HAM RADIO TODAY

AN ARGUS SPECIALIST PUBLICATION
JANUARY 1985
99p

"GOING MOBILE!"

Constructing Mobile Antennas for the HF and LF Bands

Diplexers and Dual Band Antennas for 2m and 70cm

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PROJECT OMEGA 100W RF Amplifier

ATV — G8PTH looks at the latest from Wood and Douglas

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. . . (of the pile-up)! . . .

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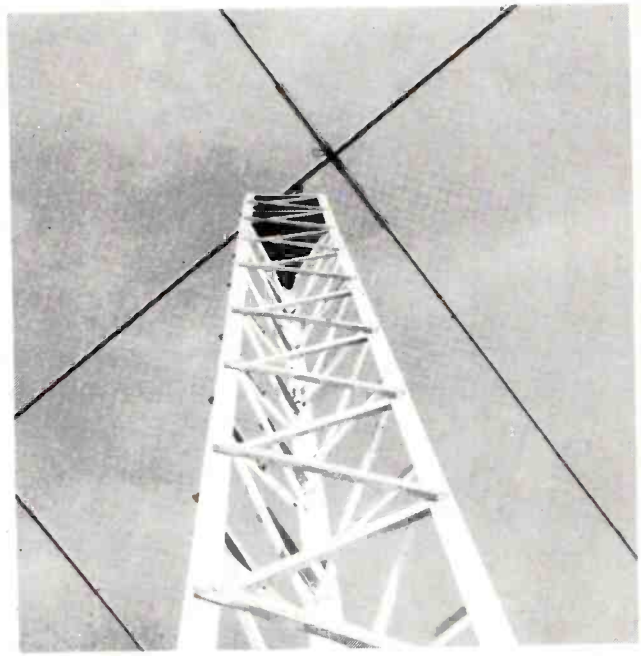
TELESCOPIC STEEL **'ULTI-MAST'**
LATTICE ALUMINIUM **'ALU-MAST'** (right)



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For a "MINI-SIGNAL" try a "MINI-ANTENNA"

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1097			

Step 3. Turn the ANTENNA! you'll need a ROTATOR

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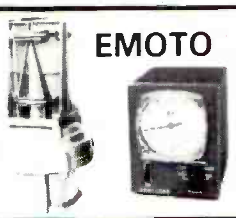
EMOTO



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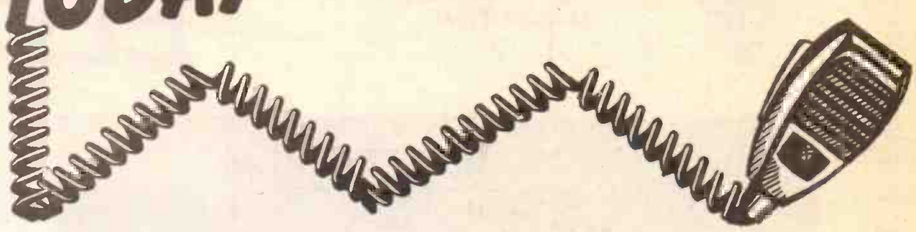

REGULAR COLUMNS

CONSTRUCTION

FEATURES

REVIEWS

• AKD • BNOS • DATONG • MUTEK • MICROWAVE MODULES • TONNA • HI MOUND

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• FREE SECURICOR ON MAJOR ITEMS

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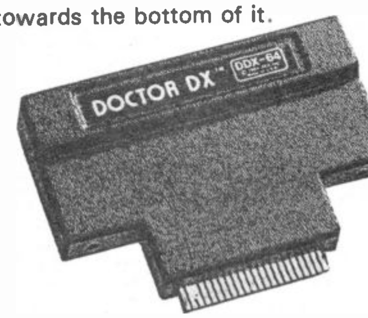
RADIO TODAY

Space Invaders For Radio Hams. . . !

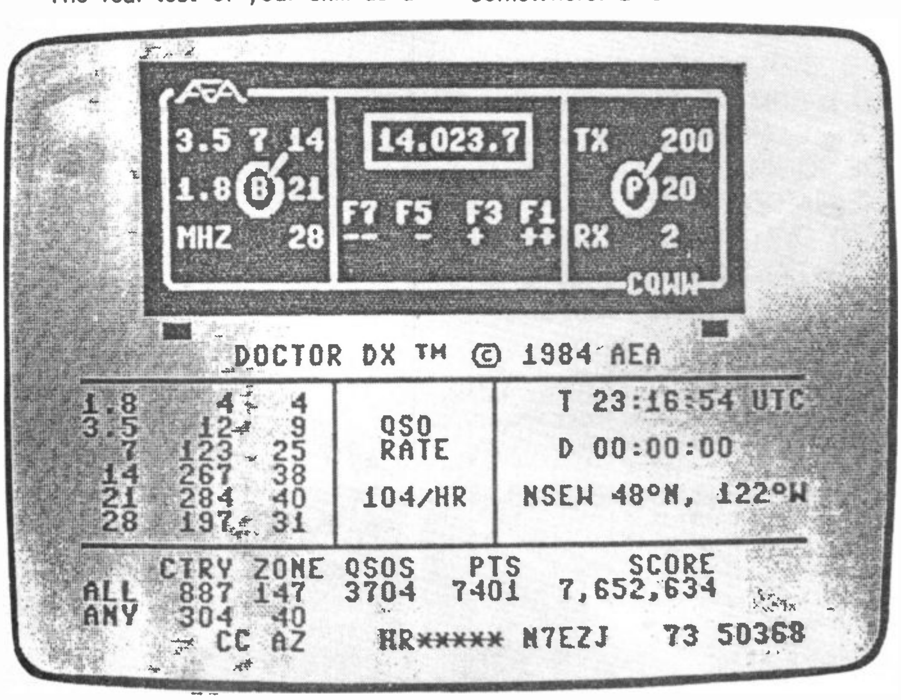
People who want to develop their CW contest operating skills may be interested in a new computer game from the USA. Called the 'Doctor DX', a small module plugs into the back of your Commodore 64 and enables you to participate in a presumably life-like reconstruction of a worldwide DX CW contest.

A transceiver appears on your TV screen and can be manipulated by touching the function keys on the computer. The program emits the Morse transmissions — including QRM — through the computer loudspeaker. By entering your position and time of day, the conditions become appropriate to your location in a sunspot maximum period. All 304 countries are represented and weighted according to their amateur population.

The real test of your skill as an operator comes when you plug your Morse key in and attempt some contacts. If you are good — according to the module — the station you have called will reply. This enables you to score points — as in the real thing. There are slower Morse stations on the upper section of each band and faster stations towards the bottom of it.



Currently attracting rave reviews in the US, Doctor DX is supposed to help to improve your contest operating ability without "embarrassing" yourself, or having to wait for a contest to come along. But at a cost of £96.95, plus £1.50 p and p, it will be a lot cheaper to swallow your pride and enter a contest, after all, everyone has to start somewhere! **G1CKF**



Further details of Doctor DX are available from ICS Electronics, on 024365 590.

Software 'Refresh'

This month the new releases fall into two main categories. The largest of these is that of 'Morse Tutor' type programmes. First up is a Morse tutor for the Amstrad CPC464, a fairly new and economic machine which has received some good reviews in the computer world.

The program which is available on cassette takes "a structured approach to the problem of gaining proficiency in the sending and receiving of morse code." Five modes of operation are possible:-

(1). Structured tutor.
(2). Specify letters to be practiced.
(3). Select random words from internal library.
(4). Type in text to be coded.
(5). Load text from data cassette.

Over two hundred words are available in the standard internal library and they have apparently been chosen "to cover a wide range of letter combinations". Further words or text can be loaded into the program from a previously prepared data cassette. This feature is useful in setting up a dummy-run of the morse test.

A separate program is supplied on the tutor cassette for the preparation of data tapes. The speed range is from 4 to 24 words per minute and has been timed using the standard 'PARIS' test word.

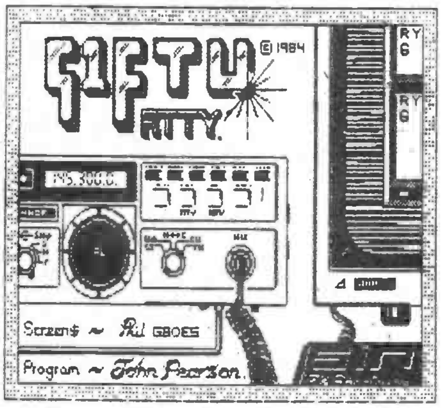
Figures are included as a separate section in the structured tutor and can be intermixed with letters in the "text" modes. Punctuation characters may also be mixed with text and figures in the "text" mode.

The program is available on cassette price £6.90 including VAT and post and packing from :
PNP COMMUNICATIONS, 62 Lawes Avenue, NEWHAVEN East Sussex. BN9 9SB (0273) 514465.

Next up is a Morse tutor for the Spectrum 48K, one of an ever increasing number of tutors for this machine, and is intended "for the complete beginner." Using as much colour as possible, this tutor is entertaining as well as educative. Eight separate programs can be chosen from the menu and the Morse speed is variable upwards from about 3wpm. One of the programs goes continually through the Morse alphabet, with an accompanying display to drum the alphabet in. An unusual feature is that of 'Rest' which takes the form of an interval and takes the stress out of learning Morse.

The tape is available from Harold Bentley, "Sixty-One", Vale Crescent South Ainsley Estate, Nottingham NG8 3PQ.

Also for the Spectrum 48K is an



RTTY Tx/Rx program from Pearsons Computing written by G1FTU. This allows the 48K Spectrum computer to transmit and receive RTTY with *no* interface or terminal unit. The user simply connects the EAR and MIC sockets on the Spectrum to the external speaker and audio input (or MIC) of his or her transceiver.

The program features split-screen operation with full type-ahead during receive and transmit, and the user has his or her own personalised CQ memory and eight other memories, of up to 255 characters each, which may be saved on cassette.

Other features include baud rate variable between 45 and 110 baud, variable transmit tones, on-screen tuning indicator, unshift-on-space, and the program has the capability to receive reversed 'mark' and 'space' tones.

The program also provides the user with a unique 'clarifier' facility for tuning accurately to FM RTTY tones.

Pearsons Computing claim that the program "will run correctly on *all* issues of the 48K Spectrum, including those fitted with microdrives, printer, joystick interface, etc" — so that you don't have to dismantle the system in order to use the program — as with some of the amateur radio and other software on the market today.

The program costs £10 inclusive and orders from licenced amateurs should be accompanied by a callsign for the CQ memory. Non-amateurs wil apparently be allocated a 'dummy' callsign.

Further details may be obtained from John Pearson at 42 Chesterfield Road, Barlborough, CHESTERFIELD, Derbys (0246) 810652.

Finally, we have a Morse transmit and receive program for the Oric-1 or Atmos Computers. This is of French origin and is retailed by a company called "No Man's Land".

The claimed main features are: complete decoding of Morse alphabet; automatic speed adjustment; direct input to low level source or loudspeaker output without interface; audio frequency selection by programme; filtering of short duration interferences; memory of 10240 characters; possibility of saving screen and memory on cassette; simultaneous or delayed impression on decoding; monitoring function enabling user to hear the signal 'filtered by the Oric.

Full, if a little confusing, instructions of how to connect your Oric-1/Atmos to your receiver/receive section are given. The instructions connecting your computer to a transmitter are rather sketchy and would be inadequate for the novice, I feel. That being said, at a quick glance the program itself seems very good and I am not aware of a program of this kind for Oric computers being available from another source.

Further details may be obtained from "No Man's Land, 110 bis, Avenue du General Leclerc, 93500 Pantin, France.

Up, Up and Away

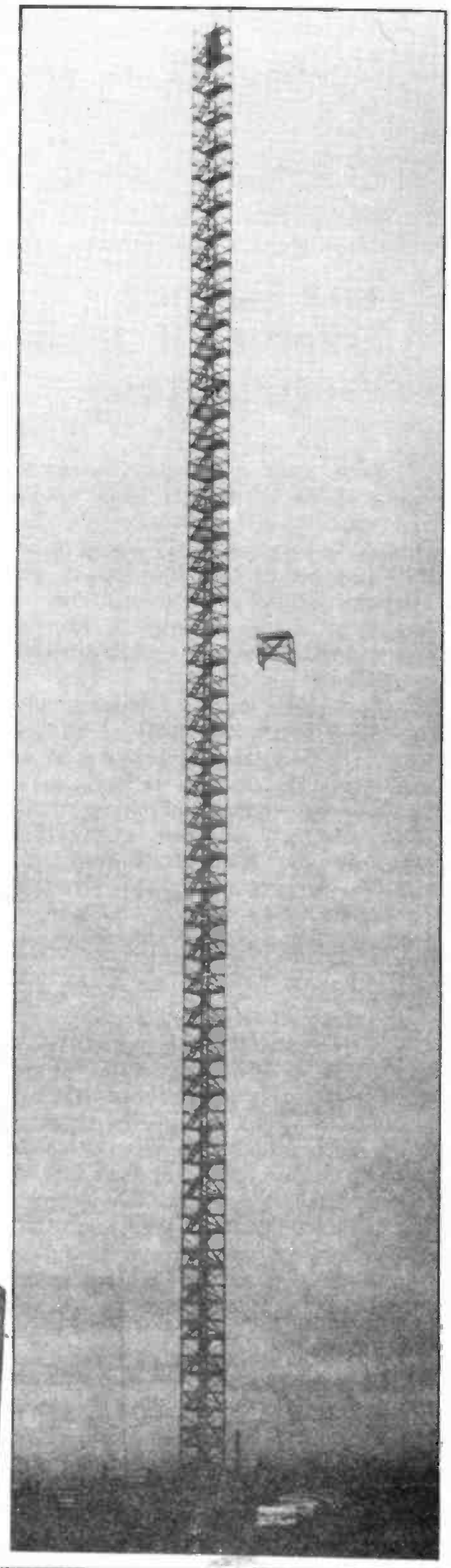
Access Equipment Ltd. have come up with a versatile 'Zip Up' aluminium scaffolding for building radio masts. These masts can be up to 300ft high if you have the planning permission — and are made up of 'Zip-Up' stairway sections of heavy gauge tube and built-in platforms. The ease of construction is apparently enhanced by the lightness of the frame and the easy clip-on structure.

Recently, Access Equipment supplied a 300ft radio mast to the RAF at North Luffenham. The special rigging team of 8 RAF personnel, who were accustomed to 'Zip-Up' equipment, managed to erect the complete tower in 2 days.

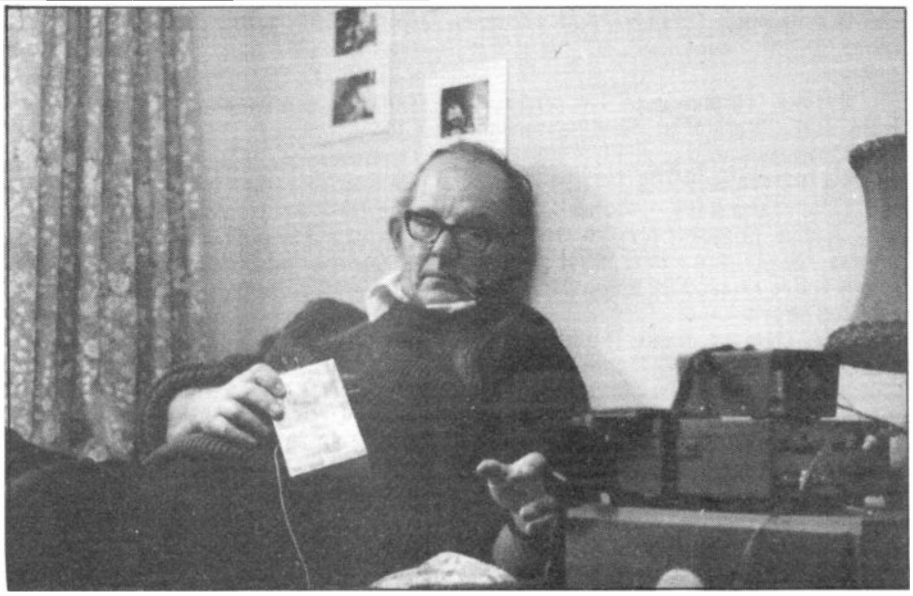
However, if you are considering this sort of tower for your garden, the price for a 6ft platform, 19ft 10" high is £1127.30 exclusive of VAT.

Further information can be obtained from the company on 0442 60101.

'Zip-Up' Tower — 300' in two days!



Yaesu's new FRG8800 (see 'FRG8800 Out Now!')



John Worthington, keyer in hand, relaxing on 80m with an FT7.

The Curious Enigma Of John Worthington

Every now and again the Editor gets a phone call from a reader who is curious about HRT cartoonist GW3COI, alias John Worthington. He has to admit that he knows little about this strangely elusive man, except that he has been drawing cartoons for the amateur radio press for well over twenty years.

Occasional reports surface of him appearing at the CW ends of 80 and 40m. The only tangible evidence of his existence apart from his cartoons lies in the monthly invoice submitted to the HRT offices headed somewhat enigmatically "Piano Tuning and Repairs, John Worthington". That is, until the photo shown nearby and the following text arrived in the office. . .

"Dear Ed,
Photograph shows a rare picture of GW3COI working A/ in a fairly 'safe house'. He is of course using CW and the equipment is a borrowed FT7 and home brew iambic keyer. The operator is in a semi-recumbent posture, enabling him to assume an appearance of slumber fairly rapidly should he hear the approaching footsteps of the xyl with instructions for some urgent household chore. At the time of the photograph all hell was being let loose on the low end of eighty metres as it was the Annual Worked All Cherished Veteran Car Registration Numbers under which conditions a gentle ragchew at 18 wpm is quite an acheivement, as can be seen from the clenched face of the emigrated Englishman. (He found later he had bitten through another pipe stem — and this without his teeth).

There is little doubt that ten watts to a random wire on such occasions is about as useful as a rubber duck in a lead mine and soon 'COI had no need to mime slumber. Look out for further pictorial evidence of his wide spectrum of activities. 73 'COI"

Well, we're waiting. . .

Multi Standard Terminal Unit from PNP Comms

PNP Communications have anounced that their new multi-standard "matched-filter" type RTTY/CW receive only terminal unit is now available.

PNP seem to have aimed this unit at the serious SWL who has the necessary home computer and can interface their communications receiver to it. The matched filter-rectifier-integrator design appears also to make the unit suiable for demodulating morse from 'CW reader' type programs.

The terminal unit is made up of 2 active filter chains: one fixed at 1275Hz for "space", the other can be switched to one of three frequency shift positions:-
1445Hz for 170Hz shift, 1700Hz for 425Hz shift. 2125Hz for 850Hz shift (used for Morse reception). It also has an ALC to compensate for signal fading and a "bar-graph" indicator for accurate tuning. It can receive signals above 200 bauds, including AMTOR and commercial TOR transmissions. Compatible TTLs are used for normal and inverted signals.

At present it is supplied ready built for £32.50 plus VAT, but kits, we are assured, will be available soon. For further details contact PNP Communications on 0273 514465.

Low Cost 'Radio Moden' From ICS

The Sussex based firm of ICS Electronics have been extremely busy of late. Seldom a month has gone by of late without a press release of a new product appearing on the Editor's desk.

Previously known for their slightly expensive but very high quality AMTOR and RTTY terminal units, ICS have recently introduced a new, versatile low cost terminal unit for the beginner, experimenter or VHF operator.

Requiring 12 Volt DC input at 150mA, the RM-1 connects to a home computer via either TTL or RS232 level interfaces (both are supplied as standard). It can be used to send and receive RTTY or AMTOR at up to 100 Bauds with 170Hz shift. Also available are CW send and receive and wide band ASCII communications at up to 1200 Bauds. European IARU tone standards are supported and the wide band receive mode can be used for receiving commercial 425, 850Hz shift RTTY, as well as data transmissions from the UoSat series satellites.

A range of software and cable packages for the RM-1 is available from ICS for many of the more popular home micro computers. Most other RTTY software on the market can also be used with the RM-1. It is also plug compatible with other ICS terminal units.

Packaged in an attractive screen printed enclosure, with a comprehensive manual, ICS claim that the RM-1 "lacks the extensive filtering of ICS's more expensive terminal units, but is ideal for most medium to strong signal applications." The RM-1 is available for £70.50 inc VAT and postage from ICS at P O Box 2, ARUNDEL, West Sussex BN18 0NX.

FRG-8800 Out Now!

In December, 1984 the FRG-8800 will supplant the world renowned FRG-7700 as the latest Yaesu general coverage communications receiver, bringing the newest advances in technology to the famous Yaesu receiver line that began with the FRG-7.

The Merseyside Special Event Group who recently activated GB0 and GB8BCL at the 'Beatle City' museum in Liverpool. From L-R, G4UVB, G4SYW, G1DFQ, G4KIN, G4YPD, G6ICR, QSL mgr G4VKV, G4HSF, and G6ZPW.

Featuring a large liquid crystal display with 100Hz frequency resolution and including a unique multi-coloured S/SINPO "bar graph" type indicator, the FRG-8800 also incorporates the Yaesu CAT System. This allows remote power control, mode and frequency selection and signal strength measurement for processing from the operator's personal computer when used with one of the Yaesu FIF-series CAT Interface Units. The CAT System allows the user to program his computer for the type of receiver operation that he desires, including such functions as unlimited additional memories (the FRG-8800 includes 12 itself as standard) and automatic tuning by station callsign (for broadcast stations) and time, unlimited choice of scanning systems and even voting reception modes to automatically select the clearest frequency of multi-frequency broadcasts. The user can literally build his own receiver functions using almost any personal computer and BASIC or any other language.

The FRG-8800 includes a 21-button keypad for frequency and memory control via the internal 8-bit cpu. Additional button switches are provided for mode and wide/narrow IF filter selection, AGC release time, noise blanker, display brightness, tuning rate selection and settling of the 24 hour dual (local/UTC) clock/timer. The 12 internal memories can be selected by either the keypad or a rotary switch. Three scanning modes are available through the keypad, by which either all or only pre-programmed memories can be scanned, or all frequencies between two memories. Squelch is all mode, and knob tuning rates of either 6.25 or 125 kHz/rotation are selectable, with steps of 25 or 500 Hz, respectively. The dual clock/timer includes power on/off and "sleep" functions.

The FRV-8800 VHF converter, which mounts inside the FRG-8800, is available as an option to add the range of 118 to 173.99 MHz to the receiver. The FRV-7700 Converters, FRA-7700 Active Antenna, FRT-7700 Antenna Tuner and FF-5 Lowpass Filter originally designed for the FRG-7700 are fully compatible with the FRG-8800.

Frequency coverage:	150 kHz to 29.999 MHz (150 kHz to 25.999 MHz and 2 MHz to 29.999 MHz versions will also be available).
Modes:	AM (wide & narrow) SSB '(USB, LSB) Cw (wide & 800Hz narrow) FM (narrow) FM wide to be available as option

Intermediate frequencies: 47.055 MHz and 455 kHz.

The FRG-8800 hopefully will be available from authorised Yaesu importers SMC and Amateur Electronics UK and other Yaesu dealers about the time of publication of this issue.

Aussie Special Event

A special commemorative callsign, VI3WI, can be heard on the DX bands (conditions permitting) until 30th April, 1985 (perhaps longer if sufficient volunteers). The callsign celebrates 150 years of European settlement in Victoria, Australia, and is being organised by the Wireless Institute of Australia and its affiliated clubs.

The volunteers hope to work all DX bands and all modes and will send a special commemorative QSL directly or via the VK3 OSL bureau for any confirmed contact.

A special award certificate is available for anyone making a radio contact (SWLs log) with one station in VK3 (Victoria) between November and April. The organisers ask for Aus$2 or equivalent and the QSL to be sent to Victoria 150 Award, Wireless Institute of Australia, 412 Brunswick Street, Fitzroy, 3056, Victoria.

Biggest Cat' Yet From Electrovalue

Electrovalue have recently published their latest catalogue which is usually updated and issued three times a year, available free on demand at Electrovalue shops or mail order service. This is the largest to date in terms of items stocked and each item is individually priced.

The catalogue is available from Electrovalue Ltd, 28 St. Jude's Road, Englefield Green, Egham, Surrey TW20 0HB.

LETTERS

BEFORE CQ

Sir, quotations (HRT 2/10 Oct 84 p6) Caption: " Norman. . . delicate final adjustments. . . '
Text: Col 2 ". . . people will no longer regard amateurs as eccentric. . ."; para 1. ". . . something you've built yourself. . ."; para 1. ". . . not having yet grasped the constructional side. . ."; para 2. ". . . give a new insight. . ."; para 4. ". . . fairly serious analysis. . ." para 4.

Col 3: ". . . it is funny. . ."; ". . . the Morse is a bit ropey. . ."; para 4.

Please: "serious"?;"funny"?: with a dirty great "dumpy" screwdriver: in that fashion?? Ha ha Ha Ha Ha Ha Ha He He He He He He He He. Oh dear! Excuse me while I find a tissue: my eyes are streaming, Not with sorrow!!! 'OO was this Ancock? There was once a Norman who *was* funny.

Yours in pain,
J W Short.
P.S. I don't feel very well!

The picture of 'Norman', the radio amateur in Channel 4's 'CQ', used in October '84 HRT, was a promotional shot, not a still from the actual play.

The technical adviser, G3YXZ, ensured that the technical presentation of amateur radio in the course of the actual filming was very fair and in no way is Norman portrayed as a technical buffoon in mine or Julie's opinion — an impression the shot should give.

I found CQ both serious and funny — as was Tony Hancock's 'The Radio Ham'. You might find watching 'CQ' a little uneasy — but not too painful, I hope.

AFTER CQ

Sir, I am afraid that I must have a moan about Channel 4's television Programme 'CQ' shown this evening.

If, in Julie Darby's (G1CKF) report on the programme, it gave the amateur publicity, I believe it was very bad publicity.

G4ESB has some super equipment — if only someone had given him a little more than basics on how to use it!

He broke just about every regulation on the licence and I quote:

Part 1 (6.5) Signals not being sent in secret code or cypher.
Part 5 The licencee shall not permit any unauthorised person to operate the station or have access to apparatus.
Part 8 (para 1) recorded messages should only be retransmitted to originating station.
Part 9 (para 2) The callsign shall be sent at beginning and end of each transmission. Yes, it was sent at the start but only once at the end right through the programme.

As for his attitude towards his neighbours TVI problem and the falsification of his logbook it certainly isn't a very good impression of a radio amateur for anyone, is it?

Maybe a good CBer would be proud of this programme but never an amateur or should I say a good amateur! And you certainly weren't kidding about the CW being ropey. I have not yet taken my Morse test, but am studying at the moment and certainly can do better than this so-called G4 on the prog.

Thank you for listening to my moan, feeling better getting it off my chest.

Janice, GM1KHV

Regarding your list of Norman's misdemeanours, I think you're being a bit hard on him. For instance, while he was often lax about giving his callsign at the end of each transmission he was having a rather exciting time — how many of us have not been guilty of similar midemeanours when working a rather choice piece of DX?

'CQ' seemed to me to use amateur radio as a framework to investigate questions like "how far will a person go in order to obtain fame" and "who deserves to be famous?" Norman is a (fallible) man first and a radio amateur second. I'm glad I've got this off my chest, too.

GEOGRAPHICAL BANDPLANNING

Sir, referring to the 'Metrewave' article in HRT in November 1984, may I suggest that G5UM should check on this statement that the concept of geographical bandplanning emerged from the fertile brain of the late G6FO. He will find that the idea was first outlined in a letter published in 'Short Wave Magazine', sometime in the early to mid 1950's, written by Ian Paul, G3CYY.

The scheme was endorsed by G6FO, the editor of SWM, and, if my

"ANOTHER ONE FOR SANTA CLAUS!"

memory serves me right, was slightly modified as a result of some debate in the columns of SWM before being more or less universally adopted.

Unfortunately, I no longer have the large pile of SWM's from the late forties and early fifties, given to me some years ago, which would allow me to verify this, and the dates.

T G Lambert, G8 EZL.

MORE SPARRING

Sir, J G Peel's letter ('Peaceful RAYNET' Nov HRT) surely avoids the main point which is that SPARS (Society for the Preservation of Amateur Radio Standards) objects to RAYNET's involvement in exercises called by the CEPO (or a substitute) which are directly linked to political/military strategy, particularly when such exercises are performed on the Amateur Bands. The final straw was the exercise on March 10th (INTEX '84), previous to which SPARS did not exist although a number of concerned individuals had been increasingly alarmed at the changing complexion of the RAYNET hierarchy and its apparent enthusiasm to be associated with activities having a political/military flavour.

RAYNET came into being after the 1953 East Coast floods and though, fortunately, only occasionally has there been a real need for their services since that time, no-one has seriously objected to them assisting with marathons, county shows and so forth, which permits them to practice message-handling in preparation for a natural, peace-time disaster.

That sir, is rather different from planning the aftermath of a nuclear war, which, as the recent TV programme 'Threads' portrayed, was not something we should be preparing for but instead should be doing all we can to prevent. The true spirit of amateur radio internationally has done, and can still do, much to prevent conflict, having been, hitherto, traditionally concerned with international friendship and goodwill — not sectarian politics. Hence the need to restore *standards* to their former level!

Of course, Mr Peel is right to proclaim the virtue of activities that are not self-orientated. Where he is wrong is in misjudging the issue.

D J Smith, G3 PZG.

Sir, it was heartening to read the letter of G4 NFL stating ". . . in no way that we as a group will be used for any of the purposes complained of by Mr. Frisby. . . "

Even so, Mr Peel seems to criticise 'SPARS' for what he has taken to be an anti-Raynet stance, which is not the factual case. Many of our members are active RAYNET members and supporters, and are fully aware of the active and socially valuable work that members have performed, particularly in this area of potential sea-flooding. It is because we actively support vital work of this type that we oppose the diversion from essential functions to the attempts of involvement into "civil defence" that is of propaganda value only, being impracticable, ineffective and unworkable.

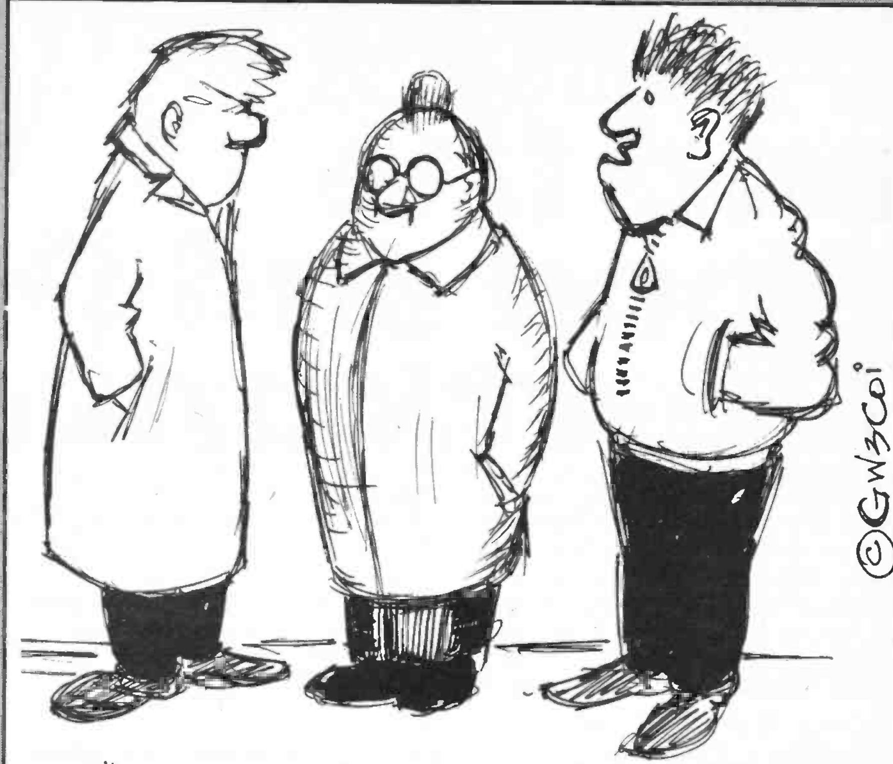
That entire policy is mono-political, and based upon the pretence that both people and equipment would survive a nuclear holocaust, which tends to purport that the aftermath would be survivable, hence more tolerable, hence making such a catastrophe appear practically acceptable.

All radio-amateurs have to be seen to steer well clear of political intrigues and dogma, as there are some of the few people who are able to act as 'ambassadors' between people of all countries and bring peace and understanding in this World.

By international friendship in their communications, and by applying their time and expertise to the continuation of socially useful functions that have won so much recognition, not to mention technical achievement, Amateur-Radio operators can actively help to improve this World. They will not achieve this if they permit their talents and humanitarian ideals to be prostituted by those anxious to divert these energies to political opportunism and administrative delusion.

If Radio-Amateurs feel that they must play "war-games" then there are plenty of frequencies available for numerous military organisations, and there is no excuse for polluting the impartial amateur-bands with such activities, which do not credit to our movement in general, and RAYNET in particular.

Pat Gowen, G3 UOR



" SYD HERE IS A KEEN VALVE MAN.... "

DO YOU USE SSTV?

Sir, although many 'G' stations are active on SSTV on 14230 kHz, there appears to be very little local activity on the LF Bands.

For some months now, GD4 HOX, EI6 EU and EI3 CZ have been very active on 80m and would welcome others to join them. They can be found on 3730 kHz most Saturdays at 2.30pm, Sundays 10.15am and often during the week at 1.15pm.

Ted Brooks, GD4 HOX

Hopefully the recent development of cheap computer assisted reception will serve to regenerate SSTV in the near future (see Ken Michaelson's review of the G3 LIV/G8 UEE SSTV interface on the BBC 'B' in the next issue).

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

24cm ATV and the Wood and Douglas 'Downconverter'

As 70cm becomes more crowded, many TV enthusiasts are moving to the next band up. Aerial systems are very compact, repeaters are planned for many parts of the country and there is DX to be had. Andy Emmerson, G8PTH, surveys the current 24cm scene and looks at the latest in equipment from Wood and Douglas.

Ideas for articles can happen in strange ways — your editor says "How about a review on Wood & Douglas's new FM TV bits if I get hold of them for you?" To which I had to reply "But I'm ahead of you — I'm already using them!" So was born this review of W&D's new 24cm ATV receiver, and for good measure an update on the TV repeater scene.

Wood & Douglas are not a bad lot really — for instance, they have helped out the Worthing TV repeater group with advance samples of their products (good idea for in-the-field product testing). When W&D recently brought out their new tunable downconverter they made sure that several people had 'samples' to evaluate. On the basis that a good product sells itself by word of mouth, particularly true in the world of amateur radio which, after all, is essentially concerned with communication(!), this is a good philosophy and I am pleased to say their new baby is a winner. But before we take it to bits, so to speak, let's look at the current situation with regard to 24 cm ATV.

24 — The Next Band Up

Traditionally amateur television (ATV) has been on seventy centimetres, just below the UHF broadcast TV band. A lot of normal 70 cm equipment can be used for ATV transmission and reception, and domestic TVs can be used for viewing the transmissions. Increasing pressure on the space of 'seventy' and the desire to try something new has led a growing number of ATVers to try the next band up. Commonly known as 23 cm this stretches from 1240 to 1325 MHz, though not all the band is used for TV. "We" use mainly the bottom and middle of the band, which is why ATVers call this ATV area more correctly 24 cm. Activity is both simplex and through repeaters, and in both AM and FM. AM or 'Ancient Modulation' was the original ATV mode but is now all but extinct, and the future I believe lies entirely with FM, which allows much simpler signal generation and power amplification. (See the Wood & Douglas catalogue for an even more convincing explanation of this!).

Since 24 cm is our lowest microwave band, people not already up there may be forgiven for thinking that working on 24 is a bit 'hairy' and is only suitable for short distances. Not so; you have to construct your whole station carefully (but really you need to do that on all bands) and propagation is very comparable with 'seventy'. Under lift conditions, '24' actually can be better, and 'openings' to relatively distant parts seem to happen more frequently. I am not saying that you'll make more contacts immediately than on 'Seventy', though — 24 is still essentially a band for people with a pioneering spirit.

Making A Start

Having read my rosy description of the potential of 24cm TV you may wish to make a start on the band by receiving the local activity. Even with a converter, a normal TV receiver will not make a very good job of displaying local-ish FM transmissions; it will work but not efficiently. And this is where the new W&D products come in: the 1250DC50 tunable 'downconverter' and VIDIF FM demodulator. Together they take an FM TV signal anywhere in the 23/24 cm band and bring it down to baseband video, which can be displayed on a normal monitor (or put into a channel 36 modulator for viewing on your domestic TV set).

The downconverter comes in a sturdy tinplate box 5" x 3.75" x 1.25". The video IF board also fits into the same box, which is available separately. I put my IF board in this box and would recommend you do likewise; the combination will then fit nicely into the standard no. 202 Verobox (see photo nearby).

Both items are available ready assembled, and the VIDIF can also be purchased as a kit. The downconverter is not available in kit form, however, and the manufacturer's explanation for this makes technical sense to me. "The complexity of the circuitry demands a high level of instrumentation to allow correct alignment, and minor variations in assembly technique could not be tolerated at such a high frequency." In other words, assembly must not only be *exact* but a rather larger amount of test gear than the average amateur possesses is necessary to make it tick!

With this in mind, I had to take the lid off and see the standard of their construction; it *is* exemplary, with separate compartments for the RF sections. Looking at the PCB, and one can see the signal entering a bandpass filter, gain-matching it for the GaAsFET and then out through another filter to the ring mixer. There is an NE219 as VCO, controlled by two BB221 varactors and a BFR91 following a VCO. A standard Plessey SL560 amplifier leads to the output of the downconverter. The overall noise figure is not quoted but from a subjective point of view seems very adequate. *(Many 23cm stations tend to use low noise masthead preamplifiers to minimise feeder losses, enabling the use of reasonably priced feeder cable such as H100 — providing the feeder run is not too long — and making the noise factor of the actual Rx front end much less important — Ed).* The AFC seemed unnecessary for FM to a colleague; the phase-locked loop in the VIDIF ought to be able to track the incoming signal without too much difficulty. This minor quibble to one side, my impression as an ATV enthusiast for a fair number of years, is that a lot of thought has gone into the design and this looks very professionally executed as well.

Looking At The Video IF

After all this hi-tech, the VIDIF board seems quite tame! No problem though, it is a workmanlike product. You get a circuit diagram in this case which helps you follow the signal past an OM335 level booster to limiting and demodulation (NE564 PLL). A positive or negative signal can be selected: all amateur FM signals are positive sense, though my board came somewhat mysteriously with the link set to negative. Anyway, it's no trouble to change this. Twin 1 volt video outputs are supplied, also a 6 MHz audio signal for external direction and AFC (for front end tracking) and AGC voltage (for an 'S' meter).

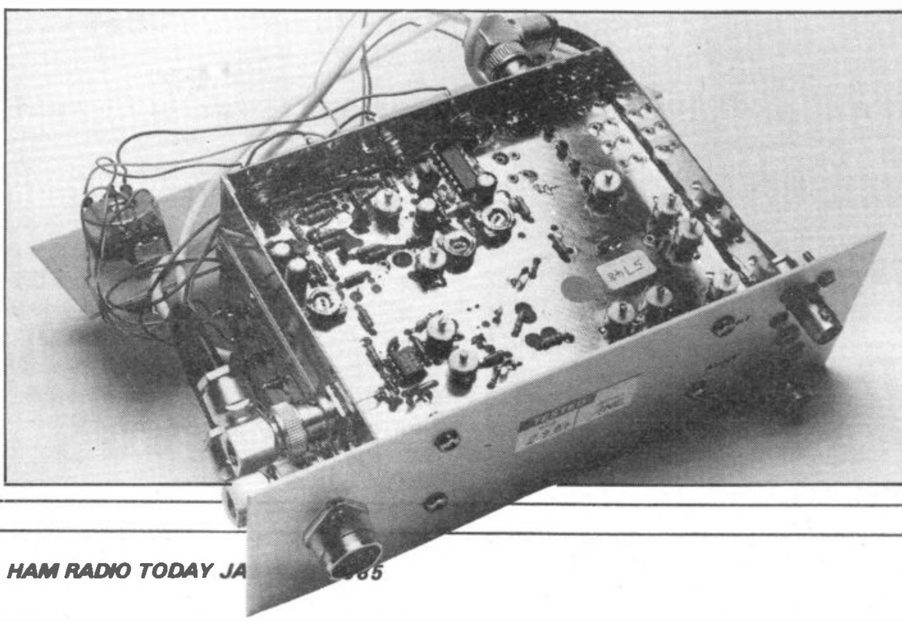
Connecting the two boards is a simple matter; the cabinet of your choice will need to be provided with a modulation sense switch and a 'tuning' potentiometer. A volume control and loudspeaker are optional extras.

Best Buy?

I do have two other manufacturers' (who shall be nameless) converters in use in the G8PTH shack, but after trying these two W & D units over a period of a fortnight I decided to buy them. This is a recommendation then: I find their performance very satisfactory and in some respects better than the opposition.

Good points to note are the first rate rejection of radar signals (pointing to good limiting) and no spurious oscillators of any kind. The modulation sense is absolute: you cannot mistune a signal with the wrong sense as you can with a rival product. The units are not a 'plug-in and turn-on' job though: you still have to build the case and peripheral circuitry. For many people this is not only more fun but is an advantage — the converter can be cased and switched to suit your particular set-up.

The lid off!



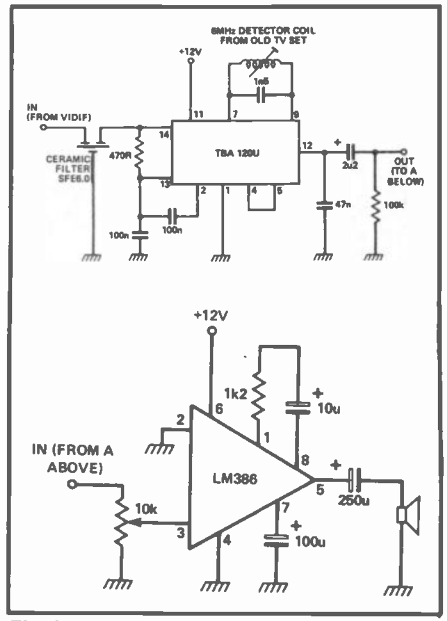


Fig.1. Sound demodulator and output stage suitable for the unit.

My sole real complaint is that the tuning spreads way above the top of the band; if there is to be an overspill why not have it at both ends as some French stations still use 1227 MHz. It is a pity that the sound demodulator is not yet ready, but you can easily build your own audio output stage (see **Fig.1**). The packing of the bare VIDIF boards does need to be improved, though; mishandling in the post caused the coils to poke through the jiffy bag and. . . crunch!

A custom-designed audio board is planned and may be reviewed here in due course. Wood & Douglas also make some modules for the construction of an FM TV transmitter; I recommend you get hold of their catalogue and check these out.

Where The Activity Is

Without a doubt the TV repeaters have given 24cm TV a terrific boost, and for this reason most of the activity is centred around the places where repeaters have been opened. There are five repeaters in Phase 1, of which two (Worthing and Dunstable) were in full operation at the time of writing. Of the others Leicester (the very first) was in beacon mode, and the other two (Bath and Stoke-On-Trent) are still under construction.

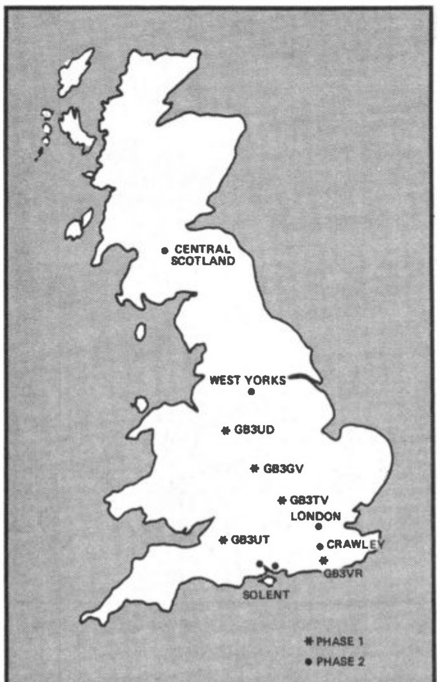


Fig. 2. TV repeaters in Britain.

As the Phase 1 repeaters are more 'experimental' than those which will follow, there are two distinct systems in use. GB3GV (Leicester) and GB3UT (Bath) accept either AM or FM input signals but radiate in AM only. The remainder, GB3TV (Dunstable), GB3VR (Worthing) and GB3UD (Stoke) are FM machines, and all the known repeaters planned for Phase 2 will be FM too. (FM is the rule in most other European countries where the 24 cm band is exploited).

More Repeaters Soon?

From the start of planning a repeater to the eventual licencing can take a long time, even if everything goes to plan. I am not aware of an official timetable for Phase 2 TV repeaters but there is no harm in mentioning those planned which are fairly well advanced. From A-Z we have:

CENTRAL SCOTLAND. Still at initial planning stage.

CRAWLEY, GB3CT. Site in ZL80H, 325 feet above sea level. Power 20W erp from an Alford Slot. Field trials show good average of North Sussex and Surrey.

SOLENT REGION. The proposal is for one or two machines, to serve firstly, Poole and Bournemouth and secondly, Southampton.

WEST YORKSHIRE. The site has been agreed — the top of Emley Moor TV mast!

I have also hear rumours of plans for machines in the Thames Valley, west of London, and also in Central London (co-sited with GB3LW). In addition, I was associated with a plan for a repeater on the Isle of Sheppey to serve parts of Kent, Essex and London. An excellent site was found and although the plans never came to fruition the opportunity is still there for enthusiasts in this area.

Simplex And Relay Working Too

Not everyone lives within reach of a TV repeater and there are pockets of keen simplex activity, especially in the Thames Valley, Midlands and Solent areas. All in all, there are some forty transmitting stations on 24cm in England now and many more 'eyewigs'. Simplex also gives you the opportunity to work a bit of DX: the Sussex Coast mob regularly have contacts across the Channel, and stations in the Midlands have had visual QSOs with France and Holland.

Relay working is also a possibility: signals can be picked up on 70 cm and transmitted further on 24 (and vice versa). With proper filtering and a wide spread between Rx and Tx frequencies, in-band relays are also a possibility.

Frequencies And Standards

Although in theory you can operate on any frequency you choose, commonsense dictates that you follow the established patterns of activity to maximise your chances of a QSO. Simplex activity is generally low in the band. 1255 MHz is the standard frequency in France and Belgium, and is becoming the rule here as well. Many Continental stations have crystal-controlled receive converters, so 1255 makes sense. The FM repeater frequencies are 1249.0 MHz input and 1318.5 MHz output. For the AM boxes, the figures are 1276.5 MHz in and 1311.5 MHz out.

FM signals are limited to a deviation of +/− 6.5 MHz, and the audio subcarrier is the same in both systems, namely 6 MHz (but 5.5 MHz abroad). Aerial polarisation is horizontal or circular.

Further technical information can be found in a six part series on 24 cm in *"Amateur Radio"*, (*What's that — Ed.*) February to July 1984 and in the BATC Amateur TV Handbook, available from the RSGB, so why not get cracking now?.

WOOD & DOUGLAS, Unit 13, Young's Industrial Estate, Paices Hill, Aldermaston, Berks., RG7 4PQ. (Telephone 07356-71444). 1250DC50 Downconverter, £69.95. assembled. VIDIF board, £38.95 kit or £54.25 assembled. Custom box for above, £5.50. Postage 75p extra on all above items.

Table 1 — SPECIFICATIONS

1250DC50	
Input frequency range	1240-1325 MHz
Intermediate frequency	50 MHz nominal
Conversion gain	25 dB minimum, 30 dB typical
First RF stage	MGF1100 GaAsFET
Mixer type	discrete Schottky ring
Post mixer processing	SL560c amplifier
Operating voltage	11.5-14.0 volts
Operating current	80 mA nominal
Internal stabilisation	8.5, 5.5V rails
External connections	AFC input, supply input, tuning voltage input, 8.5V output
RF connections	BNC
VIDIF	
Input signal range	40-55MHz
Supply voltage	12V (with internal stabilisation for PLL supply)
External connections	AGC output, AFC output, IF input, twin video outputs, 6MHz audio output, supply voltage.

WOOD & DOUGLAS

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Package Prices

		Kit
1. 500mW TV Transmit	(70FM05T4 + TVM1 +BPF433)	35.00
2. 500mW TV Transceive	(As 1 above plus TVUP2 +PSI 433)	60.00
3. 10W TV Transmit	(As 1 above plus 70FM10 + BDX35)	65.00
4. 10W TV Transceive	(As 2 above plus 70FM10 + BDX35)	90.00
5. 70cms 500mW FM Transceive	(70'T4 + 70'R5 + SSR1 + BPF)	75.00
6. 70cms 10W FM Transceive	(As 5 above plus 70FM10)	105.00
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8. 2M Linear/Pre-amp 25W	(144PA4/S + 144LIN25R)	42.00
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12. 70cms Linear/pre-amp	(70LIN10+70PA2/S)	45.00

70cms EQUIPMENT	CODE	ASSEMBLED	KIT
Transceiver Kits and Accessories			
FM Transmitter (0.5W)	70FM05t4	48.00	28.75
FM Receiver (with PIN RF c/o)	70FM05R5	65.40	45.80
Transmitter 6 Channel Adaptor	70MC06T	21.30	14.25
Receiver 6 Channel Adaptor	70MC06R	25.20	17.90
Synthesiser (2 PCB's)	70SY25B	88.00	62.25
Synthesiser Transmit Amp	A-X3U-06F	34.15	22.10
Synthesiser Modulator	MOD 1	8.95	5.50
Bandpass Filter	BPF 433	6.50	3.30
PIN RF Switch	PSI 433	7.55	5.35
Converter (2M or 10M i.f.)	70RX2/2	27.10	20.10
TV Products			
Receiver Converter (Ch 36 Output)	TVUP2	27.50	22.80
Pattern Generator (Mains PSU)	TVPG1	42.25	36.50
TV Modulator (For Transmission)	TVM1	9.85	5.75
Ch 36 Modulator (For TV Injection)	TVMOD1	9.80	5.50
Power Amplifiers (FM/CW Use)			
50mW to 500mW	70FM1	18.45	12.80
500mW to 3W	70FM3	23.45	17.80
500mW to 10W	70FM10	41.45	33.45
3W to 10W	70FM3/10	23.95	18.30
10W to 40W	70FM40	65.10	52.35
Combined Power Amp/Pre-Amp (Auto Changeover)	70PA/FM10	56.60	40.15
Linears			
500mW to 3W (Straight amp, no changeover)	70LIN3/LT	27.90	19.90
3W to 10W (Auto Changeover)	70LIN3/10E	41.05	30.15
1W to 7W (Auto Changeover)	70LIN10	44.25	32.50
Pre-Amplifiers			
Bipolar Miniature (13dB)	70PA2	8.10	6.50
MOSFET Miniature (14dB)	70PA3	9.65	7.50
RF Switched (30W)	70PA2/S	24.25	15.25
GaAs FET (16dB)	70PA5	20.10	12.80
6M EQUIPMENT			
Converter (2M i.f.)	6RX2	28.40	20.80
2M EQUIPMENT			
Transceiver Kits and Accessories			
FM Transmitter (1.5W)	144FM2T3	39.35	26.30
FM Receiver (with PIN RF Changeover)	144FM2R5	65.50	47.20
Synthesiser (2 PCB's)	144SY25B	78.75	60.05
Synthesiser Multi/Amp (1.5W O/P)	SY2T	27.90	20.65
Bandpass Filter	BPF 144	6.50	3.30
PIN RF Switch	PSI 144	7.55	5.35
Power Amplifiers (FM/CW Use)			
1.5W to 10W (No Changeover)	144FM10A	24.15	18.50
1.5W to 10W (Auto-Changeover)	144FM10B	36.11	26.25
Linears			
1.5W to 10W (SSB/FM) (Auto Changeover)	144LIN10B	38.40	28.50
2.5W to 25W (SSB/FM) (Auto Changeover)	144LIN25B	40.25	29.95
1.0W to 25W (SSB/FM) (Auto Changeover)	144LIN25C	44.25	32.95
Pre-Amplifiers			
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Low Noise, Improved Performance	144PA4	12.86	8.40
Low Noise, RF Switched, Full Changeover	144PA4/S	24.30	15.30
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Reflectometer	SWR1	6.35	5.35
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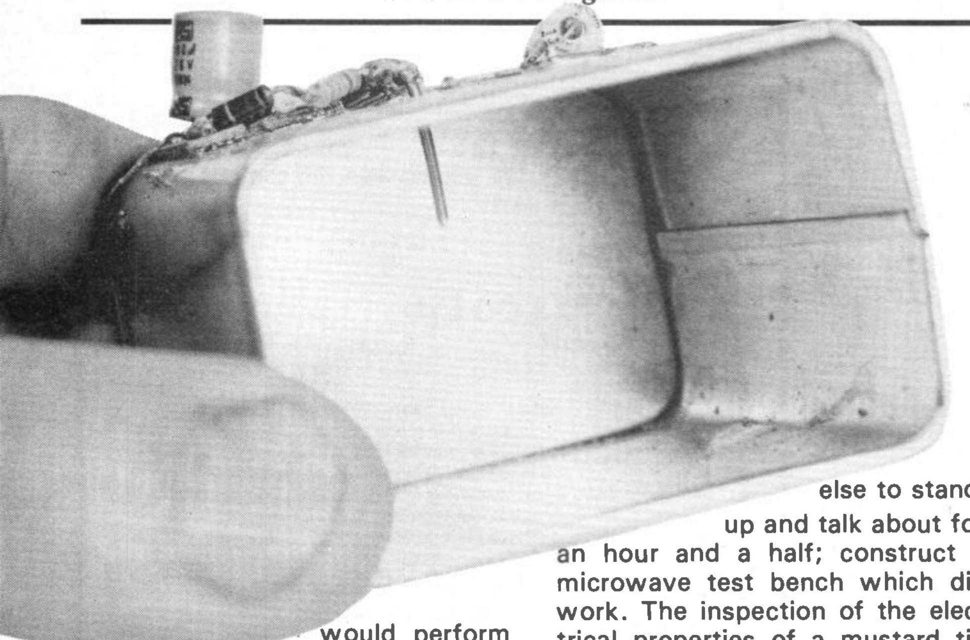
MICROWAVES with a Mustard Tin

Sitting down at my bench and looking at an empty Colman's mustard tin it occurred to me that the tin with its lid off looked rather like a waveguide which had been blanked off at one end. Could it be that it would perform like a waveguide resonator? I set about finding out.

The microwaves are an area in which amusing and informative experiments on how radio waves are propagated can be carried out. You too can feel like Marconi! Our very own Guglielmo, Frank Ogden, G4JST, describes the construction of a simple transmitter and receiver for 9cm and hints at the art of using a wok as a waveguide.



I had been asked by a local radio club to give a lecture — subject of my choice — with the request coming at fairly short notice. I decided that a microwave demonstration would be interesting — I could show how radio waves could be bent, reflected, polarised and focussed — all in the space of two village hall trestle tables.

With two days to go before the lecture I pulled out my old 10GHz Gunn oscillator and fired it up to make sure it worked. I lined up the detector, connected up the meter and. . . nothing. With rising panic I discovered that the fragile barrier diode in the detector assembly had blown, presumably due to static. The Gunn source still functioned OK but I had nothing which received efficiently at the operating frequency. I had three choices: cancel the lecture; find something else to stand up and talk about for an hour and a half; construct a microwave test bench which did work. The inspection of the electrical properties of a mustard tin followed course three!

I say all this to put the design which I offer into perspective. The total time taken to design, build, de-bug and evaluate the transmitter and receiver was approximately five hours. What follows is surely nowhere near optimum, but provides a good starting point for readers' own experiments. *Furthermore, we would like to hear about the results of these mustard tin microwave links at Ham Radio Today*. Since the entire project should cost under a fiver, there is no excuse for not building one!

Details Of The Link

The link comprises a single transistor oscillator producing around 50mW at 3400MHz (8.8cm wavelength) coupled into the mustard tin waveguide by a capacitative probe. The link uses amplitude modulation produced by applying audio to the base of the oscillator transistor. In its simplest form, the transmitter aerial is simply the open end of the mustard tin radiating into free space.

The receiver comprises a UHF Schottky mixer diode connected to the centre of a broadband 'butterfly' dipole. The diode, which is biased into conduction by a very small DC current feeds the demodulated signal into a very sensitive audio amplifier. Needless to say, the gain of the overall link (and thus its range) can be increased considerably by focussing both the transmitting and receiving radiators with dustbin lids, frying pans, Chinese woks (the author's personal preference) and other bits of metal.

The range of the link is not quite up to Marconi's experiments from Poldhu, Cornwall but is demonstrably a lot better than Hertz's. The first attempt with my experiment produced ranges of several hundred feet. Superior aerial arrangements would improve this considerably.

The Transmitter

Fig.1 shows the schematic of the sender unit. The single transistor oscillates by feeding RF from the tuned collector to the emitter via the internal capacitance of the device, a BFT95 'T' package transistor. Please note that this is a PNP type and thus requires a negative supply for its collector circuit. This type of transistor was intended as a low noise, high current RF pre-amp for TV tuner service. Its high fT of around 5GHz makes it eminently suitable for this type of oscillator.

Construction of the sender unit is essentially a mix of solder and super glue. The collector circuit,

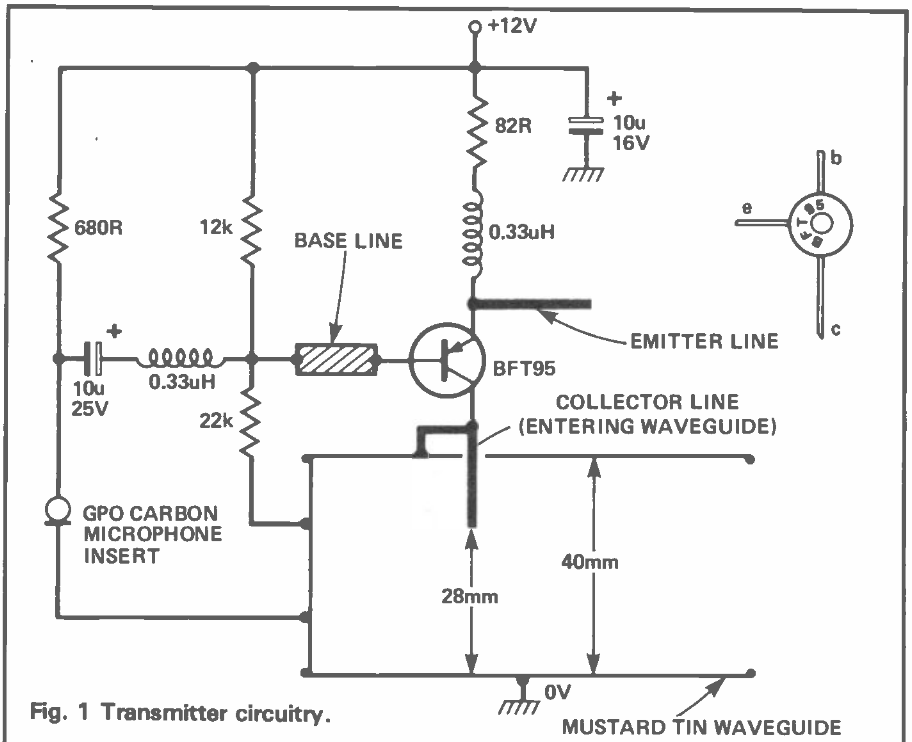


Fig. 1 Transmitter circuitry.

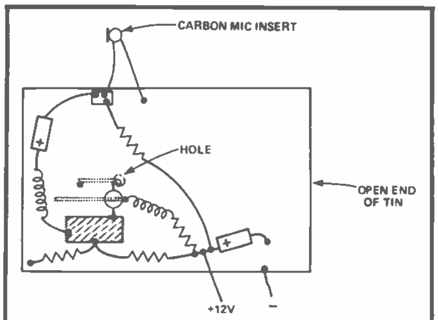


Fig.4 Layout of oscillator parts on top of mustard tin. Microwave critical parts are shaded.

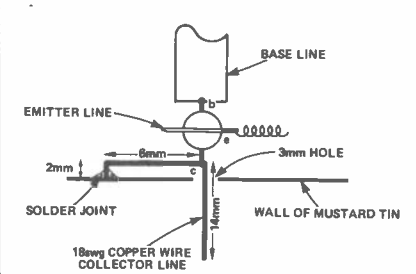


Fig.2 Detail of collector line for 8.8cm oscillation.

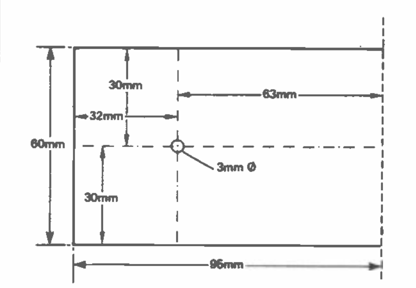


Fig.3 Drilling dimensions for the tin.

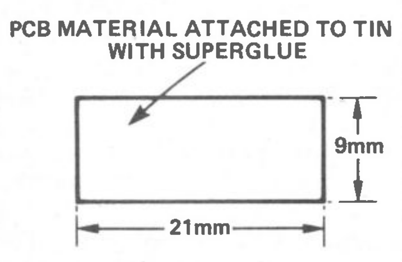


Fig.5 Dimensions of the base line.

electrically a quarterwave line grounded at one end, is a right angle of 18 SWG bare copper wire of total length 22mm. The 'hot' end passes through a hole drilled into the mustard tin waveguide. The 'cold' end has its last couple of millimeters bent into a small foot which is then soldered directly to the outside of the tin. The collector of the transistor (the long tab) is soldered directly to the collector line about 6mm from the earthy end (ie the cold end that is now soldered to the tin). The device should be soldered with the tab so short that the collector line is hard up against the transistor case. *Care should be taken during this operation that the transistor isn't cooked*. **Fig.2** shows the detail of the collector line; **Fig.3** gives the drilling details of the mustard tin while **Fig.4** shows the plan view of critical components which are active at microwave frequencies. Placement of other connector 'pads' — bits of PCB material held on with super glue — can be made at the convenience of the builder.

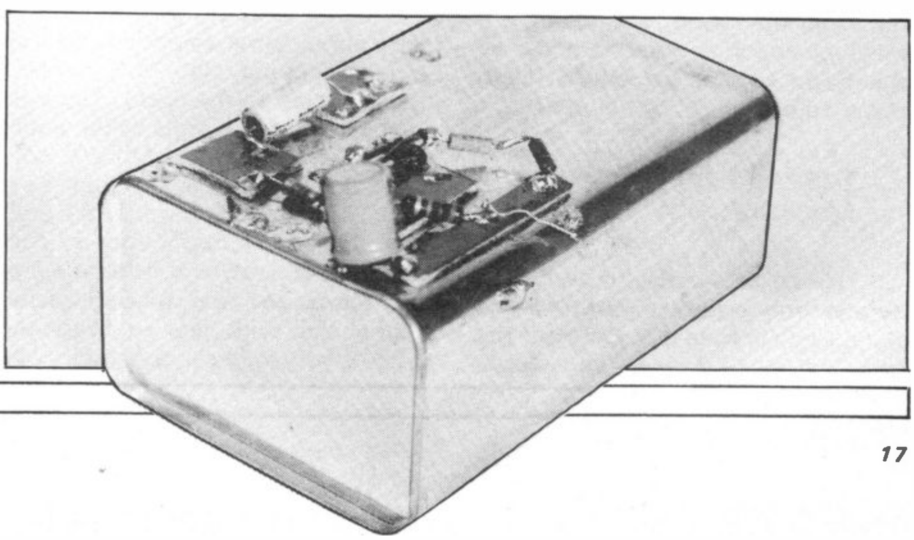
Note that Fig.4 also shows a base line, a low impedance quarterwave stub to ground the transistor base at the operating frequency, and an emitter line, a short bit of wire hung onto the emitter connection. Although not essential to oscillator function, this last addition was found to boost efficiency of the circuit substantially.

The base line is essential. This is a super glued piece of circuit board with the dimensions shown in **Fig.5**. The output frequency of the oscillator is determined by the length of the collector line. More about this later.

The circuit (Fig.1) shows a number of low value RF chokes scattered around various parts of the circuit. The prototype used 0.33 microhenry commercial subminiature units but five turns of 22 SWG wire wound as a 3mm airspaced coil (use a drill bit to wind these on) would do equally well.

The Receiver

The microwave part of the receiver is apparently just a simple broadband dipole mounted on a miniature ceramic tag strip. The Schottky mixer diode is mounted directly across the dipole with a



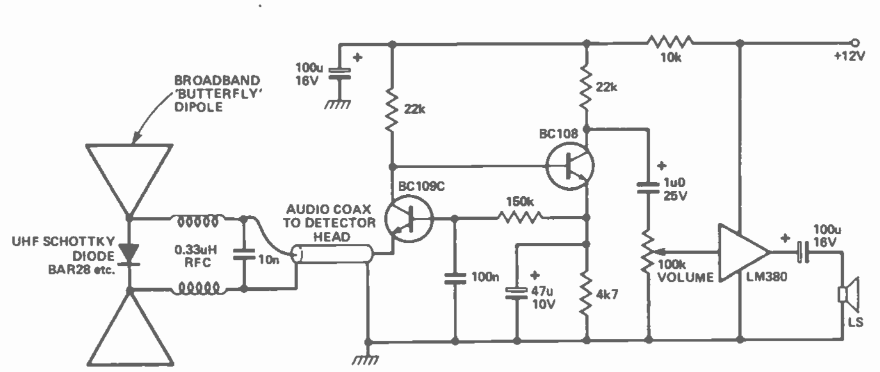


Fig.6 Complete receiver circuit.

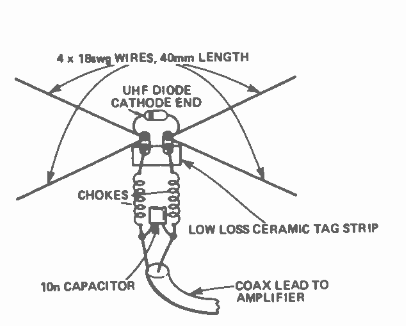


Fig.7 The receiver microwave head.

pair of small chokes taking the rectified signal to a piece of audio coax. The overall receiver circuit is shown in **Fig.6**. The details of the receiver microwave head are shown in **Fig.7**. The 10n capacitor connected across the cold end of the RF chokes is essential to prevent broadcast interference breakthrough.

The prototype audio amplifier was built on an off-cut of veroboard. There is nothing special about construction except that the audio loudspeaker output should be kept away from the amplifier input.

The first stage of the preamp performs two functions: it provides around 50 microamps of current to bias the detector diode to maximum sensitivity while the emitter input configuration provides a good impedance match to the audio output from the diode. The result is a receiver which is much superior to the basic crystal set which it appears to be.

Testing And Frequency Measurement

Having soldered and stuck the sender unit together, the obvious thing to do is to test it. Connect the unit to a 12V low impedance supply. The current drawn should be in the region of 30 to 40mA. A finger placed on the collector line should alter the current reading or stop oscillation altogether. The current should drop to around 5mA in the latter case. Placing a hand across the mustard tin waveguide mouth should also reduce the current. The transistor runs quite hot even under normal conditions.

The prototype could light a small bulb (1.2V 100mA) quite brightly by placing the bulb with a couple of 'dipole aerial' leads attached (20mm each) inside the waveguide. *There is clearly quite a bit of microwave power about and the waveguide exit should be kept away from the head and — particularly — eyes.*

Decouple Well

Working near its upper frequency limit, the transistor presents a negative resistance to the supply. Low frequency RF oscillations can result unless the supply is well decoupled. This same effect makes it quite difficult to obtain deep amplitude modulation with a simple carbon microphone connected as shown. This part of the circuit would doubtless benefit from further circuit development.

Crude but effective frequency measurement may be made by stretching a length of bare copper wire about 2mm above a large surface of copper clad PCB material (copper side to the wire). The wire is soldered to the edge of the board at one end while the other is connected to a UHF diode such as a BAR28 or a germanium OA91 unit. A sensitive microammeter is connected between the other end of the diode and the ground plane. When the wire line is irradiated with RF from the waveguide, the meter will show a deflection due to rectified RF.

A shorting bar slid along the wire and PCB ground plane will produce a series of peaks and troughs in the meter reading. Physically measure the distance between nulls on the wire and multiply by two to give you the operating wavelength.

The receiver when working correctly should produce masses of white noise with or without an incident signal on the detector head. In any case, the detector should produce a large reading when connected to a microammeter rather than the amplifier for initial checking with the microwave source in close proximity. Please note that the amplifier circuit will not function without the detector head being connected. Incident microwave energy does not quieten the white noise but doppler effects, microphony of waveguide, etc should at once be evident.

A Few Experiments

The first thing to note about the RF coming out of the mustard tin is that it is vertically polarised when the mustard tin is on its 'flat' side. The receive butterfly aerial must therefore be parallel to waveguide probe axis ie vertical. As well as radiotelephony using the carbon mic (why not build two links for true two-way QSOs?) the receiver and sender placed close together act as a dual cavity doppler module, as in the typical intruder alarm. Interferometer experiments can also be carried out. For instance, some types of wrist watch placed in the beam will reflect incident RF off the internal moving parts back to the receiver head. This mixes with directly received RF to produce an audible result similar to an 'X ray' microphone ie a very loud tick tock! Classic distance and wavelength experiments can also be done.

A miniature aerial testing range could also be made but this is something that I haven't tried (*G6CJ's famous 'aerial circus' works along those lines — Ed.*). The possibilities are endless. Speaking from a purely personal point, this is one of the most interesting projects that I've carried out for a long time. I am sure that those who build it will have at least an equal amount of fun.

ATTENTION ALL WRITERS . . .

. . . or just those of you who sometimes think "I could do better than that!"

We want to hear from you!

The magazine you hold in your hand is part of ASP's electronics group of titles. These include *ETI, Ham Radio Today, Digital and Micro Electronics,* and our new magazine, *Electronics.* All these magazines are looking for new authors, so if you've designed something for yourself that you think may be of interest to others, or if you've a subject you'd like to write a feature article on, then drop us a line with an outline of what you have in mind.

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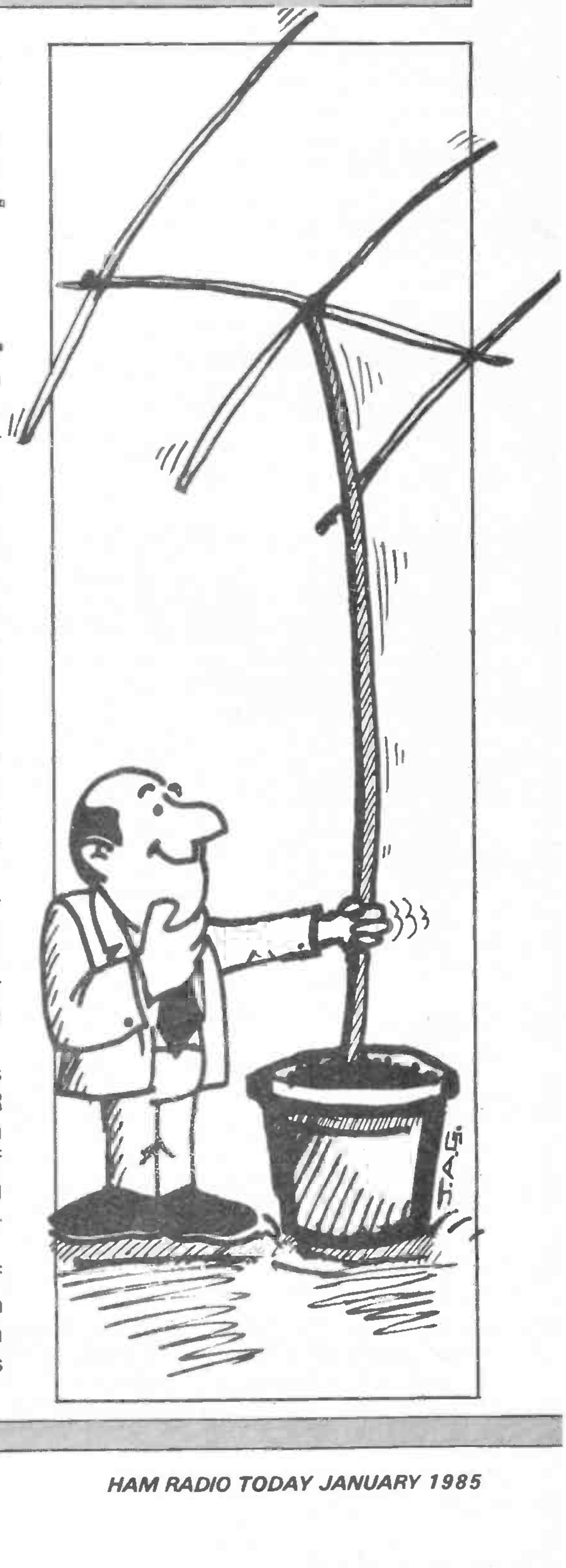
Planting a Tower

To have a tower in the garden, whether it be for HF or VHF antennas, is the dream of every radio amateur. For some lucky ones this dream comes true; I have been lucky enough to have had a tower up at two different QTHs. This article describes some of my experiences and lessons learned of 'digging in' and 'rooting up' towers.

Putting up a tower looks easy, but Nigel Cawthorne, G3TXF, explains that there is a lot of hard graft involved.



Planning Permission

Assuming for the moment that he/she has already crossed the hurdles of gardener and bank manager opposition, the next one to be encountered by the would-be tower user is obtaining planning permission.

There seems to be a mathematical formula linking height of tower, quantity of near neighbours and your chances of obtaining planning permission: the larger the number of neighbours, the higher the tower, the greater the problems of getting permission.

I do not propose to go into the 'ins and outs' of getting planning permission, but the RSGB provide an excellent support service especially the booklet covering this subject. (See the article in the July issue of HRT by Steve Voy). A letter of support from the RSGB attached to your application will increase your chances of success. Diplomacy, common sense and tenacity are probably the three characteristics that are the most helpful with obtaining planning permission.

Thankfully, I had no difficulties obtaining planning permission because I was fortunate enough on both occasions to have very few direct neighbours and was successful on the first attempt.

As part of the procedures that the local authorities went through, my direct neighbours were each sent a questionnaire after my application had gone in. Before anyone was contacted, I mentioned what I was doing to everyone likely to receive a questionnaire; and had made a point of inviting each of the more immediate neighbours in for a visit to the shack and a demonstration QSO. Good public relations are *very* important at these delicate times!

As a part of these PR operations, I have found displaying and highlighting my QSL from JY1 (King Hussein) does wonders for the image of amateur radio with the neighbours!

Where there are large numbers of neighbours involved, the PR operation might have to be on a bigger scale, and the chances of finding among them an "I'm going to object on principle" type increases dramatically!

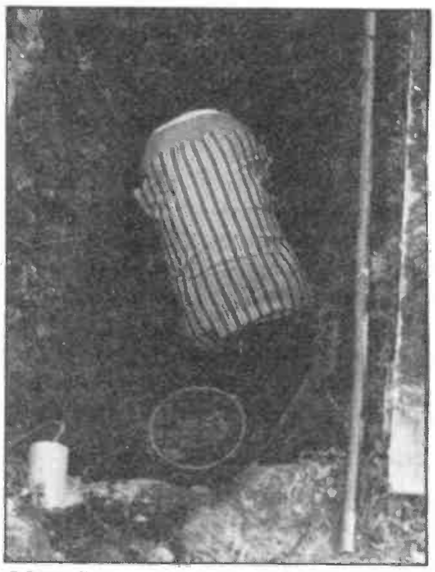
Having got over the hurdle of planning permission you can become the proud owner of a tower. All you have to do now is put it up.

Positioning The Tower

Great care must be taken in positioning the tower. If it is the tilt-over type, (mine is a Versatower P60, 60 foot post mounted type) calculations should be made of where the tower will be when it tilts over, especially where the antennas will 'land' as the tower tilts over.

The practical advantages of a tilt-over tower can be soon lost if the antennas get stuck in a tree as the tower is lowered. If the tower is being put up in the winter time when the trees are bare remember to allow sufficient clearance for clearance as spring approaches. Plan carefully where the tower is to go, although, of course, in smaller gardens, there may well be no choice in the matter.

Having planned in detail where the tower is to be positioned and its orientation, the next part is the worst bit of all — digging the hole!



G3TXF completes the hardest task of digging the hole.

The Spade Work

The most common type of tilt-over towers that use a base post require a six foot hole, which has to be about 1 foot square at the bottom. The amount of physical effort this requires comes as quite a shock to many. But the thought of all those QSO's that you are going to make keeps you going as you dig further down the hole. It may take two inexperienced diggers a full afternoon's work to achieve the required hole for the base post. But don't worry, the ensuing backache is soon to be compensated for by that big signal which will be there just as soon as the tower and antennas are complete!

John, G8IQQ, helps with inserting the base post.

Pouring the Concrete

Where a base post mounted, tilt-over tower is to be installed, great care must be used in setting the base post vertically into the ground. Half of an inch off true at the level of the base post will produce a Tower of Pisa effect on a 60ft tower. So the base post should be firmly held in true vertical position by boards or ropes. It must not budge as the concrete is poured around it.

The Non-Stick Base Post

Even while you are digging your tower base into the ground, it is worth remembering that one day you may be moving house, and that you will not want to have to leave a costly base post behind just because it is set in concrete. A useful technique for keeping the base post clean when it is in concrete, is to fix a layer of silver foil all over the part of the base post that is to be in contact with the concrete.

Unless you are in a very exposed and windy location, it is probably unnecessary encasing the whole length of the base post in concrete. Usually a 'collar' of concrete around the upper two feet of the base post is adequate. It is this upper two feet that is covered with silver foil, held on with tape. This keeps the concrete away from the *surface* of the base post.

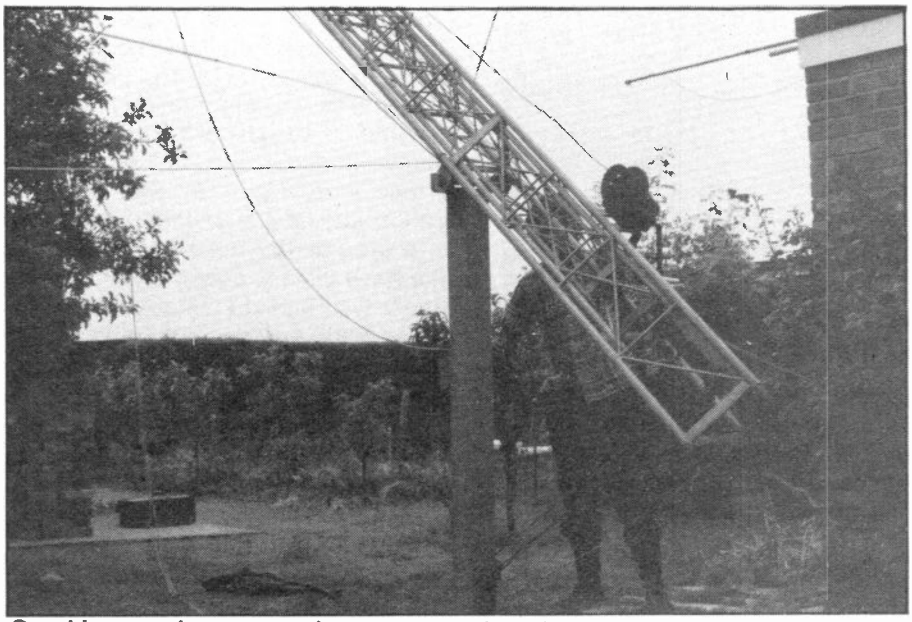
When it is time to move house, and the tower has to be dug up, the concrete collar can be dug free. With a sledge hammer the concrete collar can be broken off, leaving the tower base post in a good clean condition all ready for removal to the new QTH.

The removal of a tower from one QTH to another can add a heavy burden of work to the already onerous task of moving house! My tower is already at it's third QTH, sadly a QTH far too small and cramped for a tower. However with a fourth QTH already in view where there will probably be more space and it will soon be back to the hole digging again!

With the tower on the base post, G3TXF examines progress so far.

Leaving The Concrete To Set

With the concrete poured around the base post, adequate time should be allowed for it to harden before lifting the main body of the tower onto the base post. For a three section 60ft tower lifting the tower up onto the base post can be a problem. Not only is it very heavy, but it has to be lifted about six feet above ground level. This is a case for "many hands make light work."



Cranking up the tower, the moment of truth.

Get The Neighbours In

Getting the neighbours in to actually assist you with putting up the tower is a very useful ruse. It is probably too much to expect neighbours to help dig the hole for you, but they might be able to help you with lifting the tower onto the base post. Make a party of it! Invite them all in for tea (something a little stronger may be necessary for some!). After this get them all lined up on either side of the tower and heave! With about eight people lifting, you'll wonder what all the fuss was about!

There is nothing like it for your own good PR with the neighbours. Once the neighbours have been directly involved in putting up your tower with you, it leaves them without a leg to stand on if they want to complain about it at a later date!

Before putting any antennas onto the new tower, it is worth just cranking it up to see what it looks like and to get a feel of how the cranking system works. It is not unknown for amateurs to crank up their new tower to full height at this stage and then to take a gentle walk around the neighbourhood just to see how far away they can see it! It's like an artist stepping back from his canvas to admire his work. Quite understandable!

Installing The Antennas

Rotators and antennas should all be checked before they are fitted to the head section of the tower. Rotators can be mounted either inside the head section or just on top of a small length of tubing fitted into the head section.

Don't be tempted to try and guild the lily by putting too much extra tubing on top of the tower. It is better to be safe than sorry. Settle for a beam directly above the head section at 60ft, which survives all gales, rather than a beam on top of a 10ft pole, itself on top of the head section, that buckles and crashes down in the first gale. Seek the tower manufacturers advice if in any doubt. Whatever you do, do not overload the tower.

Allow adequate cable for antenna rotation. There should be an adequate loop of coax between the head section and the antenna above the rotator.

Check the alignment of the rotator before you fix it to the tower. If you are using a compass to set the heading, stand away from the tower itself, otherwise you're going to start off with a misaligned antenna rotator system!

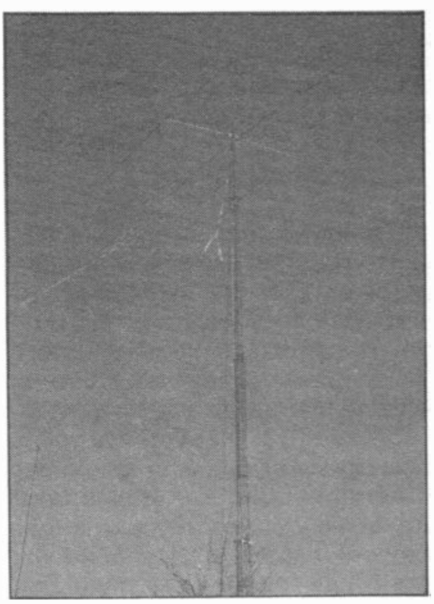
The First QSO

New tower, and possibly new antennas too, it won't be long before you're on the bands looking for that first QSO. If you've just installed a HF antenna on top of the tower, a CQ call will hopefully produce an encouraging reply. A nice run of JAs on 21MHz perhaps, just to show that the antenna is working.

The first day that it is all up and working you will probably be too tired to spend much time on the air testing out the new system. After all that digging, concrete mixing and lifting you may be on your back already!

With the tower up and with the antennas working, the bands will seem somewhat different. A CQ call produced not just one caller, or perhaps silence, but several callers at once. DX-stations come back on the first call. Pile-ups that previously were impossible to break, are now easy. The DXCC score starts to climb. Your signal becomes competitive in contests and you no longer have to wait at the bottom of the heap to make that DX QSO. No more agony of being the only station replying to a DX station's CQ call on a clear frequency; only to hear the DX station start calling CQ again because he can't hear you (even with no QRM!) But now, with your new tower up, they all come back first time! Well, almost.

The end result, well worth the effort!



Addendum

Finding Your IARU Locator

The two programs on P40 for changing latitude and longitude into the new locator and vice versa were incorrectly captioned - the captions should be transposed.

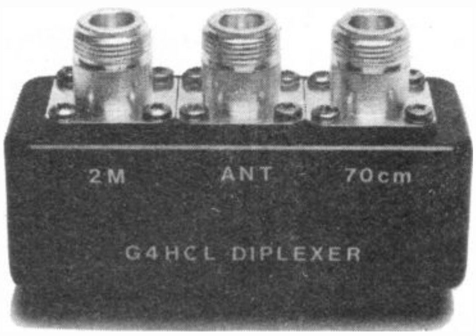
There is a mistake in the last but one sentence of the article (on P41) which seems to have caused some confusion. This should read 'To test the program, try converting IO92LD - the answer should be latitude = 52.1458, longitude = -1.04170.' Both programs have been checked on an Apple 2 computer.

DIPLEXERS and Dual Band Antennas

More and more people are operating on both 2m and 70cm from the car. Chris Lorek, BSc(Hons), G4HCL, tells how to maximise your results with a minimum of aerials and reveals some home truths about dual band operation.

The author used to run four aerials on his car, to get, he hoped, the best performance possible on each band he used. This had the usual effect of eyes being turned by passers-by, CB microphones being waved by other motorists, and so on. It may also have something to do with his car being rammed in the back by other (distracted?) drivers three times in the first year of owning the car! The final straw came when the local City Council decided, in their infinite wisdom, to close the last remaining open-air car park in the city centre, meaning for me a dismantling job on the aerials every shopping trip on a hurried dinner-time in order to be able to use a multi-storey car park. Something *had* to be done. I now have aerials able to cover 2m, 70cm, 4m, 10m, my business radio, CB, broadcast FM, MW, and LW, and a further VHF test band. However, the sum total of metalwork now is one visible 3ft long aerial and a further electrically-controlled stainless steel telescopic aerial, top loaded, which pops up when needed!

My primary interest, mobile operational wise, lies in 70cm and 2m and close investigation was thus carried out on the range of 'dual band' aerials now available for these bands. These usually act as a ⅝ over ⅝ wavelength radiator on 70cm, and a loaded ⅝ or ½ wave radiator on 2m. Gain specifications for a variety of commercial antennas for both 2m and 70cm (all made by the same manufacturer — which suggest probably the same test methods are used for each gain measurement and therefore a reasonably accurate comparison of antenna gains is possible) are given in **Table 1**.



It was considered that the theoretical figures were not too promising with regard to the gains of the dual band aerial, particularly as the majority of my monitoring was done towards the fringe areas of activity. I decided my existing ⅞ wave 2m aerial and 3 x ⅝ wave 70 cm aerial would be kept for general use, and a dual band aerial would be purchased and kept in the boot for use when a trip into the city centre was envisaged. The antennas could then be changed prior to travelling if required, whilst still allowing operation on a previously selected band, by a switch. The reason for this switch was due to my disappointment with the quoted specifications for commercially available diplexers enabling true dual-band operation, (ie one feeder to two aerials), typically 0.5dB loss and only 30 dB isolation between ports.

Table 1. Gain specifications for a (typical) range of commercial 2m and 70cm antennas.

5/8 wave whip, 2m:	Length 4ft 3ins;	Gain 3.0 dB rel.	1/4 wave
7/8 wave whip, 2m:	Length 5ft 7ins;	Gain 4.5 dB rel.	1/4 wave
2 x 5/8 whip, 70cm:	Length 3ft 1in;	Gain 5.5 dB rel.	1/4 wave
3 x 5/8 whip, 70cm:	Length 4ft 7ins;	Gain 6.3 dB rel.	1/4 wave
2m/70cm dual band whip,		Gain 2m, 2.7 dB rel.	1/4 wave
		70cm, 5.1 dB rel.	1/4 wave

Antenna Isolation

It was at this time that I decided to actually measure the typical isolation between a 2m ⅞ whip on one car gutter mount, and a 70 cm 3 x ⅝ whip mounted on the opposite gutter. 50 watts of 2m power was fed into the ⅞, and the resultant power measured coming from the 70 cm whip using a sensitive power meter. I was amazed to find a bare 17 dB isolation, ie *a full watt coming back down the coax, straight into the 70 cm rig!* I wondered how my 70 cm rig had survived for so long.

At this point I decided it would be a good idea to use a diplexer to at least alleviate this situation. With the generous help of two local amateur radio shops, the responses of two commercially available diplexers were measured using a calibrated spectrum analyser and tracking generator. The first, a Kenwood diplexer to be used with the Kenwood dual band aerial, showed a 2m to 70cm isolation of 62dB and a 70 to 2m isolation of 50.5dB. The insertion loss on 2m was 0.2dB and on 70cm, 0.55dB. The figures I felt showed good isolation but poor insertion loss with the diplexer, slightly higher than the quoted specification. Silver plated connectors with gold plated centre pins were used for the measurements. A further 0.1dB loss was found on 70cm when standard amateur type PL259 and 'N' connectors were used.

It can be seen from the

response curves of the diplexers (**Fig.1a**) that a low-pass and high-pass filter was used internal to the unit to separate the two ports.

A Hokushin diplexer was measured next, with the response as shown in **Fig. 1b**. This showed a resonant response, indicating that some form of tuned circuits were used in the unit. 2m to 70cm isolation was measured as 37dB, and 70cm to 2m, 30dB, just inside the specification. 2m loss was measured at 0.2dB, and 70cm loss at 0.4dB, within specification.

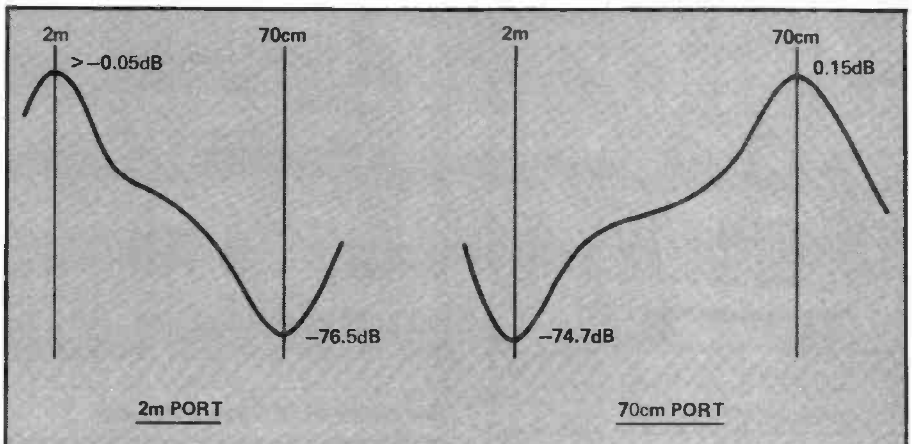


Fig.3 Frequency response of G4HCL diplexer

Going Homebrew

Both diplexers have their merits, but it was thought that a home designed job, made to a specification rather than a price, using simple components, could possibly do the job better.

The eventual design is shown below (**Fig. 2**). This gives over 70dB isolation between 2m and 70cm, with 'unmeasurable' loss (ie less than 0.5dB) on 2m, and 0.15 dB loss on 70cm. It is built in an Eddystone type diecast box, approx 1in x 1in x 3ins, with three 'N' connectors used for aerial connections. Apart from some 1.6mm dia. wire for the coils, the components listing consists simply of four good quality trimmer capacitors. The total cost if a commercial manufacturer made this would probably be in the order of £40-£50, but by doing one's shopping at a typical radio rally it may be built for less than six or seven pounds.

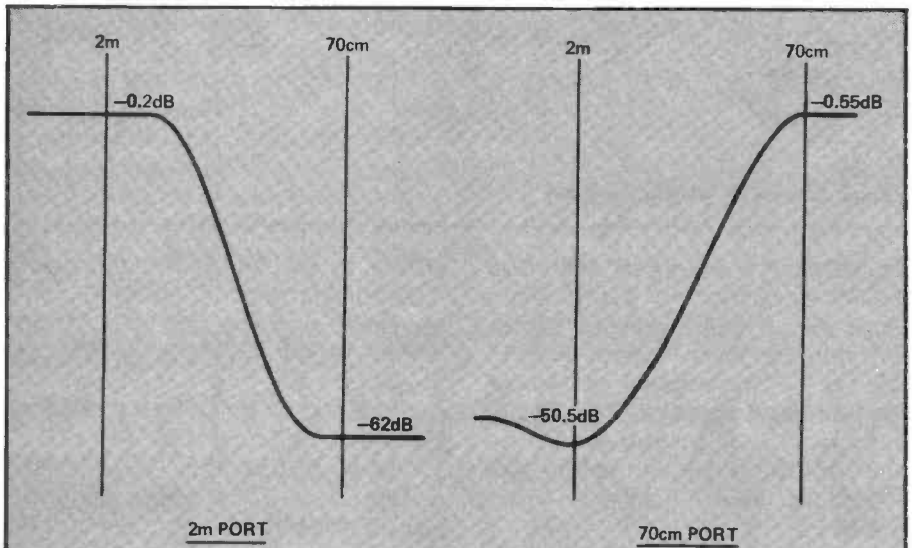


Fig.1a Frequency response of Kenwood diplexer

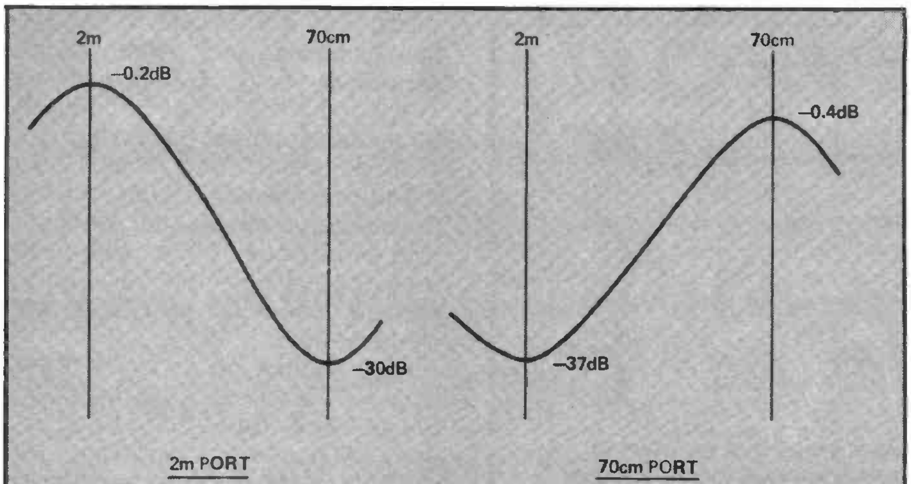


Fig.1b Frequency response of Hokushin HS-770 diplexer

All coils are wound on a ¼ inch former (you could use a drill bit), using 1.6mm diameter wire, preferably silver plated, diameter spaced between turns. The trimmer capacitors used in the prototype units were of the multi-turn variety, but one may use any mechanically stable type. *Note that high-Q silver-plated air-spaced types will give the best performance figures* — although these may prove more difficult to tune due to the sharper responses that would be achieved with them. The response of my prototype is shown in **Fig. 3**.

A tuned pass circuit resonant on 2m, comprising of C2 and L2, is used between the aerial port and the 2m port. Likewise a 70cm pass circuit comprising of C3 and L3, is used between the aerial port and the 70cm port. Between the 2m port and ground, a similar 70cm pass circuit, this time comprising of C1 and L1, is used to get rid of any residual 70cm energy. Similarly a 2m pass circuit is used between the 70cm port and ground comprising of C4 and L4.

Alignment by the user may consist of:

1) Connect 2m transceiver and 70cm transceiver to their relevant ports. Do *not* transmit yet. Tune to a moderately strong 2m signal and tune C2 for maximum received signal strength as indicated on the 2m rig S-meter. Then transfer to the 70cm rig and do likewise, this time tuning C3.

2) Then connect the 2m transceiver to the 70cm port, and

the 70 cm transceiver to the 2 m port. Once again, do *not* transmit, (you could disconnect your microphone as an added precaution). Tune to a very strong signal on the 2 m rig, and adjust C4 for minimum 'S' meter reading. Then tune to a very strong signal on 70 cm and adjust C1 for minimum 'S' meter reading.

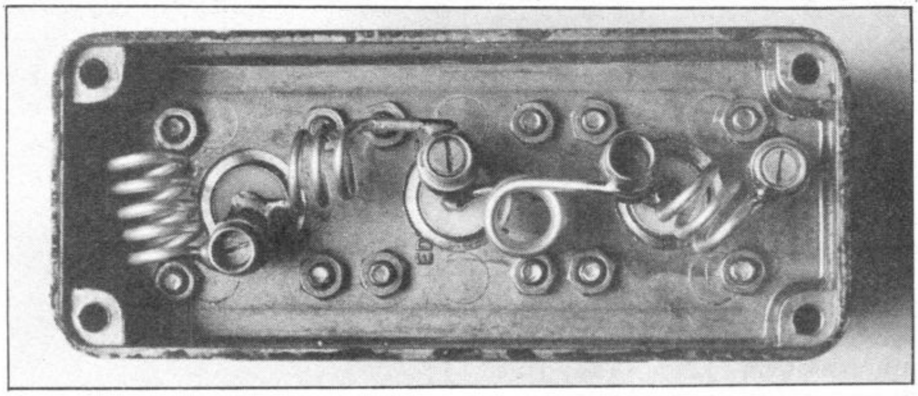
3) Now connect as in 1). It is now safe to reconnect your microphones! Final trimming is performed by inserting a power meter in the aerial line, ie between the diplexer and aerial, and fine tuning C2 for maximum power with the 2 m transmitter operated, and similarly tuning C3 for maximum power with the 70 cm transmitter operated. This final operation should ensure the ultimate in performance.

At each stage, a check should be made to ensure that fitting of the diplexer box lid does not excessively affect the adjustment made, with a slight retune being undertaken if this occurs.

The power rating of the diplexer is entirely dependent upon the individual types of components used by the constructor and the quality of soldering. As a guide, the author's units easily stand in excess of 100 watts into each port simultaneously.

Dual Band Vs Single Band

The dual band whip used, a Welz EL-770 was eventually found to outperform the 2 m ⅞ whip, due to the bending effects of the longer whip at normal driving speeds (ie movement of the vertical plane and thus also coming into closer proximity with the car metalwork). On 70 cm, in flat Fenland very slight degradation was noted with the EL-770 as against my 3 x ⅝ wave whip, yet, in built-up areas, better performance was noted, due I believe, to the radiation pattern of the dual band antenna. This finally prompted the author to retain the dual-band whip for permanent use — and to swiftly sell his other aerials!



Construction of G4HCL diplexer

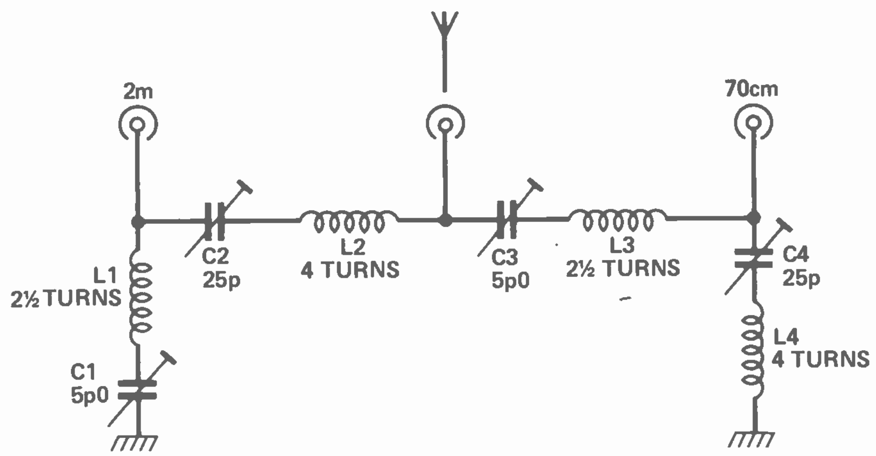


Fig.2 Circuit of G4 HCL diplexer

Accurate measurements are presently being carried out by the author to test the gains and polar radiation patterns of several commercially available 2 m and 70 cm mobile whips, using a variety of ground planes, and it is hoped that the results of these tests will be featured in a future article in HRT.

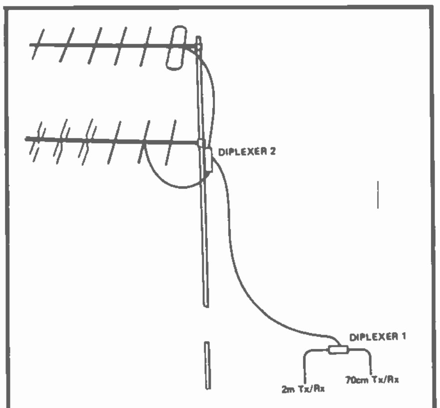


Fig.4 Using two diplexers to enable a single feeder to feed 2 m and 70 cm antennas

Several diplexers have been constructed to the design described and all perform well. Their use is certainly not limited to mobile installations: a further typical use could be in a base station installation to replace two perhaps comparatively 'lossy' feeder runs on 70 cm and 2 m with *one* good quality feeder such as Heliax, with a diplexer at either end (**Fig.4**). Also if you use a scanner type receiver to monitor these bands, separate high gain 2 m and 70 cm aerials fed from the diplexer may be used in place of the usual wide band and low gain aerial.

My thanks go to Lowe Electronics, Chesterton High St, Cambridge, and Collins Communications, Milton Rd, Cambridge, for the loan of the diplexers evaluated in this article.

FAULT FINDING TECHNIQUES for Radio Amateurs

In the final part of the series, James Finnegan, GI4FFL, demonstrates a few of the problems that can arise when fault finding in a methodical fashion and gives some advice on testing individual components.

Coming now to the **method** used in finding the faults on the equipment mentioned previously. There were first of all a number of practical points to be taken care of. Some of these included finding that, although you knew what you wanted to do, you found yourself apparently confounded by the physical layout of the equipment, access to the test points you needed to reach being seemingly impossible, or that extended boards or jumper leads were at least required. Some ways round these kind of problems are mentioned in more detail in the final sections of the article.

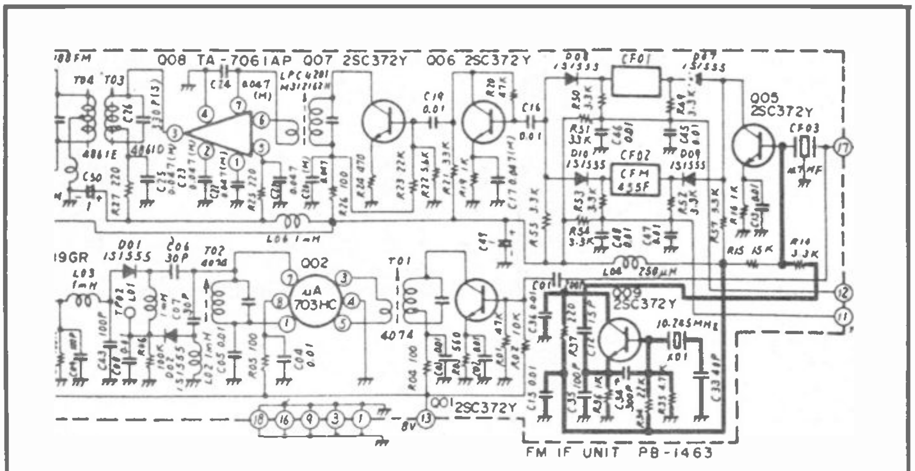
FT225RD

In this set, we have to determine why there is apparently a loss of signal between the O/P of the xtal filter XF102 at 10.7MHz and the I/P to the FM IF amp (Q306) at 455kHz. Knowing that the noise blanker is working (at least as well as can be expected!) saves us a little time, since we can take it that a signal path must be present to the ceramic filter CF301 and the NB IF amp (Q301) on the FM IF unit. This leaves two filters, one mixer (Q305) and the 10.245MHz xtal oscillator providing injection to it. What can we measure here? Using the internal marker as a test signal, we could try to measure with an RF diode probe the level of the signal produced at the I/Ps of CF301 and CF302. We could also check with it that the O/P of Q309 is present at its emitter, and also at the junction of C312 and R314. On making these checks, we find that there is no signal injection present to the mixer and that the oscillator stage Q309 is not working. Why is this?

The first thing to do is confirm that the 8 volt supply is present to the oscillator — *it's unlikely that it isn't, but measure it to be sure!* Finding that the supply is present, what next can be done to provide further information? We must check the voltages at the base, emitter and collector of the transistor or take it out of circuit and do the 'two diode junctions and wet finger test' on it with the test meter (see next stage). Nothing seems to be wrong here so, what next?

This is when the *experience* of a person doing the fault finding can prove crucial. From experience I have found that crystals can sometimes apparently die under normal temperature conditions but will work for a short time if sprayed with a little 'aerosol freezer'. Crystal XF301 was 'frozen' in circuit, the oscillator started working again and the set performed normally. Is this cause or effect, though? In practical terms, this can be difficult to determine; could something have altered in the oscillator circuit to prevent 'normal' oscillation? In this case, however, as seemed likely, a replacement crystal cured the problem and the rig has continued to work normally ever since.

Sometimes similar problems can be caused by other component failures, especially in older or valve sets where often resistors of 100K or more can become *very* high in resistance, sometimes virtually open circuit and capacitors can change value considerably outside their tolerance limits or even become 'leaky', particularly electrolytics. Despite the foregoing, I have seen some crystal oscillators stages continue to run correctly when virtually *all* the components were far from their nominal values!



FM IF UNIT

Circuit of FT225RD FM IF unit with suspect areas highlighted in black.

FT107M

In this set, we know that the 13.5V on Tx line in the AF unit has about 4 volts incorrectly sitting on it at all times, leading to RL5001 holding on after being correctly energised when the PTT is operated. Finding *where* this 'spurious' supply is coming from is the problem!

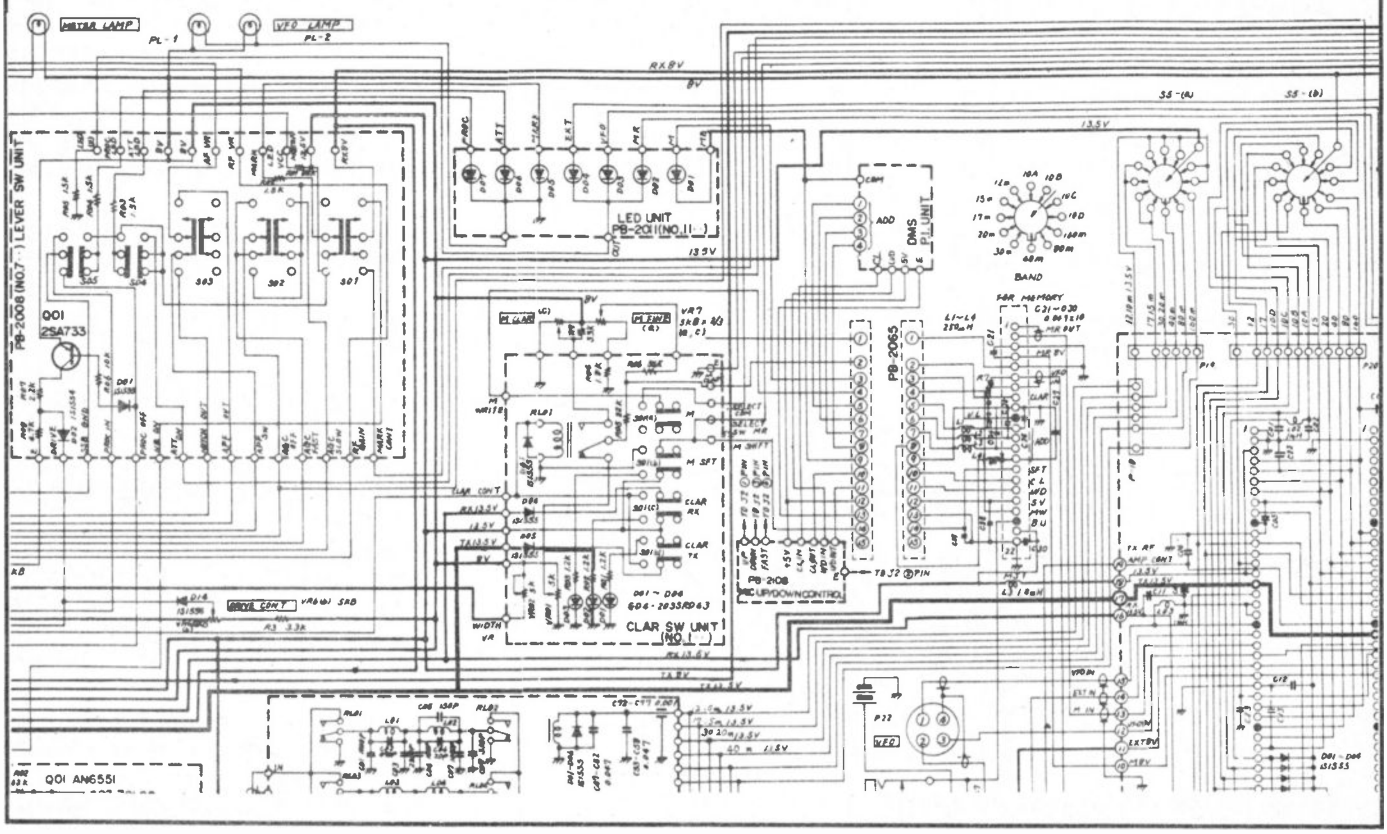
Looking at the interboard wiring diagram, we have to decide on a method to use for tracking this down. *Faced with this formidable looking circuit it's important not to panic and give up*, particularly since we are so close to the fault that a little time and patience will find it. *So what method shall we use?* Once more, we shall be logical in our attack and confirm that the fault is indeed external to the AF unit by isolating pin 23 (see diagram) at least before going on a chase through the rest of the set. Result — the spurious voltage is coming from somewhere external to this board — *but where?*

Our next step could be to remove all the other boards one-by-one to see if the voltage disappeared — I haven't tried it so I can't recommend it, but it doesn't strike me as a good procedure, especially since the fault may not even be on any of these boards! Once more, we must keep our heads and be calmly logical. Knowing that the unwanted voltage is *external* to the AF board means that we have to trace and isolate *all* external connections to the Tx 13.5 volt line! However, by using our heads, *this is where we can make one step which can save us a lot of time.* As opposed to systematically working our way through the Tx 13.5V line from the AF unit to the other boards and junctions, we could isolate the Tx 13.5V line from the complete IF mother board at P15 and see what happens. By doing this, we find that the spurious voltage, as measured at the AF board, disappears, telling us that it was coming in on the Tx 13.5 volt line *completely external to the mother board*. Although this theoretically still leaves us with the rest of the set to worry about (!) this is not quite as bad as it seems, since we can do the same type of thing again *only this time with the RF mother board*, to further isolate stages and provide us with even more information. Reconnecting again the Tx 13.5V line at P15 IF mother board and then disconnecting it at pin 17 on the RF mother board, we find that the unwanted voltage on the A/F board disappears — thank goodness for that, we are lucky, since now we don't have to dig our way around the wiring harness!

The fault would seem to lie somewhere in the circuitry on the RF mother board and a few more logical steps should pin it down. Isolating the Tx 13.5V line from pin 16 on the local unit, we find that the spurious voltage is still present at the A/F unit, but disconnecting from pin 21 on the RF unit and it disappears — the Tx 13.5V line is being supplied with this unwanted voltage *from within the RF unit*.

Let's look at this in more detail using the individual circuit diagram. As can be seen, the Tx 13.5V line enters the board at the junction of R93 and R94/L24, and further circuit isolation at this point should lead us towards the source of the unwanted voltage. On lifting the supply side of R93, we find it disappears, so we pursue the fault along this line. Measuring at the junction of R93 and L23, we find that the voltage is still present, likewise at the junction of C124 and DO4. We are getting very close to the fault now. Either the diode or the capacitor may be short circuit, but in fact they are not. With both disconnected, after testing them, the unwanted voltage is still present at R93/LO2. Measuring at DO2 anode, we find the voltage present there which we can see is

Partial circuit diagram of FT107M with suspect areas highlighted in black. The faulty D02 is shown at lower centre.



totally wrong! *Checking DO2, we find that it has gone short circuit!*

What was happening was that DO2 was completing a path of conduction along the route indicated on the circuit diagram nearby, placing an unwanted voltage on the Tx 13.5V line, thus causing all our problems! Replacing the diode soon had the rig working normally again.

Obviously, writing about something with the benefit of hindsight is always somewhat easier, and, in the examples given, some of the practicalities and pitfalls were not mentioned, but these and other general fault finding 'hints and tips' are covered in the following section:-

Practicalities, Hints And Tips

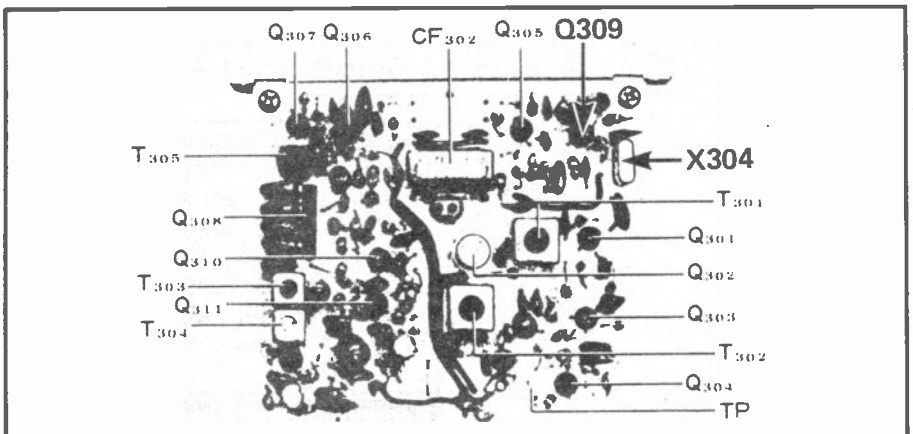
If you have decided to work on your rig, good preparation is most important. If possible, try to work somewhere where you can leave the set undisturbed and come back to it again if things seem to be getting too much! Having lots of space available is helpful, as is adequate lighting since small densely packed PCBs can be hard to examine (a magnifying glass always handy for this).

An angle-poise lamp, or even an ordinary torch, shone through a removed PCB is invaluable in locating and tracing PCB 'tracks', especially on double sided types, as increasingly used in some equipment.

Before starting to remove the covers and gain access to the circuitry, it is a very good idea to have small containers available to hold the various assorted nuts, bolts and screws which will soon start appearing in large and confusing numbers. Carefully labelling these will be of great help to you in putting the set back together again after repair and prevent you spending long periods of time on the floor looking for them — and maybe having some "left over"! Be warned, *some rigs can do very funny things if they are not cased up as they should be*.

At this stage make sure that your tools are adequate for the job, especially since you will find that the 'star head' screws encountered on most Japanese rigs will deform very easily if mistreated using a badly fitting screw driver (an unsuitable screwdriver could slip and put an unwanted scrape up the side of the paintwork) so do be careful. With the covers off the rig, pause and take a good look around to familiarise yourself with it and compare it to the photographs in the manual. This will also give you time to recover from the shock and maybe let you see something obvious, like loose plugs or sockets, for example. By this stage you should have a fair idea about what your *intentions* are and how you are going to go about it, but will most likely come up against some problem or other in trying to achieve them.

Most rigs will have a number of PCBs both top and bottom of the main chassis. Depending on the make of the rig, these will either be arranged vertically within screening (usually plugging into sockets, or onto a mother board, below) or horizontally, often with another board plugging in flush to it from above, or a combination of both. *This can make access to some parts of the circuit very difficult*. To overcome this, the manufacturers use special extender boards and looms to elevate or remove the appropriate board from the set for repair or testing (these may be available to suit your rig and this is worth checking up on). Sometimes a home made substitute will enable you to do the same. For example, 0.15 inch pitch veroboard will fit some edge connectors and sockets. Carefully using this, with an identical socket to that of the PCB mounting soldered to the veroboard, will allow you to raise some boards to a clear position, thus providing you with access sufficient to make the necessary measurements. If this is not possible, another dodge is to remove the board, determine a test point and solder a small piece of insulated wire to it on which you can attach your test probe when the board is back in circuit. This can be a time consuming process but is necessary under some circumstances.



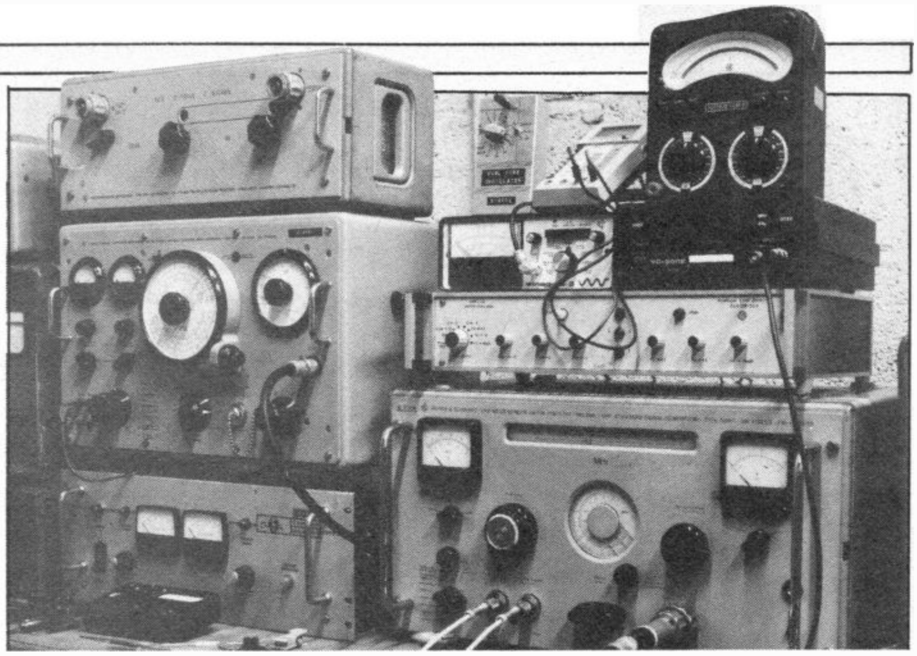
Most modern manuals give layout diagrams of individual circuit boards to aid component location. Shown above is the FT225RD FM IF PCB with the suspect components highlighted.

One point worth looking out for involves the removal of plug-in boards from their sockets. These can often be a tight fit, so take care that you don't snap the corners off them when trying to lever them out or that you don't damage the board by gripping them with a pair of pliers and squeezing too hard! Beware of some of the smaller plug and sockets which can have locking devices on them (So that you don't pull them to bits before finding this out!) Also, remove in-line phono plugs and sockets by gripping the connectors and *not* the wire to them, since some day the wire will break inside the device unknown to you and cause additional faults to the ones you are trying to clear.

Lastly, you will sometimes find that pin numbers on the circuit do not correspond to the numbering sequence on the edge connector or socket — this can be most confusing and misleading so don't presume that the two correspond — check it!

Having provided access to the appropriate circuit board so that tests can be made, it's important to have probes suitable for doing so. Very often these are not the ones supplied with the multimeter which can resemble knitting needles at the end of plastic holders and are often a liability, since the chance of accidentally shorting out something with them is very high. It's best to use smaller, better designed self-gripping types for example as advertised by Cirkit and many other component companies. Also, always check which range the meter is switched to before taking measurements — some meters don't take too kindly to being connected to a 1200 volt supply when left on the OHMS range! (*The equipment you are fault finding on won't like this either — Ed.*)

Unfortunately, space does not permit a comprehensive description covering measurement and component testing, but the following is a very rough guide on using a multimeter on a resistance range covering up to 100K ohms to check components.



Whilst the purpose of James' article has been to show readers that even complex faults may be traced with simple test equipment and a logical approach to the problem, more sophisticated test gear is admittedly useful! The above picture shows some of the test gear at GI4FFL's QSK Electronics.

Diodes

Check forward and reverse bias. With most silicon types, this should be about 1000 ohms forward bias and at least 100 times higher the other way round — germanium types show lower forward reading and usually increased leakage reversed.

Transistors

Check for two diode junctions — base/emitter and base/collector. Also check that collector to emitter reading drops when base current is supplied by a damp finger placed across collector and base, forward biasing the device.

Junction Gate Fets

Check for a few hundred ohms resistance between drain/source and that the reading varies considerably, going high and then low again with a *dry* finger placed briefly on the gate (only). Also, check for diode junctions between gate/source and gate/drain.

Insulated Gate Fets

Check drain/source as before. Check insulation separately between each gate and source/drain, also between each gate. Checking gate insulation with the meter on higher resistance range may show the presence of gate protection (zener diodes are employed for this purpose between gate and source and the meter may indicate an apparent leakage as the result of this protection. These often break down at 10V, so don't use an 'AVO' on the highest resistance range — which gives 15V!) Check leakage of large electrolytic types. Larger capacitor values charge and discharge as indicated by rising and falling reading of meter — eventually indicating open circuit. Check smaller values show O/C — if doubtful, check by substitution.

Resistors

Should indicate within tolerance limits (*If your multimeter is calibrated accurately! — Ed.*) Older higher value types often become very high in value or go open circuit. Some very low value resistors, as often found in power supply stages, also have a tendency to go open circuit.

If you are fortunate, a component failure will show itself up by providing an indisputable reading on the ohms range of your testmeter (ie short circuit!), but sometimes the only way to prove one faulty is by substituting with a device known to be good. With most modern amateur rigs (and some not so new) spare parts can often be obtained quickly within the UK from the appropriate agents, or obtained from abroad by them as required. In the meantime, an amateur might try substituting the faulty semiconductor with another similar component or equivalent. Much data on equivalents is available from books such as:-

Towers, International Semiconductor Selector; Balls, Semiconductor Data Book; Solid State Design (ARRL); the Maplin and Cirkit Catalogues and, of course, from the semiconductor manufacturers' catalogues and data books. On the subject of equivalents, it should be noted that in some parts of RF circuitry, particularly 'front ends' and mixers, the devices used are carefully chosen and a careless substitution could cause performance problems *which may not be immediately apparent*. Also, with any component found faulty, it is most important to consider *what might have caused this to fail* — this is especially so around receiver 'front ends' and mixers and also transistor RF PA stages.

It is hoped that readers who have persevered in reading this series will have acquired a better insight into the techniques involved in the repair of their equipment. That, by following the procedures I've described on the printed page, they will have seen that their equipment is not a "magic black box" to be merely feared when something goes wrong.

There was an error in the first part of Fault Finding for Radio Amateurs' (November '84 HRT) on P.23 14 lines below the heading 'Any Fireworks'. This should read "Most other types of fault are *unlikely* to get worse or cause damage with continued use during fault finding. . ."

Readers are reminded that any attempts to self-repair equipment whilst under guarantee will invalidate the latter.

Practicalities

Make your own open wire feeder, cable tips and a quick test for FETs from Ian Poole, G3YWX.

One aspect of amateur radio that never ceases to amaze me is the number of ways people have of solving problems, some of which are more scientific than others. Some years ago, I can remember working with another electronic engineer designing some video signal processing equipment. As you may imagine this had a wide band width which made it very prone to oscillation, which of course very often happened. I can remember this other engineer investigating one 'spurious' and tracking it down in his own effective way or by poking his finger onto various parts of the circuit to see which stage was oscillating. I must add that the highest voltage around was about 10V. When he touched the offending stage, the oscillation would either drastically change or disappear. Then having quickly discovered the stage he would proceed to decouple the supply or other suitable points of the circuit. Hopefully, some of the ideas this month will you save you time, just as this idea saved me a lot of time.

Shack Cable Entry Tip

One difficulty, which is encountered in many amateur 'shacks', is that of devising a suitable method of entry for the feeder through the wall. If care is not taken this can be a source of draughts, or window frames have to be drilled through etc. One rather neat method which I came across, was to use a section of 1¼ inch waste pipe to act as plastic conduit through the wall. The outside end should be terminated with a 90 degree bend pointing down as shown in Fig. 1 to prevent water entering. This will stop chaffing of the cable as it passes through the wall, and also enables new cables to be installed with a minimum of work. In addition to this, if the pipe is a source of draughts, it can easily be plugged with cotton wool or something similar.

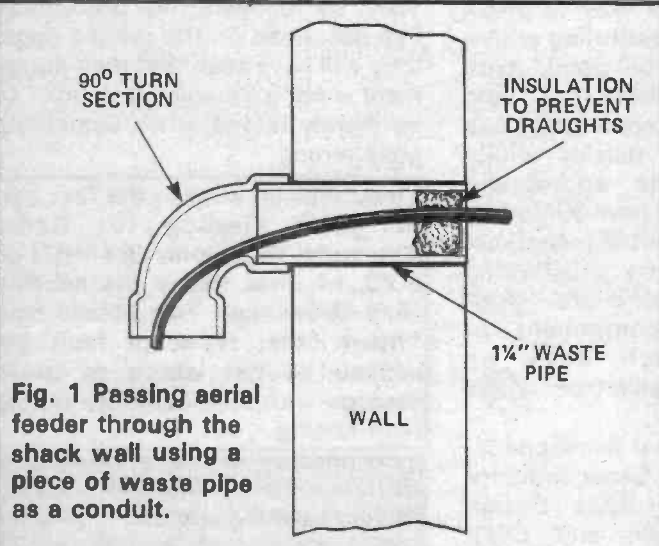


Fig. 1 Passing aerial feeder through the shack wall using a piece of waste pipe as a conduit.

Open Wire Feeders

One fact which tends to be overlooked these days is how useful open wire feeders can be. Coax seems to have gained the dominant position on the amateur feeder market and for several good reasons.

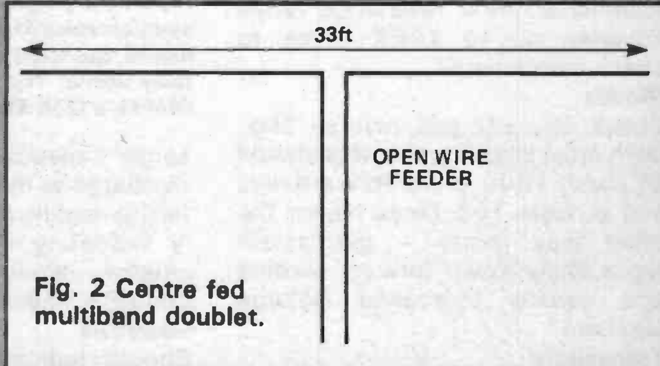


Fig. 2 Centre fed multiband doublet.

However, open wire feeders still have many advantages over coax, for a surprisingly large number of aerial systems and it should not be ignored. For example, it can operate with a high VSWR which will enable the aerial to be used over a large bandwidth, or on several different bands provided that a suitable ATU is available. The ATU should either have a balanced output, or if this is not the case a balun may be used. Using this type of system the aerial shown in **Fig. 2** can be constructed and this has been used very successfully on 20, 15 and 10 metres, providing a very neat solution to a multiband aerial problem.

In addition to this, open wire feeders exhibit a much lower loss than normal coax, provided that nearby objects are kept to a minimum and the feeder remains balanced. In fact for feeder runs where coax would give losses of a few dBs at HF, a similar run using open wire feeder would produce a loss of a few tenths of a dB. It is most interesting to note that most commercial HF transmitting and receiving stations use open wire feeders as they must obviously find them superior to coax.

If open wire feeder is to be used, it should be made and the 300 ohm ribbon cable which is available in the shops, should be avoided. The reason for this is that the plastic insulation used to cover the wires and maintain their spacing absorbs water, introducing a loss into the system.

The feeder is surprisingly easy to make. It is also very tolerant with the materials used and the way in which it is constructed. Almost any wire can be

used, provided that its resistance over the total run is low. The spacers can be constructed out of any suitable insulating material to hand. One way of constructing spacers is to drill two holes, large enough for the feeder wires to pass through at the correct spacing and then anchor them by winding some thin wire tightly round the spacer and feeder wire, as shown in **Fig. 3**. Slippage of the spacer can be reduced still further by adding a small amount of a suitable glue as shown. Even the spacing of the wires is not critical and can be around 4 inches. With this

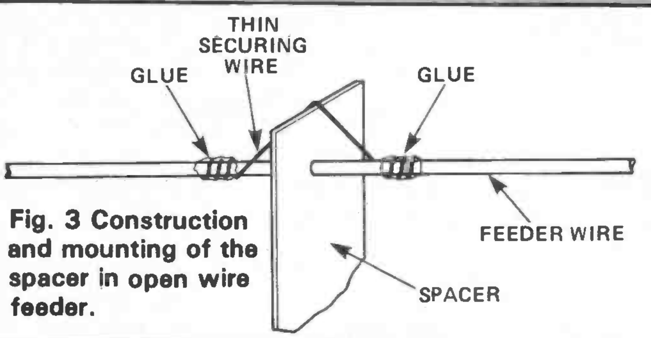


Fig. 3 Construction and mounting of the spacer in open wire feeder.

spacing the spacers should be about two or three feet apart, or more frequent if the symmetry is likely to be disturbed. However, if spacers are placed too frequently this will increase the losses slightly, especially during wet weather.

A Quick Test For FETs

Some months back I outlined a quick and easy method of testing bipolar transistors, which I had found particularly useful over the past years. There is also an equivalent method for testing junction FETs like the popular 2N3819. Unfortunately MOSFETs, IGFETs etc cannot be tested using this method, as their gates are physically insulated from the channel by an oxide layer, even though it is very thin.

The test hinges round the equivalent circuit representation of the FET shown in **Fig. 4**. The

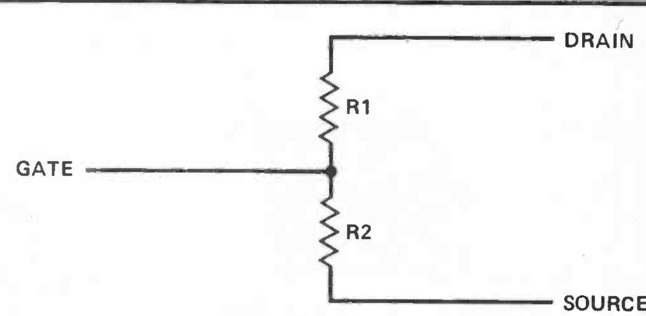


Fig. 4 Diagrammatic representation of a JFET.

resistance R1 + R2 represents the channel resistance, and the diode D1 represents the gate-channel junction. The first step is to ensure that the channel is intact by using a test meter to measure the resistance of the channel. The reading obtained should be the same in both directions and is normally about 200 ohms. Incidentally, this can be used to identify the drain source terminals. The next step is to find out whether the junction between the gate and channel is still functional, by measuring the resistance between the gate and either the drain or the source. If the FET is intact then the junction should conduct in only one direction.

Incidentally, this test can be used to identify whether the device is either n-channel or p-channel. If the FET is an n-channel variety then when the positive probe from the test meter is connected to gate, the gate-channel diode will conduct and show a low resistance. Conversely, for a p-channel FET, a low resistance will be indicated when the negative test meter terminal is connected to the gate.

Whilst this test is by no means a complete test of an FET it does give a very useful guide as to whether it has blown or not.

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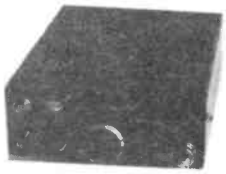

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MOBILE 'WHIPS'

With the compact solid state HF transceivers available these days, all working from 12V supplies, operating HF 'mobile' is almost as easy as VHF. Although commercial antennas are readily available, great satisfaction and excellent results — plus a good saving of money — can be obtained from 'rolling your own'. Veteran mobileer Mike Grierson, G3TSO, tells how.

Since the late 1950s when I first discovered Amateur Radio, I have had a fascination for mobile and car based portable operation. The motor vehicle makes an ideal base with a readily available power supply (your 12V battery!) and a convenient mounting base for vertical antennas. While there are a number of commercial mobile antennas currently available for the HF and LF bands — costing from £20 for a single band model to over £100 for a multiband array — there are relatively few 'homebrew' antennas among the growing ranks of mobile operators. Twenty years ago, in the good old days of AM, the homebrew 160m mobile antenna was very commonplace.

Commercial antennas do not always produce the best results, or even use the best designs and are certainly no easier to use than a simple homemade mobile antenna. With fairly limited engineering resources, homemade antennas can be tailored to suit individual requirements using whatever materials come to hand. The antennas described were all made of readily available tube, rod and scrap tubular formers. Some lathe work was done in the course of construction but the resourceful could get by without this.

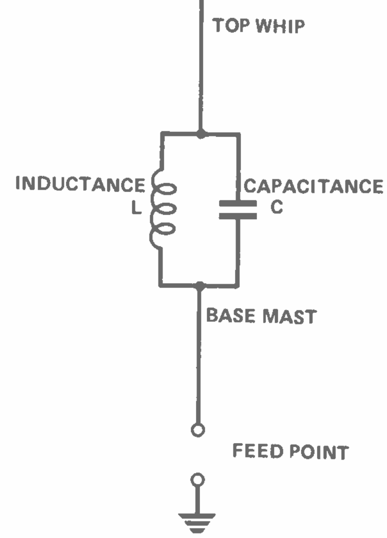
Over the last two years, the author has experimented with a number of mobile antenna designs and has produced a set of antenna parts enabling coverage of all 6 traditional amateur bands. The antennas have been compared with two commercial designs, the G-Whip and the Hustler. Total cost of construction of the six band set-up was less than the cost of a single band commercial antenna.

Both the RSGB and ARRL Handbooks have sections on mobile antennas but these sections have been reproduced without change in the handbooks for the last 30 years and are not a great deal of use to the would-be constructor who is in need of more practical data. The purpose of this article is to produce sufficient data to enable the home constructor to design and build his own mobile aerial system.

Mobile Antenna Theory

Before contemplating the construction of a mobile antenna it is necessary to have some idea of how this works. The mobile vertical antenna is essentially a shortened quarter wave vertical that has 'evolved' to suit the problems of mobile operating — this is short enough so that it will not hit trees, bridges, overhead cables and is mechanically stable enough to stay attached the the vehicle and not endanger other road users. Whilst a quarter wave long antenna is a possibility on 10m, it most certainly isn't on any of the lower frequencies (!) and some means of reducing its length must be found. In

Fig. 1 The loaded vertical antenna.



order to reduce the mechanical length of the antenna, we must introduce a form of electrical compensation or 'loading', as it is commonly called. The loading can be represented by a parallel tuned circuit inserted along the length of the antenna, as shown in **Fig. 1**, and comprises an inductive loading coil actually inserted in the antenna length. The capacitive element C is not as obvious and comprises of self capacitance in the coil and stray capacitance of earth (ie the car) of the various parts of the antenna system. The value of the loading inductance will vary depending upon the design of the antenna and relative position of the loading inductance in the antenna system.

Any transmitting antenna has a voltage node at the open end and of course zero current flow. In a true quarter wave system, the voltage and current will distribute themselves along the length of the antenna such that maximum current will occur at the feed point, which will also be the point of minimum voltage. In the shortened quarter wave antenna the purpose of the loading element is to maintain this distribution of voltage and current in the antenna. However, the distribution will vary considerably with the position of the loading element.

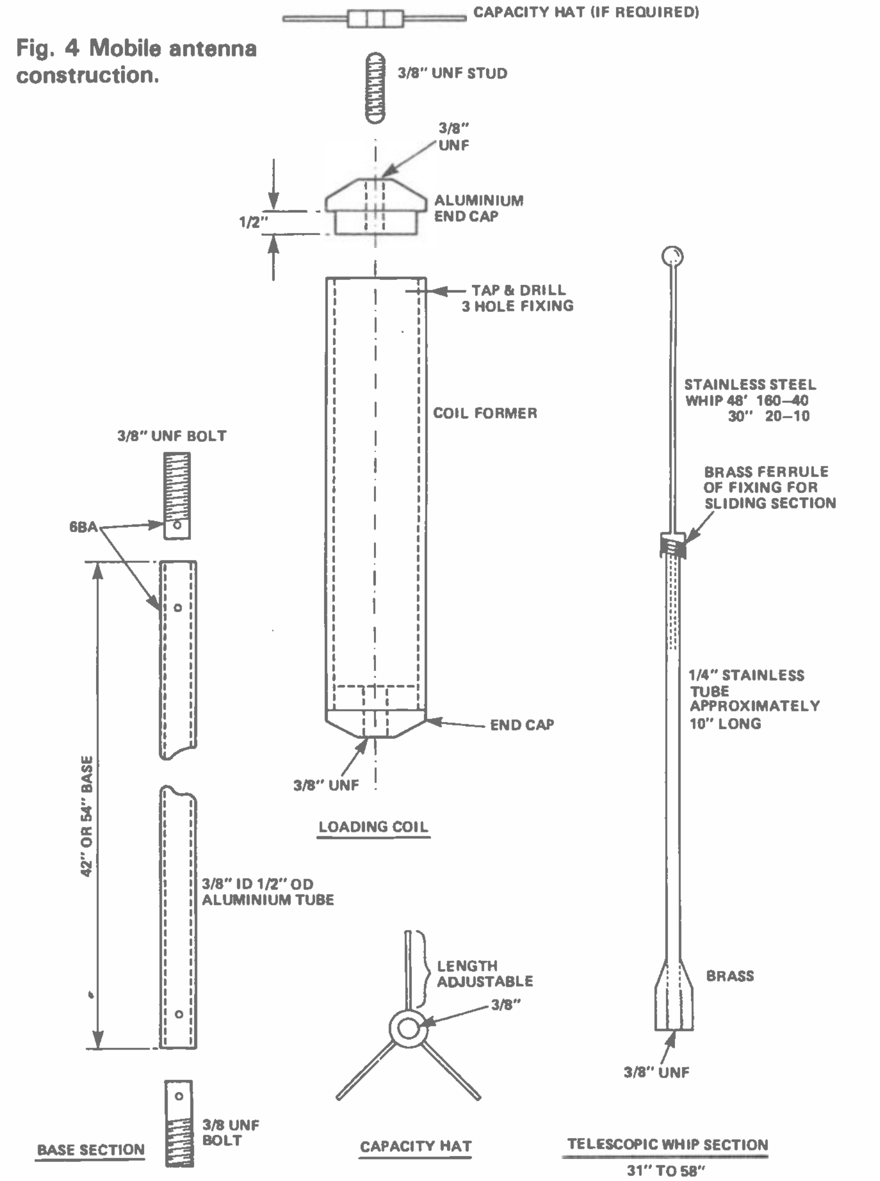
It is generally accepted that maximum radiation occurs from the part of the antenna which carries maximum current, whilst minimum radiation comes from the high voltage parts of the antenna. The position of the loading coil can, therefore, be an important factor in determining the overall efficiency of the antenna.

The current distribution in three, theoretical, loaded antennas is shown in **Fig.2**. The base loaded antenna in **Fig.2a** has the loading coil inserted at the very base of the antenna, an attractive mechanical consideration, but current distribution is confined to the coil with very little current in the antenna itself. Capacitance is high and consequently a relatively low value of inductance is required; the feed impedance is low, bandwidth is relatively high *but radiation resistance and efficiency are very low indeed.*

By raising the loading coil to the top of the antenna, **Fig.2b**, the antenna can be made to carry a maximum current and hence, improve the radiation resistance and efficiency. However, we seldom get something for nothing(!): with the coil high above ground, capacitance in the system is relatively low, which in turn means a bigger coil. Any small change in capacitance will have a significantly large effect on the resonant frequency and the bandwidth of the antenna will be very narrow. The mechanical problems inherrent in such a design are considerable.

An ideal compromise, therefore, is to centre load as in **Fig.2c**. The base of the antenna carries the maximum current, as does much of the coil, whilst the top antenna section provides sufficient capacitance to provide a reasonable bandwidth. This also allows a smaller coil to be used than would be required for top loading, but still larger than that required for base loading.

Fig. 4 Mobile antenna construction.



Any antenna where the loading element is the centre 50% of the antenna can be regarded as centre loaded. The value of inductance required to resonate a centre loaded antenna is approximately twice that required to base load the same total antenna length.

It is convenient to consider the centre loaded antenna as comprising of two parts, a base or mast section, up to but not including the loading coil, and the resonator comprising of the loading coil, top whip and capacity hat, if used. A resonator will operate on approximately the same frequency for a variety of different base mast lengths and can enable base extensions to be added for static operation. This is only recommended below 7MHz as the higher frequencies will require excessive adjustment to resonate. Often, adding a base extension on 20 or 15m will

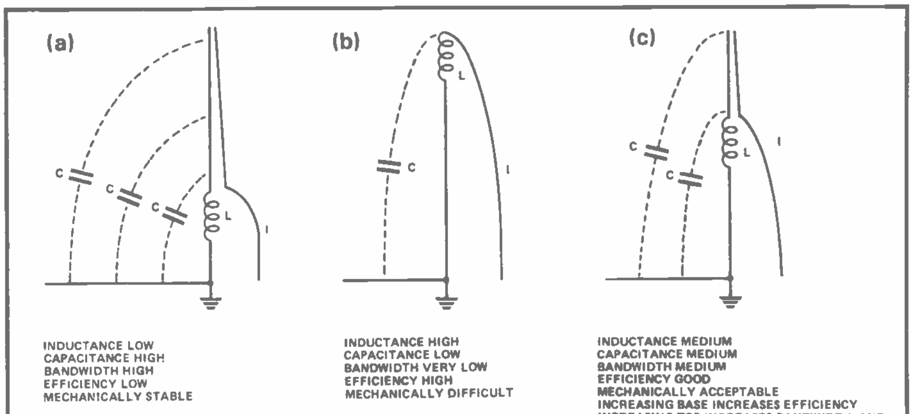


Fig. 2 Current distribution and capacitance in a loaded vertical (see text).

require increasing the top whip length, as the total value of capacitance in the system will have reduced. On 20 and 15m, a base extension will bring the physical length of the antenna much closer to a quarter wave and the coil inductance would need to be reduced for resonance, but the latter is not really a practical proposition when the antenna is in situ!

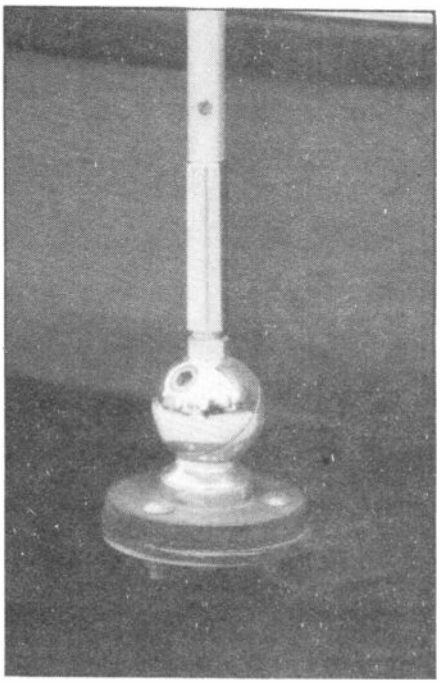
As with any quarter wave system, maximum current flow in the base of the antenna and an equal current must be able to flow in the earth or counterpoise (the car). Earthing the antenna base to the car is, therefore, of paramount importance — poor or long earths can result in inefficiency, difficulty in matching, RF associated interference at the transmitter and with car electrics and electronics, as well as changing the resonant frequency of the antenna.

Designing The Antenna

The first consideration is whether mobile or portable operation is envisaged as this will determine the overall size, strength, weight and method of construction. All future considerations in this article are based on the ability to operate whilst actually mobile on any of the bands 160, 80, 40, 20, 15 and 10 metres. Coils would therefore have to be interchangeable. The maximum strength should not exceed 8′ 6″ and the whole structure must be strong and light, as well as mechanically stable at speeds of at least 70 mph. For portable operation only, construction techniques become less critical and dimensions can of course be increased significantly.

The antenna mounting position on a vehicle may be an important factor in deciding the overall length. There are essentially three main options, the front wing, the roof or gutter and the rear bumper or boot of the vehicle. The author favours the rear for the following reasons: a more substantial mounting point cannot be found; it is normally furthest from the engine; it does not distract the driver and good earthing to the vehicle chassis is normally possible. Despite the assurances of others that the roof offers better radiation characteristics, my own experiments leave me totally unconvinced on the low frequency bands and I have worked sufficient DX on the HF bands with rear mounted antennas not to be bothered about trying elsewhere.

In order to standardise on the fitting together of components, I decided to use a standard thread of ⅜″ UNF with 24 turns per inch. This is the same thread used on the 'Hustler' commercial antenna and numerous CB antennas and base mountings. Unfortunately, the 'G-Whip' uses a coarser ⅜″ British Standard thread, but was fitted with an adapter during trials. The author uses a commercial Ball type



base unit, which has the ability to be swivelled to match a range of surface angles, as well as being readily available and reasonably strong. The antenna is fitted by means of a quick release bayonet fixing, all of which use the ⅜″ UNF thread for fixing.

The base mast should be of sufficient length to raise the loading coil well clear of the vehicle roof and reasonably strong and light. Two lengths have been used in experiments, 54″ and 42″ and comprise of ⅜″ inner diameter aluminium tube with a ⅜″ UNF bolt inserted into each end, after the head has been removed with a hacksaw. The bolts are held in position by drilling through and the tube and bolt in situ inserting a 6BA nut and bolt. The shorter length base section proved to be much more stable under mobile conditions with no noticeable loss in performance over the larger one.

The top section of the antenna can comprise of an old telescopic car radio aerial, a stainless steel VHF whip or a variety of other pieces of tubing. Ideally, the length should be adjustable, 10 to 15 inches of adjustment will normally allow full coverage of 160 and 80 metres whilst only 2 or 3 inches will be needed on the higher frequencies.

If the top section is a fixed length, adjustment can be introduced by means of a 'capacity hat'. This can simply consist of a number of short horizontal wires or spokes radiating horizontally from above the loading coil. Their purpose is to increase the capacity of the *top* section of the aerial (hence 'hat') and so lower the frequency of the antenna. Adjusting the length of these spokes so as to set the resonant frequency in the centre of the band can easily give full band coverage on 40, 20 and 15m as the hat tends to broaden the bandwidth of the antenna considerably.

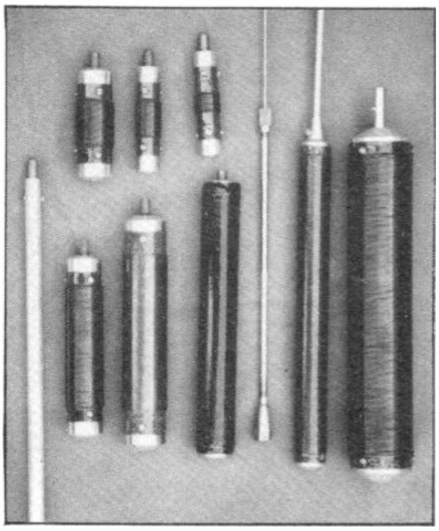
The top section used for the experiments consisted of a length of ⅛″ OD stainless tube (hydraulic pipe) fixed into a ⅜″ UNF nut with a brass ferrule attached to the upper end, to clutch a standard 2 metre stainless steel whip. The adjustable length was originally 22 inches but was reduced to 10 inches to reduce the weight. (Access to a lathe can greatly assist the production of these fitments).

An ideal top whip length of 48 inches on the three LF bands works well and can be reduced on the HF bands to around 30 inches, producing an antenna that never exceeds 8 feet 6 inches in height.

The Loading Coil

When contemplating multiband antennas, the loading problem is a minimum at 28MHz (where no loading oil need be used) while it is at its most critical on 160 metres, where efficiency is of prime importance.

The early articles on mobile antennas extole the virtues of the high 'Q' large diameter coils often seen on homebrew whips 20 years ago. The RSGB Handbook does show some reservations about the



merits of such coils and suggests that long thin coils work curiously well. After experimenting on 160m with 1 inch diameter coils and 2 inch diameter coils my final conclusion was that the long thin coil definitely worked much better than the short fat coil! Work done by another local amateur confirmed these results and established an optimum coil length of around 16 inches. The author did not have a coil former longer than 10 inches so that had to do!

Coils can be wound on a variety of formers; fibreglass is ideal, as are some plastics; teleprinter paper roll formers are often suitable and the older brown composite materials such as 'bakelite' and resin bonded fabrics have been used successfully. Plastic drainpipe *may* be acceptable but tends to bend easily, whilst ceramic is too brittle and too heavy. All the author's formers were obtained as scrap or junk.

Mounting the coils can be achieved by fitting end plugs and drilling and tapping with a ⅜" UNF thread. This is where access to a lathe greatly simplifies the construction enabling the ends to be turned from aluminium rod. The ends can be fitted to the former with three screws at either end. The top of the coil can be fitted with a ⅜" UNF brass stud to accept the top whip section.

HF coils were wound with 18 SWG enamelled copper wire, though the gauge is not critical, the 80m coil with the 20 SWG and the 160m coil with 25 SWG — thinner wire than this should not be contemplated. Often the gauge of wire to be used will be dictated by the size of former available. The DC resistance of the coil should be kept as low as possible and will determine the thinnest wire gauge to be used. 160m is the most critical, a 500uH coil of 25 SWG wire on a 1 inch diameter former had a DC resistance of 3 ohms, a figure that proved acceptable. (Note the G-Whip 160m coil is 10 ohms DC).

Coil winding should *not* begin over the end plugs but level with them. All coils have been close wound directly onto the former and once resonated, sealed with several coats of good quality yacht varnish. Heat shrink sleeving should only be used if totally sealed with varnish — otherwise problems with moisture may result.

A useful formula for calculating coil inductance is as follows:

$$L(uH) = a^2n^2 (9a + 10b)$$

where: L = Inductance in microhenrys;
a = coil radius in inches;
b = coil winding length;
n = number of turns;

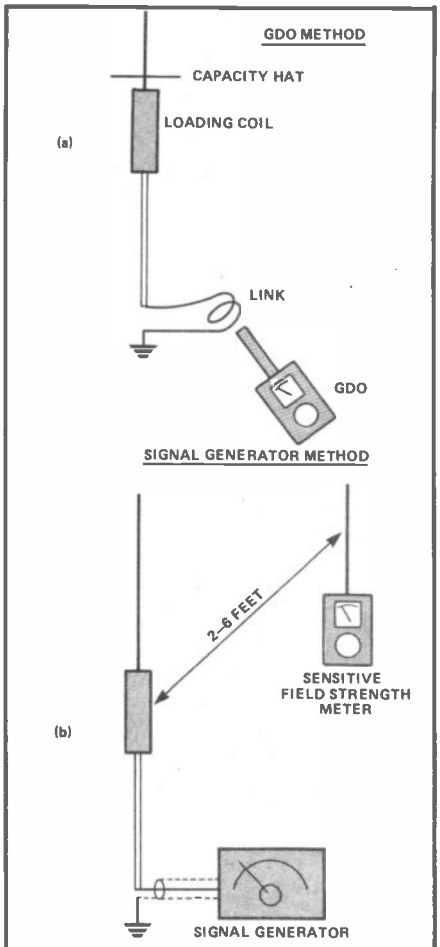


Fig. 5 Finding the resonant frequency.

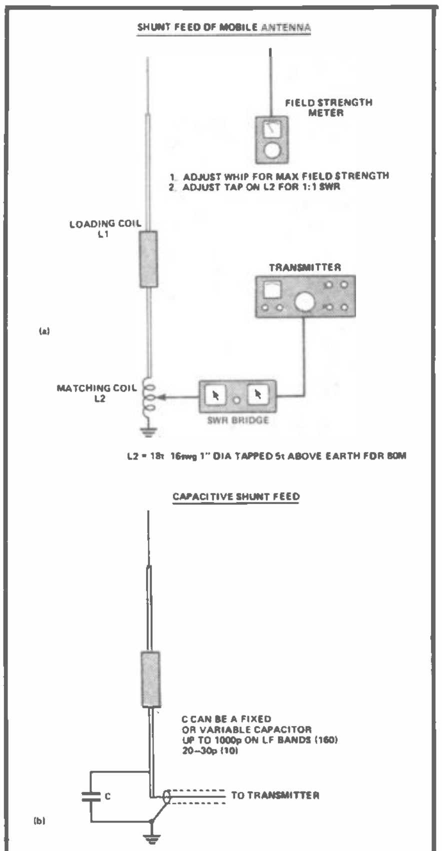


Fig. 6 (a) and (b) Feeding the antenna.

Simple rules to remember when winding coils are:
1. The larger the diameter the more inductance, therefore less length.
2. If there is sufficient inductance in the coil, rewind with thinner gauge wire.

Resonating A Mobile Antenna

To the uninitiated, resonating a mobile whip may seem a little complex. It is often not realised just how sharp the tuning can be, in particular on 160 and 80 metres where typical bandwidths can be as low as 5kHz. Essential equipment comprises a grid dip oscillator (GDO) a sensitive field strength meter and an SWR bridge — though the latter can be a positive hinderance at times!

The antenna under test should be mounted on the vehicle in the intended operating position and a two turn link fitted between the feed point and earth. The GDO should be placed very close to the link and the unit adjusted to establish a dip. Do not couple the GDO too tightly or frequency 'pulling' will occur and more than one dip may be found. An ideal method

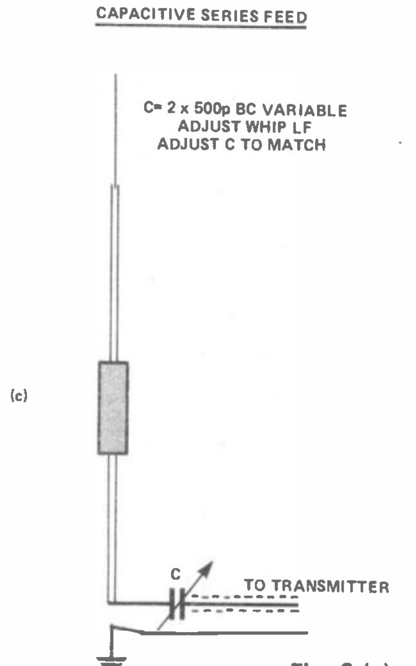


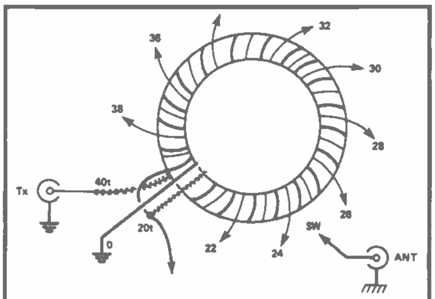
Fig. 6 (c).

of finding the exact frequency of the dip is either by listening on a receiver to the oscillator signal or with a digital frequency meter. Once the frequency of the antenna is found it can be adjusted by either changing the top whip length, adjusting the capacity hat or changing the number of turns of the coil until it is resonant inside the required amateur band.

An alternative method is to feed a signal generator into the antenna under test and, using a very sensitive field strength meter, observe a peak on the meter at the resonant frequency as the generator is swept through it (**Fig.5b**). If a noise bridge is available this can also be used to determine the resonant frequency. Once the antenna is resonant within an amateur band, further testing can be conducted with the transmitter and receiver. A noticeable noise peak should be detectable on the receiver, particularly on the low frequencies.

Using the transmitter as a low power signal generator (ie with the power reduced as much as possible), it should be possible to sweep slowly across the band to establish a peak in output on the field strength meter. This is where the SWR bridge comes in useful, with only enough power to give half scale forward deflection (1-2 watts) look for a dip in reflected power somewhere close to the frequency where maximum field strength occurs. As the antenna is unlikely to present a 50 ohm match, the lowest SWR reading should not be regarded as indicating resonance — the peak reading on a field strength is much more reliable. Further adjustments to antenna length can be made until the desired operating frequency is achieved. If the SWR is acceptable at resonant frequency the transmitter may be fed directly to the antenna, but if it is high some form of matching must be used. I shall discuss this problem in a minute.

When adjusting the antenna, increasing the length of the top whip will lower the resonant frequency, as will adding a capacity hat or increasing the size of the whip. Increasing the length of the base mast will not excessively alter the resonant frequency but may require a longer top section as well to keep resonance as the overall capacity in the antenna will have been reduced as it is moved further from the ground. It is not recommended to raise the base mast on frequencies above 7MHz as it will have a significant effect on the antenna resonant frequency as I remarked earlier. The diameter of the top whip will also affect the length required — the thinner it is the longer it will need to be. A small metalic ball of the top is a useful means of reducing the top length by an inch or two.



TAP	ANTENNA IMPEDANCE
40t	50 Ω
38t	45 Ω
36t	40 Ω
34t	36 Ω
32t	32 Ω
30t	28 Ω
28t	25 Ω
26t	21 Ω
24t	18 Ω
22t	15 Ω
20t	12.5 Ω

Fig. 7 (b) Winding the toroid.

Matching Your Antenna

Centre loaded whips can exhibit feed impedances in the order of 20 to 30 ohms and this will vary considerably from band to band. That being said, often they can be fed directly from a transmitter with a 50 ohm antenna impedance with an acceptable SWR. High SWRs in mobile installations are usually only a problem to the transmitter itself (ie the PA protection circuitry!) and a variety of methods of improving the match exist. Shunt feeding, illustrated in **Fig. 6a**, is often used commercially and is particularly suitable for base loaded single band antennas but is a little tricky for multiband operation. Capacitive shunting of the antenna base is

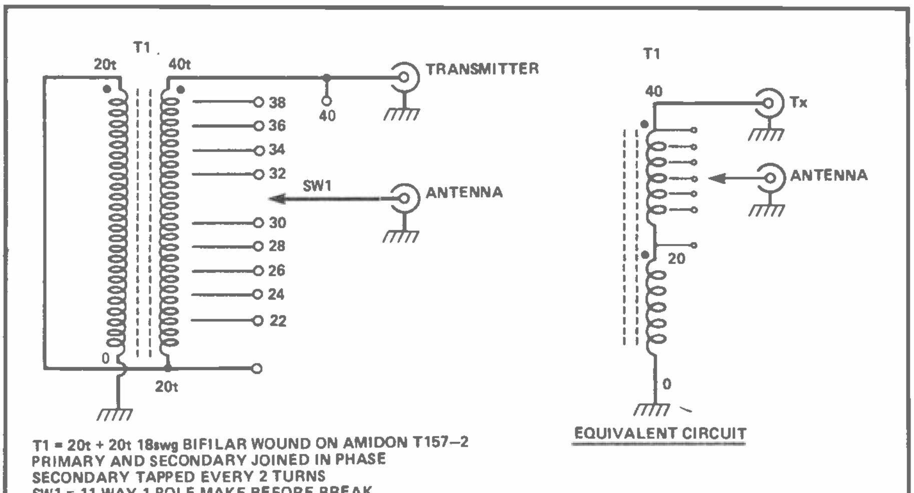


Fig. 7 Toroidal matching transformer.

both simple and effective **(Fig. 6b)**, either a fixed capacitor can be soldered across the aerial base for a particular band, or a number of capacitors can be arranged with a switch, or, alternatively, a broadcast type variable capacitor can be employed. Ideally, the capacitor should be at the base of the antenna, but it will also work at the transmitter end of the coax cable. Values in the order of 1000 pF are common on 160m, reducing to 20 or 30 pF on 28 MHz. A variable capacitor in series with the antenna, as shown in **Fig. 6c**, is another possibility.

A toroidal matching transformer **(Fig. 7)** permits the matching of a range of impedances from 50 down to 12.5 ohms. However the use of such a device can be a little tricky, particularly if the load is not purely resistive. This can often necessitate marked changes in whip length before an ideal match is found.

The miniature ATU (Fig. 7) permits the matching of a range of impedances from 50 down to 12.5 ohms. However the use of such a device can be a little tricky, particularly if the load is not purely resistive. This can often necessitate marked changes in whip length before an ideal match is found.

The miniature ATU (**Fig. 8**) will permit the matching of almost any type of mobile antenna that you are likely to use. It is very similar to some commercial designs and permits considerable flexibility (25kHz) on the lower frequency bands. *The use of such an ATU does not mean that you can simply tune up any non-resonant mobile antenna.* The antenna must still be brought to resonance as previously described and the ATU then placed in circuit and adjusted for a good match to the transmitter. The field strength meter still remains the best indication of maximum output.

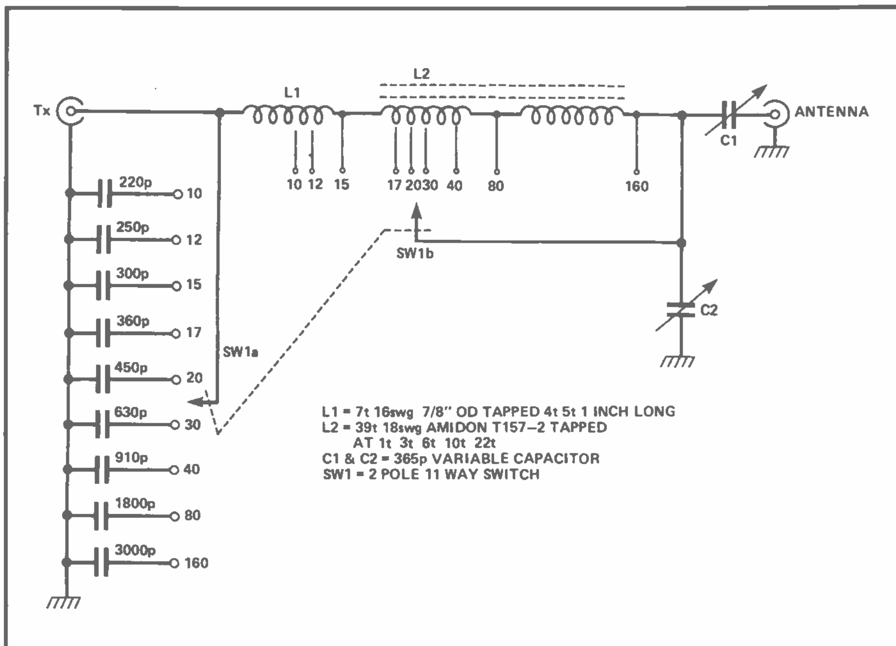
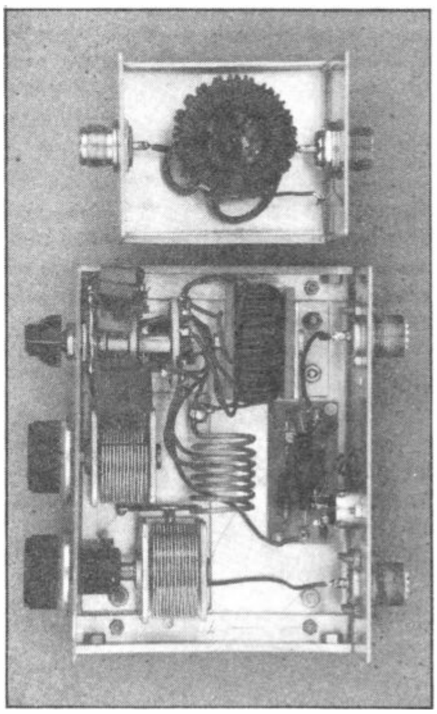


Fig. 8 Miniature mobile ATU.



Matching By Toroid

The toroidal step down transformer of Fig. 7 permits matching to a range of impedances from 50 down to 12.5 ohms. It is wound on an Amidon T157-2 iron dust core and comprises two bifilar windings of 20 turns. The windings are connected in series in phase and the transmitter is connected across both windings. The antenna is tapped down every two turns on the upper winding to get the best match. Winding the transformer with two different coloured wires, or one enamelled and one tinned makes it easier to locate the correct winding for tapping. The maximum step down of 2:1 represents an impedance ratio of 4:1.

A single pole, 11 or 12 way switch, with make-before-break contacts, is required and should have good size contacts. (100 watts into 12.5 ohms=2.88 amps!). Constructional details of the Toroid ATU are shown in Fig. 7.

A Miniature ATU

The miniature ATU, as shown in Fig. 8 bears a close resemblance to the pi-tank circuit of a valve transmitter, but the opposite way around. It is essentially a low pass filter with a fixed input impedance and an output impedance of 10 to 200 ohms. The capacitors used are 365pF single gang broadcast type units with fairly narrow spacing. They will handle 100 watts into low impedances with no problems but will flash over at higher impedances. Strangely, the only band where flash over has been encounted is 160m. The input capacitor is switched and should be a silver mica type. The value may be made up by one or more capacitors in parallel. L1 is an air wound coil whilst L2 is wound on an Amidon T157-2 iron-dust core.

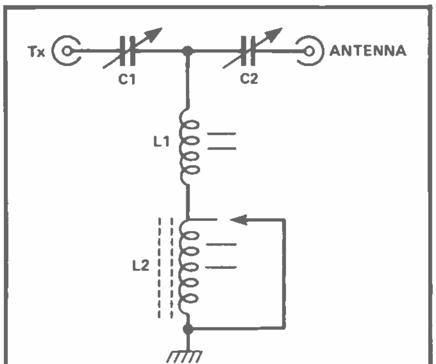


Fig. 9 Alternative ATU.

Table 1 Mobile Antenna Dimensions (G3TSO)

BAND	COIL WINDING DATA Length (inches)	Dia (ins)	Winding Length	Wire Gauge	Turns	Approx L(uH)	Base Length (inches)	Top Whip Length (inches)	Freq (MHz)	Band Width (±KHz)	Remarks
160	10	1	9⅝	25	450	500	42	58	1.93	5	Base Z=34 ohms Top 15 KHz/inch
	10	2	9½	18	187	335	54	94	1.93	10	"Jumbo Whip" Base Z=21 ohms Portable use only
80	6½	1⅜	5	20	130	142	54	44-58	3.8-3.5	7	Base Z=15ohms 50 KHz bandwidth with ATU Will match with 1000pF Series C.
							42*	48-56	3.8-3.6		
40	4¾	1⅛	4	18	70	34	54	50	7.05	40	Unable to match with Transformer. OK with ATU or 360 pF Series C
							42*	53	7.05	40	
20	2½	1⅛	1½	18	26	10	54	32½	14.2	100	Base Z=45 Ohms
							42*	35½	14.2	100	
15	2¼	¾	1¼	18	21	4	54	32½	21.2	150	Base Z=45 ohms
							42*	39½		150	
10	No Loading Coil						54	48	28.5	500	Base Z=45ohms
	2¼	¾	¾	18	10	2	42*	32½	28.5	450	

*Note: 54 inch base used with 28 inches of top adjustment and 30 inch ⅛" dia stainless whip
42 inch base used with 10 inches of top adjustment. 48" stainless whip 160/80/40. 30" whip 20/15/10.

The alternative and simpler circuit (**Fig. 9**) can use the same capacitors, L1 can be an air wound coil of approximately 1" diameter with approximately 15 turns and L2 can be 35 to 40 turns on an Amidon T157-2 core. Tapping points will need to be found experimentally.

Conclusion

The antenna dimensions in **Table 1** have been determined experimentally over a period of two years and represent the final figure for a set of mobile antennas covering 160 to 10 metres. No attempt has been made to include the three new (WARC) bands. These figures should be treated as a general guide and not as absolute dimensions as there are many variables in a mobile antenna.

Results have been compared with the G-Whip Triband Helical with LF coils and the Hustler 80 to 10 metre antennas. Hustler do not make a 160m resonator and the G-Whip is very inefficient on 160 — my smaller homemade antenna showed a 6dB improvement over the G-Whip for a length increase of only 20 inches, a worthwhile improvement. The Jumbo 160 homemade (portable rather than mobile!) antenna showed a 12dB increase over the G-Whip. The homemade antennas were very comparable with the Hustler on all other bands and showed an improvement over the G-Whip on 80 to 10m of approximately 3dB to 6dB. (Up to an S point). Considerable improvements can be achieved on the LF bands by extending the base mast when working portable.

Homemade mobile antennas are a very viable proposition and can represent a significant saving of money over their commercial counterparts with no sacrifice in performance and can also be tailored to suit individual requirements. The best finish can only be achieved with some engineering resources, but effective antennas can still be made with very limited resources and a degree of imagination.

It is essential that the sharp frequency response of loaded antennas is understood and that logical steps are taken to bring an antenna to resonance if optimum performance is to be realised. Once adjusted, the dimensions of the antenna on a particular frequency can be noted for future use and the construction of a graph or table of top whip length versus resonant frequency is a desirable aid to quick QSYing.

After 2 years experimentation the trusty G-Whip has now been permanently replaced with the homebrew antennas for both mobile and portable operation. The relatively narrow bandwidth of a mobile antenna on 160 and 80 metres (typically 10kHz) need not be a disadvantage; most fixed stations will leave you the channel if asked. Careful selection of the design frequency in the first instance will provide hours of operation without need to QSY.

The general principles outlined in this article do not need any great technical expertise to understand. The dimensions and details provided should give any practically minded amateur the basis for developing a mobile or portable antenna.

Bibliography:
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ARRL Amateur Radio Handbook.

ALL MODE TRANSCEIVER

The Omega 100W PA is here! Even if you haven't built any of the series, this article provides an excellent glimpse into the tears and fears of QRO transistor PA design. By Tony Bailey, G3WPO, and Frank Ogden, G4JST.

As most of you following Project Omega will be aware, we have experienced some problems in the development of the high power amplifier for the transceiver. On the face of it, this should have been a relatively simple part of the series, but it was not to be. Not only did the actual amplifier refuse to function quite as expected, but the Logic Switch (published in Part 5 November 1983 HRT), although capable of handling at least 100W of pure harmonic free RF, proved unable to live long with 100W of harmonic rich energy direct from the PA output. This in itself took some time to overcome, and hence the reason for the delay in publication.

We should also explain that there is a difference in the requirements of publishing a design that you have just built as 'one-off' of, purely so that you can pass on the constructional details to other people, and publishing a design that you know will be built by the hundred, and that has to match up to a previously published series of high-performance companion modules. The amateur radio press is littered with designs that 'only had one built' as many people who have tried to build them will testify. The individual constructor can play and twiddle to his heart's delight to get something working, and then publish it, but will the next 10 to be built work?

On the basis of a one-off publication, we could have printed a suitable amplifier months ago! However, it would have been full of provisos such as dire warnings of disasters should you operate the rig into an SWR of greater than 3:1. And also lacking a number of refinements and the reproduceability it now possesses. We have probably been pedantic over certain aspects of the performance, but we did say that we would not publish *any* module until we were happy with its performance — development and fault tracking takes an inordinate number of hours, and a frequent wish to throw the latest design failure out of the window. Finally here are the results of our efforts over the past 10 months.

Specification

The design allows output of 100W RF at 1.8-30MHz for a drive level of approximately 3W from the QRP PA at 1.8-21MHz and 4W at 24-30MHz. At 3W input on 28MHz, the output is approximately 80/90W. The design is able to withstand all phase angle mismatches at full power output (this is not to say that you should run it like this!) and is rated continuously for CW/SSB use at full power output. In conjunction with the accessory PCB, it also features thermal protection sensing, ALC (automatic level control), SWR/power metering, and automatic reduction of drive if 'over current' conditions exist. Under all normal operating conditions it should be impossible to damage the output devices, providing the assembly and alignment instructions are followed closely, and the unit is used in conjunction with a suitable power supply unit capable of providing 22A at 13.8V DC. It is highly advisable that the PSU also has fast electronic 'trip' facilities as a protection against DC overcurrent conditions.

This article describes the PA construction, and Part 10 next month will describe the alignment.

PA Design

The successful design of high power HF amplifiers requires a somewhat different approach to that of amplifiers in the 1-10W region. At outputs approaching 100W, currents of around 20A are going to be involved at a supply of 13.8V. This means a lot of attention has to be paid to DC physical construction, safety aspects and dissipation of all the heat generated by the output devices. Large RF circulating currents are also going to be present increasing losses in 'normal' type components, and decoupling becomes of great importance.

Heatsinks

Perhaps the biggest difference in construction against a low power amplifier is the degree of heatsinking required. It is generally true to say that as much power as is generated in RF output is going to have to be dissipated in heat. Hence we will be looking at getting rid of around 50/60W of heat from the two output devices as efficiently as possible, coupled with a means by which the PA heatsink can be monitored for excessive temperature rise and automatically cut the PA drive should this happen. This design uses a ¼" aluminium interface block between the PA devices and three extruded heatsinks which dissipate the majority of the power.

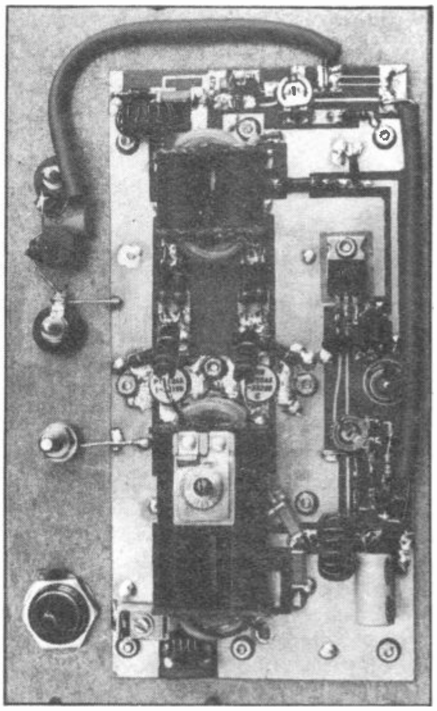
PA Devices

Our original attempts at the PA were using a pair of low-cost VHF devices — 2N6084's. While it was possible to get around 60/70W of output from these, the chances of their lasting very long were fairly remote — as we proved several times! The problem is (and it appears to be unreported with this type of device as far as we can see) that broadband operation requires large amounts of ferrite to be present in the output transformer to get the low frequency response. This can store prodigious amounts of RF energy which is normally discharged into the antenna system. If a fault develops, and the antenna develops a mismatch, much of this energy gets channelled back into the transistor itself, and coupled with transformer leakage inductance at higher frequencies, manifests itself as an RF overvoltage over and above the normal peak RF voltage present. In the case of 2N6084, the Vcbo (collector/base breakdown voltage) is 36V — this voltage was visibly observed to be exceeded with very little problem with probes.

Devices specified for HF broadband use have a much higher Vcbo rating; in the case of the TRW PT9784/A devices used in this design it is 50V, and this is more than adequate under all conditions. Unlike the 2N6084, *during development we have not lost a single device*, despite some pretty horrific things happening to them, including self-oscillation, full power/open/short circuit operation and other nasties. They are in fact rated to withstand mismatches at all phase angles under full power output conditions, and we are pleased to have proved this successfully!

Valve vs Solid State PAs

Most valve PA amplifiers have resonant tank circuits, adjustable by the operator to cope with the various load conditions presented to them. Those of you who have tuned up a valve linear will know that if the circuit is at resonance and the applied load very light, the power dissipated in the valves is quite small, as shown by the null which reduces the current taken almost to the level existing with no drive. Off-resonance, the current and therefore the dissipation increases rapidly, and possible damage to the valve may result if this is not contained. However, there is a limit to the amount of current that you can draw from a valve cathode, and this will limit the current that can be drawn from the supply.



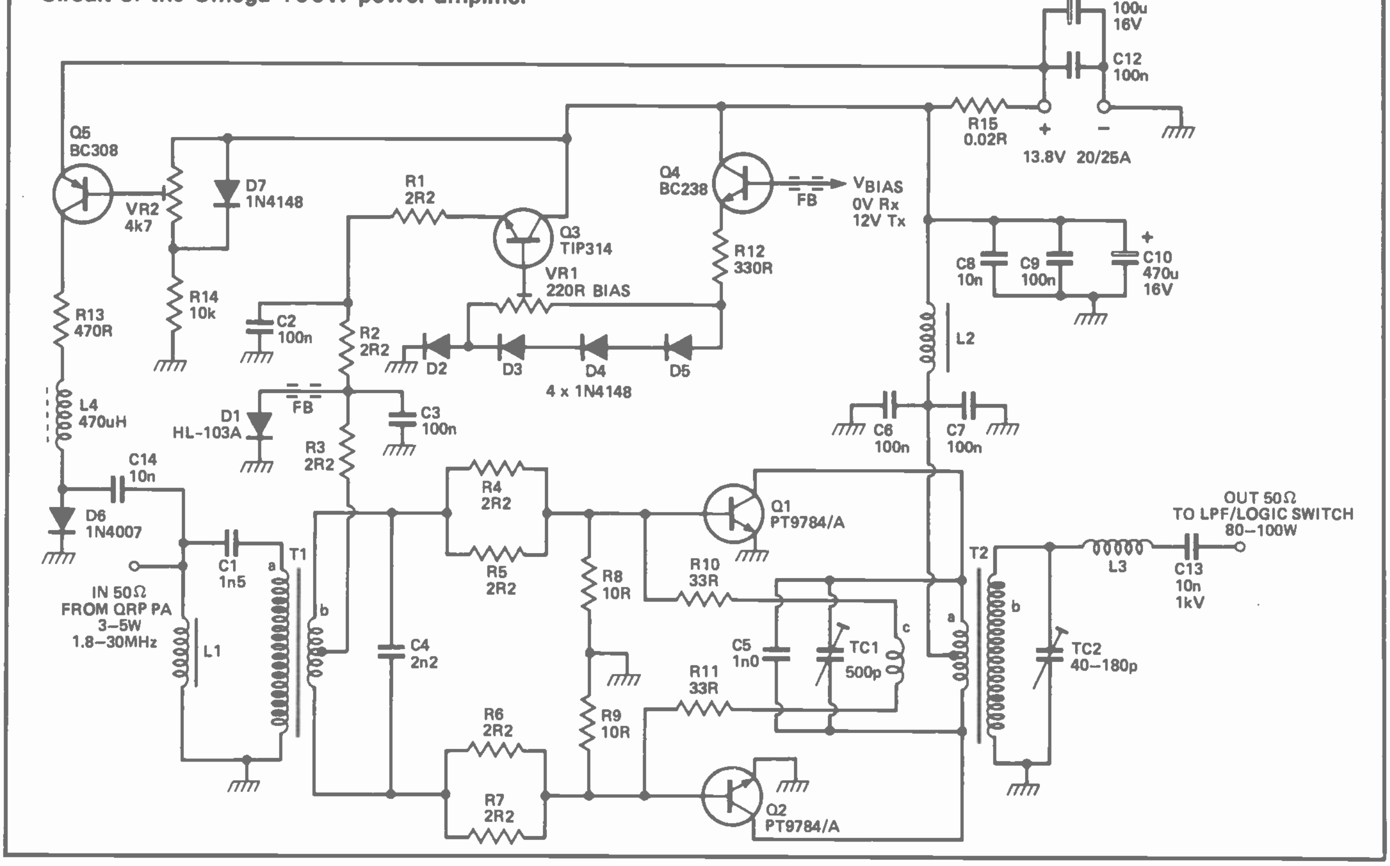
Omega PA viewed from above

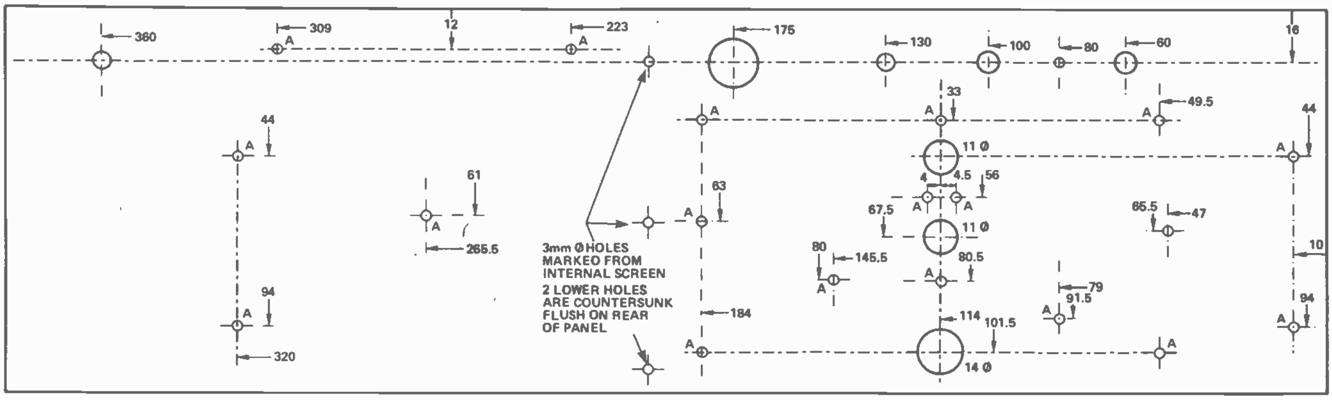
With solid state broadband amplifiers, when drive is applied without a load, there is nothing to limit the collector current and all the current taken has to be dissipated in the transistor. As the collector internal impedance is only a fraction of an ohm, very high currents can be drawn from the supply if it is not current limited, leading to rapid failure of the device.

Even under less violent mismatch conditions, problems can still arise. An SWR of 3:1 indicates that there is an impedance mismatch of three times. If our proper load is 50 ohms, under these conditions, a reflected load can vary from around 17 ohms to 150 ohms against a nominal 50 ohms. As transistors are constant current devices, dangerously high voltages may be developed across them if the mismatch is towards the large end of the range.

All this is meant to show you that solid-state amplifiers do not like looking at any other than their design load impedance, which in this case is 50 ohms, and that care should be taken to match the amplifier output to this figure via a matching unit before any appreciable

Circuit of the Omega 100W power amplifier





Omega QRO PA rear panel drilling detail

ALL HOLES MARKED 'A' 3mm Ø

power is applied to the antenna.

Circuit

The final circuit is based on a TRW applications design, with various modifications we have found necessary for stability. Referring to the circuit diagram, shown in **Fig.1**, input power at the 3W level from the QRP PA is coupled into the input transformer, T1 via C1 and L1. The latter provide low-frequency compensation for the transformer. The combined input impedance of Q1 and Q2 is around 3 ohms, and the transformer therefore has to change the input impedance from 50 ohms to this figure. A turns ratio of 4:1 (impedance ratio of 16:1) will accomplish this, and in the process provides a simple transformer construction. As described in detail later, the transformer is of classical broadband construction, using a single turn low-impedance output winding made from brass tubing, with the high impedance four-turn winding threaded through the tubing. Ferrite cores are used to load the transformer for best low-frequency response.

Capacitor C4 and resistors R4/5/6/7/8/9 are for matching and stability purposes, helping to prevent unwanted LF and VHF parasitic oscillations.

Bias for Q1 and Q2 is obtained via Q2/3 and D1. The main controlling elements are Q3 and D1, with Q3 providing a low impedance source of bias current in its emitter follower configuration. Diodes D2 to D5 provide a stable voltage reference, with preset VR1 allowing this voltage to be varied over the 0.5-1.0V range. Diode D1 is an important part of the circuit and provides the temperature compensation for the bias circuit, by virtue of being in physical contact with the heatsink surface near to Q1/2. Without this, the transistor's bias current would increase as their case temperatures rose. This in turn means they generate more heat, increasing the current still further until a condition known as 'thermal runaway' is reached, leading to eventual destruction of the devices. D1 has a negative temperature coefficient, and as the temperature of the heatsink rises, so the bias current is decreased a little to compensate. We found that the original TRW bias circuit was of little use, with the standing current, nominally 200mA, rising to 5A after a few minutes. With this design, the bias stays relatively constant.

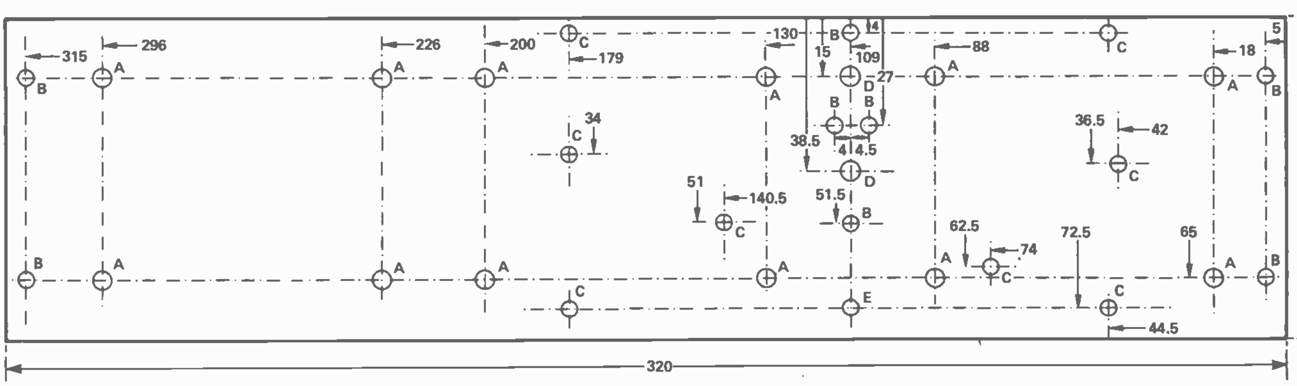
D1 is a power stud-mounting diode type HL-103A, which features the cathode connected directly to the stud and metal case. This allows convenient mounting directly against the heatsink, without having to mess around with the uncertainty of trying to mount ordinary diodes in good thermal contact with the heatsink.

As Omega features full 'break-in' working on CW, switch Q4 is fed from the bias output on the logic switch, and thus the PA is only biased on when transmitting. Its output is then in a high impedance state and allows connection directly across the common path to the antenna and receiver on the logic switch unit.

The amplified output from Q1/2 now has to be transformed up to the 50 ohms required for convenience at the output. From the usual formula the collector load impedance needed is:

$$R_c = \frac{(V_{cc} - V_{sat})^2}{2P_o} = 1.1 \text{ ohms.}$$

In push-pull, the transformer matches 2 × Zout to 50 ohms. This requires a voltage transformation ratio of 4.7, and the nearest obtainable to this using conventional techniques is 4, giving an output transformer similar in construction to the input one. The major difference is that the volume of ferrite required is much larger to cope with the higher power levels involved. In this



12 HOLES 'A' = M4 CLEAR COUNTERSUNK SUB-FLUSH FACING SIDE
8 HOLES 'B' = 3mm Ø
8 HOLES 'C' = 3mm Ø COUNTERSUNK SUB-FLUSH (FOR 6BA BOLT) REVERSE SIDE
2 HOLES 'D' = CLEAR FOR 8.32 NC 3A THREAD – PANEL MUST NOT HAVE BURRS EITHER SIDE OF HOLE
1 HOLE 'E' = CLEAR FOR 10.32 NC 2A THREAD – PANEL MUST NOT HAVE BURRS EITHER SIDE OF HOLE

MATERIAL; 1/4" ALUMINIUM PLATE
BLACK ANODISED

Omega QRO PA heatsink interface panel

case, while the input one uses 6 ferrite cores, the output needs 14, with seven threaded on each brass tube comprising the primary single turn winding ('a' on the diagram). Similarly, the high impedance (output — winding 'b') section is again 4 turns. Due to the much higher voltages and currents involved, this secondary winding is made using 1.25mm enamelled copper wire, covered in a protective PTFE sleeving. To prevent possible shorts, the input transformer is also wound in a similar manner.

Capacitor C5 and trimmer CT1 on the primary winding, plus trimmer CT2 and inductor L3 on the secondary are for high frequency transformer compensation, together with C13 for low frequency compensation.

An additional single turn link winding ('c') on the output transformer provides negative feedback to the bases of the transistors via R10/11 for gain-slope compensation, reducing the 6dB/octave gain rise at lower frequencies to a more sensible level. It also has the advantage that the transistor bases do see a real resistance under all operating conditions, reducing the chances of unwanted oscillations to a minimum.

Careful Matching

You must remember that unlike valve designs, the broadband output transformer network in solid-state designs is fixed in its tuning. Hence any reactive component in the load impedance presented to the output is transformed to the collector circuit. It is possible with certain types of reactance, especially inductive, for parasitic oscillations to arise, which, although not in themselves damaging to the devices (in the short term), may cause problems elsewhere (the logic switch particularly). Hence, although we have taken as much care as possible with suppression of such parasitics, some violent mis-matches can cause problems, and this is common to all similar designs. The answer is, of course, the use of a proper antenna matching unit, and the avoidance of setting this up at high output powers.

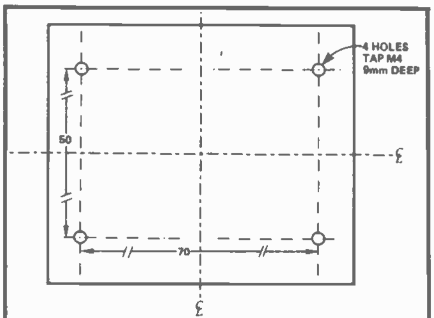
The 20 amps or so of collector current at 13.8V needed by Q1/2 is fed into T2 via a centre tap on the primary, with decoupling provided by L2 and associated capacitors. It is important that the capacitors on the T2 side of L2 are good quality polyester types — poor quality capacitors can give rise to losses and unwanted low frequency oscillations.

One of the main power transistor 'killers' is secondary breakdown. Although a current limited PSU is essential, some protection has been added against this problem on the PCB. Two of the likely causes of secondary breakdown are too much drive, or a mismatch into a lower load than 50 ohms. Both of these can be overcome by automatically reducing the drive. The circuit of Q5 (BC308 — PNP) in conjunction with R15 (0.02 ohms) acts as a current monitor with VR2 being adjusted so that Q5 conducts when a current of 22A is exceeded. Positive bias is then applied to D6 which conducts and effectively limits the drive to T1 via C14. R15 is made up from several short lengths of Constantine resistance wire in parallel mounted on the PCB.

Note that this circuit will not protect against DC problems (ie getting +12V on the base of one of the transistors), hence the advised PSU protection should not be ignored. Also, once the circuit of Q5 is conducting, distortion will be present on the output signal as the collector supplies are being current limited.

PCB Design

Although properly part of the construction side, the design of the PCB also plays an important part in the performance of the amplifier. In fact, far more than we originally thought, and it is here that some of the design problems were encountered. The PCB used is double sided, with islands on the 'track' side on which the components are mounted directly. The underside of the PCB is a common earth plane, linked through at various points to the earthy tracks on the topside. In conjunction with the wide foils used on the top side for all tracks carrying RF and high-current DC, the double sided construction is vital in the interests of electrical stability. The ground plane on one side and wide foils on the other help to prevent current loops which can cause instability, and act as small capacitors helping to prevent VHF and UHF oscillations. The copper coating on the PCB itself is heavier than would normally be used (2oz copper); as normal PCB material is barely adequate to carry the many amperes of circulating currents involved.



Omega QRO PA 'Redpoint 3K' heatsink drilling detail

Construction

Unlike the preceding Omega modules, the PA is more of a metal-bashing and assembly exercise than electronics! This is decided by the level of heatsinking required to dissipate the heat generated. The photographs* will give a good idea of how it all goes together. Basically, the PA assembly consists of 6 individual parts — a) the PCB and components mounted thereon, b) the rear panel of the Omega case (see Part 8 May '84 HRT) which holds the whole assembly, c) an interface plate made from ¼" aluminium sheet stock, and d) three Redpoint 3K extruded heatsinks bolted to the interface plate which carry out the majority of the heat radiation.

If you are building the PA as part of another project not connected with Omega, the rear panel will not of course be available. It can be replaced by a sheet of 18g aluminium, the same size or slightly larger than the interface plate. This is needed to get the correct spacing between the leads on the power transistors and the inside face of the interface plate against which the transistors mount.

The first job is to get the interface and rear panels correctly drilled as per the drawings. The row of holes along the top of the rear panel is exactly as given in Part 8 of the series with two additional ones near the left, leaving the remainder to be marked and drilled. Care should be taken in marking and drilling this part as many of the holes have to line up with matching holes in the interface plate and the PCB — it is possible to make some of these oversize later on if things don't fit exactly.

Don't forget to countersink the rear (vinyl side) of the two lower holes used to mount the rear panel to the case internal screen and the central hole to the left — otherwise the interface plate will not seat correctly against the panel.

The interface plate itself is fairly easy to drill and countersink, but not to cut! If you are obtaining this yourself, your local metal stockist will probably cut this to size for you from bulk if you ask him nicely. It will pay dividends to be precise in the drilling, using small pilot holes initially, gradually increasing in size as required. All countersink holes are made sub-flush so that the heads of the bolts on both sides are just below the surface. There is one important point about this plate — the two holes where the transistors mount should only just be a clearance for the studs of the transistors. The mounting side of the plate (the side facing you in the drawing) must be absolutely flat where the transistors mount.

This means that no burrs are allowable on these holes, nor should you effectively countersink the holes to get rid of burrs. Any burr will prevent the flange of the transistor from making perfect contact with the plate, which can be fatal; and a countersink reduces the area of flange in contact with the heatsink, again raising the device temperature.

The finished item should preferably be anodised to aid heat radiation, but this is not vital — all the prototypes used a plain finish, but anodised does perform better.

The PCB can be made by any of the usual techniques, although the basic stock material may be difficult to get hold of. As usual, this is available ready drilled and tinned, together with the transformer end plates used to construct T1 and T2.

When you have all three of these pieces made, they should be placed together the correct way round and 6 BA bolts placed through all the 3mm dia holes to check alignment. If any are incorrect, the best place to enlarge holes is the rear panel, or some of the holes may be slightly enlarged on the PCB using a small round file.

The heatsinks are available separately ready tapped as per the drawing.

Assembly

The PA is built 'back-to-front' ie the mechanical assembly of the metalwork is made first, and the components assembled onto the PCB afterwards. We suggest you follow these instructions exactly; due to the fact that bolts go in both directions through the interface plate, it is easy to get in a situation where you cannot get one bolt in at the end!

The first job is the mounting of the heatsinks onto the interface plate (IP) together with some of the bolts whose heads are on the interface/heat sink side of the assembly. You will also require some heatsink compound, preferably the white type, or Vaseline may be used as a last resort, although this is not recommended.

Initially, smear a reasonable layer of compound across the plane side of one heatsink, and over the area it will mount on at the right hand side of the IP on the rear. Looking at the rear of the IP, place 6 BA × 12mm thread countersunk bolts at each of the four positions marked 'x' into the holes — check that all the heads are below the surface of the plate. Then place the heatsink approximately in the correct position, hold the assembly together and invert. Insert an M4 × 12mm thread countersunk bolt into one of the heatsink fixing holes and tighten up loosely. Then fix the other three bolts for that heatsink in place and tighten them all up firmly.

Repeat this process with the next heatsink, inserting 6 BA bolts at the four holes 'y', and finally screw on the last heatsink.

Take one of the transistors and drop it into its mounting hole. Press on the header and check visually that it is seated perfectly flat against the IP. If not, find the cause and remedy it! Repeat with the other hole. Remove the transistors and place to one side. Now smear a light layer of heatsink compound on the IP around the areas of the two holes where the power transistors go — try to spread this evenly. Remember that too much can actually decrease the heat transfer between the flange of the transistor and the aluminium.

Next, place three 12mm long c/s 6 BA bolts through the two lower holes on the rear panel which connect the panel with the internal case screen, also the central hole to the left of these. Hold these in place on the vinyl side of the panel with small pieces of Sellotape. Now drop the panel over the IP assembly making sure that all the bolts go through the holes in the panel. Loosely fix the IP to the panel using 6 BA 12mm long round head bolts inserted from the rear through the two holes at each end of the IP. Use a plain washer on the bolt head side, and a lockwasher/nut on the inside of the rear panel.

PCB

Next, the earth foils on the PCB need to be linked through. At each of the points marked with a circled cross on the layout, push a 1mm PCB link pin (supplied with the kit) through from the continuous foil side. Press these hard home so that the heads are as close to the foil as possible, and then solder on both sides of the PCB. Do not omit these — they are important for earthing continuity. Lightly file the foil side of the PCB around each of these pins to remove any solder projections etc.

Now drop the PCB onto the rear panel and check that it will lie flat against the panel. If necessary enlarge any of the PCB holes that do not align until the PCB drops flat.

Remove the PCB, and drop one 6 BA plain washer over each of the 6 BA bolts that go through the PCB and over the four 3mm dia holes (that do not yet have bolts in them) around the transistor mounting holes. Carefully replace the PCB without disturbing the centre washers. Then insert one 6 BA 12mm long round head bolt, with a plain washer under the head through each of the centre four holes (from the heatsink side) that you placed the washers on. Do this one at a time, and loosely fix in place with a 6 BA lock washer and nut. Then loosely place further lockwashers/nuts on all the other bolts protruding from the PCB except that marked X1 (where Q3 mounts).

When everything is in place, firmly tighten up the outside four nuts which secure the IP to the rear panel, and then all the remaining nuts.

Mounting The Devices

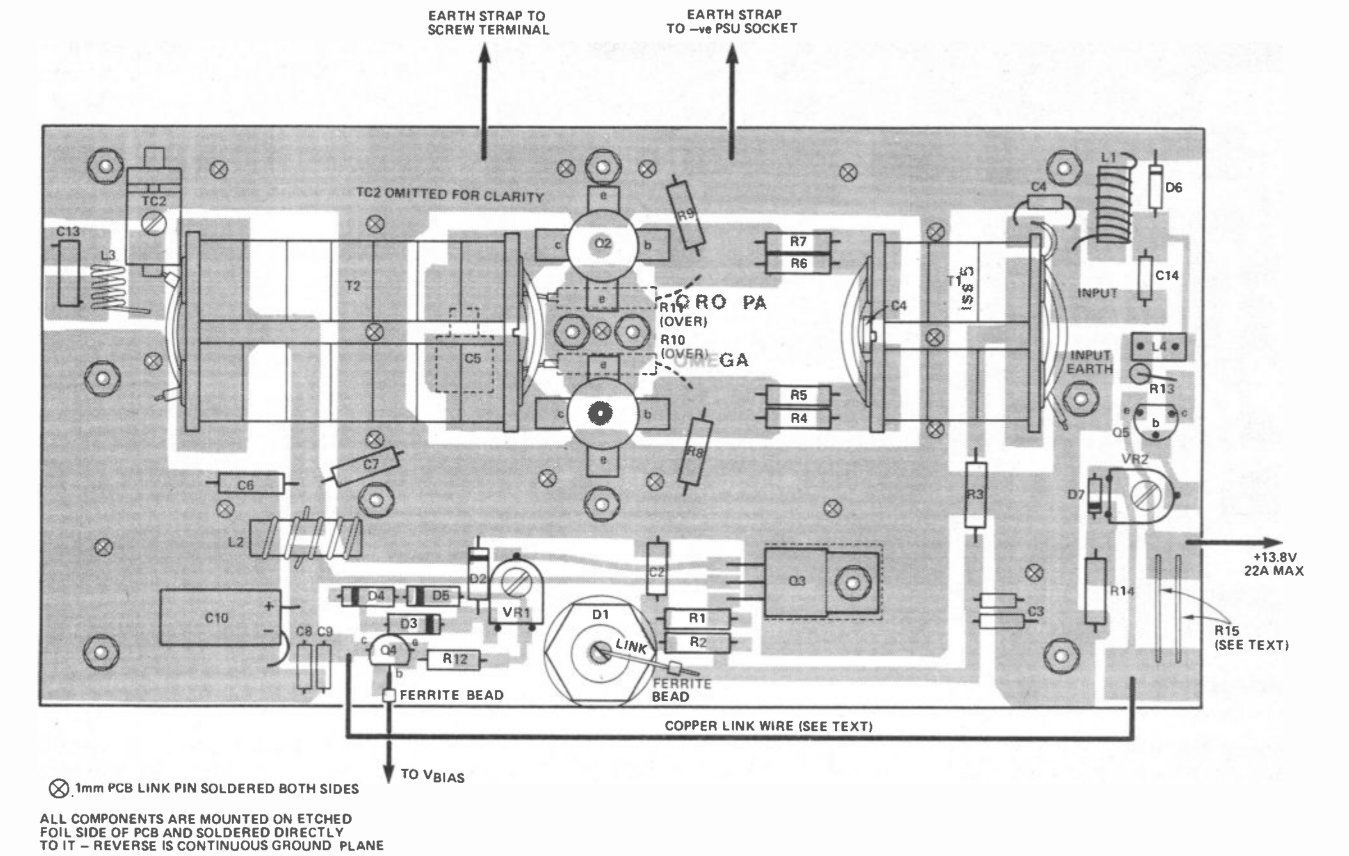
It is necessary to reduce the length of the leads on each transistor to 4mm so that they fit the PCB correctly. Do this *not forgetting to take a small amount off the corner of each transistor collector lead in order to identify it*. The collectors are also identified with a 'C' adjacent to the lead. Inspect the heat sink compound smeared on the rear of the IP through the PCB holes, and make sure nothing (swarf etc) has fallen onto it — if so, remove it! Drop one transistor into place with the collector facing in the right direction and twist it slightly to distribute the heat sink compound evenly. Screw on the nut from the underside and, making sure that the leads are orientated with the foils on the PCB, tighten up *finger tight*. You should then use a spanner, or what have you, to tighten up *just past this point and no further*. It is important *not* to overtighten the nut or the thread may strip. If you have a torque wrench, the correct setting is 10 in. pound (9kg.cm +/−10%). Do not hold the transistor in place using the leads during this operation.

Repeat with the other transistor. Check that the emitter leads of the devices can be mounted flat against the PCB without being fouled by the nuts and solder all four leads of each transistor to the PCB. During this operation (which requires a fair amount of heat as the devices are in contact with the heatsinking), the transistor headers should get barely warm, as all the heat should be going downwards! If one or both gets appreciably warm, you have a thermal contact problem with the flanges. It will then be necessary to remove the device and check for the cause before proceeding further.

Next, smear some heatsink compound on the underside of D1, drop it into place, and tighten up securely using the spring washer and nut supplied with it. Now smear some heatsink compound around the area occupied by the tap of Q3, place the appropriate insulating washer in place. Shorten Q3 leads to a total length of 7mm, smear some more heatsink compound on the metal contact side of the tab, and drop into place over the mounting bolt. Place an insulating bush onto the bolt and seat in the tab hole, then tighten up with a lockwasher and nut. Check with an ohmmeter that the tab is isolated from the heatsink. Solder the three leads to the foil tracks.

Transformers

Next comes the construction of the input/output transformers. If you are making the end plates from the foil patterns, a single sided PCB is used, preferably with 2oz copper for the output version. The holes should be an interference fit over the thin wall brass tubing used, nominally 8mm OD (5/16"). Start with the input



Omega QRO PA component overlay

transformer, insert a length of brass tube 24mm long into each hole of one end plate. Holding these in place, thread three ferrite cores onto each tube, then place on the other end plate. Adjust the tubing so that an equal amount protrudes from each end of the plates. Lightly solder tack each plate in place to the tube holding the end plates firmly against the ferrites. Then solder all round each tube in turn.

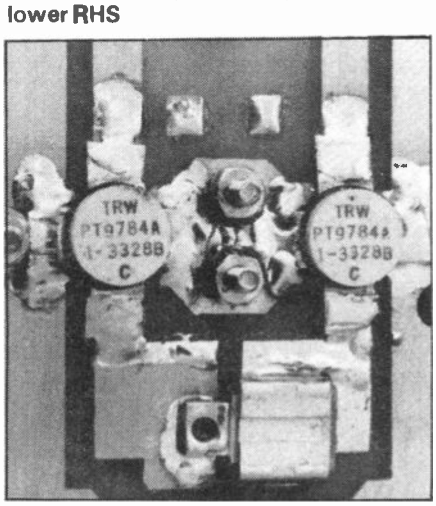
Repeat the procedure with the output transformer, using 50mm lengths of tube, and seven cores on each tube.

The high impedance windings are now added. For T1, take 35cm of 1.25mm dia enamelled copper wire and slide over it, an equal length of PTFE sleeving with an internal dia of 1.9mm. Four turns are now wound through the brass tubing, in such a manner that the two free ends emerge from *the end of the transformer that has a continuous foil end plate*. Insert the wire through one tube until about 15mm protrudes from one end. Carefully take the long end and thread it back through the other tube to make the first turn. Handling this wire is a little awkward and you should try to make a smooth bend where the wire returns through the tubing. Repeat three more times. Trim back the PTFE sleeving using a knife to within 5mm of the end plate. Clear off the insulation on each free end back to the sleeving.

The output transformer is made in a similar fashion, using 59 cm of 1.25mm en wire and sleeving, again four turns.

When you have made these, the 1000pF UNELCO wrapped mica capacitor is soldered into place on the PCB — do not substitute this with any other type as it will lead to high frequency losses and possible instability. The photo shows where this goes, underneath T2. Lay it on the PCB so that about 1mm of track is just visible outside of the body to the left of the PCB. Check that when T2 is put in its correct position, the end plate is clear of the capacitor. Solder the sides of the body in place, then the tab. *Do not* bend the tab — allow the solder to flow from the tab onto the PCB until a good joint is made. Mechanical stress on the tab may induce an RF short later.

Unelco mica capacitor in position at lower RHS

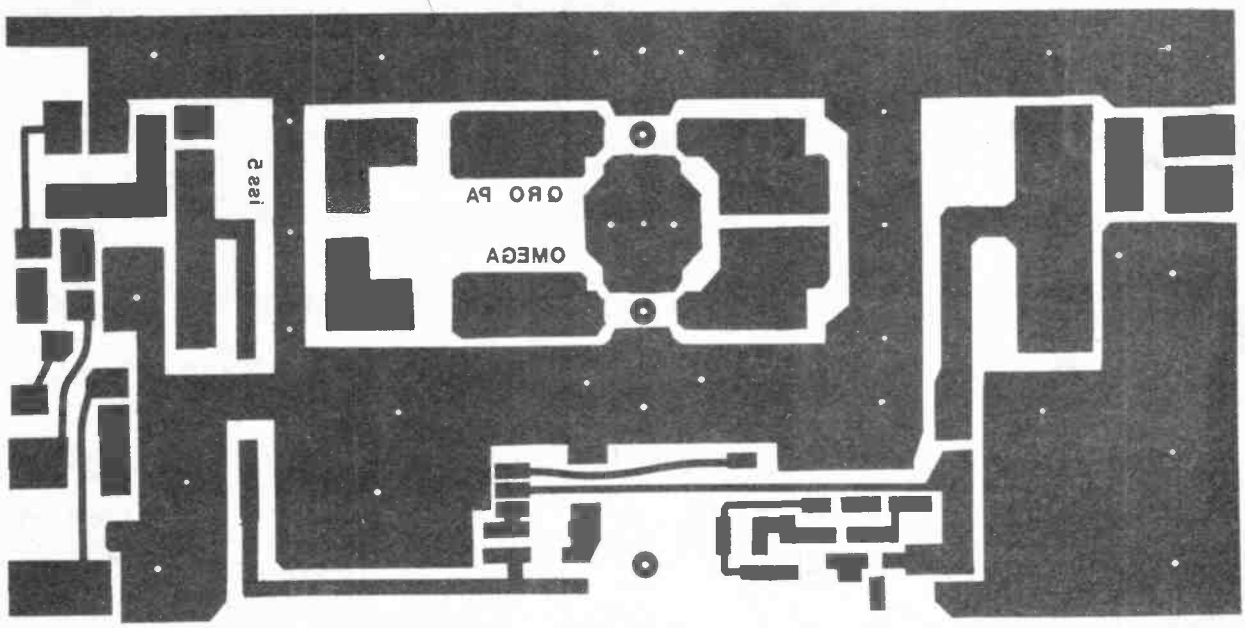


Place T2 on the PCB so that an equal amount (about 1mm) of PCB track is showing outside of each end plate. Make sure it is squarely placed, then solder the end plates to the PCB with a continuous run of solder. Take care not to bridge the gap at the centre on the right hand side of the transformer. Follow by soldering T1 into place similarly.

Next solder TC2 into place, after shortening the earthy end (tag nearest the raised portion) to 3mm long, doing the same with the other tag, then bend the tags slightly downwards. The trimmer fits with the earthy tag just at the edge of the PCB, between one of the nuts, and T2 end plate. Solder in place and check that the underside of the trimmer is not shorting against the PCB.

Bend the lead from T2 secondary nearest the trimmer down and trim it so that it just contacts the PCB against the trimmer tag. Solder into place firmly. Then solder the other lead to the earth plane immediately in fron of the transformer.

Now wind L3. Take a 15cm length of 1mm dia en copper wire, and wind 4 turns round a 7mm dia drill or former. Reduce the leads to 3mm in length, strip and tin them, and bend both slightly downwards, but not at right angles to the coil. It then mounts as shown just up in front of T2 end



Foil pattern

plates. Solder into place.

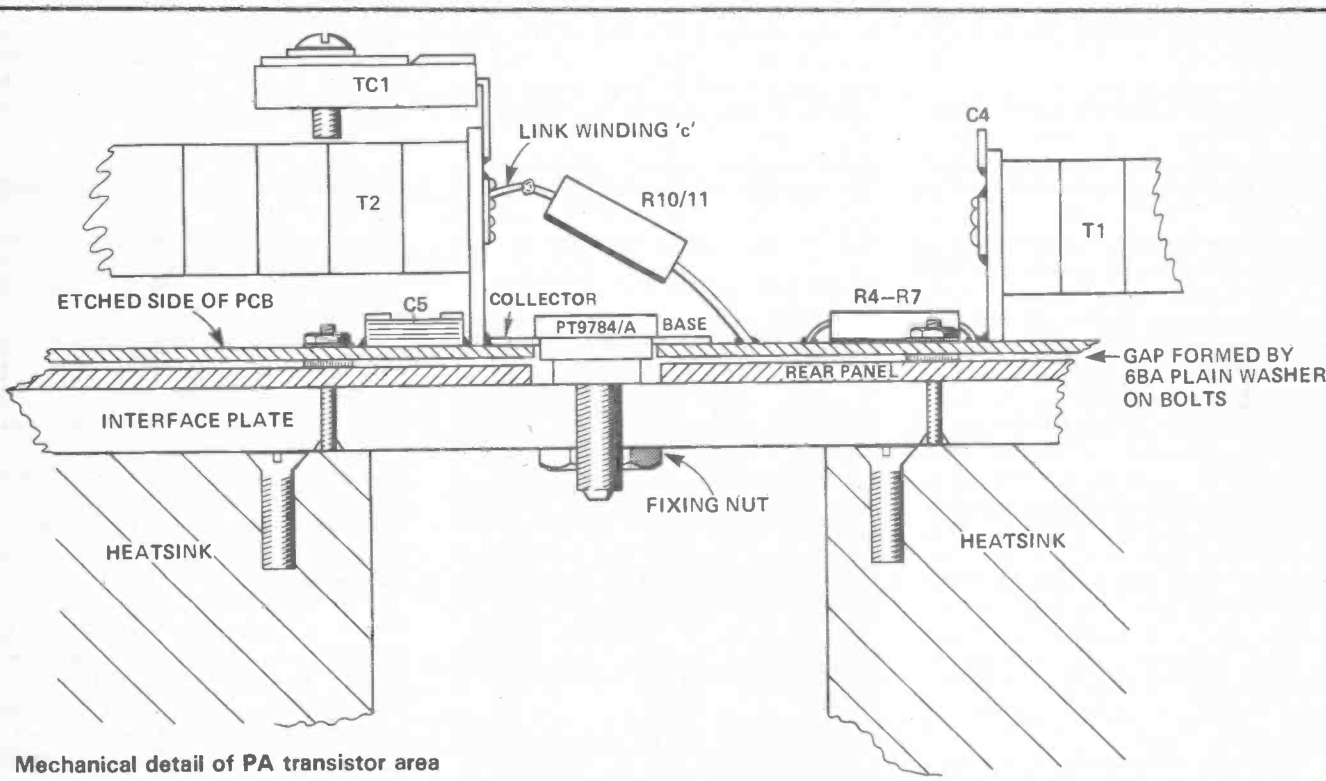
Solder in C13, keeping the leads as short as possible. Then solder in C6/C7 bending the leads out from the bodies first (care — they can break off easily) and soldering them close to the bodies.

Now wind L2. take a 27 cm length of 1mm wire, wind 10 turns onto the ferrite core (ie so that 9 turns of wire are visible on the outside), shorten the leads to 5mm, strip, tin, and solder to the PCB. Then solder in C8, C9 and C10, keeping the leads as short as possible.

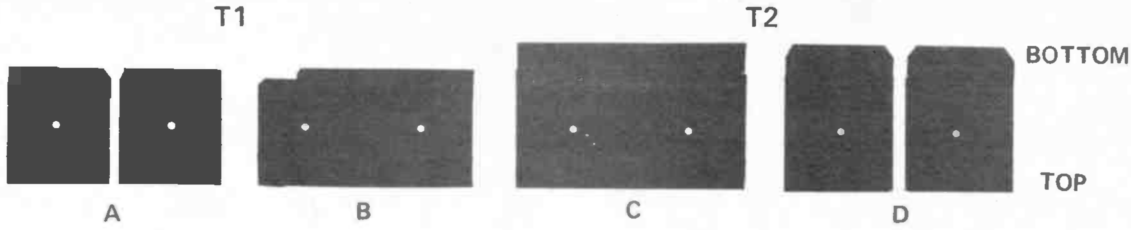
Next solder in all the fixed resistors except R3, 10 and 11. The leads should be kept as short as possible, soldered close to the bodies, with the resistor bodies resting against the PCB. Then solder in the remainder of the fixed capacitors, again keeping leads as short as possible.

Bend both leads of TC2 down at right angles against the ceramic body. Then place against the inside top edge of T2 and solder to the end plate foils above the brass tube ends so that the bolt is just above the ferrite cores.

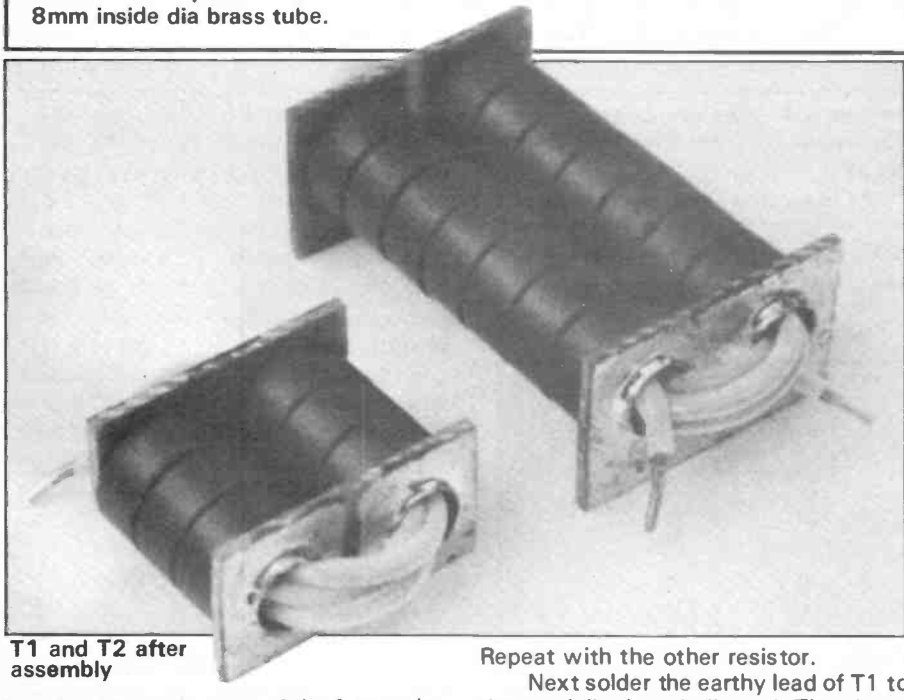
Now take a 14 cm lengfth of 7/0.2 *PTFE covered wire* and strip off 10mm of insulation from each end with a sharp knife. Tin the leads. Thread one end through the windings in one tube of T2 so that both free ends will eventually project from the side facing the transformer. Then return the other end back through the other tube. This is not as easy as it sounds — the windings will almost certainly get in the way. Some patience plus the help of a pair of tweezers may be required. Take R10 and cut one lead down to 5mm in



Mechanical detail of PA transistor area



Transformer end plate patterns for T1 and T2. These are made from single sided copper clad 2oz PCB. Plates A and B are one piece of PCB with etched clearance at centre. The holes in the centre must be enlarged to clear 8mm inside dia brass tube.



T1 and T2 after assembly

length. Firmly wind one of the free ends of the PTFE wire round the short end of R10 and solder. Then cut the other end of R10 to 10mm in length and bend down so that it can be soldered to the base lead of one of the transistors. Repeat with the other resistor.

Next solder the earthy lead of T1 to the top foil where indicated. Then bend the other lead so that it can be soldered to the PCB foil in the correct place. Now wind L1. Take a 35 cm length of 0.56mm dia en copper wire, and wind 15 turns onto a ferrite core. Shorten the leads to 5mm, strip, tin, and solder into place.

The last few operations are to solder the diodes D2-D4 to the PCB where shown (bodies resting against board) — take care they are the right way round! Then bend the last 4mm of Q4 leads out at right angles, with the centre lead projecting towards the flat end of the body. Solder into place, again making sure that the flat on the body is facing the right way. Then solder VR1 to the PCB, after bending the leads at right angles again. Using a short length of wire, solder one end to the tab of D1. Thread a ferrite bead over the lead and solder the other end to the track where shown.

Then add all the components associated with the current limiting circuit, Q5, keeping leads as short as possible, especially at the input to T1. L4 mounts vertically without bending its pins. R15 is made from two lengths of Constantine wire, each 18mm long. Solder them side by side a little way apart directly to the PCB where shown, right up to the edges of the foil at each end — this leaves exactly 1cm of each wire conducting.

You should now have all components in place with the exception of R3 which is added after checking the operation of the bias supply.

Using heavy gauge wire, connect earth straps from the PCB to the rear panel earth terminal, and the PSU input negative terminal. Then solder C11 and 12 across the PSU input terminals. Now solder a sleeved length of 1.25mm en copper wire as a link where shown along the lower edge of the PCB.

Component Listing

Resistors

R1,2,3	2R2 0.5W carbon film
R4,5,6,7	2R2 0.5W carbon composition
R8,9	10R 0.5W carbon composition
R10,11	33R 1W carbon composition
R12	33OR 0.25W carbon film
R13	470R 0.25W carbon film
R14	10k 0.25W carbon film
R15	.02R — made from two 1cm effective lengths of 28swg Constantine resistance wire in parallel

Capacitors

C1	1n5 ceramic disc
C2,3,9,12	100n ceramic disc
C4	2n2 ceramic disc
C5	1n wrapped mica
C6,7	100n block polyester
C8	10n ceramic disc
C10	470uF/16v radial electro
C11	100uF/16v radial electro
C13	10n 1kV ceramic disc
C14	10n block polyester

Semiconductors

D1	HL-103A stud mount
D2-D5,7	1N4148
D6	1N4007
Q1,2	TRW PT9784/A (380-SOE)
Q3	TIP31A
Q4	BC238
Q5	BC308

Miscellaneous

L1	15 turns 0.56mm en Cu wire wound on Fair-Rite core type 59-61001101 (u=125)
L2	10 turns 1mm dia en Cu wire on core as L1
L3	4 turns air spaced 1mm en Cu wire on 7mm former
L4	TOKO 470uH choke
T1	Broadband Transformer (see text) using 6 × Fair-Rite cores as L1. Primary 4 turns 1.25mm dia en Cu wire in 2mm ID PTFE sleeving wound through secondary
T2	As T1 using 14 cores as L1 and 4 turn primary. Single turn feedback winding using PTFE covered 7/0.2 wire
VR1	220R horizontal preset
TC1	500pF max ceramic/mica compression trimmer
TC2	180pF max ceramic/mica compression trimmer

Kits

A full kit of parts for this project including all components, drilled tinned 2oz copper PCB, transformer end plates and tubing, machined interface plate, tapped heat sinks and all wire/sleeving is available from WPO Communications for £149 inc carriage and VAT. PCB's/transformer end plate set only, cost £11.50 inc. Certain other parts are also available separately — please send an sae for details.

*** Due to lack of space some of these photographs have been held over to next month.**

Metre wave

As 1984 goes out, Jack Hum, G5UM, dons grey beard and scythe to assess the last twelve months 'metre wave' wise.

"Please, please, not *another* look back on the year a-dying and a look ahead to the year about to open!" The reader may be excused the thought at a time when the media seem obsessed — as they always do at the turn of a year — with what has happened over the last twelvemonth and what is likely to happen in the next. Need we in 'Metre Wave' in *Ham Radio Today* follow the same trend? It will profit us to do so only if we can identify any definite landmarks that arose during 1984 on the metre-wave front and can perhaps derive some instruction from the dying year.

Any landmarks, then? Yes, assuredly. Reckoning that the metre-wave spectrum is the only one where any true progress in amateur radio can be discerned (for the HF bands have long since fallen into an unchanging mould — and if you think that to be a provocative utterance, you may challenge it in the HRT letters page!), there were in '84 two major developments that affected — and affect — the generality of metre-wave users, and two less major ones, having a minority interest but holding great technical potential for the future.

The major developments first, then. . .

One of them was that significant moment at the beginning of 1984 when the number of British amateurs holding the VHF-only Class B licence exceeded those holding the Class A one. At this cross-over point, there were 26,276 Class B licences and 24,359 Class A extant in the UK, a trend that accelerated as the year progressed, helped by the large number of people coming into amateur radio from Citizens' Band. 'ticket'.

At the same time the number of CB licences issued dropped during 1983 to 280,000, a significant statistic that showed a reduction of no fewer than 80,000 in a year. Clearly, not all of these 80,000 dropped out of CB because they intended to take 'ham tickets': most of them quit because CB lost its appeal and novelty value. But thousands *did* decide that amateur radio was for them and that they would take The Examination. Of the thousands who went on to pass it a majority opted for the Class B licence simply because operation on 2 m promised to be in the style of communication with which they had had experience.

Flight from 'Two'?

In parallel with this development occurred a noticeable flight from two metres by the older hands accompanied by cries that "Two is becoming like Citizens' Band", which was a derogatory viewpoint not to be reconciled with the hard fact that most of the ex-CB recruits were quick to learn, already had

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The Metre-Wave Operator's Ten-Point New Year Resolution

"1. I will never use the wrong mode in the wrong place and to allow me not to do so, I will memorise the UK VHF/UHF Bandplan (and if I can't remember it, I'll keep a copy of it by the log).
2. To extend my range I will use the morse code to put my signal into ears which otherwise wouldn't read it — and if I don't know the morse code, I'll jolly well learn it before 1985 is much older.
3. When I use CW I'll go along at the speed of the other person — and I hope he/she has made a similar resolution to help *me* along in turn.
4. I will never from my home station use a repeater except to attract the *attention* of someone I want to talk to: if he/she is within simplex range we will QSY to a non-repeater frequency.
5. At all times I will use the lowest possible power to sustain communication.
6. I will always send a QSL when asked — but I will remember that if I send a QSL for a through-repeater contact the card has no validity for any metre-wave awards and logically should be posted to the repeater!
7. If I'm not in The Callbook I'll regularly announce my position.
8. If I haven't got a Callbook I'll buy one, knowing it's the VHF Person's Best Friend after "the rig" (No matter whether I'm in it or not. It's the other person's identity I want to know, not my own).
9. Whether I'm in The Callbook or not I'll always at the start of a QSO say where I am, remembering it's much more important than "the name".
10. I'll try never again to say "there" as a punctuation point.

I won't make any more resolutions. I might forget them. Anyway all of these have appeared in HRT during the last twelve months and I'll try to follow them."

microphone experience, and rapidly sloughed off such quirks as "the personal" or saying "Radio Five" when they meant "Readability Five" or "On this side" when the simple word "here" would suffice.

And how many of us are in the "we"? Probably 60,000 in the UK by the year end, with the implication that amateur radio has an overcrowding problem ahead of it (though hardly on the scale of some of 1984's doom mongers with their prognostications that poor old Mother Earth would need to sustain 8,000 million souls by the end of the century!). But more of this phenomenon later in this piece.

Secondly, Repeaters

What now of the second major development remarked in Paragraph 2 above? It can be put in one word: Repeaters.

Just a year ago your present writer contributed two articles to HRT on the subject of repeaters which suggested that they represented the biggest collective technical and organisation effort ever to be extended by the British amateur radio movement. That effort continues to be directed towards the improvement of the current chain of repeaters and towards an extension of their numbers where gaps in coverage occur.

No excuse is offered in restating a few basics about Britain's repeater chain in spite of the fact that most of them were rehearsed here in those articles of a twelvemonth ago. To the many thousands of enthusiasts who have come into amateur radio since then and have added their numbers to the readership of *Ham Radio Today,* it may be news that repeaters are "not provided by authority" like the National Health, say, or your local bus service. They exist solely because dedicated groups have seen a need for them, have undertaken the lengthy process of stating this need to the national society and, through the RSGB, to the Licensing Authority; and, once given the go-ahead, have designed and built the hardware that makes a repeater a viable entity, and have obtained site clearance to allow the device to be advantageously installed.

Creating a repeater station is a demanding job. For one thing, "the box" must give 24-hour-a-day unattended service. For another, it must be funded. These things happen if there is a solid technical and financial backing to each group undertaking such an enterprise. They don't if there isn't.

The newcomer, then, needs to be fully aware that the repeater they — sometimes quite casually — use is the product of the brains and the brass of his fellow hams. If he is one of its regular patrons he owes it to those fellow hams to join their group and, with his subscription, to help to keep it financially sound.

Low Down — and High Up

Now for those minority interest developments of the past year (and likely to continue into the next) which are hinted at in my preamble. They represent amateur radio activity at opposite ends of the metre-wave spectrum.

At one end of it lies "the lowest very high", meaning the six metre band, an area denied to the British operator by the declining presence of 405-line television broadcasting. It was the advent of this same TV that put paid to "Six" back in 1949 at a time when special licenses for 50MHz were held by a pioneering band of metre-wave enthusiasts, sadly granted little time to explore the band before video took it over.

Three-and-a-half decades later with archaic "405" on VHF by now superseded by colour on UHF, the seeds for hope of renewed amateur activity at 6 metres were resown, even though they offered a hard row to hoe.

For one thing, "the viewer must be protected", even though on "405" there might be no more than half a dozen of them left in the remote parts of the land. For another, services other than the Amateur Service might cast covetous eyes for space at 50MHz when television eventually vacated it. But as the months of 1984 wore on, that germinal row seemed less hard to hoe: as the broadcasters announced the closure of station after station of the old 405-line tradition, there came from official circles on high distinct murmurings of sympathy towards the amateur case for space on "Six". Already, before 1984 was very old, amateur activity on 50MHz had been authorized, admittedly by only a sprinkling of stations geographically placed to provide best experimental evidence of the band's capabilities, but at least it was a foot in the door of "Fifty". The limiting factor that transmission was forbidden within TV broadcasting hours and in no way restrained the enthusiasm and technical expertise of the lucky few.

A minority interest, perhaps: but if few can as yet transmit, many may receive. They were shown how — being retrospective again! — in another of HRT's articles of 1984, that in which the "Extrapolator" converter was described.

The other minority interest, burgeoning over many years and gathering a force in 1984 which will assuredly carry it with great momentum through 1985 and beyond is microwaves.

Here is an area of amateur radio where the do-it-yourself ethic is pre-dominant (as indeed it is on "Six" also). In spite of the increasing availability of commercial "black boxes" (a lot of them grey ones) for the 23cm band — with such an enhancement of performance that "23" now takes in many of the attributes of 70cm — it is still the case that to achieve results on the higher megahertz allocations you must be able to "do your own thing". You must be well versed in circuit design and construction using techniques comparatively unfamiliar to those used on the lower frequencies. You need much patience before you reach that magic moment when input from the home built transmitter is realised. And you need stamina and dedication to transport your microwavery to remote and inaccessible high spots where good DX will result.

Finally, That Demography

So much for the metre-wave *landmarks* of our opening paragraph, four in number. The individual reader could no doubt identify many more of his own choice. What, now, of the *lessons* to be drawn from the experience of the passing year?

Here again each individual to his or her choice. You are learning all the time when you inhabit the 'metre waves': there is so much new to do and to discover both in operating and building.

To this writer the major lesson to be learned from 1984 is a reminder that we have all got to do something about our ever increasing numbers, Metre-wave licensees are increasing at such a rate that something *must* be done if the movement is not to collapse under the weight of its own numbers and the enjoyment of amateur radio inhibited as a result.

Well, what *can* be done? In a metre-wave context quite a lot, as has been suggested here in previous articles in HRT. For example, it would abate the QRM problem enormously if the use of omni directional antennas were to be discontinued as being anti-social devices, radiating in all directions and not solely in the wanted one. They cause QRM where it need not be heard.

Coupled with this consideration is the tendancy to use more power than is necessary for adequate communications. Power amplifiers hitched on to the end of transmitters are an expensive means of "getting more e.r.p." when a cheap and cheerful five or eight element beam will do the job much more effectively — and much less anti socially because directionally.

Something else which has become increasingly obvious is the need to use more of the 2 metre band below 144.9MHz, a trend which thankfully has been gathering pace during the last year or two or three. Yet even with this resort "Two" seems likely to seen become so overfull at peak operating times that to find a clear spot will be almost impossible.

The answer? Go to the next band up, meaning 433MHz. The space it offers for pleasurable communication is vast, the antennas needed are small, and signal levels point-to-point for a given ERP little different from those experienced on "Two". If an augury is sought for 1985 you can spell it "Seventy Cems".

"I seem to have read some of this before". The longer term reader may be forgiven the thought. But today he has several thousand new companions who have *not* read it all before, and to whom much of the foregoing may well be news. Some of it may (hopefully) direct their metre-wave intentions for 1985.

That Two-Figure Phrase

Now it's time to say "73 to the retiring year of 1984" as it vanishes into history.

This valedictory signing-off term — just "73", not "seventy threes" or, worse, "seventy threeses" — was handed down into early wireless communication from the days of the American railroad telegraph.

When miles and miles of wire linked lone signal boxes across the prairies and batteries were the sole source of power, economy was essential: you sent the maximum information with the minimum of dots and dashes. Many two-letter groups came into (often unofficial) use: "73" was one of them. With just those two numerals, the lone signal boxmen would impart their best wishes to their unseen chums up and down the line. Just as we do today! 73.

HAM RADIO TODAY NEXT MONTH

SIMPLY THIS IS PACKET RADIO!
Dave Bobbett, G4IRQ, clarifies the situation with a 'Micro Net' special feature

PLUS

SOME MODIFICATIONS TO THE TOTSUKO TR 2100M
Upgrade this flexible and popular 2m SSB/CW Tx/Rx

THE CASE FOR 'F' UNITS

HOW TO START YOUR OWN NET

SPECIAL REVIEW: Angus McKenzie investigates the talking walking (?!) Trio TS711E 2m multimode transceiver - *the* state of the art?

An Antenna Discharger

A useful, inexpensive idea for protecting your transceiver from lightning or static discharges when using open wire feeder, from Peter MacKrell, G3AEP.

Amateur radio stations employing open wire feeder for the antenna, will be very familiar with the use of 'stand-off' and 'feed-through' insulators. Fitting 'feed-through' insulators, to provide entry of the feeder into the shack through a window does not require the detailed methods of drilling glass suggested in some of the earlier handbooks. These days, it is usually less work removing one small pane and replacing it with a piece of easily worked perspex or acetate sheet.

Should 'stand-offs' be required, a cheap and efficient substitute can be found lying in a corner of the average garage — the discarded sparking plug! Designed to withstand high ignition voltages, with low-leakage insulators, it is only necessary to forcibly screw them into holes of the required spacing in a piece of wood, or plastic, to form a base mounting. If the same form of construction is used with a metal base, which is then earthed, a simple form of lightning, or static, spark-gap is provided at the same time (see Fig.1). Ideally, a gas-filled, sealed unit should be used since it is not affected by varying conditions of humidity. However, the simple 'open gap' has been widely used for many years and were usually an integral part of those ceramic knife switches common to most window-sills, when domestic 'wireless sets' had external aerial/earth systems.

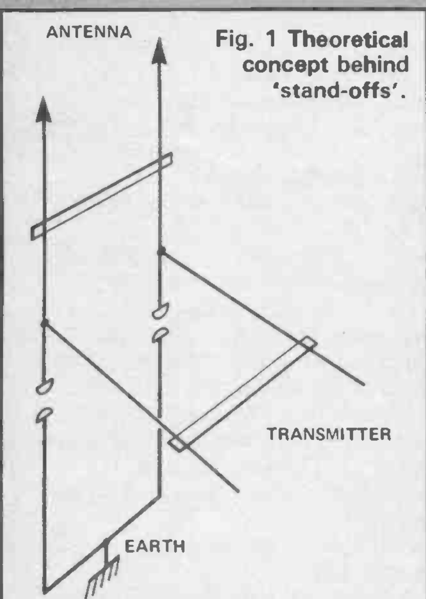


Fig. 1 Theoretical concept behind 'stand-offs'.

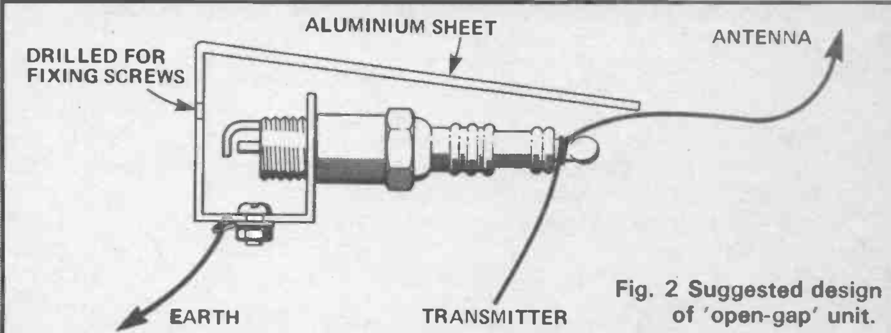


Fig. 2 Suggested design of 'open-gap' unit.

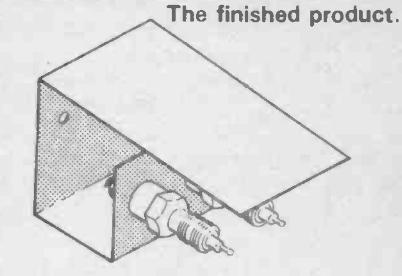
Construction

The actual construction is up to the individual, but the design shown was only a few minutes work. A piece of aluminium sheet, approximately 8½" × 3½", was bent as in **Fig.2** (the extra length merely providing a 'roof' for the insulators). Two holes were drilled and filed to *almost* the size of the plugs, which were then used to tap their own threads. As these are not tapered, some pressure may be needed to get the thread started. Continue tapping, screwing the plugs home with a plug-spanner, or wrench. Further holes were drilled to take the two fixing screws and the nut and bolt for connecting the earth lead to the copper ground rod.

The plug gap can be adjusted by gently bending the side electrode in the usual manner and checking with feeler gauges. The actual gap size will depend upon the transmitter power and feeder system in use, but should be as small as permissible without sparking occurring on power peaks *on any band* under humid conditions. With low impedance feeders it will obviously be possible to maintain a smaller gap than with feed-lines having high standing waves and consequent large voltage peaks; it therefore follows, in the latter case, that the actual voltage applied to the gap can vary at different points along the feeder and from band to band. Sparking plugs are usually supplied with the electrodes set in the region of 25 thou., but in many stations it will be possible to halve this gap without difficulty.

With talk of E.M.P. (electromagnetic pulse) from nuclear sources to add to the natural hazards of lightning and static, it seems prudent — at negligible cost — to provide *some* measure of protection for expensive equipment.

The finished product.



RADIO Tomorrow

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

1 Dec **Bristol ARC: Christmas Fayre at YMCA, 6 Park Road, Kingswood, special event callsign GB2KCF.**
S Manchester RC: club dinner.

2 Dec **RSGB 144MHz Fixed.**
Sutton and Cheam RS: Coulsdon club flea market.

3 Dec Stourdridge ARS: informal.
Stowmarket ARS: Christmas social.
Sutton and Cheam RS: natter night.
Todmorden DARS: social evening.
Worcester DARC: *The Spectrum Computer by G6CQK* at the Old Fellows Club.
BARTG Cumulative 2m/70cm RTTY contest final part.

4 Dec Chichester DARC: club meeting.
S Lakeland ARS: club meeting.
Dartford Heath DFC: pre-hunt meeting.
Fylde ARS: *Radio Astronomy by G3KEN.*
Bristol ARC: *Visit and talk by RSGB Regional Rep G3LP.*
Ealing DARC: *RTTY/AMTOR/ Packet Radio.*

5 Dec Cheshunt DARC: *Remote Imaging by G8LOK.*
S Bristol ARC: *Test Equipment with G4KUQ and G4SDR.*
N Cornwall RC: Ring PRO.
Telford DARS: Telford Radio Rally Group AGM.
Wirral ARS: *Japanese Morse by G3CSG.* **Change of venue to Heswall Parish Church Hall, next to the bus station.**

6 Dec Horsham ARC: AGM at The Queen's Head, Church Street, Horsham.
Shefford DRS: junk sale.
Cray Valley RS: *G3RWL on 'OSCAR'.*
N Wakefield RC: natter night.

7 Dec Axe Vale ARC: annual dinner.
S Lakeland ARS: annual dinner.
W Kent ARS: informal.
Maltby ARS: *Using Test Equipment by G3XXN.*
Medway ARTS: junk sale.
Radio Society of Harrow: informal and practice.
N Wakefield RC: Christmas dinner at the Swallow Hotel.
Dunstable Downs RC: Christmas TV show.
S Manchester RC: *The Smith Chart by G8UQ.*

8 Dec Three Counties ARC: Christmas party.

9 Dec Dartford Heath DFC: club hunt.

10 Dec Milton Keynes DARS: *Fibre Optics.*
Sussex Repeater Group: AGM, Queen's Head, Horsham 8pm.
Sutton and Cheam RS: committee meeting.
South Cheshire ARS: club meeting at new venue The Victoria Club, Gatefield Street, Crewe starting at 8pm. Newcomers very welcome.
Exeter ARS: introduction to club construction project — a simple frequency marker.

11 Dec Mid-Warwickshire ARS: Christmas celebrations.
Wakefield DRS: Christmas social evening.
Bury RS: AGM and cheese and wine.
Westmorland RS: *Talk about 10m by G3IZD.*
Bristol ARC: *Crime Prevention.*

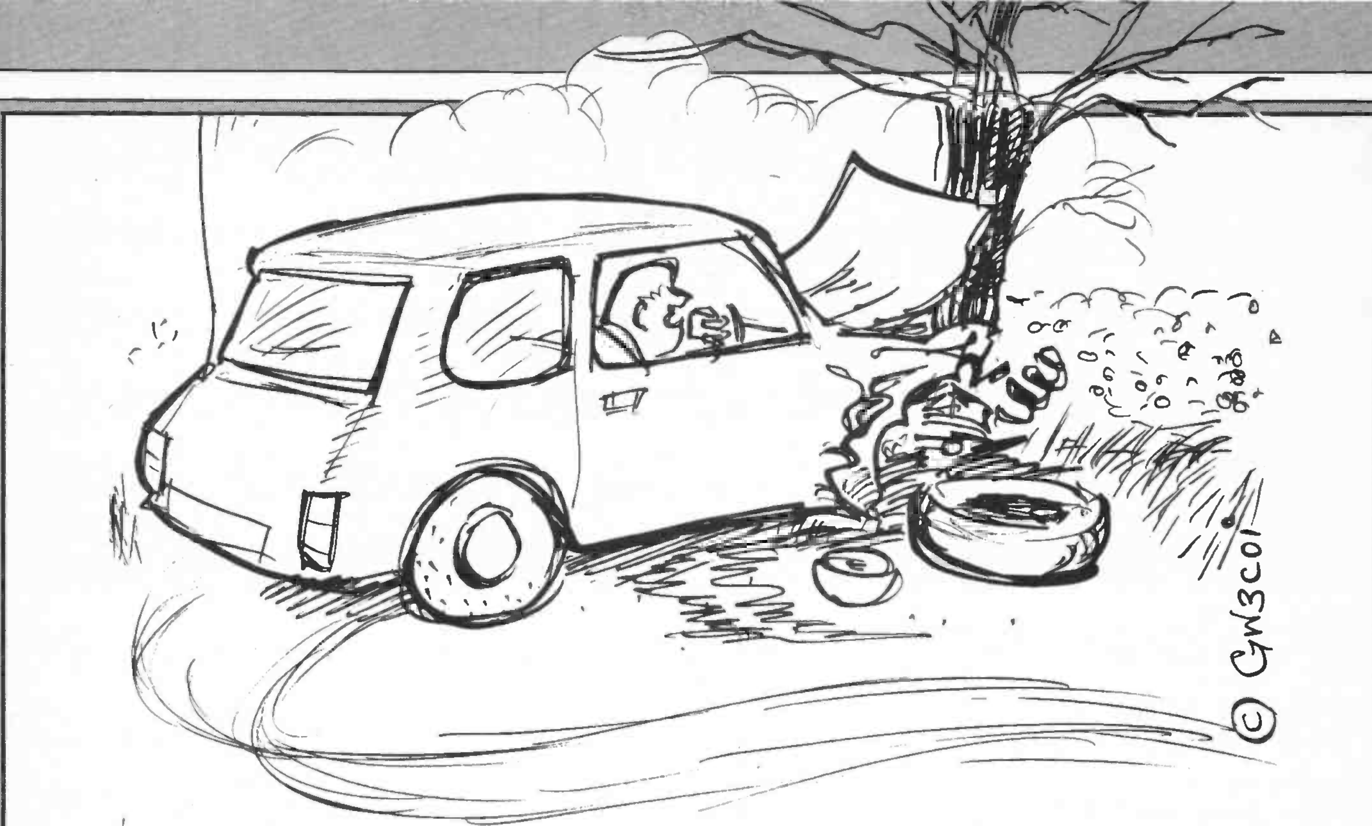
12 Dec Farnborough DRS: Christmas social evening.
Cheshunt DARC: natter nite.
S Bristol ARC: HF CW activity night, by G4SQQ.
Telford DARS: quiz night.
Chesham ARC: *RTTY/AMTOR/Packet Radio.*
Bath DARC: meeting 8pm at the Englishcombe Inn, Englishcombe Lane, Bath. Newcomers very welcome.
Rugby ATS: Warwickshire Repeater Group on GB3YJ and GB3MW. Meeting commences at 7.30 pm at the Cricket Pavilion, BTI Station, 'B' Building entrance, A5 Trunk Road, Hillmorton, Rugby.
Crawley ARC: Skittles evening, at The Haycutter, Oxted. (I hope the next 25 years of CARC are as successful as the last. Congratulations!)

13 Dec Southgate ARC: AGM.
Shefford DRS: constructors contest.
Edgware DRS: junk sale.
N Wakefield RC: on-the-air night.
Cheshunt DARC: Christmas dinner, tickets from G4UDZ.

14 Dec W Kent ARS: annual dinner.
Maltby ARS: *Make It Work with G3ZVG.*
Medway ARTS: natter night.
Radio Society of Harrow: *'Spring Valley' Computers lecture and demonstration.*
Tiverton (South West) RC: club dinner. The club meets every Monday at the Queen's Head pub, Tiverton and has been able to set up a base station in the skittle alley with the club's callsign G4TSW. The Tiverton Ten award is available from the club when operators make contact with 10 Tiverton stations.
S Manchester RC: *Three Years of SSB Field Day by G3SVW.*

15 Dec Horndean DARC: Christmas dance.

16 Dec **RSGB 70MHz CW.**
Glenrothes DARC: *Fire Safety Films by*



"... WELL I SUPPOSE YOU COULD SAY WE'RE STATIC MOBILE ..."

GM3YOR.

17 Dec Worcester DARC: skittles and social eveing at the Old Pheasant.

18 Dec Dartford Heath DFC: EGM.
Fylde ARS: Christmas party.
Bristol ARC: Christmas goodies or "It'll be all right on the night!"
Verulam ARC: AGM, film show and seasonal refreshments, meet 7.30 for 8pm.

19 Dec Cheshunt DARC: Christmas video show with G8NDR and G4OAA.
Hastings ERC: Christmas social.
S Bristol ARC: club families evening with G4YZR.
Telford DARS: RSGB video films.
Rugby ATS: informal, bring along your latest construction project for discussion, technical matters etc.

20 Dec Cray Valley RS: natter night.
Chichester DARC: Christmas social.
S Lakeland ARS: club meeting.
Shefford DRS: The Chairman's Mince Pie evening.
N Wakefield RC: lecture/visit.

21 Dec Sutton and Cheam RS: Christmas get together.
Maltby ARS: Christmas junk sale.
Medway ARTS: Christmas social.
Radio Society of Harrow: grand Christmas party.
Dunstable Downs RC: DDRC Christmas party.
S Manchester RC: Christmas party.

28 Dec W Kent ARS: Cheese and wine.
Radio Society of Harrow: No(el) meeting(?).

31 Dec S Lakeland ARS: New Years party.

2 Jan S Bristol ARC: *Discussion 'What's Legal' with G3OUK*
Cheshunt DARC: natter night.

3 Jan Cray Valley RS: *Assorted Panics by G3GJW.*
N Wakefield RC: natter night.

4 Jan Maltby ARS: *G8VHB Talk*
Medway ARTS: natter night.
Radio Society of Harrow: used equipment extravaganza.
Dunstable Downs RC: junk sale.
S Manchester RC: *Oscilloscope Design Development by G4AOK.*

5 Jan Exeter ARS: annual Christmas dinner.

7 Jan Sutton and Cheam RS: natter night in the Downs Bar.
Horndean DARC: *Talk by G6NZ.* Visitors and potential members are very welcome. An active constructors section is aimed at those knowing little of radio techniques. The club is based at Merchistoun Hall, on the A27 near the Schooner Inn. Meetings start at 1930 for 2000.

8 Jan Dartford Heath DFC: pre-hunt meeting.
Bristol ARC: night on the air.
Bury RS: to be announced.

9 Jan Three Counties ARC: *Did Morse Get It Right? by G3CCB.*
S Bristol ARC: SWL activity night.
Cheshunt DARC: *The Morse Telegraphy with G4FAI.*
Farnborough DRS: *G3AQC's Aerial Circus.*
Rugby ATS: Are the voltages correct? Bring along your multi-meters and have their calibration checked!

10 Jan Edgware DARS: AGM.
N Wakefield: visit to Pontefract junk sale.

11 Jan Maltby ARS: computer night.
Medway ARTS: *'How Can I Work Meteor Scatter' by G8VR.*
S Manchester RC: *Radio Analysis by G6EAO.*

13 Jan Dartford Heath DFC: club hunt.

15 Jan Fylde ARS: AGM, election of officers.
Bristol ARC: 70cm dish redesign and construction.

16 Jan Hastings ERC: *Compact Disc Demo by Sony (himself?)*
S Bristol ARC: activity night with G4TSS.
Cheshunt DARC: natter night.
Rugby ATS: informal plus Christmas social details(?)

17 Jan Cray Valley RS: natter night.

18 Jan Maltby ARS: RSGB video.

Medway ARTS: natter night.
Sutton and Cheam RS: *QRP with G4BUE.*
S Manchester RC: *Microwaves by G3PFR.*

20 Jan Glenrothes DARC: *DXpeditions OY, TF, 9L, ZB and VP2M (Monserrat) by GM3YOR.*

22 Jan Bristol ARC: computer night — Z80 machine code in the beginning.

23 Jan Three Counties ARC: *Steam Railways by G3ZRM.*
S Bristol ARC: To be advised.
Cheshunt DARC: *The RSGB — questions and answers with Smudge Lundegard, G3GJW.*
Farnborough DRS: construction contest winner with G4JNT.
Rugby ATS: informal.

24 Jan Edgware DARS: informal.
N Wakefield RC: *Test Equipment by G8UYZ.*

25 Jan Maltby ARS: *Morse 'The Great Debate' with G6RIL and G3ZVG.*
Medway ARTS: video — 'Japan's Visit To China' or The Japanese visit to China.
S Manchester: *RTTY by G4NTY and G4MYB.*

30 Jan S Bristol ARC: to be advised.
Cheshunt DARC: natter night.
Rugby ATS: an amateur radio video (title to be announced).

31 Jan N Wakefield RC: monthly meeting.

1 Feb Medway ARTS: construction contest.
Dunstable Downs RC: *AMTOR, RTTY and packet radio by Ian Wade, G3NRW.*
S Manchester RC: club quiz.

Will Club Secretaries please note that the deadline for the March segment of Radio Tomorrow (covering radio activities from 1st February – 1st April '85) is 15th December.

Contacts

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YAESU FRG 7000 communications receiver, all amateur bands and general coverage, excellent condition, modern digital readout clock and timer etc. £165 datong indoor active aerial plus mains PSU. £45. Telephone Ruislip (71) 39111.

DAIWA search 9 receiver fitted 8 crystals plus VFO tuner 2m £32. Two 1155 power packs original £6 each. Faversham 538196.

BRAND new 4CX250B valves unused and in carton. £25 the pair 061 740 9630.

TUNER FMT-51, eagle products, LW/AM/FM. New, unused, battery operated. Requires amplifer and loudspeaker fpr complete radio £6 ono. N. Gundry 30 Newbridge Hill, Bath, Avon. Bath 21605.

YAESU FRDX400 comm's receiver. 1.5-30MHZ amateur. bands, 10 MHz W.W.V., CB band, 4m, 2m. C.W. sharp, C.W. medium, SSB, AM wide, AM narrow, FM. 'S' meter. AVC slow, fast, off. Notch fitler, clarifier. Excellent condition. £100. Buyer inspects and collects. Call G6XM 0425 73584.

Twenty dubus VHF UHF magazines and handbook £10. Daiwa CN520 SWR/power meter. Ranges 200W or 2kW £20. AMSAT — UK technical manual £6. Ring Dursley (0453) 811454 after 6 pm.

FREE Sony 405 video recorder, if you buy Sony video camera plus lens, 405 8" monitor, microphone and tapes. Recorder needs slight attention. £50. Buyer collects. Wanted Dynamotor DM28 for BC348 receiver. Phone Wickersley 541606. G3JDK Allendale Road, Rotherham, Yorks.

YAESU FR50B amateur band receiver 'Q' multiplier fitted, good order £70. Tel G4ORJ Rushden 314250 (Northants).

YAESU FT77 HF transceiver with mobile bracket and mike, 3 months old used on Rx only £400 ono. Also Yaesu FC707 ATU £55. Contact Martin on Cheltenham 0242 517336 evenings.

BARLOW Wadley XCR2 receiver VGC with full service manual £50. Sommerkamp FL200 200W transmitter vgc with spare PA valves £50. Vintage CR100 receiver GWO with service data £30. Hastings 0424 753949 G3UFI.

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SALE unused HF600D 8 digit counter, reads up to 600MHz in 2 ranges £85. DFK Palm IV, 7 channels (0,2,4,6,8, 14, 20) boxed PSU £85. Both including P&P. Ring Winterslow 862489 after 1900. Bland, 11 Great Croft Firs Road, Winterslow, Salisbury, SP51SN.

FOR SALE Ham International Concorde 2 SSB rig AM FM USB LSB and CW, 120 channels £100 or nearest offer. Good working order and condition, or swap for HF recever for beginner. S Wilson, 26 Watson Avenue, St. Andrew's, Fife, Scotland.

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YAESU FT208R 2M FM handheld — 2.5W out — 10 memories. With NiCads, carry case and strap, rubber duck and external microphone plug (worth £8). boxed, as new — 4 months old £145 or part exchange for FT290R. Telephone Chris G1CBC Darwen 771303.

TRIO TR2200GX fully crystalled NiCads charger, good worker £65, Edison phonographic 1905 wind up but incomplete no horn, offers please. Yaesu FT221R with YC221 display and mutek plus valve amp 300W output £600, no offers. Phone Alton (0420) 82693.

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DRAKE TR7A with PS7 powr supply £850; Drake MN7 ATU £125; Drake SP75 speech processor £50; Trio TR9000 2M Multimode with PSU control unit and speaker £250; Dressler D200S 1Kw 2M linear £600. Tel 0742 666169 evenings.

AR88D Receiver, Diawa 2m receiver, home brew 20M reciever, plus Hi-Fi system, comprising realistic amplifier, tuner, sharp, belt driven deck, audiotronic front load casette deck and realistic speakers. Price £160 ono. the lot. Good condition. Phone Derby (0332) 74115.

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IC 2025 £100, TR2300 £100, 6 elements 2M Quad £20 G8 TTI, QTHR, Chippenham (0249) 658109.

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EXCHANGE or sell Trio TW4000A plus Jaybeam LW10/2m LW24/70cm Yagi's Hirshman remote rotator, all new cost £675, unwanted gift, accept £625. Or swop HF Transceiver, 9 bands plus FM FT101ZFM or FT102, etc or similar. 33 Hitchen, Merriott, or Crewkerne Somerset.

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SALE/SWAP 48K Spectrum PSU, 2 games plus Scarab RTTY system £200. Or swap for 2m multimode mobile or portable not handheld also Hallicrafters Sky Champion S20R receiver 500kHz to 46MHz £125 ono. Will pay postage. Contact Mr Bolton, 10 Bowness Rd, Ciniston Park Estate, Timperley, Cheshire.

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SELL/SWAP Old radio hard back books of the 1930's = "News Chronicle" Wireless Constructor's encyclopaedia by F.J. Camm, — The Book of Practical Radio by John Scott-Taggart — The Manual of Modern Radio by John Scott-Taggart — Admiralty Handbook of Wireless Telegraphy all in good condition sell or swap for Rx. Phone after 6pm 01-593-4439

SELL/SWAP 1 com IC25E 25wFM mobile 2VFO, 5 memories full scan, hardly used complete with box and manual. £275. Or swap for 2M synth multi contact. Ken G4UQN 0945 61029.

SWAP FT 902DM for 102 or 430S/PS 9 months old. Contact G4XNR Selby 702213 for a true base station.

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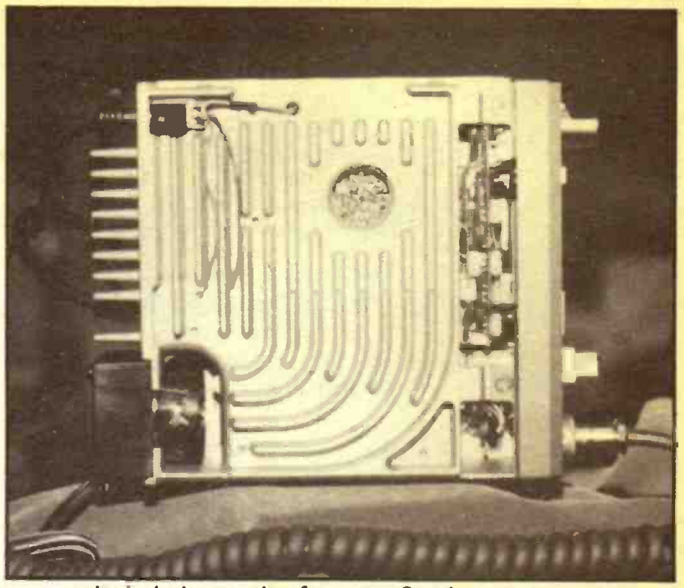

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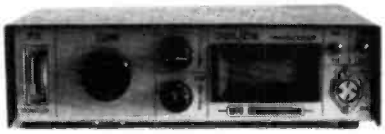

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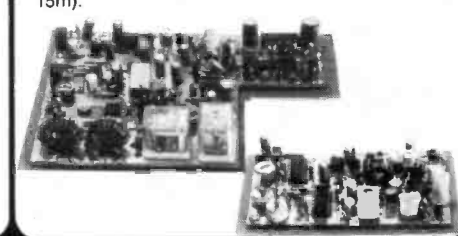

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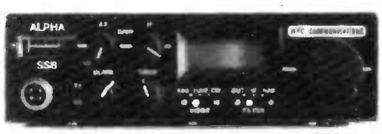

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