HAM RADIO TODAY

NEW

JANUARY '83

75p

SPECIAL PROJECT: A general synthesised HF transceiver

RECEIVING: CW with a £189 box

DESIGNING: Louis Varney G5RV on HF aerials

TESTING: Trio 9130, Yaesu FT480R, Icom IC290E lab and user reviews of 2m multimodes

ERECTING: Towers

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QUESTIONING?: The RAE

SERVICING: KW2000 series

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AMATEUR RADIO EXCHANGE

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Christmas, we are always told, is the season of good-will to all men. But now Brenda has decreed that it should be the season of good-will to the ladies as well.

So, if you have the nerve to spend £500 or more on a rig at either Acton or St Helens in the month of December, Bernie has agreed that the woman in your life should be presented with a beautiful 12-piece bone china coffee service from us as some sort of compensation.

That way **you** can have the rig you want as your Christmas present...the peace will be kept at home...and you can even have a Brenda's cup of coffee any time you want!

NEW · NEW · NEW

FT-980

Yaesu's latest HF transceiver, which fits neatly into their range between the FT-102 and the FT-ONE... and is an obvious competitor for the mythical (or merely elusive?) Trio TS-930.
Features like general coverage receive, notch filter, pass-band tuning and IF shift will make this rig a top-of-the-market bargain at a price yet to be announced, but which we anticipate will be not a million miles from **£925.**

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A worthy successor in the Yaesu range to the evergreen FT-101 series, with so many extra features.
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IC-740

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One item you certainly won't find in many other places is the unique British-made ICS AMTOR decoder for which we have just been appointed the sole London retailers!

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Welcome to HAM RADIO TODAY, the brand new amateur radio magazine with a different view. We care to think that we reflect the best in amateur radio: traditions of home building, discussions of operating practice and an interest in advanced RF design.

We also know that many operators coming into the hobby simply do not have the time to spend with a soldering iron but prefer to spend money instead. We haven't left you out. Our equipment reviews offer some of the finest and most objective appraisal on either side of the Atlantic while our servicing features should take the worry out of buying second-hand gear.

Above all, we recognise that amateur radio is a broad-based hobby. It means experimentation, communication, design and construction. It means scaling chimneys in the face of a full gale to put up a new aerial. It involves gently shivering on a remote hilltop in pursuit of a decent contest score.

It means different things to different people and those people will themselves be different. Some will be highly technical and look at radio from an angle elevated well beyond the rest of us. There will be those that just manage to scrape through the RAE but have the right sort of mind to become good CW operators. The great majority will fall somewhere in between. This is where HAM RADIO TODAY takes a different view. Whatever your interest in amateur radio, the common denominator should be enjoyment. It's our opinion that some people are in danger of losing sight of this.

There has been much debate that Class B amateurs are regarded as second class citizens by the RSGB. Perhaps there is some truth in this assumption about the RSGB and this particular view. Without doubt the Establishment which the RSGB represents is slow to respond to the widening of the amateur radio hobby. This generally translates into the belief that the RSGB is disinterested in the needs of G8's and G6's.

The fact that that person is willing to commit around a quarter of an hour/day over a period of three months to learning morse simply means that he has a desire to operate on the HF bands. It doesn't make him more knowledgable about radio theory or less likely to operate his station incorrectly. It just means that he learnt morse. No question of class A good, class B bad.

It's a personal opinion that access to the HF bands offers an interesting extension to an already fascinating hobby. As long as international regulations call for morse as part of class A licence conditions then that, I'm afraid, is the way it has to be. Go-ahead and learn morse to enjoy your hobby even more.

HAM RADIO TODAY will be about the enjoyment of amateur radio as a hobby, never underestimating the different qualities and interests of enthusiasts who make up our readership.

73 and see you all further down the log.

Frank Ogden G4JST
Editor HAM RADIO TODAY

HAM RADIO TODAY

REGULAR COLUMNS

CONSTRUCTION

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Then turn to page 47 for the job opportunity of a lifetime

RADIO TODAY

Quieter show

Whether people are running out of money or that the Granby Halls are losing their appeal, attendence at the Leicester amateur radio show was significantly down on last year.

There was a definite feeling among the trade stands that the crowds stayed away, according to one estimate by as much as a third. Having said that, the first and last days were crowded to ten deep in the aisles with plenty of the traditional bargains evident for those who could fight their way to the front.

More than one trader told us that the fall in attendance could be attributed to the growing number of small regional shows and rallies while just as many commented that amateurs had noticeably less money to spend these days.

Whatever problems there might be for the ARRA sponsored Leicester event, there was little enthusiasm evident for the move of the London show from the Alexandra Palace to the NEC, Birmingham. Many commented that while the trade may grudgingly support this event despite change of venue, visitors would not be prepared to travel to the NEC. It remains to be seen whether the London and Southern counties amateurs vote with their feet.

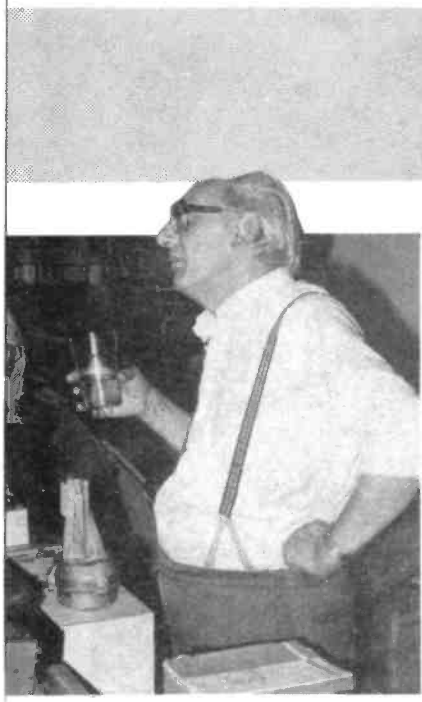
Pride of place on the Datong stand was the new FL3 frequency agile SSB filtering unit. According to preliminary reports from our reviewer, the device is excellent. However we will bring you full details next month. Dr D A Tong stands to the right of the picture.

The Leicester show wasn't short of people wanting to twiddle the knobs. However the dealers report that the amateurs were a little more reluctant with their cash this year.

The Leicester show. The guy from the Cutronics stand was trying to get himself into all the pictures. He only managed this one.

RSGB HQ change

The RSGB has moved from its old London address to Potters Bar. It can now be contacted at: Alma House, Cranborne Road, Potters Bar, EN6 3JW. Phone: (0707) 59015.



Selling radio gear is a thirsty business

Chris Moulding and XYL pictured with a mock-up of the CM1000 HF transceiver which should be available towards the end of December. The British manufactured and designed set, which operates on all bands from 160 through to 20 metres, will cost about £500 complete with power supply.

NEWSFLASH

Catronics Ltd of Wallington, Surrey has gone into voluntary liquidation. Customers should contact the company at its present address for full details. *VHF Communication* **distribution is now being handled by G3XPB, QTHR.**

British HF transceiver

Chris Moulding Radio Services, the Bolton based amateur equipment maker tells us that the first of his new transceivers should be ready towards the end of December.

Covering the HF bands from 160 to 20 (including the new 30m allocation) the set provides SSB, AM and CW operation at the 100W PEP output level from a pair of 6146 output valves.

The rest of the set is solid-state with frequency display by LCD readout. The receiver circuit is based around the Plessey high performance SL6440C mixer circuit. It also claims a "novel dual rate agc system to minimise static crashes".

Although there are valves in the output Chris Moulding has managed to do away with the classic anode tune and loading controls by the use of prealigned circuits. The TX also incorporates ALC and a speech compressor on microphone audio.

The arrangement of the set is reminiscent of the KW2000E in that it has a separate power supply contained within a box of similar proportions to the transceiver unit itself.

Chris Moulding says that the price for the new set will be £399 for the CM1000 plus £95 for the matching power supply/speaker. Ham Radio Today has been promised the first review model and we will bring you a precise evaluation just as soon as we have it.

70cms never in danger

Officials at both the Home Office and Ministry of Defence have confirmed that there is no intention to exclude radio amateurs from the 70cms band.

A spokesman for the Home Office told *Ham Radio Today* that it had received no notification from the MoD to revise the status of the band and it was therefore available to the amateur service.

A spokesman for the MoD told this magazine that the Ministry had no plans to increase its usage of frequencies within the range 430 to 440MHz and that, even now, its only occupation was six 25kHz channels interleaved with the amateur UHF repeater network. Since the amateur and military services are offset by 25kHz "both primary and secondary users could operate together without mutual interference" he said.

The story arose because of a problem with one of the North London/Herts repeaters. According to the Home Office some interference was caused to MoD installations but the problem has subsequently been rectified to the satisfaction of all parties concerned.

Six metres

For those who don't already know the Merriman report on the review of the spectrum from 30 to 960MHz recommends to the Home Office that amateurs should be given an allocation in the band from 50 to 54MHz. It is likely therefore that we will get one.

In recommending an amateur allocation the report says: "We believe that radio amateurs play a part in increasing the understanding of radio and are worthy of encouragement. We therefore recommend that, if the detailed planning of Band one can be so arranged, radio amateurs be given an appropriate allocation in the 50 to 54MHz band.

In the meantime class A licence holders wishing to experiment with six metres can apply to the Radio Regulatory Department, Waterloo Bridge House for experimental permits useable after broadcasting hours.

● We understand that US amateurs have now been given access to the 30 metre (10MHz) band. Look out for those W, N and K callsigns.

CWR600 REVIEW

Want somebody to take your morse test? This little box will for just £189.

By Frank Ogden G4JST.

I went to one of those schools which taught Latin. I realised that lessons in the dead language, at least from a practical view, were a complete waste of time but I put myself through the hoop to gain the requisite 'O' level. Quite a few years have passed since then and I still haven't been able to justify the pains of my study. More to the point, I feel much the same about the Morse code.

I drove myself to spend a quarter of an hour per night, over a four month period listening to five character groups at progressively higher speeds until I had brainwashed myself sufficiently to persuade the likes of a Post Office radio officer that I wss indeed fit for the HF bands. The ordeal of the Morse test felt about as long as that last sentence. Anyway, I passed. "Your sending is a bit ropey but your receiving's OK" and, with that, the radio officer signed the form.

Ocassionally I attempt to struggle through Julius Caesar's 'Commentaries' written in his own tongue. I also take to the key with just about the same frequency. The principle use of the Latin exam these days is as a tool to keep the proletariat masses out of the Foreign Office. The principle use for the Morse test is to keep the proletariat masses off the overcrowded HF bands.... Yes, I believe that you have to limit the numbers otherwise it's no fun for anyone. I say base the exam on practical radio equipment design or a subject at least half pertinent to amateur radio. Then people would have something to talk about once they have gained access to the airwaves...

Inhuman operators

All this sets the stage for a review of a device which is designed to take the chore out of a virtual anachronism. Actually, that's rather unfair to the CWR-600 since it also decodes RTTY transmissions extremely effectively. When the device is asked to deal with CW it behaves singularly like a human being: if it is given correctly spaced Morse, properly sent, it reproduces the code reasonably effectively. If the sending is bad with lots of 'swing' and running together of characters then it gets it wrong or gives up, just as a human operator would.

The device also has a finely tuned 'ear', in reality a phase locked loop input filter which enables the unit to differentiate a desired CW signal through the adjacent QRM. It is pretty good at this. It will ignore interfering signals of equal amplitude within a few tens of Hz of the wanted one. However, any fading on the desired signal in respect of the interfering one causes the decoder to trip up. The CWR-600 will decode good morse at the 12 wpm rate down to about S2 signal strength. This is through a standard 2.4 kHz filter in the associated receiver. There was little or no advantage to be gained by dropping the bandwidth to 250 Hz on the receiver because the PLL input filter has a far narrower acceptance band. With the receiver's 250 Hz filter thrown in weak signal performance was marginally improved, perhaps down to S1, but low level interference spikes were drawn out causing E's to appear all over the place while throwing the speed sensing circuitry. The unit is commendably insensitive to interference spikes when used with an SSB filter. The higher the morse speed, the higher the signal strength required to decode the signal correctly. At speeds around the 30 wpm mark the input signal has to be at least S6 to S8 and of perfect morse formation.

Ropey Morse

All the forgoing assumes that the unit is used with a textbook morse signal. Unfortunately there are very few of these on the amateur bands. The plain fact is that the average amateur CW operator sends virtually unreadable morse unless he is using a fully automatic keyer. The algorithm used by the decoding programme should be adequate to deal with reasonable aberrations from standard CW but most hand keyed amateur CW represents an unreasonable — and unreadable — aberration. Generally I found that there was a very good correlation between what the machine could decipher and what I could. OK, I grant that I am not a particulary experienced or willing CW merchant but I can copy

reasonably sent code. With a few more years, I might learn to deal with the CW slang which permeates the low ends of the HF bands. Unfortunately, the morse decoder, like me, is not so equipped.

To put a dimension to the problem I spent at least three hours of one September day trying to record the perfect amateur CW QSO for this review. I failed. There wasn't one that I could photograph which did not have lots of blemishes. The problem was almost entirely due to rotten sending and had very little to do with QRM, QRN and QSB. However the moment I tuned to a commercial CW station, it worked perfectly.

Operating the device is easy. You simply hook the AF input on the unit to the external speaker on the associated receiver, connect the RF output — you can purchase the unit with a baseband video output — to a domestic TV set tuned to channel 36, connect the power leads to a 12V supply and you are in business to receive either CW or RTTY.

The operating mode is set by a front panel switch. There are a pair of push buttons (upshift of space, letters/figures) pertinent to RTTY reception. The machine will display the current page while storing the previous one and a reset button scrubs the display file and sets the cursor to the top left hand corner of the screen.

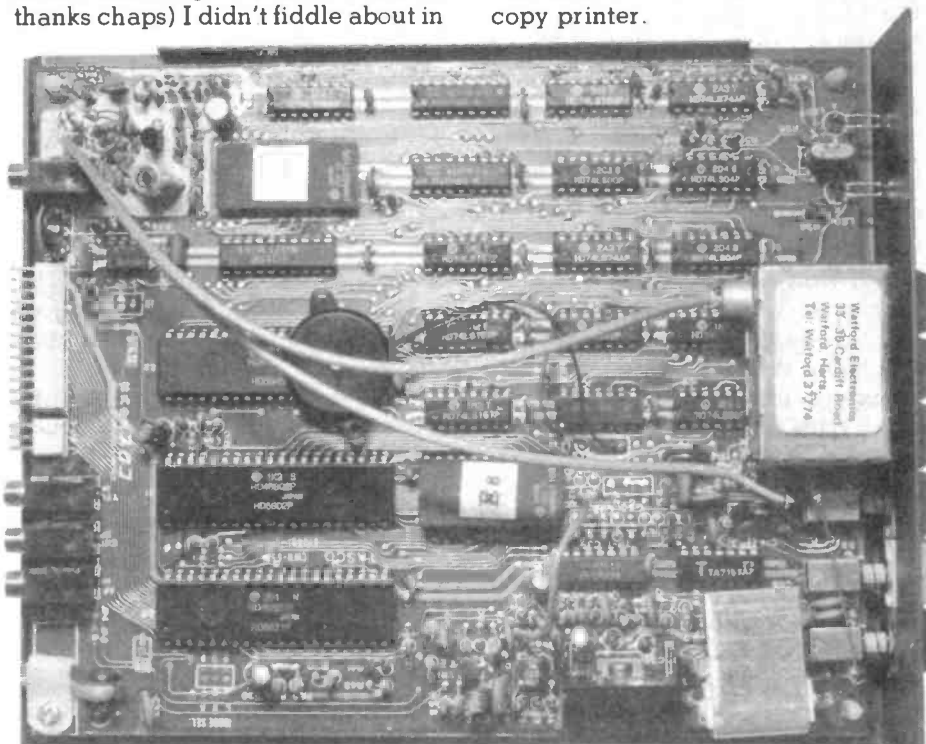
Incoming CW or RTTY lights a monitor LED and sounds a mimic buzzer inside the unit. The two between them tell the user when the pitch of the input signal is sufficiently close to the required 800 Hz to be correctly demodulated.

The handling of CW is relatively easy, the only critical adjustment being the tuning of the receiver or transceiver. It is not quite so straightforward for RTTY.

As set by the factory, the unit will only work with RTTY of 45.5 bauds. This is the amateur standard. Most other traffic is centred on 50 bauds, not much different but enough to throw the decoding circuitry. The manual supplied with the machine gives details of the internal adjustments required to alter the baud rate. The procedure seems straightforward. However, since the review unit belonged to Amateur Radio Exchange of Acton (many thanks chaps) I didn't fiddle about in an attempt to change the baud rate.

It handles RTTY very well. It decodes correctly down to signal strength S3 or less. The main tuning is rather fiddly, perhaps the only shortcoming as an RTTY decoder. This is because the input circuitry handles RTTY in the same way as CW — unlike dedicated RTTY decoders there is no PLL tracking of the frequency shift keying. The moment the carrier shifts away from the 800Hz tone, the unit sees a mark whether the shift be 170 Hz (amateur) or much more.

The unit has a Centronics interface connector on the back for those with about £300 to spend on a hard copy printer.



It works well but radio interference leaking from the board can cause problems.

Having said all this the CWR-600 has wrinkles. It will not copy CW that chirps — changes frequency during keydown — a characteristic of many UA, UB and UK CW stations. This is perhaps a small defficiency in comparison to the major technical drawback, the generation of appreciable amounts of harmonics from the internal digital circuitry.

It is possible to detect harmonics from the unit all over the place on bands from 7MHz upwards. They sound just like normal heterodynes until you tune them into the passband of the decoder. The PLL locks on, the MPU starts processing, the heterodyne stops, the MPU falsely detects an 'E' and throws it onto the screen, the heterodyne re-starts only to commence the process all over again. The net result is that the machine chucks out neat columns of 'E's, not very helpful when the average amateur CW poses quite enough problems already.

To be fair I was using a wire aerial connected to an ATU adjacent to the morse decoder and receiver. I suspect that a coax or balanced line feeder to a remote aerial would have cured the problem. However I don't have one and trouble was evident. The harmonics were measured at the S3+ level and were present throughout the frequency spectrum. There are about half a dozen in any 100 kHz section right up to 30 MHz. They are easy to recognise though because they fill the screen with 'E's...

Summarising, this unit is no substitute for years spent getting to grips with grotty amateur morse. If you expect the decoder to lay those bottom kHz wide open, then forget it. However, given half a chance, it does work and is great fun, something that I believe amateur radio should be. It copes with RTTY admirably and on that account alone is worth the price tag of £189. One thing is for sure, it is a lot more useful that all those wretched Latin verbs.

```
__I_IJI_IJ___I_IJI_IJ I1UIJ+K _DDEI_
_ I 1UIJ J __I__ I1UIJ___ I1UIJI1UI_
 I 1UIJ+K I_IJ_ RKEE E HIIORL? ORL?D
E__HANT T CQ CQ CQ CODEY2JIA Y__A YU
 IIIII I IE > CQ _K _ _DE__SA __SA _
 _ _ CQ _DE__IA __IAKOE.T _ CQ _ CQ
_DE__SA __SA _ _ _ _DE __HA Y2JEA Y2
15A + PSE NT __A EN ENGA OC TU ,UR R
ST 569 569 FB TI EATH IS NR R OST TC
V NR I _S TO6K/ BALTIC SEE E MTASEE
_NANE IS E B E R H A A D B ER S I A
E I I_E G NE EI N EC__A NT _L FG_IIG
3J_B__VTU T_,THEREW^ AOMON_NT_I_IIT_
INGWITH VYSTRONSIGNALES COULNT COPYP
Y6ING SREE, _ATN _= SO_ERPTALLOC G 3
JTGNEEDE_(6A NT ■
```

A) What appears on the screen for most of the time is gibberish. In actual fact, it is not the fault of the unit. The simple truth is that most hand sent amateur morse bears little relationship to the neat charts shown in all the textbooks.

A typical case is this CQ call received S5 on the 7MHz band. No one thinks about the way they bang out CQ with the result that the message is unintelligible to the machine and only a little more comprehensible by a human. Those dashes are what the unit prints out when it can't make any sense.

```
Q CQ CODE UB5FCL UB5FCL UB5FCL+Q CQ
C=DE UB5FCL UB5FCL UB5FCL + K GYWHEU
B5FCL=GDDROM=URRST5NN 599=QTHIS ODES
SI E DESSA =NAMEIS OLEG OLEG OLEG =H
U? F6GYWDEUB5FCL KN R6GYWDEUB5FCL=OK
DROMPAUL=T_FORQSO=MYQSLSUREVY73ESDXD
ROMPAUL+F6GYWDEUB5FCLSKEE ■
```

B) This is a picture of some fairly respectable CW received at S5 to S6 in the 20 metre band. Once again, it is not totally understandable but this time for a different reason. Rubber stamp QSOs are a useful aid when both parties do not have an otherwise common language. However they look rather strange when you see them in print.

```
AIS ENCORE EXIGZ LE RETRAIT DE
LARMEE ISRAELIENNE DZ LA VILLE... LA
 SECHERESSE DJ VERBZ, LE TON
SO_ENNEL UN TANTINET GAULLIEN, LHEUR
E TARDIVE, LE SUSPENSZ DE
L6ATTZMTE.. TOUTHYHETAIT POUR SOU_IG
NER LA GGAVITEHDUHPROPOY,)L6IMPOGTAM
VZ BZ LA BEVISPOM,#SUGGZGZG OUZ VZLL
Z-VI ZMAMAIT DZ LA.
PZGYOMMZHYZOLZHBOHPGZSIBENTHBE GEPUB
LIQUE... MITTERRWNDHAHSOLHWBPLEMENTH
OTILPYEGHL6EVENEMEMTHPOOGHVONFORTEGH
SONHPMAGEHBZHCHEXHDE
L6ETAT... AHOBSERVEG LEYHVHOYEYHDEHP
LOY PGES,#LEHPGEYPBENTHBEHLA
REPOB_POOEHNEHVOORAITHD6APLLZU3S PUS
```

C) The CWR-600 has been adjusted by the manufactures to receive amateur RTTY traffic at 45.5 baud. In this picture, the unit attempts to cope with 50 baud with a resulting heavy error rate.

```
 PA3CCH   DE  EA3EXN   THIS TIME DIF
ICU_ COPY ALL NOT..
FOR    VERY QRM  QRM     SO THANKS FOR
 NICE CONTAC DEA MY QSL. CARD
SURE VIA BUREAU I HOPE TO MEET YOU A
GAIN VERY SOON THE BEST 73 AND
GOOD LUCK FOR YOU AND FAMILY GOOD DX
. IS    STANDING BY FOR YOUR FINAL
.    GB. GB.  GB.  ........  YOU SIG
NAS  IS 45. 43 .  THIS THE PROPAGACI
ON     PA3CCH     DE EA3AXN    PSE KKK
KKKKKKKKKKK■
```

D) When presented with RTTY traffic at the correct speed, the unit decodes it perfectly. Having said that, the tuning of the main receiver needs to be very precise. If the station is more than about 100Hz of frequency ie, the wrong heterodyne tone is presented to the unti for decoding it will not be accepted and the CWR-600 will either do nothing or print out gibberish. Correctly tuned, it is possible to receive RTTY at signal strengths below S3.

```
U_LETIN D'ENVIRONNEMENT POUR LE NORD
 DU BASSIN MEDITERRANEEN OCCIDENTAL
 VALABLE JUSQU'AU 23 SEPTEMBRE EN SOI
REE AVIS DE COUP DE VENT:NEANT SITUA
TION GENERALE:COURANT D'OUEST MODERE
.FAIBLEMENT PERTURBE P R E V I S I O
 N S : -------------------- -CIEL D
EVENANT TRES NUAGEUX AVEC ONDEES ORA
GEUSES PAR PLACE SUR LION ET OUEST P
ROVENCE.AILLEURS:TEMPORAIREMENT PEU
NUAGEUX SE COUVRANT PROGRESSIVEMENT
AU COURS DE LA NUIT -DEVELOPPEMENT D
'ECLAIRCIES PAR L'OUEST DES ZONES EN
 FEN DE SOIREE DU 22 -VENT:S_ORIENTA
NT NORD OUEST 15/2_KTS SUR LION EI I
■
```

E) Presented with well formed CW the unit is capable of decoding with 100 per cent accuracy. Here is a french coastal weather forecast sent by machine generated CW at 18 wpm. It is faultless at this speed down to about S4.

```
LZ1KDP LZ1KDP DZ1KDP CQ DX CQDX CQDX
 DE LZ1KDP DZ1KDP DZ1KDP CQ DX CQDX
CQDX DE LZ1KDP BM>LZ1KDP PSE DX K F
C E EE 5 NE E TATI  TDSWMANFRED UUOK
 TOIEPCBW VDO

MY RIG RTTY IS:

TRANSCEIVER ICOM PUWP A
COMPUTER TONO 7000 E
MONITOR JB 902

-----
,53,- $843::89NAL 3 ELEMENTOS
MODELO HY GAIN 10/15/20 METROS
```

F) Front panel controls enable the user to switch between CW and RTTY without causing hiccups or altering the text content already held in the memory. In this instance the unit decodes a Bulgarian CW station who is calling CQ and retains the information while the main receiver is retuned to an RTTY signal.

```
LVZ DL3SZDED__ [RR HR VY_MQRM/QRN QR
N-PSE RPT RPRT II PSE R PT RPRT ?] B
KDE DLVZ OK HR KEIN QRM NW RPT = RST
 5 89 589 IN DEN SPITZEN 599 FB QTH
ANSBACH ANSBACH DOK B02 B02 NAME ADI
 ADI RIG DRAKE 4C LINE UND HABE SOEB
EN DIE LINEAR EINGESCHALTET, INPT KW
 MIT GP UND 3 RADIALS NW OCZ DK9XVDE
 DL3SZ K >>DL3SZDEDK9_ _ E JETZTIST
ALLES KLARLBR ADI INANSBACH-- HR ZIE
HT SCHE INBAR EIN GEWITTER _E _D DA
WAR EINE P ERIOB E MIT STARKEN PRASS
 EL GERAU E US CH EN-- STD SR IST TS
820 PL_ LINEAR FL21TTZ BEIDES _E SPA
RFLAMME ABT 2 T T _TT _T _D PT _DZN
■
```

G) Here is an example of a CW QSO conducted at 18 wpm on the 40m band between a couple of German stations. It has to be said that the clarity of this particular piece of decoding is not typical of the majority of amateur QSOs.

```
Z2CQ EN FB VALERY T_QSO , , E S LI E
S LI U W AS T E LEFNIN T ELEFON WY M
OVETE LI POZWONITX U C2 BF ET F2BF Q
KOWU EI E F2AW E E Q K I T ^DEEMEA Z
 VS 6 BFDEU K5E EA PSE KN _ CQDKDE S
M5_ SM5_CQ__DE SM5_ SM5UH CQ CQ [ _B
 SM5UH SM5UH DX K SAT EM I E N E EA
UK5 I E A UK5 E EA=FBDROMMY_L _LLSUR
E4IABUREAUESVYPSEUR_LFER MYSTATION=N
W V Y73BESTDXESHOPECUAGN73 NEESTDXGB
DROM=ES V Y PIE QI O QSOWID QSOWID _
O_DUK 5 E A R S 5 E A A VKH E A RSAA
TION= RA TGBGBTUV S 6 DF DEUK5 E EM
U K 5 E EAGBTUEE E ■
```

H) The norm of decoding CW is more like this particular example. A reasonably proficient CW operator would make considerably more sense of the text than the machine has done.

```
OS T E NM3_E_DEF >5XP F5TUFTS TUDE_T
9_-GDDROMMYTNNF_C_LH_O_I6CSUE STIHT5
7957957_INQEQ6NR GOB=M_POT_M__E_ISMA
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X 5XIZIZ GCM_MPSEK TUF5TU HEEEF5TUDE
Y3_ S_T8X-GDDROMTNNER_CALL-RST_T5795
79579INQ6QTHNRPOTSDAM/POTSDAMESNAMEN
AGISMATIMATIMATI6EOH_E+F5TUDEY39_BK
T ____ZBF5XR5X- TE _B_ _____N ____IS
ISLL E LILLE TEA _Y __ISIS_N__Q = _C
ST 57 9 5 7 0 _R__8BF5TU M $ _9BS_E_
LO_JM_[_I_S-MY_LISSUREDRJA__E_^LVIAB
_E_-TSXFERNICE_OHRPQHPE REUGN7373CHE
ER2_DGBGDT TJA_+FE TUDE_T9_
EE _R
EE T ECQ_ EI U_ _ _B_T ■
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I) As for picture H. This shot combines the effects of sloppy sending and weak signals together with a bit of interference. A human operator would do considerably better.

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J) This is the effect of the only discernable fault with the unit. The internal circuitry of the decoder causes low levels of RF interference to radiate throughout the entire HF band. When the unit displays the picture alone, a large number of regular harmonics appear at low level. If you tune into one, the radiation stops with the result that the machine thinks it heard an 'E' (see text). ●

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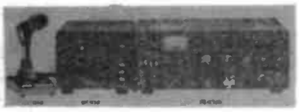

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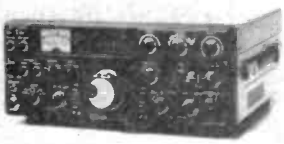

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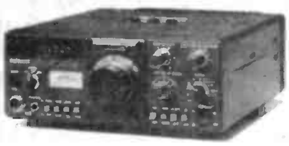

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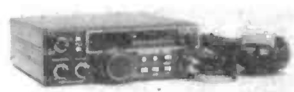

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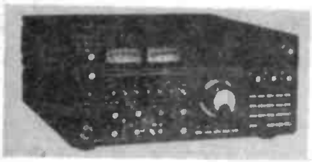

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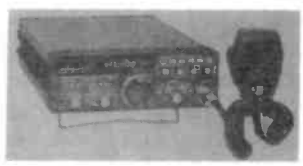

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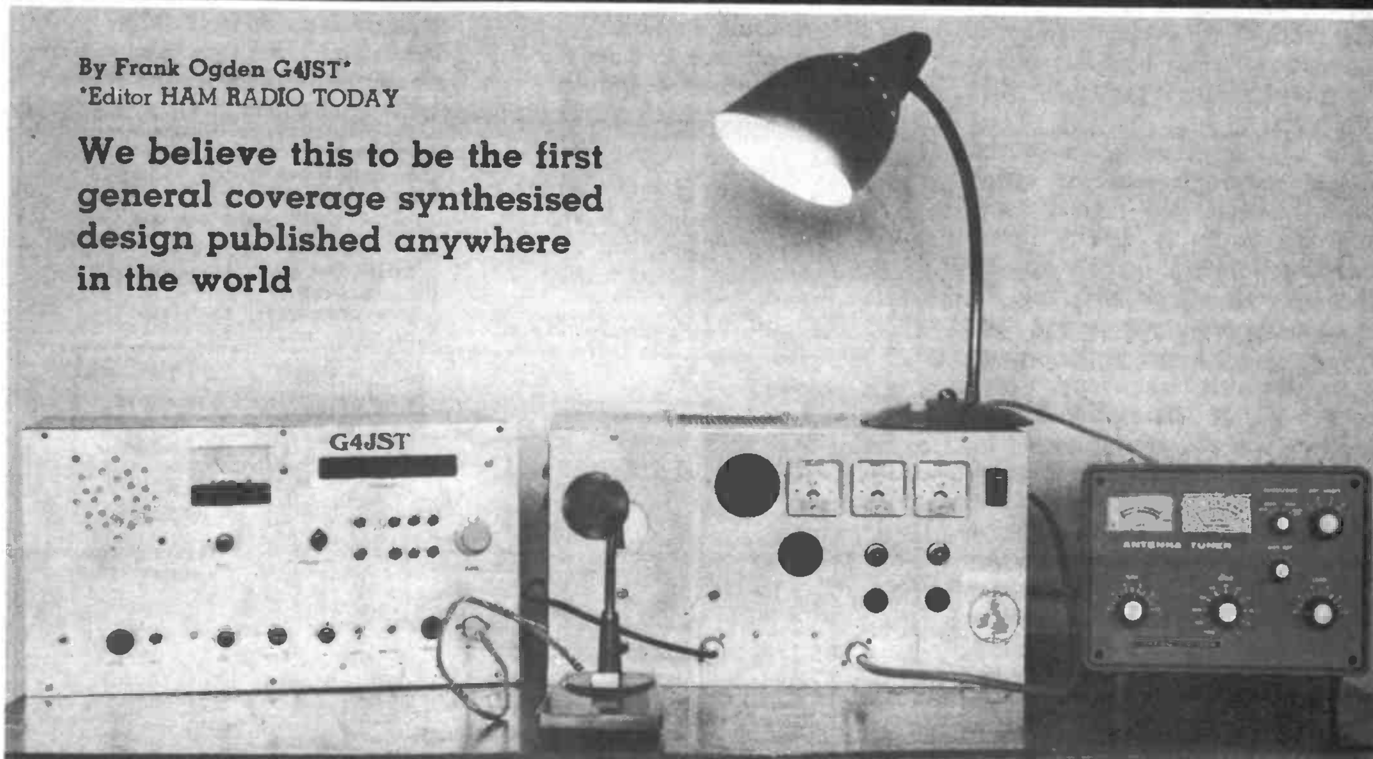
A general coverage synthesised HF transceiver

By Frank Ogden G4JST*
*Editor HAM RADIO TODAY

We believe this to be the first general coverage synthesised design published anywhere in the world



The author's station. The transceiver (left) is coupled to 500W PEP output linear amplifier, the subject of another constructional article in Ham Radio Today. The basic transceiver delivers about 20W PEP although the linear requires only 10W for full output. Taking a second look at the photo, things seem a lot tider than they usually are!

This transceiver, while of necessity not a simple project, is quite a lot simpler in design than just about all the available Far Eastern black boxes although little in the way of performance has been sacrificed. If anything, the techniques used in the manufacture represent a significant advance on orthodox thought by designing out critical components and adjustments. Although the unit will receive and transmit on any frequency between 1 and 35MHz (up to 90MHz on receive!) there are just five trimming adjustments: USB, LSB and CW IF crystal trimmers and two IF traps. That's it — the lot. Oh yes, there is an on board speech processor which has a preset pot but that hardly constitutes a critical adjustment . . .

You've guessed it. In reality, the transceiver is one big broadband circuit stretching from the RF pre-amp, a Plessey SL560 IC, to the pair of BLX39 output trasnsistors on the RF PA with a Schottky ring balanced mixer in between. Incidentally, those transistors in the output stage produce about 20 watts PEP or CW and are guaranteed unburstable in this circuit. One of the delights about designing and building your own is that you can put margins in. None of this prissy business about watching the SWR and keeping it below 2:1 otherwise the set shuts down. You run this home brew machine short circuit, open circuit or even into a proper 50 ohms + or — 0j. You don't need protection circuits when the transistors are so under-run. Incidentally there is a secondary payoff in the TX intermodulation performances as well. Big chips amplify linearly. However, if you really want to go for the QRO big league, I have also designed a matching 500 watt PEP output linear amplifier which can be used with this rig, or something like a TS120V. The amplifier project will appear in a coming issue.

You may see from **Fig 1** that the block diagram is very straightforward. There are only three frequencies of interest: signal, local oscillator and IF regardless of the set being in transmit, receive, SSB or CW. It really is that simple. The transceiver is a single conversion superhet with an IF of 9MHz. No bells, whistles, tunable passbands or even interference limiters. Even the pre-selector filter (that part of the circuitry which gets rid of the image response; in this set the LO always runs 9MHz above signal frequency) is essentially low pass rather than a bandpass (conventional) and scarcely needs adjustment from one particular MHz to the next.

In all it represents a splendid general coverage receiver which operates without any kind of band changing with a pretty good transmitter thrown in. To operate you simply plug in an aerial into the 50 ohm input/output socket and press the front panel buttons to go up or down in frequency. Once you've got to the part of the spectrum that you are interested in, just peak the signals on the pre-selector knob. In conventional terms, the bandwidth of the latter is plus or minus a MHz or completely flat below 5MHz. To transmit, press the PTT or front panel switch in the CW mode, wind up the transmit gain until the peak reading RF voltmeter (which doubles as S meter on receive) indicates saturation and wind it back a little. Switch back to SSB or whatever and talk. You will automatically be spot on the receive frequency. Just compare that with the average black box.

I have to admit that my desire to keep it simple has led to the transceiver being somewhat spartan in its specification. For instance, there is no RIT control, no interference suppressor, no VOX circuits, no continuously variable IF bandwidth arrangements and no transmit ALC circuitry as such. However operating the basic rig for the 19 months or so that I have done teaches you that most of the gadgets which are taken fo granted are really unneccessary anyway. Perhaps an RIT control would be a good idea for some CW stations but the facility is just a pain for the SSB. If only everyone transmitted bang on their receive frequency and didn't move about once they were there. Well, this set is as stable as the quartz rock which controls it but if you really wanted the full range of bells and whistles, they could be tacked on at a later stage. Which brings me to the heart of the set, the synthesised local oscillator.

Terry Giles G4CDY, an immensely clever man, is responsible for the design of the two big LSI CMOS chips which make this wide ranging single loop synthesiser possible. Manufactured by Philips, the HEF4750 and HEF4751 chip set contains everything required to make a high quality systhesiser system running up to about 20MHz directly. This transceiver calls for an LO frequency ranging from 10MHz to 99MHz (this concurs with a signal frequency from 1 to 91MHz plus a 9MHz shift for the IF). A single dual modulus prescaler chip, a Plessey SP8690, provides the extra division ratio necessary for this circuit. Interface of the extra divider is easy: the main chip set is capable of controlling up to two dual modulus prescalers although this circuit calls for just one.

There are a great many standard texts on synthesiser design and I don't propose to write yet another treatise on the subject.

FIG. 1

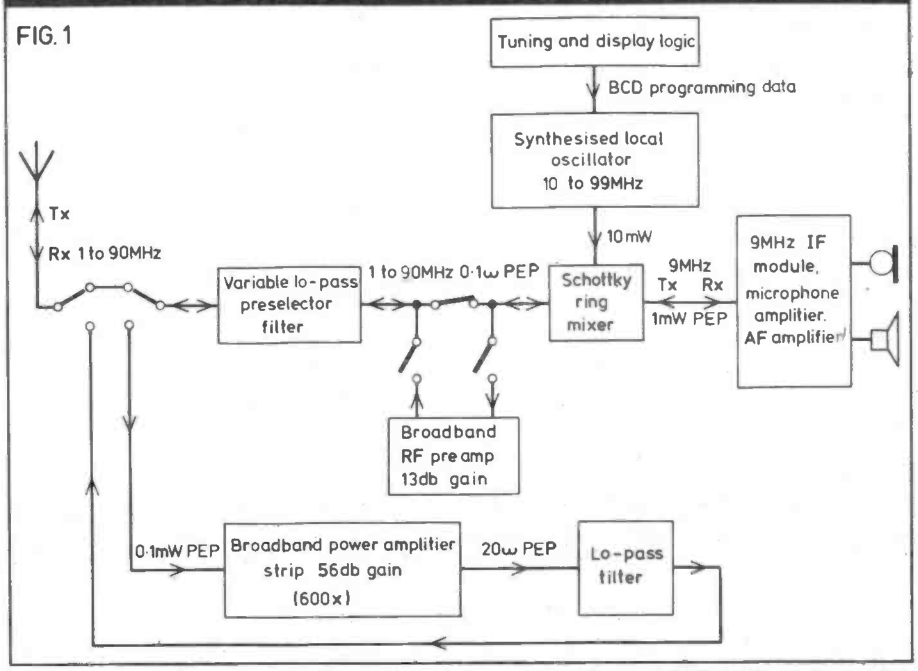


FIG. 2

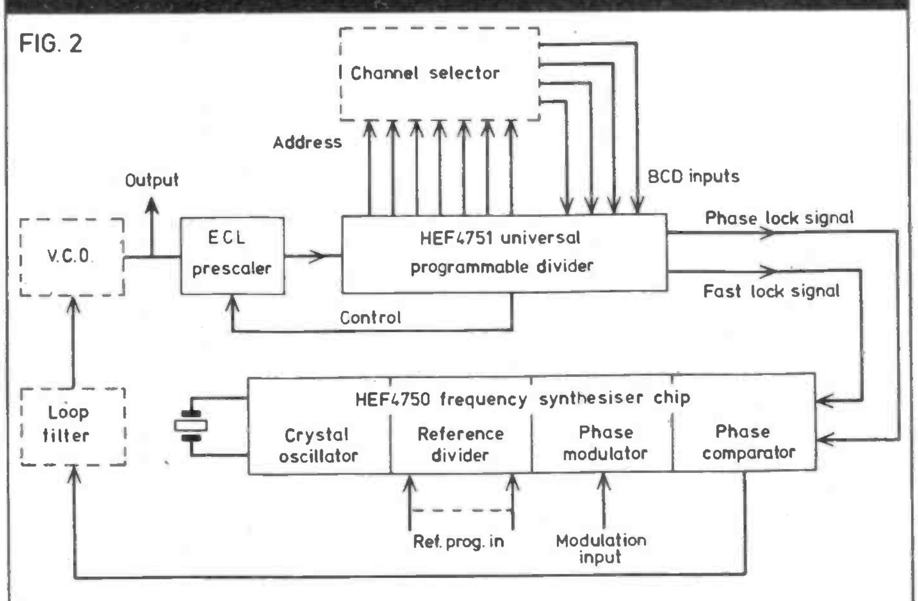


FIG. 2. Basic synthesiser structure using the LSI chip set.

Sufficient to say that you can do a lot more than I have done with these particular systhesiser chips. For instance a VHF or UHF synthesised transceiver would be an easy task to manage. If you have any interest in adapting this type of circuit, I suggest that you write to Mullard Ltd at Mullard House, Torrington Place, London for the application note entitiled 'Versatile LSI frequency synthesiser system' M8I-0023.

Figs 2 and **3** offer just a hint of what is in the chip set. The HEF4750 combines a reference divider, set up in this circuit to provide a 10 kHz frequency from a 5MHz crystal, a crystal oscillator circuit to produce the input to this divider, a phase modulator (not used) and two phase comparators.

The chip provides two phase comparators to enable a fast locking speed combined with a very high frequency stability. It achieves this by running the first comparator, an edge triggered flip-flop arrangement, at ten times the final comparison frequency. This raw comparator input is the FF signal from the universal divider IC (HEF4751) obtained by programmable division from the VCO. Once a rough type of lock is obtained, the edge triggered flip-flop comparator is disconnected and the high accuracy, low noise comparator (PCI) takes over. Although this circuit is also driven from the basic 10 kHz reference, the 1 kHz FS signal from the universal divider also derived from the VCO division strobes PCI into an active state on every tenth reference pulse using the edge of the reference signal (derived from the crystal oscillator) as the absolute timing reference.

Although the system is as complicated as it sounds, it works exceptionally well. The real strength lies in the analogue comparator section (PCI). It provides incredibly high phase comparator gains — the output voltage of the section as a funtion of the phase shift between the divided VCO signal phase and the reference signal phase — enabling high stability at low reference frequencies. The initial transceiver design uses a channel spacing of 1 kHz with interpolation provided by a fine tuning control. The addition of two CMOS 4000 series ICs will enable the unit to operate at 100Hz spacing with no sacrifices in performance. A commercial communications receiver manufactured by Redifon uses the same chip set down to 10 Hz spacing with professional standards of synthesiser performance. Details

Front panel of the transceiver. The receiver section covers for 1 to 91MHz, the transmitter section one to 35MHz with continuous coverage.

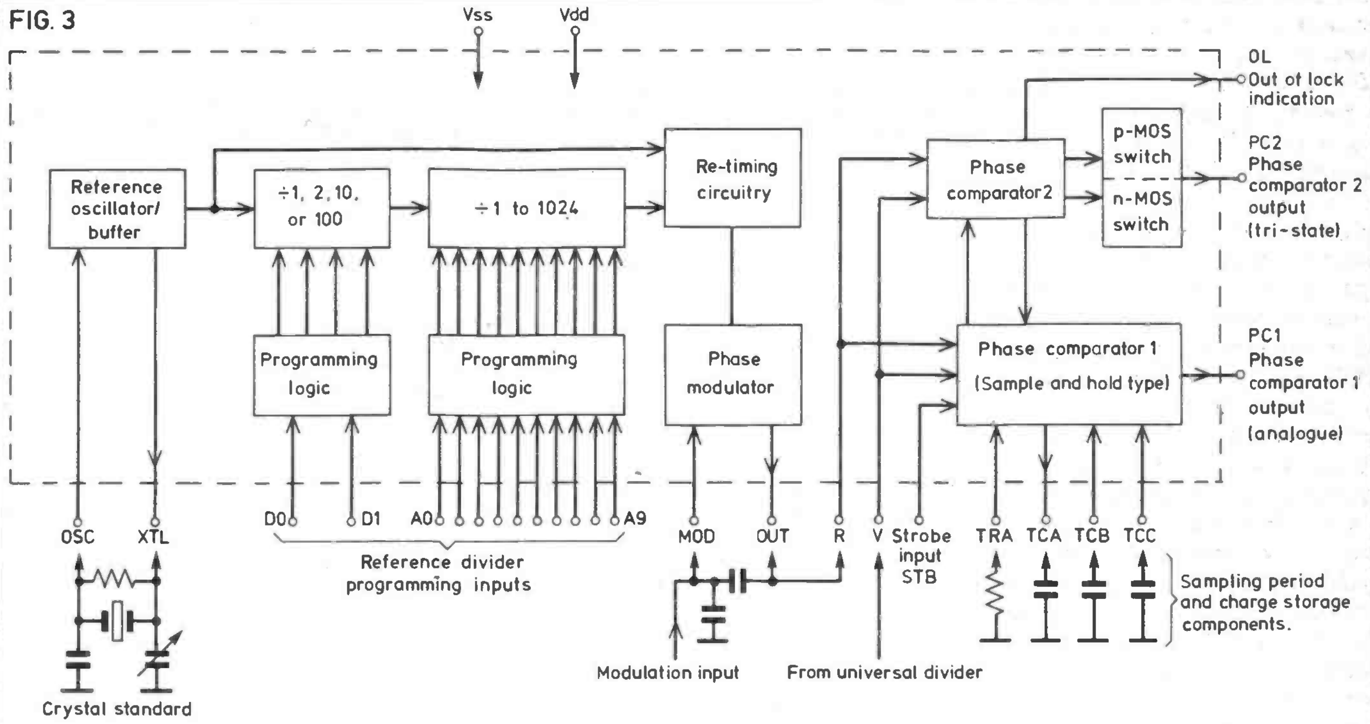


FIG.3. Detailed structure of HEF4750 synthesiser IC

of this modification will be given in a subsequent issue.

The analogue heart of this synthesiser is the VCO, transistor Q9 in **Fig 4.** Many experiments were done on this part of the circuit in attempts to get the best oscillator noise performance coupled with the wide frequency range demanded by the transceiver. To cover the basic HF spectrum of 1 to 30MHz requires that the VCO, the local oscillator input to the Schottky ring mixer, sweeps from 10 to 39MHz, a range of nearly 4 to 1. In theory the KV2225 (VC2) tuning diodes could provide the capacitance swing but the oscillator performance at the low frequency end would be marginal to say the least. Furthermore, the digital part of the synthesiser can run clean up to 100MHz (91MHz signal frequency) and I wanted the analogue part to match it. There was no way that a VCO could be made to run from 10 to 100MHz without band changing. The net result of all these deliberations was a compromise. The VCO covers the 90MHz span in three ranges switched by reed relays driven

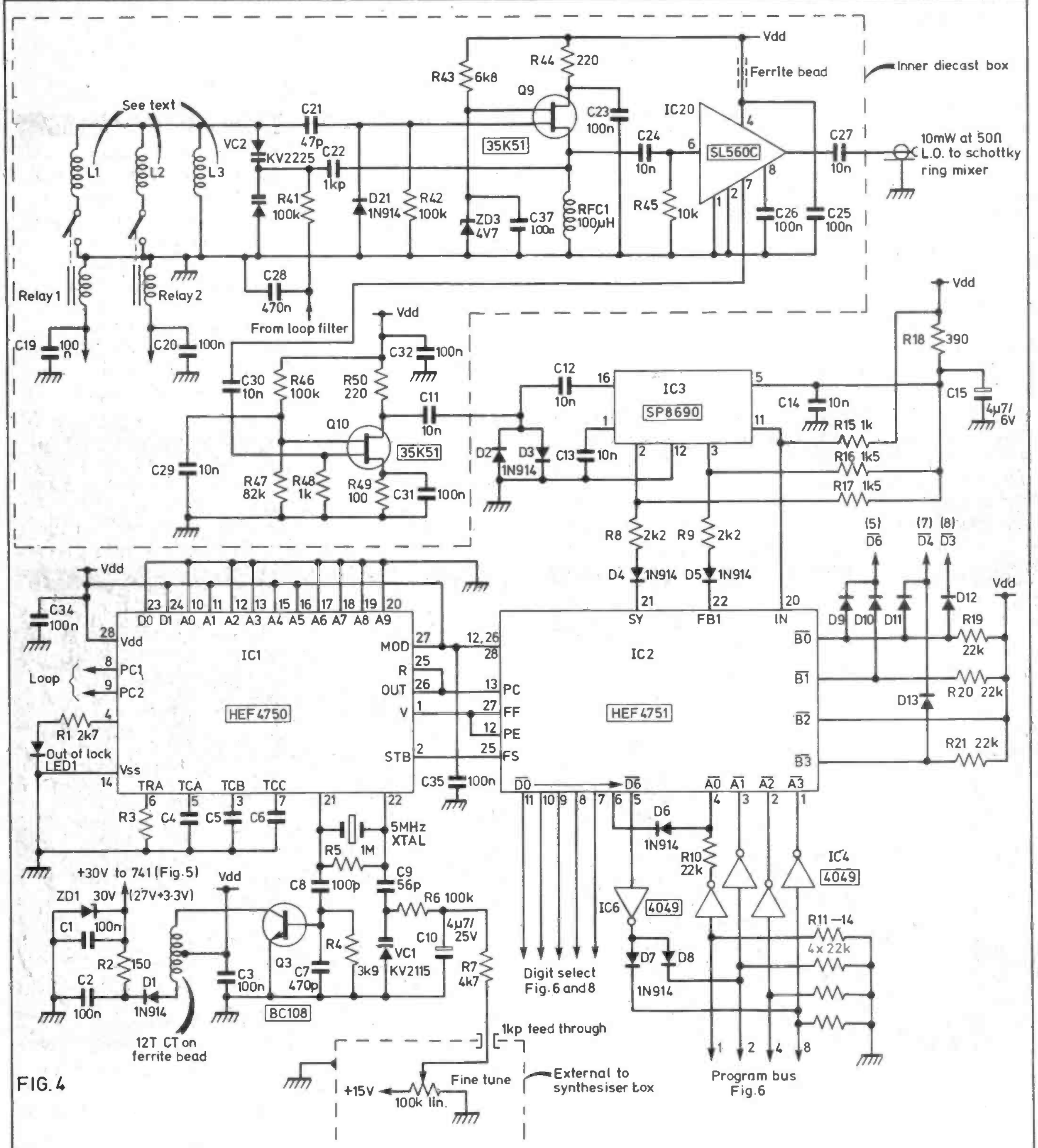


FIG. 4

automatically from the tuning logic (**Fig 6**) IC7, Q7, Q8.

The switching points have been chosen as 20MHz and 60MHz signal frequency (LO 29MHz and 69MHz). The oscillator inductors are progressively put in parallel with each other by the reed relays. Up to 20MHz is covered by L1, 20 turns on a T37-6 core; up to 60MHz is coivered by both L1 and L2, 10 turns on a T37-6 core; up to 91MHz is covered by L1, L2 and L3, 7 turns on a T37-12 core. 24 SWG wire is used for all three inductors.

The VCO signal is taken from the source of Q9 to IC20, a relatively high power, low noise buffer amplifier which has been biased to provide about 10mW of saturated power output right across the frequency range. It provides a very high degree of isolation and provides more than enough power for the Schottky ring mixer. The VCO signal is picked off one of the intermediate outputs on the buffer amp to drive IC3, the divide by 10/11 ECL prescaler circuit. Although there is more than enough signal available to drive IC3 directly, the circuit is buffered by Q10, another dual gate MOSFET. You have to do this because the high internal switching speeds of the prescaler chip produce quite a lot of noise at the input pins which could be coupled back to the VCO output. From the constructional point of view, the VCO was built on a piece of double sided copper laminate with one side divided up into small squares. The individual components are then soldered to the squares. The result is a bird's nest comprising Q9, Q10, the three toroids and the SL560C buffer amplifier, IC20. This complete lump of circuitry is mounted inside a small diecast aluminium box fitted with bolt type feedthrough capacitors. All earth connections are made directly

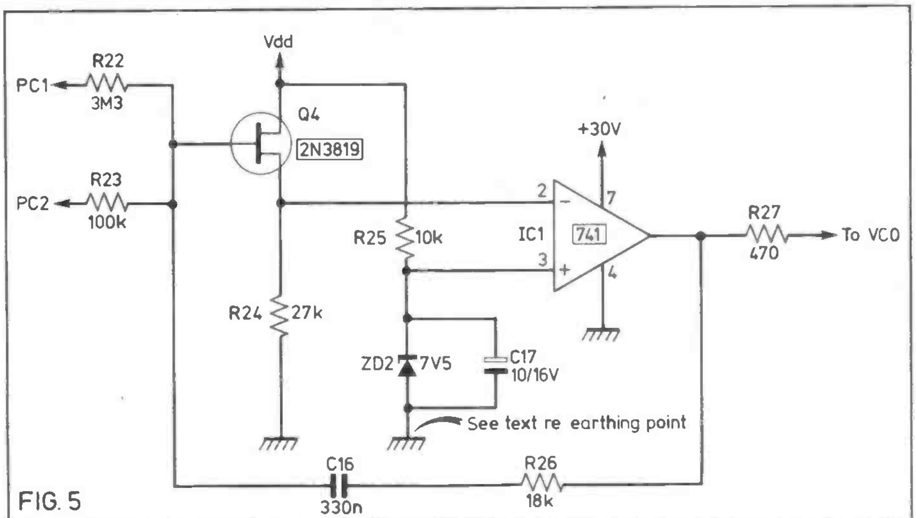
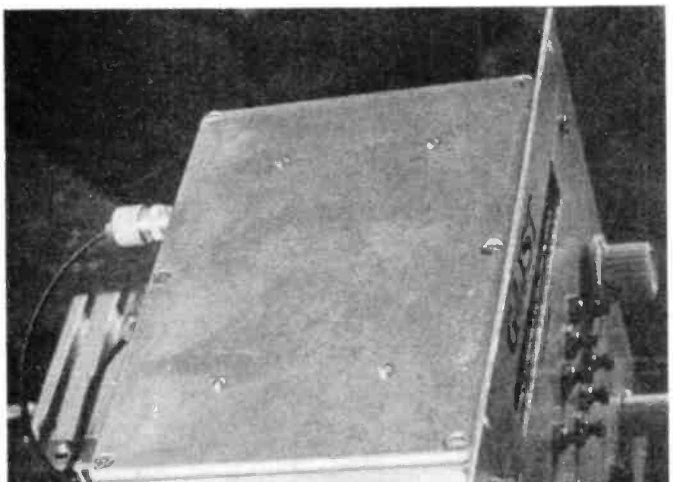
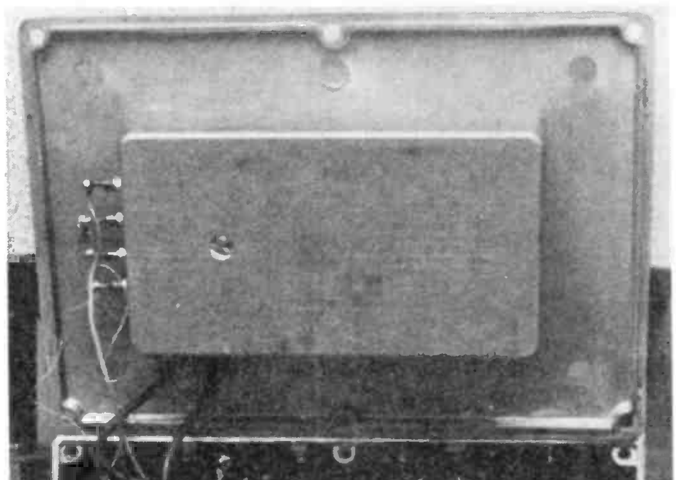


FIG. 5


The complete synthesiser module needs to be built inside an RF tight box. This is to stop the RF envelope getting in and digital RFI getting out.


The VCO module is a box within a box for best stability and noise performance. Th digital board fits in the bottom of the box. The complete synethesiser module is, in effect, a high power (10mW) VFO unit delivering a local oscillator signal ranging from 10 to 99MHz.

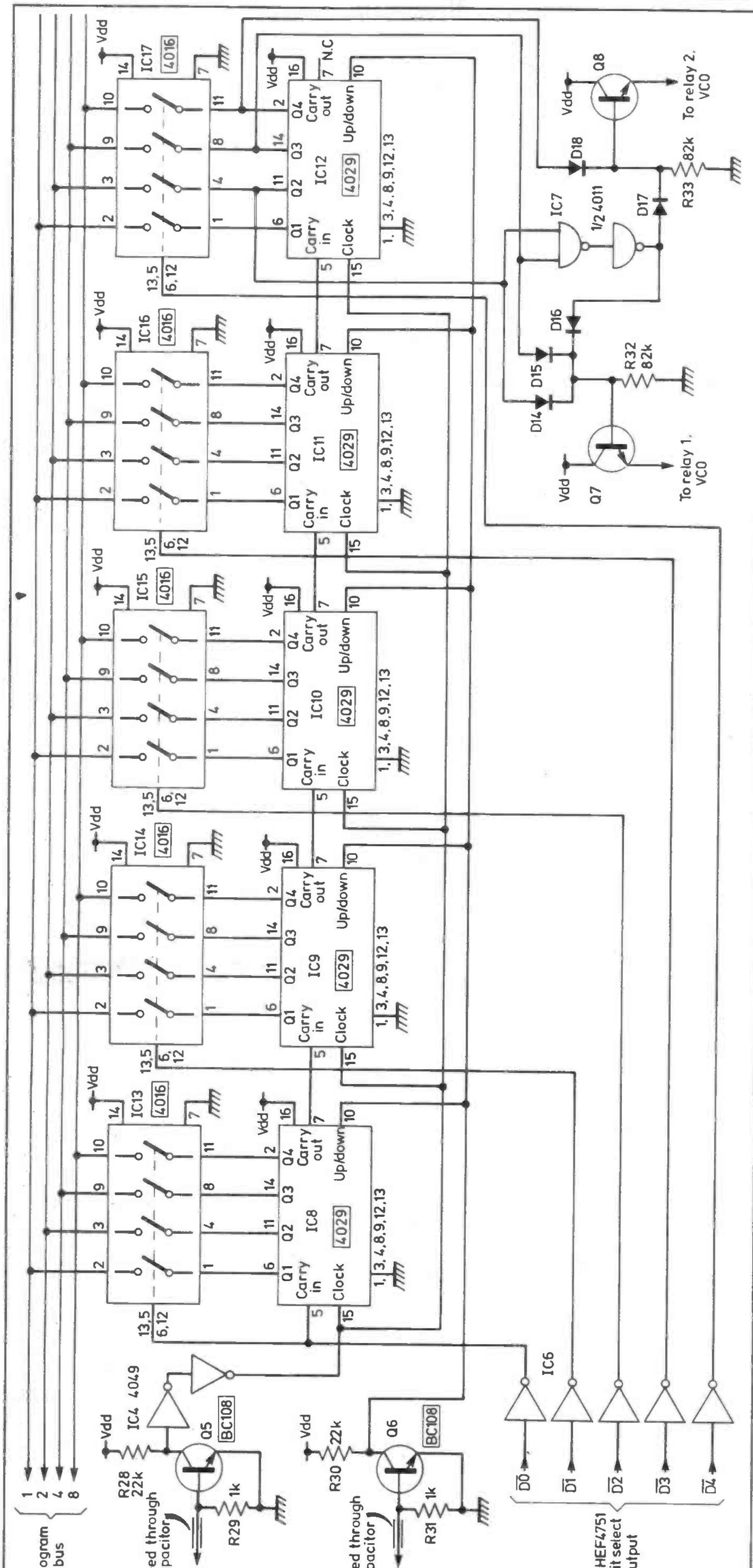


FIG. 6

through to the groundplane side of the copper laminate. Having established that the module works, the entire diecast box is filled with molten candle wax to give the highest degree of mechanical stability once it sets. This rather oddball method of construction gives complete electrical stability without any tendency towards microphony. Anything that wobbles in an oscillator circuit is definitely to be avoided.

VCO noise problems

The good design of the VCO local oscillator is so critical to the performance of any communications receiver worthy of the name that it deserves a bit more discussion. The trouble with just about any sythesiser system is that the VCO circuitry has far bigger noise sidebands than almost any free running oscillator circuit that you can care to name. The effect is not quite so evident when listening to SSB or FM; the comparitively wider bandwidths and continually changing modulation content mask a really rather unpleasant effect. However, listen to a CW signal on a synthesiser set and then compare it with the same signal recieved on an AR88 or HRO valve radio and you wouldn't know you were listening to the same station. Where a strong CW signal sounds 'clean' on one, it sounds a 'pure DC note' on the other.

In spite of having spent some 15 months putting this transceiver together, the spectral purity of this, and other transistorised gear still does not equal the old valve communications sets (or even a KW2000) because the signal levels are so much lower with transistor circuitry. The problems become even worse when you control the frequency of an LC circuit with any kind of varicap diode. Not only do the signal levels have to be even lower for them to operate at all, but they have a substantial noise contribution all of their own. The result is that the circuit given here, and those of most other synthesiser designs, is a very poor compromise.

It would be marvellous to wave a magic wand and reproduce the clarity of my old HRO but I can't. The circuit given here represents the best of a bad job. Lots of bipolar oscillator circuits were tried, as were various types of MOSFETs and JFETs. Hartley, rather than Colpitts circuit variations were also put to the test. The one given here with bias for Q9 generated by signal rectification through D21 was the best. I even tried to minimise the noise contribution of the varicap diodes, VC2, by feeding the control voltage from a low impedance voltage source but to no avail.

Commercial Japanese black box manufacturers attempt to get around the problem by tuning very narrow bands so that the contribution of the varicap diode to the total LC product of the oscillator circuit is small. You can get away with this to some extent on amateur gear where the bands are generally narrow and few in number which is why you hear about HF boxes "with nine separate VCOs". Having spent much time studying the problem, I have come to the conclusion that dedicated amateur HF gear is best constructed using the tried method of mixing the output of a switched crystal oscillator (beautifully low noise devices either in their valve or transistor forms) with a narrow band free running VFO. However, neither "nine separate VCOs" or the old method would do what I wanted: a totally general coverage transmitter receiver combination. If I had longer than the 15 months, I would have included both the general coverage VCO shown here, and switched low noise VCOs to cover each of the amateur bands but I thought that 15 months was quite enough for anything.

In the event the performance is good enough for SSB and adequate for the majority of CW working (but not a delight). In fact the noise performance, considering the enormous frequency span, is not significantly worse than the majority of modern solid state amateur gear. I'm waiting for some bright spark to re-invent the valve . . . In fact, I shall make it my next project.

Containing RF

The VCO diecast box was made to fit within a larger diecast box housing the rest of the synthesiser circuitry. The digital parts, and in particular the multiplexed LED readout (**Fig 7**) are immensely dirty in terms of the ammount of RFI they generate. The entire system, including the display, must be housed in an RF tight box using bolt in feedthru capacitors for all supply and signal leads (except the RF output which uses very carefully screened and terminated high quality miniature coax to a flush mounted Belling-Lee socket). As a result of these precautions, interference leakage from the box is not detectable.

The output from the Q10 buffer feeds the prescaler which in turn provides the input signal for IC2, the HEF4751 divider. This IC, like all the other parts of the synthesiser circuitry operates from a 10 volt supply rail. Note that IC3 is bipolar and requires a 5 volt rail. Although all the applications notes always show a voltage regulated supply rail for these circuits, electrically they behave very much like Zenner diodes. The SP8690 draws little current until the supply reaches around 5V where the supply current increases rapidly. The result is that you can use a dropping resistor, 390 ohms, with a high degree of confidence that the chip will run correctly without risk of it going over voltage.

IC2, the programmable Universal divider, is programmed by two sets of multiplexed BCD numbers, the A inputs ($\overline{A0}$ to $\overline{A3}$) and the B inputs ($\overline{B0}$ to $\overline{B3}$). An internal subtractor circuit takes away the B number — the desired IF offset — from the A number — the desired signal frequency. The digit selector outputs, $\overline{D0}$ to $\overline{D6}$, strobe the digits making up the A and B numbers onto the A and B inputs in turn. In the way that

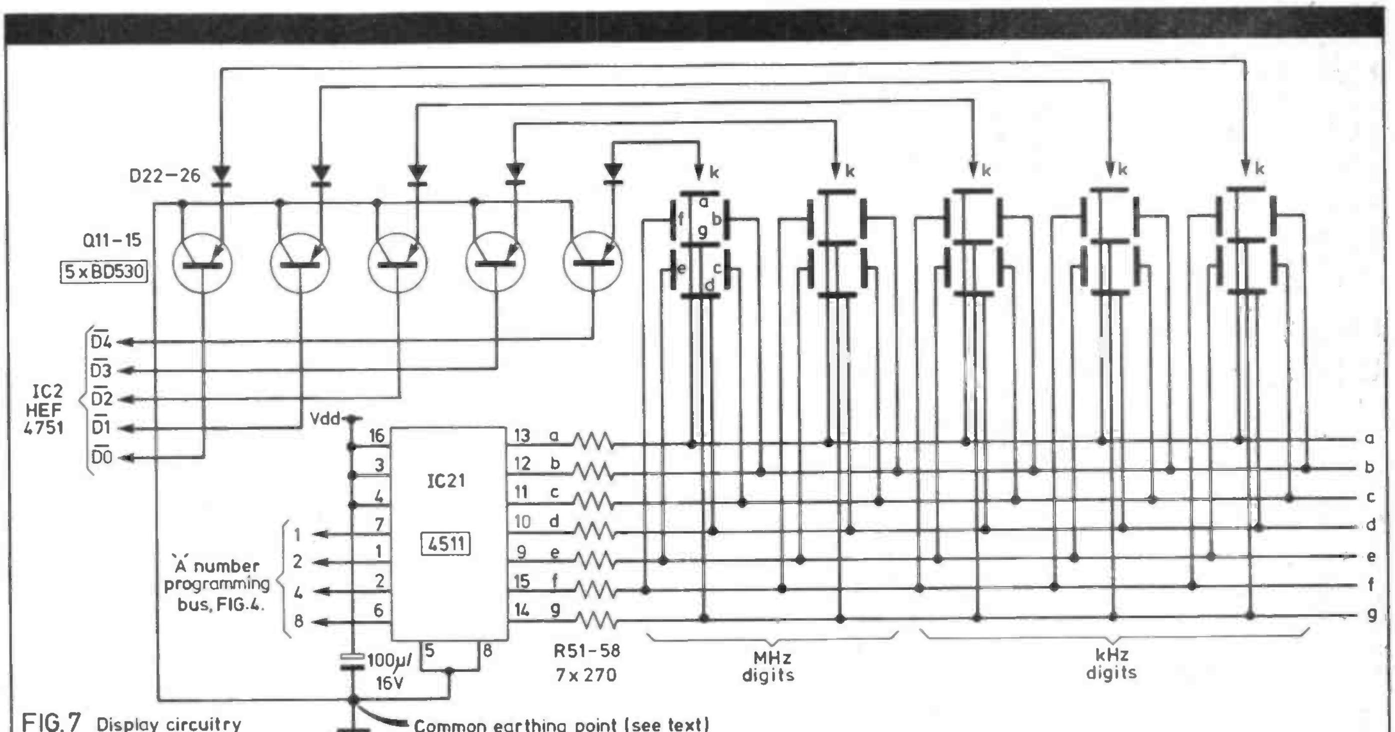


FIG. 7 Display circuitry

synthesiser has been configured only $\overline{D0}$ to $\overline{D4}$ are of direct programming significance, each digit corresponding to one figure in the display LED readout.

Suppose you wish to receive or transmit a signal on 28.215MHz. It requires that the synthesiser produces a local oscillator signal of 37.215MHz, ie 9MHz above. The push button tuning circuitry of **Fig 8** either increments or decrements (counts up or counts down) the row 4029 up/down counters, IC8 to IC12. An upper row of buttons on the front panel causes the counter chain to count up at various rates — each button selects a different output of a 4040 ripple counter — while the lower set of buttons does exactly the same but in the downwards direction.

IF offset

The result is that the 4029 counter chain provides a five digit BCD number which corresponds exactly to the frequency that you want to receive or transmit on; in the example IC12 will have a BCD '2' on its outputs, IC11 will have an '8' and so on until IC8 which has a '5' on its output. Together the counters display the frequency 28215 which represents the program number for the HEF4751, IC2.

IC2 requires that the digits of the programming number are fed into it sequentially to the A port $\overline{A0}$ to $\overline{A3}$. A row of 4016 CMOS switches, IC13 to IC17, are turned on in succession by the digit select outputs on IC2, $\overline{D0}$ to $\overline{D4}$. Note that all programming inputs and strobe outputs are active low, inversion by the hex invertors IC4 and IC6.

You might well ask yourself 'so far, so good but what about the IF offset? I've loaded 28215 into the synthesiser but the frequency I really need is 37.215.' If you were really awake while you have been reading this you might also have noticed that IC2 has just a subtractor, not the adder that you really need. Exactly put, number B is always subtracted from number A even when you need to add them together (A=28216, B=09000, LO=37215).

It requires a little trick to get 37215 programmed into the synthesiser while displaying 28215. You simply add 100000 to number A so that the actual programming number is 128215, and subtract 9000 from 100000 and use the remainder, 91000, as the constant program number for the B input. So now: 128215 (number A) — 91000 (number B) = 37215, the LO frequency needed for reception of 28215. QED.

A 10.7MHz IF offset is obtained with B=89300, 21.4 MHz offset with B=78600, 35.4 MHz offset with B=64600 and so on. The B number is constant and programmed by diodes D11, D12 and D13 making the BCD number 91000. D9 and D10, pulled down during $\overline{D6}$, program the internal counter configuration and have nothing to do with the frequency programming. Similarly D7 and D8, also active during $\overline{D6}$, perform a similar function on the A input. Descriptions of the actual functions is beyond the scope of this article. D6, active on the A input during period D5, puts the '1' in front of the 28215 of the example to produce 128215.

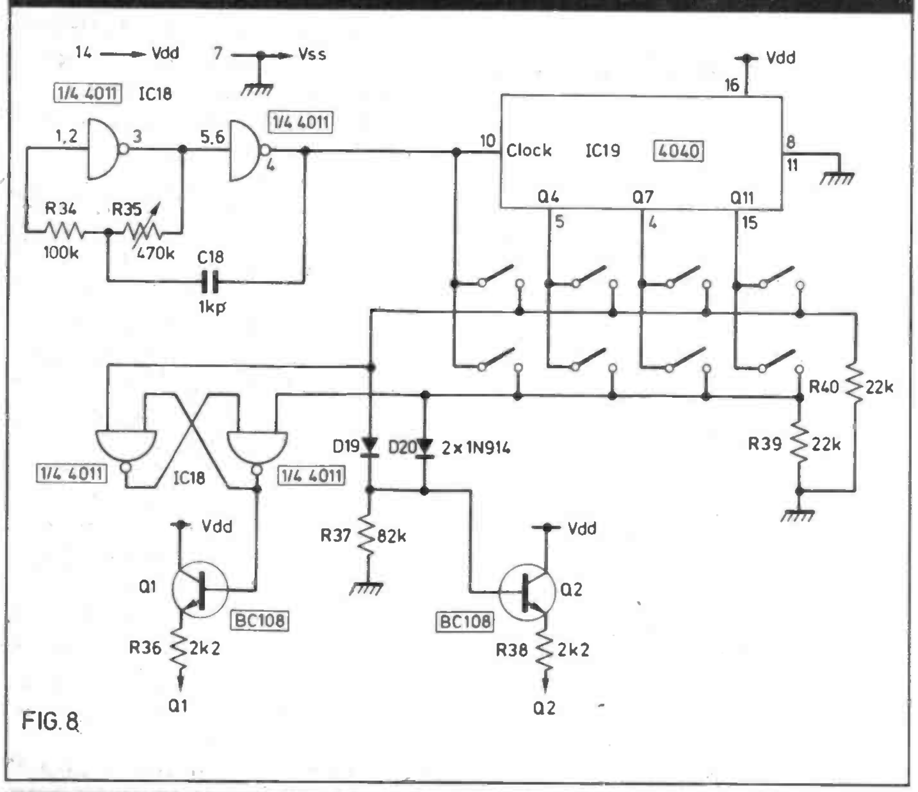


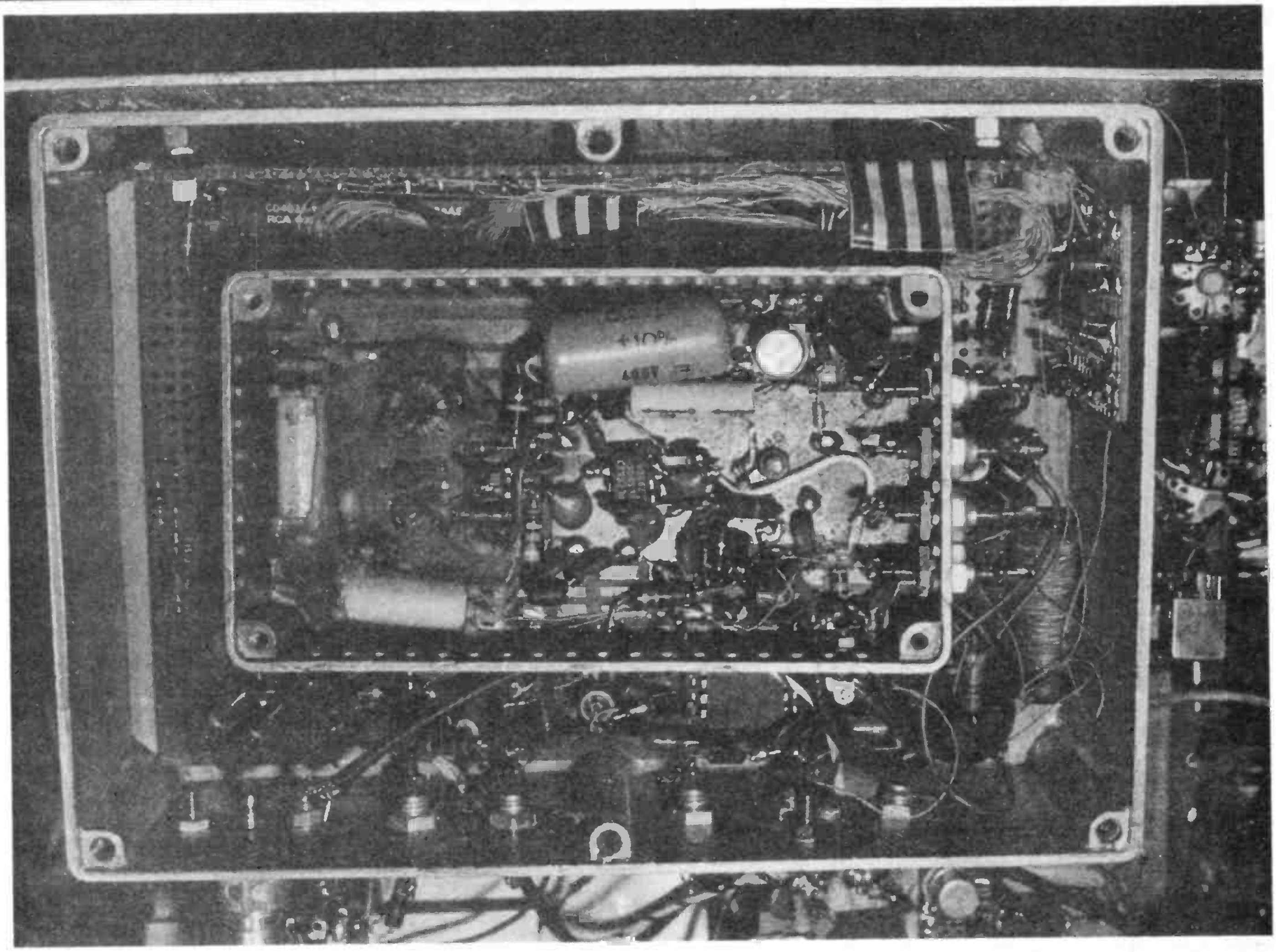
FIG.8

Step size

IC1 and IC2 (**Fig 4**) comprises a frequency synthesis system which operates in two stages. The 5MHz crystal is divided down to produce a 10kHz reference frequency. A 5MHz crystal has been suggested for the reference oscillator but any crystal frequency up to 10MHz would have done equally well. The only proviso is that the crystal frequency produces a whole number when divided by 10kHz. The required division ratio is programmed by hard witing of IC1.

Although the final synthesiser steps are arranged in 1kHz, the system does a first approximation at 10 kHz using the X10 output designed FF. When the signal and reference frequencies ae sufficiently close, the system moves to 1kHz resolution using the high accuracy analogue phase comparator circuitry mentioned earlier. In a later issue, we plan to give details of a simple addition to the basic circuit which offers synthesis in 100 or 10Hz steps. Resolution at this level only requires the addition of four cheap 4000 series CMOS circuits.

The comparator outputs are summed in an integrator circuit, Fig 5, and rescaled to provide up to 25V for the varicaps in the VCO. As an interesting aside, the 30V supply rail to the circuitry of Fig 5, essentially a 741 op-amp, is provided by a little step up inverter, Q3 driven by the crystal oscillator output on IC1. The step up transformer is nothing more than a ferrite bead wound with 12



The VCO module within the synthesiser module.

turns of 36 swg wire tapped at six turns for connection to the collector of Q3. The voltage is stabilised by ZD1, a 30V combination made up of a 27V and 3.3V device in series.

With reference to IC1, the components TRA, TCA, TCB and TCC set up the conditions of the high accuracy analogue phase comparator. Their value depends on the VCO gain (MHz/V) and the step size. In the circuit shown, the values are respectively 18K ohms, 4700pF, 1000pF, 47nF. It is important that the capacitors should be of low leakage variety such as polystyrene.

When altering the synthesiser step interval, in the case of this circuit 1kHz, then the comparator components will also require alteration to produce the best control loop damping.

With regard to **Fig 7**, the display circuitry, the digit drives are enabled from the digit select outputs on IC2 via PNP emitter followers. A single 4511 connected to the A program bus provide segment decoding for the common cathode LED display digits. Note that a high pulsing current flows from pin 16 of the 4511 through the LED display to the collectors of the PNP digit drivers which are at ground potential. There should be just two power connection points to the display circuitry: directly to the electrolytic capacitor terminals bridging the sythesiser 10V regulated supply rail. In particular, the integrator circuitry shown in **Fig 5** should be separated as far as possible from the display decoding and driving circuitry. Because the VCO has a very high gain — just one millivolt of ripple on the VCO control line will produce 1kHz of frequency modulation on the VCO carrier — the circuitry must be kept away from any stray electrostatic, magnetic or ground loop fields.

With this one proviso layout is uncritical although good RF practice needs to prevail in the construction of the VCO, buffer amps and ECL prescaler circuitry. For the rest, the prototype was built on matrix pinboard using a wirewrap system.

The raw DC supply to the synthesiser 7" x 4" x2" in its metal diecast box is 15V from a standard three terminal regulator. It is re-regulated internally using a 5V three terminal device with a 4.7V Zenner diode between the ground terminal and ground. This combination provides the 10V required by the synthesiser circuitry and completely isolates the unit from external supply variations. For instance, those which occur during transmit. The synthesiser unit draws around 300mA of current, most of which goes towards operating the display

Part 2, the receiver section, next month together with parts list for the synthesiser module. PCBs will be available in due course.

A PLAIN MAN'S GUIDE TO MASTS AND TOWERS

A S Barraclough G3UDO*

Informed advice about selecting and erecting aerial towers

It is well known that the higher an aerial is raised above the ground, the better will be its performance. Ideally of course, we would all like to have our aerials mounted on top of a 120ft tower, situated on a hill But alas most are not so fortunate and must make do with less ambitious aerial installations. However, even with a modest increase in aerial height above ground, there are a number of advantages to be gained. It is hoped that in this series of articles we can examine these advantages and explore some practical ways in which an aerial can be got aloft. Although this is not intended to be an in-depth study into aerial theory or tower construction it should give the less experienced some useful guidelines about selecting a suitable mast or tower and putting its erection.

Most radio amateurs today are buying commercially made rigs and aerials in preference to 'home brewing', something most did not so long ago. A look through any radio magazine will reveal a staggering amount of adverts for commercially made transceivers, amplifiers, add-on gadgettry and aerials. All of it very expensive, some costing a small fortune even by today's standards. So much so that the 'rig' has now become something of an investment to many radio amateurs.

However, where more mundane but never the less necessary items of radio hardware is concerned, such as, aerial masts and towers, the picture is often quite different. Many radio amateurs are content to operate their expensive rigs into an equally expensive aerial that is supported an on inadequate, makeshift pole either in the back garden or stuck on the side of a chimney stack. Poorly situated and relatively inaccessible, the aerials are left to fend for themselves. Even though the aerial may have been properly tuned to start with, left unattended for long periods the performance will gradually deteriorate to a point where the aerial has become virtually useless.

A typical QSO on the subject may go something like this.

"Got the new rig Fred, a real nice piece of gear, running it into the three ele boom on a 20ft pole in the back garden — loads up okay with the ATU though the SWR goes high sometimes.

"Well with the linear on I get out okay, still I should have a look at the aerial. Trouble is, I can't get it down very easily so it tends to stay up! ah well one day . . ."

Unfortunately, no matter how good the rig or how much power is pushed out, how well the RF radiates will depend almost entirely on the performance of the aerial, particularly when transmitting. The performance of an aerial can be effected by a number of factors, such as its height above ground, its locations, losses in the feeder cable, how well the aerial was tuned, surrounding terrain, impedance characteristics and its physical condition. So what has all this got to do with aerial masts? Quite a lot really.

Looking back at the situation outlined earlier the aerial was difficult to raise or lower when mounted on a 20ft pole. The neglected aerial gradually deteriorates in performance so that more and more power from the transmitter is wasted and less signal reaches the receiver in the reverse direction. In all, not a very satisfactory state of affairs.

The same aerial, mounted on a telescopic tiltover mast or tower can be quickly and easily raised up to a reasonable working height or lowered down to almost ground level

*Allweld Engineering Ltd

for servicing and maintained at maximum efficiency all the time. Tuning up or replacement is an easy job and raising it up to a reasonable working height will improve the performance. In short, the aerial system, which includes the mast or tower, can often be the weakest link in the chain and deserves as much consideration as the rig.

Having decided that the aerial has to go aloft on a mast or tower, the next thing to sort out is what would be the most practical height for your situation. In theory, the aerial should be in free space completely out of the influence of the earth, a situation that is physically impossible to the radio amateur. Unfortunately even the dream height of 100ft is not a practical or economical proposition for most of us and we have to set our sights a little lower, bearing in mind such things as the cost, our neighbours and last but not least, the local planning authority. So what can be achieved?

Before you rush out to get the tower you think you need, it is useful and cost effective to look a little more closely at the kind of effect the height of an aerial above ground will have upon its performance; this should help in choosing the most economic and practical height of mast or tower you buy.

Any aerial placed within a certain distance (height) of the earth (ground) will have its characteristics modified in some way. How much and what kind of effect the ground has on the aerial will of course depend on a number of factors, such as: operating frequency, the length of the aerial, its height above ground, its orientation and how good a conductor the ground (earth) is.

Radio waves leaving an aerial do so at any number of different angles with respect to the horizontal plane, some going off at angles above the horizontal while others are angled downwards below the horizontal eventually striking the ground. The earth acts like a large reflector to these downward angled waves bouncing many of them back up again in a very similar way to light being reflected off a mirror. Remember that like light waves, radiowaves are also electromagnetic radiations but of a very different wavelength. So, just as in the case of light, the angle of reflection of a

downcoming radio wave is equal to its angle of incidence. For example, in **Fig 1** imagine a wave leaving the aerial A at a downward angle of say 20°, this wave finally meets the earth (ground), at point D and is then reflected upward again at an angle of also 20°, ie the same angle.

This reflection does not always take place at the surface but depending on the frequency, and condition of the ground, the actual reflection may occur some way down below the surface of the ground. In addition, depending on the frequency, not all of the waves are reflected and as the frequency gets beyond about 14 MHz, more and more waves are 'absorbed' by the earth and less reflected.

At some distance away from the aerial, the reflected waves, now angled upward, will meet and combine with the direct waves leaving the aerial, that is those angled above the horizontal. The way in which the reflected waves will combine with the direct waves depends on several factors such as the orientation of the aerial with respect to the ground, its height above ground, its length and of course the conductivity of the ground; the ground is never a 'perfect' conductor. At the same angles above the horizontal, the reflected and direct waves combining will be in phase with each other, that is the field strengths will be maximum at the same time; thus the resulting field strength will be equal to the sum of two waves. At other angles above the horizontal, the two waves will be out of phase and the field strength will be minimum. The resulting field strength here will be the difference between the two waves.

Ground reflections

Thus the effect of ground reflection is to produce a series of points around the aerial where the resultant field strength is increased to a maximum, greater than the direct wave on its own, and others where the field strength is at its minimum or somewhere in between. When plotted these look like a number of power lobes at various angles of radiation. See **Fig 4.** The slope, number and power of these lobes as well as their angle of radiation is effected by the height of the aerial above ground as well as the other factors mentioned earlier (see **Fig 3**).

When considering the effect of reflection, it is convenient to imagine the reflected wave coming from an image aerial that is situated at the same depth below ground as the height of the 'real' aerial above ground. **Fig 2** shows such an arrangement. You will see that in the vertically aligned aerial, the current, shown by + and −, is in phase therefore ground reflection affects vertically and horizontally polarized aerials quite differently.

Because the ground is not a perfect conductor some of the higher frequencies are not reflected at all but absorbed by the ground. This takes place more and more as the frequency gets nearer to 30 MHz with the result that a lot of the energy radiating at very low angles is lost because it never gets reflected.

Another effect that ground reflection has on an aerial is to alter its radiation resistance or impedance. This is why the SWR changes when you raise the aerial up. The reason for this is that some radiated waves go vertically up again. As they pass the aerial they induce an additional current in it. Depending on the phase of this induced current the radiation resistance of the aerial changes. However, as the height of the aerial approaches a half wave length, the effect on radiation gets smaller and can easily be tuned out.

Fig 4 is a diagrammatic representation of the radiating fields from a half wave aerial at various heights above ground. The height is shown as a multiple of fraction of the wave length of the operating frequency being considered. You will see that as the height of the aerial is increased so the number and shape of the lobes change and their radiating angle gets lower to the horizontal. There is a marked change in the field of radiation of an aerial at a quarter wavelength height (**Fig 4A**) as compared to the same aerial one half wave length high (**Fig 4B**). At a half wave length there are only two major lobes of radiation angled at about 30° from the horizontal. Increasing the aerial height further

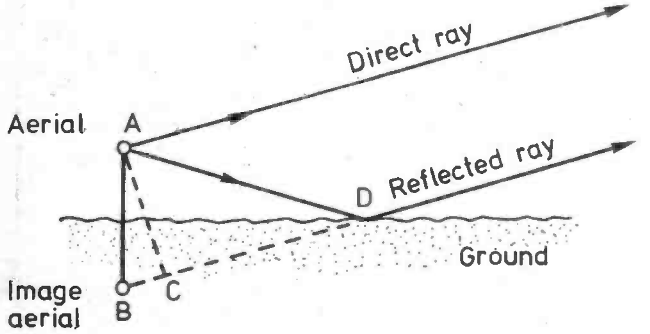


FIG. 1

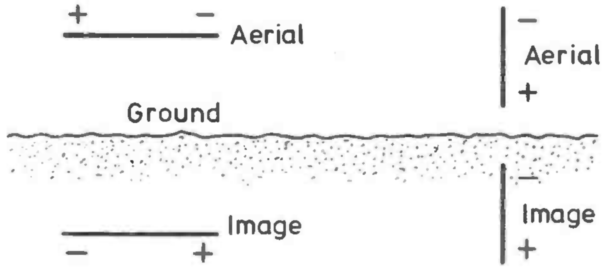


FIG. 2

(**Fig 4C and D**) change the radiating pattern to three lobes and reduces the angle to 20° at a full wavelength height.

It goes to show that once the aerial is at a half wave length above ground or more, there is an increase in the number of energy lobes and a decrease in the lowest radiating angle. However, after a height of one wavelength above ground, the lowest radiating angle tends to remain unchanged at 20°.

So how does all this affect the average sort of aerial set-up that is put onto a tower or mast? The most popular aerials that are mounted as towers or masts are 'directional beams' for the HF, VHF and UHF bands. Due to the limitation of physical size, 20 meters is about the lowest frequency for which people use directional beam aerials. These are generally of the three band variety covering 20, 15 and 10 meters mostly with two to four elements. The purpose of these directional aerials is of course to direct the radiating energy in one designed direction mainly for long distance or DX working. When working DX stations, the angle of radiation of the signal is instrumental in how far the signal goes. Very high angles of radiation means a 'shortened' range where as a low angle of radiation means a longer range. Bear in mind of course that very low angle radiations at high frequencies can be adversely effected by ground effects. In practice taking angles of approximately 10° to 30° are satisfactory and preferable.

TABLE 1 HEIGHTS IN WAVELENGTHS

		¼ λ / 45°	½ λ / 30°	¾ λ / 25°	1 λ / 20°
14MHz	20m	16.7′	33.4′	50.1′	66.80′
21MHz	15m	11.14′	22.28′	33.4′	44.56′
28MHz	10m	8.35′	16.7′	25′	33.4′
70MHz	4m	3.34′	6.68′	10′	13.36′
144MHz	2m	1.62′	3.25′	4.87′	6.49′

SHOWS HEIGHTS IN WAVELENGTHS WITH APPROXIMATE RADIATING ANGLES FOR THE MAIN LOBES OF A HALF WAVE HORIZONTAL AERIAL.

At VHF and UHF frequencies, the picture changes because the surrounding terrain such as hills or highrise buildings will have the major effect on the radiating, or incoming signals.

Since the wavelengths at VHF and UHF are physically short, even a modest height of 30ft can represent several wavelengths at VHF, thus minimise any 'ground effects'. However, getting over the top of terrain or high buildings is quite difficult and more often than not only a compromise is possible, unless you can afford the Eiffel Tower! In these circumstances, the only practical solution to get the aerial as high as you can 'afford' to go, bearing in mind the neighbours and local authority as well as your pocket.

As you will see from Table 1, at a height of 34ft, a 20m aerial will be at half wavelength, a 15m aerial at ¾ wavelength and a 10m aerial at a full wavelength. A 4m VHF aerial would be at 2.5 wavelengths and a 2m aerial at roughly 5.2 wavelengths above ground.

Another important factor to take into account when deciding on a suitable height for your aerial system is the length of co-axial feeder you are going to be using. Long runs of co-axial feeder cable can be quite lossy and will reduce the amount of power that finally reaches the aerial. At VHF and UHF frequencies, the reductions can be quite considerable and could become unacceptable.

Part 2 next month

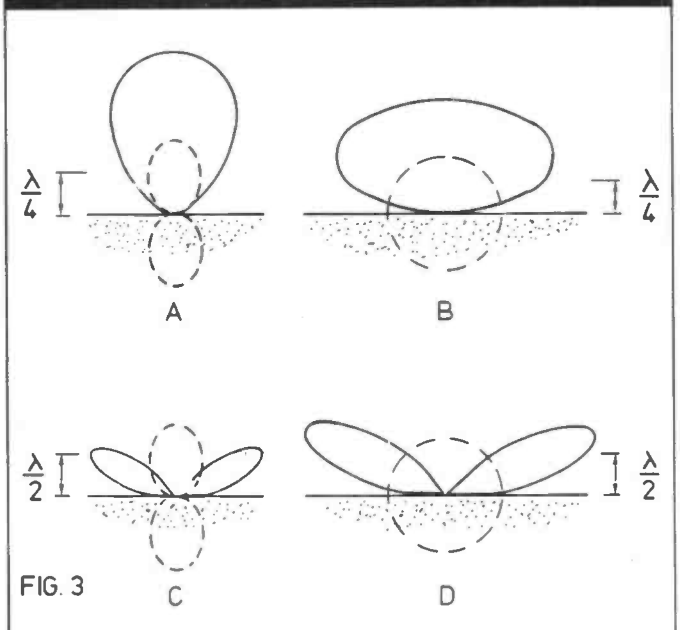


FIG. 3

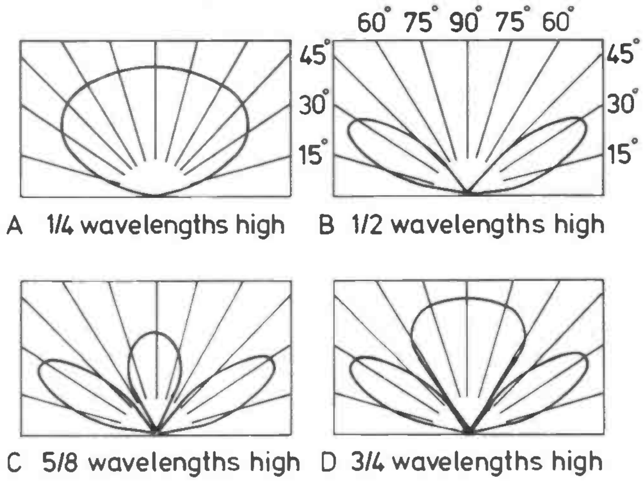


FIG. 4

HAM RADIO TODAY

NEXT MONTH

SPECIAL FEATURE: Working meteoscatter. The definitive article.

Introducing: amateur television

Examining: six metres with Jack Hum G5UM

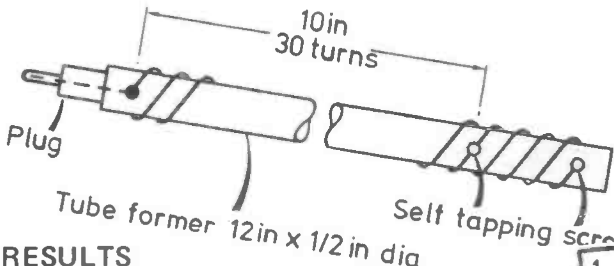
Testing: the Yaesu FT102 HF all band transceiver and FT79OR 70cms multimode

Constructing: an ATV pattern generator

Operating: VHF propagation

Practising: the RAE

Processing: speech



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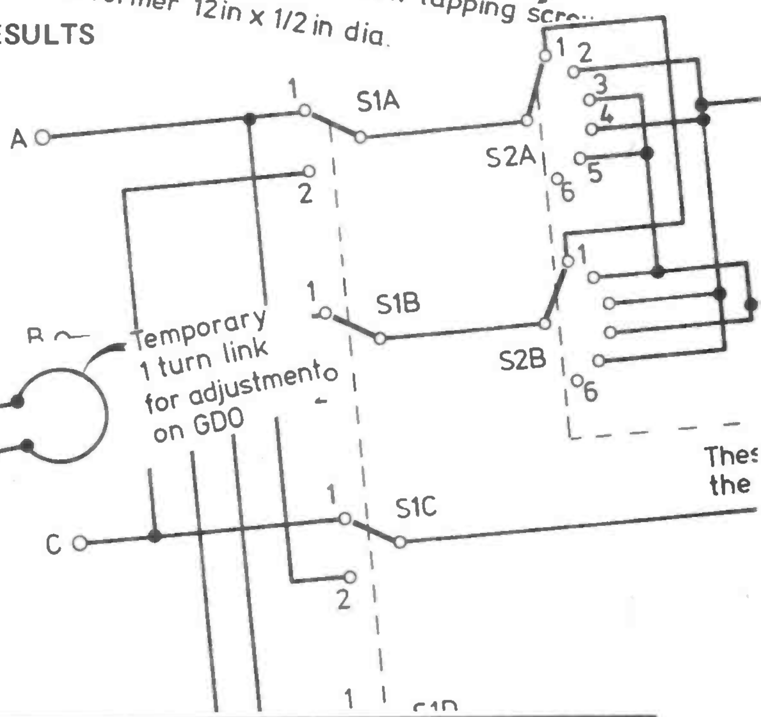


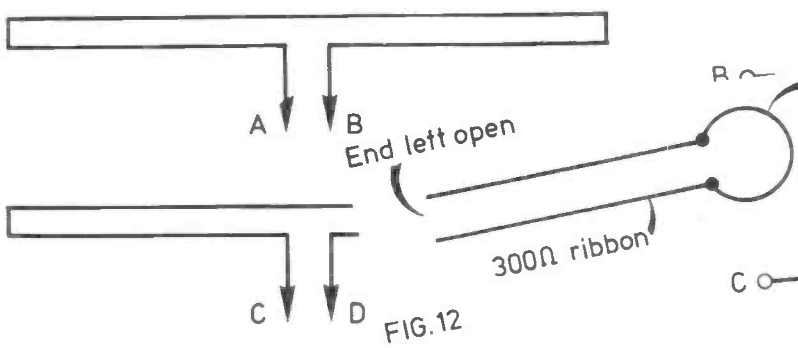


FIG.12

AB } = 2 seperate feeders, 300Ω ribbon, or open
CD } wire of identical length to switching unit in FIG. 11

ON SALE JANUARY 7th 1983

CLUB NET

Cyril Young G8KHH

Not to show any favouritism we will jaunt around the clubs in alphabetical order. I'm sure there must be some clubs whose names start with A or B but so far I haven't heard from them, so let's start our tour of the clubs way down on the South Coast with the CHICHESTER AND DISTRICT AMATEUR RADIO CLUB who are now well and truly established in their new accommodation at the FERNLEIGH CENTRE, 40 NORTH STREET, CHICHESTER. They meet every first Tuesday and third Thursday in each month in the Green room on the ground floor, meetings start at 7.30pm. There is a club net on 145.275 (SII) every Wednesday at 1900 local time, or futher information may be obtained from the Honorary Secretary T.M. Allen G4ETU, 2 Hillside, West Stoke Chichester, Sussex. PO18 9BL or telephone West Ashling 463.

The next club meeting on Tuesday December 7th is not being held in the usual Green room for some reason, but in the Long room, but they revert back to the Green room for December 16th when they hold their Christmas Social, so if you go along that night you had better take a bottle!

It is possible that some of the Chichester Club members have worked members of our next club, at least on HF. Let us then go due north to the COVENTRY AMATEUR RADIO SOCIETY, who are celebrating their 50th Anniversary. Well done chaps, here's wishing you well for the next 50 years from all at Ham Radio Today.

Celebrations have included using the special call sign GB2CRJ from time to time. The Secretary, Dave Farn G4HRY has not told me about forthcoming events, but I have no doubt they will be at least as good as in the past. The 35 strong club meets every Friday at 8 pm at the Baden Powell Scout Head Quarters in RADFORD, COVENTRY. For further information contact Dave Farn at 14, Corfe Close, Clifford Park, Coventry CV2 2JC.

From the smoke of Coventry we come to the smoke of London to the CRYSTAL PALACE AND DISTRICT RADIO CLUB in fact. They can be found on the third Saturday of each month at 8 pm in the All Saints Church Parish rooms, in the shadow of the IBA Television mast at the junction of Church Road and Beulah Hill, Upper Norwood. I have no list of forthcoming events but a call to G. Stone G3FZL at 11, Liphook Crescent, Forest Hill SE23 or by 'phone (01) 699-6940.

If you write don't forget an SAE. This applies to all clubs; it's only fair to help with the finances, there are very few affluent clubs about today.

The SOUTH DORSET RADIO SOCIETY receives its fifty or so members from a large catchment area, some travelling up to 25 miles for a meeting; that's dedication for you! A lot of clubs could do with a few members like that. They meet on the first Tuesday of the month at 7.30 pm in the Wyke Regis Army Bridging Camp, Weymouth. The Secretary, Andrew Prior G6HEL, 3 Greenways, Dewlish, Nr. Dorchester, tells me in his letter of some of the club's activities during the year like DF hunts, mobile picnics, parties on Chesil Beach and skittles. The club has keen interest in taking part in contests and are trying to raise £150 for a generator, hopefully from the profits of a Grand raffle. The club meets next on December 7th for a Quiz and then on 4th January 1983 for a film show.

Just a couple of hours drive eastwards, on the coast road from Weymouth, we find Brighton and the small village of Ovingdean, nestling in the beautiful south downs is to be found Ian Fraser House, home of the St. Dunstans organization for war blinded. St. DUNSTAN'S AMATEUR RADIO SOCIETY has a membership of 40; a well equipped shack in the house feeds a Mosley beam and co-linear aerials. The call signs for the base station are G3STD and G8STD. Obviously there is a great deal of interest in operating gimmicks to help all white stick operators to the point of forming the BLIND RADIO AMATEUR AUDITORY GIMMICKS INFORMATION SERVICE, (BRAAGIS). Details are available from Peter Jones, Club Chairman.

Skating back now along the South coast to the FAREHAM RADIO CLUB, who meet every Wednesday at 7.30 pm in room 12 at the Porchester Community Centre. Club Secretary Brian Davey G4ITG, says new members and visitors are always very welcome. I would think it is safe to say this is true of any club. Setting up for satellite operation by G8VOI is the title of the next meeting on December 8th. On December 15th there is to be a slide show on . . .? he didn't say! For full details on forthcoming events, write to Brian c/o 31 Summerville Drive, Fareham, Hants PO16 7QL.

Trekking our way North again to the much loved spot of all Scouts Gilwell Park, Chingford, North East London. THE GILWELL AMATEUR RADIO GROUP, Station call sign G3WGP. The ham shack has a constant stream of visitors, licenced or not, of all ages and nationalities. Space does not permit details of all the activities at Gilwell. Why not give them a shout on the air? But expect a long QSO, otherwise contact Jerry Lockyer, 18 Allison Close, Waltham Abbey, Essex EN9 3NY for full information.

Our next port of call is at GOOLE RADIO AND ELECTRONICS SOCIETY at their new location in Paradise Street, where there is ample parking space. To find the meeting room enter the door marked "Goole Junior Chamber and WRVS", at the top of the stairs you will find their new QTH.

Meetings are held every Tuesday at 7.30 pm and usually go on until after 10 pm. The club newsletter has a refreshing approach, it is unfortunate that the print area is too large for the paper it's printed on. Some of the work got lost! December meetings are a Project evening on Tuesday 7th, the following week Tuesday 14th is a Computing evening. The Club's Christmas Party will be held on Tuesday 21st. Further information can be obtained from Richard Sugden, 8, Kings Road, Swinefleet, Goole, North Humberside DN14 8DJ.

We come swinging back down country to THE RADIO SOCIETY OF HARROW, who hold their meetings on Fridays at 8 pm in the Harrow Art Centre, High Road, Harrow Weald.

Yet another interesting Newsletter, covering a wide range of subjects apart from club activities. The club continutes to grow and membership has now reached 138. One point of interest that I read is the formation of a technical help group. A panel of experts which you always find in every club, put to good use in an effort to help members with their problems. I can only fault their Newsletter on one point — how about a name and address to contact. I only have the name of Peter Marcham G3YXZ, Publicity Officer, but no address or 'phone number.

Who said all Ham activity was in the Midlands and North of England. We go back now to the South Coast again to the HASTINGS ELECTRONIC AND RADIO CLUB, where 32 new members bring current membership up to 175.

Their newsletter 'Vital Spark' is certainly a mixed bag, something for everyone. I was impressed by their ability to get a 'quart into a pint pot'. On the first page fifteen members of their Committee are listed in a unique fashion. For example, listed at No.4 the Secretary George North, G2LL and his 'phone number; in the lower half of the page at No.4 is his address.

Despite this, the club has accommodation problems. Since its formation, club meetings have been held in a shop below a member's flat, but now has to move. It looks as if they have been successful in finding new accommodation in Downey Road, St. Leonards, but for confirmation contact the Secretary on Cooden 4645. However their next meeting is on 15th December, the Christmas Social, at which YL's and XYL's are welcome. January 19th 1983 starts the New Year's meetings with Astronomical Electronics by P. Read of the Royal Greenwich Observatory.

IPSWICH RADIO CLUB is next on the list, with the station call signs of G4IRC and GB2IRC. The Secretary is Jack Tootill G4IFF at 76 Firecroft Road, Ipswich, Suffolk, on Ipswich 44047. Meetings are held on 2nd and last Wednesdays in each month at the Rose and Crown 77, Norwich Road, Ipswich. This well produced quarterly magazine is well worth the 25p charge, containing much interesting and helpful information and obviously profitable advertising. Regrettably the copy received by me contained no information on future events. An interesting point is the consideration given to ten other local clubs listing their meeting places and some events.

We now jump on the magic carpet, switch on the computer and press a few of the right buttons to visit the only overseas society whose details we have, this is THE RADIO SOCIETY OF KENYA who tell of the preparations for the Kenyan Award which are now completed and invite applications from all interested Radio Amateurs. Requirements are ten points. One point from each 5Z4 station who must be a member of the RSK. Five points scored by contacting 5Z4RS, the Club Station; all modes and all bands permissible. Witnessed Photo Copies of Log Book are required and should be sent to the Radio Society of Kenya, P.O. Box 45681, Nairobi, Kenya, accompanied by a self addressed label. A charge is made of 5 US dollars of surface mail or 10 US dollars for airmail.

From the Kenyan sunshine we splash down in East Lancashire where at the Shadsworth Centre, on the outskirts of Blackburn we find the EAST LANCASHIRE AMATEUR RADIO CLUB, who hold their meetings on the first Tuesday of each month at 7.30 pm. On 7th December they hold their A.G.M. and January 4th 1983 is a talk on Raynet by Mr. T. Hore G8LTC. The Centre in Shadsworth Road has a good car park and many leisure activities including a bar. For further information contact Norman Jenkin, G4CGT, 5 Minster Crescent, Darwin, Lancs BB3 3PY or phone (0254) 75037.

In Yorkshire we find the formation of a new club THE MALTBY AND DISTRICT AMATEUR RADIO SOCIETY (MARS) meetings are held every Friday at 7.00 pm in the Methodist Church Hall, Blyth, Maltby. For further information contact Ian Abel, G3ZHI, at 52, Hollytree Avenue Maltby, Rotherham, Yorks. Phone (0709) 814911. Best wishes for the Club's future.

When they're not riding the surf boards, you will find members of the NEWQUAY AND DISTRICT AMATEUR RADIO SOCIETY at Treviglas School Newquay, where they meet on alternative Wednesdays. The Secretary P.L. King G4GRY, hasn't given me any dates or forthcoming events, but a call to him at Truro 71133 will answer your questions, or S.A.E to 23 Trevella Vean, St. Erme, Truro, Cornwall.

Norfolk folk appear to be very short on words. The few details I have from THE NORFOLK RADIO CLUB G4ARN, are that the Secretary is K.W. Bilton G4NRL. From the newsheet, I understand that meetings are held each Wednesday at 7.45 pm at the Crome Centre, Telegraph Lane East, Norwich. The meeting on 8th December is 'a short meeting' and on the 15th bring your YL's and XYL's evening.

The next club obviously enjoys its Field Days, their last one 4th/5th September, was full of wonderful surprises for them. The club concerned is the POOLE RADIO AMATEUR SOCIETY, who meet at the Poole Technical College on the last Friday of each month. Visitors are always welcome. Again we are short on the ground when it comes to forthcoming events, but I am sure Tony Laycock G3XYD of 36, Bushell Road, Poole, will fill you in! The Christmas dinner is planned for January 1983 (odd!)

It's nice to see our hobby is not just for whizz kids, it has its more useful aspects like helping to keep disabled folk in contact with the outside world and increasing their circle of friends. The PINFOLD SOCIAL & HANDICRAFT CENTRE FOR DISABLED AND HANDICAPPED PEOPLE is one organisation. The PINFOLD RADIO CLUB at this time has only three members, but are not lacking in enthusiasm. One white stick operator took the R.A.E and is now licenced; the other two are expecting their licences soon. Christopher Moore, Club Secretary, tells me one of their main interests is home brewed equipment, despite the fact that only one member can weild the soldering iron with anything like safety. Christopher is trying to recruit further members for the Radio Club by encouraging his colleagues to use their domestic receivers medium-wave DX listening. To this end he has enlisted the woodworking fans at the Centre to make him some one metre square loop antenna's that can be loaned to anyone interested enough to hunt for something different. He has one problem, a shortage of 500 pf variable capacitors to tune the loops. Come on chaps, dig in your scrap boxes, and give those old 'C's a new lease of life. Send them to Christopher Moore, Pinfold Radio Club, 24 Sally Ward Drive, Walsall Wood, West Midlands, WS9 9JZ.

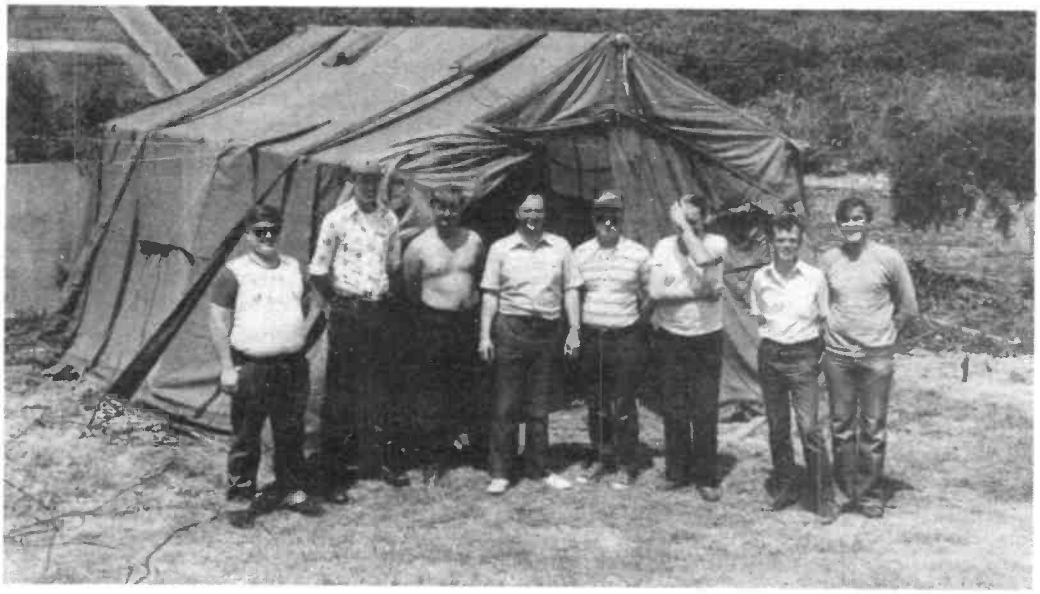
Of all the new clubs and newsletters I have read while compiling this column, S.P.R.A.T Newsletter of the QRP Club, is one of more attractive efforts. I would truly love to hear some of the Reverend George Dobbs' sermons, if they are half as good as the quarterly journal he produces for the QRP Club, the church must be full to capacity. it is refreshing, in these days of 1Kw linears, to see that over 1,300 members of the QRP Club communicate with 5W or less.

The G-QRP Club is open to world wide membership and has many interesting facilities available to members. Weekly club activities take place on Sundays at 1100 — 1200 and 1400 to 1500, also on Wednesday from 2000 local time. Full details are available from the Club Secretary, Rev. G.C. Dobbs, G3RJV, 17 Aspen Drive, Chelmsley Wood, Birmingham, B37 7QX.

From an international low power club we come to a high power club on Merseyside, it is in fact the ST. HELEN'S AND DISTRICT AMATEUR RADIO CLUB, G4LCK and G6LCK, who meet at the Conservative Rooms, Boundary Road, St. Helen's at 7.45 pm, every Thursday evening. From past events it is a club, though only 60 strong, which is very active in just about every field of amateur radio. Unfortunately I don't have any details of forthcoming events, but contact their Public Relations Officer, Alan Manchester, G6FJU at 67 King Edward Road, Denon's Green, St. Helen's, Merseyside.

Whenever I hear of Spalding, I think of acres and acres of flowers in bloom. I suppose some of the deft fingers tending the blooms could rattle a morse key equally as well.

The very active SPALDING AND DISTRICT AMATEUR RADIO SOCIETY, founded in 1965 now boasts 150 members. Club meetings are on the first Friday of each month, except for December and January, when they are held on the second Friday. All meetings are held in the Market Room, White Hart Hotel, Market Place, Spalding, from 7.30 to 10.30. Just in time for last orders? Activities include a 30 week course for RAE examinations every Thursday — practice morse sessions are given by a member G400 three times a week on 1980 kHz; and as a note for your rally diary Spalding Mobile Rally 1983 is held on the last Sunday in May — my calendar says that's the 29th. For full details on this and all other club events, contact the Chairman, Dennis Hoult, G400, Chespool House, Gosberton, Risegate, Spalding, Lincs PE11 4EU or on Risegate 382.



RAFARS DXpedition to the Scilly Isles. L to R G4NVD, G8RVK, G3XMU G40K0, G5DYG, G6ESD, G3ZDW and G4NSG. The two members not shown were G3YTT and GW6FOY.

Now for the first time on our tour we don our kilts and sporrans and go North of the border.... can't you just smell the haggis? From the CENTRAL SCOTLAND FM GROUP comes an action packed newsheet. I hope by now the co-channel interference between three of their repeaters has been resolved; this was to involve channel changes. As always the lads were ready to make the changes necessary, but the Home Office were dragging their feet again. Unfortunately my visits to G.M. land are rare, but one gets the impression from reading F.M. News, everyone up there is mobile. For more information contact Colin Dalziel, B.Sc., GM8LBC, 12 Dunure Drive, Earnock, Hamilton, ML3 9EY. (Don't forget the SAE).

One Scottish club with more than repeater interest is the LOTHIANS RADIO SOCIETY, GM3HAM. Established for over thirty years the club holds its meetings at the Drummond High School, Edinburgh on the second and fourth Thursdays of each month. The next meeting on December 8th is a talk on Police Radio — ten four! On January 13th 1983 there is to be a series of mini lectures. The Secretary E. Evans GM6JAG, 4 Burdiehouse Street, Edinburgh, EH17 8EY or on 031-664-5403, will be happy to give you full details of the club.

South of the border again to the WHARFEDALE REPEATER GROUP, who are responsible for GB3WF, Channel RB 14 70cm Repeater, covering the Leeds area and the Valley Wharfedale to the North and down into the Vale of York, located 9 miles North West of Leeds at Otley, a local beauty spot, at approximately 850 ft. above sea level, and has been in operation since 1979. The proposal for another 70 cm repeater to cover Leeds City, is in its application stage and has already been submitted to the Home Office for phase 7, proposed for operation on channel RB11. For further information contact the Secretary, Jack Burgess, G3KKP, Moor End, Hawksworth, Guiseley, Leeds, LS20 8NX

Turning left at Leeds we run across country to a point between the river Dee and the Mersey, to the WIRRAL & DISTRICT AMATEUR RADIO CLUB whose club call signs are G4MGR and G8WDC. From their Newsletter production they appear to be one of the more affluent clubs. Entitled Airwave 325, the book is full of interesting items for all tastes.

Only five years old, the club has a membership of over 90, covering a wide range of ages. Normal meetings are held on the second and fourth Wednesday of each month at Irby Cricket Club at 8 pm. Social activities play a large part with this club, known as 'D&W' nights, which stands for 'drinking and waffling' sessions.

The club 'net' frequency is 145.325 MHz, channel S13. (Now you know why its Airwave 325). For details of future events contact Gerry Scott G8TRY at 45 Stringhey Rd, Wallasey, Merseyside, L44 1EF. The next club meeting — December 8th is Chairman's Night (that should be good for a pint!). On December 15th a D&W meeting from 9pm onwards at the Greave Dunning, Greasby.

Weston-Super-Mare here we come, to Locking in fact, home of the ROYAL AIR FORCE AMATEUR RADIO SOCIETY, which needs really no introduction from me. Originating at Cranwell in 1936, the club moved to its present base in 1951. The callsign is G8FC (Flying Corps) was issued to the Society in 1936. The Society has 800+ group members throughout the world. Three stations are active from Locking, using the call signs G8FC, G3RAF and G8RAF. A nightly RAFARS 'net'

Photo shows 'Meander of York' 50' ketch at present on voyage to the U.S.A. Members of the YORK AMATEUR RADIO SOCIETY on board before she sailed. L to R. SWL John, G6MCQ, G6JZQ, G3WHH, G4ESU, G4MIY, G4EMA, G3WVO and G3FTS.

operates seven days a week from 1830 hrs local, at 3.710 MHz, with G2FIX or G4HRV as 'net' controllers.

Earlier this year a DX-pedition to the Isle of Scilly involved 10 members together with 2½ tons of equipment, took place. In the 10 days of operation a total of 918 contacts were made.

Forthcoming event organised by RAFARS is the Christmas Contest on 12th December 1982, from 1200 to 1700, all modes all bands. Further information on the contest can be obtained from Flight Lieutenant D.F. Rycroft, G4OKO, R.A.F. Locking, Weston-Super-Mare, Avon, or 'phone Banwell 822131, extension 335/237. (If you get your finger out).

With our feet back on the ground we visit the ROLLS ROYCE AMATEUR RADIO CLUB at Barnoldswick (no, I hadn't heard of it either) Lancashire. The club meets on the first Wednesday of each month in the Rolls Royce Sports and Social Club, Barnoldswick. The membership has grown at an alarming rate from the eight founder members to over eighty in only three years. Apart from the monthly meeting, which usually consists of a lecture or film show followed by refreshments, members get involved in the usual run of events, Foxhunts, Constructional Contests, Junk Sales, etc. Other nights of the week hum with activity also. Monday night is morse night, Thursday RAE swot night, Fridays you can sit back and listen to more CW from the club's slow morse transmissions; and if you're not caught by the XYL on Sunday morning to peel the spuds, you can listen to construction classes. For more information contact Les Logan G4ILG, 19 Fenton Avenue, Barnoldswick, Colne, Lancashire B88 6HB, or on Barnoldswick 812288. Of course the club call sign is G3RR, what else would you expect!

An apparently active club is the THORNTON CLEVELEYS AMATEUR RADIO SOCIETY with over 180 members, meeting every Friday evening from 8 pm at the Sports Centre, Victoria Road East, Cleveleys, near Blackpool. In the New Year they move to a local Scout hut where they can erect aerials and set up a club station, I am told by the Club Secretary Mrs. Jean Ward G8YOK. This is yet another club where some effort has been put to good use in the production of an excellent journal. The September issue I have even contains a little bit of nostalgia. Congratulations to its Editor! Apart from that the club have been active in several contests, using the club call signs G4ATH and G6GMW. They also run their own RAE and morse classes. For further information contact Jen Ward, 143 Arundel Drive, Poulton-le-Fylde, Blackpool, Lancs FY6 7TZ.

Now we come to that massive society of the 'Senior Service', the ROYAL NAVY AMATEUR RADIO SOCIETY. From all the newsletters produced by the various clubs, the one produced by this society must be the standard by which to judge all others. (Even considering all the facilities that must be available to them, they still make good bedtime reading). The information contained is so vast and varied it is impossible to pick on any particular item without making a major feature of it. (Perhaps the Editor will let me do this sometime) Full information on the Society can be obtained from CRS M Puttick, G3LIK, 21 Sandifield Crescent, Cowplain, Portsmouth, Hants. 'Phone Waterlooville 55880. The society is open to all current and ex-naval personnel.

Back on shore and into the MID-WARWICKSHIRE AMATEUR RADIO SOCIETY, whose meetings are held each first and third Tuesdays of the month at 61, Emscote Road, Warwick, at 8.00 pm. The next meeting on December 7th is an open meeting and on 21st December they hold their Social. The Tuesdays when no club meeting is held a club net on 145.350 MHz commences at 8.00 pm. The Society has also provided and maintains two repeaters GB3MW on RB10 and GB3YJ on R7. Further information on club activities are available from Mary Palmer, G8RZR at 12, Edmonds Close, Woodloes Park, Warwick, CV34 5TX enclosing an SAE.

G3WRS the WAKEFIELD AND DISTRICT RADIO SOCIETY are next in view. This Society has meets on alternate Tuesdays in Room No 2, Holmfield House, Denby Dale Road, Wakefield, meetings start at 8.00 pm sharp. The next meeting is on 14th December which is the Christmas Social Evening in the bar. On 28th December they have an 'On The Air' natter night. Further information from the Secretary, Rick Sterry, G4BLT on Wakefield 255515.

Last, but not least we come to YORK AMATEUR RADIO SOCIETY, who hold their meetings each Friday at 7.30 pm in the United Services Club, 61 Micklegate, York. The Society was formed in 1947, though they proudly boast they can go back to antiquity. One member G4MIY is at present on a two year voyage in his ketch 'Meander of York' en route to W land via the Canaries and West Indies. A two year voyage. Les is on the air most days signing G4MIY/MM. Details of his sked available from the Club Secretary K. R. Cass G3WVO, 4, Heworth Village, York.

I would like to take this opportunity of thanking all participating Secretary's for their able assistance in forwarding all the literature. Two points for future reference, it would be appreciated if future communications included a current diary (dates two months ahead please) and at the same time ensure we have a lot more christian names, just like being on the air!

STATE-OF-THE-ART

Two metre pre-amp

By TIMOTHY EDWARDS*

This is an entirely new version of the 'High Performance 2 metre Pre-Amp', a well known and popular design by Timothy Edwards published early last year in another magazine. Nearly 1000 of the units are now in use and various comments from readers have been evaluated and incorporated into the Mk2 design.

It has become apparent that several 2m transceivers are more sensitive than originally thought and the fitting of the Mk1 Pre-Amp did not always produce the improvement expected. In most commercial equipment the limiting factor of sensitivity will be the aerial changeover relay loss, not the noise figure of this pre-amplifier. The inter-modulation performance of any receiver will, of course, be degraded if a pre-amp is fitted. However, if you don't live close to a taxi rank transmitter or similar then the improvement in sensitivity is well worthwhile. Cross-mod and inter-mod in the pre-amp itself is not very likely as the BF981 is very robust and in this circuit has a 1dB compression point of +10dBm (10mW).

The main problem with the original Mk1 design was the use of the NEC transistor 3SK88, the choice of this FET was mainly influenced by its excellent performance at 900MHz and by the assurance of the UK representatives that its performance at 145MHz was significantly better. Unfortunately after pressing NEC for a firm specification at 145MHz none was forthcoming. Indeed it appears that the noise figure bottoms out at around 500MHz and does not continue to fall to 100MHz as originally anticipated. Although the original samples showed excellent noise figures at 145MHz this has not been the case with production samples. Just after the original article was printed the author became aware of a new device made by Philips, the BF981, distributed by Timestep Electronics Ltd., which has a noise figure of only 0.7dB at 200MHz when operated with a drain current of 5-10mA and gate 2 at 4-5 volts. This device seemed too good to be true but reference to the Philips Data Book confirmed that these figures were in fact guaranteed. Extended optimization tests with an Adret Synthesised Signal Generator resulted in an FM Sensitivity using a Trio 2300 of 0.07uV for 12dB SINAD. This is the best result ever achieved in the author's laboratory. It has since been confirmed by an independent laboratory.

As the original article had several misprints, in particular the capacitive taps on the input and output and the component layout and printed circuit board appeared to be upside down, a new PCB was designed which eliminates these errors and also allows the fitting of the BF981 which has slightly larger legs. As all of the values have been changed to incorporate the BF981 it is not recommended that this device be fitted to the Mk1 Pre-Amp.

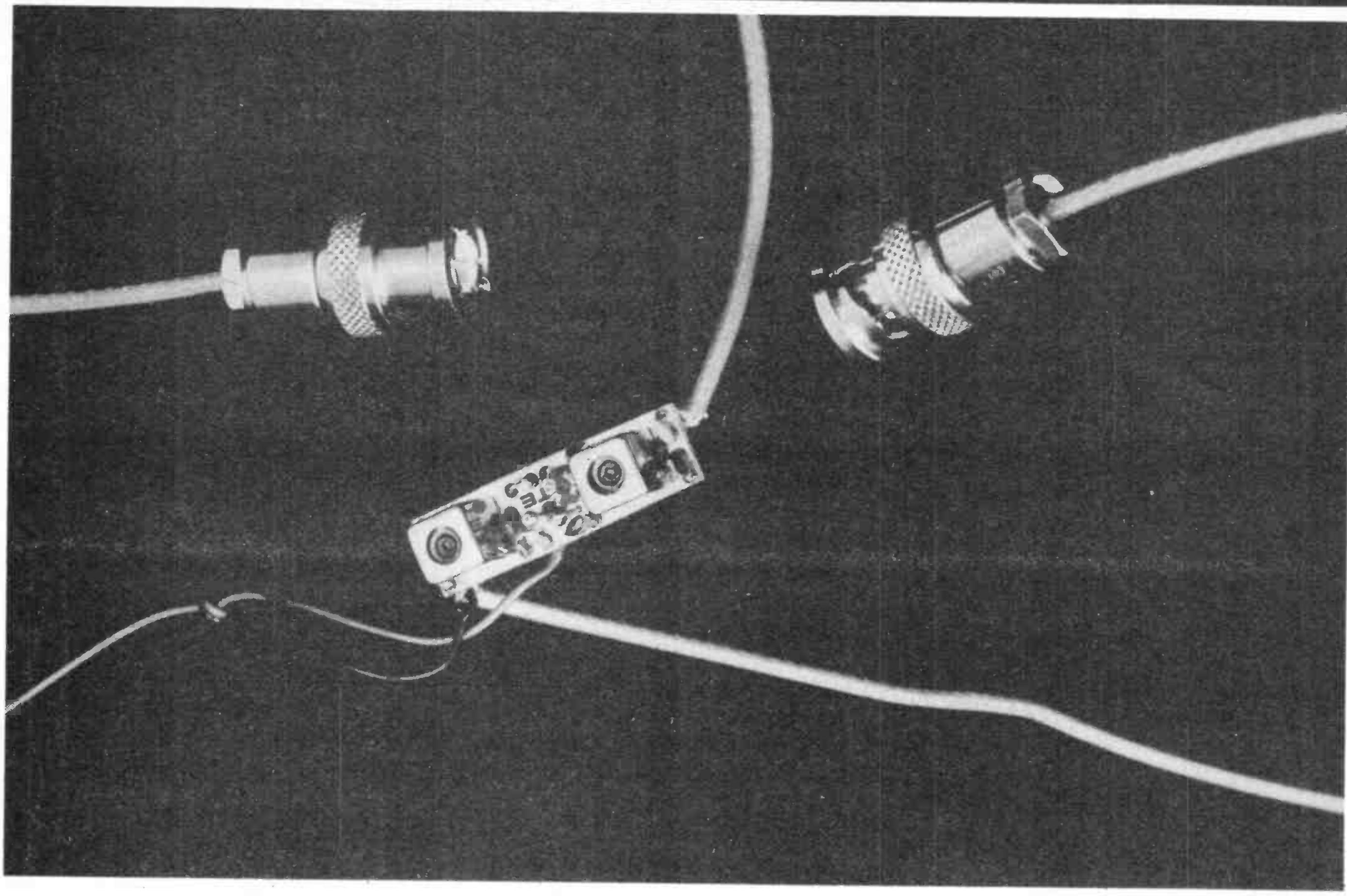
CIRCUIT DESCRIPTION

The capacitive tap on the inductor L1 matches the 50ohm input to gate 1 of the MOSFET. The values of C1 and C2 were optimised with a noise figure test set. The gate 2 bias was derived to set the optimum current recommended for the BF981 by Philips. The capacitively tapped output network was adjusted to give 26dB gain which is 4dB more than the original. The gain on the Mk1 version was found to be lacking in some instances. The resistor R3 is fitted to stop spurious oscillations in the range of 1 to 2GHz.

CONSTRUCTION

Mount all the components leaving the coils and cans until last, the coils will need the pips cutting off with a sharp knife or sidecutters so that they sit down on the PCB properly. Don't forget to solder the can legs of L1 and L2 and also the source leg of Q1 to both sides of the PCB. The pre-amplifier must be installed in the coaxial cable to the receiver. You must make sure that this is the

*Timestep Electronics Ltd



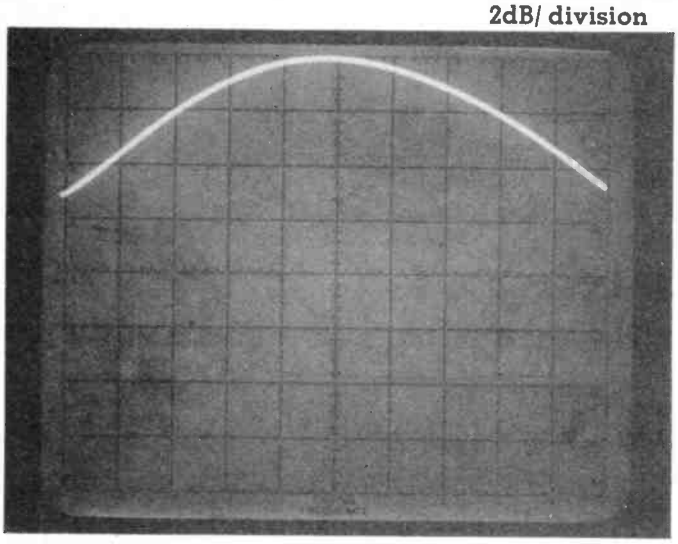
'receiver' cable only as if it is inadvertently connected in the common aerial cable or transmitter cable then the pre-amplifier will be irrepairably damaged when the transceiver is switched to transmit. The aerial side of the cable is connected to the track under C1 and C2 and the receiver side soldered to the track under C5 and C6. It is essential that both screens of the coaxial cables are connected to the earth pads next to the capacitors. Connect a supply (less than 17V) to the pad under R4.

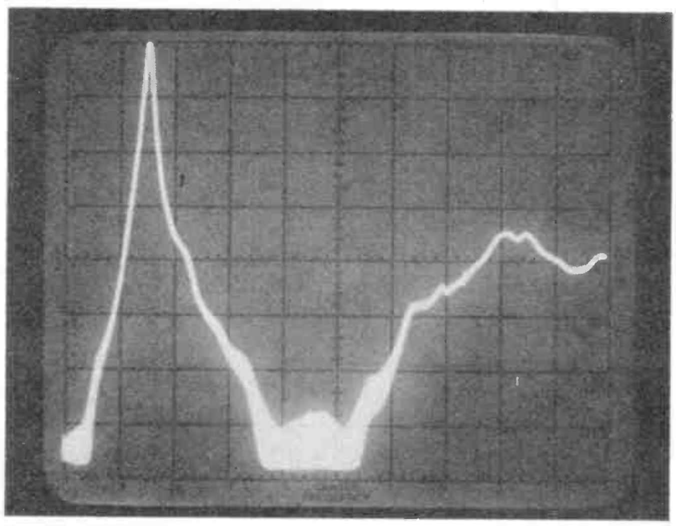
ALIGNMENT

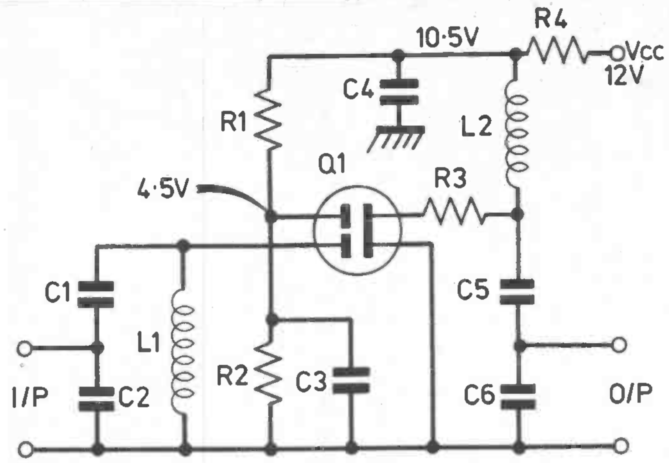
Pre-set the cores of L1 and L2 so that they are flush with the top of their formers. The pre-amplifier should work at switch on and all that is required is to adjust L2 on a weak signal for maximum quieting or maximum S meter reading and then carefully adjust L1 for best signal to noise on a noisy signal.

Right: Stopband characteristics, x axis 100MHz/ division, y axis 10dB/ division
Left: Bandpass characteristic, x axis 1MHz/ division, y axis 2dB/ division

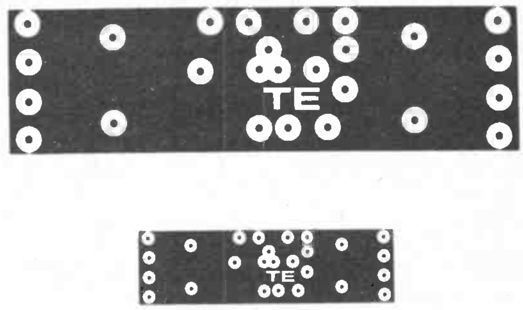
This may not necessarily agree with maximum S meter reading as minimum noise figure does not always correspond to maximum gain. The alignment should preferably be done at around 145MHz. The spectrum analyser photographs show that the bandwidth is sufficient to cover the whole band. If the pre-amplifier doesn't work then check for solder splashes, dry joints etc. The voltages at various points of the circuit are shown on the circuit diagram.





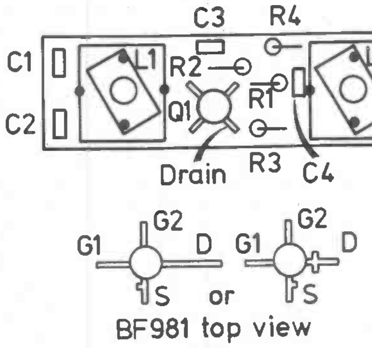


Schematic diagram

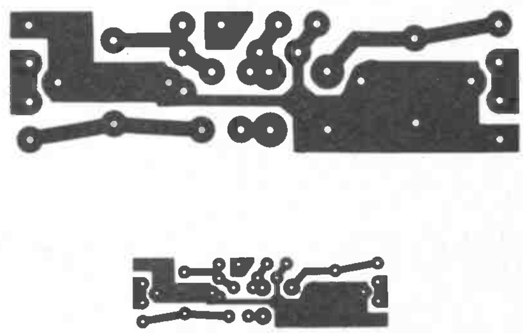


Above: component side PCB groundplane actual size and X2 projection

Below: trackside of PCB actual size and X2 projection



Component layout



CONCLUSION

The Mk2 pre-amplifier should perform better than the Mk1 pre-amplifier and certainly out-perform most of its rivals. It is interesting to note that in the last few days word has it that one of the most professional pre-amplifiers on the anateur market has changed from the 3SK88 to the BF981 as their engineers have now agreed that the BF981 is predictably of a higher performance and more reliable. The spectrum analyser photographs were taken with a Hewlett Packard 141T spectrum analyser and matching tracking generator. Compression tests were carried out with an Adret synthesised signal generator and Hewlett Packard power meter. Noise figure measurements were performed with the Adret signal generator into a receiver of known IF bandwidth and the results calculated from measured sensitivity.

A complete kit for this pre-amplifier is available from Timestep Electronics Ltd., Egremont Street, Glemsford, Sudbury, Suffolk at a price of £4.95 including VAT and packing and postage.

Readers wishing to build this pre-amplifier without buying the kit will find the PCB layouts* correct.

Please note that Timestep Electronics Ltd holds the copyright on the PCB design.

SPECIFICATION

3dB bandwidth	±3.0MHz
Noise figure	1.0dB
1dB compression	+10dBm
Saturated output	+15dBm
Supply voltage	8-17V
Supply current	5-10mA
Input impedance	50 ohm
Output impedance	50 ohm
Size	34/ 9/ 15mm
Gain	26dB

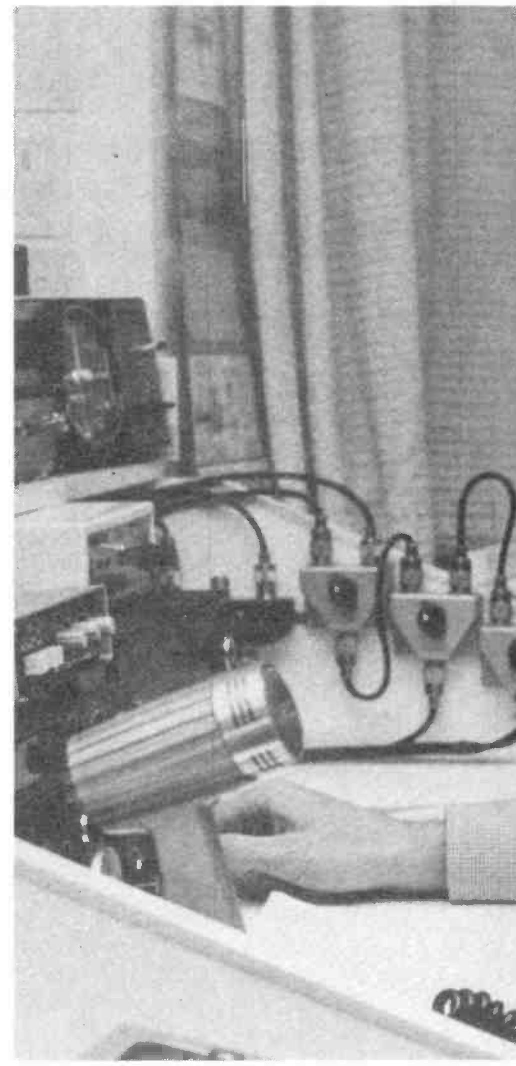
Spectrum analyser scaling conditions.
Bandwidth: Vertical scale 2dB/Division. Horizontal scale 1MHz/Division. 140-150MHz centered on 145MHz.
Ultimate rejection: Vertical scale 10dB/Division. Horizontal scale 100MHz/Division. 0-1GHz centered on 500MHz.

COMPONENTS LIST

Resistors (all 0.125W)	
R1	120K
R2	100K
R3	47R
R4	220R
Capacitors (all miniature plate)	
C1	6p8
C2	27p
C3	1n
C4	1n
C5	8p2
C6	39p
Semiconductor	
Q1	BF981
Inductors	
L1	MC108 8½ t
L2	MC108 8½ t
Cans (2)	7mm
PCB	Timestep

NEWCOMER'S

There's always something new to be found in amateur radio no matter how many years spent on the air.



Tony Bailey G3WPO

Everyone is a newcomer to amateur radio at some time or other and even the most seasoned of us regularly stumble across new facets of the greatest of all hobbies. Even the editor of Ham Radio Today, Frank Ogden G4JST, admits surprise at the depth and variety he found in amateur radio when he got his G8SNW ticket four years ago. And this, he says, was after more than 20 years playing around with RF complete with skull and cross-bones flag hoisted up the aerial attached to his ex-WD No. 22 set. They're coming to take you away, Frank. *(Oh no they won't because I'm going to scrub this bit — Ed.)* Kidding aside, this is the purpose of the column — to introduce, inform and delight people about amateur radio.

Above all, I need your help. This is a FORUM where we can share ideas and problems but this cannot be done without input from our readers. If you have any specific problems or ideas, (or even hints and tips) you would like to see sorted out in this section, then please write. I will do my best to sort them out, as space permits, but will be unable to assist with personal replies.

The odd piece of construction should also find its way in — if you have any ideas then send them along — they may also find their way into the Technical section. We would like to make this the best of the Ham Radio magazines available and with your help it can be done.

Since the author was licensed, one major change that has ocurred within the hobby is that of what may be termed the 'engagement' to amateur radio. The practice of Short Wave Listening was obligatory to anyone intending to obtain a licence, during which a great deal of the operating techniques used both on HF and VHF were acquired for putting into practice later. During recent years, this process of familiarity has fallen into disuse, one major contributory factor being the advent of legal CB, with many CB'ers forsaking their limited access to the radio spectrum in favour of the wider horizons and considerable 'magic' of ham radio, but without the SWL background they would once have had.

'Ham radio'? Shouts of horror from many quarters can be heard, but the term seems to be accepted these days without the derision it would once have had.

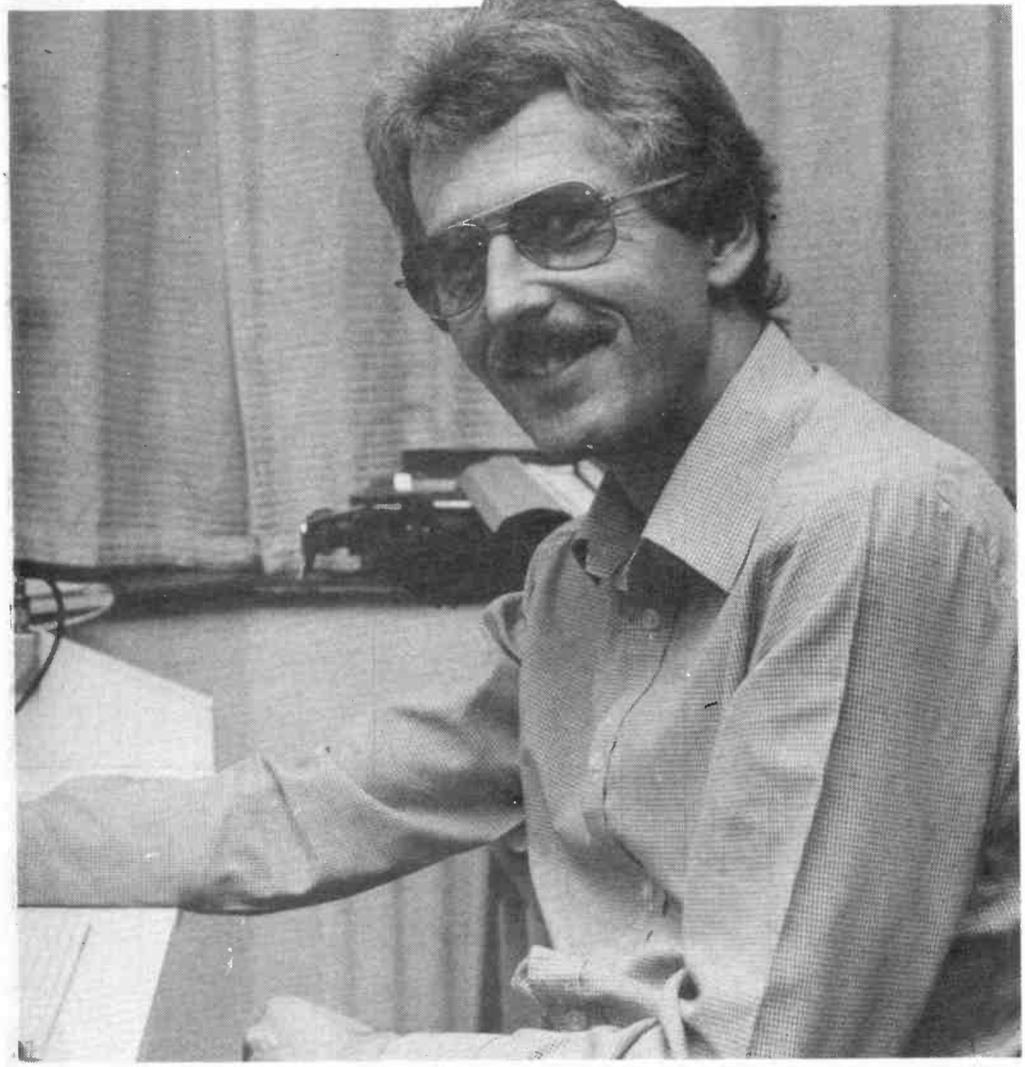
QRZ, QRZ?

Back to operating. One of the consequences of less introductory listening is that the newly licensed (and not so newly licensed) amateurs use many of the terms in everyday use without really realising what they actually mean. The writer's prize one is "The fading is caused by the QSB", but this may be an extreme example. A more common misuse is with the term QRZ. The international meaning is "Who is calling me?", when suffixed by a question mark. A frequent statement is "QRZ the station on this frequency?" even when said station was known to have been calling CQ. If he had been actually calling you then the correct response would have been "QRZ? This is G3WPO". Otherwise QRZ is not a suitable term anyway.

The whole question of the use of Q Codes on telephony is one that has been debated in the past. I personally regard it as part of amateur radio, much as other hobbies have their own jargon. The argument against using them in conventional QSO's has its merits, but the chances of their use being restricted to CW only is pretty remote. Old habits die hard.

One piece of operating practice worth adopting is that of listening on the frequency you intend to use before making any transmissions. On VHF FM simplex I have often heard stations make contact on S20, then gaily fly off to a nominal channel without checking it first. Chances

FORUM



"CQ CQ CQ from G3WPO G3WPO G3WPO", repeating this sequence three times, with phonetical emphasis of the callsigns. There is nothing worse than 25 CQ's followed by a garbled callsign a couple of times. If there is no result, either no-one has heard you or they didn't want to talk to you. Try again, and if still no result, try another clear frequency rather than burn a hole in the bit of ionosphere you were using.

And do use the recognised phonetics, which even the dimmest of pidgen English users can comprehend. Home brew alternatives generally have at least one other interpretation and that will be the one used by the VK station trying to read you through a wall of JA's. However, use some commonsense in the number of times your callsign is repeated — it isn't needed every transmission (at least once every 15 minutes minimum), especially during rapid exchange. Nothing sounds worse than G6ZZZ from G3WPO. Yes. G3WPO from G6ZZZ." . . .

For your first few contacts, don't be afraid to call other stations just because you are not sure what to say. You will probably get better results than calling CQ and you have the choice of who to contact. The other point against an initial CQ is that you may well suffer from an overload if a rare DX station (hopefully) comes back to you, at least when you have called a station you have a short time to prepare yourself. Another point is that by calling CQ you are implying that you will answer any calls resulting, which may not be the case.

If you feel your brain won't cope with the strain for the first few times, then make a crib sheet of what information needs passing. I did this for my initial CW contacts on HF, after abandoning the first QSO when after five minutes I hadn't sent my callsign correctly once!

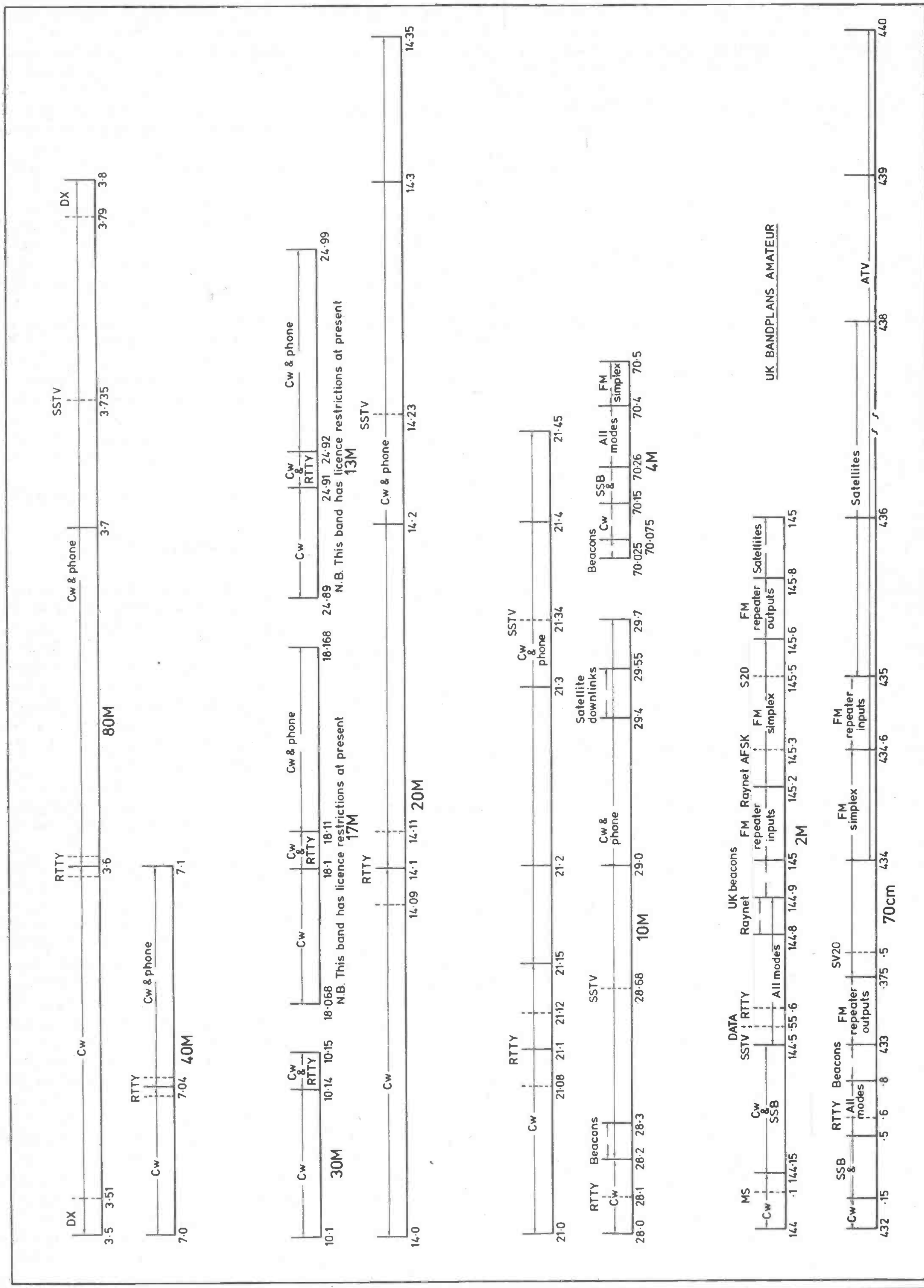
Another worthwhile occupation is to spend a period of time listening around the band you intend using. You will then have an idea of propagation conditions, levels of activity, and whether there are any stations on, you would particularly like to contact. This applies especially to VHF where a look in various compass directions, if you have a beam, could pay dividends prior to transmitting. Some of the

are there is a QSO already on that channel if it is one if the popular ones — if it happens to be you then you will know the ensuing comments which take place. Even if nothing is heard, a local may be in QSO with a distant station you cannot hear, so a quick 'Is this channel in use?" before occupying it (or QRL on CW).

This idea is of even more importance on HF with the vagaries of propagation. Mind you, a fair proportion of Eastern (and nearer) European stations do not seem to have any clue as to correct operating practice anyway. How many times have you heard a DX station calling for W's alone, only to find that all the W's have suddenly acquired European prefixes!

Getting Contacts

If you are newly licensed, there are a number of ways in which you can increase your chances of contacts. On HF, the world is available to you and would most likely delight in working you given the chance. The way you operate can greatly influence the results, with one of the most off-putting methods to other stations being the extended CQ call. The old standard of a 'three-by-three call is worth sticking to i.e.


UK BANDPLANS AMATEUR
80M
DX
3·5
3·51
Cw
RTTY
3·6
Cw & phone
3·7
SSTV
3·735
3·79
3·8
40M
7·0
7·04
7·1
Cw & phone
30M
10·1
10·14
10·15
Cw & RTTY
17M
18·068
18·1
18·11
18·168
Cw & phone
N.B. This band has licence restrictions at present
13M
24·89
24·91
24·92
24·99
N.B. This band has licence restrictions at present
20M
14·0
14·09
14·1
14·11
14·2
14·23
14·3
14·35
Cw & phone
SSTV
10M
21·0
21·08
21·1
21·12
21·15
21·2
21·3
21·34
21·4
21·45
Cw & phone
Beacons
Satellite downlinks
28·0
28·1
28·2
28·3
28·68
29·0
29·4
29·55
29·7
4M
Beacons
SSB &
All modes
FM simplex
70·025
70·075
70·15
70·26
70·4
70·5
2M
MS
Cw & SSB
DATA
SSTV
All modes
Raynet
UK beacons
FM repeater inputs
Raynet AFSK
FM simplex
S20
FM repeater outputs
Satellites
144
·1
144·15
144·5
·55
·6
144·8
144·9
145
145·2
145·3
145·5
145·6
145·8
146
70cm
SSB &
Beacons
FM repeater outputs
SV20
FM simplex
FM repeater inputs
Satellites
ATV
432
·15
·5
·6
·8
433
·375
·5
434
434·6
435
436
438
439
440

more spectacular openings to Europe are very short lived, and the fact that you were tuning around at the right time could result in some very nice QSO's

Try not to bore your contact! He (or she) will no doubt want to know where you are and the rest of the normal details, and the fact that you received all his information OK. If you leave it at that then the QSO is probably already over, so try telling him something that you would like him to tell you (within licence regulations . . .) and you may have a longer contact with a more conversational note, which will help put you at ease.

American stations have this latter knack, in some cases to excess, so be prepared for more of a chat with this part of the world.

Sayqueue Dog X-ray . . .

The term 'DX' is relative and depends on a number of factors. On HF, it is often taken to mean a rare station, when it really means that contact is required with a station outside of the calling station's Continent. Many USA stations call CQ DX, meaning they don't particularly want to talk to other Stateside stations. Unfortunately, Europeans often give it another meaning, usually that they will talk to anyone other than their own countrymen, especially if the station they hear is calling Pacific only — it is surprising how many European countries have dreams of grandeur along the Tropic of Capricorn. If you really want to work DX in the sense of rare stations, then you will have to listen for it, and be prepared to do battle with many other stations, but that is another subject.

On VHF, the term DX is generally restricted for use during openings, and then indicates someone more distant than would be normal for that station, or if the band is open to the Continent then the operator is probably looking for contacts in that direction.

With the advent of repeaters (and usually a love or hate relationship with most people) VHF openings bring a multitude of additional repeaters into your grasp. Cries of all the DX worked through them can be heard when the lift has died down. But is it really DX? At best, you have worked the repeater itself, as that is as far as the signal has travelled unaided, but far more is achieved if the contact is made direct — harder no doubt but much more satisfying. Repeaters were evolved to aid the mobile stations, not as an aid to fixed station psuedo 'DX' working.

Bashing The Key

To really raise a controversial subject, how about a few words on the subject of morse. Not whether it serves any purpose or should be scrapped (of course it shouldn't . . .) but the best way to learn it. There can be little doubt that learning CW is easier than learning to talk — if you have the will to try it. If it is regarded as a chore to get to the Class A licence then it will become a chore. Try looking at it as another means of communication with its own benefits and method of operating, like RTTY or SSTV. If properly mastered, the art will never be lost, even after a period of disuse, when a few minutes back on the key will kill the rust. If anyone has a pet method which worked in their case then let everyone in on the secret via this column.

If you do operate CW and are still battling along at relatively low speeds, don't let the other half of your QSO get away with sending too fast for you. If he is half an operator he will have slowed down to match your speed anyway. If not, tell him to slow down (pse QRS) — if he doesn't then forget it and look for someone more considerate. More intelligence is probably passed in a slow 10 minute CW QSO than half an hour of average chat on 80 meters phone, where many stations seem to have special Home Office permits for permanent occupation of the frequencies they use. "Sorry old man, you just called CQ on the Old Groaners Net Frequency — we will be using this tomorrow at ten so please QSY" (it really is almost true).

Bandplan

Bandplans — to accept or ignore? All amateur bands have a bandplan or a gentleman's agreement as to what modes should be used in which sections of the bands. On today's heavily populated bands it seems sense to accept them, although you will always have the non-conformists, as in society. Unlike society, there aren't any penalties for infringing them, but despite this they do seem to work in the main. On HF, the divisions are reasonably easy between CW and phone, with the odd RTTY and other specialised allocations. Few people infringe this convention, and hardly ever the actual band edges, although for some reason there always seems to be someone to be found on 6.999 MHz . . .

At VHF the position is more complicated with additional modes vying for space (with the MOD possibly vying for 70cm in its entirety). The newcomer can be, forgiven for not knowing all of them, what with RTTY, SSTV, FM RTTY, Satellites, Meteor Scanner, Repeaters, Moonbounce, Beacons, Raynet, Calling frequencies and assorted other paraphernalias, not to mention those nasty "spot frequencies" we must avoid. To overcome this deficiency, we have published all the bandplans up to 23cm.

Satellites

One specific part to avoid, and which has now been internationally accepted for a number of years is the portion 145.8 — 146.0MHz. This is no longer allocated to FM (believe it or not) but to Amateur Satellite Service. Satellites do not have large high powered transmitters and the downlink signals and beacons are generally fairly weak.

This will become even more important when the first (or second if you count the first disaster) Phase III satellites are launched early next year, bringing a new era of communications to the VHF/UHF bands. The engineering beacon will be transmitting in this band, not to mention the fact that UOSAT already has its general data downlink Tx on 145.825. Although you may not currently be using the amateur satellite frequencies, you might find that your example of keeping clear of these frequencies pays dividends some time in the future. Remember that an awful lot of people put immense efforts into getting these satellites up, with little monetory reward, so help as much as you can by taking FM off to the dozens of other channels available.

On that thought, I will leave you to take pen to paper and see you next month with some more thoughts on the subject of operating. ●

NEXT MONTH

electronics today INTERNATIONAL

THE ETI ORGAN
Here's a major project for all you budding musicians — a two-manual and bass pedals organ. This design has a single main board that does all the usual organ stuff and also includes a very realistic-sounding multi-voice rhythm module. Sounds expensive, doesn't it? Wrong. The start-up kit to build one keyboard will cost less than £100, while a full kit (excluding cabinet) will be available for under £300. A fully-built version will also be available, still at well under the price of organs with an equivalent performance.

ZX81 ENHANCEMENT
Here's a very cheap little project for anyone who owns a ZX81 and sometimes feels like breaking it by hitting it with the cassette recorder. Yes, we've got details on how you can solve all the legendary problems this computer has with SAVEing programs, and very cheap it is too!

LOGIC PROBE
Not another logic probe? Yes, here's one that's a little more complex than before, which will give you an indication of pulse presence and polarity besides the usual high and low indications.

CRYOGENIC COMPUTERS
Do you get cold feet when you think about electronics? IBM's design engineers took it a stage further, and next month we'll be telling you what they're up to.

DESIGN COMPETITION
There's one group of people who'll be camping outside the newsagents next month: the ones who entered our Design competition. The next issue will reveal the name of the person who won the £100 prize for the best design based on free PCB we gave away with the October issue. We've also decided to publish one or two runners-up.

LOOK OUT FOR THE FEBRUARY ISSUE ON SALE 7th JANUARY

Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

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TECHNICALITIES

negative resistance

parametric problems in transistor PAs

power grid circuitry

magazine newsround

As circuitry goes the standard transistor PA stage appears, at least at face value, pretty straightforward. Looks can be deceiving. The early radio pioneers faced in many ways an analogous problem when they tried to use tetrodes in RF stages principally worked out for triodes. Using a second grid to isolate the grid and anode circuitry seemed to present no obvious problem until the volts were applied. Things started to produce RF whether they had a drive signal at the control grid or not.

It took a bit of time for some bright spark to work out that electrons travelling from the cathode bashed into the new fangled screen grid knocking off more free electrons than it caught. Secondary emission was born. With a bit of experimentation the pioneers deduced that if the anode volts were dropped to a value a little below that of the screen grid, electrons sailing clean past the screen grid would hit the anode knocking off, like the screen grid, more electrons than were captured and delivered to the anode load. Under these conditions it became possible for the normal state of the circuitry to be reversed: as the anode volts fell, the anode current actually increased. This particular effect is known as negative resistance and a tuned circuit connected to a source of negative resistance will oscillate robustly, the situation occurring whenever the negative slope resistance (Va/−I) was less than the dynamic resistance of the tuned circuit and its load.

In modern times, negative resistance is used to good effect in tunnel diodes, Gunn devices and avalanche diodes generally. However, for the early amateurs who found that anodes could behave like cathodes, screen grids could behave like anodes and that control grids could absorb large amounts of VHF RF power without actually drawing any grid current (the transit time effect) negative resistance was mostly a pain in the power supply.

Which brings me to the caveats surrounding the design of transistor power amplifiers. **Fig 1** shows a pretty bog-standard circuit for a 10W FM transistor PA. For a circuit with so few components and an apparently simple mode of operation — you are not even asking the device to amplify an RF envelope linearly — it is full of pitfalls, due in most part to negative resistance.

There are at least two prominent points of negative resistance in the circuit which only await the right sort of reactance to turn an amplifier into an uncontrollable oscillator. To complicate matters the two modes are quite distinct and tend to appear at opposite ends of the radio spectrum. The first is LF instability due to the fact that an RF transistor driven fairly hard with RF applied to the base has a hefty dose of negative resistance in the collector circuit. Simply, if you drive the transistor with the collector supply disconnected and put an ammeter in circuit connected to a variable power supply (of low impedance) the transistor takes a lot more current for the first volt or so than for other, higher potentials.

The limiting case occurs where the power delivered to the load requires an increase in current with supply voltage greater than the drop in current due to negative resistance. After the limiting case occurs, there are no further problems . . . or are there? That ferrite bead on the 'cold' side of the collector circuit feedthru capacitor turns that section of wire into a substantial

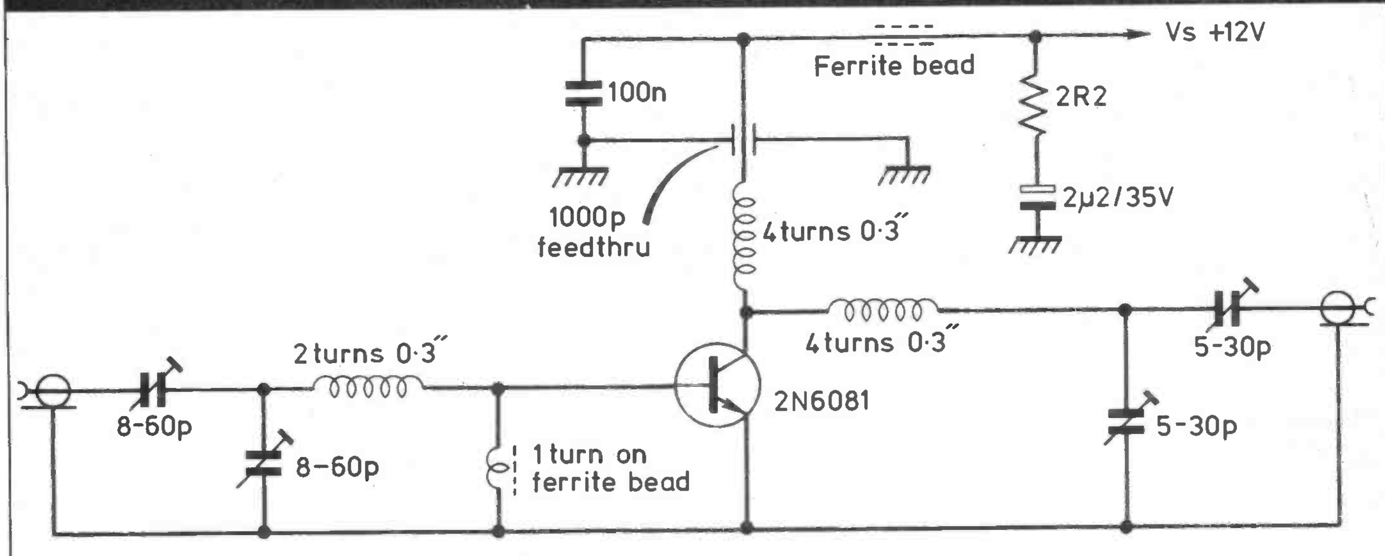


FIG.1. FM 10watt 2m PA. Spot the mistake.

low frequency inductor. When used with the bypass circuit shown, the 100n capacitor and inductance of the bead behaves as a parallel tuned circuit across which is connected the negative resistance of the transistor. Result, oscillation in the region of 500kHz to 3MHz or higher modulating the HF (or VHF) signal envelope.

You may think that I am making a little bit too much fuss about nothing in particular. Not a bit of it. I remember one evening about two years ago I was having a long chat on 2m using a home-brew transceiver when I recieved a call from the East Sussex police. Unknown to me, my machine had just this problem with the result that I was putting out three distinct signals: my nominal transmitting frequency, a spurious about 3MHz above and a similar one 3MHz below. The lower one was neatly accessing the East Sussex police repeater six miles away with 5 by 9 reports from the ops room. Since I am a well behaved amateur and always give my call sign, it didn't take them long to trace the source of the interference.

The answer to this particular problem is shown in **Fig 2.** The use of ferrite beads in high power RF circuitry should be judicious to say the least. If you must include the things in a PA section always put them after the low frequency decoupling and never before. As a general rule it is much more satisfactory to use airspaced low value RF chokes than ferrite beads. In the case outlined previously the oscillatory voltage across the bead was sufficient to drive it into magnetic saturation evident by the high temperature that the ferrite bead reached in service.

Resistive termination

There is another point. Almost every PA circuit that I've ever seen shows a low value resistance in series with the LF discoupling capacitor. The 'lossy' nature of standard aluminium electrolytics is quite enough to damp down even the most recalcitrant of LF parasitic circuits encountered in transistor PA stages providing that it is put in the right place.

There is another place where ferrite beads must be used with care. People invariably stick them in the base circuits of transistor PAs leading to a condition where the transistor sees a low resistance at the operating frequency (if the input matching circuitry is doing its stuff) and a high impedance towards the LF and HF sides of the operating frequency. The HF high impedance state is usually of little importance (but beware, there are special cases) because device gain will be falling off rapidly, typically at 6dB/octave. However, it goes towards the opposite way in the LF direction and it is quite usual to see some sort of negative resistance in the base circuit towards this end of the spectrum. The result is once again robust LF parasitic oscillation with exactly the same results as for the other case. It can also destroy the transistor.

The answer is to use resistive rather than inductive termination in the base circuit. It might appear that the connection of a low value resistance across the base might adversely affect the gain of the circuit at the operating frequency. The actual reduction in gain is marginal and usually undetectable. In most circumstances the actual input resistance of the transistor at the operating frequency will be less than two ohms for the typical 10W 2m case. The insertion loss of the resistance over the usual ferrite bead will amount to fractions of a dB. In other words nothing at all. However, at frequencies away from the operating frequency the maximum excursion will be limited to the value of the resistance rather than the 1000's of ohms which is otherwise the case. Remember too that the input capacitance of this kind of PA transistor will be in the region of 300 or 400pF and when paralleled with an inductance — ie, a ferrite bead — a relatively high 'Q' LF tuned circuit can result. The solution is to think resistors rather than the usual ferrite bead.

All these LF parasitics cannot

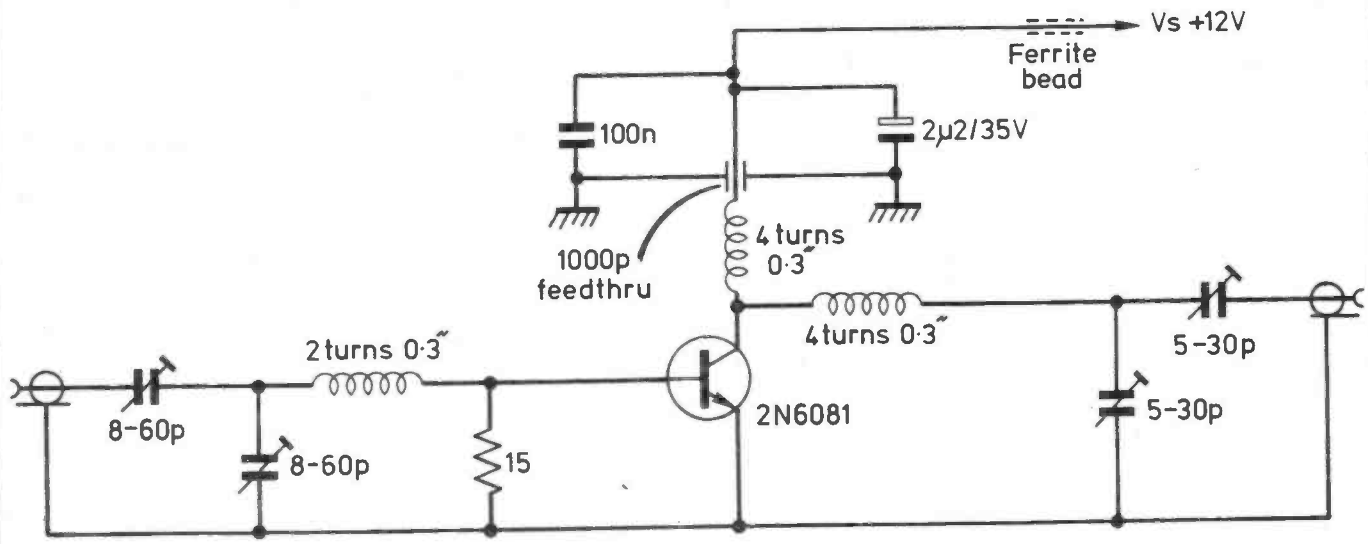


FIG. 2. Almost exactly the same circuit as fig.1, but unconditionally stable

be detected with the type of conventional absorption wavemeter so beloved of the RAE examiners. It is essential to have an instrument which can detect spurii a couple of MHz out from the operating frequency. The best way to achieve this within the confines of the amateur radio station is to splice a tap on a high 'Q' tuned circuit across the feeder going to a 50 ohm dummy load. The other side of this combination is connected to the transmitter under test through a conventional sensitive SWR meter. With the tuned circuit taken out, a one to one SWR should be obtained whatever the condition of the transmitter. With a correctly tuned tank in circuit the same state should be obtainable. However, if the TX has got substantial spurii, these will be reflected as increased SWR. Furthermore, this SWR will alter with adjustment of the various PA trimmers. In particular, look for any discontinuity as you adjust the circuit. Spurious emissions of this kind tend to come and go at various positions of the circuit trimmers. When a spurious appears or disappears there will be a distinct kick or step change recorded on the SWR meter.

That describes the first type of negative resistance to affect these 'simple' PA circuits. The other — high frequency — kind relates to the parametric affect present in all bipolar transistors (and indeed to the majority of FETs but that is another story). The basic problem is that the base-collector junction is typically a reverse biased diode complete with all the depletion layers and general device physics associated with diodes. In short it means that the average bipolar power transistor behaves as though it has a variable capacitor connected between the collector and base, the exact value of the capacitance dependant on the instantaneous collector-base voltage. In other words the junction is a varicap, parametric diode, call it what you will.

Varactor diode

There are certain circumstances when the parametric effect can be used to good advantage. You can make highly efficient doublers and triplers simply by pumping these diodes with a fundamental voltage while siphoning off the harmonic current which flows., It's an interesting point, this. You apply a fundamental RF voltage across a reverse biased diode and might reasonably expect a fundamental current to flow in what is after all, pure capacitance. Not a bit of it. The capacitance actually changes during the RF voltage cycle with the result that it is harder for the applied voltage to change nearer the bottom (more capacitance). The current that flows in the device is forced to change its value twice as often than if it were purely fundamental. The current that flows is double the fundamental frequency.

If the harmonic current is forced back into the device by short-circuiting it with a series resonant tuned circuit, it becomes a harmonic voltage superimposed on a fundamental which interact to produce the next harmonic up. Thus a tripler circuit is born.

The typical PA transistor will do all these things. It is not always appreciated but a humble 2N3866 will work splendidly in most of the parametric tripler circuits which are published from time to time. The emitter and base are connected together with the collector used as the cathode. It is robust, efficient, cheaper and easier to obtain than a custom parametric device. But back to the business in hand of taming wild transistor PA circuits.

Under hard driving conditions, the typical circuits of **Fig 1** and **2** will cause high values of harmonic current to flow in both the collector and base circuits: Horrible prospect, isn't it? That same parametric current generated internally within the circuit device flows simultaneously in both the input and output circuits linking them together in a harmonic mash. The more I start to think about it, the more astonished I am that these things ever work at all.

There is a great temptation

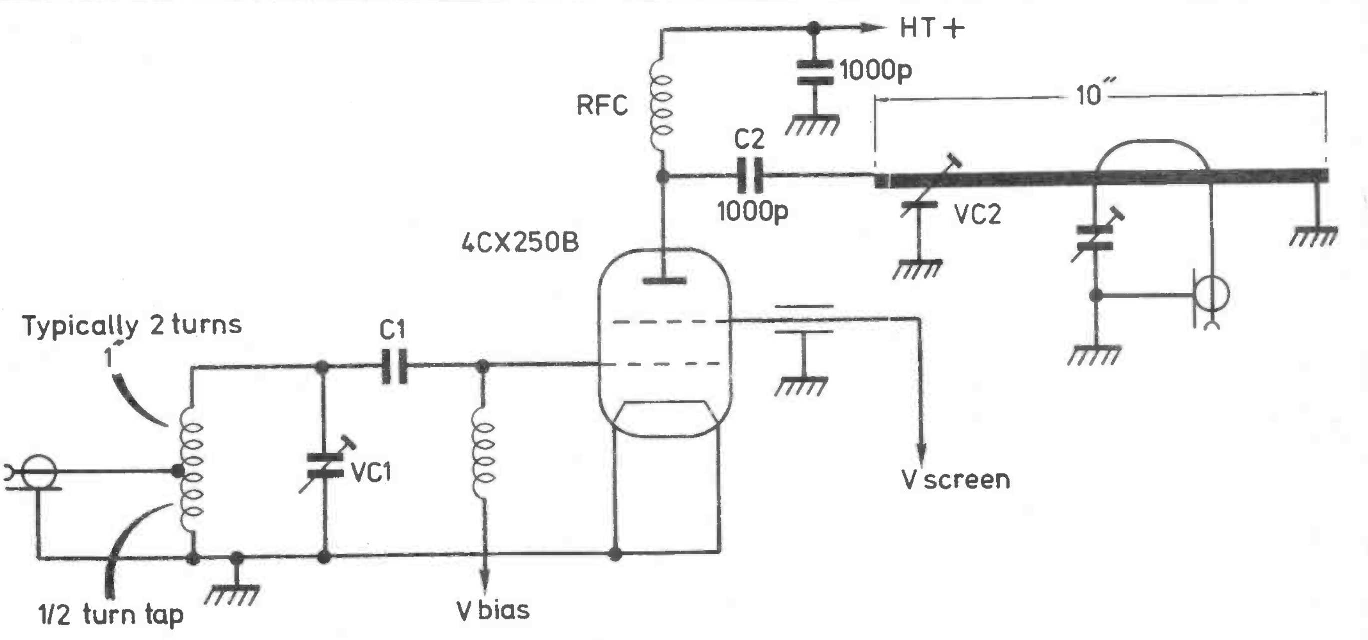


FIG.3. This 4CX250B circuit is trouble

when building RF amplifier projects to splash out a lot of money to buy the highest gain devices that the pocket will allow. For instance. Devices specified for 470MHz operation offer bags of gain at 144MHz enabling the amplifier strip to be designed, at least on paper, with fewer stages than would otherwise be the case. Don't do it my friend unless you are an acolyte in the black arts. Simple circuits often contain stray resonances at harmonic frequencies and these will cause oscillation if the device in use has enough gain in this part of the spectrum. As a rule of thumb, don't go for more than 10dB stage gain unless the circuitry cancels harmonic terms. Just remember this. Output current flows in the emitter while parametric harmonic current flows in the base.

From empirical experience, I've noted a couple of ways where high gain transistors can be used safely and effectively at HF. For some reason, they seem to be stable when working into transmission line type HF transformers, possibly because the leakage losses damp down VHF and UHF resonances. Similarly a low value resistance — in the region of one or two ohms — in series with the base lead offers a suitable repository for harmonic currents. Perhaps someone reading this has got thoughts on the matter. I would be pleased to hear them.

There is one more caveat. Everything said about using transistors with too much gain for the application applies to small signal devices as well. Harmonic problems can degrade receiver noise figure and produce various modes of UHF oscillation with even the best (and most expensive) devices. Design of RF pre-amps should always acknowledge the parametric effect. The judicious use of low value resistance and ferrite beads will nearly always lead to an improvement and perhaps be essential.

Grid troubles

Remember valves? They're great things and in many ways much easier to use than transistors, especially in high power circuits. They are certainly more robust and you can take liberties with them that you would never dream of with QRO solid state.

Most of the circuits that you see for 2m PAs using the 4CX250B indicates a grid circuit tuned in the manner of **Fig 3.** Furthermore there will usually be a low value resistor — about one kilohm — connected somewhere in the grid circuit "to ensure that the circuit is stable under any conditions". What the designers are really saying is that they can't get the thing stable without slugging it to death.

Very often they attribute the "liveliness" of the circuit to lack of neutralisation. In a way they are right but for the wrong reasons. In a VHF design the instability usually occurs at UHF, mostly in the region of 500 MHz. It happens whether the designer uses the vastly expensive Eimac UHF socket or not. Mostly he thinks that the problem is at signal frequency; manifestations of instability are there but the problem is higher up the spectrum.

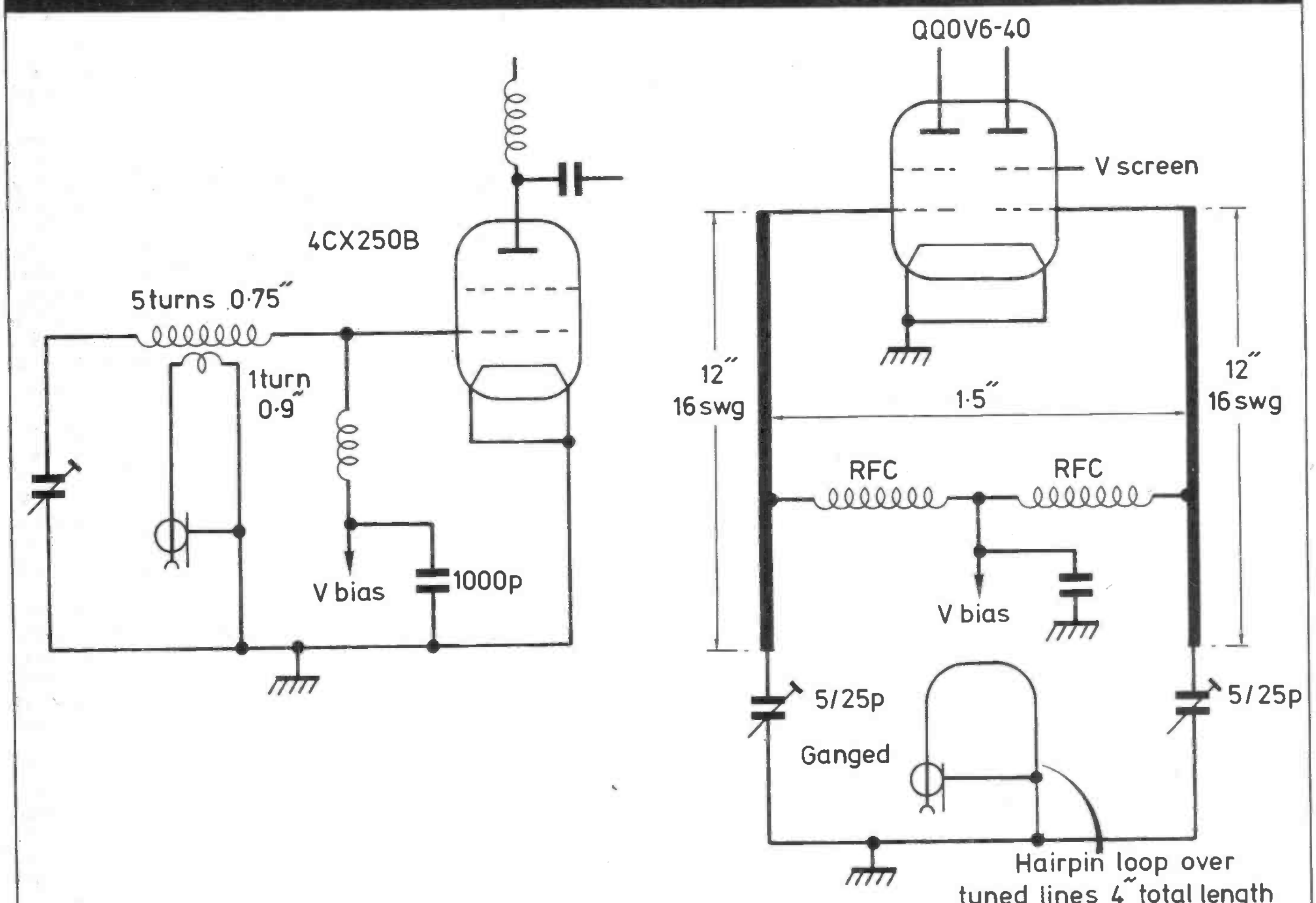


FIG. 4. Halfwave grid circuitry

The problem — unless there is something very seriously untoward — tends to lie in the control grid circuitry. At a particular turnover frequency the capacitance of the screen grid structure of a valve will resonate with the lead inductance causing the neutralising properties to be completely lost. The grid circuit of **Fig 3** has two resonant modes. The first one is what the designer wants: ie the control grid structure resonates at a frequency set by the input capacity of the valve, the capacity of the trimmer and the inductance of the input tank circuit. The other one bypasses the inductance of the tank circuit and becomes purely that of the grid lead inductance, the inductance of CI in series with the inductance of VCI. Parallel resonance is then provided purely by this stray inductance together with the input capacity of the valve. This is about 25pF for a 4CX250B.

The result of all this is what old timers know as a TATG oscillator circuit: tuned anode, tuned grid except the 'anode' in this case is the stray resonance of the screen grid. When power tetrodes of the 4CX250B class act as TATG oscillators, the effects on everything including the operator's nerves are pretty dire. This all happens of course at frequencies far removed from VHF and are difficult to detect directly.

This mechanism is not restricted to 250B bottles either. I've seen precisely the same mechanism strip the oxide off the cathode of the ubiquitous QQVO6-40 double beam tetrode in a blaze of uncontrollable anode current. My friend, Keith, G3TLB, will testify to this. It was his linear.

The answer is very simple. Tune the control grid circuitry with halfwave lines or halfwave lumped circuits. This technique is shown in **Fig 4.** The main point about this is that all capacitance is hung on the far end of the tuning element so that all control grid circulating currents have to go through the input inductor. It has the effect of placing all control grid resonances well out of the line of frequency turnover effects in the screen grid.

My own 4CX250B amplifier (which uses halfwave lumped circuits throughout) uses no neutralisation, no input slugging and produces more than 120W of RF with just one waft of drive at the grid. It is completely stable. **G4JST**

Magazine review

Another of our regular features under this heading will be a monthly review of the amateur radio content of other magazines with comments on what to look out for.

October Radio Communication, the RSGB's journal has another of Peter Harts, G3SJX, excellent reviews — this time of the FT-ONE, the all singing/dancing Yaesu box. Overall conclusions are favourable, except for criticism of the close-in dynamic range. Pat Hawker's column has a useful little basic 2M converter design, and an interesting idea on protecting high-power valves from thermal problems using a spring, microswitch and heat sensitive material. All this among a wealth of other useful information in 'Technical Topics'.

The QTC section also attempts to debunk the rumour that the MoD are about to remove 70cm from our use in favour of their own Repeater system. As the MoD have overall control of the band, one would imagine that if they do decide to take it, that will be that, despite WARC etc. Hands up all those who will continue to use it anyway . . .

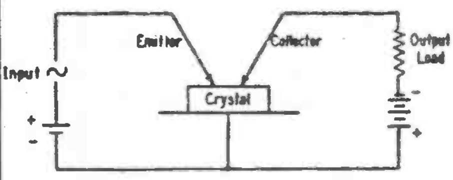
Our Stateside namesake, Ham Radio, starts the October issue off with part one of "An Intelligent Ham Gear Controller', intended as a base for control of such things as a memory keyer, morse board, synthesiser/repeater/transceiver controller etc. The system uses a motherboard based 6502, but you'll have to write to the author for EPROM's and software listings. Other articles are on computer aided UHF preamp design, and a very enlightening (?) piece about ways of working with static and transient sensitive digital circuits. To quote — "a 7-second stroll across a carpet can generate 10,000 volts...".

Members of AMSAT-UK will have their September issue of "OSCAR NEWS", an excellent publication for the satellite user. Edited (and mainly written, due to the usual lack of member effort apparent in most vol-

NOSTALGIA! From QST for October 1948. Note last paragraph!

The "Transistor" — an Amplifying Crystal

There was a time in the early days of radio when the "Oscillating crystal" could be catalogued with sky hooks, left-handed monkey wrenches and striped paint, because no one knew how to amplify a signal with a galena, silicon or other cyrstal. All this is changed by the recent Bell Telephone Laboratories' announcement of the "Transistor", a small germanium-crystal unit that can amplify signals, and hence be made to oscillate.



Housed in a small metal tube less than one inch long and less than a quarter inch in diameter, the Transistor has no filament, no vacuum, and no glass envelope, and is made up only of cold solid substances. Two "catwhisker"-point contacts are made to a surface of the small germanium crystal, spaced approximately 0.002 inch apart.

The Transistor shown is connected as an amplifier in the accompanying sketch. The contact on the input side is called the "emitter" and the output contact is called the "collector" by the Bell Labs. A small positive bias of less than one volt is required on the emitter, and the output circuit consists of a negative bias of 20 to 30 volts and a suitable load. The input impedance is low (100 ohms lor so), and the output impedance runs around 10,000 ohms.

In operation, a small static current flows in both input and output circuit. A small current change in the emitter circuit causes a current change of about the same magnitude in the collector circuit. However, since the collector (output) circuit is a much higher-impedance circuit, a power gain is realised. Measuring this gain shows it to be on the order of 100, or 20 db., up through the video range (5 Mc. or so). The present upper-frequency limit is said to be around 10 Mc., where transit-time effects limit the operation.

The Bell Labs have demonstrated complete broadcast-range superhet receivers using only Transistors for oscillator and amplifier functions (with a 1N34 second detector and selenium power rectifiers). An audio output of 25 milli watts was obtained by using two Transistors in a push-pull connection. However, it seems likely that in the near future Transistors will find their maximum application in telephone amplifiers and large-scale computers, although their small size and zero warm-up time may make them very useful in hearing aids and other compact amplifiers.

It doesn't appear that there will be much use made of Transistors in amateur work, unless it is in portable and/ or compact audio amplifiers. The noise figure is said to be poor, compared to that obtainable with vacuum tubes, and this fact may limit the usefulness in some amateur applications. These clever little devices are well worth keeping an eye on. — B.G.

untary organisations) by Ron Broadbent, G3AAJ, it is full of interesting gen, with much useful info on UOSAT, now back in operation after the problems of the past months. Thanks go to Stamford University, USA, who managed to switch off the 2M TLM beacon, after all other efforts had failed.

Radio & Electronic World, Ambits house magazine, offers an updated 2M converter design, and a rather short review of the FT680, Yaesu's multimode for 6M. With the special permits now on offer for this band (if you want to stay up late), they should have the market for a while, unitl the other manufacturers get their wares in the shops. R&EW's verbal onslaught on the Home Office continues here and there, in between attempting to satisfy all other aspects of the electronics/computing fraternity in one publication.

Elektor sometimes carries articles of interest — the October issue has some information on DSB, and a suitable demodulator. Also a preamp for their SSB receiver, attempting to use this to overcome deficiencies in the original design,

plus an Active Aerial, useful for the SWL with severely limited antenna space.

One magazine which seems to have sorted out where it is going this month is Practical Wireless, which aims itself at the radio amateur completely in the November issue, no sign of a Stereo Tuner to be seen, apart from a series of 16 circuit ideas as a pull out. Besides the start of a series on RFI suppression, and a very brief review of the IC4-E, you can find a Repeater Time Out Alarm, and more ideas on the Stour (who thinks up these names...) 160M transceiver, amongst others. The Editorial also adds to the confusion on the MoD and 70cm, definitely on the scaremonger side of the wall.

American mags

The August issue of QST (yes, it takes a while to get here via surface mail) has a nice 70cm PA design using a 4CX250, with reasonable constructional detail, and intended as a means of accessing the Phase III satellites. It also has its own simpler version of the Ham Radio micro controller, and some info on a multiple impedance toroidal transformer. A good and favourable review of the ICOM IC-720A HF transceiver was noted — also of the FT-680R, commenting that the noise blanker wasn't much good with ignition noise when mobile, although otherwise satisfactory. The problem for the UK reader with QST is that it is, like RadCom, a society journal, and being from the States, contains a lot of non-interesting information, unless you care to take a closer look. Some of the comments about problems with CATV in the States do not bode well for us if it ever gets introduced here — with HMG's record on CB, we will probably get a repeat performance in the UK.

Also noted were the continuing efforts to get US hams on 10MHz *(They now have it — Ed),* and for permission to use AMTOR, the state-of-the-art RTTY system. If you have a micro on 100 Baudot RTTY turn to page 62 of QST for details of how to access the auto-response systems in the States, some of which have Bulletin Boards.

Next month, we will add VHF Communications to the list. if YOU find anything interesting elsewhere, let us know. **G3WPO** ●

WANTED URGENTLY

A RADIO AMATEUR WHO CAN WRITE, OR EVEN BETTER A LITERATE *AND* TECHNICALLY COMPETENT RADIO ENTHUSIAST WILLING TO ACT AS AN EDITOR'S ALTER EGO.

DUTIES TO INCLUDE ALL ASPECTS OF MAGAZINE PRODUCTION: SUBBING, WRITING, ORGANISATION, THE ARRANGEMENT OF EQUIPMENT REVIEWS AND A DOZEN OTHER THINGS CONCERNED WITH A BRIGHT, NEW AMATEUR RADIO MAGAZINE. IT WOULD HELP IF YOU HAVE HAD PREVIOUS EXPERIENCE ON A MAGAZINE, BUT DON'T LET IT STOP YOU APPLYING IF YOU HAVEN'T!

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IF YOU'RE INTERESTED APPLY WITH FULL C.V. TO RON HARRIS, MANAGING EDITOR, ARGUS SPECIALIST PUBLICATIONS, 145, CHARING CROSS ROAD, LONDON, WC2 OEE. ALL APPLICATIONS WILL BE TREATED IN THE STRICTEST CONFIDENCE AND MUST NOT BE TYPEWRITTEN.

QUESTIONING THE RAE

So you're thinking of taking the RAE? Well I'd be the last person to put you off, but I want to tell you of my experience. As a former mathematics teacher well-used to O-and A-level examinations, the May 1982 RAE came as an unbelievable shock!

I remembered very little electronics from my University course and was in the same position as most candidates in that I relied heavily of the text of the Radio Amateurs' examination manual for my preparation. This was my first mistake but I really had tried to find other suitable textbooks without success. (Even my husband, G8DCZ, who is an electronics teacher couldn't help here). In the end, my only other reference source was the series "Passport to Amateur Radio" by J. Thornton Lawrence, GW3JGA published in Practical Wireless some time ago.

The RAE manual is at fault in two ways. Firstly, there are some words bandied about without proper definition. In the May 1982 examination, I was almost caught out by "characteristic impedance" where the four multiple choice answers included one I had heard at University (some 10 years ago!). I was lucky here — other candidates might not have been. (For your information, characteristic impedance, Z, may be defined as the value of resistance which terminates a line of infinite length to produce complete absorption of an incident wave).

The manual's second fault is that the sample examination papers, at the back of the book, while being useful factually are far more straightforward than the questions you will meet in the examinations room. The actual questions are worded with very subtle differences between the given answers so that a

The controversy which has surrounded the RAE appears to have fallen on deaf ears. In my opinion the ambiguities are still there.

'sometimes' in one version may change to 'always' in another. Indeed some of the answers needed a good pass in O-level English Language just to be able to decipher the information given. (Who said that multiple-choice papers were an easy option?)

My second mistake was believing the RSGB's announcement that questions on power limitations for the different bands would be discounted for the May 1982 examinations (due to the new schedule). Under the circumstances City and Guilds did well to discount two of these questions but unfortunately had failed to eliminate one about the maximum power on side-band. I would still like to assume that this question was eventually discounted but was glad that I had not been so stupid as to entirely ignore the new schedule in my revision. Indeed this was the first of several queries to which I alerted the invigilator in case he had any further instructions on the matter.

I am sure that if you have heard other candidates discussing the May 1982 examination you will have been drawn into discussion of the callsign to be used by a "touring caravan in Wales". Okay, so what's so difficult about that you say — Welsh callsigns start with GW. Fine so far, but what exactly is a "touring caravan"? Let's consider the options:—

1) callsign/M if the car towing the caravan has been parked for less than 15 minutes (you cannot actually travel in a towed caravan while it is in motion).
2) callsign/P if parked at a location eg at the roadside for more than 15 minutes.
3) callsign/A if parked at a postal address eg a campsite. In fact the words "Touring caravan" brought the picture of a dormobile into my mind so you could transmit while in motion as well. Confusing, isn't it? Surely the point of having this type of question in the RAE is to check that the operator knows how to fill in the log book correctly. As it stands, this question certainly doesn't do this and having spoken to local, experienced radio amateurs it seems that even they would have found this question ambiguous.

Shortly after the start of the second examination paper my hand was again raised to attract the attention of the invigilator. This time the problem was that to calculate a frequency using $f = \frac{1}{2\pi\sqrt{LC}}$ I needed some rough paper the answer grid supplied being too narrow to work out a question with powers of 10 everywhere. At first the invigilator said that he was not allowed to give me any and sat down again. Then seeing the look of despair on my face, he came back with a spare answer grid and told me to write my candidate and centre number on it as he would have to send it to City and Guilds with the actual answer grids. That was fine by me, the ignomy of getting a purely mathematical question wrong being my only concern. It still does seem strange that this must be the only examination board not to recognise the fact that an "answers-only" examination paper needs somewhere to do the working out. I was lucky with the intelligent thinking of my invigilator; other candidates might not be, so I hope that City and Guilds will rethink this problem and issue suitable instructions to their examination centres.

But back to the question in hand, for you may be wondering why I didn't use my calculator like all the other candidates seemed to be doing, clicking away at their keyboards. I suppose it stems from my schooldays (before calculators) when you were taught to "cancel down" all sums before resorting to your log tables. In fact, armed with my working out paper, I simplified this question until I was left with just one reciprocal sum to do on my calculator. This being quickly accomplished imagine my surprise when I looked at the four choices of answer provided and found that not one of them agreed with my answer. I checked carefully through my well set out calculations and, finding no error, I also joined the calculator brigade just in case I had overlooked something. Having convinced myself that I was correct, I again attracted the invigilator to ask if he had any corrections to this question. He told me that the answers should be right but added that if there was still an error the question would be discounted so not to worry.

For the benefit of those who were not in the May 1982 examination let me explain the problem with the four answers given. They all involved the same digits (937, I believe) but with different decimal places. The correct answer should have been 0.937MHz but the question paper had answer (d) printed 1.937MHz. To any experienced teacher setting a multiple choice paper, this type of printing error should be obvious. I cannot help wondering how carefully the City and Guilds do check their examination papers before despatching them to the examination centres.

By Sharon Metcalfe B.Sc, LTCL and lately G6LCC.

Like many other candidates, I cannot help feeling disgruntled for the time I wasted on this and other invalid questions. One fellow candidate later remarked that this particular question had used up two sets of calculator batteries!

Another problem with this paper was the quality of the circuit diagram on the last page. The diagram had a large number of transistors and resistors with their values written alongside and required the calculations of a voltage.

The paper had been printed in standard typeface except for certain 'additions', in this case many of the components' values, which appeared to have been 'pencilled in' just before the actual printing. The result was that the relevant figures needed for the calculation were either illegible or, I suspect, still actually missing. This question was a deserving case for making an intelligent guess at the correct answer for, being one of the final questions, I had had enough. I would like to thank my invigilator G3ZYE for his patience, for suffice to say I was the only female candidate at the Hove centre, Sussex, and the only candidate who queried anything.

In conclusion, I still say good luck to prospective candidates, the joy of being on the air more than compensating for the irritation of sitting the examination. I only hope that the City and Guilds received enough complaints about the unprofessional quality of the May 1982 Radio Amateurs' Examination papers that future candidates will not be similarly inconvenienced. ●

'HOME BREW WITH KITS'

We think that kits are a good idea. Buying black boxes off the shelf has become a retrograde habit in recent years and anything which enables amateurs to get their hands dirty will improve the quality of the hobby. The few notes which we've put together clearly show that it is possible to build nearly everything which you can buy from your local emporium. And if you start off with a decent kit, the performance of the finished article will be just as good.

Save money, get the satisfaction of running gear which you've built and give yourself something to talk about once you're on the air. That's what kits and homebrew is all about.

With the ever increasing cost of ham radio equipment it's not surprising that there is a tendency towards "home brew" or the modification of some of the older commercial equipment; but this is not always a satisfactory answer to the problem.

Generally "home brew" runs into difficulty sooner or later with the purchasing of small quantities of components. Whilst there are still a number of component suppliers, advertisements gracing the magazines, they are a dying breed and the range of components offered is limited.

The simplest answer to lower cost equipment (notice I say lower and not low) is the construction from kits of some of the more exotic pieces of equipment. However kit building can conceivably cost more in the long run if you take into account the cónstruction time and perhaps the cost of having it aligned.

Heathkit were one of the first companies to produce kits for the home builder. Their claim of little or no experience required to build their kits is certainly true of the simple equipment, but a project like a transceiver, despite any incredibly simple step by step illustrated instruction manual, a reasonable degree of construction experience is required. Even so, this is still a relatively simple approach to owning a sophisticated piece of gear which you have built yourself.

Kit building gives a great deal of satisfaction and considerable experience in handling tools and components. Just about every kit manufacturer is willing — for a small fee — to fault find and get your kit working if you are in trouble.

Some manufacturer's instruction sheets do leave something to be desired; things like not being familiar with colour codes or the connections on transistors, are small points that can make or mar a kit. It's very much a case of "you pays your money and takes your pick".

The following are just some of the kit manufacturers or distributors. All have comprehensive catalogues for the asking —

Timestep Electronics Ltd.,
Egremont Street,
Glemsford, Suffolk.

Timothy Edwards MK 2 144 MHz Pre Amp Kit has a noise figure of 0.7 dB at 200 MHz **£4.95**

Timestep Digital Frequency Counter Kits DFC4: 3½ digit readout measure up to 150 MHz for use with 22 different IF offsets for use as a Digital read out for receivers. FM4 Tune Kit covers 87.5 to 108 MHz, also AM 525 — 1650 KHz and 155 to 270 kHz. Digital read out kits for use with FRG7 — SRX 30 and SSR1 receivers.

Piper Communications,
4 Severn Road,
Chilton,
Didcot, Oxon OX11 0PW

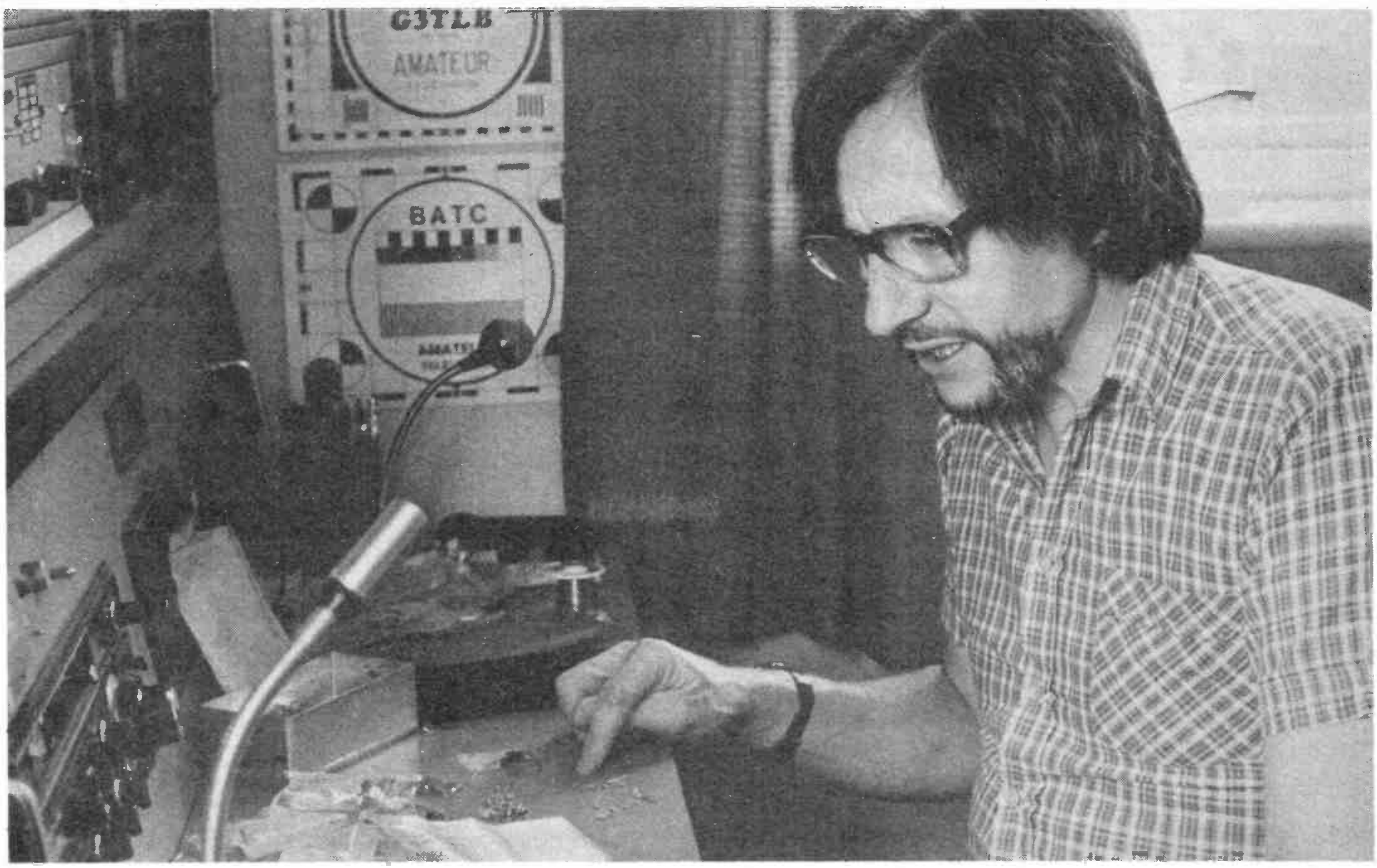
Piper Communications are the sole distributors of the German manufactured SSB Electronic equipment. Their range of kits include:

Receive Converter Kit for 23 cm with IF's for 28 or 144 MHz. A Linear Transverter 144/28 MHz kit, input power 0.8 — 15 watts output power 1 — 30 watts.

2 metre Transverter TV28144 kit enables 10 metre Transceiver to be used on the 2M amateur band, using a Schottky ring mixer for transmit and receive mixing and a low noise dualgate MOSFET RF amplifier.

144-432 MHz high quality transverter kit. Using low noise high stability 96 MHz oscillator. Providing reference signals for the fet mixers — IC regulators stabilise oscillator dc power supplies.

70 cms Transverter System Kit.



Keith G3TLB muttering dark things about the instructions

This system is for where only the best will do. Comprising three units Rx mixer, Tx mixer and high stability oscillator. This versatile system warrants a lot more description than the space here allows.

23 cm Transverter System Kit. Similar in arrangement to the 70 cm system but plus a 3 W linear amplifier on SSB or 1.5 W ATV.

Each unit forms a separate kit.

Linear Amplifier Kits

Model PA281 28 MHz 10 W out — input 50 mW

4321 432 MHz 8-10 W out SSB — — 3-4 W ATV for an input of 10-60 mW SSB, 30-50 mW ATV.

4325 432 MHz 50 Watts output SSB FM — 20 Watts ATV for an input of 10 Watts SSB or 4 Watts ATV.

P. R GOLLEDGE ELECTRONICS
Merriott,
Somerset TA16 5NS

A large number of kit manufacturers do not supply crystals in their kits. This is usually due to the wide range that would be required to satisfy everyone's needs. There are a number of crystal manufacturers of which this company. is just one, with a specialist range for amateur requirements, in standard and subminiature sizes covering monolithic filters ceramic IF filters etc.

As with crystals kit manufacturers do not always include connecting cable or co-ax. Usually there is sufficient to wire the kit, but when it comes to connecting your kit into the system you're left to your own devices, so here is just one of many suppliers of all types of cables sold by the metre and the necessary plugs and sockets.

W. H. Westlake,
West Park Clawton,
Holsworthy,
North Devon.

This Company is constantly adding to its range of kits, which are not always aimed at amateur radio.

From my own experience they generally perform the function required of them, therefore if you are a beginner in kit construction, or you want a cheap kit to experiment with, Cambridge is a name to remember. The poor quality of the instruction sheet is my only criticism.

Useful kits for the ham from their lists are:

Antenna noise bridge
Tuneable audio notch filter
Speech compressor
Two tone oscillator
Crystal callibrator.

Wood & Douglas,
9 Hillcrest, Tadley, Basingstoke,
Hants RG26 6JB

Another well established kit supplier with a very comprehensive catalogue — much too large to list in full — but here's just a few examples:

70 cm Synthesiser
2 Meter FM Transmitter
2 Meter FM Receiver
Display Decoder for Synthesisers
3 W TV Transmitter
Reflectometer
Pattern Generator
and a range of goodies for ATV fanatics.

Heathkit,
Bristol Road, Gloucester CL2 6EE

This must be the brand by which all other kit manufacturers are judged. Their current catalogue contains a wide range of ham equipment from simple to construct morse oscillator to a 2kW linear.

A few examples from their catalogue are:

Morse Oscillator and key **£21.**

QRP HF Transmitter £185.
100 W CW Transmitter £315.
2 kW Linear £675.
and their top quality transceiver HW 101 comparable to the FT 101 and is priced at £520.

There is a wide range of quality test gear in kit form and also just about everything for the computer man.

For those whose training must be done at home or require extra studies to supplement their normal training, Heathkit manufactures a range of private study courses, consisting of books, tapes and practical components and equipment.

As I said earlier these are all well designed kits, using top quality components (even if they are a little ancient in styling) although they are not cheap.

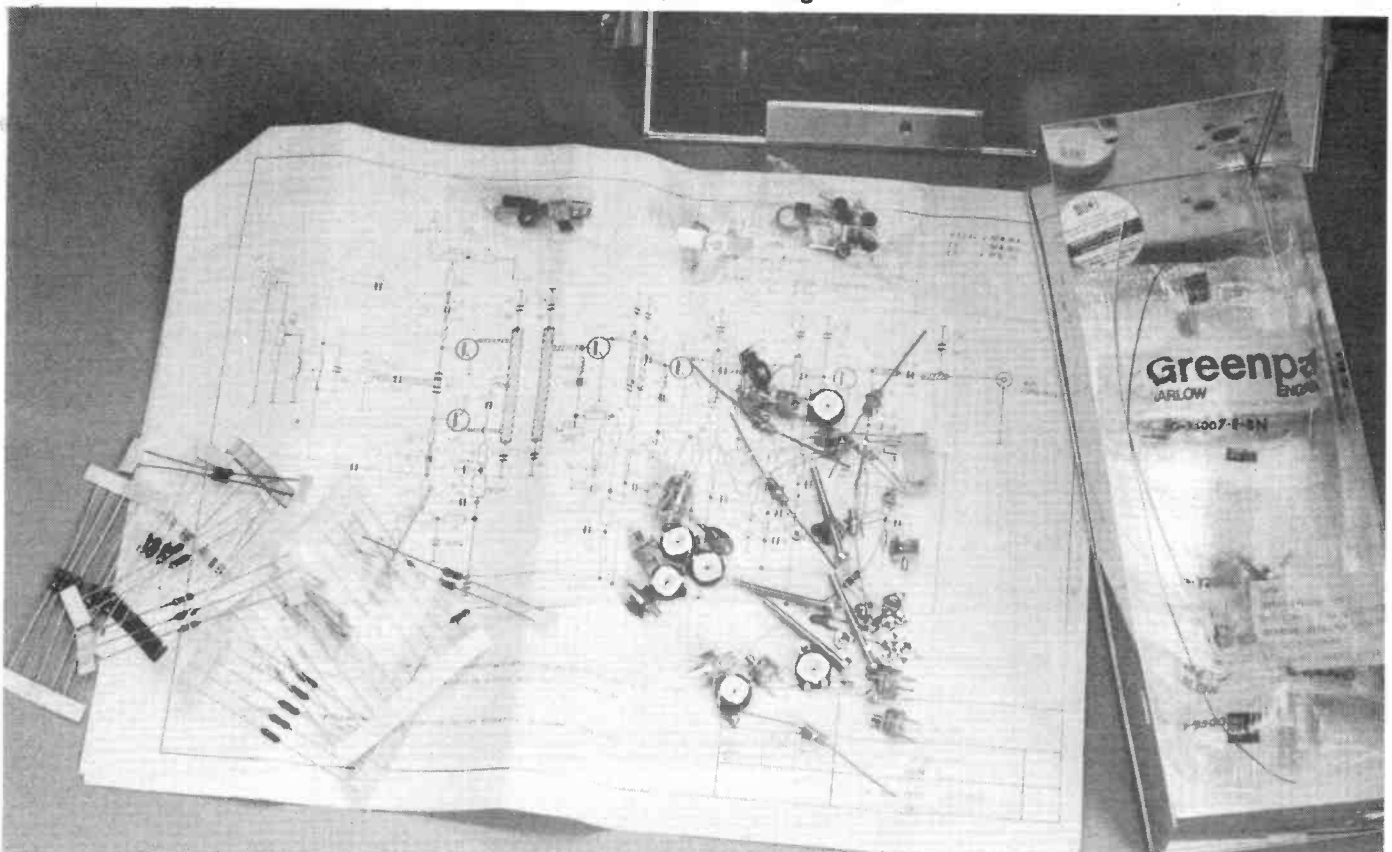
This mini survey of kit suppliers is designed to whet the appetite of the would-be builder and in no way forms a comprehensive list of suppliers.

For the beginner a soldering iron, wire cutters and screwdriver are possibly all the tools required to get the majority of kits into operation. The construction of the simpler kits, forms good basic training in soldering techniques and learning colour codes etc. ●

It may not look as prepossessing as a shiny overpriced black box from the shelf but these modules before assembly represent a 23cm high performance station for well under £200

We believe in kits enough to put them to the test. Keith Smith G3TLB, a well known voice around Crowborough in Sussex, is to be the Ham Radio Today guinea pig. We've bought Keith a complete 23cm amateur television (and other modes) transverter system, a kit distributed in this country by Piper Communications and one of the most advanced designs around.

By his own admission G3TLB is not a whizz-kid with a soldering iron. He is competent and certainly not stupid and probably represents a typical challenge for the kit designer. He is going to let us know how he progresses in prose versed in his own inimmitable style. The last time I spoke to him he was muttering dark things about the English translation of the German instructions. He was also moaning about having to file out slots in the PCB for chip capacitors. It should be an interesting series.



Some of the bits are quite fiddly. This is just one of the modules of the 23cm transverter system before assembly

The mechanics of propagation Part I

A practical understanding of propagation is fundamental to the practice of amateur radio. In this article we look at the HF spectrum. Next month VHF.

The manner in which radio waves manage to travel long distances in getting from point A to point B is arguably the most fascinating aspect of amateur radio and, like it or not, there comes a time when the text books get dragged out to find out just a bit more about the subject than is required to pass the Radio Amateur's Examination. It is the vagaries of radio propagation, as it is called, where one's favourite HF band is full of exotic DX one day and virtually dead the next, that never fails to intrigue whether one is a young beginner or an OAP.

One way of finding out what propagation is all about, if you are a listener, is to log everything you hear on every HF band for a couple of years, or preferably 11 years (more on this later) after which it will begin to percolate through the grey matter that seperates the headphones that there seems to be some sort of a plan in it all after all! That certain parts of the world come through best on a particular band at a certain period of the day, or night, and that these factors change slowly with the season of the year.

If you keep at it for 11 years or so it will be found that there is yet another cycle in propagation conditions that peaks very roughly every 11 years. This corresponds to the level of sunspot activity which has a very profound effect on propagation. Other interesting phenomena include a complete wipeout of virtually all HF frequencies for varying periods and brief periods of intense noise that also tends to over-power all the usual signals. If anyone knows of a hobby more exciting than amateur radio I'd like to know about it!

Of course, if you are a licensed amateur already you can carry out all this research yourself by working everything you hear instead of just logging it. All very tedious, naturally, when a relatively short study of just what goes on 'up there' will reveal it all. This knowledge will be absolutely invaluable when taking part in a DX contest or in a Field Day when advance plans can be laid down so that operation can take place on the most advantageous bands at any time of the day or night. This can make all the difference between coming in the top ten and dithering around at the bottom of the listings. However the techniques of contest operation deserve seperate treatment.

As far as the HF amateur bands are concerned they cover 1.81 to 29.7 MHz (generally referred to as

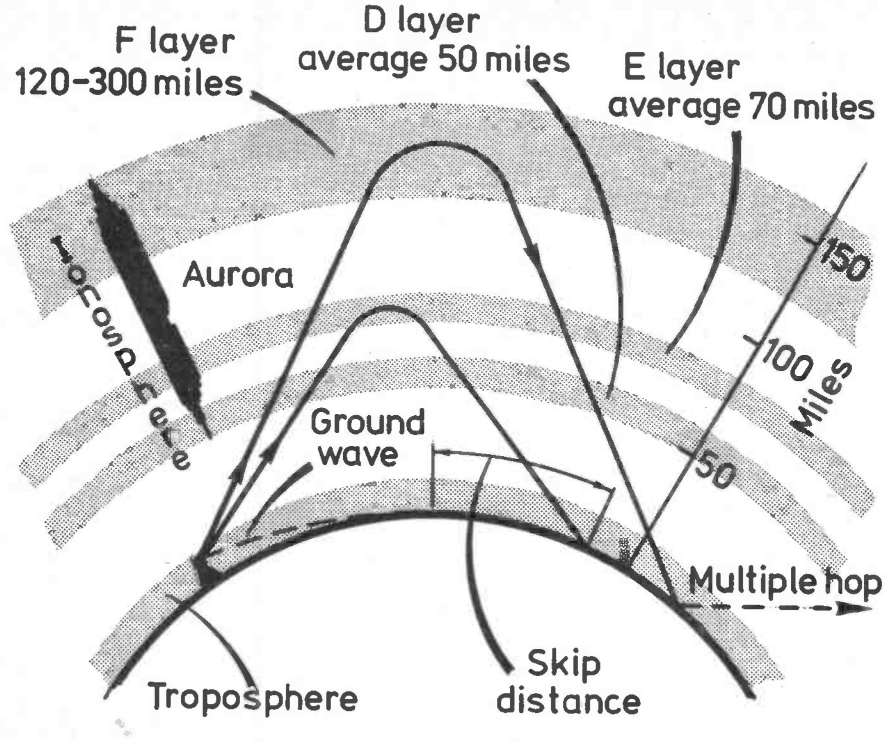


FIG. 1

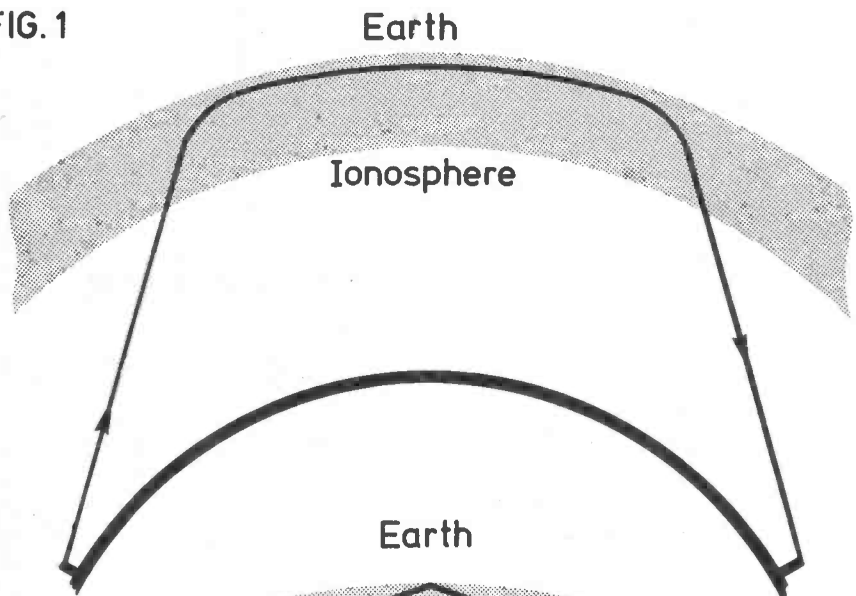


FIG. 2

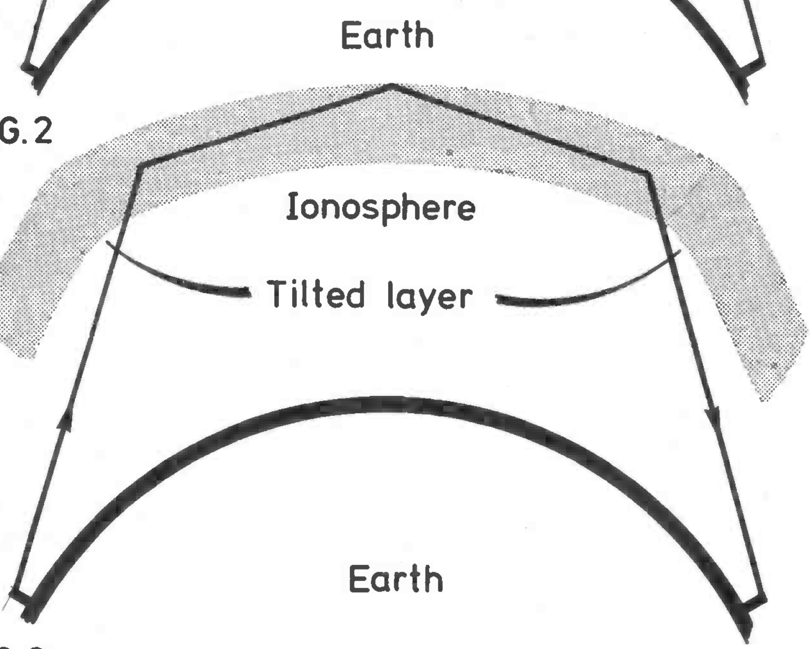


FIG. 3

160m to 10m) in nine seperate bands so that the effects or propagation changes can vary considerably from band to band. The classical diagram of **Fig. 1** is almost too well-known to warrant yet another description of what goes on in the ionosphere some 200 or so miles over our heads. We can only portray events in two-dimensional diagrams so it must be remembered in looking at the diagram that the earth is really a sphere, almost, or huge ball and that the ionosphere and the various layers depicted are hollow spheres or shells around the earth, all of considerably varying density from almost one minute to another and very "patchy" indeed, as well as varying in depth and height above the earth's surface, as depicted in **Fig. 1.**

Conductivity in thin air

We should not forget the names of two pioneers in ionospheric research, Appleton for his discovery of the existence of the F layer and Heaviside in connection with the E layer. The ionosphere is formed basically by the action of the sun on the rarified gases at heights from 50 or so miles above the earth out to around 300 miles, the degree of ionisation depending upon a number of factors such as sunspot activity and time of day. If the sunspot factor is strong enough the E and F layers may themselves each

Fig. 1 This diagram illustrating the propagation of radio signals is out of all proportion compared to reality. The height of the F layer, for example, is only a couple of hundred miles but the hop via the F layer may be a couple of thousand miles between transmitter and receiver.

Fig. 2 One suggestion as to how chordal-hop transmissions may move inside the ionosphere, requiring very low angles of take-off for the signal.

Fig. 3 Should there be areas of the ionosphere that are tilted relative to the rest of the layer then the chordal-hop mode could result, as shown here.

split up into two seperate layers, E1, E2, F1 and F2. The general effect of ionisation is to make the outer atmosphere conductive.

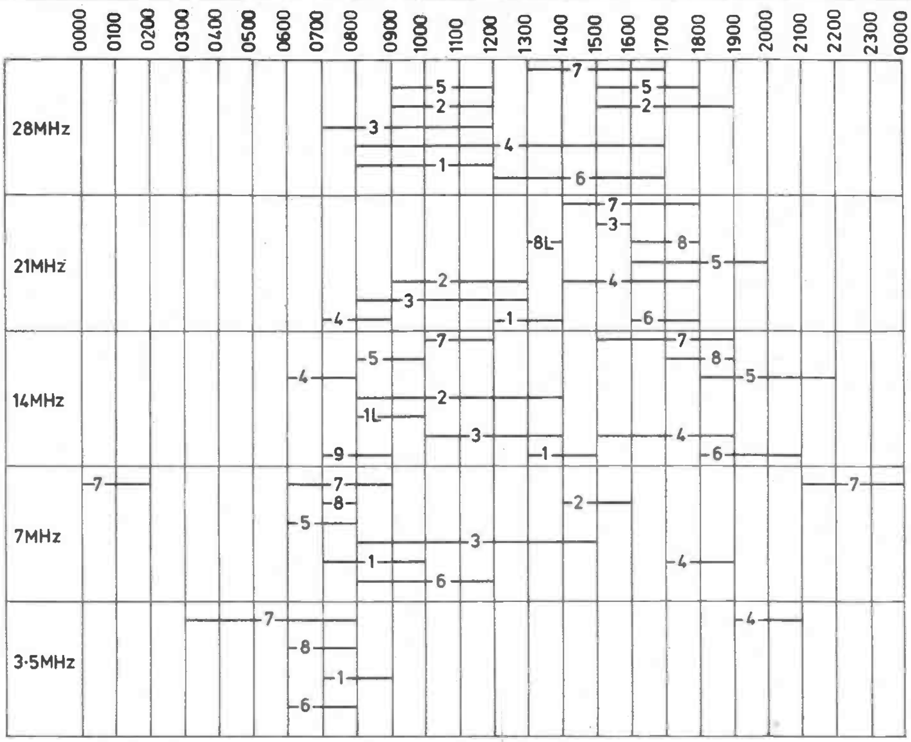
When the conditions of ionisation are absent, as during the local night time, the layers lose their conductivity to some extent but much depends upon the ratio of night and day, and when daytime is long compared to the dark period then the layers may very well retain their conductivity to varying degrees through the 24 hours. During long nights the layers may cease to be conductive for extended periods. The importance of this varying conductivity will now become apparent.

On the HF amateur bands long distance working (DX) is achieved by sending the signal upwards at a small angle to the earth's surface when it eventually reaches the lower regions of, say, the F layer. On passing into the conductive medium the wave is refracted and, if the ionisation is of sufficient magnitude, will eventually emerge from the bottom of the layer and travel on back to the earth's surface from where it may very well be reflected upward again for a second hop or even more. In this way the signal may travel to the furthest points of the earth.

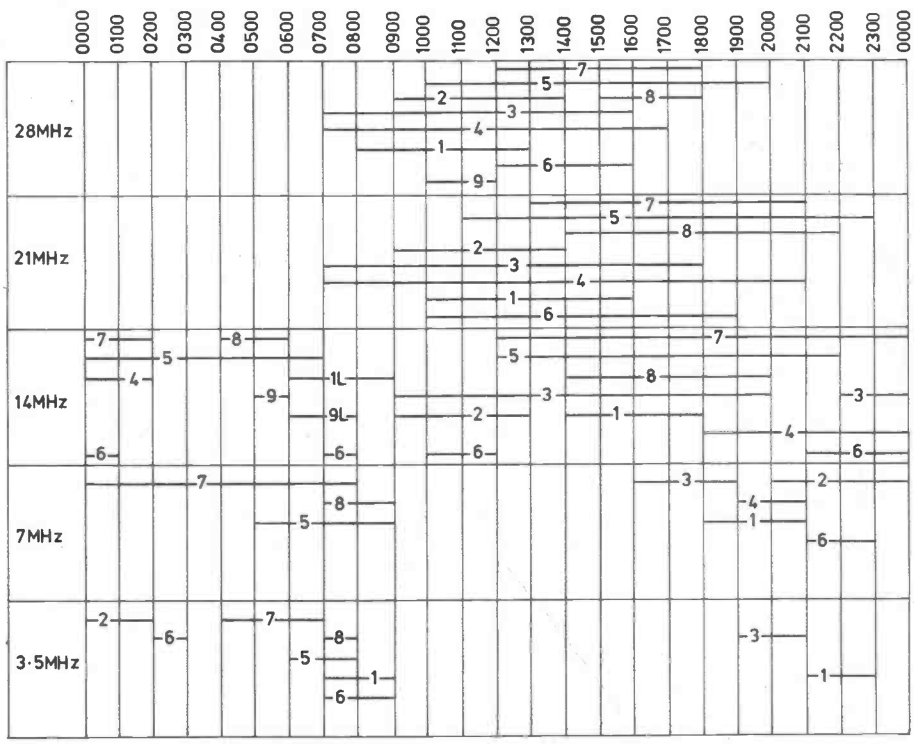
Better signals will be received at the distant station if the reflections from earth have been made from seas or oceans rather than the rough land surfaces. An excellent example is that early mornings, very strong signals are consistently experienced because the signals take the **long** path to Australia over the southern Atlantic and Pacific Ocean which is virtually water all the way providing the best conditions for reflection of radio waves.

The alternative short path over Europe and Asia is best in the early evenings but seldom provides signals of the same strength as those received over the long path. Because the fewer the number of reflections made by the signal means less path loss, antennas for DX working aim at maximising the radiation at low angles to reduce the number of hops required.

To revert to the point where the signal was entering the F layer, if the ionisation level is low enough the signal will not be refracted to any great degree and will pass out of the top of the layer and be lost. The fluctuating nature of the ionisation

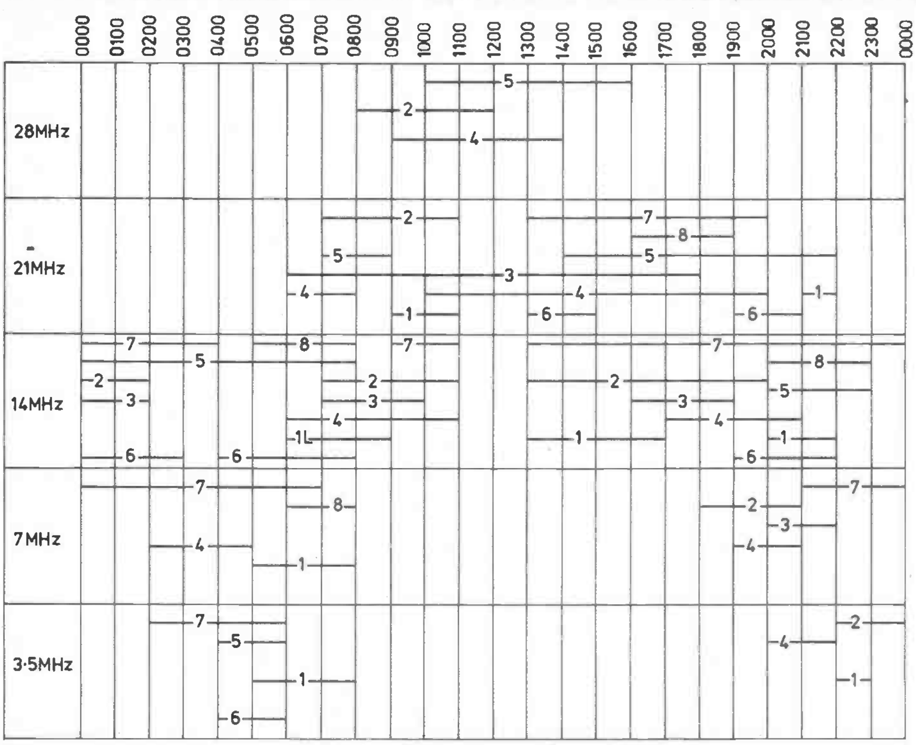


Period December–January–February (L=long path)

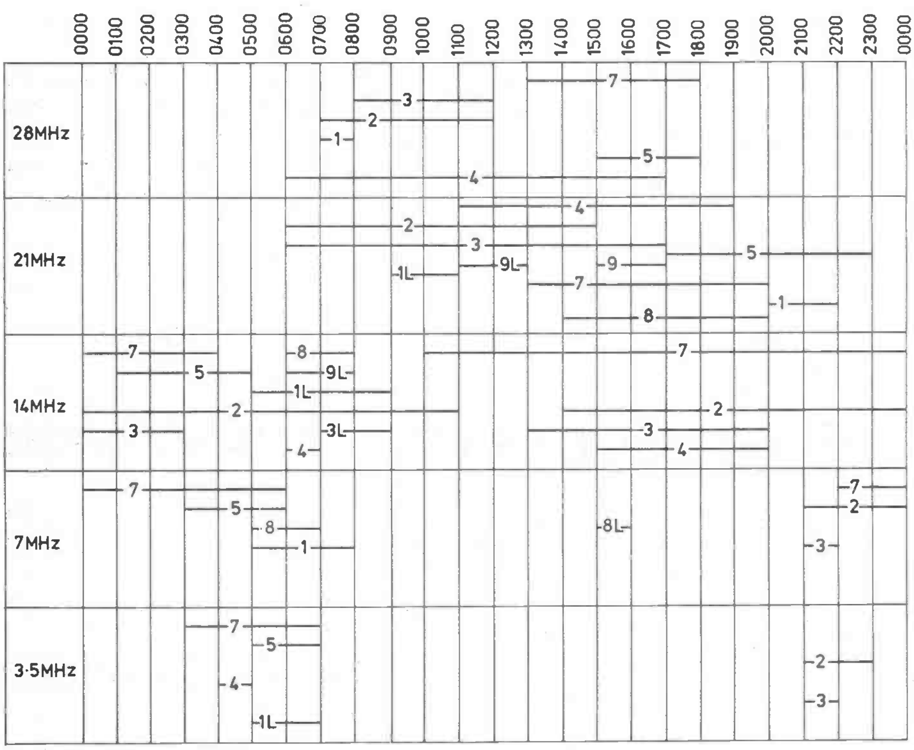


Period March–April–May (L=long path)

Propagation conditions in a typical year. Near sunspot maxima the lines will be longer, at the bottom of the cycle shorter. The numbers refer to the great circle bearings given in **Fig 4** *and the table beneath.*



Period June–July–August (L=long path)



Period September-October-November (L=long path)

Propagation conditions in a typical year. Near sunspot maxima the lines will be longer, at the bottom of the cycle shorter. The numbers refer to the great circle bearings given in **Fig 4** *and the table beneath.*

produces the fading signal with which we are all too familiar, especially when we remember that several refractions and reflections will have occured over a long distance of possibly many thousand of miles.

Just to add to the complications it will be found that, in general, the higher the frequency the greater the depth to which the signal penetrates the particular layer and the longer the hop becomes. Should the lower E layer be sufficiently ionised to sustain complete refraction of a signal then the hop becomes much shorter, as shown in **Fig. 1.** In fact the bottom of the E layer may be so low over the earth's surface that signals from very short distances of a 100 miles or so may be received on the higher frequency bands during the day.

Inevitably, some of the radiated signal travels over the earth's surface being rapidly attenuated after only some tens of miles, the remainder forming the sky wave. The distance between the end of the ground wave and the point where the sky wave first returns is commonly called the 'skip distance', obviously a very variable distance depending mainly upon the ionospheric conditions and the frequency in use.

Multipath fading

During periods of maximum sunspot activity the ionosphere will maintain DX conditions on frequencies as high as the 50MHz (6m) band at present only allocated to countries in the Americas but soon to be released to UK amateurs albeit with certain restrictions as the frequency comes within the UK TV Band I allocation. This band is being closed down for 405-line TV and reallocated to the private mobile radio service and certain other mobile uses, as is the Band III TV allocation. The Home Office has already agreed to release a band at approximately 54MHz which will enable UK amateurs to communicate with the Americas directly on this band without recourse to cross-band operation as at present.

Fading of a signal may be due to movements of the refractive layer, as already mentioned, but it may also be due to the reception of two more signals via differing paths, such as by ground wave and sky wave when the signals may be randomly additive or subtractive giving much wider variations in the resultant signal strength than may occur from sky wave signals only. This effect is very well known on the higher frequencies in the medium wave band as evening advances and the normally received ground wave combines with the gradually increasing strength of the sky wave signal, causing violent and rapid changes in signal strength accompanied by severe distoration of the audio signal.

Ducting

The appearance of an aurora in the northern sky is a visual indication of very intense radiation from the sun, the particles from the sun bombarding the upper layers of the ionosphere to the extent that light is produced, seen as an aurora on the earth. However its significance in propagation is mainly on much higher frequencies, as will be seen in Part 2.

Although the classical theory of propagation via the ionosphere has never been challenged, since the theory has always been borne out in practice, some further ideas have been formulated over about the last 20 years suggesting that other propagation paths are possible. These have arisen because there have been many examples of very long distance propagation with very low power levels that could not have occured by normal multi-hop propagation after the path losses had been calculated.

In addition, certain SW broadcast stations, mainly concerned with political propaganda, were observed to be putting down tremendous signals into certain parts of the world which, again, could not be accounted for by standard transmission techniques. To cut a long story short, it was proposed that these signals were entering the ionosphere but instead of being refracted and turned down to earth they were travelling along a spherical path inside the ionosphere before once again being refracted and returned to earth. **Fig. 2.** Thus the attenuation of the normal hops at the earth's surface were eliminated and the resulting signal strength considerably increased. This 'chordal hop' mode of transmission was found to represent a path of some 4000 miles in some cases.

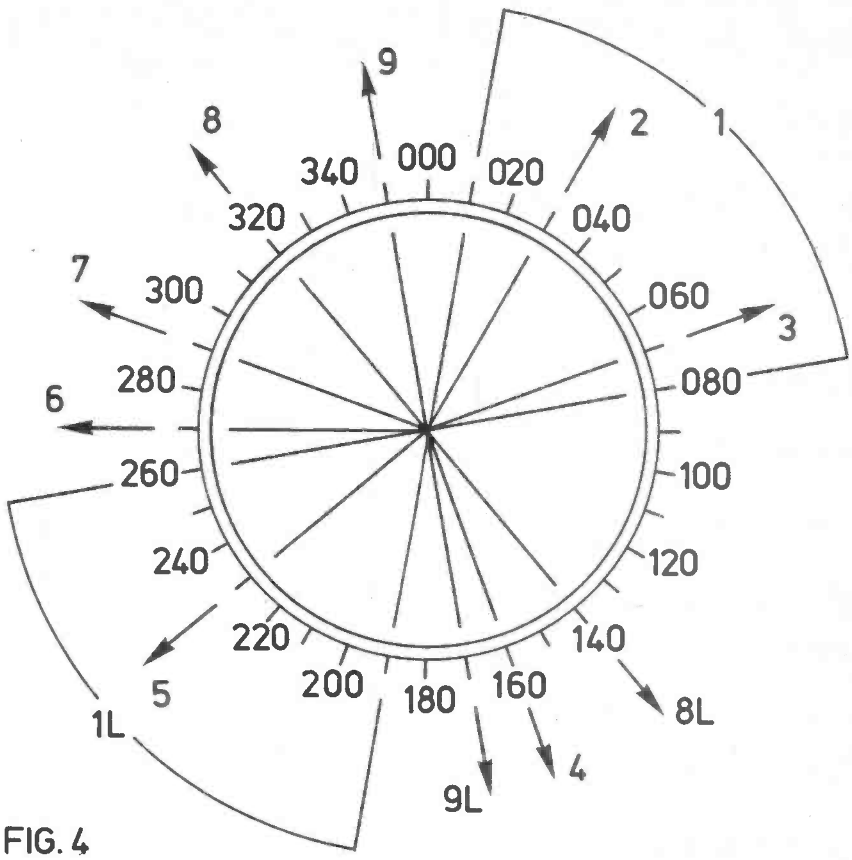


FIG. 4

Approximate great circle bearings, from the UK, to principal areas of amateur activity. Check the number on the bearing and locate that number on the appropriate table against time of year and time (GMT) to find optimum propagation period for that area. Remember that the 28MHz band is subject to large variations linked to the sunspot cycle.

1	Australia-New Zealand	6	Caribbean
1L	,, ,, long path	7	East coast USA
2	Japan-USSR in Asia	8	West coast USA
3	Far East	8L	,, ,, long path
4	Africa	9	Central Pacific
5	South America	9L	,, ,, long path

The secret was to use antenna systems having extremely low angles of radiation, much less than the five degrees that is the best that the average amateur can hope to achieve. Les Moxon G6XN, antenna expert par excellence, solved the problem by erecting a simple antenna, such as an inverted-V dipole, on a very steep slope of some 35 degrees with the slope continuing in the desired direction for many wavelengths. Thus he was able to consistently get into VK-land with powers as low as 1W.

As an alternative to the spherical path of the signal inside the ionosphere it has been suggested that parts of the layer may be tilted away from the normal giving the effect shown in **Fig. 3,** thus achieving much the same result. This field of investigation is eminently suitable for the radio amateur especially so now that we have such a wide choice of frequency bands on which to try out ideas.

Possibly the best way to sum up all the many vagaries of propagation on the HF bands in a practical manner is to look at the principal bands over four periods of the year for every hour of the day and night. This assumes average conditions, if there is such an animal, as sometimes the conditions may be bad enough to preclude hearing stations from a particular area at all or they may be good enough to allow reception over a period longer than that shown on the tables.

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9 bands in a small garden

Getting out on the HF bands from cramped spaces.

By Louis Varney, C.Eng. MIEE. AIL. G5RV.

For the amateur who wishes to operate on all the HF bands from 1.8 to 28 MHz but who has very limited space, the problem of what kind of general purpose and effective antenna to use is not an easy one. However, given a total garden length of 50 to 60 feet, there are a number of possibilities and two of them which have been tested by the writer have given very satisfactory results. Their design, construction and performance are described in this article; but first let us consider the constraints that such a relatively small garden length imposes.

Constraints

The two basic types of simple antenna that are capable of radiating effectively nearly all of the HF energy fed into them are, as is well known, the horizontal dipole and the quarter-wave vertical, the latter either using a ground plane or a really effective low-resistance earth system. Unfortunately, both these types are impracticable for the 1.8 and 3.5 MHz bands for the majority of amateurs. A horizontal λ/2 dipole for 1.8 MHz is about 260 feet long and should, ideally, be supported at half a wavelength above ground. For 3.5 MHz its length would be about 128 ft and it should be supported at that height above ground for optimum results. A vertical λ/4 antenna for 1.8 MHz would need to be at least 100 feet, even if used with a top loading capacity 'hat'. If used as a GP, the radials would each need to be 130 feet long. For operation in the 3.5 MHz band these figures would, of course, be halved. Clearly, all these requirements are quite impossible for the vast majority of radio amateurs. Even those of us who are fortunate enough to have long gardens which can accommodate a λ/2 dipole for top-band cannot hope to support it at anything like the optimum height above ground. It should be remembered that the effects of supporting a λ/2 dipole at heights considerably lower than a half-wave above ground are twofold:—

(1) The radiation resistance at the centre of the dipole, nominally about 75 ohms, rises slightly to about 80 ohms at λ/4 above ground and at λ/8 high it falls to about 35 ohms.

(2) The polar diagram of the radiated power is modified, especially in the vertical plane where the energy tends to be concentrated at very high zenithal angles, unsuitable for DX working.

Two Possible Solutions

First, the half-size G5RV antenna, shown in **Fig. 1**, will work very efficiently on the seven highest frequency bands — 7, 10, 14, 18, 21, 24 and 28 MHz provided that it is used in conjuction with a suitable ATU. On the 1.8 and 3.5 MHz bands it should be used as a Marconi T type antenna, again with a suitable ATU. On these two bands the radiation efficiency, compared with that of a dipole will, of course, be reduced but, nevertheless, it will provide coverage of the UK and Europe with licensed power inputs to the transmitter on CW and SSB. **Fig. 2** shows the arrangement recommended for operation on the 3.5 MHz and **Fig. 3** shows the ATU for 1.8 MHz. Second, a simple end-fed wire antenna may be used, again with a suitable ATU. It is important to use as long a length of wire as possible in the prevailing circumstances. A minimum overall length of 100 feet, including the down-lead right to the output terminal of the ATU, is recommended if operation on the 1.8 MHz band is required. However the overall length may be reduced to 68 ft for operation on 3.8 MHz and above. It should be noted that, for successful operation on 1.8 and 3.5

A vertical approach

I have made the assumption when writing this article that about 60 feet of garden are available. Of course there are many people who will have to make do with rather less than this. Please don't despair. It is a repeatedly observable fact that even the smallest, most inefficient antenna system will radiate some RF and that contacts, occasionally surprising ones, will be made regardless.

The all band system with perhaps the smallest area requirement is undoubtedly the trapped vertical of the H5V, 18AVT type. This type of antenna is markedly more efficient on the higher bands than the lower ones where the radiation resistance is very low and the tuning critical at the LF end. However it does have the advantage of a reasonably low radiation angle on all bands offering the possibility of some DX working from an otherwise poor QTH. This type of antenna should be attached to a really good earthing spike, at least three feet long driven into damp ground or, alternatively, operated with a radial system with a minimum of two radials per band.

It is possible to broaden the bandwidth of this type of antenna by connecting it to the transmitter through a standard unbalanced ATU. Although the SWR between the ATU and antenna will be high at the band edges it should be possible to let the transmitter 'see' a one to one match.

Generally speaking though a wire antenna will show slightly better performance on the lower bands than a trapped vertical, particularly if the main interest lies in local working. If the decision is made to go for a wire aerial then the only rule is to get out as much as possible as high as possible over the maximum amount of ground area available.

MHz, a good low resistance earth connection is required. A suitable counterpoise wire may, of course, be used in place of the HF earth connection, but in practice, there may be objections to such a wire, supported at a suitable height of 7 or 8 feet above ground across the garden being used. If a counterpoise is used, it is still essential that the equipment be connected to earth, even though this may not be what is considered an effective HF earth, to safeguard the operator in the event of electrical failure in the equipment causing dangerous voltages to appear on the chassis and cabinet.

The Half Size G5RV Antenna

Although the writer strongly recommends the use of any convenient length of 75 ohm twinlead or, even better, open-wire feeder from the output of the ATU to the base of the 17 foot open-wire matching section (see **Fig. 1**), it is recognised that, for a variety of reasons, many amateurs prefer to use 50 or 80 ohm coaxial cable. For this reason, the arrangement shown employs this type of feeder. Thus, the type of ATU required is the unbalanced-to-unbalanced type and one suitable form is shown in **Fig. 2** and the component values for 3.5 to 28 MHz are given in the caption. This type of ATU is also suitable for use with an end fed antenna from 3.5 to 28 MHz. On each band, the ATU should be adjusted by selection of optimum values of C_1 and C_2 and of L, so as to obtain the lowest possible VSWR on the length of coaxial cable between the output of the transmitter and the input of the ATU. The use of a suitable 50 or 80 ohm VSWR meter is essential for correct operation of the antenna and feeder system. On all bands except 28 MHz, the VSWR on the coaxial feeder from the *output* of the ATU to the antenna will be moderate to high. However, the losses in the relatively short length of feeder employed in a small garden will quite acceptable — a fraction of 1 dB only. On the 28 MHz band, the coaxial feeder will 'see' an almost non-reactive 80 to 90 ohm load at the base of the matching section. The use of 50 ohm coaxial

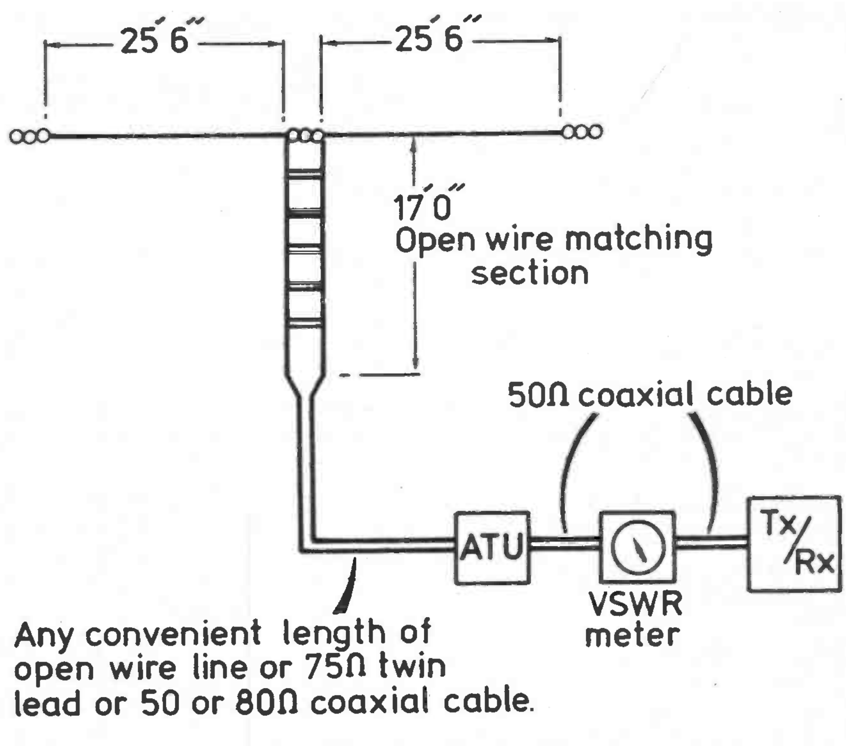

Fig. 1. The half-size G5RV antenna. Arrangement for use on 7 to 28 MHz bands.

cable feeder will therefore result in a VSWR of approximately 1.8:1, which is quite acceptable even when using a transistor output stage in the transmitter having a wide-band untuned output circuit which requires to work into a load representing a VSWR not greater than 2:1. The use of 80 ohm coax will result in a 1.2:1 VSWR. However, although the antenna and feeder system will work satisfactorily on this band without the use of an ATU, its use is recommended since it will also improve the front-end selectivity of the receiver, giving useful reduction of cross-modulation effects. On 1.8 MHz an 'L' network ATU is more suitable and is described below.

The End-fed Wire Antenna

This may take the form of the typical 'L' antenna and, if necessary, the far end may be allowed to hang vertically, or at some convenient angle to the horizontal top, for up to about 10 or 15 feet without seriously affecting its performance. This antenna also requires the use of a suitable ATU a 'T' network as shown in **Fig. 2** for 3.5 to 28 MHz and an 'L' network for 1.8 MHz. However, since on the 1.8 MHz band this antenna of 100 feet overall length represents something between one eighth and one quarter of a wavelength, it may be found better to dispense with the capacity of the 'L' network and simply use a suitable value of inductance in series with the antenna so that the wire plus the coil represent a $\lambda/4$ antenna electrically. This may be done, effectively, by setting the 'L' network condenser at minimum capacity and adjusting the number of coil turns in use (by suitable taps) until the lowest VSWR on the coaxial cable from the transmitter to the input off the simple coil ATU is obtained. **Fig. 3** shows the 'L' network and the component values are given in the caption.

Comparative Performance

Both the antennas described have been tested over a period of about six weeks and, by means of a rapid switching facility, received signals on the various bands (except 10, 18 and 24 MHz) have been compared both by S meter and by ear with those from a full-size G5RV antenna. On 1.8 and 3.5 MHz a difference in signal strength of one to two S points in favour of the full size G5RV antenna has been observed, and this is what one would expect. However, it must be said that the full size G5RV antenna was supported at a height of 35 feet whereas both the half-size G5RV and the 100 feet 'L' antennas were supported at only about 25 feet at the house end, the half-size G5RV sloping to 20 feet and the 'L' antenna to 8 feet above ground level at the far end. From observations on received signals and reports received on transmitted signals and taking into account the height advantage of the full-size G5RV antenna, these observed results would appear to be reasonable. However, from 7 to 28 MHz the half-size G5RV and the 100 feet long end-fed wire 'L' antenna both performed very well indeed and, despite the height advantage of the full-size G5RV antenna, the observed difference in signal levels was usually nearer one S point. ●

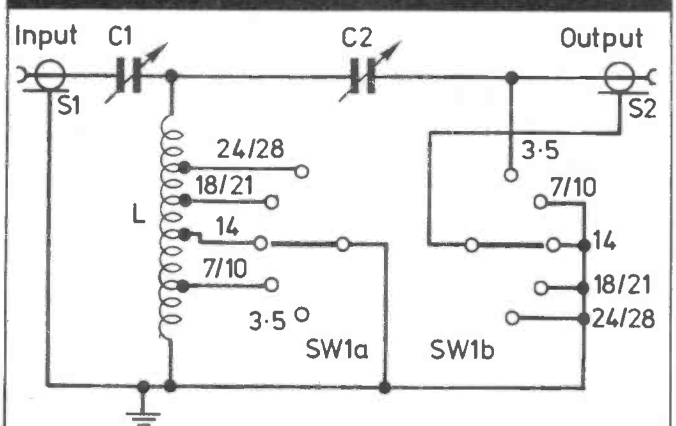

Fig. 2 The T network ATU for use with the half-size G5RV or the end-fed 100ft antenna on all bands from 3.5 to 28 MHz.

Component Values

L Total of 22 turns of 18 SWG enamel copper wire close-wound on a 40mm ID former. Tape, counting from earthed end of coil:—

7/10 MHz 8 turns
14 MHz 5 turns
18/21 MHz 4 turns
24/28 MHz 3 turns

C1, C2 160pF max. capacity. Receiver type for powers up to 100 W. PEP output.

S1, S2 Type S0239 coaxial sockets.

SW1, SW1b, each single pole, 5 way wafer switches ganged. Ceramic wafers preferred, but not essential.

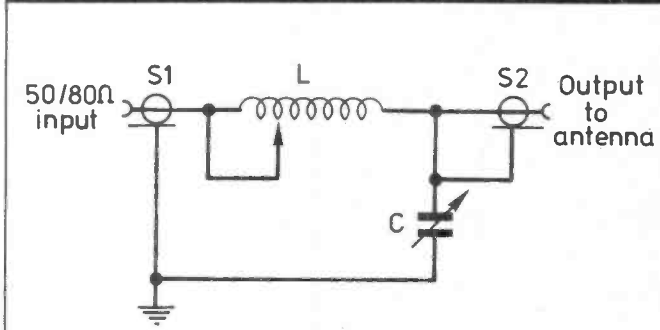

Fig. 3. The 'L' Network ATU for use with the half-size G5RV or the 'L' antenna on 1.8 MHz.

Component Values

L Approximately 14 turns 18 SWG enamel copper wire close wound on 40mm ID former. Optimum number of turns to be determined by trial and error.

C 160pF variable, receiver type. (May not be required).

S1 and S2 Type SO239 coaxial sockets. (Note that S2 has outer and inner connected together. This socket must be insulated from the metal cabinet or front panel of the ATU.)

COMPETITION

Remember our great handitalkie competition at Leicester? Probably not since about 3000 went to the show and we expect to sell about 50,000 of this issue. However we'll give you a second chance to attempt our great multiple choice exam but first the good news, at least for the winner of the Leicester show entries.

He is:

John Regnault G8FQO, 32 Pearcroft Road, Ipswich IP5 7RE. John wins an IC2E handitalkie plus remote microphone. Laura Scott G4HUV of Oscroft, Chester is runner up.

Unfortunately there are no prizes for coming second. However there is a prize for coming last. B Mann G6MTZ distinguished himself by getting just one question out of 14 right in the multiple choice test in complete opposition to the laws of chance.

G6MTZ wins himself a CB aerial.

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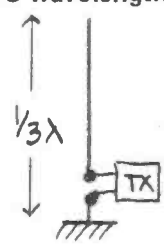
Just put the question numbers followed by the letters together with your name, callsign (if you've got one) and address.

Have fun,

Frank Ogden G4JST

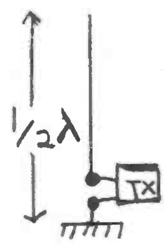
1) You increase the power of your rig from 10 watts to 40 watts.
Will the received signal go up by:
a. ½ S point, b. 1 S point, c. 2 S point, d. 4 S point — a b c d

2) A groundplane aerial has a length equal to 1/3 wavelength.



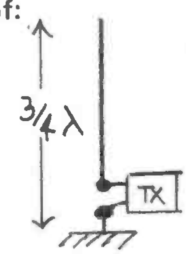
Will the transmitter see:
a. capacitative, b. inductive, c. resistive load — a b c

3) For the aerial shown below, will the transmitter see:



a. low impedance, b, medium impedance, c. high impedance — a b c

4) Assuming that the aerial shown below is used with an infinite, perfectly conducting groundplane, will the transmitter see a resistance of:



a. 25 ohms, b. 35 ohms, c. 50 ohms, d. 75 ohms, e. 100 ohms, f. 120 ohms — a b c d e f

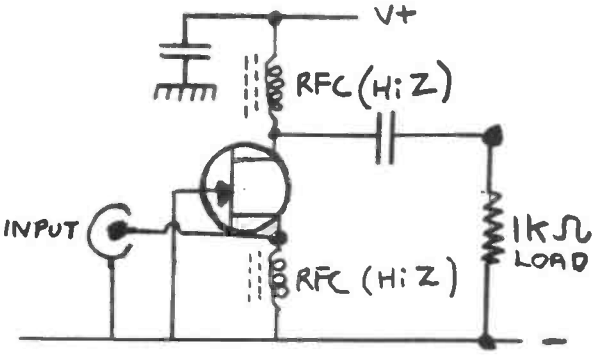
5) If the aerial shown in question 4) was just ¼ wavelength long would the resistance be:
a. 25 ohms, b.35 ohms, c. 50 ohms, d. 75 ohms, e. 100 ohms, f. 120 ohms   a b c d e f

6) A VHF co-linear aerial has a gain of 6 dB over a standard dipole. If the dipole aerial produces an EMF of 1 mV across the receiver terminals, what should be the EMF produced by the co-linear across the same receiver:
a. 2 mV, b. 4 mV, c. 8 mV, d. 10 mV   a b c d

7) A transmitter connected to the hypothetical dipole of question 6 produces an ERP of 1 watt What will be the ERP produced by the co-linear aerial:
a. 2 watts, b. 4 watts, c. 8 watts, d. 10 watts   a b c d

8) A transistor is quoted as having a 10 dB gain. How much power should it deliver to a matched load if one watt is correctly matched to its input circuit:
a. 5 watts, b. 10 watts, c. 20 watts, d. 40 watts   a b c d

9) The FET RF pre-amplifier shown in the circuit diagram has a transconductance (mutual conductance) of 10,000 micro-mhos (10 mA/V).



What is the effective input impedance at its source terminal:
a. 10 ohms, b. 20 ohms, c. 50 ohms, d. 100 ohms   a b c d

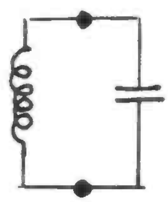
10) The FET pre-amp of question 9 has a 1K ohm load connected in its drain circuit. What will be the voltage gain across this load assuming that the in put circuit is driven from an RF source of negligible impedance and that the measuring instrument places no additional load on the drain circuit:
a. 5, b. 10, c. 20, d. 50   a b c d

11) What do you think would be the most likely figure for the dynamic range for a typical cross section of amateur HF receivers:
a. 145 dB, b. 125 dB, c. 105 dB, d. 95 dB, e. 75 dB   a b c d e

12) What would be the most likely typical figure for a professional communications receiver:
a. 145 dB, b. 125 dB, c. 105 dB, d. 95 dB, e. 75 dB   a b c d e

13) If you double the turns on a torroidal (O ring) ferrite core, will the inductance be the initial value multiplied by:
a. 2, b. $\sqrt{2}$, c. 4, d. 8.   a b c d

14) You want the circuit shown to resonate at twice the initial frequency. To achieve this should you:



a. double the inductance, b. halve the capacitance, c. halve both the capacitance and inductance, d. halve the inductance.   a b c d

Upgrading the KW2000 series of HF transceivers

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

There's no denying that starting in Amateur Radio these days can be an expensive business. Gone are the days when, given a couple of evenings and a well-stocked junk-box, it was possible to knock up a rig which could hold its own against the competition on the DX bands. Today a commercially-built transceiver is a virtual necessity unless one confines oneself to CW, and even then the possessors of the latest black boxes have a considerable advantage when it comes to snaring rare DX stations. With the cheapest ready-built HF rig now selling for about £450, it is not surprising that many newly-licensed (and not so newly-licensed!) amateurs turn to the second-hand-market for their gear and, fortunately, there is plenty of good second-hand equipment available. One rig which represents particularly good value for money is the KW2000 which, in its basic form, can be obtained for as little as £75, and even in its later forms rarely sells for more than £150. The purpose of this series of articles is to familiarise newcomers to the amateur field with a rig which, although now about 15 years old, is nevertheless capable of giving a very good account of itself on the HF bands, and to describe some of the many modifications which can be carried out to bring the performance of the rig up to a standard approaching that of its vastly more expensive modern competitors.

The story so far.

It may come as a surprise to anyone who has come into Amateur Radio during the last few years to learn that there was a time not very long ago when the market for ready made equipment was not dominated by the Japanese, and when at least one British manufacturer produced a rig which sold well, and was highly respected, all over the world. The time was the late 60s, and the manufacturer concerned was KW Electronics, a firm who, happily, seem to be making something of a comeback into the market after several years of virtual absence. At that time, most amateur operation took place on HF, the Class B licence having only recently been introduced and still being restricted to frequencies above

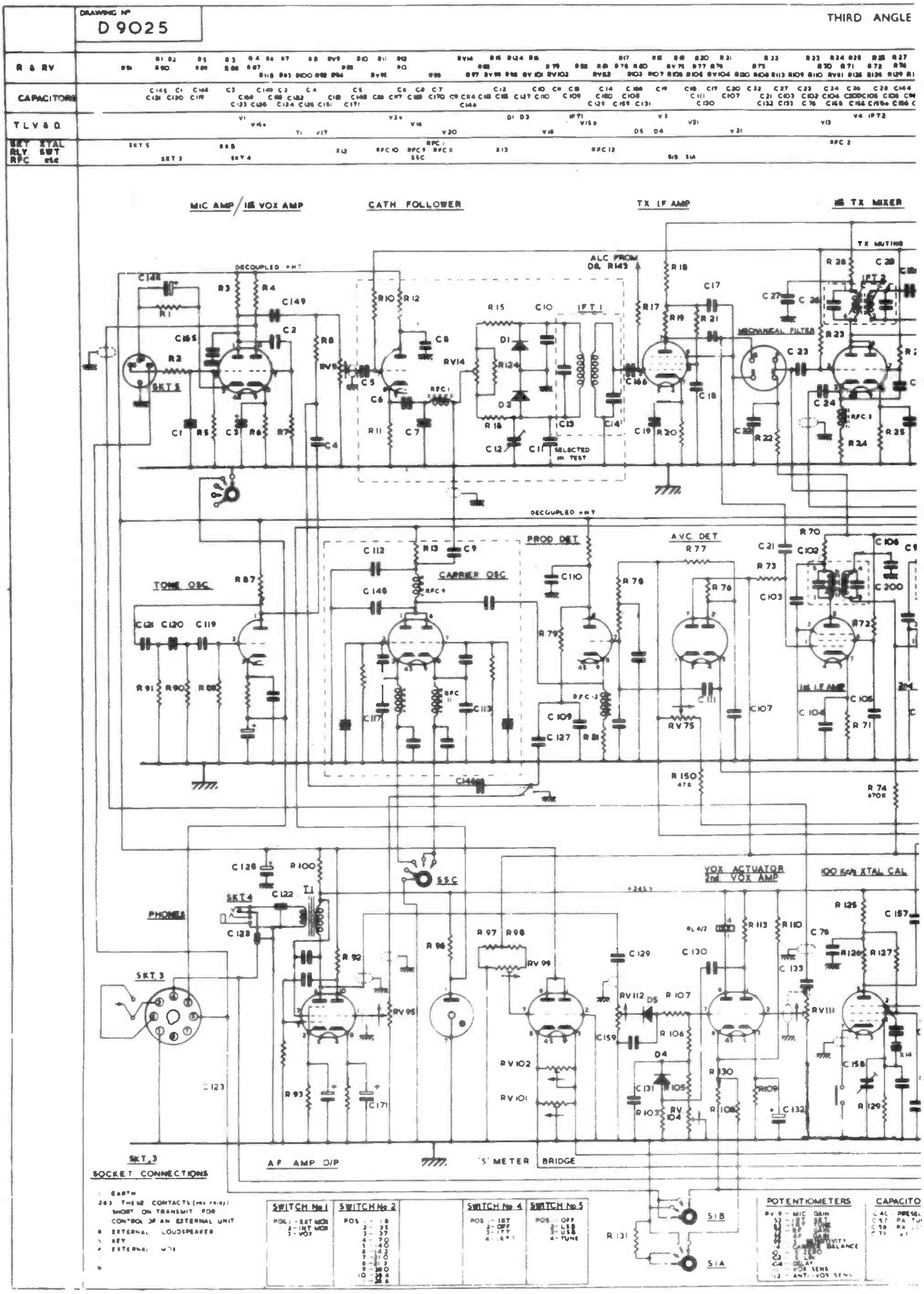
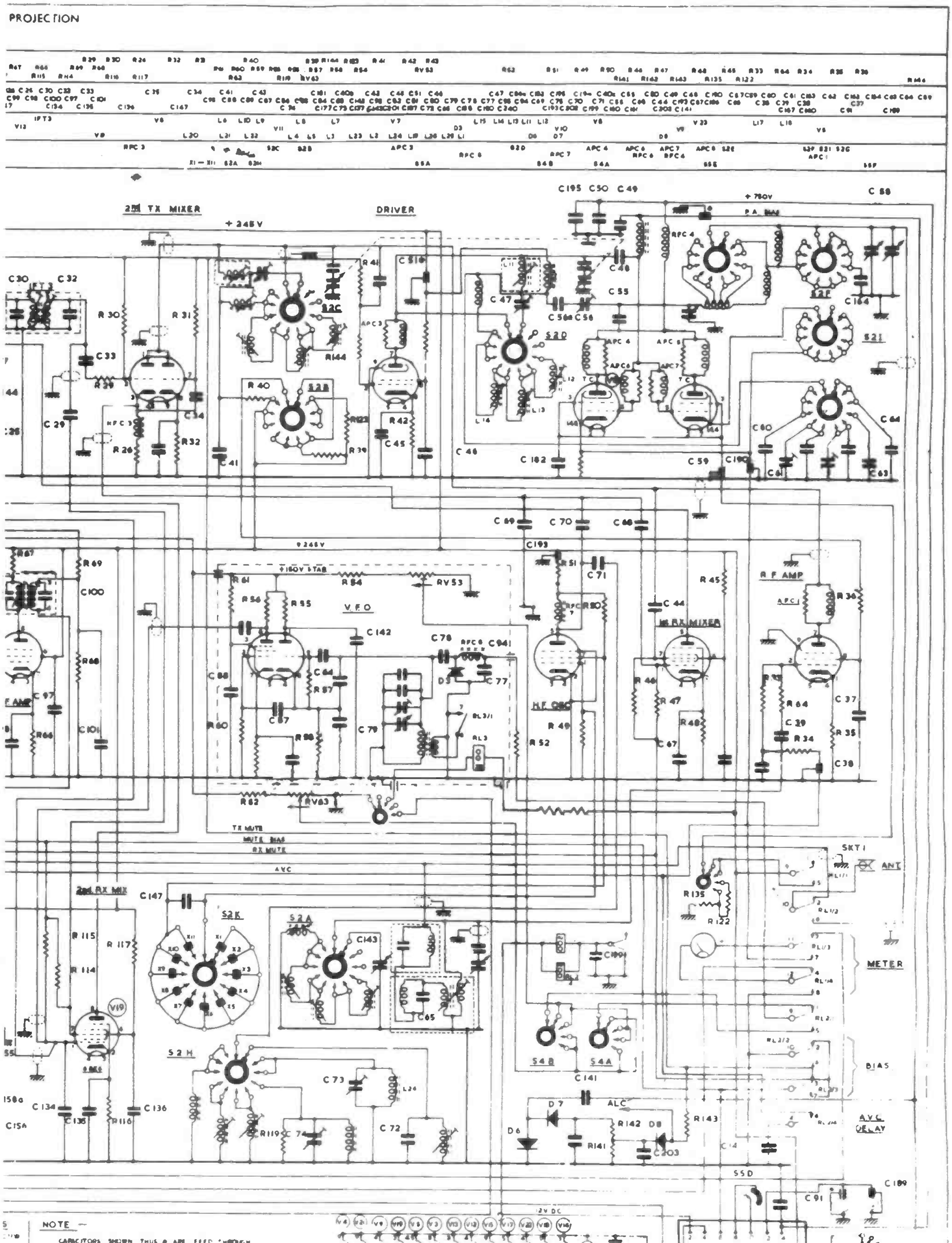


Fig. 1. Circuit of KW2000 A. KWZ000 is similar, but does not have V23 (2



.d PA valve) or ALC circuit (D6,D7,D8 and associated components).

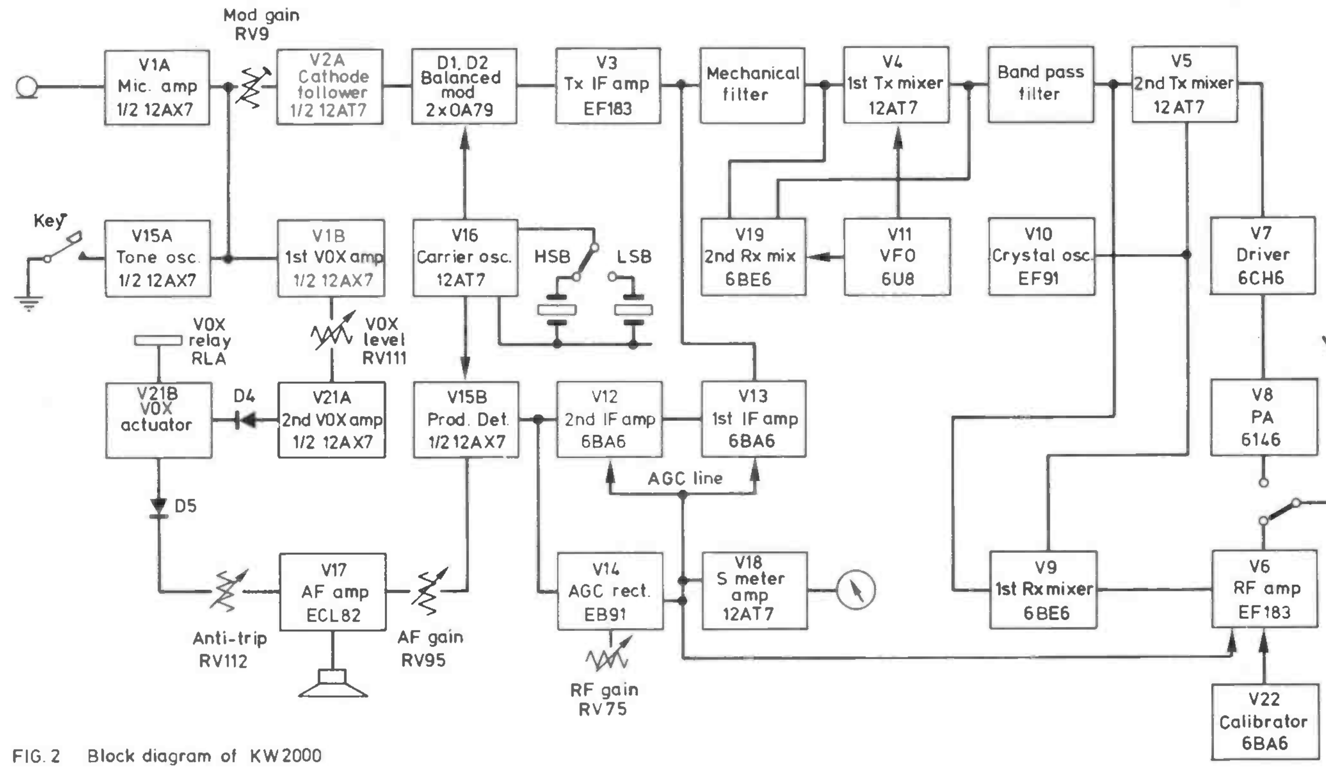


FIG. 2 Block diagram of KW2000

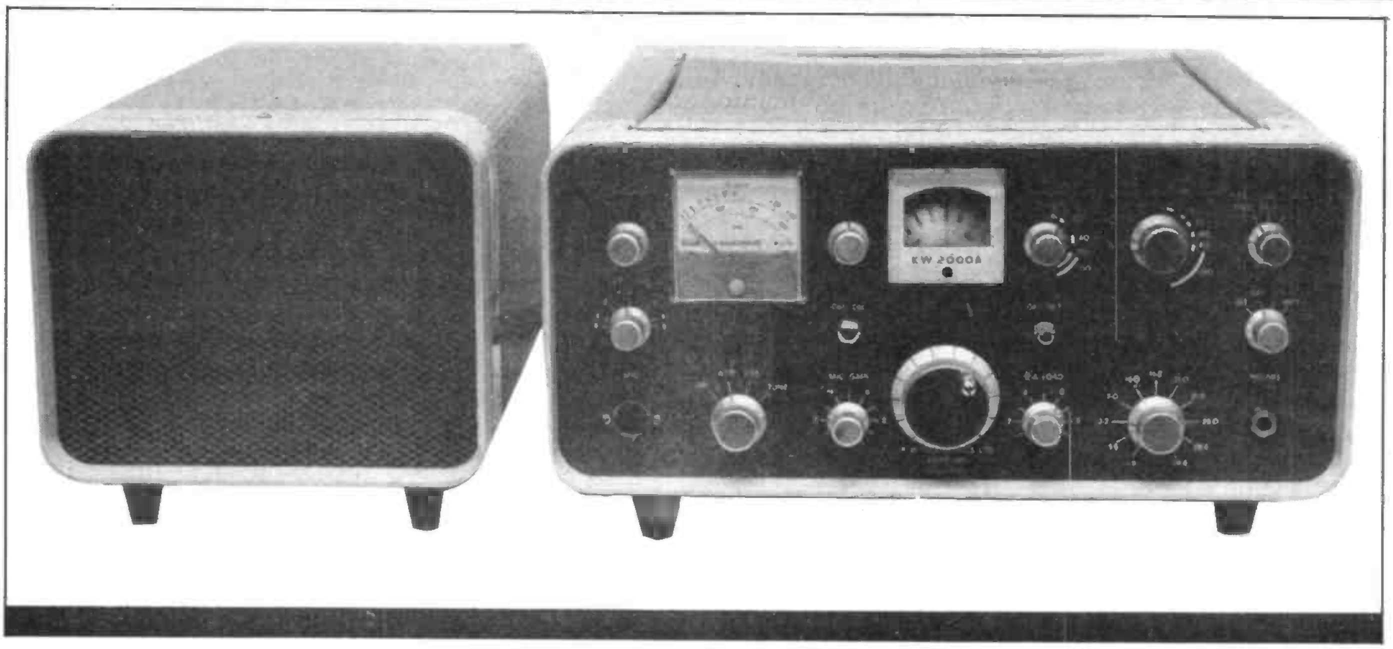
420MHz (yes, 70cms started at 420MHz in those days!), and the dominant mode was AM. It was the very end of the era when normal practice had been to buy an ex-forces communications receiver such as an AR88 or HRO, and to build a simple all valve transmitter to use with it. SSB was just beginning to appear on the bands and was regarded with great suspicion by some of the older hands! It soon became apparent even to them that SSB was the mode that would mainly be used in future, and more and more amateurs put their old AM rigs to one side and began to use sideband. The greater complexity of SSB transmitters as compared to those for AM deterred many who would normally have built their own gear from doing so, and there was thus a great upsurge in the demand for commercially built equipment. It was this new market that KW Electronics tapped, first with the Viceroy transmitter, and then with the KW2000 transceiver which, with its successors, was undoubtedly their most successful model. In its heyday it sold all over the world (including Japan) and was widely regarded as representing the state-of-the-art in amateur equipment. *It was also one of the first transceivers, as opposed to separate transmitters and receivers, to appear on the market and, with its successors the KW2000A, B, and E, it remained in production until, in about the mid 70s, it was overtaken by more modern designs from Japan. However, many thousands were sold, and most of them are still around and still giving a good account of themselves on the air.

Circuit description

The basic KW2000 was an all valve transceiver covering the 1.8, 3.5, 7, 14, 21, and 28 MHz bands, and producing an output of 50 watts from a single 6146. Its appearance can be seen from **Fig. 1**, which actually shows the KW2000A; however, the appearance of the KW2000 was virtually identical. Despite being all valve it was not significantly larger than its modern counterparts,although, as can be seen, the power supply was separate from the transceiver, an alternative mobile power supply being available. The actual dimensions were 35x15x27 ins for the transceiver and 20x15x27 ins for the mains power supply, their weights being 7.25kg and 9kg respectively. The cases of both units were of 'wrap around' construction, meaning that they formed complete removable sleeves around the chassis. After removing the four feet the cabinet could be slid away from the rig leaving both sides of the chassis exposed. In addition, a hinged flap was provided in the top of the transceiver case allowing valves and pilot lights to be replaced without the case being removed.

A block diagram of the transceiver is shown in **Fig. 2**. Starting at the top left, the signal from the microphone is amplified by a single valve VIA (½ 12AX7), and then fed via a complete follower V2A (½ 12AT7) to the balanced modulator which consists of two germanium diodes (OA79). In common with many rigs produced in the early days of SSB, the KW2000 generates its SSB signal at a comparatively low

** A rather frivolous indication of the esteem in which it was held is that, when Peter O'Donnell wanted to introduce an Amateur Radio interest into his "Modesty Blaise" cartoon strip, he showed Modesty and Willie using KW2000Bs to maintain contact between London and South America. It was obviously considered that no well-equipped amateur would use any other rig!*



frequency, 455 kHz to be precise, and it is approximately this frequency which is fed to the balanced modulator by the carrier oscillator V16 (12AT7). A front panel switch allows the selection of either of two carrier crystals, one HF and one LF of the filter passband, producing lower sideband or upper sideband respectively.* From the modulator the signal passes through the sideband filter, a mechanical filter 2.1 kHz wide. It is then fed to the first balanced mixer V4 (12AT7), where it is mixed with the signal from the VFO V11 (6U8), which tunes 2.5 to 2.7 MHz, to produce a tunable IF of 2.955 to 3.155 MHz. It will be noticed that this is a tuning range of only 200 kHz, and in fact all the models in the KW2000 range, with the exception of the KW2000E, cover the bands in 200 kHz segments rather than the 500 kHz segments common on more modern rigs. In practice this is no great drawback until we reach the 21 MHz band to which only two segments are allocated, resulting in a gap of 100kHz in the middle of the band! The situation is even worse on 28 MHz, where only 600 kHz of this 1.7 MHz wide band are covered, namely 28.0 to 28.2 and 28.4 to 28.8 MHz. However, it is quite easy to modify the rig to overcome this deficiency, as will be described later.

**In fact, the sidebands are inverted in a subsequent mixing process, so that the LF carrier crystal actually produces the lower sideband at the output of the rig, and vice versa.*

The VFO utilises both sections of VII, the triode section being the actual oscillator and the pentode section functioning as a buffer amplifier. Both sections are supplied from a stabilised volt HT supply, V20 (OA2) being the regulator, and their heater is obtained from a separate 6.3 volt supply which can be regulated to improve VFO stability (see modification in a later article). Incremental tuning is provided by a varicap diode D3, and this can be switched to operate on receive only, transmit only, both or neither. In addition, a small relay RL3 introduces a shorted one turn link into the VFO coil when LSB is selected, reducing the inductance and hence moving the VFO slightly HF. This ensures that the output carrier frequency remains constant when sideboards are switched, a feature not always found in modern rigs!

The tunable IF signal from V4 passes through a bandpass filter composed of two back-to-back IF transformers and is then applied to a second balances mixer V5 (12AT7). Here it mixes with the output of the crystal oscillator V10 (EF91) to produce the desired output frequency. The crystal frequency is always on the high side of the output frequency, and this results in the frequency range being inverted. In other words, as the VFO tunes from the LF end of its range to the HF end, the output frequency moves from HF to LF. It is important to remember this if the VFO ever has to be serviced! From the second mixer the signal passes via the driver valve V7 (6CH6)* to the PA, a 6146 operating in class AB.

On receive, the signal traverses a similar path in the opposite direction, using mostly the same filters. The signal from the aerial is first amplified by the RF amplifier V6 (EF183) and then passed to the first receive mixer V9 (6BE6), the tuned circuit used between the two valves being the same one as is used between the second transmit mixer and the driver stage. V9 is also fed with the signal from the crystal oscillator V10, and thus converts the incoming signal down to the tunable IF, which is passed through the bandpass filter to the second receive mixer V19 (6BE6). Here it mixes with the VFO signal to produce 455 kHz, which passes through the mechanical filter before being ampilified by two IF stages, V13 and V12 in that order (both 6BA6). It is then fed to the product detector V15B (½ 12AX7) and from there via the AF gain control RV95 to the two stage AF amplifier V17 (ECL82) which drives the loudspeaker.

The IF signal from V12 also drives the AGC rectifier, one half of V14 (EB91), and the AGC voltage developed controls the two

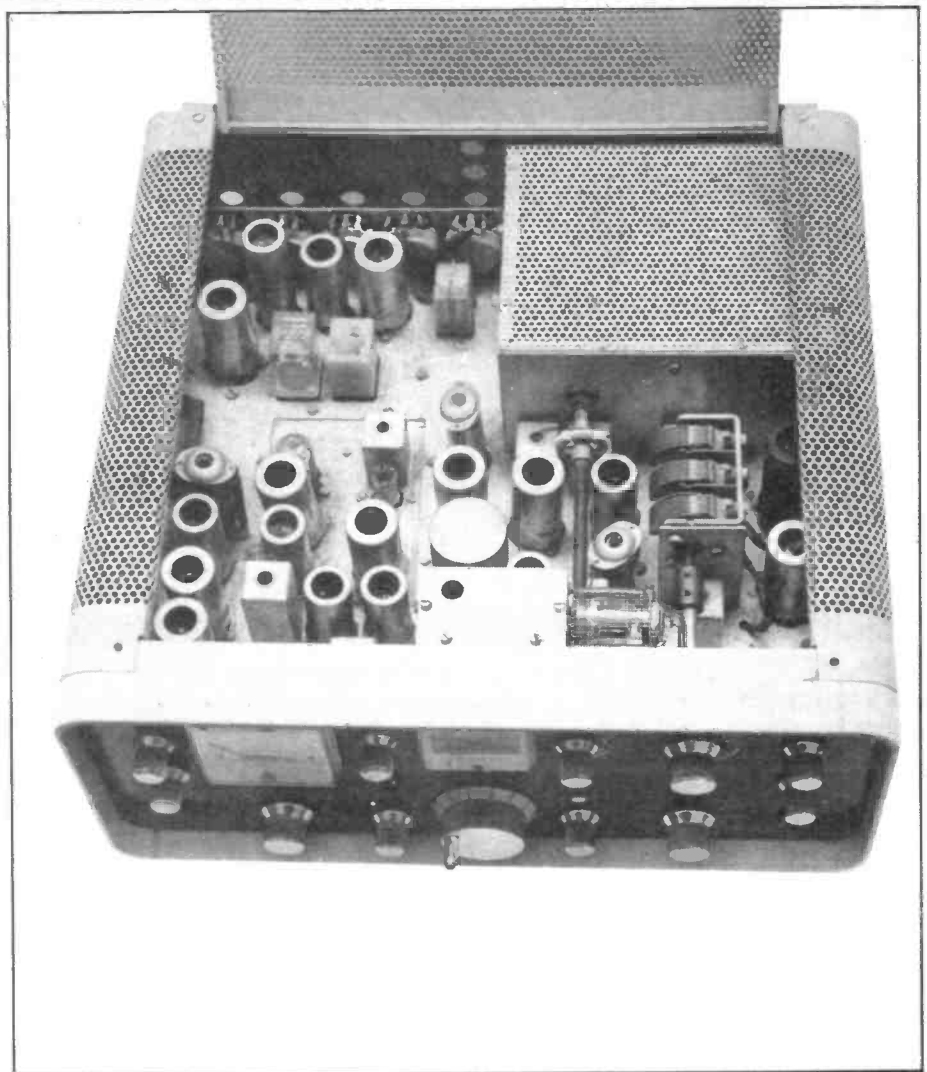
**This valve, by the way, is ridiculously expensive, costing almost twice as much as the PA valve!*

IF stages V12 and V13 and the RF stage V6. The RF gain control also acts via the AGC line, a fixed negative voltage being applied to the AGC line from the RF gain control RV75 via the other half of V14. The S meter is operated from the AGC line via V18 (12AT7). This, incidentally, is arranged to give a true logarithmic characteristic, which means that the 'S' calibrations and dB markings are accurate unlike many modern so-called 'S meters' which simple measure the AGC voltage on a linear scale. The meter is switched by a relay to read PA cathode current on transmit.

For CW operation an audio oscillator V15A (½ 12AX7) is keyed, its output being coupled at low level to the modulation gain control RV9. The audio tone is also fed to the receiver AF gain control RV95 to produce side tone. The tone oscillator is also used for tuning up; when the function switch is put into the TUNE position the rig is switched to transmit, the tone oscillator is switched on and the PA is put into Class C and its screen voltage is reduced.

The VOX circuit employs two valves, VIB (½ 12AX7) and V21 (12AT7). VIB is fed with audio from the anode of the VIA (which point, incidentally, is also connected to the top end of the mod gain control, and hence receives the signal from the tone oscillator V15A). VIB further amplifies the audio before applying it to the VOX gain control RV111 which feeds a further amplifier V21A. The output of V12A is rectified and used to turn on V12B whose anode lead contains the VOX relay RL4. The signal from the anode of the receiver output stage V17B is rectified in the opposite sense and used to provide anti-trip, the level being controlled by RV112. One pair of contacts of RL4 operate the main send/receive relays RL1 and RL2, and the other set of contacts are brought out to pins on the accessory socket to control external equipment such as linears.

The one valve which has not so far been mentioned, V22 (EF91) is a 100 kHz crystal calibrator, activated by a push button on the front panel. A small knob allows the cursor on the VFO tuning dial



to be moved by about ±10 kHz to correct calibration errors.

The power supply unit provides two HF voltages, 245 volts which is used by most of the stages and 750 volts for the PA anode (the screen is fed from the 245 volt rail). In addition, two negative bias supplies are provided, one variable between 50 and 65 volts, which provides the operating bias for the PA, and the other fixed at 65 volts, which is used to switch off whichever stages are not being used in either transmit or receive modes, and also to provide the RF gain control voltage. In addition, the power supply produces -12 volts DC for the relays, 12.6 volts AC for most of the heaters, and a separate 6.3 volt supply for the heaters of the V10 and V11.

Variations on the basic theme.

The KW2000 was quickly followed by the KW2000A, which used two 6146s in the PA thus increasing the 100 watts, and also possessed an ALC system, which derives its control voltage from the spurious audio which appears at the PA grid when that stage is driven into grid current. The ALC voltage is applied to the grid of the transmit IF amplifier V3, controlling its gain. The next model to appear was the KW2000B whose main improvement was a better slow motion drive for the VFO. The last, and least successful, member of this family was the KW2000E, which increased the VFO tuning range to 500kHz, but at the expense of stability. The C and D suffixes were used for models produced for professional use, eg ship to shore communication.

**The next article in this series will deal with common faults, and tell the reader how to return a newly acquired KW2000 to full working order, which should be done before any modifications are attempted.*

LETTERS

Because this is the first issue of the magazine, we haven't got a letters column yet. We will have and you — the readers — are the people who are going to write it.
To give you food for thought we have assembled some of the opinions concerning amateur radio which we encountered in producing this new magazine. Frankly, most of them are jaundiced to say the least but they nearly all raise some aspect which may be worthy of discussion.
We came across them in the same manner which most of you will have done — by listening to both the harangue and humour of the airwaves. A few of them were offered directly: "Why don't you do an article on..." to which we reply: "Why don't you write one then?"
We would like this column to be an open net. We promise that we won't censor or cut correspondence (unless it's very boring) within the limits of the law of libel.
Please write to us with your views c/o Frank Ogden G4JST, Ham Radio Today, 145 Charing Cross Road, London WC2 0EE.

RAE too easy

The boom in Ham Radio is obviously caused by the lowering of the RAE standards with the introduction of the multiple choice answer examination. The famous book "So you want to be a radio amateur" became a book at bedtime and a guide to finding a lucky pin. The new RAE examination has had wider repercussions than just making the good time for the retailers. There is a noticeable decline in the standard of amateurs coming into the hobby. They're nothing more than a bunch of CBer's in the main.

Channelisation

A certain G3 insists on holding QSO's on the calling channel! May be he's right, the air belongs to anyone who is entitled to hold a licence and has paid for it, so get stuffed is the attitude of many! Who said the band has to be channelised anyway? The Home Office, RSGB? The likes of our G3 frield is going to appreciate even less the 12.5 kHz spacing that must be inevitable if the deluge of new licences continues year after year.

Self control

There always has to be a policeman these days to control a situation when more than a handful of people are playing the same game and that is what Ham Radio has come to — a game — yet the licence is still issued for electronic experiments and self teaching. The minimum age to hold a licence should be raised to 18. Kids should be out of their nappies before being allowed to belch profanities over the air. Listening to some of the lids, wallys and squeakies, call them what you will, it is obvious they are well beyond any self control. The RSGB as the wouldbe governing body of Ham Radio in the UK doesn't have the facilities or legislation required to clamp down on the offenders; while the Home Office is just not interested.

Too many contests

There's nothing but contests on the HF bands these days. It seems that wherever you tune the ciy is "CQ CONTEST, CQ CONTEST". It's really difficult to get a word in edgeways these days without some Italian or Russian station coming up and shouting over the top of you. There are just far too many. It really takes the fun out of the hobby for those of us who simply what to ragchew. Contests should be cut right back.

Amateur vs CB

"I understand that you're a radio amateur."

"Well, yes."

"I wonder if you could explain to me the difference between ham radio and CB?"

"I'll try. Amateur radio takes in far more than simple CB. True, both of them are concerned with two way radio but ham radio is concerned with long distances and things like bouncing signals off the moon."

"It sounds very interesting but a friend of mine is a radio amateur and he's got something called a two metre black box... I listened to it and it sound very like CB. What's the difference with that?"

"Price, I suppose."

CW anachronism

CW is the most archaic form of communication, even the tribesmen of Africa use it with their drums. Why are we not taught morse code at the same time as learning to talk if it is so important a form of communication? There's a lot more sense and value in teaching everyone to type in their youth (they do in the States), those becoming Hams could then use RTTY or a typewriter to a morse converter (another black box) with the replies displayed on a VDU. It's a lot easier to learn to type than to use a morse key. Those that can't spell lose out either way, that's why the Q code was invented!

Homebrew

"I did it my way" is the cry of the home brew merchants. They always manage to design something that out performs any black box. "I've only tuned it up by ear, but it's better than my (a well known black box)". You've heard it so many times on the air, isn't it amazing how they manage to get a component to perform a task it was never designed to do, and what is more they set it up with a neon screwdriver, at UHF frequencies of course! How is it these guys are always road sweepers, and not working for Marconi?

Contest barmy

Hams are contest barmy! Every weekend there's a contest on at least one band. Not twenty four hours content to have just, Oh no, forty eight hours is a man sized contest. Everyone winds up the RF to legal limit, plus 400%. What does it all prove in the end? Nothing, it's always the same idiots that win! A good long rag chew is more beneficial to all.

QSL cards

The result of a contest is usually a deluge of useless QSL cards. The only people getting any real satisfaction from them is the printer and the post office. Mine go under the leg of a table to stop it rocking. If you're an artistic freak, you'll probably paste them on the wall to cover the cracks. Anyway, you can never believe what's written on them. The sender doesn't want you to think his station is inferior to yours, so he frigs the signal reports.

A bit silly

Hundreds of new licences are issued annually to candidates who only just scrape through the RAE with a large slice of luck. With the ink still wet on a grubby little bit of paper, they spend an arm and a leg on an all singing all dancing black box. Selecting the local repeater channel they hog it for hours, calling CQ-DX this is G6... continually 'til eventually one of their club mates two roads away replies. After giving their name which they spell phonetically three times and the same with the QTH they continue "Oh yes, well you know that don't you John, and I guess the weather's been the same with you etc, etc, etc,".

RAYNET

During the East coast floods in the mid fifties, a number of Hams did trojan work in helping the emergency services and ships at sea. This became the germ of an idea to form an amateur emergency communications network, from volunteer Hams. "RAYNET" as it's now called was the result. It's a well known fact that when an Englishman is up against the wall, he's at his best and this is how its been on numerous occasions when RAYNET has gone into action. But at the debriefing afterwards the controllers gently pat themselves on the back for a job well done; except their report shows things might have been better if only... the mobile had gone to the right grid reference. Why give him a bunch of numbers, when he could have been told to stay outside Jones the Butcher's Shop in the High Street; and if only the portable station had stayed in contact! No credence is given to the fact the poor sod had fallen in the swollen river losing his 'hand held' and almost his life. The report recommmends more map reading and operating exercises. It's suggested the controllers go out into the field for a change. It's time the top brass remember we're a bunch of volunteers, not a battalion of soldiers. The organisers who would have these volunteers trained to military standard should join the professionals and stop "playing" soldiers.

Don't knock CW

People who knock CW tend to be silly people who mostly can't be bothered with the effort of learning it themselves. All that rubbish about it being an anachronism is just patently wrong. There is nothing like it for pulling a QSO out of the noise or QRM. It can be sent at any speed with the minimum of equipment and it is certainly much more effective than the other so called 'narrow band' media such as RTTY, Amtor, etc.

In any case, you should hear the drivel which pours forth out of the mouths of babes, so to speak, most of whom are newly licenced G6's. You hear them baying for a novice licence which, in reality, is just a request for a substitute for a bit of study, application and hard work. To scrap morse would be to cause yet further degeneration in the standards of our hobby. You've only got to listen to them. Most of the newcomers are simply full to bursting with boring inanitities. Witness what's happened to the repeaters.

Condescending

People who build their own equipment are in the main a bunch of self opinionated, egotistical folk who look down on those of us who get our enjoyment with shop built blackboxes. They should remember that amateur radio can mean all things to all people.

As for patronising us 'mere mortals' you always know a home brew merchant by the dreadful quality of the audio. At least we don't inflict the unpleasant results of our labours on other unfortunate stations.

RAYNET vigilantes

The idea behind Raynet and the motives of the majority of its members are good to the point of being laudable. Having said this, a small number of them see themselves as vigilantes of the radio spectrum. I have lost count of the number of times that I have heard the extremists come up and say something to the effect of "Do you know that this is a Raynet frequency? Do you mind moving off to another channel". You go back to them and point out that there is no current occupation of the frequency and therefore you cannot see what harm is being done. They typically reply that these frequencies are set aside for Raynet use whether they are presently in use or not. In any case the call for Raynet to use them could come at any time and therefore you should never use them except on Raynet business. You then reply that your licence entitles you to transmit anywhere within the prescribed bands, etc. The debate degenerates from there.

The whole 2m spectrum seems full of Raynet frequency proscriptions. Any reasonable person naturally keeps clear of traffic which has serious intent whether it emanates from Raynet or not. However it seems that the attitude of some Raynet members borders on the unreasonable and is definitely OTT.

Think then speak

People who say "This is G6ZZZ calling CQ and looking for any possible calls" get right up my nose or, at any rate, fill me with despair about the state of my hobby. All calls are possible, especially if someone goes back to them. I appreciate that this is a character tick but I do wish people would think a bit before they open their mouths.

Protiteering

"So you're setting up a new magazine are you? You should do an article on the amateur radio dealers and their profit margins... Listen mate, I know. I've been to the States and I've compared the prices that you can buy the same equipment over there. They must be making an absolute bomb out of us."●

RADIO YESTERDAY

Cross-channel microwave, 1934 style

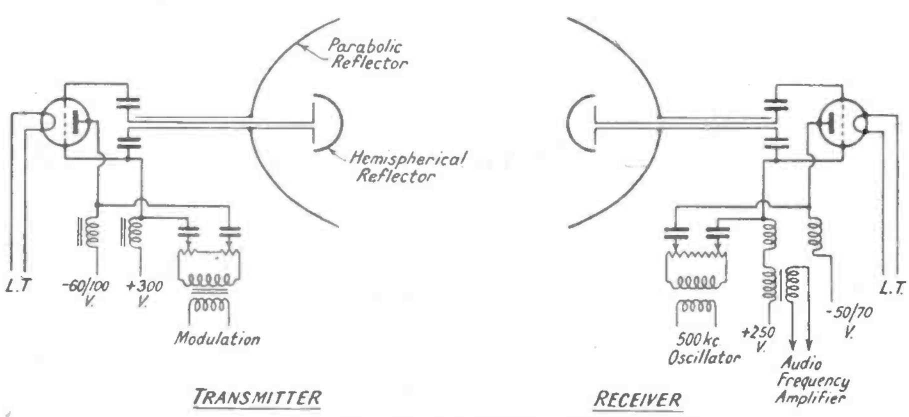


DIAGRAM OF ENGLISH CHANNEL MICRO-WAVE LINK

by **Andy Emmerson, G8PTH**

From a radio amateur viewpoint the microwave scene appears to be a pretty modern phenomenon. Despite the efforts of pioneers like, say, G5RZ during the 1950s, amateur activity in the microwave bands (23cm and higher) seems to be a speciality mode which has only just caught on. While this is not strictly accurate it is certainly true that recent developments such as low noise GaAs FETs at affordable prices, microstripline circuit techniques and the availability of commecial equipment have made microwave operation a lot more fun. Gone is the need to be an expert in 'plumbing' or at recognising exotic pieces of military surplus gear to get on the air. In short, the technology has become a lot more comprehensible and within the reach of the average amateur.

In the light of this, the problems which faced pre-war experimenters in microwaves look even more formidable. Despite this over fifty years ago the two sides of the English Channel were linked on 17 cm with just half a watt of RF power. Three years later, in 1934, a full commercial service was in operation. The story of this world first is an unusual and interesing one, which has been somewhat obscured in the mists of time.

The instigator was a certain Colonel Sosthenes Behn, president of the International Telephone and Telegraph Corporation (ITT), who in 1927 decided to set up a R & D laboratory in Paris. Flamboyant character that he was, he demanded positive results quickly — the exact field was not important so long as the results were spectacular! Radio clearly had a promising future so it was decided to exploit the extremely short wave region, then unexplored territory. Plans were quickly made: radio energy would be produced at wavelengths around 17 cm and concentrated in sharp beams by means of parabolic reflectors. Calculations indicated it ought to be possible to cross the English Channel at its nar-

Circuit diagram from original article. The 'triode' is infact an early klystron

rowest point, using almost the same route as Blériot did when he was the first to cross the Channel by aeroplane in 1909.

In charge of the project was André Clavier and by 1931 his team had brought the concept to reality and was ready to make the first public presentation. A large gathering of officials from the British and French post offices, scientists, military experts and pressmen attended a demonstration of microwave telephony which was 100 per cent successful. The news had wide coverage in the press and ITT's London publicity man, McGrath, coined the term 'microwave' to give the transmissions a catchy name and capture popular appeal. ITT quickly realised the potential of the technique, describing in a technical paper the project of a microwave link from London to Paris using repeaters 50km apart. The technicians also observed that ships crossing the beam, which in the middle of the Channel ran close to the water, interfered with the transmission and the size of the ship could be established. The significance of this early experiment in radiolocation was not, however, realised at the time.

Line of sight

The air ministries in Britain and France were sufficiently impressed to order a commercial system to link airfields on either side of the Channel at Lympne (near Folkestone) and St. Inglevert (near Boulogne) and this was put into use in 1934. The length of this link was 56 km, the frequencies used 1724 and 1764 MHz (17.0 and 17.4 cm) and the transmitter power 0.5 watt. Line of sight operation was assured by locating the aerial parabolas on high towers (see photo). The diameter of the paraboloid reflector was 10ft 6in, having a gain of 28dBd. A hemispherical reflector at the focal point added an extra 5dB. Separate TX and RX dishes with frequency separation were used initially to allow simultaneous duplex operation. Later on a single reflecor was used, with outward and inward transmissions cross-polarised at right angles to each other. The link was used for both speech and teleprinter (RTTY) signals.

Special triodes knowns as 'micro-radions' were used and these were made to oscillate by reversing the usual potentials on grid and anode. The normal control function of the grid was not used and there was no anode current. Other details will be apparent in the diagram. *(It operates in the manner of a primitive sort of travelling wave tube or klystron to my way of thinking — Ed.)* And that, in a nutshell was the world's first commercial microwave radio service. When it ceased I have been unable to find out, and any further details readers may be able to supply will be most welcome. In future articles I hope to explore other unusual applications of radio from the past.

Re-printed from THE ELECTRICAL REVIEW Feb 2, 1934

Micro-ray Telephony

Power of the order of 0.5 W is radiated from aerials less than an inch long on a wavelength of 17 cm. (claimed to be the shortest so far used commercially), as compared with 900 m. for civil air traffic and 1,380 m. for route traffic messages. The wavelength used for reception is 0.5 cm. longer than that used for transmission, which slight "stagger" permits duplex working by telephone and "Creed" teleprinter. Hitherto wireless teleprinting has been done experimentally only, owing to the difficulty of obtaining a radio signal of constant strength and free from interference. The micro-ray system overcomes this handicap and messages will be transmitted at a speed of sixty to seventy words per minute.

The distance between the two terminals is 56 km. and the path between them is clear of obstacles, the electro-optical equipment being installed on the roof of a hanger 43 ft. above ground at Lympne, and on 66-ft. steel towers which have been erected at St. Inglevert.

For generating the oscillations at the rate of 1,7000 millions per second use is made of a specially designed micro-radion valve, fitted with a double-ended helical grid and a normal cylindrical plate electrode. The double-ended grid, in addition to being biased positively, is included as a tuning element in the main oscillatory circuit. The actual wavelength is a function of valve geometry, output circuit, and electrode voltages; the latter are therefore the tuning elements. The normal control function of the grid is not used; it is the "oscillating electrode", while the "plate" is the "reflecting electrode". The latter is biased negatively, and there is no plate current; the grid id biased positively, and in many respects replaces the anode of a normal valve. For example, the grid dissipates the power lost in the valve. The filament is of tungsten, and is operated at a temperature giving voltage saturation of the space current with respect to the oscillating electrode.

Electro-optical Systems

The main reflector is paraboloidal, 10 ft 6 in. in diameter, and is spun out of an aluminium sheet about 5 mm. thick. A spherical reflector, three wavelengths in diameter, faces the large reflector, to which it is attached by three radial wooden members. The antenna, of the half-wavelength type, is placed at the focus of the paraboloidal reflector, which coincides with the centre of the spherical reflector.

The focus of the paraboloidal reflector is situated in the aperture plane of the spherical reflector, and the radiation emitted from the antenna on the transmitting, side is concentrated int a very sharp beam by means of the main paraboloidal reflector. The spherical reflector is used to reflect the direct forward radiation of the antenna back to the paraboloidal reflector, thus increasing the gain of the total electro-optical system. The gain of the paraboloidal reflector alone is of the order of 28 decibels, which rises to 31 decibels when the spherical reflector is added to the system. The same gain is obtained on the receiving side.

The antenna is fed by a concentric transmission line, the external surface of the outer tube being tapered, and of great rigidity to prevent antenna movement on windy days. The inner member is insulated by "Micalex" spacers located at the voltage nodes the purpose being to keep the loss as low as possible.

Behind the large reflector the valve is mounted in a socket of the conventional bayonet pattern, but the two lead-in wires to the oscillating grid electrode of the valve are adjustable in relation to the transmitting line in order to tune the oscillatory circuit of the micro-radion valve on site. The length of the tubular transmission line is made equal to three-fourths of the wavelength used, to match the impedance of the antenna to the internal impedance of the valve, and thus give optimum working conditions. Adjustment of the tube is by a screw and small hand-wheel. All surfaces conducting high-frequency currents are gilded by a galvanic process to prevent corrosion. Other metallic parts are painted.

On the transmission side, the auxiliary transmission line is connected to a thermocouple, and an associated galvanometer in the control room acts as a radiation indicator.

Apart from the adjustment of the oscillatory circuit and transmission line, which does not have to be changed except in the event of the valve burning out, all control adjustments are located in the control room on a number of panels mounted on two vertical bays.

Potentiometers control the voltages applied, and modulation, which may be speech or 3,500-cycle signals coming from the teleprinter unit, is increased in amplitude by means of two amplifiers. The first is an ordinary transformer-coupled two-valve amplifier of the repeater type with attenuators for gain control, and the other is a push-pull output stage employing three valves. Signals coming from the amplifiers are applied to a voltage divider which supplies the modulation to the electrodes of the micro-radion valve in a suitable ratio.

Incoming signals are picked up by a receiving reflector, focused on the receiving antenna, and demodulated by means of the micro-radion valve. To stabilise the demodulation process an auxiliary oscillator applies a 500 kc voltage to both electrodes of the receiving valve in a different ratio, which is determined from the constant frequency curve of the valve in the same way as the corresponding ratio for the modulation on the transmitting side.

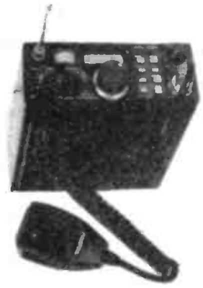
It is stated that this method renders the adjustment of the system much less critical in operation. The demodulated signal is then fed into a receiver amplifier and gain control panel and passes into an ordinary telephone receiver, or is transmitted to the teleprinter equipment for a second demodualtion used in conjunction with a single-current voice-frequency equipment.

The signal distortion is very small, and the circuit includes a device to maintain the detected current approximately constant over a wide variation of signal strength. since the teleprinters operate on the start-stop principle, there is no need to synchronise the transmitting and receiving machines. Further, the operation of the voice frequency unit and the radio system is simplified by reason of the fact that the speed of the signals sent out are independent of the rate of striking the teleprinter keys.

TWO AND SEVENTY — HAVE THE SOLUTION

- ★ Multimode USB, LSB, FM, CW.
- ★ 100Hz backlit LCD Frequency display.
- ★ 10 memory channels '5 year' backup.
- ★ Any TX/Rx split with dual VFOs.
- ★ Up/Down tuning from microphone.
- ★ AF output 1W @ 10% THD.
- ★ Bandwidth 2.4kHz and 14kHz @ – 6dB.
- ★ LED's; 'On Air', 'Busy'. m/c meter; S, PO.
- ★ 58(H) × 150(W) × 195(D) (1.3kg).

SMC2.2C	NiCad 2.2A/hr, "C"	TOS
SMC2.0C	NiCad 2.0A/hr "C"	2.35
SMC8C	Slow Charger (220mA)	8.80
MMB11	Mobile Mount	22.25
CSC1	Soft carrying case	3.45
FL2010	Linear Amplifier 2m 10W	64.40
FL7010	Linear Amplifier 70cms	99.65



2 or 70!

FT290R

- ★ 144-146MHz (144-148) possible.
- ★ 2.5W PEP, 2.5W RMS/300mW out.
- ★ FM: 25kHz and 12.5kHz steps.
- ★ SSB: 1kHz and 100Hz steps.
- ★ ±600kHz repeater split 1750Hz burst.
- ★ Integral telescopic antenna.
- ★ Rx, 70mA, Tx; 800mA (FM maximum).

FT790R

- ★ 430-330MHz (440-450 alternative).
- ★ 1W PEP, 1W/250mW FM/CW out.
- ★ FM: 100kHz and 25kHz steps.
- ★ SSB: 1kHz and 100Hz steps.
- ★ 1.6MHz shift with input monitor,
- ★ 1750Hz burst.
- ★ Rx; 100mA/200mA. Tx; 750mA max.
- ★ BNC Mounting ¼λ flexi antenna.

2 or 70!

- ★ USB-LSB-CW-FM (A 3j, A1, F3).
- ★ 30W PIP A 3j, 10/1W out A1 F3.
- ★ Any Tx Rx split with dual VFO's.
- ★ Four easy write-in memory channels.
- ★ Memory scanning with slot display.
- ★ Up/down tuning/scanning from mic.
- ★ Priority channel on any memory slot.
- ★ Digital RIT. Advanced noise blanker.
- ★ Satellite mode allows tuning on Tx.
- ★ Semi break in with side tone.
- ★ Very bright blue 100Hz digital display.
- ★ Display shows Tx & Rx freq (inc RIT).
- ★ String LED display for "S" and PO.
- ★ LED's; "On Air" Clar, Hi/Low, FM mod.
- ★ Size (Case): 8.3" D, 2.3" H, 6.9" W.

Ills. c/w SCI station consol and YD 148 mic.

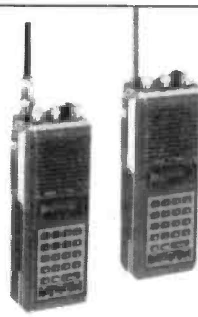
FT480R

- ★ 144-146 MHz (143.5-148.5 possible).
- ★ ±600kHz standard repeater split.
- ★ Excellent dynamic range and sensitivity.
- ★ FM; 25, 12½, 1kHz steps.
- ★ SSB; 1,000, 100, 10Hz steps.

FT780R

- ★ 430-434MHz (440-445 possible).
- ★ GaAs Fet RF for incredible sensitivity.
- ★ FM; 100kHz, 25kHz, 1kHz, steps.
- ★ SSB; 1,000, 100, 10Hz steps.
- ★ FT780R 1.6 fitted 1.6MHz Shift £459 inc.

- ★ Keyboard entry of frequencies/splits.
- ★ LCD digital display with backlight.
- ★ Any split + or – programmable.
- ★ Ten memory channels '5 year' back up.
- ★ Up/down manual tuning. Memory scan.
- ★ Manual or auto scan for busy/clear.
- ★ Priority channel with search back.
- ★ Scan between any two frequencies.
- ★ Auto scan restart. 1.750Hz tone burst.
- ★ Built in condenser microphone.
- ★ 500mW to int/ext speaker.
- ★ External speaker/mic. available.
- ★ 168(H) × 61(W) × 39(D)mm.
- ★ C/w Quick change NiCad pack, helical.



2 or 70!

FT208R

- ★ 144-146MHz (144-148 possible).
- ★ 12.5/25kHz synthesizer steps.
- ★ ±600kHz repeater split.
- ★ 2.5 or 0.3W RF output.
- ★ Rx: 20mA squelch 150mA max. AF.
- ★ Tx: 800mA at 2.5W RF.
- ★ 0.25μV for 12dB SINAD.

FT708R

- ★ 430-440MHz (440-450 option).
- ★ 25kHz synthesizer steps.
- ★ ±7.6MHz EU split standard.
- ★ 1W or 100mW RF output.
- ★ Rx: 20mA squelch, 150mA (max AF).
- ★ Tx: 500mA at 1W RF.
- ★ 0.4μV for 12dB SINAD.

2 and/or 70!

- ★ Four easy write-in memory channels.
- ★ Rx priority channel (auto check).
- ★ Scanning band/memory empty/busy.
- ★ Up/down tuning/scanning from mic.
- ★ Optically coupled tuning control.
- ★ Manual and automatic tone burst.
- ★ String LED's for 'S' and PO, 7 status LEDs.
- ★ 1½W of audio to internal/external speaker.

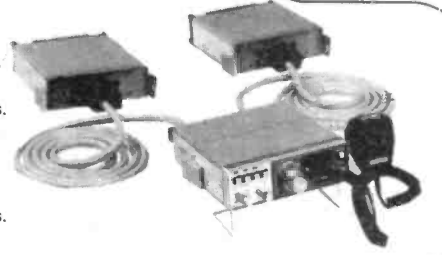
FT720 Control Head.

- ★ 3.3(4.3)" D × 6" W × 2 (2.2)" H.

S72 Switching box.

- ★ Pushbutton band change Auto steps/spits.

E72S	Extension cable, 2m long.
E72L	Extension cable, 4m long.
MMB3	Mobile Mounting bracket for deck.



Ills. c/w S72 and two E72S cables.

FT720RV

- ★ 144-146MHz (144-148MHz possible).
- ★ 12½kHz synthesizer, 600kHz shift.
- ★ 0.3μV for 20dB quieting.
- ★ Rx 0.5 Tx RV 3.5A, RVH 6.5A.
- ★ 5.8(6.5)" D × 6" W × 2 (2.2)" D.

FT720RU

- ★ 430-434MHz.
- ★ 25kHz synthesizer steps, 1.6MHz shift.
- ★ 0.5μV for 20dB quieting.
- ★ Rx 0.5A, Tx 4.5A.
- ★ 5.8(6.5)" D × 6" W × 2 (2.2)" D.

- ★ 150(W) × 50(H) × 176(D)mm.
- ★ Up/down, memory/band scanning.
- ★ Easy "write-in" memory channels.
- ★ Memory backup "5 year" lithium cell.
- ★ Ten memories with priority functions.
- ★ Supplied with scanning microphone.
- ★ Large illuminated "any angle" LCD display.
- ★ Display to 100's of Hz and special functions.
- ★ Two completely independent VFO's.
- ★ Operation between memory and "other" VFO.
- ★ Full reverse repeater function.
- ★ Manual and automatic tone burst.
- ★ Large "full sound" internal speaker.
- ★ Concentric volume and squelch controls.

2 or 70!

FT230R

- ★ 144-146MHz (extensions possible).
- ★ 25W RF output, 3W on low.
- ★ 25 and 12½kHz steps provided.
- ★ ±600kHz repeater split, 1750Hz burst.
- ★ Tx; 5A. Rx 300mA (standby).
- ★ UHF socket. IF's; 10.7 and 0.455MHz.

FT730R

- ★ 430-434MHz (440-445MHz possible).
- ★ 10W RF output, 1W on low.
- ★ 25 and 100kHz steps provided.
- ★ ±1.6 MHz repeater split, 1750Hz burst.
- ★ Tx 3A, Rx 300mA (standby).
- ★ 'N' socket. IF's 46.255 and 0.455MHz.

THREE MULTIMODES REVIEWED

By Peter Metcalfe B.Sc. G8DCZ.

Under starter's orders: from the left Yaesu FT-480R, Icom IC290E, Trio 9130.

Anyone who has kept an eye on advertisements in this and other publications can't have helped noticing that recently there has been an increase in the number of multi-mode 2m rigs available. The choice can at times be a little bewildering if one has no local 'emporium' where comparative tests can be carried out. Even then, a few minutes 'twiddling' is hardly sufficient to realise the potential or discover the idiosyncracies of modern 'all singing, all dancing' rigs. I must come clean at the outset and declare an interest in one of the following rigs, for I bought it a few months ago. When I was asked to carry out this comparison I jumped at the chance but with one reservation; how would my pride and joy stand up to the others? Hopefully it will not be too obvious which rig is mine but if a little bias slips in please forgive me — over £350 is a lot of money to throw away!

The three chosen for comparison are the Yaesu FT48OR which appeared at the end of 1980, the Icom IC290E which followed in late 1981, and the Trio TR9130 which surfaced rather — hesitantly in summer 1982. The TR9130 may be the newest rig but it is really the TR9000, which has been available for a couple of years, with some 'user suggested' modifications.

Documentation

One of the many criticisms made about the 'modern' radio amateur is that he/she tends to be relying more and more on black boxes, with little thought as to what goes on inside. It seems that Yaesu and Icom have done their bit to dispel this rumour. These two manuals are extremely comprehensive making the new owner feel thoroughly at home with his purchase, whether a newcomer or old hand.

The Yaesu manual is 36 pages long with four well-drawn, large circuit diagrams on unfolding sheets. The operating instructions are fairly clear but I have one small gripe about descriptions of the frequency range and synthesiser steps since the USA version (model A) is assumed throughout. The description of the circuit operation is very thorough and the external socket connections are shown clearly. Four well-labelled photographs of the opened rig allow the inquisitive to find their way around the set and it is a very nice touch that the next two photographs show all the alignment and test points in the rig along with comprehensive instructions on setting up the transmit and receive sides. The final page of the manual

All transceiver equipment reviews appearing in Ham Radio Today are undertaken in three parts. In the first instance we send the equipment to experienced amateurs who provide a subjective opinion — we allow them to be as nasty or as nice as they like — on the practical operating aspects. We ask them specifically not to undertake any technical tests but simply to tell us — and you — if it is fit for the use intended by the manufacturers. For instance, are the knobs in the right place? Is it too slow to use for a meteorscatter contact? Does it sound OK (in the reviewer's opinion)?

After the reviewer has operated the set(s) for a couple of weeks, we take them away for delivery to our review laboratory, in reality, the research and development labs of Redifusion Radio Systems — Redifon — a sister company of the publishing house which brings you Ham Radio Today. The lab runs a series of tests devised by us and prepares a report. At no time does the 'practical' reviewer see its contents until he hands in his own report to us. The result is that the reviewer has to go out of his way to be fair. He knows that if he makes unsubstantiated claims about the performance apsect of a particular piece of gear, a jaundiced view is open to exposure in the dispassionate light of the testing lab.

As Editor of Ham Radio Today it falls to me to weigh up the balance of the review — the third part of the process — and add notes and observations as I see fit. For instance, I have tried to put the rather bald figures from the lab tests into perspective.

In searching for the most objective viewpoint I believe that we have succeeded in a way that no other amateur radio magazine has ever done before. However we have not yet reached the end of the line and we welcome suggestions to improve the process still further.

Frank Ogden G4JST
editor, Ham Radio Today

gives details on how to convert the European model to greater frequency coverage (143.5 - 148.5MHz) and to different synthesiser steps (eg 20kHz, 100kHz etc) by the insertion of diodes, in case you intend travelling with the 480R.

The general impression gained is that Yaesu is not trying to hide anything and anyone with the irresistable urge to tweak or modify the rig should feel reassured. If more manufacturers took heed of this, the hobby could benefit greatly.

The Icom manual gives a similar impression being 44 pages in length and having a circuit diagram on a double-sided unfolding sheet. Although slightly smaller than the Yaesu diagram, this one still does not necessitate the use of a microscope to follow the circuit, as do some other manufacturers'. One rather novel touch is the use of a large fold-out component layout for the circuit board. Good open top photographs, block diagrams and comprehensive circuit operation notes make this manual very useful indeed. Icom does seem to blow its own trumpet rather too much with comments like "Outstanding performance" and "The IC290A/E has everything you need to truly enjoy VHF operation". This tone tends to detract from an otherwise extremely readable manual. After all, who need sales talk after you've bought it?

The usual advice when writing articles is to save the best till last, but unfortunately this is not the case here for the Trio handbook is honestly quite disgraceful. The unfolding circuit diagram does need that microscope and it is rather disconcerting that lines seem to change their labelling as you trace along them. Block diagrams help a little but the complete absence of any discussion of the circuit operation is a deplorable omission. Only one tiny photograph of *half* the lower board is shown and this is primarily to indicate where to plug in the memory back-up battery. To be quite honest, I don't know why Trio bothered! With the exception of the circuit diagram, one could learn at least as much information from the two-page glossy advertising sheet. One glance at this manual would be enough to put anyone off with the intention of: (a) learning a little more about VHF construction techniques and (b) getting one's hands dirty in modifying or tweaking the last scrap out of the rig.

One of the purposes of amateur radio is for self-training and experimentation and Trio needs reminding of this fact, for not everyone wants to treat their rig as a black box. However, having said all this, I have recently found out that service manuals, intended primarily for the trade, are soon to be made available. These are supposed to be very comprehensive including such things as abridged specifications for all those integrated circuits with funny reference numbers, extensive setting-up and fault-finding chapters, board layouts, approved modifications etc. The only problem being that you will have to fork out an extra £7 or £8 for the privilege. Check with Lowe Electronics for further details.

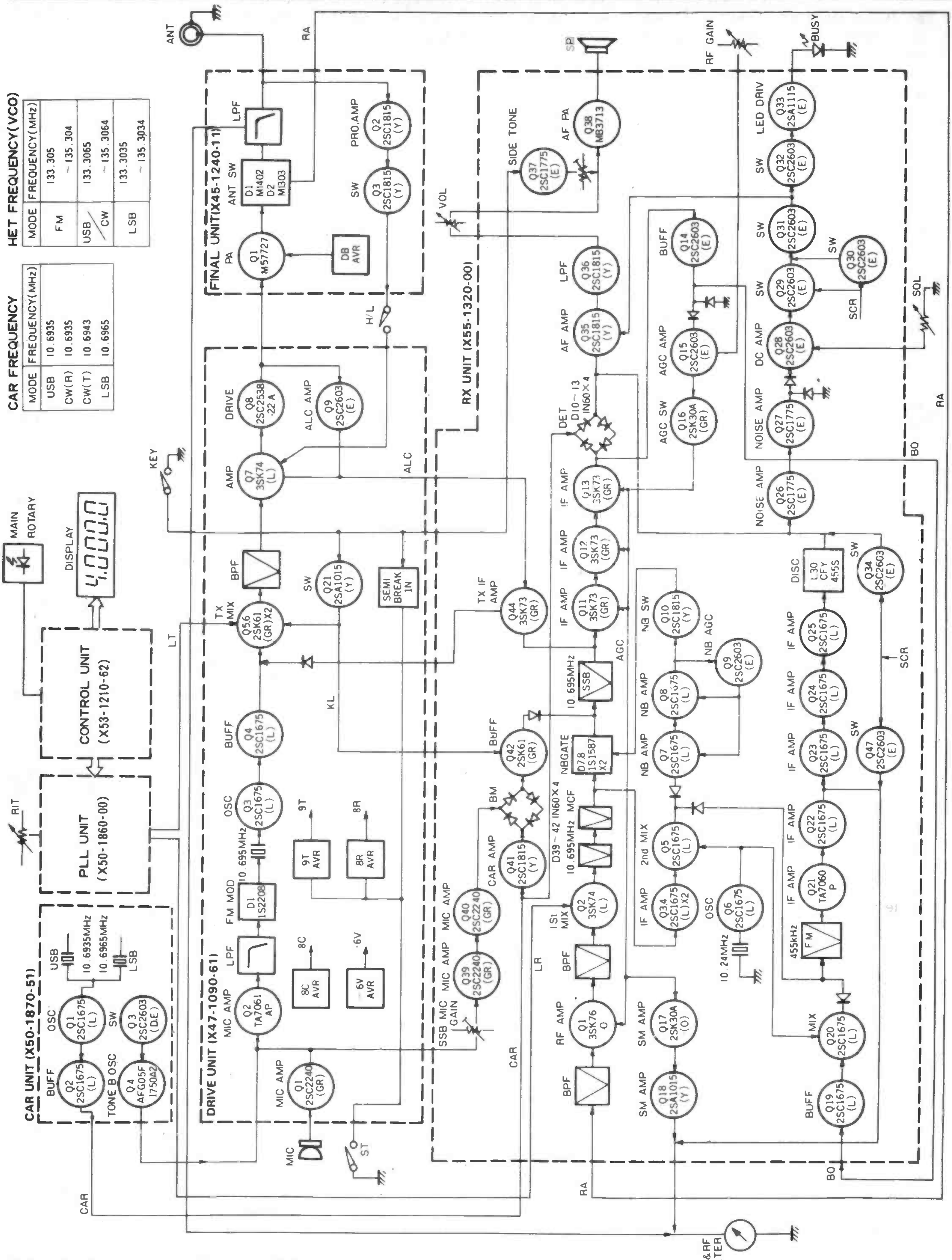
Technical summary

Which rig is the best technically? Well, it's swings and roundabouts really. All three rigs have such similar RF line-ups that apart from odd little quirks, such as inductor pulling of oscillators or the redundancy of active devices (could it be considered 'belts and braces'?) there seems little to choose between them. I feel, therefore, that the decision needs to be made on ease of operation and synthesiser functions.

Visual impressions

Often first impressions can be valuable, but equally they can be misleading. I state this here simply because it is usually first impressions that sell a rig during that quick, embarrassed flick around in a crowded shop with dozens of other amateurs avidly peering over your shoulder.

Physically all three rigs are about the same size, the 480R being slightly heavier. The first point I noted was that the 290E has a double fused lead — nice touch you think until your gaze travels up to the connector. Although no trouble was experienced with this during tests, I feel that in time it could become loose especially when the rig will probably be put into and taken out of the car many times during its life.



Block diagram: Trio 9130

Some form of plug-strain relief would be welcome. Yaesu and Icom both seem to be catering for the larger car, if the lead length is anything to go by! Another hair splitting point is the position of the fuse in the lead. The Trio and Icom rigs have this near to the set, whereas the Yaesu has it closer to the free end, which invariably means a quick hunt under the carpet/dash etc if replacement becomes necessary.

Mobile mounting

I have owned an FDK700, FM only, rig for a couple of years and have frequently longed for a third hand while struggling to align it exactly into the channels of the mobile mount, before tightening up the side screws individually. Consequently this is one feature that I now check up on at an early stage when comparing different rigs. The 480R has a system similar to the FDK but I found it considerably easier to mount. The other two rigs have quick release systems which are very easily mastered. The 290E mount has the rather useful feature of a clip and loop which can be used to padlock the rig into its mounting. This seems a thoughtful feature but is unlikely to deter the determined thief.

Microphone

The microphone is, to my mind, often ignored in reviews which seems rather odd for, unless you are going to use a mobile mic (and if you don't, you ought to!) or you have a base station mic on a stand, you are going to be clutching this little wonder for many hours. (Why can't they make left-handed mics?) Microphones seem to be sprouting controls everywhere nowadays and it is with some pleasure that one finds the Trio mic small, simple and lightweight, with just up/down and push to talk (PTT) buttons. The Yaesu's PTT is slightly more positive and nice to the touch but the Icom's PTT is awful with a very thin plastic overhanging lip which could easily be caught and, one would imagine, broken. (I didn't try it!). Also the Icom's up/down buttons are very stiff and guaranteed to give you a sore thumb if you like using this feature.

Looking at the rigs themselves, the 480R looks very neat and most impressive, but, with so many similar looking and rather small buttons all in a line, I can foresee problems with mobile operation. Also the 480R has three slide switches mounted on the *underside* of the set. One's obvious fears are confirmed when you notice the many warnings about using stands etc to prevent damage to them. The 9130 is also most impressive, although possibly the least aesthetically pleasing due to many different types of controls and less formal panel layout. However, this does have the advantage of making quick or mobile operation much easier, due to the grouping of controls for a particular type of function. Unfortunately the 290E gives a first impression of being rather shoddy; the simplex/duplex switch seems particularly cheap and nasty, and I would not be surprised if it caused problems after a few years' operation. The *priority* button looks as though it is an afterthought, having a panel hole drilled about three sizes too large for it. Also due to other controls the priority button is very difficult to get at, but perhaps that's the idea!

The next step was to get inside the rigs and here the first problem arose for the 480R takes quite some time to get into (what's to hide?). Perhaps there's a knack to opening it which I couldn't find (no chance of carrying out quick mods here). All three rigs are pretty crowded inside and the general impression is that of good quality construction.

The 480R is possibly the 'messiest' with wires everywhere and no attempt at a cable-form. Also there are many components which appear to be put in as modifications/afterthoughts which could make circuit tracing awkward. Much of the inside is protected from vibration by a thin layer of plastic foam which is a nice touch but making it difficult to get at in a hurry. The 290E has evidence of the extensive use of plugs and sockets for board connections and access to the components, except for one double stacked pair of boards, is quite good. Trio have gone to a lot of trouble to neaten up the inside of the 9130, with extensive use of plugs/sockets and neat cable-forms around the sides of the boards. This rig again would present problems if the need arose to 'dabble', due to the compactness of the boards.

As far as the speakers are concerned, the 480R comes off best with a 3in square, 2W speaker, the 290E has a 2¼in round, 0.3W one (well it says 0.3W on it!) and the 9130 has a miserly 2in round one of unspecified power rating. All three rigs seem to employ a final RF power amp module rather than discrete components and while there is no apparent reason to doubt their durability, I feel sure that many people will feel a little wary of their inclusion with a view to easy repairs.

TABLE ONE

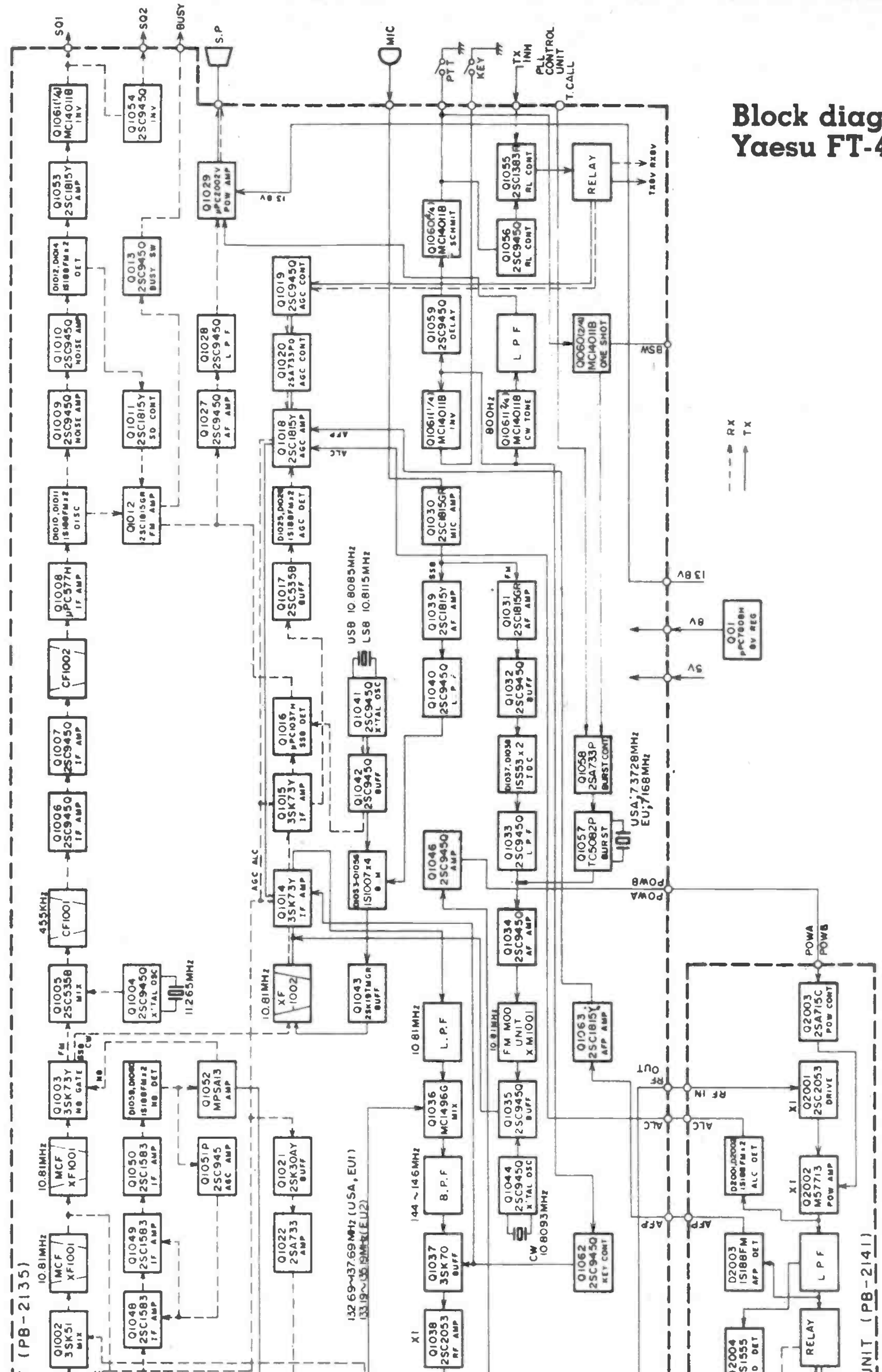
DYNAMIC RANGE IN dB AS CALCULATED FROM TEST6
TRIO 9130: 95dB ICOM 290E: 93dB YAESU FT480R: 87dB

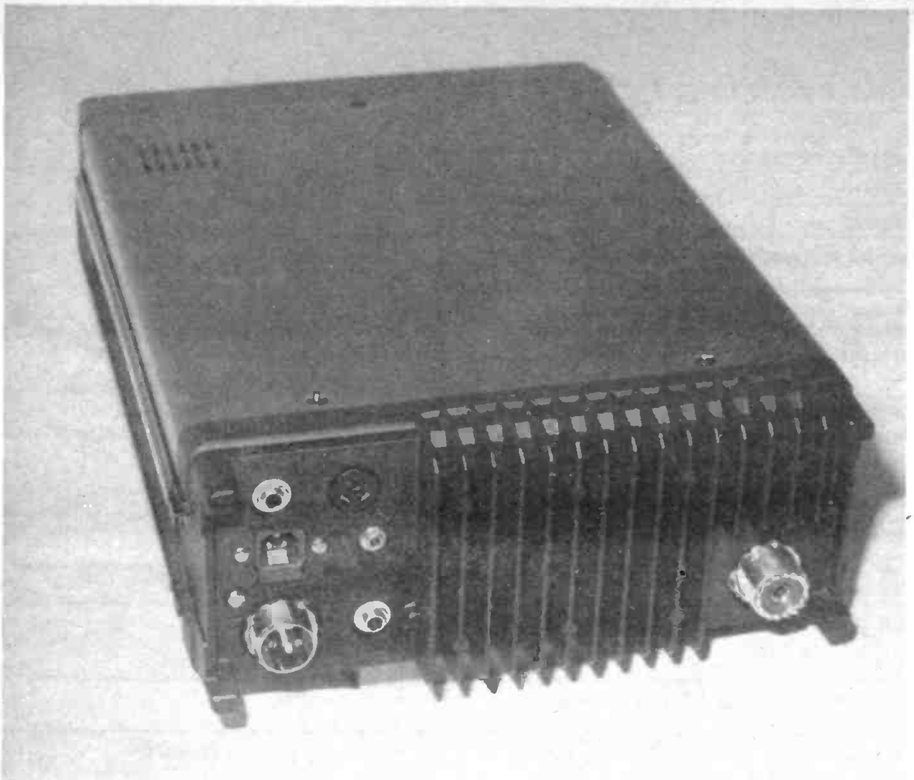
DYNAMIC RANGE IN dB AS CALCULATED FROM TEST7
TRIO 9130: 62dB ICOM 290E: 73dB YAESU FT480R: 66dB

DYNAMIC RANGE IN dB AS CALCULATED FROM TEST12
TRIO 9130: 80dB ICOM 290E: 73dB YAESU FT480R: 83dB

DYNAMIC RANGE IN dB AS CALCULATED FROM TEST13
TRIO 9130: 60dB ICOM 290E: 52dB YAESU FT480R: 57dB

Block diagram: Yaesu FT-480R





Rearview: Trio 9130

There is nothing more frustrating than having one of these sealed units go dead on you. But having said this, I look forward to the days when manufacturers make 10W or 25W drive modules more readily available to the general market.

Operating impressions

The first obvious difference when switching on the rigs, is in the type of display. The Icom display consists of five large 7-segment LEDS, Trio has five large green LEDS and Yaesu a 9-digit blue phosphorescent package. Being wary of the problems with reading various types of display under strong sunlight and knowing that one of Trio's claimed improvements on the 9130 over the 9000 was the display colour, I checked this out. The results were: Icom terrible, hardly visible; Trio, not much better (think again chaps!); Yaesu, best of the three. Having nine digits on the 480R took quite some getting used to however, and perhaps this is a case of too much information being presented to the operator.

Listening tests seemed to show that all three rigs performed about equally as far as sensitivity was concerned, on both FM and SSB. However, they were very different when one takes into account ease of listening. On strong signals, both FM and SSB, the only difference is in the general audio tone, this ranging from a rather richer tone on the 290E to a more reedy tone on the 9130. Now preferences on this characteristic will be totally subjective, of course, just as the position of the tone controls on your hi-fi, but when this affects the intelligibility it is a rather different matter. Under weak signal or noisy environmental (mobile) conditions, I found the 9130 and 480R both excellent but the 290E was practically impossible to use. When carrying out tests with weak sideband stations (reports 4-1) it was necessary to change to either the 9130 or 480R to make any sense of the signal. A partial cure for this poor audio quality on the 290E was found and consisted of turning the set upside down and opening the case! Perhaps with an external speaker or even a changed internal one, many of these criticisms could be ignored. Quite fortuitously, while testing the rigs a very strong aurora occurred. Great fun was had with both the 480R and 9130 but, after initial attempts, the 290E was swtiched off and pushed to the back of the bench! Another rather disconcerting feature of the 290E is the fact that on FM the squelch does not completely mute the audio. As I sit writing this in an otherwise quiet room, waiting for a local sked, I can hear weak stations breaking through causing initial confusion as to where the sounds were coming from!

On the subject of squelch, the 290E and 9130 both have this facility on SSB and CW. I suppose that this could be considered useful to reduce noise on local sideband contacts, although I didn't take advantage of this as local contacts are more easily made on FM, horizontally polarised especially. The 9130 goes one step further in this craze for redundant features and provides an RF gain control. Possibly the only real use for this is if you operate under crowded contest conditions, where the weaker QRM could be eliminated. However I found it more of a nuisance than a boon especially as the knob was concentric with the receiver incremental tune (RIT) control and could easily be knocked off maximum gain.

Both the 480R and 290E employ an LED S/power meter whereas the 9130 has the more conventional moving coil meter. While I see the point in LED meters as far as ruggedness is concerned, I found them most unresponsive with weaker signals. For example, a S2 on the 9130 gave no indication on the other two meters even though they all agreed at S7 to '40 over 9'. Which one can you believe? (Moral: watch out for all those signal reports!)

Reports

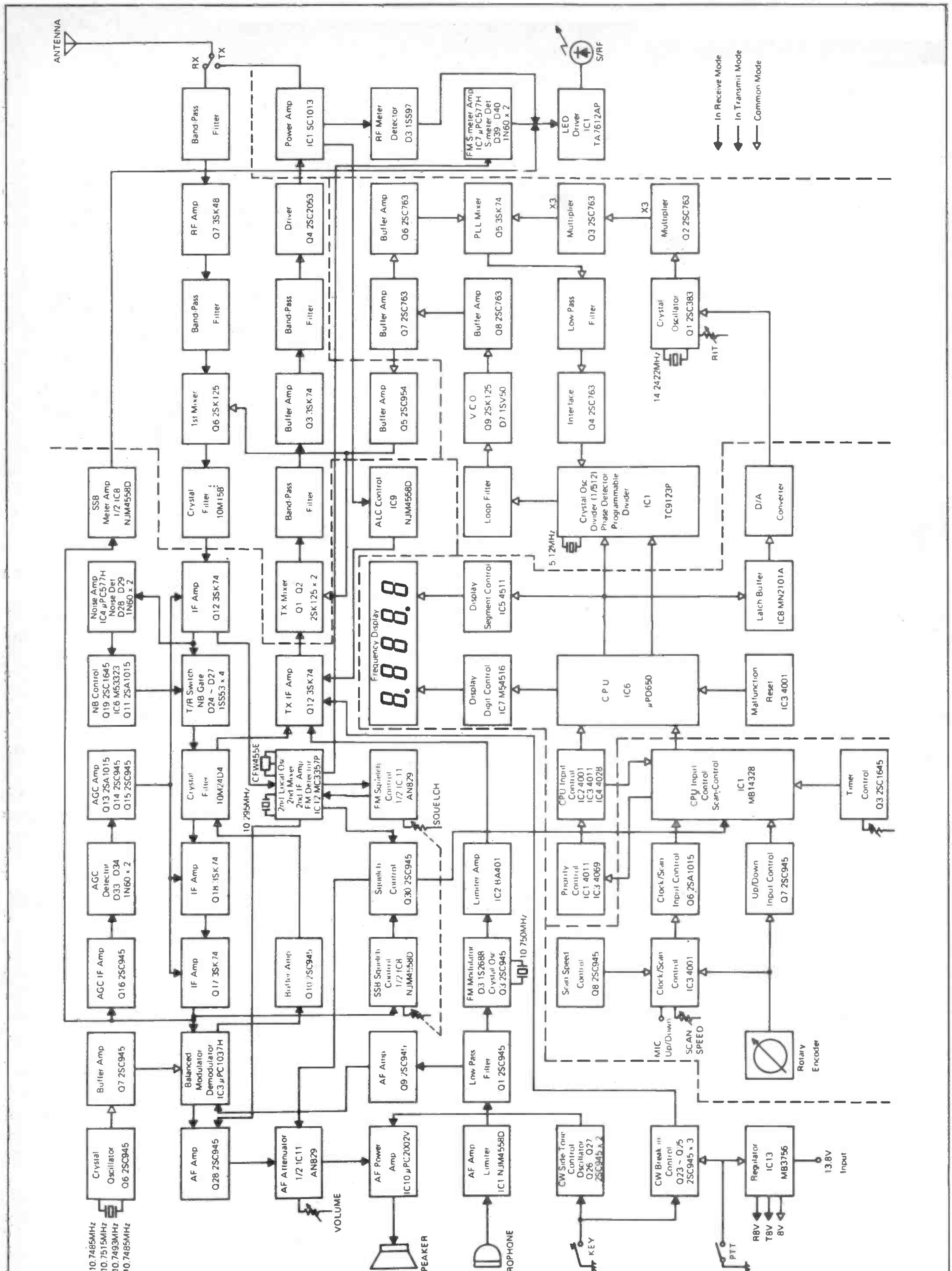
Before transmitting, the low power setting on the 9130 was adjusted to 10W (see circuit description) so that a fair comparison could be made. The extra 15W of power on both FM and SSB is an obvious bonus with the 9130. Reports received were of very good audio from all three rigs with nice clean RF on both FM and SSB. Close as they were, the ranking seems to be: the 480R has slightly more 'top' and therefore is rather easier to read when the signal strength is low (both FM and SSB), the 9130 on FM is better than the 290E but the opposite is true on SSB where the 9130 is rather 'bassy' and a little difficult to pick out (however, switching to 25W is the obvious solution to obtain best readability). The flexibility of 0 to 25W (assuming you perform the modification for SSB low power) seems to make the 9130 an excellent choice for the ardent QRP operator

Each equipment tested as follows: RECEIVE MODE: signal source adjusted for 5kHz deviation. F mod 1kHz. Test No ?	Trio TR9130
1) Set equipment to FM: test dial calibration at 145MHz	−663Hz
2) Set generator level for 12dB s+n to n at 145 MHz: record level	0.24uV emf
3) Set generator level for 12dB s+n to n at 144 MHz: record level	0.24uV emf
4) Set generator level for 12dB s+n to n at 145.975: record level	0.28uV emf
5) Connect 50 ohm dummy load to antenna: record any spurious signals across tuning range of equipment	none
6) Set equipment to 145MHz: couple two generators through a combiner: adjust one for 20dB s+n to n: tune second generator to 145.250 MHz CW and increase signal to level which creates a 1dB degradation in signal to noise ratio at 145MHz: record the levels of both generators	0.63uV emf @ 145MHz 35.5mV emf @ 145.25MHz
7) As for test 6: tune second generator to 145.025MHz, 5kHz deviation: increase level of generator 2 until a 1dB degradation in signal to noise ratio occurs or adjacent channel breakthrough becomes evident with CW on generator one: record the levels of both generators	0.63uV emf @ 145MHz 0.8mV emf @ 145.025MHz
8) Set equipment to 145MHz: sweep a 1mV signal (into 50 ohms) from 450 kHz slowly through to 200MHz: record and quantify any responses	none
9) Set equipment to SSB (USB): test dial calibration at 145MHz	−640Hz
10) Set CW generator level for 12dB s+n to n at 145MHz: record level	0.7uV emf
11) Connect 50 ohm dummy load to antenna input: record any spurious signals across tuning range of equipment	none
12) Set equipment to 145MHz; couple two generators through a combiner: adjust CW signal level for 20dB s+n to n with one generator: set other generator to 145.05MHz and increase level of this CW signal until signal to noise ratio is degraded by 1dB: record the level of both generators	1.8uV emf @ 145MHz 20mV emf @ 145.05MHz
13) As for test 12 but set second generator to 145.006MHz	1.8uV emf @ 145MHz 2.0mV emf @ 145.006MHz
14) Set equipment to 145MHz: sweep a 1mV signal (into 50 ohms) from 450kHz slowly through to 200MHz: record and quantify any unscheduled responses	none
TRANSMIT MODE: Supply voltage 13.8V unless otherwise stated, antenna socket connected to 50 ohm dummy load.	
15) Set equipment to FM: test dial calibration at 145MHz	−663Hz
16) Measure power output	22w
17) Measure power output at 12V supply voltage	18.5w
18) Record and quantify any spurious emissions in output spectrum	none
19) Set equipment to SSB (USB): connect two-tone generator to microphone input and increase the level of two equal tones until the PEP output reaches the level designated in the manufacturer's specification: record the level of intermodulation products in the output spectrum	3rd order 32dB below tones 5th order 35dB below tones
20) As for test 19 but increase the level of both equal tones by 14dB: record PEP output level	20w
21) As for test 20: Record intermodulation products	3rd order 18dB below tones 5th order 36dB below tones
22) As for test 19: adjust level of two equal tones to produce an output corresponding to 6dB below the rated output level: record results as per test 19	3rd order 30dB below tones 5th order 36dB below tones
23) Check transmit operation for sensitivity to high VSWR on output, look for any instability at 3:1 VSWR, single tone full output	No instability at 3:1 VSWR
24) Operate for 10 seconds at infinite VSWR (short and open circuit on output): Check for satisfactory operation following this test.	Satisfactory

RESULTS

ICOM IC-290-E	YAESU FT-480R	OUR OBSERVATIONS
+80Hz	−450Hz	
0.28uV emf	0.28uV emf	Tests 2 to 4 measure the practical maximum sensitivity at the band centre and its edges. There is nothing to choose between any of the sets in the FM mode; the overall result is no better than average.
0.28uV emf	0.36uV emf	
0.24uV emf	0.28uV emf	
none	none	
0.36uV emf@ 145 MHz 18.0mV emf @ 145.25MHz	0.56uV emf @ 145MHz 14.0mV emf @ 145.25MHz	This represents the dynamic range of the receiver sections in FM mode. Refer to **Table one** for the actual figure expressed in dB. They are all very good.
0.35uV emf @ 145MHz 1.6mV emf @ 145.025MHz	0.56uV emf @145MHz 1.2mV emf @ 145.025MHz	This represents the adjacent channel rejection. Refer to **Table one** for dB values. The Trio and Yaesu are really not too good in this respect. The Icom comes out as having a very good all round FM performance. However this is not true of the same set operating in SSB mode.
none	none	
+80Hz	−450Hz	
0.7uV emf	0.22uV emf	Receiver sensitivity in SSB mode. Both the Trio and the Icom are shown to be poor. There is no apparent reason why this should be so though.
none	none	
0.7uV emf @ 145MHz 3.5mV emf @ 145.05MHz	0.56uV emf @ 145MHz 8.0mV emf @ 145.05MHz	The dynamic range of each set in the SSB mode. Refer to **Table one**. The performance of the Yaesu and Trio sets is adequate given the conditions on the 2m band. However the performance of the Icom could pose a problem in some circumstances. For instance, some de-sensing could be experienced when a number of people are all trying to use the same crowded hill top at the same time.
0.7uV emf @ 145MHz 0.3mV emf @ 145.006MHz	0.56uV emf @ 145MHz 0.4mV emf @ 145.006MHz	This represents the adjacent channel performance when receiving SSB. Refer to **Table one**. The performance is not really adequate for a typical field day — the Icom comes out particularly badly in this respect. However you would probably have little trouble in the typical domestic situation where the RF population is much lower.
none	none	
+80Hz	−450Hz	
10w	9.5w	The Trio and Yaesu sets do not meet the manufacturers' specifications when determining FM power output, even at 13.8V supply. However a station at the receiving end would not notice the shortfall.
10w	9w	
none	none	
3rd order 28dB below tones 5th order 46dB below tones	3rd order 24dB below tones 5th order 23dB below tones	Trio set could not produce output power in accordance with manufacturer's specification. We suspect the review sample.
15w	12w	This test causes the sets to develop the maximum sideband power of which they are capable. In practice it simulates shouting into the mic.
3rd order 14dB below tones 5th order 30dB below tones	3rd order 22dB below tones 5th order 23dB below tones	These are the intermod products associated with test 20. The Trio and Icom 3rd order products look poor but a further 6dB should be added to each to ascertain the true level of intermod products below the maximum PEP output level. Thus the Icom set would normally be quoted as having an intermod performance of −20dB below maximum output, a tolerable level.
3rd order 38dB below tones 5th order 40dB below tones	3rd order 14dB below tones 5th order 23dB below tones	This test represents the intermod performance at the quarter power level. The Yaesu performance is very poor suggesting that the bias circuitry in the review sample required adjustment.
No instability at 3:1 VSWR	No instability at 3:1 VSWR	
Satisfactory	Satisfactory	

Notes:
1. Audio tones used 1100Hz, 1700Hz
2. Test equipment used (TF 1066B C101 23
3. 2 signal generators type Marconi (TF2006 C101 37)
4. Spectrum Analyser type HP8554B C121 35
5. R F Voltmeter Racal 9301A C105 25
6. 100w dummy load Bird 6151 C108 15
7. 100w 30db attenuator Bird 8321 C112 27
8. Counter R.F. Racal 9839 C102 26
9. 2 Tone A F generator Dymar 1745 C104 24



Block diagram: Icom IC290E

or the 'Sunday afternoon hilltop/P' jaunt where 100W linears would make restarting your car a source of physical exercise. Also the easily varied power would mean that one could drive any of the currently available linears if one should so desire it (yes, I do like working QRP).

Bells and whistles

The general impression one gets nowadays is that the manufacturers have got the RF side pretty well sewn up. All three rigs were practically inseparable in performance, their main differences lying in their synthesiser 'frills'. With the advent of the digitally synthesised VFO, the door was opened to the control of functions by microprocessors. However, this technology is still in its infancy when applied to transceivers and the various manufacturers are avidly vying with each other to produce more and more sales gimmicks. *(I couldn't agree more — Ed)*. I look forward to the rig that boasts a Z80 or 6502 chip along with programs strored in ROM or EPROM which can be either factory or user programmed. After all, not everyone wants the same functions, and interests often change at a later date (witness the number of 'mods' which proliferate in skeds, user clubs, magazines etc). With this in mind, I tackled the 'ease of operation' section of this review with trepidation. So what does one get for £350 odd? On the face of it all the desirable functions appear on all three rigs (dual VFO, repeater shift, up/down stepping, RIT (clarify) scanning and memories), but apart from the names, all similarity ends!

A/B VFO

On the 480R, VFOB is for receive only and when in this position pushing the PTT will transmit on the frequency set by VFOA. Using this feature allows for odd repeat shifts, eg 1.6MHz when used with a 70cm transverter, but for sideband operation there is effectively only one VFO. The 290E does have two separate VFOs and they can be used independently but problems then arise with using the memories and repeater shift, for example. In all the time I had the 290E for review, I still could not work out the logic of the VFO and VFO/memory functions! The manual doesn't help a lot in this area and I quote just one short paragraph from the two pages devoted to this combination:

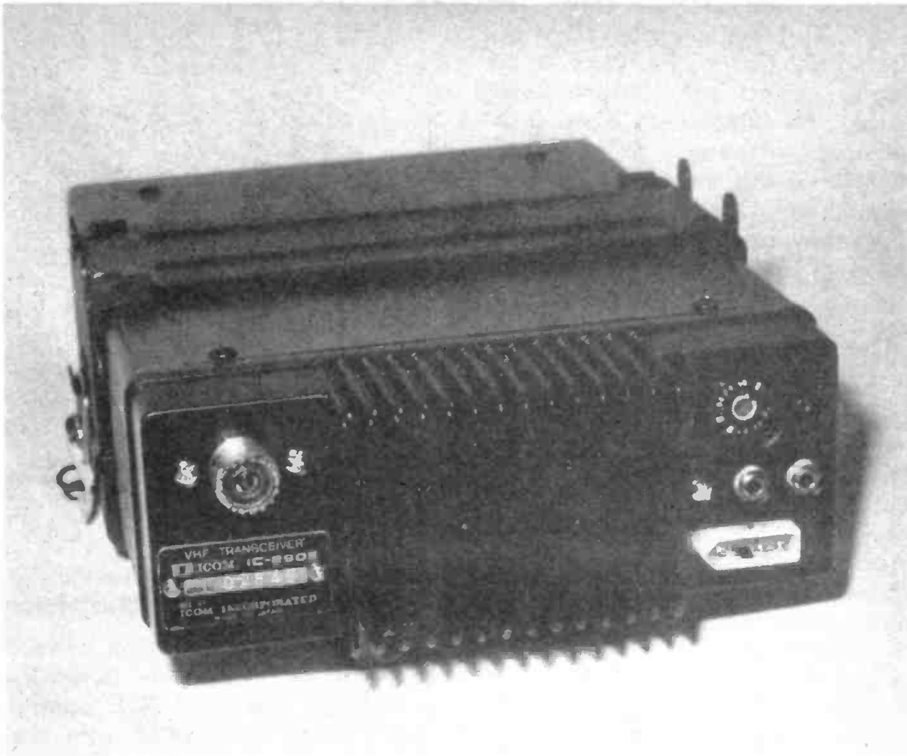
"When 'A' VFO is 144.255.5MHz and 'B' VFO is 144.355.0MHz, pushing the VFO switch to select 'B' VFO, then the MEMORY/VFO WRITE button, 'B' VFO's frequency becomes the same as 'A' VFO's (144.255.5MHz). Now the 'A' VFO's frequency is memorized in the 'B' VFO, and you can operate anywhere with 'A' VFO or 'B' VFO. When you want to return to the previous frequency (144.255.5MHz), switch back to the other VFO. To reverse this (A the same as B), select 'A' VFO first, then push the MEMORY/VFO WRITE button".

The manual goes on like this for about six pages. The 9130 on the other hand is simplicity itself with the two VFOs behaving totally independently and consistently.

One of the most desireable features, to my mind, especially on SSB is the ability to 'quick QSY' up or down, along with quick changes from SSB to FM and back again, for example, when checking channels. The three rigs behave very differently as far as this is concerned.

The FT 480R has frequency steps of 25kHz, 5kHz and 1kHz on FM and 1kHz, 100Hz and 10Hz (clarify) on SSB/CW, all selected by a single 3-way rotary control. If you wish to change frequency steps or mode (eg from SSB to FM), the VFO continues in the new step length from the old frequency. This can be a little disconcerting when you find yourself on 145.502.4MHz, FM mode. However, there is an F-set button which restores the correct base frequency (145.502.4MHz reverts to 145.500 MHz on FM with 25kHz steps). This button naturally gets a lot of use, so it seems strange that it should be placed in the middle of a long line of similar-looking controls, and it's very small. It is even more fun trying to find it when mobile! Quick QSYs on SSB can be a little awkward with only 1kHz steps but one soon becomes adept at switching to FM, QSYing in 25kHz steps, switching back to SSB and then continuing (tricky but effective!). I found the 'Clarify' function not very easy to use. It operates in the 10kHz step position with the main tuning dial acting as control and, although you have infinite control (not limited to ±800Hz, for example), there is no indication of the 10 Hz steps on the display, so you could be ±90Hz without knowing it. Furthermore, if any adjustment is made to the main dial tuning, all clarify information is lost on return to the original frequency.

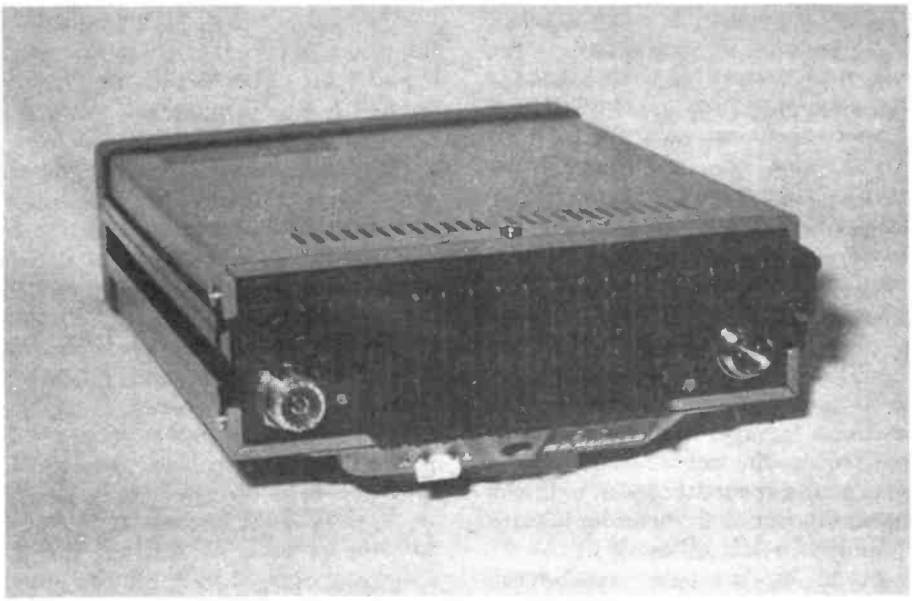
The 9130 synthesiser steps are 25kHz (FMI), 12½kHz, 1kHz (FM2)



Rearview: Icom IC290E

on FM and 5kHz, 100Hz on SSB/CW. These are selected by the digital step (DS) button which, to my mind, is placed just a little too close to the main dial and could be knocked inadvertently. A problem/ feature of the DS button is that, when the step length is changed, the frequency reverts automatically to the next lowest base frequency for that step. This can be awkward if you quickly want to check on another frequency and then go back to the first one. I found the 5kHz step on SSB very useful for quick scanning and except under exceptional circumstances (contests, aurora, big lifts etc when stations can be very close packed), 5kHz seems the maximum step length one can use without missing stations on the band. 1kHz steps can be achieved by pressing the scan button and this makes for a very versatile set of features. RIT on the 9130 is performed by a separate control giving ±800Hz and the only problem here is in forgetting to reset it to zero when returning at the end of a QSO.

The synthesiser on the 290E is enough to baffle anyone and with frequency steps of 25kHz and 1kHz on FM and 1kHz and 100Hz on SSB/CW one is very limited. Quick QSYs are very difficult to make and the inclusion of shifts to the centre frequency for each mode makes switching FM/SSB etc very tedious. The displayed frequencies (assuming f for frequency in FM mode) are: for CW, f−700Hz; for USB, f−1.5kHz; for LSB, f+1.5kHz. This, coupled with the fact that there is no way to reset to the correct base frequency for a particular mode, means that switching to, say, FM could leave you on 145.505.6MHz with no way to get back to 145.500MHz except by switching back to SSB on the 100Hz step length, going down to 145.505MHz, changing to the 1kHz step length, going down to 145.500MHz and then switching back to FM to continue. If you are prone to setting up horizontal FM skeds on SSB, warn the other guy to hang on for a few minutes! Here is another case where VFOs A and B do no seem to behave in the same way but please don't ask me to explain. I give up at this point and you'll have to try it for yourself (there must be some logic in there somewhere). The RIT operates in much the same way as the 9130's, having a separate control, however, the absence of any indicator to warn you when RIT is switched in is very annoying. Also the RIT control itself, being concentric with the volume control, can cause problems. *(Most of the time the features mentioned here are totally irrelevant. This applies to all three transceivers — Ed.)*



Rearview: Yaesu FT-480R

Using repeaters

Repeater operation on the 480R is marred by the absence of a direct 'listen on the input' facility, although one could program the input frequency into one of the memories (fiddly to do when mobile.) The repeater shift is set at ±600kHz by one of the nasty switches on the underside of the rig. Odd shifts can be catered for by VFO 'B' but the auto tone burst is accessed by another of the underside switches (I lost count of the number of times I worked simplex with the tone burst on).

On the 9130 a 'listen on the input' button, labelled REV, is available, non-standard frequency shifts can be catered for by Memory 6 (which is standard Trio practice) and the auto tone burst can be switched in easily (note the improvement over the Trio 9000).

At first sight, the 290E has no 'listen on the input' facility but I discovered that once the repeater shift is switched in, the WRITE button does give this facility (where's the logic there?) Non-standard frequency shifts can be programmed using the OFFSET WRITE button and the default value is ±600kHz. One major failing is the lack of auto tone burst. The only way to access the repeater is to press a front panel button on the rig and then to operate the PTT on the mic for audio (shades of the IC2E?). Having to operate the rig button for tone burst on each over could make mobile operation very 'interesting'. Another problem with the 290E is that, unlike the other two rigs, the repeater shift is *not* cancelled in SSB or CW mode.

Memories and scanning

Entering frequencies into the six memories of the 9130 is a single button operation, with memory recall and memory scan facilities equally easy to use. The major criticism is the very limited memory scan facility, where it stops on busy channels only, but I believe that Lowe Electronics have a mod for improving this. A novel feature is the use of a piezo-electric transducer which gives bleeps on certain button pressings and is particularly useful for warning the operator when frequency storage in memory 6 is attempted. A second pressing of the 'M' button shuts it up if you wish to use memory 6 as a simplex memory. Although this 'bleeper' is a nice touch, it can't be heard in a noisy environment.

The four memories on the 480R are equally easy to programme and when memories are recalled the memory number appears on the display. An added feature of the 'priority channel' is that the dial frequency will be momentarily replaced by the selected memory frequency every five seconds. Memory scan is possible either manually from the microphone up/down switches or automatically, where there is a choice of stopping on either clear or busy frequencies.

On the 290E only VFO 'A' can be used to write frequencies in the five memories but entry of them is fairly straightforward. Memory scanning is particularly versatile and can operate in many ways (stop on busy/clear, pause then continue, etc). However, many of the controls for these features are inside the rig and require the top to be removed to change the speed of scanning or the function. Such a versatile feature shouldn't be locked away.

All three rigs retain their memory frequencies when switched off but still connected to the power supply but the 9130 has space on board for a PP3-type Ni-cad (not supplied) to retain information when disconnected eg while transferring from base station to mobile use. Band scanning facilities are provided on all the rigs, the most versatile being the 290E, with its hidden switches for programming, and a full or limited band scan available between the frequencies set in memory 1 and memory 2. The 480R has auto/manual full band scan (stop on busy or clear) which is accessible from the microphone also. The 9130 however, has its scan facility limited to 1MHz ie covering either 144-145MHz or 145-146MHz depending on the frequency from which the scan started. In the SSB mode, the 9130 scan can only be used manually, for auto-scan is useless as it stops where the squelch is open. (The squelch will always be open on SSB unless looking for a very local station).

One a final point concerning the digital side of things, I was rather concerned by the three slips of paper packed with the 290E warning about the possibility of 'lock up' if the power was momentarily interrupted. Of course, I had to try this out! Sure enough, both the 290E and 480R tended to lock up in a most obscure manner when supply interruptions occurred. The restart procedure I found most effective was to switch off, wait, switch on and then start again (annoying but not serious). The 9130 however, does not exhibit this little foible.

Conclusions

In summary therefore, I found the three rigs very similar as far as performance was concerned, with the exception of the terrible audio quality of the 290E. The 480R and the 9130 were a pleasure to operate with the 9130 being possibly rather more straightforward but the 480R being a little more versatile. I did *not* enjoy operating the 290E but perhaps given a year or two I could come to love it. When assessing price against the ease of operation and performance, I feel that the 9130 comes out on top due to its 25W of RF, but if this doesn't concern you (ie linears are available) then the 480R is fine. ●

PRICES: Trio 9130, £395
Icom IC290E, £366
Yaesu FT-480R £379

Thanks to Thanet (Icom) and Ham International (Yaesu) for loan of review equipment.

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