loop. No metering was used at all on the rig! The aerial had to be cut *exactly* to resonate on the band and a chart which showed wire lengths and tap positions was provided by the author.

The transmitter was then tuned to the antenna frequency. This was done by observing how the antenna 'pulled' the anode circuit and took out power, so reducing the brilliance of the bulb on its loop. The antenna feed was tapped down near the earthy end of the anode coil until a point was found which loaded up the transmitter but still allowed a stable and clear note. Transmitters similar to this design were still in regular use on the amateur bands in the USSR and its satellite countries through the 1940s and early 1950s. The writer will never forget some of the excruciating notes and the amazing drift of some stations which sailed right through his receiver passband during each of their overs!

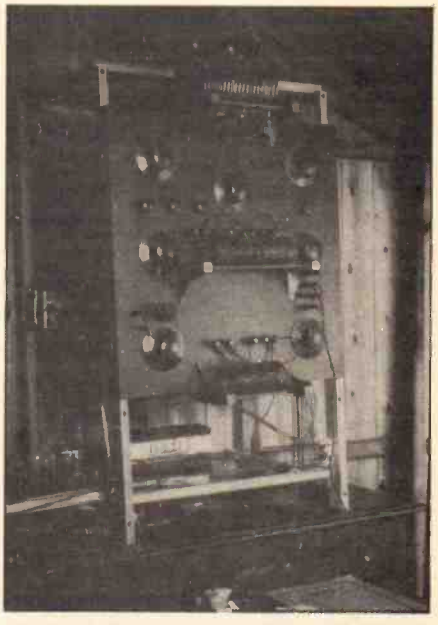
Grammer's little TPTG transmitter was really obsolete by the time it was 'written up', for the year 1930 and the rest of that new decade saw the rapid escalation of crystal control and the virtual outlawing of self-excited single valve rigs in most of the world. They survived however on the old 5 metre band where they could be received without difficulty on the broad, super-regenerative 'rush box' receivers in use.

Finally . . .

Sunspot Cycle 16 peaked around 1927, it had certainly helped to stimulate interest in long distance amateur communication. The propagation which favoured the higher frequency bands led to much DX work on those bands and during 1928 and 1929 there was a growing interest in 10 metres. Work on 20 and 10 metres needed good transmitter stability, for which there was no urgent need when amateur wavelengths were considered short at 180 metres! The number of amateurs increased rapidly between 1920 and 1930 and the new problem of QRM arose. The much increased band occupancy made frequency control using crystals essential. The multi-stage transmitter concept which isolated the frequency determining circuits from the antenna and also allowed crystal control together with high output powers, replaced the single valve transmitters in general use earlier.

On January 1st 1929 a new condition was attached to Experimental Licences for amateurs in this country. No more ICW, Tonic Train or raw AC was to be used henceforth! There were to be no more 'CQ' calls (this ruling persisted until after WW2) and perhaps most importantly every transmitting amateur had to possess a quartz crystal wavemeter. The amateur bands available after that date were Top Band (1740-1970 kHz), 40 metres (7050-7250 kHz), 20 metres (14060-14340 kHz), and with special permission 10 metres (28100-29900 kHz) and 5 metres (56150-59850 kHz). A self-excited transmitter without a crystal wavemeter just could not be kept within the specified bands and to stray outside those limits could mean a 'Pink Ticket' or even loss of licence.

The growth in the use of crystal control led to the technique of tuning the entire band for replies after first making a 'test' call. Some of the leading lights could be found by tuning to their known crystal frequencies, but it was largely a matter of luck and not just of signal strength which decided who could be first heard by a DX station when he was called. This method of calling and tuning for 'possible' replies (that was when the phrase first surfaced) was a laborious business and was one reason for the great length of time needed to run a DX contest, which might last for weeks rather than days! The universal use of the VFO was a post-war concept and apart from the Meissner 'Signal Shifter' of the late 'thirties crystals were used in every rig. In this country a certificate was supplied with each crystal bought which stated the



A neat rack construction housing G5FY's transmitter 1929-30.

tested frequency of the 'rock' and this certificate *had* to be produced during station inspections. This also went on for a few years after WW2.

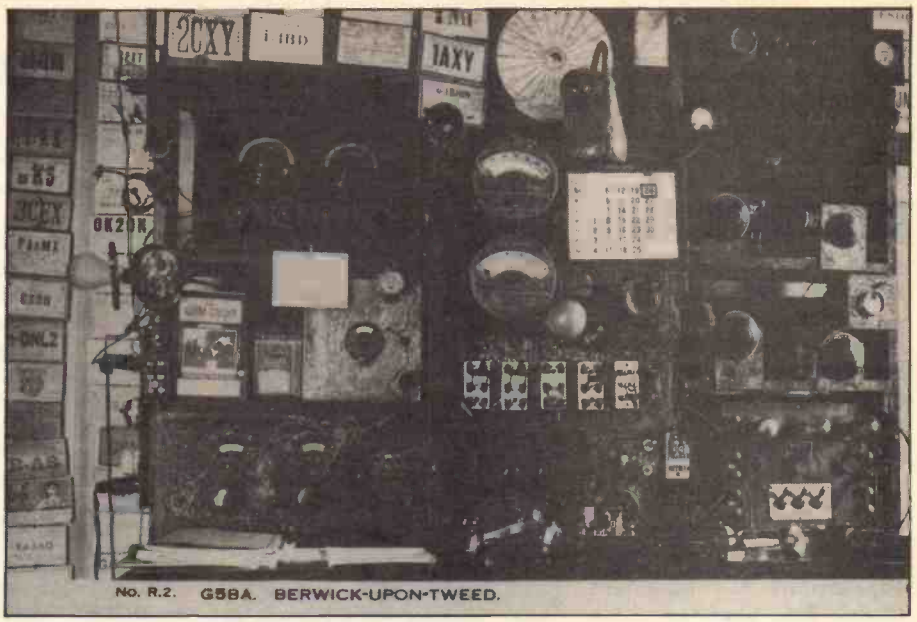
Construction techniques up to 1929 still centred upon bread board layouts but these were often arranged in racks; some amateurs even used glass fronts to their rack systems. The simple square boards were replaced by elongated plank-like boards which could accommodate a chain of transmitter stages right through from the oscillator via buffers or doublers to the PA valve. Photographs of gear and shacks at that time show that they were considerably neater and tidier than those pictured some five or six years earlier.

Components were becoming easier to find and by 1930 good quality high voltage working mica capacitors could be bought 'off the shelf'. Many amateurs dismantled, double spaced, and re-built broadcast receiver variable capacitors for transmitter use. Self supporting coils made from copper tube or very thick wire were used in most transmitters, even low powered ones. Glazed ceramic was commonly used as an insulator for 'stand offs' to hold coils and those parts of the circuit at high DC or RF potential.

Ebonite and the new material Bakelite were also used for panels and for mouldings such as valve holders, coil formers, rotary switches and fixed capacitors. The thermoplastics did not appear until after the mid-thirties; a material called 'Trolitul' being one of the first transparent varieties. A substance called 'Micalex' was developed for high frequency insulation in the USA but it remained relatively expensive and difficult to obtain. An advertisement for the National Company's transmitter type variable capacitors in 1929 mentioned that the insulation used for the lower voltage types was 'hard rubber' (ebonite) and 'Crolite' was for the high voltage wide spaced models. Interestingly the 'ad' also stated "Micalex can be furnished on special order to those licensed to use it."

Non-inductive resistors made from a composition of vapourised metal film began to replace wire-wound components in RF circuits. Some of the new resistors could dissipate up to 10W so were fine for transmitter grid leaks. An increasing use of AC mains supply to power amateur transmitters was made easier by the new mercury vapour rectifier valves. The famous and long lived type 866 high voltage valve diode rectifier was certainly available before 1930. A 'Vibroplex' semi-automatic morse key (known as a 'bug') could be bought for 17 Dollars but over here such 'Yank' devices were despised by many old time brass-pounders.

It is hoped that this necessarily brief look back at amateur transmitter development and use will have proved of interest, not only to the dwindling band of grey-beard pioneers but also those holders of new and shiny 'G' callsigns who might marvel at the way the pioneer generation achieved so much using so little. The 10 years following 1920 saw tremendous changes in every aspect of amateur radio, particularly in transmitter design and the use of shorter wavelengths. Receivers however changes very little and even up to the end of the 1930s simple O-V-1 TRF sets dominated the scene. Multi-wave superhets were considered to have a very noisy performance, and with the exception of the famous HRO receiver which appeared in 1934 this was no doubt true. The period 1930 to 1939 was one of consolidation and there was no great change in basic transmitter design during that time; the crystal oscillator followed by one or more stages remained the norm in most amateur shacks.



The shack of G5BA in 1930 with his crystal controlled transmitter rack to the right.

An American advertisement for a complete 10W transmitter kit in 1929. The transmitter was crystal controlled and used three valves.

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SALE. Trio TH21E 2m FM mini hand held £130. Akai M8 4-track 3-speed reel to reel tape recorder £50. 70cm MBM 48 ELE Yagi £20. all ono. G3ILO, ring Nailsworth (Glos) 0453 83 3411.

AVO model eight mark 2, new, boxed and guaranteed unused. Want Eddystone valve type receiver, with manual, no mods. Cash adjustment for excellent model. W.E. Stedman, 133b Lynton Road, Bermondsey, London SE1 5QX.

SALE. Centronics 306 printer large £60, new VDU case for 14" tube £10, computer PSU +/– 20V 5V 5A £5, CR tubes SFP7A £5 each, 12" uncased monitor separate syncs and video £6. Wanted, PF2UB SP400 speaker. Ring 0254 580983 after 6 pm.

G1MGV. Selling Mirage B108 10W I/P, VGC, also 17 ele F9FT from Tonna (plus mast if required). Amplifier £90, Tonna £25, or both for £100. Phone 0966 33633 between 7 and 8 pm, ask for Dave Goode, G1MGV.

FLEXIBLE drive for ¼inch spindle/shaft, 8 inch, suit tuning condenser, potentiometer, £3. Class "D" wavemeter No1-MK2, 1MHz, 100kHz xtals, VFO. Harmonics 30MHz, mains, instructions, £12. Partridge transformer, mains to 293-0-293, 323-0-323, 353-0-353V, 250m/A £5. Tel G3MBL, (0284) 60984, Bury St Edmunds.

TRIO TS430S HF Tx/Rx with AM filter, ATU, as new, boxed, £600 ovno. Yaesu FT790R, nicads, charger, case, mobile, 2×⅝ wave, base 3×⅝ wave, SWR meter, Wood and Douglas 70PAS, 70LIN10 preamp + linear built, untested with suitable case £260 ovno. Tel Gordon, G8WWD, 0527 402557.

FOR SALE. Yaesu FT225RD transceiver, excellent condition, C/W manual, original packing £495. Sota 2m 100W linear, 10W 1/P £95. Walters 80 character parallel/serial dot matrix printer £80. Homebrew RTTY unit comprising keyboard, VDU, 8080UP £40. Phone Brighton 504213.

B40/D +SSB unit, good working order, all leads, manuals and spares, £100 ono. Tel Steve, Watford, 0923 775451.

DRAKE TR7 general coverage Rx/Tx 100 watt multimode. All filters NB7FA7 ext VFO spkr fans PS7FA7 RF clipper base station mic recent overhaul £900. Gone QRT Commodore 16+4 64K computer ACE + 16 pack joystick cass £70 ono. C64 owner Sony IC200ID £250. 31c Anerley Park, SE20.

TWO Epsom half height disc drives, double sided, uncased, £50 each or £80 the pair! WHY? Phone Epping 78710 after 6 pm.

YAESU FT290R 2m multimode, excellent condition, no mods, complete with nicads and charger. Also microwave modules 30W linea amp to match, SWR meter and HB9CV 2 ele antenna. Complete 2m station for £290 ono. Phone Martin, G6KJJ, on Reading 0734 67583.

TRIO R600 excellent condition £185. Phone 0524 53104 ask for Mike.

YAESU FR50B receiver 80-10mtrs, excellent condition. Suit beginner or experienced SWL. £70 including delivery. G4STB 0726 882812 Cornwall.

TRANSMITTER type R9231 ex govt 200-400MHz continuously tunable, weight approx 100lb, hence buyer collects, in good condition, £40 ono. Tel 0380 830428 (Wiltshire).

FOR SALE. Concorde II multimode ideal for conversion, good working order, boxed, instruction and service manuals, £40. Realistic DX302 0 to 30MHz general coverage receiver, digital readout, triple conversion excellent condition, no manual, £100 ono. Phone 01-807 2462.

COMPLETE station comprising TS820 fitted 12V inverter MC35S mic SP820 SEM transmatch HQ-1 mini beam original cartons £580. No splits. Rugeley (Staffs) 78981 after 6 pm.

FREE TS830S 2x10mtr masts to purchaser executive QTM English Lakes 350ft ASL, magnificent views, 3 bed, lounge, hall, study, dining rm, bathrm, fitted kitchen, garage, fully CH, dbl glzd, carpeted, heated swimming pool, some built-in furniture offered, freehold about £68,000. Details, viewing 0229 85669.

SPECTRUM Wafadrive, 8 cartridges inc transfer, £75. Tandy CGP115 4-colour printer/plotter £49. Maplin RS232, b-board software on EPROM £19. Currah microspeech, and ZX81 16K rampack + power supply, offers. All boxed and hardly used. Tel Radnage (024026) 2065.

COMMUNICATION receiver collectors item 1953 CR100/B28 6 bands 60kHz to 420kHz, 500kHz to 30MHz. Working order, needs attention, buyer collects. Phone Scarborough 0723 363825.

SURPLUS components, capacitors, pots, HV connectors, edge connectors, plugs, sockets and transformers, large SAE for lists. Wanted, 3CX400/8874, 3CX800U7, 3CX1500/8877, 8938s and bases. G6HUN, Canal Lodge, Bath Road, Padworth, Berks RG7 5HR.

STOP. Look, HF Icom 730, superb condx, boxed etc £350. 70cm C78 FM portable, good condx, boxed etc £150. Morse tutor Datong D70, boxed £45. Offers considered on all items. Tel 0442 61936 evenings only.

DATONG morse tutor, mint, boxed, £40. SAE please to J. Holmes, 46 Danemore, Tenterden, Kent.

JRC NRD515 receiver with matching speaker, mint condition, manual. Frequency range 100kHz to 30MHz. Owner deceased, therefore must sell. Price £500 ono. Tel Billericay (Essex) 52485 evenings and weekends.

SALE. Yaesu FT101Z external VFO type FV101Z. Excellent condition £65 ono. Phone Coventry 450476.

LINEAR amplifier, 2kW, PEP Hunter 2000C, employs two 3-500z Eimac triodes, replaced 1985. Covers 80 through 10 metres, imported from USA, £425 ono. Phone 0475 673748, GM4XHL QTHR.

1980 Muirhead M100M commercial receiver, 10Hz-30MHz, solid state, digital readout, O/A, £400, buyer inspects/collects. BNOS linear LPM, 144-10-180, £200. Trio MC85 micrphone, unused, £60. RM 940 infra-red microphone, unused, £20. Meteor 600 counter and aerial, unused, £130. Phone Dronfield 413413.

SELLING, FT101ZD FM, FV101DM digital VFO, Diawa CNW518 ATU, Tono 350 RTTY receiver, also FT290R, Mutek, NiCads, Sota 30W linear, Diawa 620A, 8EL Yagi, rotator. phone Saltcoats (0294) 62955.

FOR sale, Kenwood R820 receiver, operating manual, also Kenwood SP230 speaker, used by SWL, cost £624, 1982, £380 ono, buyer to pay carriage. Phone (0783) 267125 (Tyneside).

SELLING complete hi-fi station, Trio TS130V, 0.5kHz CW filter, HF5 ant, SEM Z-match with Ezitune, PSU, mic, G4BMK RTTY software and interface (CBM64), £475 ono or exchange for CBM128 with d/drive and monitor, deliver/collect 50 miles. G3PXU, Mereside (073129) 403.

SINCLAIR micro TV, case and mains adaptor, new condition. Air band ARE VHF receiver, Quad Electrostatic speaker. Phone 01-840 6665.

FOR sale, 8" floppy disc drive, £50. VHF/UHF absorbtion wavemeter, model WA1, 120-440MHz, brand new, £18. AEC SWR-9 meter, £8. YW3 PWR-SWR meter, £10. 3 x 6' x 1½" diameter aluminium telescopic portable mast, £16. MBM 88 70cm 88 ele Jaybeam antenna, £35. Phone Redhill 69251.

EXPERIMENTER'S delight, I have several big ugly 50W valve amps (audio), ideal for making linears, Txs, transverters, etc, or use as

guitar amps, Contain HD power supply, 450V, KT66s, etc, £12 each. Phone 01-657 0716 (evenings), G0DLN.

IC720A TCVR with CW filter, FM board, desk, mic, £550. Daiwa CNA2002 2kw auto ATU, £75. FC301 ATU, £50. KR400C rotator, £50. Philips stereo phones, £5. Azden speaker, £5. Stuart Senior G4MIB QTHR, 01-675 0280.

COMMODORE 64 with disk, printer, cassette, RS232, WP package, compilers, books, etc, £250. Stuart Senior, G4MIB QTHR, 01-675 0280.

TRIO TS820S, fitted CW filter, c/w microphone, manual, brand new, spare 6146Bs, mint condition, £495. Drake SPR4 general coverage Rx, fitted noise blanker, calibrator, all accessory xtals, also Drake MS-4 speaker included, absolutely mint condition, £350. G0AYZ, phone Gosport 589560.

FDK multi 700EX 2m FM, unmarked, £130. AVO type 8, with new leads, leather case, a bit ropy, meter in excellent condition, £55. 38 sets plus PSU and manual, £12. 10 set extal calibrator, £6. Bob, Canvey Island, Essex, (0268) 697906.

FOR sale, Yaesu FT290R, with dealer fitted mods, plus case, boxed and in excellent as new condition, £235 ovno. (0772) 634267.

CONVERTER, 100kHz to 60MHz input, 100.1MHz to 160MHz output, suitable for VHF scanners, £25. Phone Stevenage (0438) 725926.

FOR sale, Eddystone receiver model S508 with speaker. This set is in good working order, £50 ono. Phone 01-688 1278 (after 6 pm).

FOR sale, Eddystone 680X receiver, 550kHz to 30MHz, 2 RF stages, variable selectivity, £95. Aerial rotator, complete with control unit, £35. Wanted, linear amplifier for HF bands, anything considered including homebrew. Phone (0283) 63767.

FOR sale, KW204 transmitter, works but requires some attention, £75. Staines 50947.

HAVE Pye F460 UHF (station), Tx and Rx and control unit (remote), in cabinet, fcy 460MHz requires tuning to 70cm, will swap for any 35mm camera and flash gun or enlarger or super 8mm projector. P. G. Robins, G8BSK, 290 Priory Road, St Denys, Southampton, SO2 1LS.

DRAKE TR7 DR7 AUX7 SP75 RV7 SP7 FA7+2 PS7 7077 7073 all filters, general coverage transciever AM SSB RTTY CW filters fitted NB7. Quality not Jap £850 ono. Sony 2001D latest £225. AOR2002 £350 regretful sale. Write or call 31C Annerley Park. SE20.

FT290B with nicads, charger, new case, mobile mount, etc. Bargain £240. Phone Bill G4Z RG on 051 638 1550. QTHR.

TR-2200GX 2mtr TCVR 10 channel fully crystalled CW nicads/charger £75. Microwave Modules MML28/100S 100W 28MHz linear with preamp £75. Wood/Douglas 70MP05T3 70cm transmitter kit with toneburst and crystal £38. GM4OKG QTHR 0383 416688.

FT225RD immac cond, Muter FE BOARD original packing £325. Yaesu FL2100Z linear new bands, mint £240. Westower 3S/FBD 45ft, two years old £210. New QTH forces sale. Tel: 0932 780917.

48K SPECTRUM with Alphacom printer, 9" b&w monitor, cassette recorder, full size keyboard, RTTY interface, terminal unit, loads of software, books, £250 or exchange for FT290R or other 2m multimode rig eg TR900. Paul G8XVP 070 681 5138 after 6 pm.

IAMBIC keyer Spacemark ETM-3C as new £45. Dummy load Weltz CT150 £30. Weltz SP200 SWR power meter £60. All equipment little used, immaculate. G4AQZ. Tel: Clacton-on-Sea 435700.

FOR SALE FDK multi 700EX 2m FM in mint condition, variable power 1-25 watts, scan mode £240 or nearest offer. Contact B Semple, 99 Rothfarnham Road, Dublin 14, Ireland. Phone 905768 after 6 pm.

PRO-2003 programmable AM/FM scanning receiver. Keyboard entry of 20,584 frequencies, 2 speed scan and search, bands FM 68-87 88-107MHz, air-AM 108-136 138-148 148-174 410-450 450-470 470-512MHz, mains or 12 volt operation, memory back up with 9 volt battery, cost £300, bargain £150. Phone G6HVS on 051 334 6859.

FOR SALE 1155 Rx WS38 MkIII 109 Rx oscilloscope, 13A. Phone Reading 883851.

FOR SALE Admiralty B40D receiver, good unmodified condition with superb handbook, £85 ono. Tel: 0448 60817.

JUMBO Ham International legal 27MHz CB FM 26.515-28.305, good condition £150 ono. FD50 frequency counter 0-40MHz £35. Zetagi 27MHz pre-amplifier £15. 26-30MHz matchbox tuner £15. Please phone Adam 01 874 2142.

YAESU FT101E mint condition, will deliver £425 or best offer or WHY? (anything considered). Rotherham (0709) 554750.

BEARCAT scanning receiver 40 channel AM/FM seven bands 66-512MHz including aircraft, marine 2m 70cm amateur public service £195 ono. HRO HF receiver c/w power supply, seven coils £45 ono. Buyer inspects collects. Phone 08293 2884.

FIRST reasonable offer for complete HF station — HW101 with PSU 220W PEP immac cond. Hanson FH500S meter (new) VR3 ant (new) 8 over 8 beam. 20'×2" mast with loft ext. AR2000 rotator. Plus many accessories. Emigration forces sale. Callers or written offers welcomed, Mr Knight, 130 Main Street, Kinglassie, Fife.

SONY ICF 2001 PLL AM/FM/SSB CW Rx 150KHz to 30MHz plus 76MHz to 108MHz FM as new and boxed, manual £89. Ken Ballance, 18 Rambleford Way, Parkside, Stafford ST16 1TW. Tel: Stafford (0785) 44964.

AOR2002 scanning receiver, frequency coverage 25MHz to 550MHz and 800MHz to 1300MHz, perfect condition £330. Martin Duffy, 44 Cortolvin Rd, Monaglen Town, Eire, c/o 047 82057.

19 INCH rack cabinets, to take 10½" high racking. Cabinet 16" deep £8. 140mm high card frames to suit above, £2 each. Tel: Hitchen 811591.

CITIZEN Band radio sets. Mustang CB3000 FM with roger beep, 40-channels. Delta tune, RF-gain tone, squelch, AF-gain, CH9 switch and inbuilt PA, £30. (Ideal for 10m conversion.) Richard Bridge 061-430 7515.

MM2001 RTTY to TV converter. Overhauled and excellent condition. Nearest £120 secures. Mr Tagg 0602 606071 (Nottingham).

YAE SU/Sommerkamp 9600 VHF/UHF SSB/AM/FM receiver. One week old. Including HF converter, covers 0-905MHz without gaps. Also complete with AC adaptor and mobile mount. Reluctant sale. Best offer secures. Please ring 01-845 4008 (Ruislip).

YAESU FT7B mobile HF tcur with YC7B digital display, mobile bracket, manual £350. Tel: Pete Jenkins 08926 4489 daytime works.

COLLINS receivers: R-389VLF, R-390/A, R-391/URR. URR-27A, URR-35C, R-444. APR-4Y, HRO coils, AR-88D, sig-gen, TS-382 URM-25D, 26B 27B, TS497B HP608, BC-348, BC-375, R-216. CV-89A 561A oscilloscope. Valves: 2C39A £10. Wanted: Loctal valves, Nuvistors. Bob Wright, 249 Sandy Lane, Hindley, Wigan. Tel: 55948.

HEATHKIT SB102, transceiver 10-80m 180 watts. With HP23B PSU SB600 speaker, and SB650 digital frequency display, 400Hz c/w filter, mic, spare valves and all manuals. VGC £245 ono. G4JXK. Dave, Fareham 230737.

BRAND new radio harness suit Burndept 470-600 range. Pye PF1 Rx/Tx RB4 with batts, Epaulette speaker circuit info £35. Same again for SU8. Dragon computer 32K with RTTY/CW cartridge and all info. £60 WHY? Phone 0302 835280. W150FM 10 channel £70.

ICOM 745 transceiver with Icom SM6 desk mike, as new and boxed. List price £935, bargain at £750, no offers. Phone 0579 42384.

PAIR Castle Conway 3 way hi-fi loudspeakers in homebuilt mobile enclosures 30×15×14 walnut veneered, would cost around £190 new, offered at £75 or WHY in the ham radio line? John G4WLD 01-857 8096.

MUTEK 10GHz (GDIF 107UB) Gunn diode board £42. Solfan 10GHz in line Gunn unit £12. Rank Xerox 400 telecopier £20. Yaesu SP102 speaker £40. Icom SP3 speaker £42 (new). Wraase SC1 SSTV/FAX unit, latest model £700. Phone Paul (0293) 515201.

WANTED

WANTED, Trio TS 120S or TS 130S, will exchange for Drake general coverage Rx with all accessory xtals, noise blanker, calibrator, complete with Drake matching speaker MS-4, value £350 or cash; also VFO 120, AT 130, PSU etc. G0AYZ QTHR. Phone Gosport 589560.

HELP help help. Does anyone know where I can purchase any ham radio software programs on discs for Apple II E as I am desperate for them. Please contact Captain Creasy, CPA, PO Box 1, Hong Kong.

BURNDEPT UHF handheld wanted, 470 or 471 or BE600. Will swap for Dragon 32K computer plus all sorts of programs, etc. Also wanted, Whitehall Control Box. Please phone (0302) 835280.

WANTED by OAP for SWL grandson, Sicura Globe-trotter wristwatch, complete and working or complete but not working but repairable, moderate price please, only have pension. Phone Bilston 403887.

WANTED, Yaesu FT 77, 100 watts or 10 watts PSV also, good price paid if in good condition. Phone Belfast 242663, Mr William McCann, or write 1 Ross Road, Belfast 12.

WANTED, Yaesu YO-901-P multiscope, must be in vgc, fair price paid. Wanted, Yaesu SP-901-P phone patch speaker, also vgc. G4YIQ, 0642 244415.

BEGINNER in ham radio requires general coverage receiver. Available for P/X or swap is complete set of Aeroplane Monthly plus many other aviation books (plus some cash if necessary). Worcester (0905) 56818.

HAS anybody the working instructions and layout diagrams for a RCA oscilloscope that I can borrow, will pay expenses incurred, model LA 545 (665 897 4658), pre-amp LA 545-54D. Phone (0222) 790688.

WANTED, "Com-in 64" interface plus manual for Commodore 64 or source of supply, any information gratefully received, costs reimbursed. For sale, Z80A CPU and VDU cards, also other computer bits and pieces. Phone Manchester 061-437 7899.

WANTED for spares, incomplete/faulty/scrap chassis, wireless set No 18 Mk III, must have exterior case and aerial, also phones and mic for above. Phone Tony, 051-931 1716.

WANTED, HF linear, commercial or home brew, anything considered WHY. Phone (0608) 811102.

WANTED, Codar preselector PR30, Codar receiver CR45. G3AOS, (02605) 2764.

WANTED, Sony CRF330K S/W receiver, must be in excellent condition. Phone (0206) 394336 (Essex).

WANTED, Yaesu FR101D (digital) Rx or FRG7 Rx (digital), rigs must be in good condition and digital readout. Phone Jackson (GM4VYU) after 6 pm, (0750) 62259.

DRAKE R7A and TR7A, must be vgc. Bob McHenry, G3NSM, phone (0865) 56321 (Oxford).

WANTED, old wireless books, magazines, call-books, QSL-cards, service manuals, equipment, valves, morse-keys, etc, for museum, collection arranged. Please phone Douglas Byrne, G3KPO, Ryde (0983) 67665, or details to 52 West Hill Road, Ryde, IOW, PO33 1LN.

YAESU FT102 trx fitted AM/FM board, FV102DM external VFO, FC102 antenna tuner, fitted 4-way selector, all delivered as housebound. QTHR G4GOF, Jess, E. Sussex, no phone.

WANTED, Yaesu FT77, also operating manual for Realistic DX-302 receiver. Please contact Dave, PO Box 596, Birmingham, B16 0JA.

WANTED urgently, FAX-Receiving Program for the Spectrum 48K, will pay all charges. ON4ABT, Box 135, 2500 Lier, Belgium, or phone Belgium 03/480.41.51 and I will call you back.

CAN anyone help? I want to reduce bleep level on AOR 2001, anyone know how to do it? Write Chris, Lindham, College Rise, Maidenhead, Berks. Thanks.

WANTED, workshop manual for FT107M, buy or loan, your price paid. G4HZF, Grimsby (0472) 71215 (anytime).

WANTED, Kenwood Trio TL922 linear amplifier in good condition, cash waiting. Phone (04712) 594 (anytime).

WANTED, matching power supply and external VFO for the Belcom liner 2 plus circuit details, handbook and info on any mods. G6CJL QTHR, (0422) 54635.

NORWICH YMCA camps department (registered charity) requires cheap (£40 max) or free general coverage receiver, AR88, HRO, B40, etc, for use on childrens camp. Phone Norwich 665989 and ask for Alan, G4TVJ.

WANTED, FT-102 or TS-830S, etc, £500 cash waiting. Write giving history, etc. Also I have Kenwood AT-230 and SP-180, will anyone swap for a FC-102? Please write to G0EIU, 5 Hollybank Court, Highfield Road, Widnes, Cheshire, WA8 7DP, all letters answered.

WANTED, cheap 2m, 70cm and HF gear, ex PMR or valve rigs OK, must be cheap. Phone (0705) 261399 (Hants).

WANTED, service sheet/circuit or ex WD Bendix aircraft receiver type RA-1B. Brackley, 11 Fifth Avenue, Chelmsford, Essex, CM1 4HB.

WANTED, NATO 2000 in good condition. Phone (0283) 221870.

WANTED, HQI mini beam or Altron AQ20/ZE, must be in vgc. Phone Malcolm on Coventry (0203) 456128 (evenings).

EXCHANGE

EXCHANGE Mini Kity home workshop, planer/thicknesser, circular saw, spindle moulder, slot borer, disc sander, etc, on table, as new, five hours use only, for IC735, TS430S, FT757GX, must be mint condition. G0BNT QTHR, Plymouth (0752) 777777.

HAVE Akai VP7100 portable vtr, spare battery pack, charger, plus Panasonic pack charger, plus Panasonic WV3000E colour camera, swap for best transceiver offered. Vic Driver, Woodhall Spa (0526) 53576.

SWAP Colecovision TV games console, two joysticks, power supply, Atari games console allowing you to use all Atari cartridges with the Colecovision plus 7 cartridges, also a Kodak 4000 disc camera, swap for any general coverage receiver. Joe, 21 Newbarns Road, Barrow in Furness, Cumbria.

TRIO TR2400 speakermike, leather case, ST1 base stand built in, pulse charger, rubber duck, standard mike, boxed, exchange 290 Yaesu, tatty one accepted if not been tweaked with. 7 Meadow View, Green Meadows, Holmewood, Chesterfield, Derbyshire.

EXCHANGE for heavy duty rotator, Ham International multi-mode, USB, LSB, AM, FM, fine tune, professionally Eprom converted to 28.270-29.700MHz, or sell £120. (04246) 4723 (Sussex).

EXCHANGE Storno 900 System 4 direct dial car telephone for UHF or VHF mobile rig or HF linear. G4VNG, (0733) 231639.

EXCHANGE VHF PMR transceiver SMC 1015L1 working order, frequency not known, good for conversion or parts, eg RF power module M57719. For a frequency counter covering 27MHz or WHY. M Jones, PO Box 4, Liverpool L14 4DH.

EXCHANGE Sprite Muskateer caravan, fridge, fire, toilet, gas bottles, stabalizer. Very roomy, ready to roll, good condition, many extras. For FT225 FT726 or any similar 2mtr 70cm. Cash adjustment either way. Finally caravan must go — WHY? Ray G1LBT. Rotherham 892388

EXCHANGE ST5MC RTTY terminal unit and Pye pocket-phone PF20B with charger, mike and crystals, battery and Sinclair 48K Spectrum with leads. Would exchange the lot for SX200N scanner or Revco RS2000E scanner. Phone Clive on 021 788 8447.

EXCHANGE Heathkit Oscilloscope type HO12 in good condition with leads and manual for — WHY? G6HVS. 051 334 6859.

INSTANT movie outfit, Polaroid Polavision movie camera zoom lens c/w land player (monitor) as new, swap for HF Rx/Tx Rx HF ant vert or horiz. Anything considered in GWO or sensible offers — WHY? 01 200 3825. NW London buyer collects.

EXCHANGE my N120 integral ten, sound cine camera c/w editor splicer + accessories. All boxed as new for your Yaesu FT290. Ring Fred 0673 84 3127. Also have a Bolex H16 RXVS without instruction book at £200 ono.

Rubbish Tips

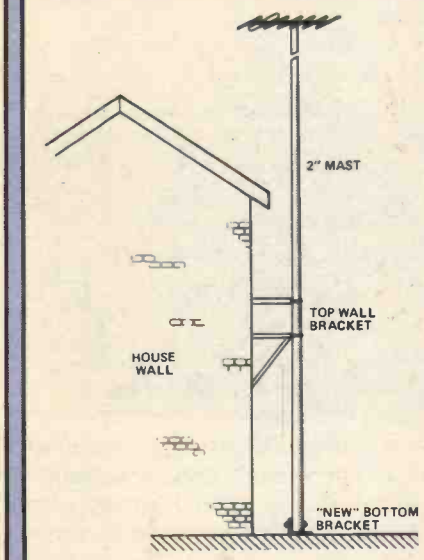


Fig. 1 How the mast holds your house up!

This idea for a mast and rotator using the 'arm-strong' method comes from G Peters, GW1FEA.

It's nice to have an electric rotator for your VHF or UHF beam, but many like myself, when newly licensed and with so much equipment to get, found the old wallet ran dry long before we got round to rotators. I was thus forced to devise a simple yet effective way to turning the beam by the "arm-strong method" using fairly low cost materials, such as scaffolding tube for the mast and a car wheel bearing for the base pivot point.

First The Mast

The scaffolding tube, like the metal for the mounting brackets, can be obtained from a second hand steel supplier or scrap metal merchant. The taper wheel bearing for the base pivot was 'second hand', in fact one I had recently replaced on my car, but still plenty good enough for this job. Your local garage will probably give you one they have replaced, if you don't have one to hand.

Now to work; first, the scaffold tube base will have to be matched to the taper on the bearing. This will mean a little filing or grinding inside the base to get the correct angle to fit the bearing. The better the fit, the easier the finished mast will rotate. The base bracket can now be made, see **Fig. 2**, and the "U" bolts, to suit the diameter of the scaffold pole, fitted — new ones are a must.

The top wall bracket can be made to suit your own site, roof overhang etc, or even purchased! You need a good sturdy double bracket that will take a 2" scaffold pole, The top wall bracket can then be fixed in place and the mast offered up. The position of the base bracket can now be determined.

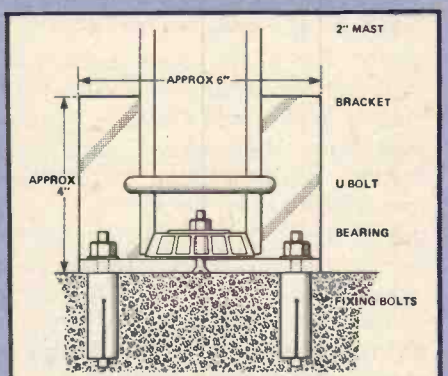


Fig. 2 The front view of the bottom bracket and base pivot.

Final Checks

Check that the mast rotates fairly easily and that everything is in line (ie vertical) then secure the base bracket with good ground bolts. Now, don't forget the U bolt backnuts: to allow the mast to rotate the U bolts are not fully tightened, so the lock nuts are needed to stop the U bolts from working loose in service. The tension of these bolts will determine the ease with which you will be able to turn the mast and I found that they need to be tight enough so as not to allow the mast to freely turn in the wind, yet be reasonably easy to turn by hand.

Having aligned the mast, check the tension of the bolts and that the brackets are firmly fixed. Finally give all the working parts a good coating of grease to keep out the rain water. You should now have, at moderate cost, a mast that will rotate, all be it by hand.

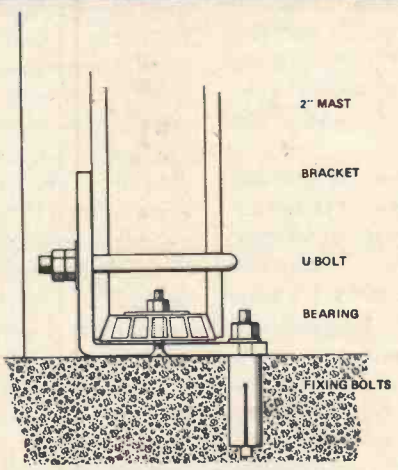


Fig. 3 The side view of the bottom bracket and base pivot.

Mighty Mi

Chris Lorek, G4HCL, has lots of summer fun with three of the latest Japanese mobile black boxes.

Trio TM2550E

Power levels used for 2m mobile operation are going higher and higher all the time, with many amateurs fitting a 'stick it under the seat and forget it' RF amplifier as a natural part of a mobile installation. Rig manufacturers don't go around with blinkers on and the latest offering from Trio gives selectable 45W or 5W output to please the power merchants, enable more solid QSO's and flatten your battery quicker!

Mobile Mission Control

Guaranteed to impress onlookers, the TM2550E offers just about anything you could wish for in terms of operational flexibility — although it took yours truly a bit of time to work out how to use all the various features.

Covering 144-146MHz in 5kHz steps as supplied (but see later), frequency selection can be made using the up/down buttons on the microphone shell. Each depression is accompanied by a bleep from the internal speaker. Holding down a button gives you a rapid QSY facility. Alternatively, direct frequency entry using the front panel mounted keypad is possible for the mobile suicide squad operator.

23 memories are provided, storing both frequency and repeater offset if programmed, but not all may be available for normal use. Channels 16/17 and 18/19 are 'paired' for two frequency operation and others are used for frequency selective scanning. Memory channels are accessed by either the up/down buttons or by the main rotary control knob.

Scanning of virtually anything is possible, with halt selectable between carrier hold, where scan stops until two seconds after the signal disappears; or time operated with scanning resuming a few seconds after a signal has been found. The time hold period is internally adjustable. Memory channels are scanned by a touch of the 'SC' button, any of the channels may be inhibited from scan by the 'LO' button, whilst still allowing manual selection. Using two dedicated memory channels, upper and lower frequencies may be set for a programmable frequency scan, all frequencies between those two being sampled for activity. A priority channel scan (alert) facility lets you automatically check a chosen memory for activity, the set bleeping at you when a signal appears.

Many local amateurs know that for some time I have been slating the do-everything microprocessor controlled sets because they cannot be programmed between different frequency offsets depending on which part of the band you are on. So the mobile operator has to fumble around to switch the repeater offset out when QSYing simplex from a repeater contact. Well maybe the message somehow filtered through to the land of the rising sun as this is the first Japanese set I have seen which automatically selects −600kHz shift when you tune above 145.6MHz. A press of the 'REV' button gives a most useful instant listen on input.

A 1750Hz auto toneburst is switchable by a front panel button. An adjacent button operates the optional voice synthesiser module and tells you all about the frequency, selective calling codes, subaudible tone data and so on. Further buttons select low/high power on transmit, frequency lock — to prevent accidental QSY — and backlighting of controls. A large liquid crystal display shows frequency, memory channel (whether selected or not), Tx offset, toneburst on/off, memory lockout, priority channel, scan operation, reverse repeater and centre tuning indicators, and a quasi-analogue S/RF level by a series of bars behind a green and red coloured section.

The Trio Digital Channel Link system searches out 11 frequencies in a range previously selected, checks for absence of signals for around 1½ seconds, and returns to the original frequency. If this is occupied, it waits patiently — telling you by bleeps it's doing so. If the calling channel is free it transmits a digital code, after accessing the repeater with toneburst if appropriate, tells your contact's set what frequency to go to, and takes you back there with your contact following.

In addition, you may also program a five digit access code, together with your callsign in ASCII to use as a digital code squelch, to enable silent monitoring of a frequency for club or net use. This may be used either independently, or combined with the DCL system as you wish. A further optional display allows you to observe the callsigns of any similarly equipped stations

who have called you in your absence.

Inner Circuitry

As you can see from the internal photograph, components are well spaced out and are all leaded discrete apart from five small sub-boards with chip components. In all, this makes servicing relatively simple, with each main board being easily removable. The chassis construction is a multi-piece bent metal fabrication with a die-cast rear heatsink, self-tapping screws being used to hold all the sections together.

The receiver uses the usual dual conversion superhet principle, with IFs of 10.695MHz and 455kHz. IF filtering is carried with a pair of monolithic dual crystal filters and a ceramic 455kHz filter. Sharp eyed constructors will see the Toko three stage RF input filter giving good out of band rejection. This is followed by a 3SK129 FET, further filtering and a 3SK74 mixer.

It is interesting to note that two forms of squelch are used, noise squelch for manual mute control, plus carrier squelch switching at a preset level of 0.2uV pd to use with the DCL system. This would have the effect of the operator being able to 'fool' the set into thinking it has found a free channel just by turning the squelch control higher and hence possibly causing eventual QRM.

On transmit, the main VCO is directly modulated with processed microphone audio and amplified using discrete transistors before being applied to the M57726 block module. Diode aerial changeover switching is used and reverse power is sampled and used to switch in protection circuitry in case of a high VSWR being present.

Two synthesisers are employed, with Motorola MC14151 and MC145155 ICs being used. An in-loop mixing process gives fast switching steps from the final frequency VCO whilst still allowing a spurious free signal. Two microprocessors, one master and one slave, control the transceiver functions, these employ a lithium battery backup with a five year lifetime estimated by the manufacturer.

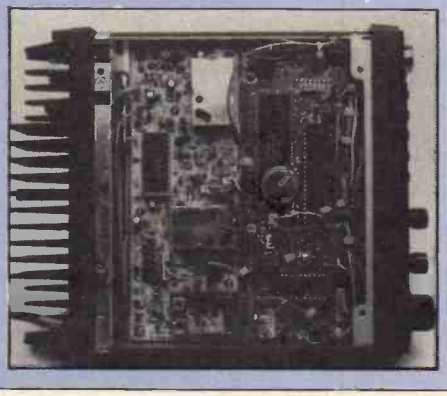
Inner Thoughts

A user manual is provided with the set, which gives a circuit diagram and a few simple internal adjustments points such as bleep tone and voice synthesiser output level. No circuit layout or fault finding information is unfortunately supplied. One operation that will certainly be needed after a few years is replacement of the lithium battery, but no information is given on what type it is or how to replace it. It is soldered in, so some amateurs will have to send the set back to the dealer, as the manual recommends, due to the use of CMOS circuitry (the micro program is commendably stored in non-volatile RAM and is unaffected by battery backup).

The manual is mostly well written if a little in the usual Trio style of literal translations which never fail to amuse me.

The economic form of mechanical construction could lead to problems in microphony and electrical disturbances in the grounding affecting the VCO signal. Thus causing rumbling and scratching noises to be superimposed on your transmitted FM modulation. The two VCOs are encased in wax to try to minimise the microphony, showing that this was noted at the design stage.

Inside the Trio TM2550 one can see the luxury of space to fault find.



In Use

The set was initially tested for base station use, followed by a period mobile. In the shack, after familiarising myself with the operation, I found it extremely easy to use in memory mode. However, I felt let down when I wished to change frequency in VFO mode to search for general activity. One reason was that the main knob did not function at all in this mode and each press of the up/down buttons caused a rather loud and annoying bleep, independent of the volume control. Out came the screwdriver, a quick adjustment, perfect silence. Another reason was the 5kHz steps, requiring five presses to change channel. Now some amateurs like 5kHz steps as in some regions, local nets congregate on unusual frequencies.

For general use however, 25 or 12.5kHz steps are the norm, and this really is where the the 2550E scores, as a quick snip of an internal diode, as described in the manual, allows you to step up and down in 12.5kHz increments, but still allows frequencies to be entered in 5kHz steps from the front keypad. These were stored in memories in my case and the end result was the best of both worlds. Together with automatic repeater shifts coming in where appropriate, this made a fast QSY in VFO mode possible.

If you operate on 145.8MHz watch out, as the auto shift extends up to 145.85MHz for the European market. This may be overridden by pressing the offset button if you forget to do this each time, you'll find you're transmitting on 145.2MHz.

One problem I did note concerns the automatic toneburst. This is switchable on/off, of a fixed length and not unfortunately of a 'push it for as long as you want a tone' type. Again this is often a matter of personal preference, but the tone length was excessively long, over a second in fact. A 555 timer IC is used to generate the tone, the frequency being adjustable by a potentiometer shown on the circuit

diagram. The tone length is controlled by the microprocessor and cannot be altered, this caused me severe problems.

My local 2m box requires detection of speech within the first two seconds of transmission, the long toneburst corrupting this and requiring around half a dozen attempts on average before getting access. My usual set with manual toneburst gets in first time, every time. Sorry Trio, yours is not suitable.

After some practice whistling 1750Hz, the set was fitted in my car for road testing. Using the memory channels was a delight and quick transfer between memory and VFO was made easy by Trio's sensible positioning of the M.CH button, allowing operation by touch rather than glancing down from the road ahead. Ample volume was obtained from the internal speaker. This is positioned on the case top rather than the bottom — as is common with many mobile sets — and I didn't feel the need for an external speaker.

The DCL option would certainly have proved useful if I had found many similarly equipped stations, but this system must become popular before that would happen — a catch 22 situation. I think the only way it can catch on is if Trio fit it as standard to their sets, this would cost very little extra if incorporated into the manufacturing stage as most of the work is done in the existing microprocessor.

At the time of writing (June '86) I understand the DTI require that your callsign in speech must accompany each digital selective calling transmission which is sometimes not possible with this set. However, Lowe Electronics have assured me that the use is legal, as your callsign in ASCII accompanies the digital data, which sounds sensible in these digital communicative days.

The transmitted quality was reasonable, one or two reports claimed it was on the 'toppy' side but still very readable. The 45W output proved useful when operating in fringe areas. I must confess to being a power merchant myself with a switchable 100W amplifier The receive sensitivity seemed all right but the odd contact was lost because of transmit power differences, I could also get into repeaters I could hardly hear. The squelch range seemed better than most, operating on low power during a lift in conditions I could usefully squelch out weaker distant repeaters. No problems with induced microphony were noted, this was specifically checked in view of the mechanical construction.

At night, the back illumination facility was superb.I did find that it was difficult to see the S/RF level, as this tended to be obscured by the coloured area of the display glass in front of it. When observed, there seemed to be a lack of range in the indication, fully quieting signals not giving any reading at all and little difference in strength needed to give full 9++ indication — this often happens in FM only sets.

The DCL board was then fitted, and a test performed over a 100 mile path to test its effectiveness, the other station also using a DCL equipped rig. After setting up an agreed digital selective code, he effectively managed to call me and open the squelch, my set ignoring other non-DCL signals on channel. Then to test the QSY facility, I called him after setting up 145.2MHz as a starting point. Contact was established, when I pressed the link control the set immediately jumped to S8, saw there was no signal, went back to the original channel, transmitted the burst of data, and lo and behold we automatically ended up on S8 talking to each other.

For a more rigorous test, I placed a carrier on S8 from another set, and after the set had shifted to find a clear channel I placed a further carrier on the original frequency. The set coped admirably, selecting S9, then returned and waited until the original channel was clear, giving periodic bursts of three bleeps to inform of its actions. As soon as I dropped the carrier, the DCL code — a short 'squawk' signal — was transmitted and we both hopped onto S9 without further ado.

The DCL system will only function of course if both sets have the facility switched in, but to prevent accidental QSYs of all similar sets on, say the local repeater, depression of

Laboratory Results

RECEIVER

Sensitivity — signal level giving 12dB SINAD, 3kHz dev, 1kHz mod.

144MHz	0.240uV pd
145MHz	0.231uV pd
146MHz	0.235uV pd

Adjacent channel rejection — ratio of wanted to unwanted signal level causing 6dB degradation of 12dB SIN AD signal, from off channel signal modulated with 400Hz at 3kHz dev.

+12.5kHz	45dB
+25kHz	77dB
−12.5kHz	41dB
−25kHz	78dB

Blocking rejection — measured as above.

+1MHz	96dB
−1MHz	97dB

Image rejection — rejection level of tuned frequency.

−(2×10.965MHz)	94dB

Squelch sensitivity

Threshold	0.082uV pd
Tight	1.05uV pd

Maximum audio output — level measured on threshold of peak clipping.

Into 8 ohm load	1.8W RMS
Into 3 ohm load	3.9W RMS

S meter linearity

S1	0.54uV pd	−9.4
S2	0.62	−8.2
S3	0.73	−6.8
S4	0.83	−5.7
S5	0.96	−4.4
S6	1.08	−3.4
S7	1.23	−2.3
S8	1.39	−1.2
S9	1.60	Ref 0dB
S9+	1.86	+1.3
S9++	2.21	+2.8
S9+++	2.85	+5.0

TRANSMITTER

Tx power and current

Voltage	Power	144MHz	145MHz	146MHz
10.8	high	27.6W/6.3A	28.0W/5.9A	28.4W/5.8A
	low	3.96A/2.5A	3.98W/2.5A	4.00W/2.5A
13.8	high	41.3W/7.0A	42.2W/7.1A	42.5W/7.1A
	low	4.12W/2.6A	4.09W/2.6A	4.07W/2.6A
15.6	high	42.3W/7.0A	42.7W/6.9A	43.3W/7.0A
	low	4.03W/2.6A	4.02W/2.6A	4.02W/2.6A

Frequency accuracy — −50Hz.

Peak deviation — 4.65kHz.

Toneburst deviation — 4.37kHz.

Harmonics and spurii

2nd	−79dB
3rd	−86dB
4th	−76dB
5th	−94dB
Spurii at +/−10MHz	−75dB
All others	−100dB

the 'C.SQ' (code squelch) allows this to occur only if the two programmed five digit codes match.

Laboratory Tests

The receive sensitivity measured reasonably but I really would have expected a little better in view of the high transmit power available. The good adjacent channel rejection of +/−12.5kHz is commendable, this probably being due mainly to the CFW455F ceramic filter used. At +/−25kHz it was far better of course and the only problems you should normally experience would be due to the transmission width of adjacent signals, rather than limitations in receive selectivity. The blocking and image rejection was equally good.

As noted during on-air usage, the squelch range was good for a noise operated circuit, with a tight squelch of greater than 1uV. The S meter on the other hand showed the normal uselessness apart from comparative reports over a small signal range.

On transmit, the frequency accuracy was within 50Hz and the deviation was well set at slightly under 5kHz which should not cause problems to adjacent channel users. Transmit harmonics were well suppressed, the only spurii noted were limited to an adequate level. Some earlier Trio mobiles, when on repeater shift, transmitted for a fraction of a second on the output frequency before appearing on the correct frequency. This was tested for using a fast sweep on the spectrum analyser, the set transmit frequency being notched as usual for measurement with a pair of high Q cavity filters. Commendably, no untoward emissions were found on Tx keying, showing that the manufacturers have finally got their timings correct.

The measured output power was slightly under 45W, and was well regulated in level for changes in voltage above around 12.5V. Below this, the power dropped rapidly. Current drawn was very reasonable for such a high power set, showing the PA module to be very efficient. The rear heatsink proved adequate in getting rid of the waste heat produced, always staying below 50°C in free air when the Tx was keyed with a 50% ratio over 30 minutes of testing.

Conclusions

A very user friendly set, giving the option of considerable versatility but also offering simple operation when mobile by using pre-programmed memories and microphone mounted buttons. The excessive length of the auto toneburst may or may not cause you problems, it would certainly be annoying to your contacts if you forget to switch it off. For a mobile, it is a bit on the large side, looking inside shows a good deal of empty space, but here you must consider the versatility and ease of maintenance also. The automatic shifts and quick listen-on-input facility make it most useful for repeater usage. The high power, rapid QSY, and 12.5kHz steps as well as 5kHz make it equally effective for simplex working.

My thanks go to Lowe Electronics for the loan.

Yaesu FT770RH

Many amateurs are used to operating around 10W on 2m, but historically power levels on 70cm have always been lower than those used on 2m. There are several reasons for this, the use of higher gain mobile whips available give an increase in ERP equal to that used on the lower frequencies, and also RF circuitry usually gets more expensive as the frequency of operation increases.

With these factors in mind, 70cm mobile operation has taken its time to catch on, but now that amateurs are realising the advantages of 'new pastures', more and more licensees are adding 'the other band' to their car. Naturally, manufacturers have responded to this need, and the latest set from Yaesu seems to have rather a lot to offer.

Small But Powerful

This tiny rig, 140mm (W)×40mm (H)×162mm (D) and weighing 1.2kg, offers switchable 25W and 3W output power, coverage from 430 to 440MHz in either 12.5 or 25kHz steps, and a host of VFO and memory functions. Two VFOs are fitted, controlled from either the main tuning knob which rotates with soft click steps, or from up/down buttons fitted on the microphone shell. Coarse 1MHz steps may also be selected from a front panel mounted rocker switch.

Ten memory channels are available with eight having the ability to store independent transmit and receive frequencies. Scanning of either the whole band, the programmed memories (with a 'skip' facility available), or between any two preset frequencies is possible. A 'priority watch' facility allows you to monitor a VFO channel whilst checking a preset memory channel every few seconds. If this isn't enough, it is even possible to select normal scan mode in conjunction with the priority watch! Scanning stops on busy channels and recommences either six seconds after halting, or two seconds after the channel becomes clear, the scan recommence mode being selectable by a small switch on the underside of the set.

Repeater operation is catered for with a selectable +/−1.6MHz transmit shift, instant reverse repeater (listen on input) at the press of a button and automatic toneburst, as well as 'push for tone' button. The backlit LCD display gives frequency information, selected memory channel or VFO, and reverse Tx/Rx indications. A ten selection LED bargraph display indicates relative receive strength and transmit power, and further LEDs indicate transmit mode or busy channel.

The rear panel has a temperature controlled cooling fan fitted, a short hard wired DC power lead terminated in bullet connectors for the main lead supply, and a flying coax lead terminated with an 'N' type aerial socket. A 3.5mm socket connects an external speaker if required, although a small internal speaker is fitted to the underside case lid.

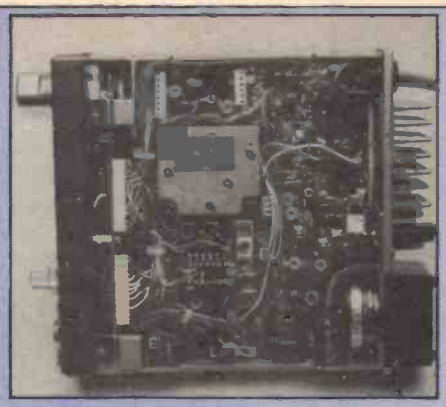
Optional extras include a sub-audible tone unit, with operation possible on encode only or encode/decode for club or net use. A speech synthesiser, actuated by a microphone mounted control, gives indication of operation frequency, VFO or memory selection and tone squelch frequency if fitted.

Opening the case shows that a very compact construction method has been chosen by the manufacturers. The main printed circuit boards have the coils and larger discrete components on the topside, with chip components mounted on the underside. Several plug and socket interconnections make board removal easy for component replacement, but difficult for in-circuit fault finding. The front panel also has circuitry fitted to it. I have previously spent hours changing bulbs on sets like the FT290 and I feel this set does little to ease the job of the service technician. However you've got to cram the circuitry in somewhere I suppose.

A good quality solid die-cast chassis is used, with a ducted airflow pattern. This allows good heat dissipation aided by the rear fan in a very small package, as well as giving good mechanical stability to the internally mounted circuitry.

Circuit Design

On the receive path, the signal is applied via a low pass filter and aerial switch straight into the first RF amplifier, a 3SK121 dual gate



Opening the Yaesu FT770RH, you hope you won't have to take a soldering iron to it.

MOSFET, without the usual high Q bandpass filtering. This gives good sensitivity but at the possible expense of out-of-band responses and blocking. However, a dual stage filter follows, then a further RF amplifier — this time a 2SK125 — a three stage network before applying the signal to the 2SK125 mixer.

The resultant 21.6MHz IF is passed through a pair of monolithic two pole crystal filters and a further amplifier into the TK10420, an MC3357 'lookalike'. This performs the mixing for the second IF of 455kHz where the signal is further filtered by CFW455E ceramic filter, detection and noise squelch operation. The audio is then finally amplified to loudspeaker level by the now common uPC2002 IC.

On transmit, the final frequency VCO is directly modulated and, following a buffer stage and three discrete tuned amplifiers, is amplified to the final power level by an M57729 block module. The forward power is sensed and used to drive the power indication circuitry and control a feedback loop, giving the selectable low power facility. Temperature sensors detect the heatsink temperature, and at 50°C the fan is enabled, at 90°C the set is automatically switched to low power.

The operation of the set is controlled as usual these days by microprocessor: this time a HD44868 linked with a HD44750, with a HD61603 display driver performing the 'housekeeping' functions. A rotary mechanically switched encoder, rather than an LED photochopper-driven unit, is used on the main knob to give up/down steps. A separate crystal and TC5082 binary divider IC generates the 1750Hz toneburst and another IC is used to drive the S-RF display.

Impressions

Yaesu have managed to fit a great deal of well-designed circuitry into a very small box. I'm pleased to see a final frequency VCO has been used giving the possibility of a clean spectrum on transmit and no spurious reception problems on receive. An extremely solid case ensures good protection against microphony problems corrupting both transmit and receive signals

One thing of possible concern is the total lack of reverse power shutdown protection. If a high SWR is present, the set just keeps on transmitting until the expensive PA module blows up. The manual does however give the usual warning about transmitting with no aerial or dummy load connected.

Another point of greater concern is that, although the specification gives the allowable supply voltage to be 13.8V +/−15%, the manual repeatedly warns against supplying more than a 15V level, stating that the warranty is invalidated if this occurs. Yaesu state that your car voltage regulator must be adjusted to below 15V to use the set, which is totally ludicrous as most regulators are sealed units with a nominal output of 15.6V — 15.9V. I think if Yaesu cannot manufacture their mobile sets to be used in the cars their nation churn out, they should not be making them in the first place! However the importers, Amateur Electronics UK, told me that the set may safely be used mobile.

Apart from this, the manual is extremely well written. It gives excellent operating instructions for such a comprehensive range of facilities, with several typical examples. Circuit diagrams are included but unfortunately no component layouts, which would make fault finding difficult. Having said that, even I would be a little unwilling to go inside such a compact set.

On The Air

I initially tested the rig mounted in my shack, into a variety of repeaters and also the occasional simplex QSO. The set was very sensitive, although I noticed that it took a fairly strong signal to light the

Laboratory Results

RECEIVER

Sensitivity — signal level giving 12dB SINAD, 3kHz dev, 1kHz mod.

430MHz	0.21uV pd
435MHz	0.18uV pd
440MHz	0.197V pd

Adjacent channel rejection — ratio of wanted to unwanted signal level causing 6dB degradation of 12dB SIN AD signal, from off channel signal modulated with 400Hz at 3kHz dev.

+12.5kHz	12dB
+25kHz	75dB
−12.5kHz	16dB
−25kHz	73dB

Blocking rejection — measured as above.

+1MHz	94dB
−1MHz	93dB

Image rejection — rejection level of Tuned frequency.

-(2×21.6MHz)	67dB
-(0.5×21.6MHz)	88dB

Squelch sensitivity

Threshold	0.11uV pd
Tight	0.52uV pd

Maximum audio output — level measured on threshold of peak clipping.

Into 8 ohm load	1.45W RMS
Into 3 ohm load	2.45W RMS

S meter linearity

S1	0.81uV pd	−15.9
S2	1.40	−11.1
S3	1.72	−9.3
S4	2.31	−6.8
S5	2.85	−5.0
S6	3.35	−3.6
S7	3.95	−2.1
S8	4.40	−1.2
S9	5.05	Ref 0dB
S9+	5.60	+0.9

TRANSMITTER

Tx power and current

Voltage	Power	144MHz	145MHz	146MHz
10.8	high	16.3W/4.7A	16.9W/4.9A	16.3W/4.7A
	low	2.01A/1.8A	2.35W/2.1A	2.09W/2.0A
13.8	high	27.7W/6.0A	27.7W/6.2A	27.7W/6.0A
	low	2.26W/2.0A	2.61W/2.2A	2.26W/2.0A
15.6	high	29.0W/5.9A	28.9W/6.1A	29.0W/5.9A
	low	2.33W/2.0A	2.73W/2.1A	2.44W/2.0A

Frequency accuracy — within 10Hz of nominal.

Peak deviation — 4.79kHz.

Toneburst deviation — 3.76kHz.

Harmonics and spurii

2nd	−61dB
3rd	−67dB
4th	−86dB
Other	all −90dB

first LED on the signal strength display. Operating for over an hour on high power did not cause the fan to burst into action, which proves that given good ventilation, the diecast chassis is doing its job in getting rid of the heat. The temperature of the set never reached what I would call hot.

The internal speaker was adequate for shack use when the front of the set was tilted upwards using the supplied base station stand. On transmit, reports of excessive clipping were obtained when speaking around 40mm from the microphone. I backed off to around 250mm and the Tx audio was described as 'perfect'.

I also tested the set using AFSK on the local RTTY/DATA 70cm repeater, with inherent long overs as I'm not a very fast typist. No problems were experienced on Tx but I noticed on receive that the S meter indication fell off from ten to six LEDs lit as the set warmed up. Checking the received strength with a separate receiver showed the effect was not due to the received signal fading. A quick check with my signal generator showed that the FT770RH sensitivity was not falling off, showing that the A/D converter and LED driver IC was varying a little with temperature.

The set was then tested mobile to see how the tiny buttons and controls lent themselves to operation whilst on the move. The simple answer was not very well! It was extremely difficult to use the VFO mode, which coupled with moving the rather stiff and awkwardly placed repeater shift control, required me to take my eyes off the road for longer than I'd feel comfortable doing. So I pulled into a lay-by and started to program the memories.

If you program separate Tx and Rx frequencies into the memories, as I wanted to do — so I could instantly step between repeater and simplex channels — you lose the very useful 'listen on input' facility. All is not lost, however, and I ended up programming three local repeater channels with their inputs on adjacent memory channels, SU8 and SU20, into memory channels 1-8. Channels 9 and 0 were programmed with 433.09 and 433.575 respectively, and together with the programmed reverse repeater channels, locked out of scan mode. This gave me virtually everything I could wish for. Scanning the memories when local, in QSO via repeater I could check the input by a quick press of the 'up' button on the mic, and the PMS scan mode using channels 9 and 0 allowed scanning of all repeater and simplex channels. If I wished to find out what else was going on around the band, using the PMS but pressing the 'down' button allowed scanning of the band with the exception of commonly used channels.

Operation was possible therefore with great ease by using mainly the microphone buttons. The low profile of the set allowed mounting close to the windscreen without impairing road vision, so a quick glance was all that was required to see exactly what the set was doing.

When using the 1MHz up/down rocker switch, the display cycles round the band, but resets any kHz steps to zero. This may be useful or useless depending on your personal preference. I found it rather useful whilst driving to have a starting point for QSY use, instinctively counting ten 1MHz steps and then counting the clicks of the up/down mic buttons.

Transmit audio was described as very good, provided I kept my distance again from the mic. Very little mobile noise was reported and I found the mic element fairly directional. This would explain the observed effects but required me to talk into the mic rather than across it. On receive, the small speaker just couldn't cope at high speeds — an external speaker solved this problem instantly. The fan only came on when operating during a hot day when the set was behind the windscreen, being scorched by the sun, it was reasonably quiet and certainly not distracting.

In To The Lab

I first measured the receiver sensitivity, and as shown by the on air tests, the set was quite sensitive, due to the cascaded front end amplifier. The slight lack of selec-

tivity noted is illustrated by the image response of 67dB, falling around 390MHz, but this should not cause too many problems as it is not the most RF polluted part of the spectrum. The half IF response was measured and found to be quite reasonable.

In many areas, amateurs suffer from problems caused by MOD 'Mould' base stations, separated from amateur channels by 12.5kHz. it gave mediocre rejection of modulated +/−12.5kHz signals, the rejection of blank carriers was several dB greater. I would recommend replacement of the CFW455E IF filter with something like a CFW455F, available from Cirkit, if you do have problems although this would probably invalidate any guarantee. The rejection of 25kHz spaced channels was very good however, and the blocking performance excellent for a UHF transceiver.

The squelch range was reasonable and allows you to stop it lifting on distant repeaters when scanning. The maximum audio output was sufficient; the small internal speaker itself causes the low level of volume rather than the available power.

On transmit, the maximum power output was always above 25W when supplied with 13V or more, and hardly varied at all across the band. The current drawn was quite low for the power output, which means it has an efficient PA. The low power setting was well regulated to around 2.5W and the peak deviation set to just less than 5kHz — again very good. The transmitted frequency accuracy was excellent on switch on, only drifting slightly on warm up. The only spurii noted were harmonically related, showing that the final frequency VCO design has scored good results.

Conclusions

A good performer for both 70cm mobile and base station use, small and well designed. The variety of its memory facilities make it extremely easy to use when mobile using the microphone mounted buttons and its small size allows it to be mounted with a view to mobile safety. The availability of over 25W output coupled with good receive sensitivity should enable many more stations to be worked.

Watch out for 12.5kHz spaced signals, as they could possibly cause you problems, although I would expect no worse than with older 70cm gear. Its compactness is obtained through tight packing of internal circuitry, making it important to ensure that after-sales backup is available.

My thanks go to Amateur Electronics UK for the loan.

Icom IC28E

I first saw the IC28 advertised in a foreign amateur radio publication, but when I saw one I was quite taken aback by how small it actually is (measuring a diminutive 140mm (W)×50mm (H)×133mm (D) and weighing just less than a kilogram.

The front panel of the set is very uncluttered, as many controls have a dual or even triple function. At first glance the set seems very basic but when one operates it, its full capabilities become evident. The set operates between 144 and 146MHz in 25 or 12.5kHz steps; frequency control is either by the main front panel knob or by the up/down buttons on the set's own microphone, which has a small locking switch (on the rear) to prevent accidental QSY. 1MHz up/down buttons are mounted on the front panel. 21 memory channels are available to store channel frequency and an offset, which may be either 600kHz or any selected frequency shift up to +/−7.9875MHz.

The reason for this unusually large split and the need for a 1MHz shift facility is that for some countries operation is possible from 138-174 MHz, and this is the spec as sold to the USA. The version supplied had receive facility over this range but fortunately transmission was inhibited outside of 2m. It didn't take Icom long to think of combining a VHF scanner with a 2m rig. Switching between VFO and memory operation is performed by a single button push and frequency information for the memories can be written to and from VFO by a single button push. Pushing the 'call' button again takes you back to where you were.

Volume and squelch controls also serve a dual purpose: a push on volume switches power on or off, and pushing the squelch gives instant listen-on-input facility for whatever Tx/Rx split is programmed. This operates in wideband VHF receive mode also, so you can program 4.8MHz split or whatever into some commercial receive frequencies for test purposes. The law in this country frowns on reception of many services such as radiotelephones, so you must (of course) remember to avoid these frequencies.

On 2m transmit, 25W (switchable down to 5W) is provided; a higher power version, the IC28H, is available which gives 45W max output. A 1750Hz tone button is provided on the microphone, the element itself is followed by a single transistor pre-amplifier inside the case in the usual Icom fashion. A large backlit LCD display shows operating frequency, mode (duplex or simplex), memory channel

number and indication, high/low power, code squelch indication, and a quasi-analogue S/RF bargraph. An automatic dimmer control senses the ambient light and varies the backlight illumination to suit.

A 'set' switch allows you to set the channel steps, fixed and programmable offsets, and tone option facilities. There are two tone options available. The first is a sub-audible tone operated encoder with three tone memories. The other facility available is AQS, a digital tone squelch and QSY control common to Icom, Yaesu, and Standard.

Amateur Quinmatic System (AQS)

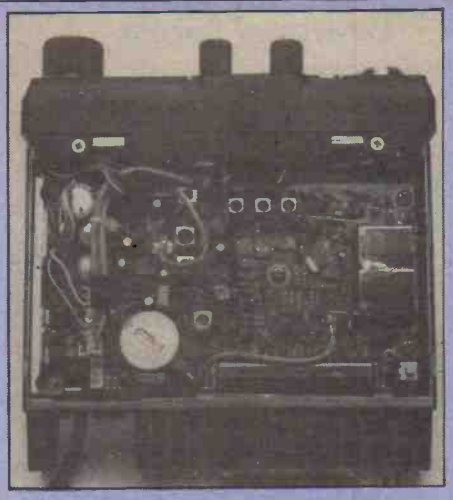
This is so new that I have only seen a data sheet written in Japanese, but basically it is in competition to the Trio/Kenwood DCS. Its features are:

- Callsign squelch, where the receiver's squelch opens only if the receiver's callsign is sent by the calling station;
- Five digit code squelch, similar to call squelch but more suitable for group use;
- Automatic selection of empty channels for QSY purposes;
- CQ mode for general calling;
- Data transmission mode allowing messages up to 14 characters in length, using a display separate to radio equipment.

Unfortunately the manual supplied with the IC28E shows only how to fit it, so we will have to wait a little longer to see if it eventually catches on. The AQS system it appears would go one step further and tell me on an LCD display exactly what the nature of the message was.

As with the Trio system, it will catch on only if the manufacturers fit it as standard to all equipment. Although it uses the same digital frequencies as Trio (1200Hz and 1800Hz), the protocol is different rendering the two systems incompatible.

Opening the set up shows a standard of construction, not surprisingly, more associated with small portable gear, with sub-miniature components neatly arranged. A large empty space is evident for code squelch options. In common with many other sets of this type, a lithium cell is used for memory backup, but the manual shows you



its position, if it were not obvious, and the type, voltage, etc is clearly visible making the inevitable replacement a simple user job.

The receiver and synthesiser/Tx boards are on separate sides of the sturdy die-cast chassis, giving good isolation as well as mechanical stability and allowing easy servicing. The transmitter PA module is bolted straight onto the rear heatsink section. The control board is mounted in a relatively inaccessible position on the front panel, and uses a liberal amount of chip components that service engineers have nightmares about. Unfortunately a circuit diagram and component layout was not supplied with the set as is usual with Icom equipment,

On receive, the signal passes via a low pass filter and diode aerial switch to a pre-tuned high-Q helical bandpass filter centred on 2m; this is bypassed by diode switches in general coverage mode. A 2SC3355 transistor amplifies the signal before passing on to a three stage varicap tuned bandpass filter, and into a 2SK241Y mixer. This produces a 17.2MHz IF which is filtered by a pair of cascaded monolithic dual crystal filters. After amplification, the signal is fed to an MC3357 FM subsystem IC which performs down conversion to 455kHz and further filtering with a CFV455E ceramic filter. Detection, noise squelch and audio amplification then takes over.

Frequency control is accomplished by a single loop synthesiser employing a variable modulus prescaler under control from an MB87001 synthesiser IC. The loop filter operates from a 30V supply, produced by a DC-DC converter, and this gives a wide voltage swing for application to the VCO and front end varicaps for a given tuning range. A central uPD7514 microprocessor gives overall control of the set's many functions.

On transmit, the VCO signal is directly modulated with speech audio, digital squelch and sub-audible tones are fed to the loop filter for frequency deviation. The RF is fed via a pair of buffers, the second forming an out-of-lock gate (but see lab results), and on to the transmitter power amplifier module, using an SC-1019 'black brick'. A phase detector is used inthe PA protection, which is very good indeed as the PA is then less prone to VSWR damage caused by the coax length being the wrong number of quarter waves combined with a poor aerial match, where normal VSWR detectors would be fooled into thinking there was nothing amiss.

First Impressions

Because I'm a sociable sort of chap, the sets that come my way invariably get seen by several other amateurs. The reaction from them normally takes the form: "Oh, that's the new rig from so-and-so is it, mutter, polite mumbles, yes very interesting". In the case of this one, it was invariably: "Gosh, isn't it small, you mean it receives all that lot as well, did you say 25W, room for more gubbins inside too?"

One thing that caught my eye quickly was the microphone mounted toneburst. I have always modified my mobile gear where necessary with a button on the mic for this purpose, as I believe it is the most sensible place for it, and I'm glad that Icom have followed suit, so to speak. A 7.168MHz crystal and divider is used (yes, I did open it up to find out) which gives excellent stability.

The manual is very well written, if a little simple in places. For instance, to transmit, "Push PTT switch on microphone", (drawing of microphone with arrow on PTT), "Speak into microphone", "Release PTT switch". Come on . . . who do you think we are? However, inside views showing main component positions with maintenance and troubleshooting charts are given, together with a block diagram.

Without further ado, the set was hooked up to aerial and power. I found it extremely easy to use, in fact it was some time before I

needed to open up the instruction book. I did miss the facility of being able to scan sections of the frequency range, such as just the top part of 2m, and frills like a priority channel watch.

After a short period in the shack, I decided to put it through its paces mobile. As this set is so tiny, it was very easy to find a space.

The majority of operation was performed using the pre-programmed memories for repeaters and a few favourite simplex frequencies, with the VFO set to S20 in readiness for QSYing. I must say that this was the easiest Japanese synthesised set I have used, and this includes the IC240 which couldn't be much simpler! The display was very easy to understand, and was very readable.

The transmitted audio received excellent reports, something I always seem to find with Icom gear; even when travelling at 60mph with the windows open very little background noise was reported. I did find that the up/down buttons tended to get knocked if I didn't watch myself; the small inhibit switch on the back of the mic which takes these out of circuit tended to cause more confusion than accidentally knocking them, so I tended not to bother with it. Eventually I learned to hold the mic differently.

The scanning functions worked well, and the loudness of the internal bleep (produced on pressing control buttons) was linked to the volume control, which I appreciated. When using the main tuning knob to search for activity, though, I found that fast rotation tended to miss channels, due to the inability of the synthesiser to repond quickly enough. Slowing the rotation down to around three steps per second was necessary to avoid missing signals. There was adequate volume from the internal speaker only when travelling slowly, and I found that a small external speaker pointed at me was needed for good readability. As is typical for S meters on FM sets, this one was also virtually useless, fully quieting signals not even registering but stronger ones hitting the imaginary end stop.

As an experiment the set was fitted into the glove box with poor ventilation, and was used for over an hour on a very hot day for 50% Tx, 50% Rx. Despite my misgivings over the size of the heatsink, the set performed admirably, with the entire chassis becoming warm but not hot,

Laboratory Results

RECEIVER

Sensitivity — signal level giving 12dB SINAD, 3kHz dev, 1kHz mod.

144MHz	0.190uV pd
145MHz	0.190uV pd
146MHz	0.190uV pd

Adjacent channel rejection — ratio of wanted to unwanted signal level causing 6dB degradation of 12dB SINAD signal, from off channel signal modulated with 400Hz at 3kHz dev.

+12.5kHz	32dB
+25kHz	74dB
−12.5kHz	33dB
−25kHz	78dB

Blocking rejection — measured as above.

+1MHz	98dB
−1MHz	101dB

Image rejection — rejection level of

Tuned frequency minus (2×17.2MHz)	91dB

Squelch sensitivity

Threshold	0.09uV pd
Tight	0.28uV pd

Maximum audio output — level measured at threshold of peak clipping.

Into 8 Ohm load	2.0W RMS
Into 3 Ohm load	3.9W RMS

S meter linearity

S1	0.71uV pd	−7.8dB
S3	0.92uV pd	−5.6dB
S5	1.20uV pd	−3.3dB
S7	1.47uV pd	−1.5dB
S9	1.75uV pd	Ref 0dB
S9+	1.90uV pd	+0.7dB
S9++	2.18uV pd	+1.9dB

TRANSMITTER

Tx power and current

Voltage	Power	144MHz	145MHz	146MHz
10.8V	high	22.5W/4.8A	22.8W/4.8A	22.8W/4.9A
	low	5.22W/2.5A	5.27W/2.5A	5.35W/2.5A
13.8V	high	31.1W/5.5A	31.0W/5.5A	31.2W/5.6A
	low	5.25W/2.5A	5.28W/2.5A	5.36W/2.5A
15.6V	high	31.2W/5.4A	30.8W/5.5A	31.2W/5.6A
	Low	5.16W/2.5A	5.28W/2.6A	5.37W/2.6A

Frequency accuracy — 20Hz

Peak deviation — 4.60kHz

Toneburst deviation — 4.43kHz

Harmonics and spurii

2nd	−83dB
3rd	−94dB
4th	−98dB
5th	−100dB
Other	−100dB

Laboratory Tests

The receiver sensitivity was quite good at 0.19uV, giving a good reciprocity to its 25W transmit power. Rejection of +/−12.5kHz was fairly good, and that of +/−25kHz excellent for the type of set. Blocking again was excellent as was the image rejection; in all not bad at all, I'm impressed. The sensitivity was quickly checked higher up in frequency, and was OK up to 150MHz but fell quickly to 1.4uV above this, where it was reasonably constant (constantly deaf, that is) up to 174MHz. This is on par with several wide band scanner receivers in use however. The S meter linearity measurements confirmed my on-air results.

The transmit power was a bit higher than 25W but not excessively so, I don't think most users would complain with that in any case, and the frequency accuracy was within 20Hz, which is excellent. Deviation was nicely set at just under 5kHz, and harmonics and spurii were very well down in level; again, I'm impressed.

What I did notice though, when testing duplex operation, was a quick 'splurge' of off-frequency power on transmit, for a few milliseconds before reaching final frequency. However within the narrow 2m range this would not cause too many problems, but it shows leakage through the buffer gate in the transmitter or a time delay in operation.

Conclusions

This is a lovely little set, very easy to use and sure to be popular with many amateurs wanting a basic mobile equipment that will fit almost anywhere. I was extremely impressed with its excellent technical performance. The 138-174MHz receive coverage facility may be useful to the more nosey amongst us, but watch that you do not fall foul of the law when using it.

My thanks to go R Withers Communications for the loan of the set.

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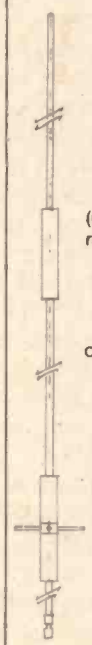

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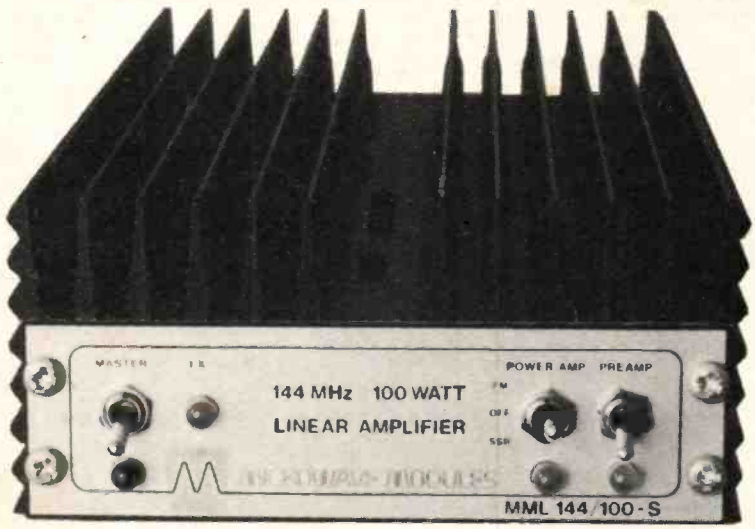

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MML144/100-HS	2m 100W Linear, 25W input	159.85	C
MML144/100-LS	2m 100W Linear, 1 or 3W input	169.95	C
MML144/200-S	2m 200W Linear, 3, 10, 25W input	334.65	D
MML432/30-L	70cm 30W Linear, 1 or 3W input	169.05	C
MML432/50	70cm 50W Linear, 10W input	149.50	C
MML432/100	70cm 100W Linear, 10W input	334.65	D
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MMT144/28	2m Linear Transverter, 10W o/p	129.95	B
MMT144/28-R	2m Linear Transverter, 25W o/p	236.90	B
MMT432/28-S	70cm Linear Transverter	195.50	B
MMT1296/144-G	23cm Linear Transverter	258.75	D
MMX1268/144	1268MHz Transmit Up-Converter	195.50	D
MMT 50/144	6m Linear Transverter 20W o/p	245.00	B
ATV			
MMC435/600	70cm ATV Converter, UHF output	35.65	A
MTV435	70cm ATV 20W Transmitter	197.80	B
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MM2001	RTTY to TV Converter	189.00	B
MM4001-KB	RTTY Transceiver with keyboard	299.90	D
MMS1	The Morsetalker	115.00	B
MMS2	Advanced Morse Trainer	169.00	B
CONVERTERS			
MMC50/28	6m down to 10m Converter	35.65	A
MMC144/28	2m down to 10m Converter	35.65	A
MMC144/28-HP	2m High Performance Converter	47.90	A
MMC432/28-S	70cm down to 10m Converter	39.90	A
MMC432/144-S	70cm down to 2m Converter	39.90	A
MMK1296/144	23cm down to 2m Converter	129.95	B
MMK1691/137.5	1690MHz WX Satellite Converter	145.00	B
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MMG1691	1690MHz GaAsFET Preamp	129.95	B
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