# HAM RADIO TODAY

AN ARGUS SPECIALIST PUBLICATION JUNE 1987 £1.30

## TWO METRE MINI MONITOR

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REVIEWS ● 2m 'EXPLORER', LINEAR ● G-WHIP HF MULTIBAND ANTENNA ● TH215 VHF HANDIE ● A 'FUN' TRANSMITTER FOR 20 ● HAVE YOU EVER BEEN /MM? ● AERIAL MANOEUVRES—A SALUTORY TALE ● TECHNOLOGY ROUNDUP—VMOS ●

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# ON AIR IN THE AIR


***Do you know where to look for aviation users of the airwaves? Brian Kendal, G3GDU, throws a few pointers.***

Ever since the 27th August 1910 when the Canadian aviator, J.D.R. McCurdy circled Sheepshead Bay Racetrack, New York and transmitted a radio signal to his colleague Harry Horton on the ground, radio communication has assumed an ever increasing importance in flight safety. In commercial aviation today, radio communication is used to control all air traffic and with one exception (Inertial Navigation System), radio aids are the sole means of navigation for aircraft.

The frequencies used vary from a few kiloherz to several thousand megaherz, but before describing the systems it would be useful to see how air traffic movements are managed.

## Management of air traffic

The first division of airspace is into flight information regions (FIRs), which are defined geographical areas under the juridisction of a single air traffic control centre (ATCC).

The FIRs are, in turn, divided into several types of airspace eg: danger areas, prohibited airspace, uncontrolled and controlled airspace.

Within the uncontrolled airspace, aircraft may travel with little restriction except that at night or when flying in instrument meteorological conditions (IMC), the altitude at which the pilot flies will be relate[d] to his track. In such circumstances however, it is entirely the pilot'[s] responsibility to keep a sharp lookou[t] and maintain separation from othe[r] aircraft.

Within controlled airspace, how-ever, the aircraft must previousl[y] inform the air traffic control authorit[y] of his intention to use the airspac[e] and, once having entered, fly at th[e] height, track and speed allocate[d] and must not digress withou[t] specific permission of that authority. To ensure that navigation is to th[e] required standard, specific radi[o] equipment must be carried and th[e] pilot must be suitably qualified.

In return, the air traffic contro[l] authority ensures that aircraft ar[e] separated in accordance with laid down minima and that their journey[s] are accomplished in an expeditiou[s] manner.

At first this may seem a[n] unnecessary restriction, but when i[t] is realised that there are in the orde[r] of a million aircraft movements [a] year over the United Kingdom alone the necessity of such contro[l] becomes evident.

## Controlled airspace

The basic form of controlled air-space is the airway which normall[y] connects major airports. Airways ar[e] corridors of airspace, ten nautica[l] miles wide and of defined vertica[l] extent. Their location is delineate[d] by VHF omni range beacons (VOR) and distance measuring equipmen[t] (DME) and/or non-directiona[l] beacons at either end and at inter-vals between.

The region where several air-ways converge, usually adjacent t[o] airports, is defined as a termina[l] movement area (TMA). On long hau[l] flights, such as trans-atlantic, it i[s] not possible to install VOR along th[e] whole route and in such circumstances the aircraft makes use of onboard navigational systems such as Omega, doppler radar or INS systems until another VOR can be received.

As an aircraft nears its destination, with the permission of the ATCC, it will leave the airway and contact the aerodrome approach control. Under their guidance and using various aids such as approach radar, instrument landing system or similar, the aircraft will be positioned for final approach.
When aligned for landing, control will be transferred to the tower controller who will monitor the final approach and landing. On leaving the runway, instructions for reaching the stand will be given either by the tower controller or a separate ground movements controller, depending on the size of the airport.

### Radio telephony

Possibly the most important aid to the safety of aircraft is the ability to speak directly to air traffic control. Depending on the size of the FIR, this may use either VHF AM or HF SSB. Within heavily populated areas, such as Europe or North America, the VHF aeromobile band is used exclusively. This depends from 118.00 MHz to 135.975 MHz using a 25 kHz channel spacing. All transmissions use amplitude modulation with vertical polarisation. Within this waveband are included: airways, approach, tower, ground movement, company and two types of broadcast frequencies. In general, the airport channels are towards the lower part, the airways and broadcast in the middle and the ground movement and company frequencies at the higher frequency end of the band.

There are two types of broadcast transmission, Volmet and ATIS. The former is a continuous transmission of meteorological information covering a number of airports. Perhaps the best known of these are the London Volmet South on 128.6 (covering the southern airports), London Volmet North on 126.6 covering the northern airports and London Volmet Main on 135.375 covering a number of UK and continental airports.

ATIS is an acronym for aerodrome terminal information service and continually broadcasts details concerning, for example, runway in use, altimeter pressure settings, operating restrictions, etc, for a specific airport. These transmissions may also be heard in the 112.0 to 117.9 MHz band where they are transmitted in conjunction with a VOR beacon.

Possibly the most surprising fact about aircraft VHF R/T communication is the very low power used. Aircraft equipment is normally synthesized to provide the full 720 channels and radiates a power of between five and 25 watts. The aircraft aerial is usually a quarter wave whip.

At the ground stations, the power is again in the five to 25 watt region, this time using dipole aerials. These are normally preferred to ground plan aerials, for common aerial working for several channels is standard. The use of dipoles allows good isolation to be obtained between vertically spaced transmitter and receiver aerials.

By amateur standards, the muting (squelch) level of the receivers is set to quite a high level, usually two to three microvolts (S8), for, due to the line-of-sight working conditions, signal strengths are normally high and such levels permit "armchair copy" on all received signals. Despite such restrictions, it is frequently possible to contact high altitude aircraft at distances well in excess of two hundred and fifty miles.

### HF use

In more remote areas, such as trans-ocean or across large areas of Africa, VHF has not sufficient range, especially for the lower flying aircraft. In such circumstances it is more practical to use HF SSB (upper sideband).

A number of different wavebands are allocated for HF aeromobile operation, these being at approximately 3, 5, 8, 11, 13, 17 and 21MHz, the frequency in use being selected in accordance with the time of day, distance to be worked and band conditions.

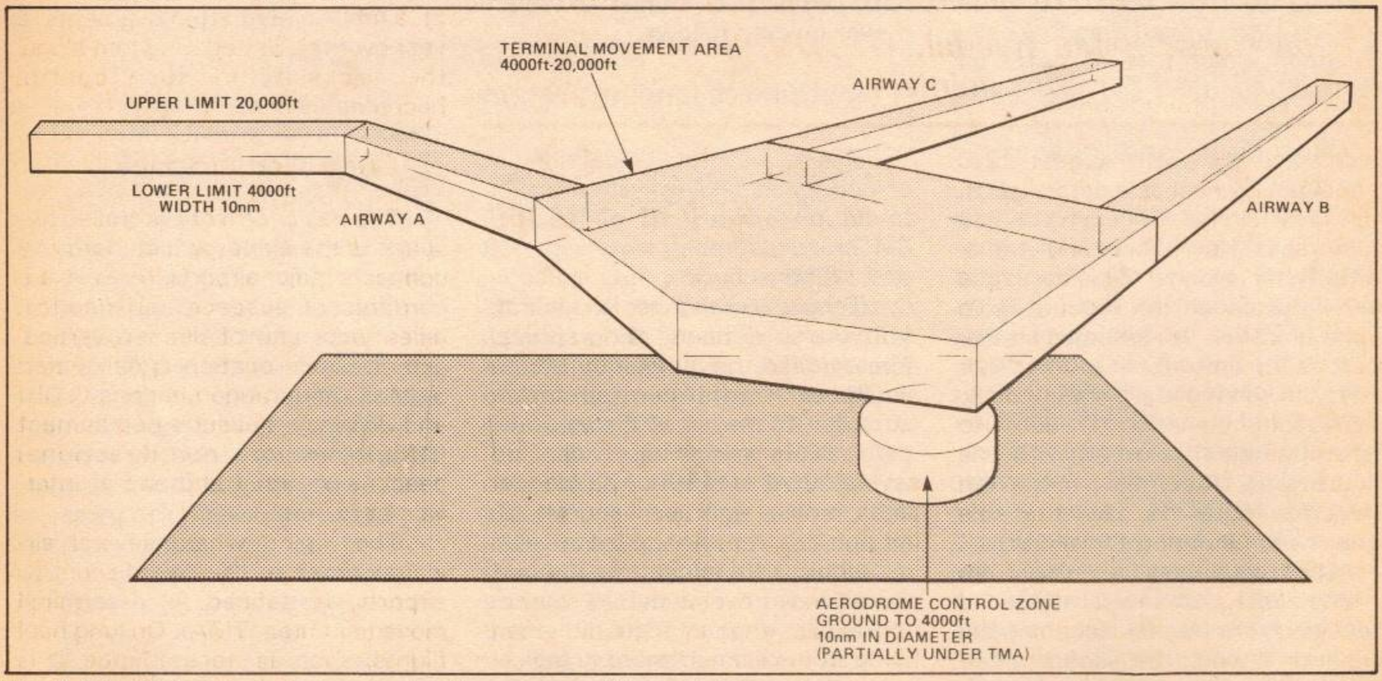
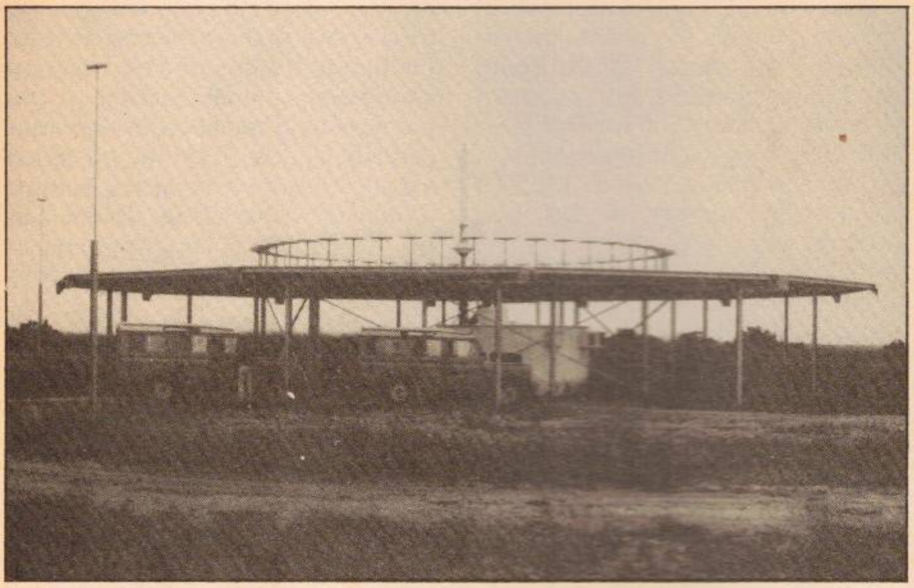


**Fig. 1 A typical pattern of airways showing upper and lower limits.**

The equipment for SSB operation is far more powerful than that for VHF. The normal power for the airborne installation is 400 watts PEP. The transceivers are remote controlled from the flight deck and are fully synthesised for operation from 2.0 to 30MHz.

The ground stations normally run between 1 and 5 kilowatts peak into wideband unipoles or dipoles. For reception, standard communications receivers are normally used but, in order to minimise cross-talk and intermodulation problems, the transmit and receive sites are usually separated by several miles. Volmet is also transmitted on HF, one of the loudest in the United Kingdom being Shannon which may be heard on: 3413, 5640, 8957 and 13264 kHz.



**A DVOR, which is a VOR using the Doppler principle to produce the FM on the sub-carrier. This beacon is located at Chileka airport, Blantyre, Malawi. (Photo courtesy the author).**

## Non-directional beacons

The simplest of the navigational aids is undoubtedly the non-directional beacon (NDB). These radiate a carrier on the MF band (250-500kHz) modulated at intervals by the call sign in morse code. They are located at airfields or along airways and are used in conjunction with the aircraft's automatic direction finding equipment. The power radiated by NDBs varies widely depending on their purpose. Airfield beacons usually radiate quite low power into relatively inefficient aerials, however, as the required range is normally only 10 to 15 miles, this is of little consequence. Airways beacons in Europe radiate up to about 200 watts but in the tropics, where static levels are high and a long range is required, powers up to several kilowatts may be used.

The beacon band is very congested and the same frequency may be used by several, geographically separated, stations. The power radiated must therefore be carefully regulated to avoid mutual interference. For this reason, the signal strength of all beacons located in the United Kingdom are monitored by the Civil Aviation Authority's radio measuring station near Rugby and if any are found to exceed the specified level a request to reduce power quickly follows.

## Instrument landing system

The azimuth guidance element of instrument landing system is to be found immediately HF of the VHF FM broadcast band between 108 and 112MHz.

This transmission is radiated from the up-wind end of the runway. The carrier is modulated by 90 and 150Hz such that if the approaching aircraft is to the left of the approach path 90Hz modulation will predominate whilst 150Hz will predominate to the right. On course, the modulation depth of both tones will be equal. In the aircraft equipment, the audio from the received signal is applied to 90 and 150Hz filters and the outputs are compared to give an indication of the diversion of the aircraft from the correct course alignment.

The vertical element of ILS operates on approximately 330MHz and is similar in operation except in this case 90Hz Predominates above the glide path and 150Hz below.

There are two method of indicating and distance from the runway: marker beacons and distance measuring equipment (DME).

The marker beacons are low power transmitters located under the approach path at distances of approximately four miles and three quarters of a mile from the runway threshold.

These radiate a vertical 'fan' beam on 75MHz such that each will only be heard for a few seconds as the aircraft passes overhead. The modulation of each is distinctive and, as well as being heard on the crew headphones, the modulation is frequently arranged to light an indicator lamp on the instrument panel.

More recently, many airports have now installed distance measuring equipment which gives a continuous reading of "distance to run" on the approach path.

The integrity of modern instrument landing system installations is such that when the receivers in the aircraft are coupled to a suitable flight director system, fully automatic landing can be safely achieved in visibility as low as 100 metres.

## VHF omni range beacons (VOR)

When associated with distance measuring equipment (DME), VOR is the international standard short range navigational aid and as such is used to delineate airways and also as an identification beacon and approach aid for airports.

The principle of operation is that two independent 30Hz modulations are impressed on a VHF ground station transmission in the 112.0 to 117.9MHz band. These two modulations are known as the reference and variable phases and their difference in phase, measured in degrees, as received at any remote station, corresponds to the bearing of that station with respect to magnetic north.

The variable phase is a 30Hz amplitude modulation whilst the

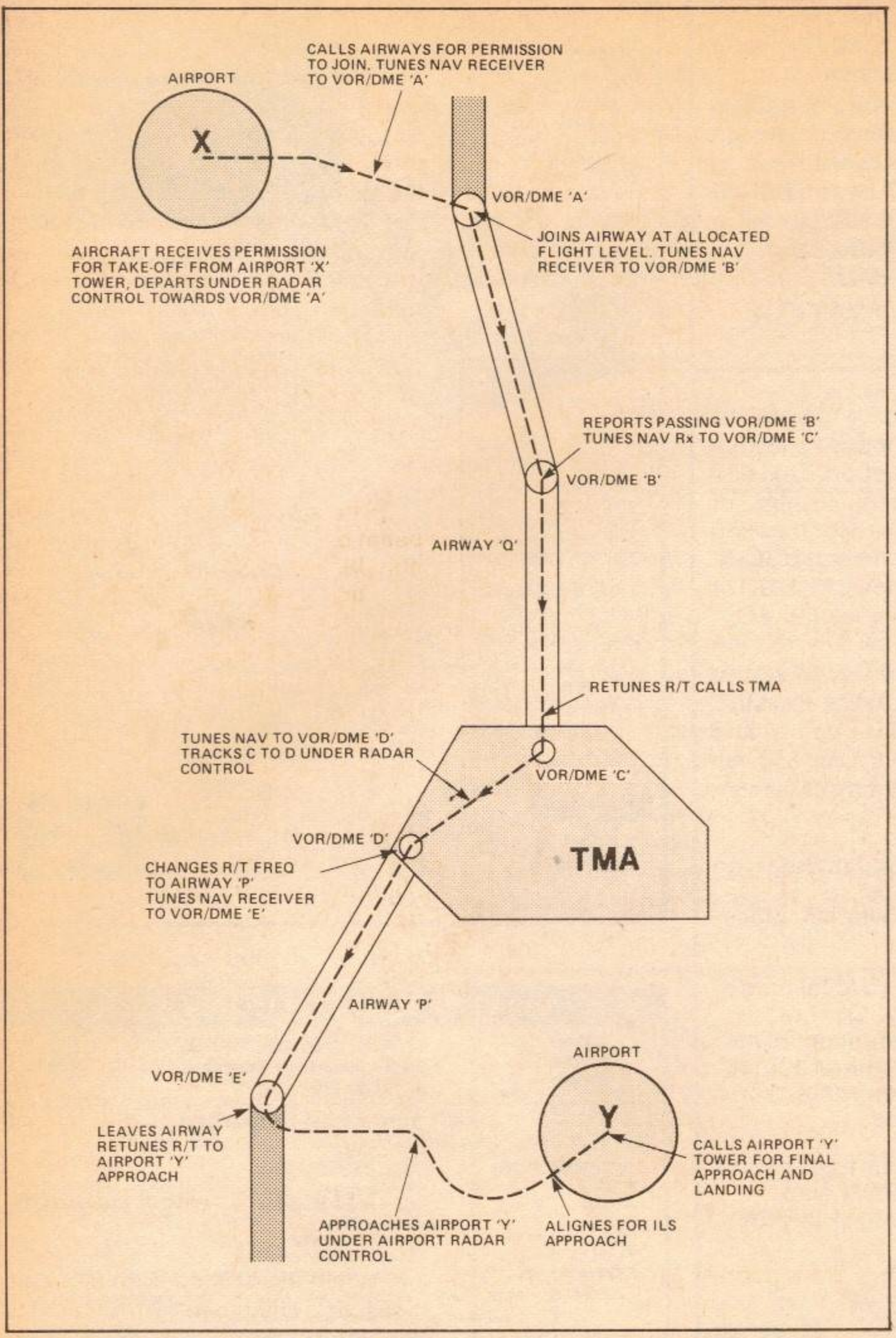



**Fig. 2 Use of radio during a short flight. In this time, six R/T frequencies, five VOR/DME installations and three different radar stations have been used.**

reference phase comprises a 30Hz frequency modulation impressed on a 9960Hz amplitude modulated sub-carrier.

The total modulation depth due to the reference and variable phases does not total 100%, thus it is possible to include a further audio channel. This may be used for a morse identification or alternately an ATIS broadcast.

## Distance measuring equipment (DME)

Whilst VOR provides an accurate bearing from a ground station, DME provides the distance from that station and thus permits the pilot to determine his position. Unlike the aids so far mentioned, DME is a form of secondary radar and uses pulse techniques. The aircraft interrogates the ground beacon by transmitting a series of pairs of pulses. On receiving a pulse pair from the aircraft, the DME beacon waits for 50 microseconds and then radiates a pulse pair on a frequency 63MHz removed from the interrogator frequency.

This transmission is received by the aircraft and from the time interval between initiating interrogation and reception of the reply, and allowing for the 50 microsecond delay, the equipment calculates the distance from the beacon.

DME interrogations are on 160 channels between 1025 to 1150MHz with replies 63MHz either above or below, this being selected by the spacing of the interrogating pulse pair.

In recent years, in addition to operating in conjunction with VOR, DME has also been used with ILS.

In this instance, the ground equipment is located in either the azimuth or glide slope transmitter building and the 50 microsecond delay is altered so that the aircraft receiver will indicate zero distance at the threshold of the operational runway.

## Ground radar

Radar is hardly a signal which can be listened to, however from time to time, and particularly on the 23cm band, some cross modulation interference may be experienced from this source.

There are two types of radar, primary and secondary. The former utilizes the direct reflection of the radar pulse from the aircraft whilst the latter relies on the transmitted pulse chain being received by the aircraft equipment and triggering an appropriate answer. This provides such information as aircraft identification, height, etc.

More important from the amateur point of view, however, is the relative power of the two types of transmission. Primary radar equipment transmits with peak powers of up to several megawatts radiated from aerials of 30dB gain or more.

Secondary surveillance radar need far lower power, 1kW being about average, with an aerial gain of about 23 dB.

## Conclusion

Of all the modes of transport in use in the world today, commercial aviation relies on radio aids and communications more than any other. Without their assistance it would be impossible to sustain present levels of air traffic without totally unacceptable risk of collision or other accidents.

# DXing from the Minquiers

*Martin Atherton, G3ZAY, visits the unprenouncables*

Where is the most southerly land in the British Isles? The Scillies? The Channel Islands? You're getting warm because the most southerly islands are the Minquiers (pronounced Minkies) roughly halfway between Jersey and France, 12 miles south of St Helier. Because of their position they were claimed by France for many years until in 1956 the International Court at the Hague awarded them to Jersey.

At high tide only about a dozen small islands are visible but at low tide the sea falls away to reveal 100 sq. miles of sand, rock, and shingle. The islands are not usually inhabited but the largest one — Maitresse Ile — has about 20 stone cottages and a helicopter landing pad.

The cottages, built by fishermen in the 18th century, lay derelict for over a hundred years but the majority have recently been restored by their Jersey owners. One is an official customs house and is left open and provisioned as a refuge for shipwrecked sailors lucky enough to get ashore. The helicopter pad was constructed jointly by the French and British governments to facilitate air-sea rescue work in the area.

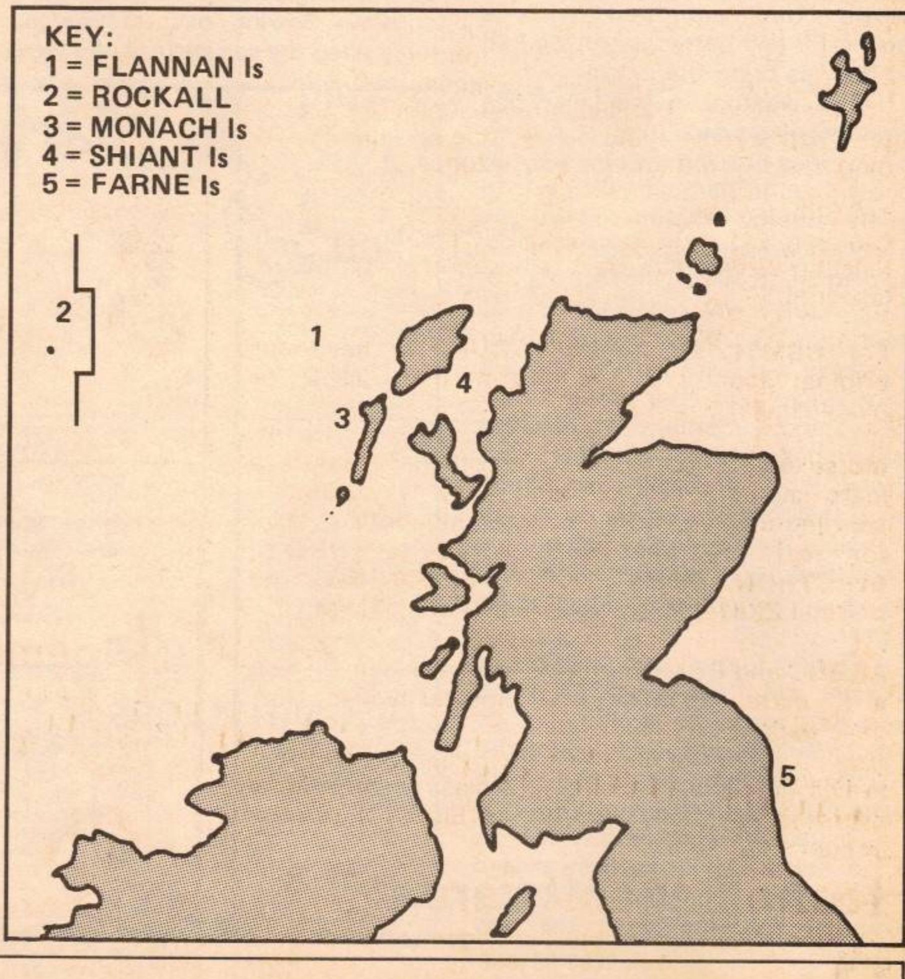
If the islands sound familiar, it may be because they were featured in a recent episode of 'Bergerac' and are the setting for much of the action in Hammond Innes's novel 'The Wreck of the Mary Deare'.

So much for the general knowledge lesson, but why should anyone want to operate an amateur radio station there? The answer can be summed up in one word — IOTA; the acronym for the Islands On The Air Award, developed and administered for many years by Geoff Watts (a leading British SWL and founder of the DX News Sheet) and recently taken over by Roger Balister G3KMA on behalf of the RSGB.

In order to qualify for one of the IOTA awards you have to contact a certain number of islands (see inset for details) from a master list published by the Awards Manager. The Minquiers had been on the list for many years but had never been activated and I decided it was about time they were tackled.

The main problem is that the islands are extremely difficult to reach. The approach involves precision navigation through narrow channels against powerful currents generated by the 35 foot tidal rise and fall. The channels are marked only by 'beacons' (painted pillars and posts) on the rocks, and different pairs of beacons have to be kept visually in line at different stages of the approach. Definitely not a place for a novice sailor. Only one man was listed at the harbour office as being willing to take tourists out to the islands: Mike, the local lifeboat coxswain.

With Dennis, GJ3YHU, who was also interested in putting the Minquiers on the air, I made arrangements for a day trip one Saturday in July and Dennis covered most of the charter costs for Mike's boat by selling tickets to local residents who wanted to visit these remote bits of Jersey. Flying out on a weekend package deal, with my



trusty TS120 transceiver in a waterproofed suitcase, I met the rest of the group on the quayside at St Helier just as the tide was starting to ebb.

### Tidal Trials

The recommended procedure for visiting the Minquiers is to arrive when the tide is half-way down and leave six hours later when it is half-way up. This seemed rather strange at first. Wouldn't you want as much water over the rocks as possible? Mike explained that since the final transfer to land would be by rubber dingly it was necessary to let the surrounding rocks emerge from the sea to form a natural harbour. A landing at high tide would be impossible in anything except a flat calm. Departing from St Helier just after high tide would ensure that we arrived at just the right time as the voyage would take about two hours.

Apart from my TS120 we had a second HF transceiver on loan from SMC (Jersey), a 20m dipole, and a multiband vertical. Power, we hoped, would not be a problem as we had been given permission to operate from one of the cottages which its owner had equipped with a generator and batteries. All we had to do was bring the petrol.

The weather on the quayside that morning was not good. A brisk breeze was flapping the pennants on the yachts in harbour while out to sea a fair crop of white horses was visible. Nevertheless, Mike decided to give it a go and 'Tamalou' his 30' cabin cruiser roared away from its moorings. Outside the harbour progress was very slow in the 6-8 foot waves and after about a mile Mike reluctantly made the decision to turn back. The conditions, he said, meant that if anything went wrong with the boat there'd be no safety margin and he'd have to call out his own lifeboat to rescue us! A very disappointed group returned to St Helier.

During August and September Dennis and I kept watch on the weather forecasts waiting for a sustained anti-cyclone to guarantee a period of light winds and calm seas. Nothing materialised. We made preliminary arrangements with Mike on several occasions but they always had to be cancelled when the weather deteriorated at the last minute. The Minquiers were beginning to seem impossible.

### And Then Again . . .

The last chance in 1985 came at the end of October when I planned to be in Jersey with a number of other operators for the annual CQ World-Wide SSB contest. Mike was in the process of selling 'Tamalou' but was able to introduce us to Frank, the owner of the well equipped cottage on Maitresse Ile which we had hoped to operate from during the summer.

It turned out that Frank had already been plannng to visit the islands during the contest weekend and immediately invited us all to join him for an overnight stay. Unfortunately, the need to keep the contest station (GJ6UW) on the air for 48 hours meant that only two of us could be spared; myself and Don, G3XTT.

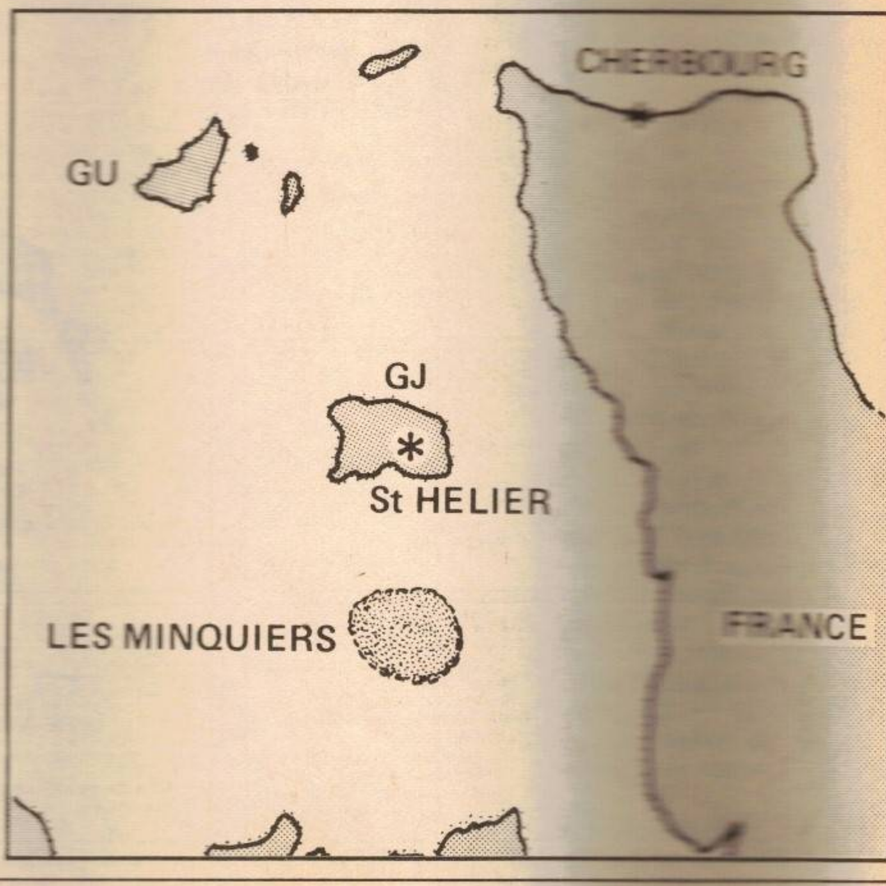
The weather was kind to us this time and the sea was almost a flat calm for the crossing. The final approach to the islands was every bit as dodgy as the books claimed and in several areas the boat appeared to be steaming up or downhill as strong currents flowing over submerged reefs tilted the sea surface. We were thankful that Frank's normal job was as a pilot in Jersey harbour.

We had rather less equipment with us this time as the contest station had first claim on what was available. My TS120, some inverted vee dipoles, and a 25 foot portable mast made up the entire station.

### Dry And Running

As a result we were ashore quickly and within half an hour of landing the mast had been assembled from its 5' sections and GJ3ZAK/P was active on 80m. The only difficulty had been finding enough space to stretch out the 80m antenna, the QTH being rather close to the end of the island. Fortunately it seemed to work reasonably well with the final 20' wrapped round a boulder so there was no need to go swimming in search of a more distant support! The generator at the cottage had started easily and was float charging the batteries as we operated.

Despite the contest QRM there was a steady stream of callers, many having been alerted by announcements on the DX News Sheet voice message system (01-725-7373). During the evening, operation moved to 40 & 20 metres



and the performance of the station comfortably exceeded our expectations. The inverted vees were only 25′ off the ground but their height above the surrounding sea varied from 50 to 85 feet as the tide went in and out. In 14 hours of operation, these simple antennas produced QSOs with all continents, Australasia being represented by New Zealand on 40m CW.

Only having one rig meant that the off-duty operator had plenty of time to explore the island, and with Frank as guide there was plenty to see. Although the cottages are left locked and shuttered when not in use, the owners have copies of their neighbours' keys and Frank was able to get into most of the buildings. One of the most interesting, owned by a shipyard in St Helier, was a single-storey affair which had been converted into a pub; complete with dartboard, emergency beer supplies, and even a piano!

Sunday morning was departure time and our desire to operate for as long as possible almost left us stranded. The tide was going down fast as we packed up the gear and hurled it into the rubber dinghy, and the boat got clear of the anchorage with only inches of water to spare as it crossed the reef. It had been an enjoyable but short expedition which had satisfied several hundred IOTA enthusiasts. Our host had been astonished by the ease with which an amateur transceiver smaller than his VHF marine unit had pushed a signal around the world, and may yet be a convert to the hobby.

If anyone else fancies an IOTA "first" the following British island groups have yet to be activated: the Flannan Is, Shiant Is, Monach Is, Rockall, and Farne Is. How about it readers?

## RSGB Islands On The Air Programme — IOTA

The IOTA Programme consists of 15 separate awards:

| | |
|---|---|
| IOTA Century Club 100 | (IOTA-CC-100) |
| IOTA Century Club 200 | (IOTA-CC-200) |
| IOTA Century Club 300 | (IOTA-CC-300) |
| IOTA Century Club 400 | (IOTA-CC-400) |
| IOTA World Diploma | (IOTA-WW) |
| IOTA Arctic Islands | (IOTA-AI) |
| IOTA British Isles | (IOTA-BI) |
| IOTA West Indies | (IOTA-WI) |
| IOTA Africa | (IOTA-AF) |
| IOTA Antarctica | (IOTA-AN) |
| IOTA Asia | (IOTA-AS) |
| IOTA Europe | (IOTA-EU) |
| IOTA North America | (IOTA-NA) |
| IOTA Oceania | (IOTA-OC) |
| IOTA South America | (IOTA-SA) |

The QSL requirements are as follows:

**IOTA-CC-100:** Any 100 activated islands/groups appearing in the Directory, including at least one from each of the seven continents.
**IOTA-CC-200/300/400:** Any 200/300/400 activated islands/groups.
**Each Continental Award:** 75% of the activated islands/groups in that continent OR 75 islands whichever is the less.
**IOTA-AI, IOTA-BI, IOTA-WI:** 75% of the activated islands/groups in those areas.
**IOTA-WW:** 50% of the activated islands/groups in each of the seven continents.

Activated islands/groups are those from which amateur operation has taken place and which have a reference number in the current Directory at the time of application.

An "Honour Roll" listing scores above 100 islands appears quarterly in DX News Sheet.

Copies of the current Directory may be obtained from the IOTA Awards Manager, G3KMA, (QTHR) at £1.50 inc. postage.

# HEATHERLITE EXPLORER VHF LINEAR

*Looking to beef up on 2m? Chris Lorek, G4HCL, has been flexing 400W of muscle.*

In days of old, when amateurs were bold, they built their own 4CX250B linear amplifiers if they wanted to run QRO on 2m. They had little choice but to build from scratch, as the Japanese hadn't got any available off the shelf!

As HT potentials of kilovolts were involved, many amateurs were, and understandably still are, reluctant to start 'playing around' with such things unless they were either foolhardy or very experienced. I must confess to having stored all the bits for a twin 4CX250B 2m linear and lately a 5CX1500A HF linear for several years before deciding not to build them up for this very reason; one forgetful slip could be fatal, and death lasts for a long time. An amateur workmate, professionally qualified to degree level in electronics, still has bodily scars from such an accident showing it could happen to anyone.

Although a homebrew amplifier similar in outline to the 2m Explorer but made from 'rally-bought' components could be constructed at a fraction of the cost, it is little wonder there is a thriving market for such commercially made equipment. Needless to say, I was extremely pleased to be offered the first UK review sample to test for the readers of HRT, of both the 2m Explorer and the complimentary HF Explorer, the latter to be reported on in a future issue.

## Features

The amplifier operates over 144 to 146MHz, and gives a conservatively advertised 400W PEP RF output on SSB. The unit is offered with a choice of output valves, these being the 4CX250B and the 4CX350A, with corresponding amplifier prices of £535 and £575 respectively. A built-in power supply is fitted, this generates the 2000V HT, grid bias supplies, heater, and associated control circuitry voltages. The front panel houses controls for mains power on/off, operate/standby, anode tune, and meter controls. These switch the indication between anode current, screen grid current, and relative RF output, the latter using a small meter sensitivity knob. LEDs indicate mains power on (ready), amplifier switched into Tx (on air), and warning of control grid current being drawn (grid current).

Amplifier frontal view

Round the back panel is a preset control for bias adjustment, together with SO239 (UHF) sockets for connection to your transceiver and aerial system, a phono socket for PTT control, IEC mains socket, and a 6.3A internal mains fuse holder. A short circuit applied to the phono PTT socket is required on transmit to place the amplifier in circuit. Internal relays provide either a straight through connection, or an optional BF981 preamplifier, in the receive path. There is no provision for gain adjustment or ALC output to cope with variation of drive power, the amplifiers are individually hand built but with slight variation of input damping resistor value to suit the customer's requirements.

The unit measures 330mm(W) x 360mm(D) x 170mm(H), and weighs a heavy 17kg. The front panel is a brown hard baked epoxy finished aluminium with engraved bold lettering, the remainder of the chassis being made from steel with a hard-wearing beige paint finish. A mains lead and PTT switching lead are provided, together with a well-written user manual giving details on operation, valve changing, and a full circuit diagram. The review amplifier supplied was the 4CX350A version.

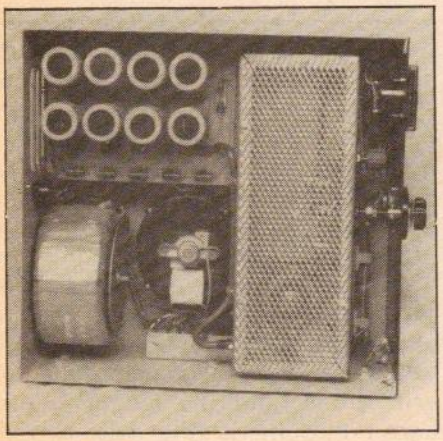
### Valve advantages

For linear amplifiers running above around 200W, valves offer a more cost-effective solution coupled with better linearity than their transistor counterparts. Possibly more importantly for amateur purposes, they are far more tolerant to abuse, be this caused by over-running them to squeeze the last possible watt of output, or simply using an aerial system that suddenly develops an unexpected SWR problem. The former often occurs in practice when working DX, whilst the latter happens if one puts too much metalwork in the air and the wind starts blowing!

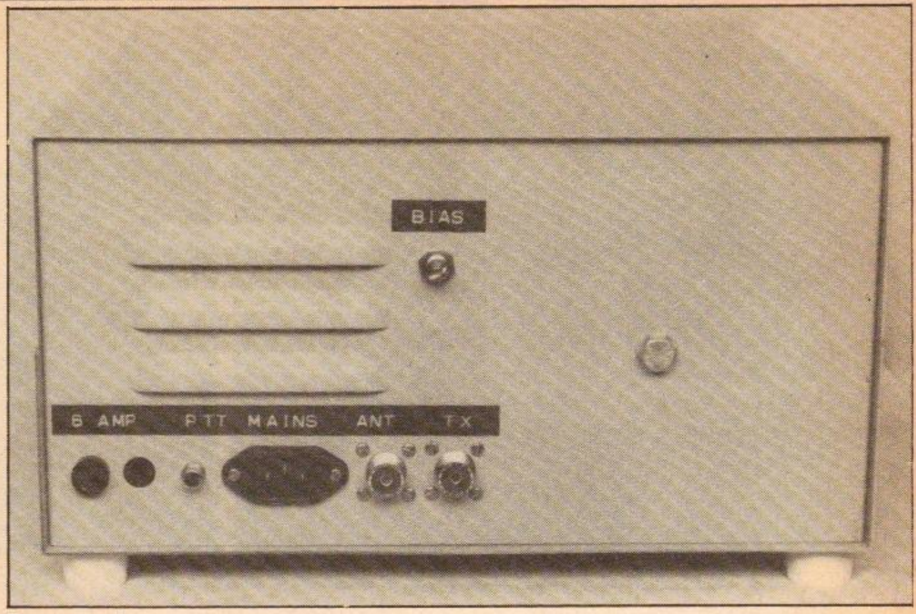
Where economy is needed together with resistance from abuse, the valve still reigns supreme in amateur high power service. No doubt this was bourne in mind by Heatherlite Products in their initial design stages, the result being in my opinion a good value amplifier, especially when one takes into account the cost and performance of a solid state equivalent complete with its high current power supply (typically around £570 for 200W PEP capability). The 4CX250B offers reasonable output linearity coupled with 250W anode dissipation, the 4CX350A gives slightly better linearity and 350W dissipation which would be more suitable for contest use and the like.

### Circuitry

The accompanying diagram **(Fig. 1)** shows the circuit of the RF section. The RF input is passed via



**Internal top view**




**Rear panel**

the input relay and inductively coupled to a tuned circuit at the control grid, this also being swamped by a large wattage resistance to RF ground via a decoupling capacitor. This swamping resistance removes the need for external RF stabilization. The anode tuned circuit is a large aluminium stripline, tuned to resonance with a large air-spaced capacitor linked to the slow motion dial on the front panel. An inductive output link tuned by a series load capacitor couples the amplified RF output to the silver-plated coax switching relay, in turn connected to the output socket. This is a well-proven design, similar but not identical to the 8930 tetrode 144MHz linear in the 1987 ARRL handbook.

A toroidal power transformer generates the HT and greater voltages, a voltage doubler being used in the case of HT rectification and smoothing. Although toroidal transformers are normally more expensive than the usual closed-core type, they offer the advantage of smaller size (hence lighter weight) per watt and far less stray magnetic field. The external voltage doubler reduces the possibility of HT flashover and hence shorted turns in the transformer secondary.

Smaller closed-core transformers are use to supply the two grid potentials and 12V for the relay controls. The screen grid is bridge rectified and well smoothed but is not stabilized, this is of little consequence due to the small change in screen current drawn. An LED is parallelled with the bias potentiometer, this is placed in line with the control grid supply to effectively warn of grid current. The

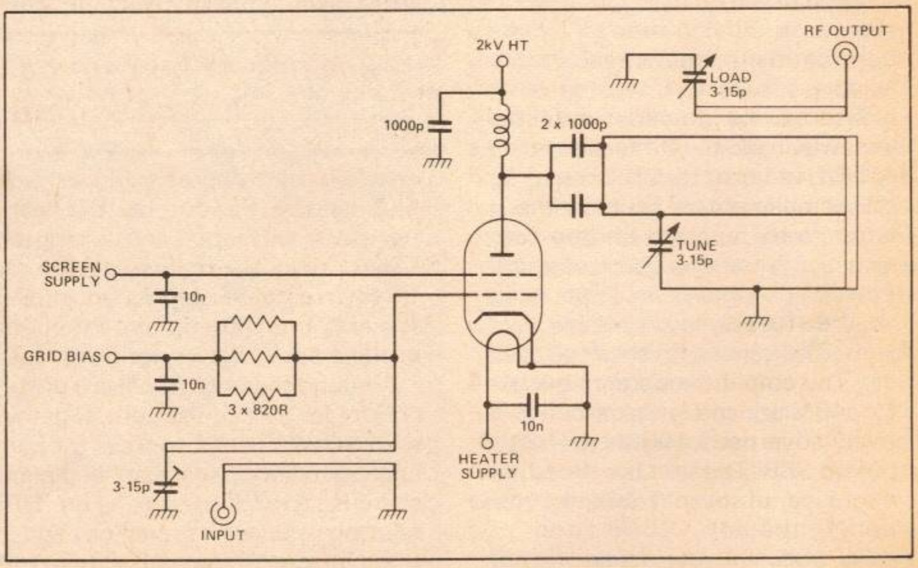
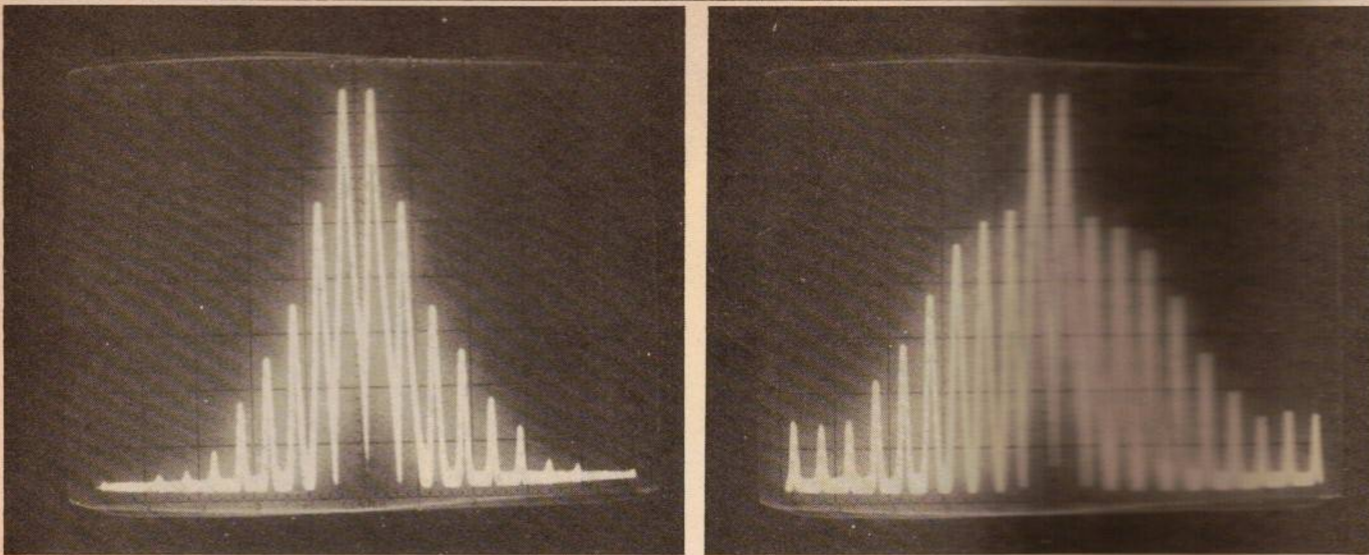



**Fig. 1 Circuit of output stage.**



**5W input drive signal (left) and corresponding 416W output (horizontal scale 200Hz/div, vertical 10dB/div)**

anode and screen currents are indicated by the large front panel meter. RF output indication is performed by a high resistance tap from the output connector, the RF is then rectified and fed via the 'RF set' potentiometer to the metering circuitry.

A 1A fuse protects the anode HT supply from excessive current being drawn; if the HT fails the screen grid would effectively act as an anode and draw excessive current, so this is protected by an 80mA fuse. High-wattage high-value resistors between screen grid supply and ground protect the valve against negative screen grid current. There is no HT safety interlock to protect you against electrocuting yourself by opening the case with the HT on; the manufacturer advises waiting three minutes before opening the lids following switch off, and I found the HT reduced down quite adequately within this time.

## First impressions

The review amplifier was delivered by personal messenger, I think he was glad that I carried it in, as it certainly is very big and heavy! This is mainly due to the heavy-duty power supply and large blower, immediately giving one the impression that it isn't just a toy, it means 'real power'. The general finish of the case gives it a rugged, hardwearing look, although this is often typical of many British made products for the radio amateur which lack the brushed chrome and shiny knobs of far eastern imports.

On switching it on, I was pleased to find that the fan was very quiet indeed considering its size, and the air intake is at the base with the outlet at the rear, better than using the case sides which would create more noticeable turbulance in typical use. The amplifier valve is reasonably protected from damage through fault conditions, such as HT or bias supply loss, however it is not protected against mis-use such as gross overdriving or use without adequate 'warm-up time'. The lack of amplifier gain adjustment or ALC confirms that the unit is geared at the amateur who knows what he is doing (ie how to use the power control on his rig), and the manufacturer has indeed informed me that no-one has blown one up — yet!

## On the air

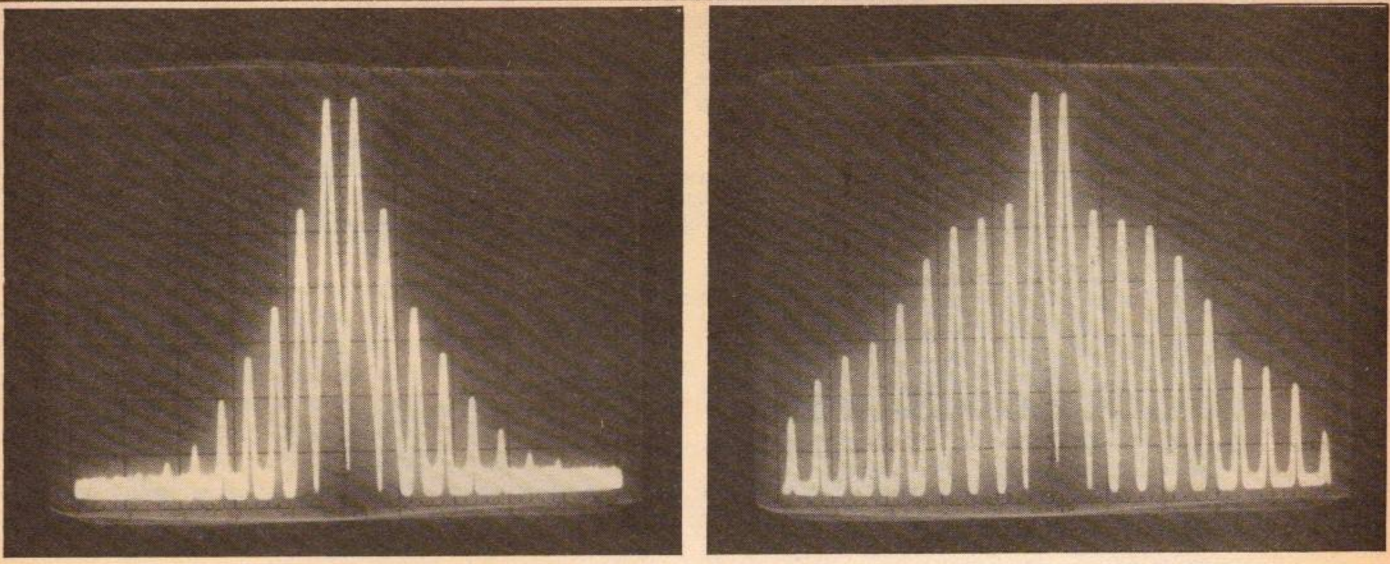
Living on a small housing estate, the ugly possibility of TVI was a worry, so a small colour portable complete with set top aerial was placed right on top of the amplifier, and plugged into the same mains outlet strip. On sending out a test transmission at full power, not even a glimmer of TVI was evident! So instead a supply of 'How to Improve Television and Radio Reception' booklets were kept handy, together with my trusty homemade stock of 2m coax notch filters, to dish out to the neighbours when the doorbell rang (I used to run high power many years ago!). Combined with a demonstration in the shack of TVI-proof operation this normally sends one's neighbours back to their TV dealer demanding to know why their set is picking up things it should'nt do!

Joking apart, if you're going to run this sort of power, make very sure that your own house is in order, otherwise you'll be extremely unpopular. The Heatherlite amplifier passed this rigorous test at my QTH with flying colours, showing there was good case screening and mains filtering as well as freedom from spurious outputs.

Now then, I thought, let's see what can be worked on 2m from Cambridgeshire, pity conditions are flat. There's a weak GW calling CQ, I'll give him a shout to see if he can hear me ... no problem, instant QSO! Yes it certainly was pushing the power out, when asking for signal difference reports with the amplifier switched in, a typical report was S4 changing to S9+20dB, on weaker signals the difference was from complete readability to no trace whatsoever of a signal.

On working a relatively local station, a professional radio engineer of long standing (G3SEP, now retired, he used to be my boss at work!) who often kindly helps me with tests giving honest reports, no extra spreading of signal was noticed when switching the amplifier in line. This was also confirmed by several other stations, showing that non-linearities in the output signal were clearly limited by the cleanliness of the driver rig rather than effects caused by the amplifier.

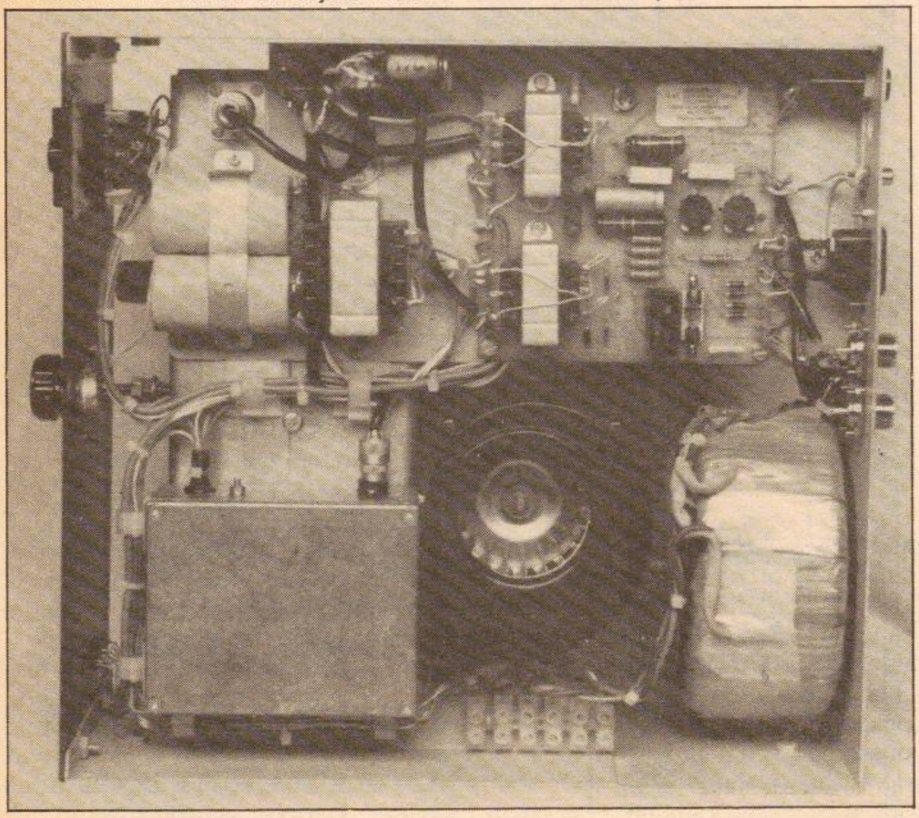
Tuning the amplifier for maximum output on change of frequency was a simple one-knob affair, this was done with the slow-motion vernier calibrated dial on the front panel. I found it unnecessary to retune over the 144.15—144.45MHz



10W input drive signal (left) and corresponding 490W output (same scale)

when initially tuned at 144.30, there being less than 0.5dB reduction in output level at the extremes. The accurate calibration of this control however made tune-up a once-only affair, as it was possible to keep a record of the setting required for each band segment, and to pre-tune to this when making a large shift in frequency. The 'load' variable capacitor was internally adjustable, this is set by the manufacturer to match into a 50 ohm load. I found this accurately matched my Heliax feeder/Tonna beam aerial system, and did not need further adjustment.

I gave the amplifier a final 'thrashing', during the early March 2m/70cm contest, to see how it would perform under high duty-cycle use combined with heavy speech processing to increase the demands somewhat. Without calling CQ, in one hour G, GI, GW, F, PA, DL, and ON were worked (with three German stations in 7 minutes on a band all and sundry were complaining of poor conditions on!). After several hours, a well filled logbook, no angry neighbours at the door, and an amplifier still running cool and quiet, I was most impressed.

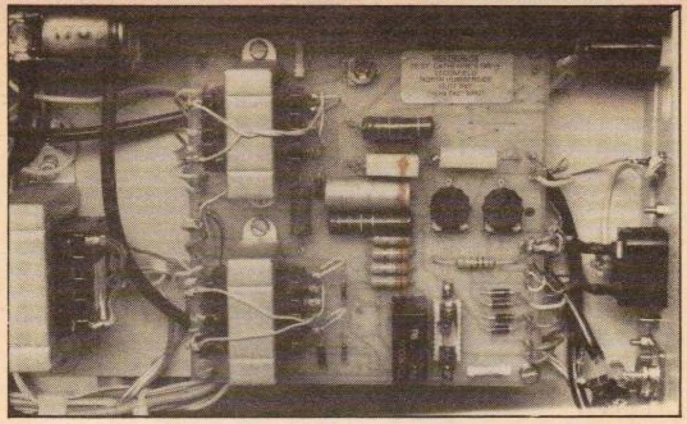


Internal underside view

## Laboratory tests

The amplifier was first tested with constant carrier input to simulate FM usage, with the bias set to achieve standing currents of 80mA as recommended (class ABI) and 10mA (nearer class C to increase efficiency). As would be expected, the gain was higher with 10mA but of course non-linear, the gain starting to compress in both cases at around the 4W input level. The UK power limit on FM/CW is 20dBW (100W) at the aerial, the amplifier in both cases loafs along at this level, hence I would not feel the need to change this in use.

After the expected HT voltage drop with takeup of standing current, there was very little variation with change of power output, this would give good linearity in practice and confirms that the amplifier has been constructed with an ample margin in hand. The input VSWR measured at slightly less than 2:1 at 10W input drive, this reduced slightly with less input drive and certainly should not cause any problems to drive transceivers. The through loss of 0.15dB was extremely good, and the SWR presented when switched straight through was less then 1.05:1, which is excellent. The output harmonic levels were generally reasonable, the 2nd harmonic was a bit high but radiation of this would in practice be attenuated due to the high impedance presented by a typical 2m aerial at this frequency. Beware however the 5th harmonic at UHF TV channels 52 and 53, a simple double stub notch filter would attenuate these by a further 40dB or



**Amplifer control PCB**

so in practice, this shouldn't in practice be needed unless you live in one of the areas served by these channels and would probably have already experienced the problem.

Two-tone tests were carried out by using a pair of signal generators into a hybrid combiner, driving a 10W linear amplifier to 2W and then driving a 50W linear amplifier to up to 15W maximum, attempting to ensure a relatively clean driver signal. A calibrated HP thermistor bolometer power meter and calibrated RF attenuators and spectrum analyser were used for measurement purposes. In all cases, the output intermodulation products were quite reasonable, with very rapid fall-off of the high-order products at lower output levels. At 416W PEP output, corresponding to 5W PEP drive, the low-orders (those near to the centre of the signal) had started to come up due to gain compression, but did not grossly rise with even 10W PEP input.

Comparing the achieved results with Eimac's claimed typical performance for the 4CX350A in their valve catalogue and 'Care and feeding of power grid tubes' applications book show the performances to closely match. Deliberately overdriving the amplifier with 15W PEP, where grid current was *just* starting to be drawn, showed that it would happily give just under 700W output! Here we can see that the amplifier is gaining the maximum possible out of the valve used, and the advertised output power of 400W is conservatively rated, this being achieved with reasonable linearity rather than following the practice of grossly exaggerated figures sometimes claimed by amplifier manufacturers.

## Conclusions

The amplifier, in my opinion, has been designed to offer a very good RF performance combined with an economic price. There has been no skimping on the quality of internal components where these are required to provide good RF performance. The lack of 'idiot proofing' such a povey temperature protection I found unnecessary in use, the blower kept the valve exhaust very cool and the HT supply coped adequately. If however you continue operating with a bright red LED flashing away at you, then you should know that you're doing something wrong. However it is easily possible to accidentally transmit before the valve heater has had a chance to warm up, a time delay circuit has been allowed for on the control PCB and is due for incorporation by the manufacturer in the future where required.

Again, most amateurs who would run an amplifier such as this would be aware of how to use such things correctly, and the price I believe is very reasonable for those who are unable, or do not wish, to construct one themselves. I had great fun using the review sample, the manufacturers tried to get it back but failed, as I purchased it. This doesn't often happen, especially as I'm a keen 'homebrew' merchant, so need I say more?

*My thanks go to Mr. P. Rodmell of Heatherlite Products for the supply of the review sample.*

### Laboratory results

**Constant carrier power output: at 145MHz**

| PA standing current | RF output | |
|---|---|---|
| | 10W in | 15W in |
| 100nA | 274W | 296W |
| 90mA | 274W | 294W |
| 80mA | 270W | 292W |
| 70mA | 268W | 287W |
| 60mA | 263W | 283W |
| 50mA | 261W | 281W |
| 40mA | 256W | 274W |
| 30mA | 253W | 269W |
| 20mA | 245W | 263W |
| 10mA | 236W | 261W |

**Through loss (unkeyed): 0.15dB**

**Through SWR (unkeyed): Less than 1.05:1**

**Linearity, constant carrier: at 145MHz**

| Input | RF Output | | |
|---|---|---|---|
| | 10mA bias | 80mA bias | Anode current (80mA bias) |
| 1W | 26W | 125W | 265mA |
| 2W | 86W | 195W | 330mA |
| 3W | 161W | 217W | 340mA |
| 4W | 182W | 232W | 345mA |
| 5W | 194W | 240W | 350mA |
| 6W | 215W | 245W | |
| 7W | 221W | 252W | |
| 8W | 227W | 258W | |
| 9W | | 262W | |
| 10W | | 268W | 360mA |
| 11W | | 275W | |
| 12W | | 278W | |
| 13W | | 282W | |
| 14W | | 289W | |
| 15W | | 291W | |

SSB two-tone power output: Tested at 145MHZ with 100kHz spaced carriers.

| PEP input | Gain | PEP output |
|---|---|---|
| 1W | [illegible] | 123W |
| 2W | [illegible] | 214W |
| 3W | [illegible] | 295W |
| 4W | [illegible] | 365W |
| 5W | [illegible] | 416W |
| 10W | [illegible] | 480W |
| 15W | [illegible] | 585W |

Harmonic Output: Measured with 10W constant carrier drive power

| | |
|---|---|
| 2nd | [illegible] |
| 3rd | [illegible] |
| 4th | [illegible] |
| 5th | [illegible] |
| 6th | −71dBc |
| 7th | −73dBc |
| 8th | −74dBc |
| 9th | Less than [illegible] |

All other spurii less than [illegible]

HT voltage Drop: Measured with constant carrier input

| Input drive | HT voltage |
|---|---|
| 1W | [illegible] |
| 2W | [illegible] |
| 3W | [illegible] |
| 5W | [illegible] |
| 10W | [illegible] |
| 15W | [illegible] |

Unkeyed voltage [illegible]

# TECHNOLOGY ROUNDUP

***Ian Poole, G3YWX, explores what makes a VMOS FET better than a FET, other than the longer name.***

When VMOS FETs were introduced they revolutionised the use of semiconductors in RF power amplifier design. Previously this had been an area dominated by the bipolar transistor, but VMOS FETs out-performed them in many respects making the design and construction of RF power amplifiers much simpler, easier and cheaper. Since then VMOS devices have firmly established a place for themselves in the semiconductor market making them one of the success stories in the semiconductor industry.

## What is VMOS?

VMOS was able to overcome many of the problems which had previously prevented FETs from being extensively used in power applications. This was achieved by using a totally new structure within the device in which the current flowed vertically rather than horizontally, as in conventional FETs. This new vertical metal oxide semiconductor (hence the name VMOS) effectively provides two channels giving two paths for current flow and it enables much higher current densities to be achieved. Whilst employing this revolutionary advance in technology VMOS still retains the oxide layer between the gate and channel which means that it has all the advantages of high input impedance associated with the more standard MOS range of FETs.

In **Fig. 1** the basic VMOS structure can be seen. The source has two connections, one at either side of the V groove allowing for the maximum current carrying capacity. The gate consists of a metalised area over the oxide layer in the V groove and it controls the current flowing through both channels which are located in the P regions either side of the groove. In comparison to this the standard type of MOSFET structure has all the electrodes on the same surface and only one channel path. Although this type of structure is simpler it has a much lower current density and it is not suitable for power applications.

## The advantages of VMOS

The V groove structure is the key to the advantages which VMOS provides, and many of them are of particular interest to radio amateurs. The high current density this new type of structure provides enables it to handle much higher power levels than other FET devices making it useful in RF driver and power amp stages. Interestingly, this also leads to these FETs having low internal capacitances and in particular a low gate drain feedback capacitance. This means that they are quite stable when they are used at HF and VHF which makes design and construction of these circuits much easier. In addition to this, the fact that little stabilisation is required means that the efficiency of the circuit will be high — another bonus.

As well as all this VMOS devices are very robust. They have a high drain source breakdown voltage which means that they can be run with fairly high voltage rails, and they also have a good immunity to high VSWR levels. For example, a VSWR of 20:1 at any phase angle should not present any problems.

For those interested in high power levels several VMOS FETs can easily be run in parallel. Because heat causes the current consumption to fall they are

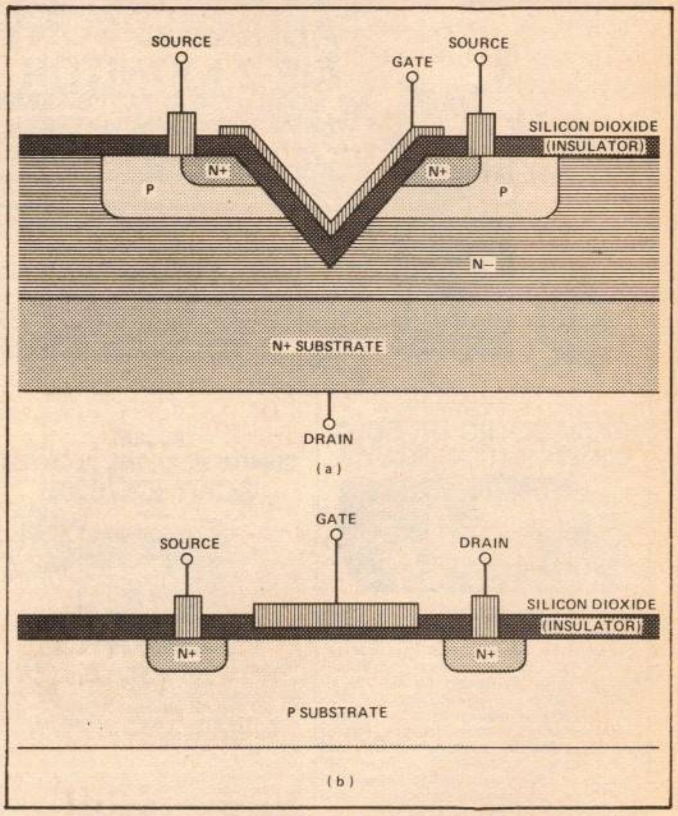



**Fig. 1 Comparison of VMOS and standard MOS FETs: (a) cross section through a VMOS channel; (b) cross section through a standard MOS channel.**

not only resistant to thermal runaway but will also share current between several devices without the need for external circuitry. The way in which this happens is quite simple. If one transistor were to take too much current it would heat up more than the others, and therefore its current consumption would tend to fall.

Finally, impedance matching using VMOS is far easier than for many other types of RF semiconductors because they present a constant input impedance regardless of the output conditions. Therefore once the input has been set up the output conditions can be varied without the need to readjust the input again.

### Actual devices

The two devices which are most widely used are the VN10 and VN66 in their various forms. They have become most popular with QRP operators as they are capable of handling power levels within the range of about 1 to 5 watts depending upon the device used. Many circuits of QRP transmitters using VMOS output amplifiers have been published and they have proved easy to build and use.

Despite what one may think these are not the only VMOS devices which are available and there is a whole range of them to fulfil a wide variety of applications. As well as single, discrete devices, they are available in quad arrays in the standard 14 pin dual in line IC package.

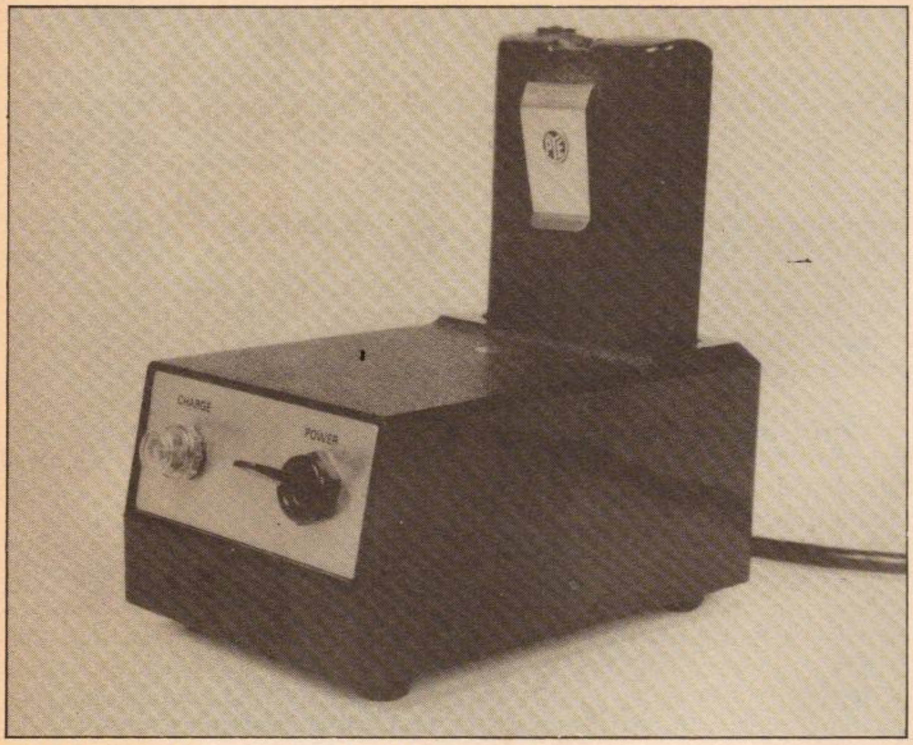
### The future

In addition to VMOS, which is made by Siliconix, there are now other similar power FET technologies which have been developed by other companies and which offer similar characteristics. Therefore we can expect to see power levels and frequency limits being increased together with falling prices. With these factors in mind we can look forward to seeing RF power FET s on the market in larger quantities as well as seeing higher power amplifiers which use them.

Which will be the first company to launch a transceiver with a high-power FET PA?

*' Modern devices are also easier to install . . . '*

# LOW COST VHF MONITOR



The Pager and accompanying charger unit.

***Chris Lorek, G4HCL, tells the story of how a humble ex-fire service pager became a 2m monitor***

Fancy a portable 2m monitor receiver for around a tenner? Or could your group make use of a pager system for emergency callout? Well the fire brigade needed a radio callout system around fifteen years ago and the Pye SR1 fitted the bill nicely, now hundreds of these top-pocket pagers are reaching the amateur market and they are selling for just a few pounds each. By adding an off-the-shelf crystal and a cheap IC you can walk around monitoring your favourite local natter channel, or if you're involved with Raynet or the like then just change the crystal and add one capacitor to give you an emergency bleeper responding to a four second 1750Hz toneburst. Interested? Read on . . .

## Operation

The pager itself is a complete receiver with tone decoding and processing circuits added so that it will respond to audio tones. It was not not originally intended for voice reception, but that of course does not take the resourcefulness of radio amateurs into account! The accompanying block diagram **(Fig. 1)** shows what goes on inside the black box, where we can see that a standard FM receiver is used with demodulation down to audio performed in the usual way. By removing the reed and placing an earphone across the appropriate contacts **(Fig. 2)** you can easily hear what's going on, albeit without any squelch action to save you from being deafened by white noise in the absence of signals. The receiver was designed to operate over the 142-174MHz range, but all those I have seen on the surplus market have in fact been crystalled up for 147.8MHz, which is of course very close to 2m.

Two tone detectors are used, a resonant reed for the 'test' tone, and

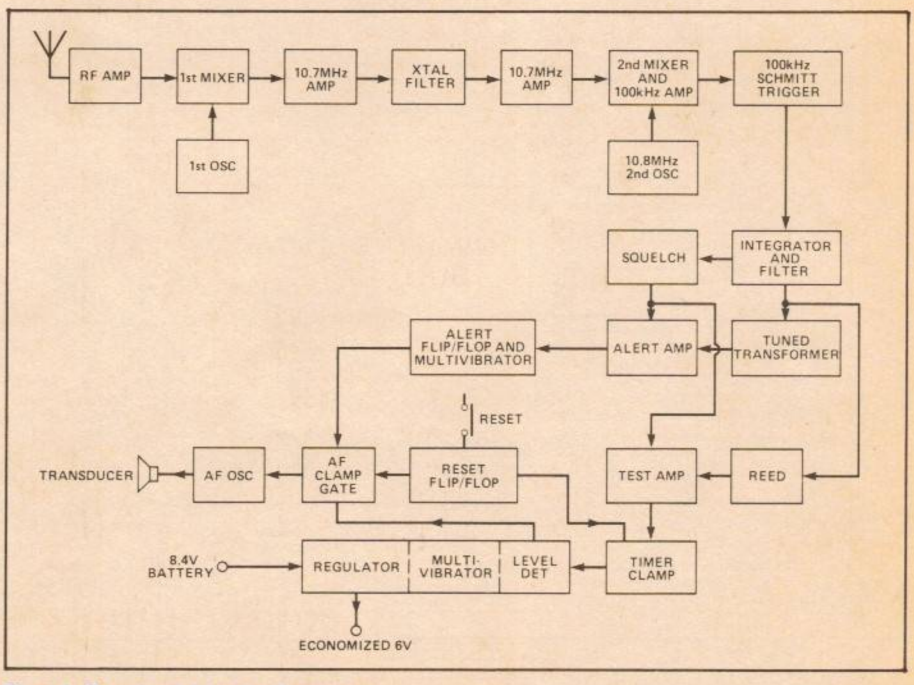



**Fig. 1 Sentinel block diagram.**

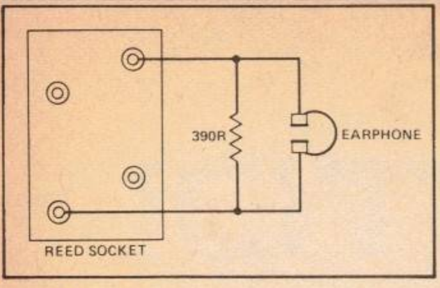



**Fig. 2 Earphone monitor connection.**

a tuned transformer for the 'alert' tone, both being used in conjunction with active buffers and diode detectors. The reed is encapsulated in a small rectangular metal case and plugs into a wired PCB socket in the receiver, resonating at a precise frequency in the range 600Hz-1.6kHz. Those found ex-service have normally used 600.9Hz, 614.7Hz, or 634.5Hz, but you may find that some sets are sold with the reed removed. The transformer is a large ferrite cored affair mounted on the main board with an adjustable core which allows fine tuning of its resonant frequency which is usually 3kHz, however some versions are tuned to 2.8kHz.

In use, an RF carrier modulated with the test tone causes the pager to send a constant tone for 20 seconds, or until the reset button is pressed. If the modulating tone is then changed from the test tone to the alert tone of 3kHz, the pager alarm changes to a fast intermittant bleeping to warn of an emergency, this again lasting for 20 seconds unless reset. When first inserting the battery, a test alarm is automatically sounded by the pager to function as a battery check. There is no on/off switch, as there was no need for one in its original form.

An 80mAh 8.4V nicad is used, of the same dimensions as a PP3 and similar to the PF1 RX battery. It's life is extended by the use of an economizer, where the receiver is switched on for a few hundred milliseconds every two and a half seconds or so. This cycling action only stops when a test tone is detected to prevent continuous carriers draining the battery.

## 2m Conversion

I will be detailing two modifications, firstly a simple one of conversion into an amateur frequency pager, and secondly adding an audio amplifier for conversion into a monitor receiver. Either modification may be performed, or of course if you're an experienced constructor, by adding a small switching circuit you can use it for both purposes. But first of all, let's get it going on 2m, for this you need to get a crystal for the 2m channel you want to operate on.

The required overtone crystal frequency is:

$$\frac{(\text{RX FREQ} - 10.7)}{3}$$

A HC18/u (wire ended) crystal is normally used, however a more-commonly available HC25/u (pinned) crystal will fit if you don't mind cutting the pins short and soldering them in. These crystals are normally available from suppliers ex-stock on popular 2m frequencies for about £2.50 or so.

Remove the receiver board from it's case by pressing the two upper notches inward with a couple of scewdriver blades or similar whilst withdrawing the upper portion, an extra pair of hands is useful here! Desolder the 1st oscillator crystal (refer to **Fig. 3**) if fitted, and replace with with your 2m crystal. If using an HC25/u crystal you may find it convenient to solder thinner wires to the pins and then solder those to the board rather than enlarge the PCB holes. Next, temporarily disable the timing circuitry by desoldering the pin 1 connection to the economizer; this may easily be done by bending back the lead on the printed circuit side of the motherboard.

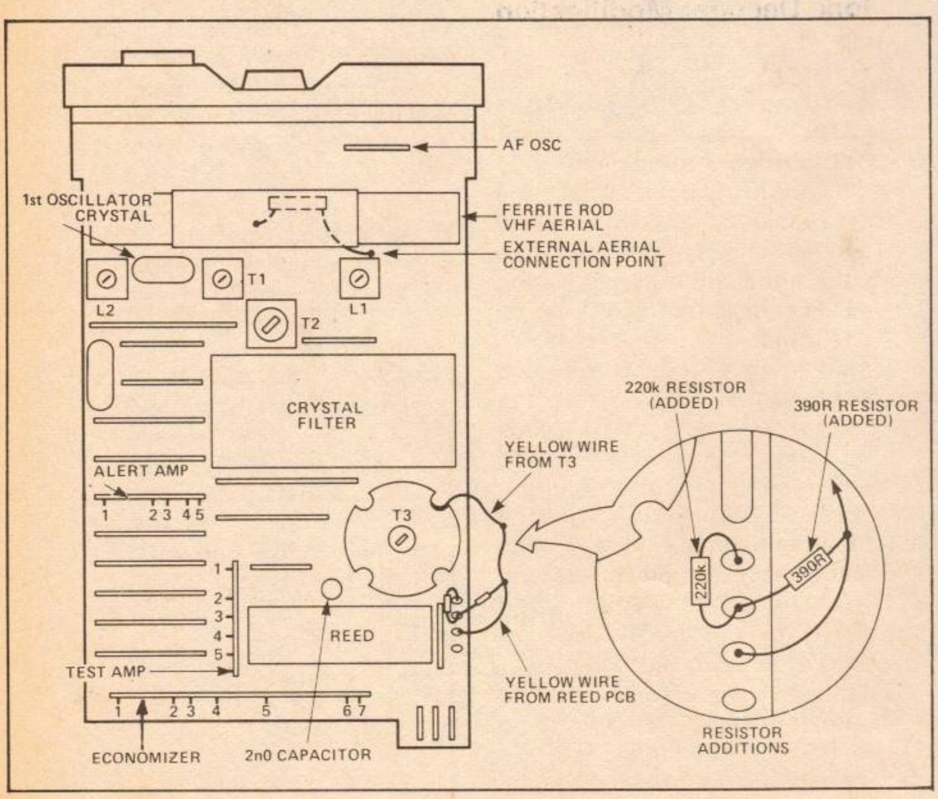
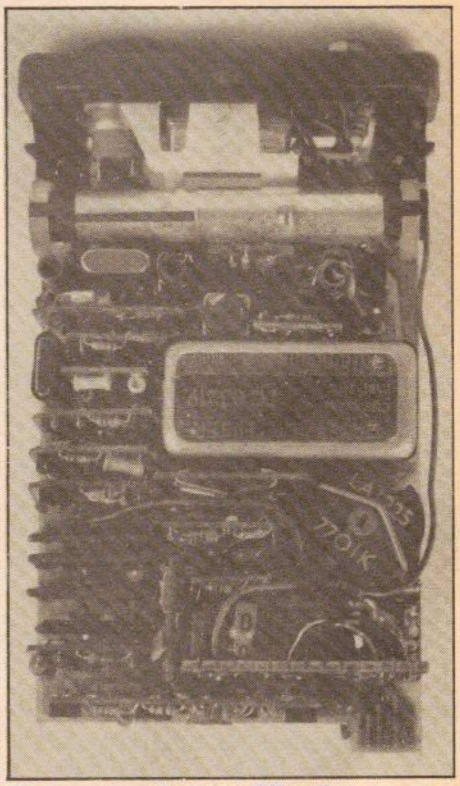
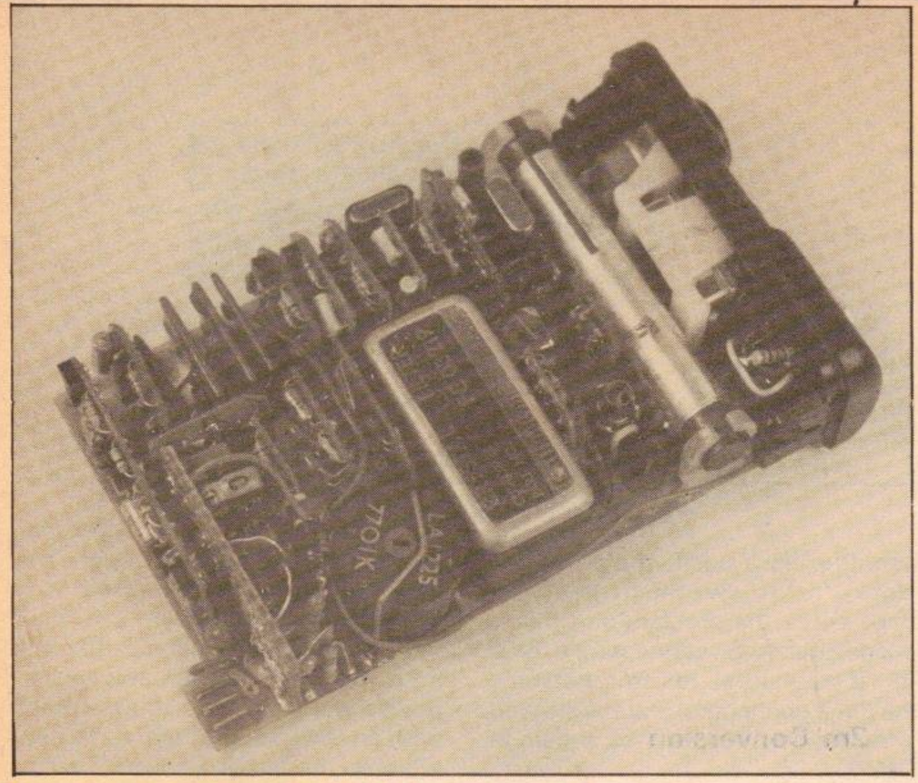



**Fig. 3 Layout/alignment diagram.**



**The pager after modification — showing the add-on audio amp board.**



**Some pagers are supplied with the reed unit already removed.**

Now connect an earphone or similar as shown in **Fig. 2** and find a reasonably local signal on your crystalled channel. Those with access to a low-leakage signal generator may couple the output to the capacitor connection between the ferrite rod sleeve and the motherboard. The receiver should already be fairly sensitive but, using a *non-metallic* trimming tool tune L2, T1, and L1 in that order for best reception. Note that L2 is the crystal trimmer and you should adjust this first to obtain least distorted audio before any further adjustments. Don't be tempted to use a metal jeweller's type screwdriver for tuning, apart from upsetting the inductance of the coils you'll probably break and hence jam up the fragile ferrite cores.

On one or two sets I found tuning T1 tended to send the set into self-oscillation, identified as a rapid quieting of background noise whilst drowning the wanted signal. Slight de-tuning of the core from it's optimum position is required to effect a cure.

T2 is the IF coil which should already be aligned and will not require trimming. Finally, move the outer metal slider of the ferrite rod aerial for best quieting on a weak off-air signal, this will normally have to be moved slightly to the right as viewed holding the set with the transducer at the top. Resolder the economizer pin 1 connection, remove the earphone connection (leaving the 390R resistor soldered in if no reed is fitted) and that's it! — your set is fully aligned.

## Tone Decoder Modification

If your group's pagers all have similar frequency reeds fitted and you wish to use them for their original purpose, then you may usefully skip the rest of the modification details. A test tone will be sounded following reception of a reed tone modulated signal lasting for 3-4 seconds, if this is followed by a 3kHz modulated tone then an emergency alert will be sounded from the pagers. However as the pagers may come with no reeds fitted (and to save dedicated transmit tone generators) I thought it would be useful to detail modification to enable an alert to be sounded on reception of a long 1750Hz tone, as many amateur FM sets have this facility available as standard on a push button.

As a 2nF capacitor is used to resonate the tuned transformer to 3kHz, RAE mathematics (see — they're useful for something at long last!) show that a 5.87nF capacitance will resonate it to 1750Hz. This can easily be performed by soldering a standard value 3.9nF polystyrene capacitor across the existing 2nF one and tuning the core of T3 for the small amount of fine adjustment required. Remove the earphone if you have fitted this for monitoring purposes, but do remember to keep the 390R resistor in circuit. Couple a high impedance AC millivoltmeter, or more usefully an oscilloscope probe, to pin 2 of the test amp board. Failing this a DC voltmeter may be coupled to pin 4 of the test amp, which is the rectified output with a small DC offset superimposed. In either case, tune the core of T3 carefully for maximum reading when receiving a signal with an accurate 1750Hz tone.

Now we need to make the set think it's receiving a test tone followed by an alert tone. Referring to **Fig. 3**, remove the two yellow wires leading from the reed PCB and T3, then solder them together and ensure that they are insulated from any other board connections then disconnect the brown wire from the reed board and connect it to this junction. Reconnect the 390R resistor to the rear of the motherboard as shown and remove the remainder of the wires leading to the reed PCB and discard then, then connect a 220k resistor as shown to couple unfiltered audio to the alert amp board. Once these mods have been performed, the test amplifier will become active on reception of a 1750Hz tone (of a long enough duration to capture the economizer sampling period), hence sounding the test tone from the pager. The economizer will be defeated, and the

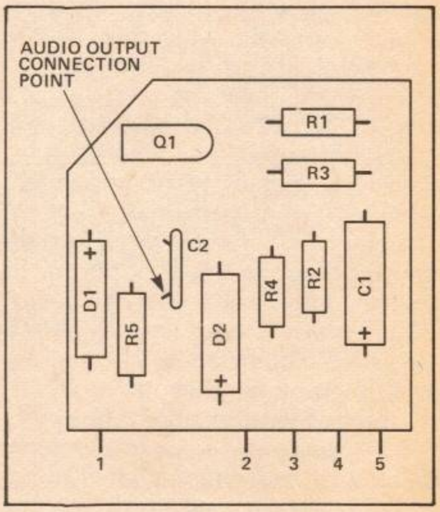



**Fig. 4 Alert amp board layout.**

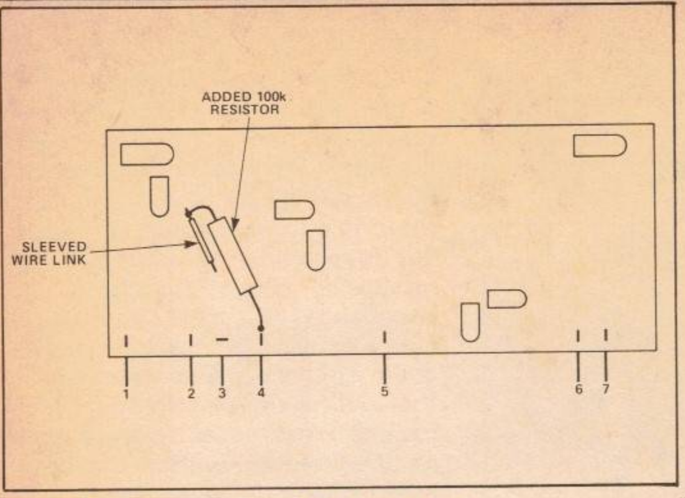



**Fig. 5 Economiser board linking detail.**

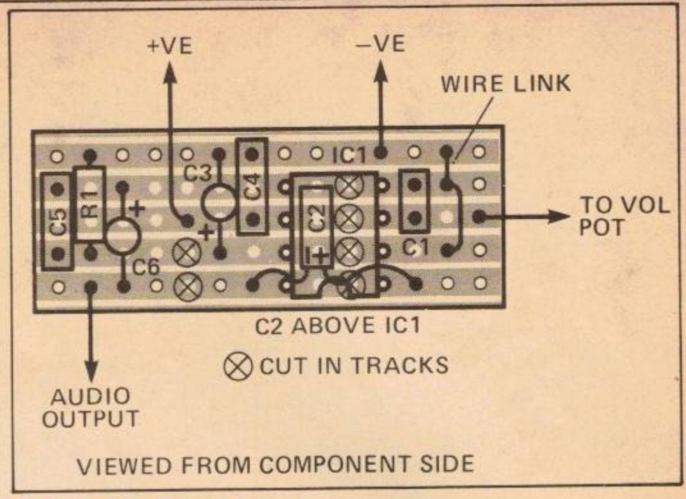



**Fig. 6 Audio amp layout.**

alert amp placed into operation which will also detect the 1750Hz tone and immediately switch the pager into alert mode.

Because only a single tone is being decoded, albeit using a very high-Q and hence narrow bandwidth filter, one must remember that false alerts may be possible with someone whistling or a normal toneburst used on a repeater channel just happening to catch the sampling period of the economizer. For this reason it is preferable to use a 'quiet' channel for alert use. Also remember that some repeaters have a 1750Hz notch filter in the audio path which could influence use either way. In practice I have found that even with the economizer disabled, normal speech received on a simplex channel would rarely, if ever, trip the alert tone.

## 2m Monitor Conversion

We have seen that unsquelched receiver audio is available from the set and if we tap in at a later squelched stage then suitably amplify the audio we would have a normal voice receiver. Although it is possible to have the economizer running in this mode, the sampling interval of several seconds as used would cause the loss of the initial parts of transmissions or even complete loss of short calls. Rather than attempt to modify this for a shorter time with the result of diminishing returns, it was felt better to disable it completely. This may be performed by open circuiting Pin 1 on the economizer board, however this still keeps the economizer clock running with resultant quiet clicking noises superimposed on the audio, which could be a little annoying in use. Placing a positive bias on the clock 'hold' switching transistor base cures the problem and this is accomplished by connecting a 100k (or thereabouts) resistor between the Pin 4 connection and the sleeved wire link on the board, as shown in **Fig. 5**.

High impedance squelched audio is available at the lower C2 connection on the Alert Amp board, this is the point immediately prior to it passing to the detector diodes for rectification. This connection will drive a high-impedance crystal earphone direct, but you will find the level insufficient to drive a low-impedance earphone or speaker. Keen constructors may have their own ideas for a simple audio amplifier, however there is a small low-cost audio IC widely available in the form of an LM386N which is ideal for this purpose. **Fig. 6** shows a copper matrix-board layout of a suitable amplifier circuit using this device, whilst **Fig. 7** shows the circuit diagram itself. If a unit is constructed exactly as shown, the board will fit nicely in the space previously occupied by the test tone reed, the reeds metal clip having also been carefully removed from the PCB. Component values are not particularly critical, 10V working electrolytic capacitors should however be used in as small a case size as possible. Don't be tempted to use, say, 3V capacitors otherwise you'll find they tend to melt! The voltage supply may be taken from the adjacent battery terminal connections.

Under no-signal conditions, the amplifier draws only 5mA, increasing with output volume of course when amplifying audio. The maximum audio output depends upon the individual type of '386 used, it is available in LM386N — 1, 2, or 4 suffixes, the higher the suffix the more power, but even the lowest power will give over 400mW RMS with an 8.4V supply from the nicad, which is more than enough. There's only a small battery in there remember, and using an earphone with a series 1k resistor to earth (to stop you deafening yourself) will only result in around 12mA current being drawn by the amplifier at normal listening volume, the receiver itself drawing 20mA typical.

The internal transducer may be used as a speaker by disconnecting it's four wires and using the black and white wires as speaker connections. you will however find it's quality extremely 'tinny', very similar to early Pye PF1 pocketfone receivers in fact. By removing the tuned transformer and replacing the primary winding, (the two wires **not** connected to the 2nF capacitor) with a resistor of around 1k, and drilling holes in the case front to let the audio out, you may find enough room to fit a tiny speaker, with the magnet fitting into the space vacated by the transformer.

The small AF Oscillator board at the top of the unit may be removed entirely making room for a volume control or earphone socket if required and the defeat button also may be removed to make further room, eg for an on/off switch if needed. I found a simple fixed resistor attenuator rather than a large volume control gave a useful compromise in space, using a 6k8 in series with a 3k3 to earth with the amplifier input being taken from the resistor junction in place of the

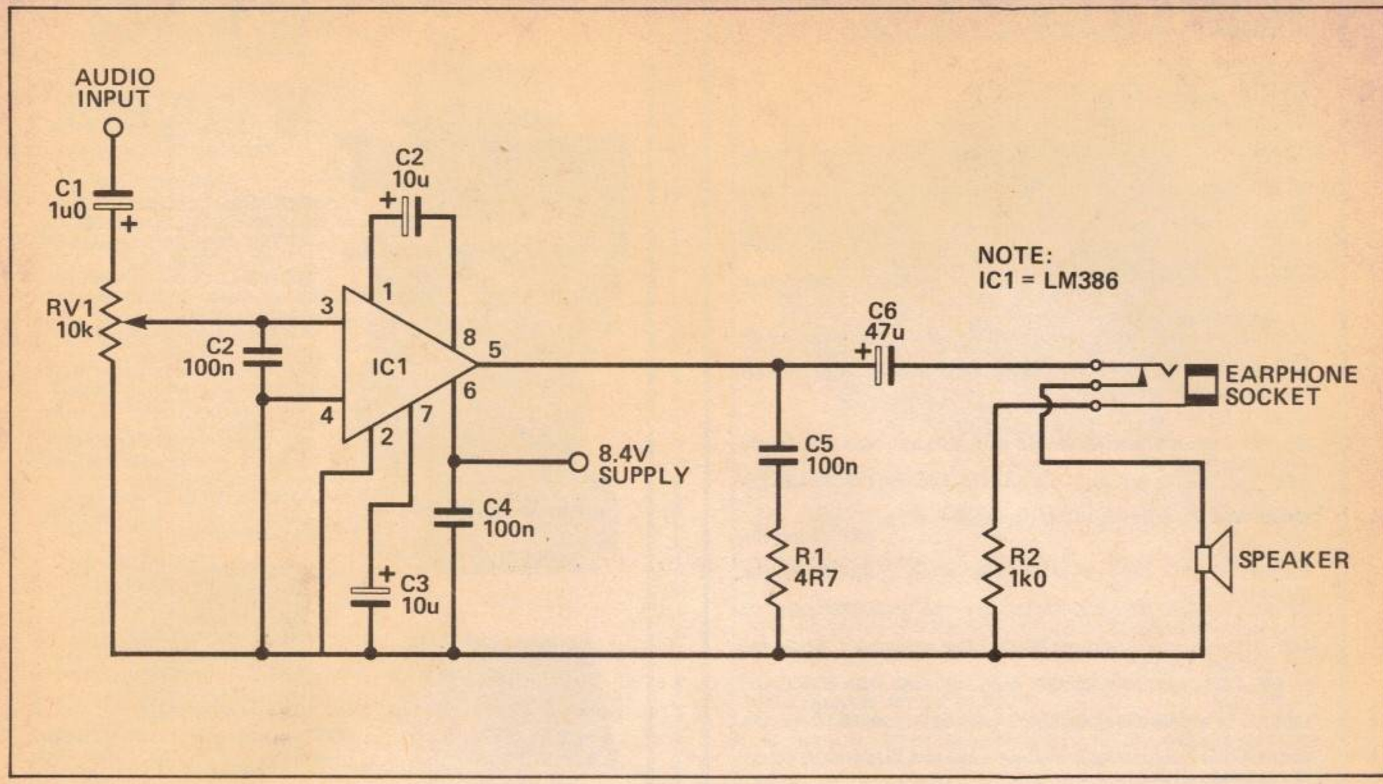



**Fig. 7 Monitor audio amp circuit.**

volume control slider.

## The End Product

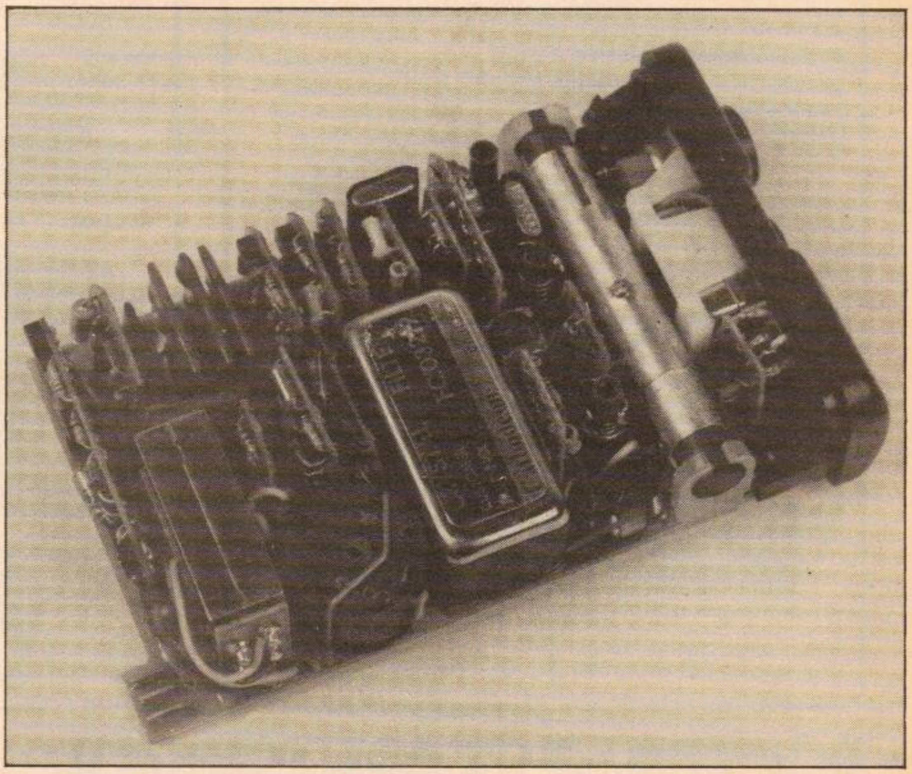
The modified set is small, light, and easily fits into an inside pocket or clips onto one's belt, making it a useful 'go everywhere' companion. It's use is certainly not limited to portable operation however, in the shack it makes a useful monitor for the local chat channel whilst the main rig is used on another frequency. An external aerial may easily be used by fitting a single-hole BNC socket to the top of the case and connecting the centre pin of the socket to the capacitor which links the ferrite rod sleeve and PCB — the outer connection of the socket is simply connected to the PCB earth plane. When testing in my shack, with a 500mm long test length of wire, the set was just as sensitive as my normal 2m portable with a helical whip.

A number of sets have been modified and found to operate satisfactorily, but if you do have problems then the major causes of faults are dry joints between board pins and motherboard, intermittent reset buttons, or more likely a faulty nicad, all easily rectified. You may also find suppliers are offering spare nicads at low prices, these are certainly worth taking advantage of.

If you don't obtain a plug-in charger with the set (these again are being sold very cheaply) then note that the required charging current is 8mA over a 14 hour period. Using the set as a pager, plugging it into the matching charger overnight, will ensure continuous operation without the battery going flat. As a monitor receiver, expect around three hours use with an earphone and less when using a speaker; so spare nicads could be useful here.

So now that the rally season is under way again, you'll know what to look out for if you want a super cheap 2m receiver. Happy hunting!

*My thanks go to Garex Electronics and Quartslab Marketing for the supply of equipment and crystals used for the preparation of this article.*



**Internal view of an unmodified pager.**

# REVIEW: G·WHIP HF MULTIBAND ANTENNA

The radio amateur wishing to choose a multiband aerial suitable for use in the typical small garden is faced with a bewildering variety of designs from which to make a selection. Wire antennas, such as dipoles and the popular G5RV, have the advantage of simplicity, but a certain minimum size of garden is needed if operation on the lowest frequency bands is to be achieved, and it may be difficult to attain sufficient height, particularly if the QTH is a bungalow and there are no tall trees in the garden.

**_Can one single antenna, small in size and relatively cheap, give acceptable performance on eight bands? Julian Moss, G4ILO, thinks the G8-100 multiband vertical may fit the bill._**

Trapped verticals covering up to five bands may be the only solution for very small gardens, and even when more space is available, their unobtrusiveness may make them an ideal choice. Verticals give a low angle of radiation which is ideal for working DX, but they are felt by many to be poor performers due to the use of lossy traps and the fact that, in the usual ground-mounted position, some of the RF will be absorbed by surrounding trees and buildings.

It is likely that any antenna selected for operation in a limited space will be a compromise based on such criteria as the length and width of the garden, height of supports available, bands to be covered and whether or not the need for an ATU is acceptable.

The writer's QTH has a 40-foot rear garden, with nothing in it greater than 15 feet in height, including the property itself which is a bungalow. As 80 metre operation was required, a five-band trapped vertical such as the Hy Gain 18AVT seemed to be the best solution. These come expensive however, the price new being almost £200 due, no doubt, not only to the weakness of the pound relative to the dollar, but also to the fact that one is paying for traps able to take a power of 1kW, making the antenna somewhat over-engineered for the typical British station.

However, the writer remembered an item in 'Radio Today' in the February 1985 HRT announcing the launch of a new compact base station antenna from the British firm of G-Whip, which would cover all bands 80-10m, including the WARC bands, 30, 17 and 12m, using 'a combination of top loading and LC type traps'. The cost turned out to be less than half that of a new 18AVT. The writer decided to obtain one from the local emporium, Arrow Electronics.

### A true compact

The G-Whip G8-100 certainly lives up to its description of being a compact antenna. Its overall height is about 14 feet and it is constructed using very slim alloy tubing. It differs from more conventional commercial designs in the use of electrical top-loading to achieve multi-band capability. For each of the bands above 80m, small tuneable coils stand off at right-angles to the mast. These are provided with screws or in the case of the 30m and 40m coils short lengths of steel wire may be adjusted to give resonance in the required part of each band. For 80m a larger coil axial to the mast is used, with a telescopic whip which is adjusted for resonance.

A drawing of the G8-100, showing the configuration of the loading coils, is show in **Fig. 1.** Although unusual in appearance, the antenna is actually quite unobtrusive due to its low height and the small diameter of the mast and coils.

The antenna is supplied complete with an iron mounting stake and two copper wire radials which are to be buried just below the surface of the ground. The radials are bare copper wire, and are each about 10ft long, thus far less surgery is required on the lawn than would be necesary to install a system of four resonant length radials as recommended by the manufacturers of most commercial trapped verticals. Although the writer later added three copper earth rods to the system, good results were achieved with the minimal earthing arrangement supplied.

The mast consists of two sections of light alloy tubing, the top of the uppermost section being threaded internally to take a short length of solid alloy rod. Two brass collars slide on to the solid section, into each of which screw three loading coils covering 12 to 40 metres. The 10m coil screws into a plastic collar which is located on the tubular mast section about 6" below the 12-17m coils. The top of the solid rod section is threaded and into this screws the 80m coil and its adjustable telescopic whip.

Although the materials used in the construction of the G8-100 seem to be of good quality, the aerial lacks the high standard of finish one has come to expect from American or Japanese manufacturers. The feeder connection, for example, is a crude aluminium bracket with an SO-239 on it, with no attempt being made to shield the coaxial plug from the ingress of water. As already mentioned, the tubing used for the main mast section is very slim and light, and the antenna whips about alarmingly in a high wind. The writer's antenna has in fact sustained a slight permanent bend as a result of the severe gales experienced in February 1986.

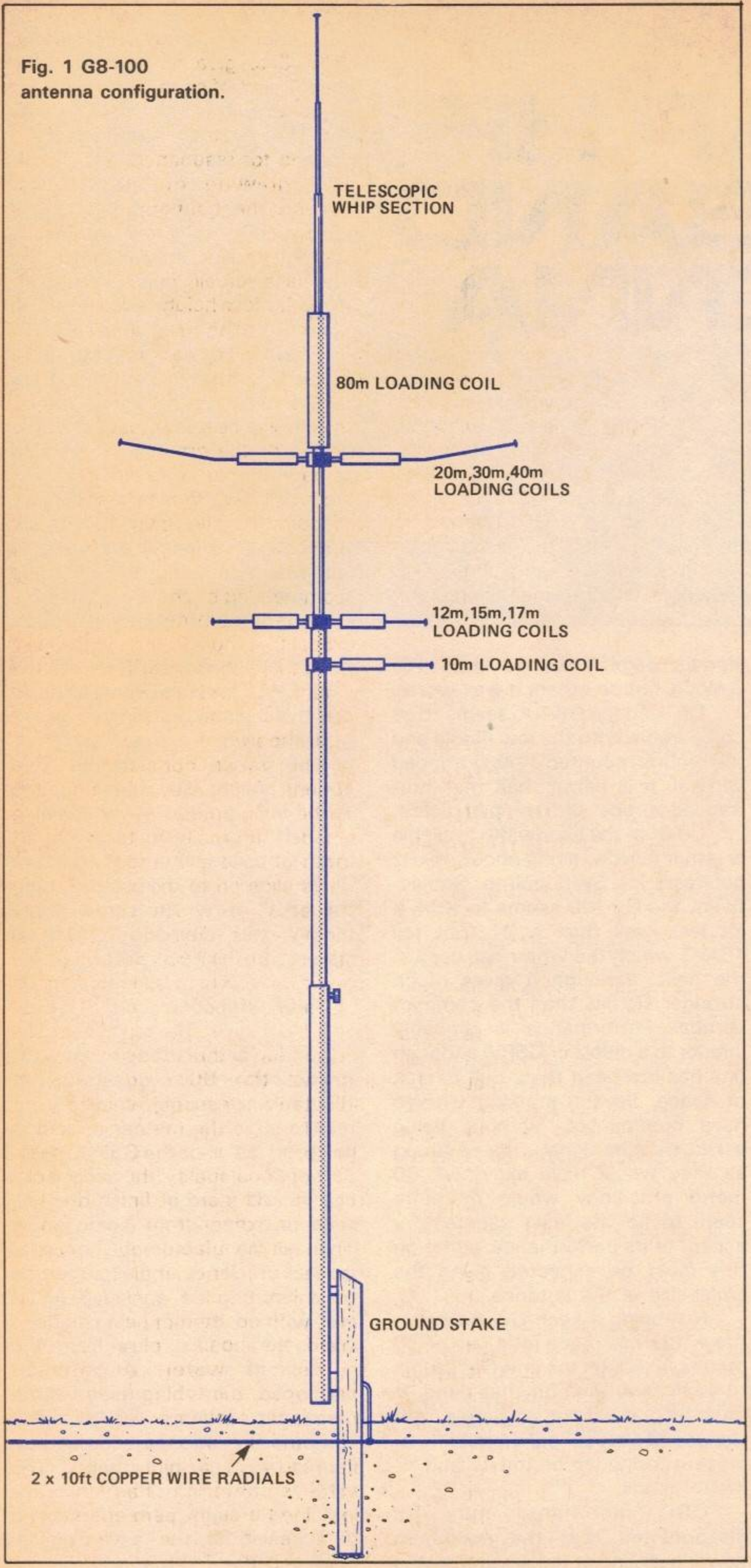



**Fig. 1 G8-100 antenna configuration.**

The loading coils are sheathed in a shiny black heat-shrink type of plastic. The aerial has not been up long enough to judge how well this material will withstand prolonged exposure to ultra-violet rays and extremes of temperature.

## Adjusting SWR

Once erected, the antenna is tuned for lowest SWR at the chosen point on each of the eight bands by adjusting the screw on each of the five high-frequency band loading coils, and the wire elements on the 30, 40 and 80 metre coils. Graphs showing the SWR across each of the bands as achieved by the author are given in **Fig. 2.** Tuning the G8-100 is very easy as the adjustment on one band has no measureable effect on any of the others, and it is necessary merely to screw (or slide) the adjusters in to raise the resonant frequency, and out to lower it. As can be seen, it was possible to achieve an almost perfect 1:1 SWR on all of the bands except 12 and 10m. With the 10m adjusting screw out as far as it would go, the best SWR was obtained in the FM and satellite part of the band. Although this suited the author, using a longer screw would have enabled the antenna to be found to favour the SSB part of the band, if required.

Since a good match to 50 ohms is readily obtained, the aerial would seem to be ideal for use with modern broadband PA's without the need for an ATU. Unfortunately, it was soon discovered that rain falling on the loading coils had a significant effect on the tuning. On 14MHz, for example, the minimum SWR point moved about 200kHz low, so that an acceptable 1.3:1 became an unacceptable 3:1. No real cure for this problem has been found, although spraying the coils with a water repellant such as WD-40 may encourage the water droplets to run off rather more quickly. Many users therefore, the writer included, will prefer to use the antenna in conjunction with an ATU.

These criticisms aside, the writer has been delighted with the performance of the G8-100. This remarkable little antenna gives an astounding performance for its size. Ground-mounted, in a far from ideal situation, surrounded by fencing, trees, bushes, a garage and an

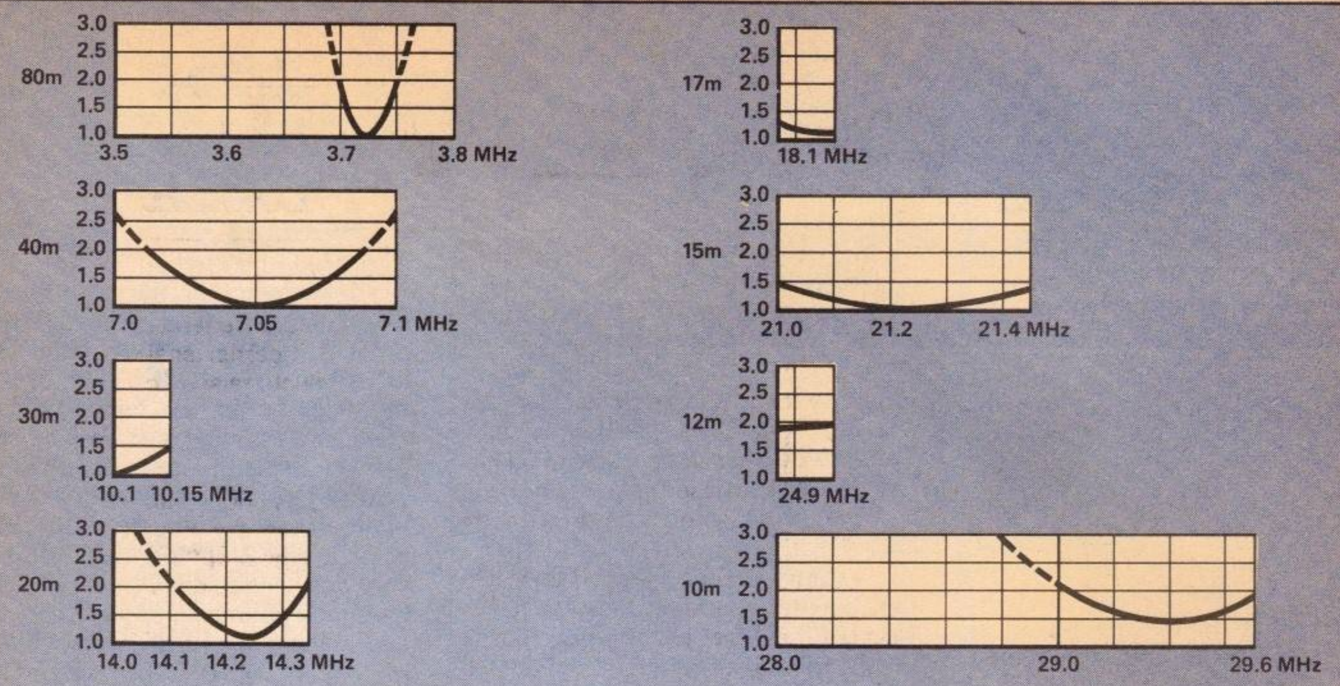



**Fig. 2 SWR curves obtained by the author.**

aluminium framed greenhouse, the G-Whip outperforms or is the equal of almost every type of 'inconspicuous' aerial it has been tried against.

It performs better than or equal to a ground mounted trapped vertical on the higher frequency bands. It gives much better results than an expensive compact multiband vertical with trapped radials mounted at about 14ft, although the latter reportedly works well when much higher, 30 feet or more above ground level.

## Performance in detail

On 10m FM, the performance is roughly equivalent to a trapped vertical at 16ft with wire radials. Compared with a monoband half wave vertical at the same height, it is about 6dB inferior. This is very good considering the half wave not only has gain but is also in an unobstructed position. In the SSB part of 10m, where the author's G8-100 is well off resonance, the more broadband half wave is far superior, indicating that the multiband antenna is very selective.

On 15 and 20m, the G-Whip ground-mounted trapped vertical. On 20m, a trapped vertical with wire radials was found to receive some signals slightly better than the signals slightly better than the G-Whip, but on others it was worse.

On 40m the G8-100 seems to be comparable with the low dipole and the ground mounted 14AVQ trapped vertical. It is better than the short trapped vertical with trapped radials.

On 80m the bandwidth available is rather narrow, being about 45kHz between 2:1 SWR points. Subjectively, the G8-100 seems to work a lot less well than a 27 foot tall 18AVT which the writer has used in the past, although it gives much stronger signals than the compact vertical. Performance is probably inferior to a dipole or G5RV, although one has not been tried, due to lack of space. Several stations worked have commented, without being asked, that the signal is not as strong as they would have expected. 80 metre efficiency would therefore seem to be the least satisfactory aspect of its performance, although this must be expected given the small size of the antenna.

Not being a keen CW operator, the writer has made little use of 30 metres, although the antenna seems to work very well on that band. It must be pointed out, of course, that the use of vertical polarisation is at present forbidden on the 12 and 17 metre bands.

QRO merchants may be disappointed that the maximum power handling of the aerial is stated to be 100W PEP in SSB use, and 75W CW. This is not likely to be too much of a restriction for the majority of users, except perhaps those who operate using RTTY. The author has always limited the power used on 10m FM to around 40 or 50W.

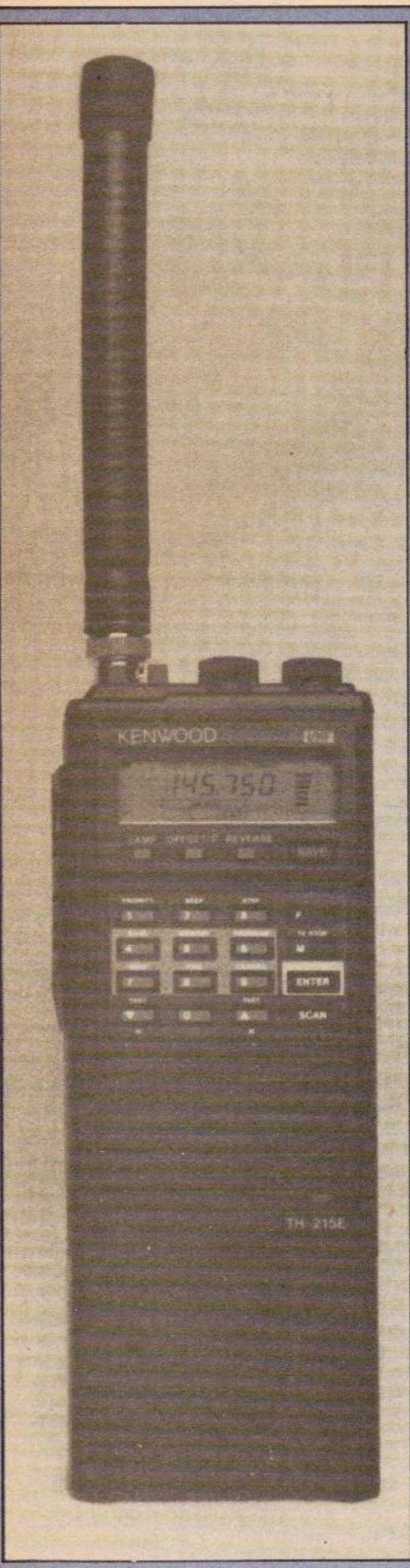
Although not tried, the manufacturers state that additional loading coils are available to cover the short wave broadcast bands, making the antenna of particular interest to the keen SWL.

## Conclusion

The performance of this multiband vertical suggests that the top-loading principle produces results which are better or at least as good as those obtained using conventional traps. The writer would like to see a larger version of this antenna, some 20-25 feet in height. This would presumably produce greater efficiency and allow a wider bandwidth to be achieved on 80 metres, and perhaps even allow a coil to be added to cover Top Band!

Despite some minor criticisms, the writer can thoroughly recommend the G-Whip G8-100 as a compact multiband antenna for base station use. Although small, it gives really worthwhile performance, and will enable eight-band operation to be achieved from even the smallest garden.

# KENWOOD TH215E REVIEW




Front view of set.

When testing the TH205E handheld (reviewed in HRT March 87), I commented that the manufacturers had taken a gamble in the introduction of a simple, rugged set but with limited facilities, and that the gadget lovers amongst us would probably not take a shine to it. Well it looks like these types are going to have a whale of a time with the TH215E, Kenwood's solution to keeping everyone happy! Rather than say what operating features it has, it may be easier to say what it hasn't, but here goes . . .

***A rugged rig with bells and whistles? It's music to the ears of Chris Lorek, G4HCL — quite literally.***

### Features

The set covers 144-146MHz in user selectable 5, 10, 15, 20 or 25kHz steps. The transmitter gives a nominal 2.5W output from the standard 8.4V battery pack and operation up to 5W output is available by using an optional battery or from an external supply, a switchable low power mode gives approximately 0.5W in all cases. Frequency selection is by direct keypad entry to the nearest 5kHz, or by single-key recall of one of the ten memory channels. Frequency shift in the user-defined steps is accomplished again by a single key touch of the Up or Down shift keys; keeping your finger pressed gives a manual scanning facility until you let go. By pressing the 'F' button first, a fast QSY is initiated to get you to a different part of the band quickly when using small frequency steps.

There are nine automatic scanning modes, arranged in a well laid-out matrix format. One of three *frequency-scan* modes can look for signals either on the programmed memories, frequencies between those stored in memories 8 and 9, or the entire 2m band. The three *scan-stop* modes are Seek, Time, and Carrier; seek scan halts as soon as the squelch raises and stops there, time scan stops when the squelch raises and carries on scanning 5 seconds later regardless of squelch state, and carrier scan stops when the squelch raises, carrying on 2 seconds after the squelch has closes. A priority watch facility may be used when you're not scanning around, this briefly samples memory channel 1 every five seconds and gives a bleep and flashing indication on the display when a signal is found.

The usual 600kHz transmit offset is provided for repeater usage, which is selected by depression of a tiny button and cycles through '+', '–', then back to simplex. However, this may be changed from 600kHz in 100kHz steps if you wish and any offset may be stored in memory together with the programmed frequency. Reverse repeater 'listen on input' may be momentarily selected by an adjacent button, and a latching top panel button gives an automatic 1750Hz toneburst at the start of each transmission.

Battery economizers, where the receiver is switched on for a fraction of a second followed by a longer period in a low-current no-receive state, are certainly nothing new. However they often suffer from the problem that when a signal is received, you may miss the first word or so due to the sampling period delay before a signal is recognized. Kenwood have incorporated a variable delay feature in the TH215E, where the user may preset the time ratio from 1:1 to 9:1 of no receive:receive, with a 300mS sampling time. This allows a greater saving in battery power if the user can tolerate a longer time delay, and of course vice versa. As well as this, two economizer modes are selectable, *save* activates the economizer two seconds after the squelch closes, and *auto save* activates it one minute after the last keypad depression when the squelch is closed.

As is normal practice these days, the large LCD gives many and varied indications of the set's operation. The large frequency read-out is accompanied by step size, memory channel, offset, scan range and type selected, save mode, priority, busy, on air, and low battery warning indicators. In addition a six section 'barchart' S-meter is used, which also gives an indication of Tx mode. The display may also be backlit by pressing a small 'lamp' button.

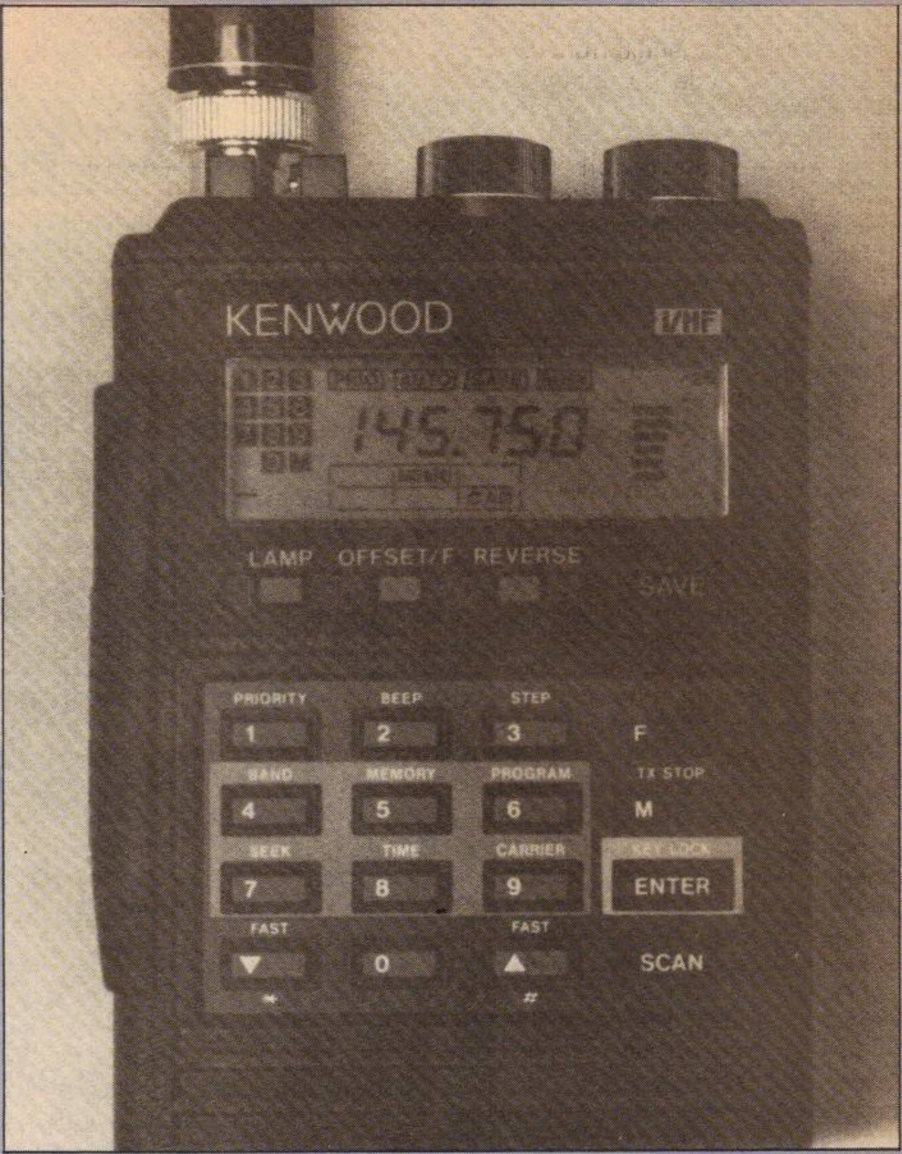
As can be seen from the photograph, a multi function keypad is used, the 'F' button giving most of the keys a further second function displayed above the key indication. The keys themselves are made from a rubbery-covered material to provide a degree of moisture protection and apart from the backlight control, each button has a different tone bleep eminating from the speaker at a pre-set level. Operating the set in a quiet environment can be quite entertaining at first, certainly novel and quite different from the typical bleep tones you find with most other equipment. You can of course disable this facility if you are reluctant to give short musical recitals every time you change frequency!

Top mounted rotary controls are fitted for volume and squelch, and the side mounted PTT bar is complemented by a 'monitor' bar which opens the Rx squelch. A BNC socket is fitted for the helical whip, also allowing external aerials to be connected, and adjacent sockets are provided for external power, speaker, and microphone connections.

The set is supplied with a 135mm 'stubby' helical, an 8.4V 500mAh nicad and charger, a rubber protective insert for the top mounted sockets, and a user manual including a full circuit diagram. The set itself measures 67mm(W) × 173mm(H) × 37mm(D) and weighs 520g with the standard battery pack. Optional accessories include a range of different batteries, chargers, carrying case, a belt clip, speaker/mic, longer and shorter aerials and external DC cables.

## Impressions

I often find that when I look at portable sets, it only takes a few minutes to find out what they can doi in terms of operational flexibility. But with this one, I was still learning after half an hour, and what's more it all seemed very simple and logical. As with the TH205E, the case appears to be built to withstand a good deal of knocking around and the rubbery keypad compliments the rugged design.



**Close up of keypad/display.**

The large range of accessories available shows that the set could be put to a variety of uses but what a pity it can't be used on 12.5kHz spaced frequencies without suffering a 2.5kHz error. The manufacturers certainly seem to have thought of almost everything else, and apart from the 12½kHz problem the set gives many more facilities than other similarly priced portables. The size is much larger than the latest 'micro rigs' so this aspect may not appeal to some users whilst others may prefer a 'chunky' but light set — it really is a matter of personal preference. I was pleased to see a full circuit diagram given in the manual, however the instruction text suffered from the odd 'literal translation' (or 'Janglish') problem, occasionally confusing matters a little.

## On The Air

The receiver was certainly very sensitive and the helical supplied also seemed very efficient at radiating the available transmit power, rather than just heating the coil up due to skin effect losses. I must say that I found the overall range achievable with it just that bit greater than other handportables. However it is also larger overall, so although it did fit nicely into my inside suit pocket, a noticeable bulge was evident.

In use, very complimentary audio reports were received on transmit and the received audio from the set was very readable too, but only with the volume below the three-quarters mark; above this there was noticeable distortion which degraded readability. I also found that the squelch lacked sufficient hysteresis, the receiver often filtering badly when receiving a weak signal around the threshold level.

On the plus side, the keyboard was simply a delight to use and I found the one-touch memory access facility to be very handy. Although not stated in the manual, a further press of the selected memory button puts you back to the previously selected frequency and offset, which was useful in toggling between memories and the 'VFO' when looking for a simplex channel to QSY to. It was also possibly to QSY from any memory channel simply by hitting the up or down button.

When scanning using 5kHz steps, the scan often halted before the receive centre frequency was reached due to the squelch opening with the resultant distorted reception. This didn't cause me any aggravation as I normally used the 25kHz steps, but it may be relevant to those searching out 12.5kHz spaced stations. The musical bleep tones emitted on key depressions were at a sensible level from the speaker, but rather loud when using an earphone as I often did, though one can easily switch the tones off when required.

One problem I did come across occured when using the set as a monitor at home or during lunch breaks at work with the set being placed on a desktop. Firstly, it was extremely difficult to see the LCD readout when your eyes were not level with the display, so when the squelch opened on scanning I had to tip the set up to see which frequency it was on, a second TH215E was found to exhibit the same effect. Secondly, I often like to keep a portable battery 'topped up' by plugging in the charger when monitoring at a fixed location, this was not possible as the supplied charging lead cut off the battery supply to the set when in use. One of the optional desk-top chargers or indeed a second battery or power supply would solve this problem, but at further expense.

Several amateurs have had problems in operating their portable sets outside in very low winter temperatures, I always had trouble on freezing mornings with one of my 2m mobile rigs that often needed a 10 min 'warming up' time. The recent harsh winter highlighted this problem where communication was often vital to safety. Many amateur sets are specified to operate down to $-5°c$ whilst some aren't specified at all, so I was extremely pleased to see a $-20°c$ spec for the TH215, similar to some professional sets. I briefly tested this, and although the LCD was very slow to change the set operated perfectly, well done Kenwood!

## Circuitry

The internal construction and analogue circuit arrangement is virtually identical to that of the TH205E (*HRT March 87*), so I won't repeat all that was said there. A different control board is fitted to the front panel and this uses a 64 pin micro-processor together with associated LCD driver to generate the control functions of the set, sending serial data to the synthesiser for frequency control. The Tx and Rx boards are only very slightly different to those of the TH205E, the main differences being in switching and the use of two cascaded monolithic dual crystal filters, rather than just one with a wire link fitted in place of the second, which would improve the receiver selectivity somewhat in practice.

## Laboratory Tests

Due to similar circuitry to the TH205E being used, it was not suprisingly that the achieved results were also very similar. A definite


**Display close up from above — the display is actually switched on.**

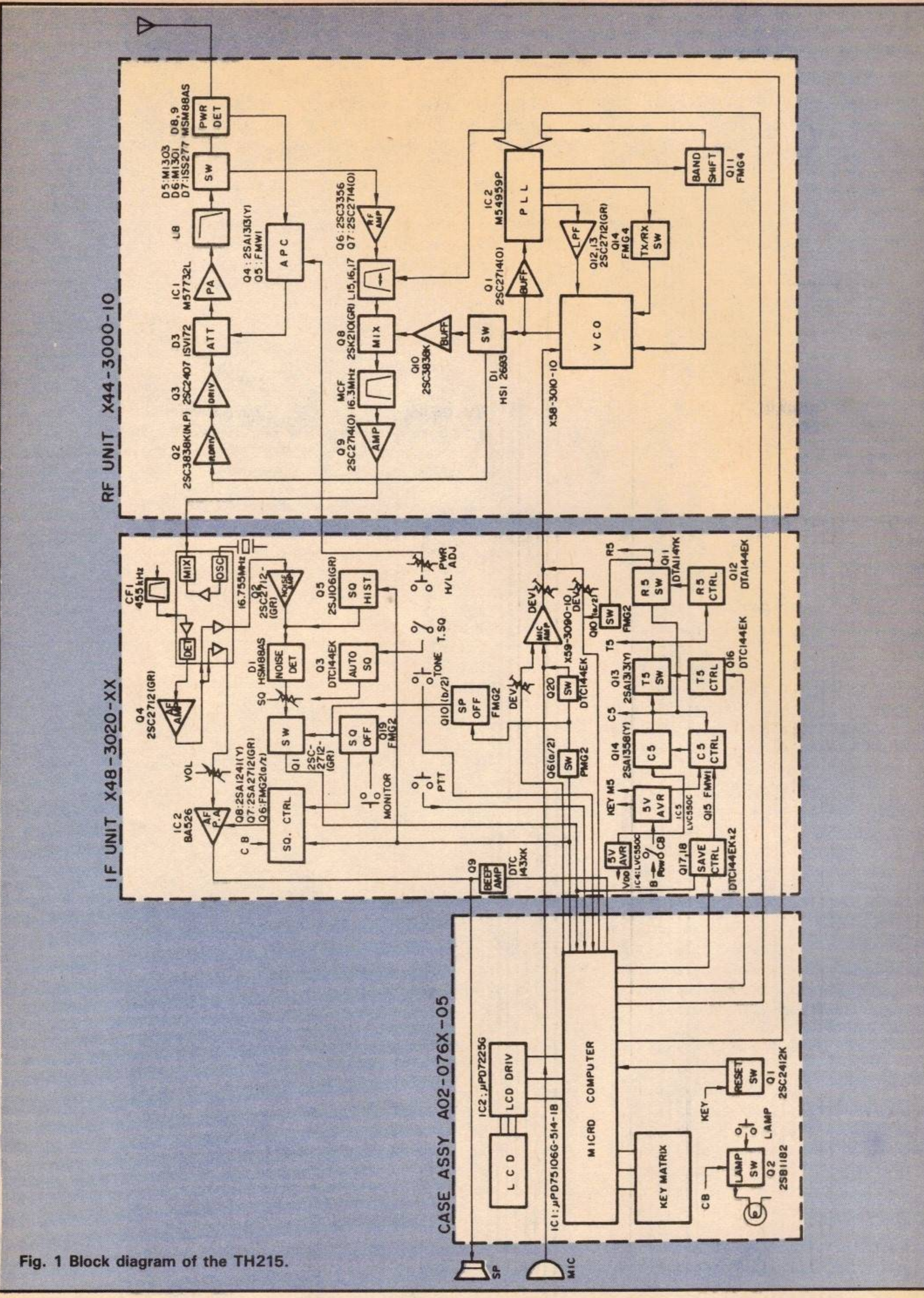


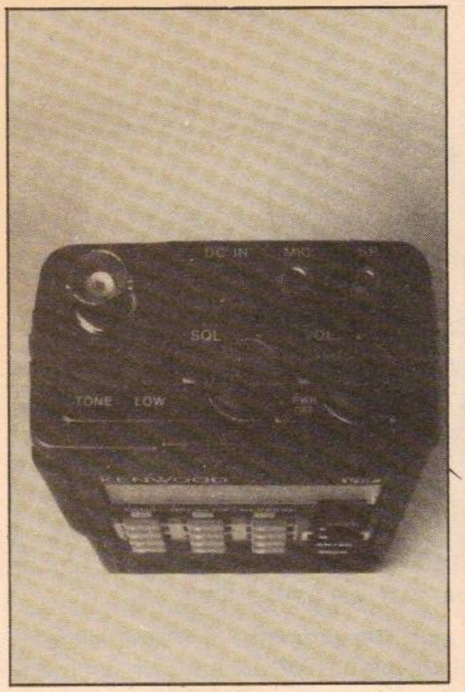

Fig. 1 Block diagram of the TH215.

improvement is that of adjacent channel selectivity, at 25kHz spacing, around 10dB improvement has been obtained, achieving quite a good figure for a portable of around 67dB although 12.5kHz rejection was assymetrical, quite good on one side but not on the other. The 5kHz minimum step limits the use of this spacing but one may still suffer the odd problem from stations operating 12.5kHz LF or your frequency, it really depends on the type of activity you prefer.

In other respects, the set performed quite well, the intermodulation rejection was a few dB better than the '205, again probably due to the extra filter reducing 2nd mixer IMD, and the blocking and sensitivity results were very good. A fairly useful range of S-meter readings were given, but strong signals did tend to just give maximum indication whilst transmit, all segments were displayed regardless of the power output selected. The standby current under economizer operation was very low, and coupled with the facility of the variable economizer ratio this would allow a good battery life to be achieved between recharges when monitoring a quiet channel.

The Tx peak deviation was a little over the 5kHz maximum but within reasonable setting tolerance, and the transmitter power efficiency was quite good, again improving battery life. The harmonics and spurii were at an extremely low level, and the frequency accuracy was also good.

In all, a good technical performance that I couldn't complain about.



Top mounted controls.

## Final Thoughts

Not everyone would like the multiple 'bells and whistles' offered with this set, and for them a set such as the TH205E would serve nicely. But for those who want a starter set that does virtually everything, to be used initially use as a mobile, base portable, and do not wish to use 12.5kHz steps, this set should give a good account of itself. The scanning facilities and general operational features are very good as well as being simple to use; this coupled with a good technical performance gives an end result of a very versatile set. I didn't like the relatively large size in comparison to other portables now available, but you must judge this for yourself as many amateurs would prefer a set that could be handled with clumsy fingers!

*My thanks go to Lowe Electronics Ltd for the loan of the review equipment.*

**Postcript:** Further investigation has revealed that it *is* possible to modify the TH215E to 12.5kHz channel spacing. Involving changing of crystal frequency and internal links, this is definitely not a DIY mod! Contact the importers, Lowe Electronics, for the details.

## Laboratory Results — TH-215E

### Receiver

| Squelch Sensitivity: | |
|---|---|
| Threshold | 0.068uV pd 3.5dB SINAD |
| Maximum | 0.175uV pd 17dB SINAD |

| Receive Current Consumption: | |
|---|---|
| No Signal | 12-32mA average (user variable, economizer operating) 53mA (Standby) |
| Mid Volume | 86mA |
| Max Volume | 145mA |

**Image Rejection:** Increase in level of signal at −32.6MHz to give identical 12dB SINAD signals: **69.3dB**

**Adjacent Channel Selectivity:** (Measured as increase in level of interfering signal, modulated with 400Hz at 30% system deviation, above 12dB SINAD ref. level to cause 6dB degradation of 12dB SINAD on-channel signal).

| | |
|---|---|
| +12.5 kHz | 41dB |
| −12.5 kHz | 26dB |
| +25 kHz | 66.5dB |
| −25 kHz | 67dB |

| | |
|---|---|
| Sensitivity: | 0.145uV pd for 12dB SINAD |

**Blocking:** Increase over 12dB SINAD level of signal 1MHz away to cause 6dB degradation in 12db SINAD on-channel signal.

| | |
|---|---|
| +1MHz | 97dB |
| −1MHz | 96dB |

**Intermodulation Rejection:** Increase in level over 12dB SINAD level of two interfering signals giving identical 12dB SINAD on-channel 3rd order intermodulation product.

| | |
|---|---|
| 25/50kHz | 66dB |
| 50/100kHz | 65.5dB |

**Maximum Audio Output:** Measured at 1kHz on the onset of clipping, into an 8 ohm load.

| | |
|---|---|
| 415mW RMS | (8.4V supply) |

| Strength Meter Indication: | | |
|---|---|---|
| 1 segment | 0.186uV pd | 0dB ref |
| 2 segments | 0.458uV pd | +7.8dB |
| 3 segments | 0.852uV pd | +13.2dB |
| 4 segments | 1.36uV pd | +17.3dB |
| 5 segments | 1.96uV pd | +20.5dB |
| 6 segments | 2.97uV pd | +24.1dB |

### Transmitter

| | |
|---|---|
| Peak Deviation | 5.29kHz |
| Toneburst Deviation | 3.70kHz |
| Frequency Accuracy | −190Hz at switch-on |

| Harmonics/Spurii | |
|---|---|
| 2nd Harmonic | −77dBc |
| 3rd Harmonic | less than −90dBc |
| 4th Harmonic | less than −90dBc |
| 5th Harmonic | −88dBc |
| 6th Harmonic | −86dBc |
| All other outputs less than −90dBc. | |

| TX Power and Current Consumption | 7.2V Supply | 8.4V Supply | 12.0V Supply |
|---|---|---|---|
| Low Power | 0.475W/495mA | 0.475W/495mA | 0.475W/495mA |
| High Power | 2.24W/1.05A | 3.08W/1.22A | 5.51W/1.41A |

# HAVE YOU EVER BEEN /MM

***You may have heard mobile marine stations, but how many have ever been one? Not many! Come on in, the water's lovely, says Paul Holland, G3TZO.***

**The author going /MM, with an FT901DM, ATU and R2000 ATU.**

The real value of having amateur equipment on board was bought home to me last year. Disaster nearly struck when cruising off the west coast of Scotland. The boat, a Princess 37 twin-engined motor cruiser had been equipped for the passage to Campbeltown on the Mull of Kintyre with a Yaesu FT 225 RD 2m transceiver. The antenna, a ¼ vertical, was mounted about 12ft above the sea level up on the flying bridge. With the Pillar Rock light on the south west tip of Arran just starting to appear through the spray crashing on the wheelhouse screen and the sea making life just a little difficult for all on board, the port engine suddenly stopped.

Before we had time to consider the implications of this untimely occurence the starboard engine also stopped. For the non-nautical types this meant we had no engines at all! I had no option but to try and attract somebodys attention via 2m. The local repeater in this area is GB3AY and although somewhat scratchy at that range, with the violent motion of the boat not helping, I was able to get a reply. The amateur concerned contacted the Coastguard and informed him of our plight.

The outcome of this episode is somewhat of an anticlimax: there were no subsequent interviews for 'News at Ten', no ride in a bright yellow helicopter and gladly no post mortems. The engines were restarted with some frantic encouragement and a safe port was reached but the value of the communication available was underlined.

## Why amateur?

At sea the modern seafarer is surrounded by technology. This grew from the early days of spark transmissions, which ensnared the infamous Dr. Crippen, to the present day with sophisticated satellite communications which allow transmission of voice, data and facsimile to a ship at any time, anywhere. It would seem superfluous to carry amateur bands communication equipment on board! This takes no account of the basic desire of any amateur to explore the potential of the bands and communicate with other amateurs. However commercial links whether by satellite or MF/VHF cost money: they are not provided for casual contacts.

The amateur afloat who wishes to pursue his hobby must obtain the Amateur Maritime Licence. This licence is issued by the Department of Trade and Industry, who recently took over this responsibility from the Home Office. To get one, the following requirements must be met:—

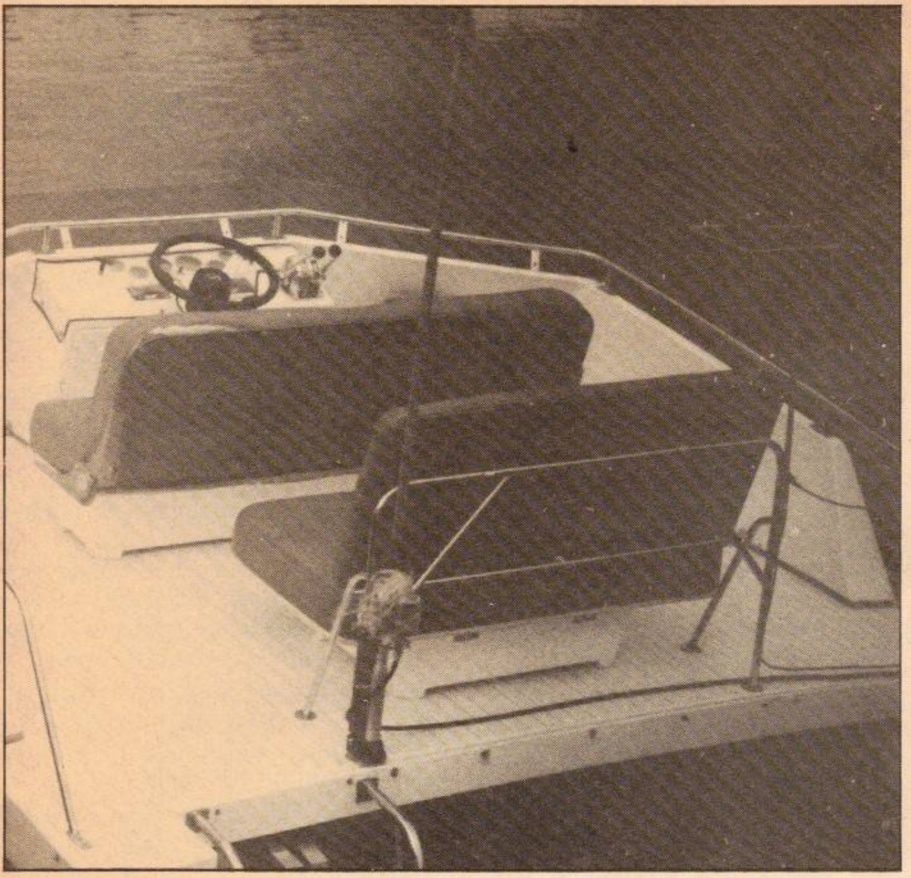
**1.** You should have an Amateur Radio Certificate. This certificate is issued when proof is shown that the applicant has passed the Radio Amateurs Examination of the City & Guilds of London and is issued by the DTI;

**2.** You must have proof of having passed a 12 words per minute morse code test which has been administered by the Radio Society of Great Britain;

**3.** If you are not the owner of the boat, you need a copy of permission given from the owner or ship's master (if applicable) and, if on a large vessel, the company responsible for the main radio equipment. If you are the ship's radio officer, you would also require permission from your own company;

**4.** You must also produce proof of British nationality.

The third of these requirements probably reveals why there are so few /MM operators. There are many who have tried to obtain the appropriate authority but for one reason or another few have finally emerged with a licence. This is a shame because there have been a few celebrated cases, such as the sinking of



**The flying bridge showing a high-gain 18AV vertical and 2m halo. Note the use of nylon ties to secure to stanchions.**

the 'Flying Enterprise' some years ago, where amateur radio equipment on board has passed the vital distress traffic. For those afloat on commercial vessels, perseverance must be the order of the day.

However, for the majority of us who dabble in boats the prospect is far brighter. As can be seen from **1.** and **2.** above the essential requirement is a Class A licence. If you are the owner of the boat then the third requirement holds no perils. You will have to apply separately for a /MM licence and the bad news is you will have to pay a fee equal to that of your existing licence, renewable on the anniversary of issue.

## New horizons?

What do you get then and, what can you do? Well the Amateur Maritime Licence effectively permits that which is excluded in Para 1 (a)(iv) of the main licence, that is operation while the vessel is berthed, mooring or anchored in any port, harbour or estuary in the UK or while at sea.

There are important restrictions for installations on board commercial vessels, relating to location of equipment, connection to an independent power source and non interference to the ship's navigational equipment but for private vessels owned by the licensee, the main restrictions are that you must maintain radio silence for three minutes at 15 minutes and 45 minutes past each hour, and that operation must be by the licensee only. The problem of maintaining a radio silence can be difficult when caught in mid-over or when it occurs just as the other station passes it over to you, but if the situation is explained there is usually no problem.

There is one significant difference between the standard Class A licence and the /MM licence in that the schedule of operating frequencies is somewhat restricted afloat. Operation on 160m and 80m is not allowed (I assume that this is intended to minimise the possibility of interference to the MF shipping frequencies and in practise it proves to be no insurmountable loss). Operation is allowed on the bands 40m to 10m together with 2m. Interestingly, the only other allocation is at 24GHz which will certainly provide scope for the enthusiast who wants to provide rare squares for the microwave fraternity!

## Which band?

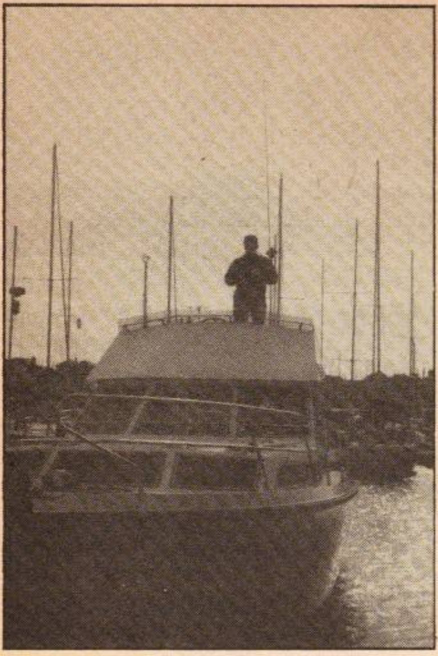
The extensive network of 2m repeaters in use now offer some real advantages to operating VHF afloat. Obviously there is nothing closer to operating from sea-level than actually being on the sea. Coupled with the pitching and tossing often encountered at sea this will often limit normal ship to ship communications to something like 10 miles. The presence of a local repeater ashore can extend this range considerably.

I have tried both horizontal polarisation with a halo antenna and vertical polarisation with various whips but the depolarising effect of the boat's movement make any conclusion difficult. Perhaps vertical polarisation is more effective, if only due to the ubiquity of vertical antennas on 2m nowadays.

Many locals are somewhat surprised when called through their local 2m repeater but the majority are usually highly intrigued as to the nature of the operation. The most unusual contact I have ever had was with a station using a hand held transceiver whilst walking down Saughie Hall Street in Glasgow whilst I was departing from Holyloch on the Clyde. This was achieved via the GB3CS repeater.

Operation on the HF bands is equally challenging and exciting. For UK working I favour 40m during daylight hours. Unless operation is from a vessel of substantial proportions which would allow the erection of a horizontal wire antenna, you are almost certain to opt for a vertical. The sea makes a perfect ground

**A view of the gear on board the 'Eilene Á Leanian'**



**First officer G4JMF on the flying bridge of 'Eilene Á Leanan'**

plane so the vertical is a particularly effective antenna. From the west coast of Scotland I have worked regularly into G and have maintained regular skeds with stations in Orkney using 40m. The noise environment is of course very low at sea which permits QSOs at a much lower signal threshold than would be possible from the home QTH.

At night 20m operation invariably takes over. There are several /MM nets regularly in operation on 20m and there is always a fascination in completing a QSO with another boat many miles away.

## Operating

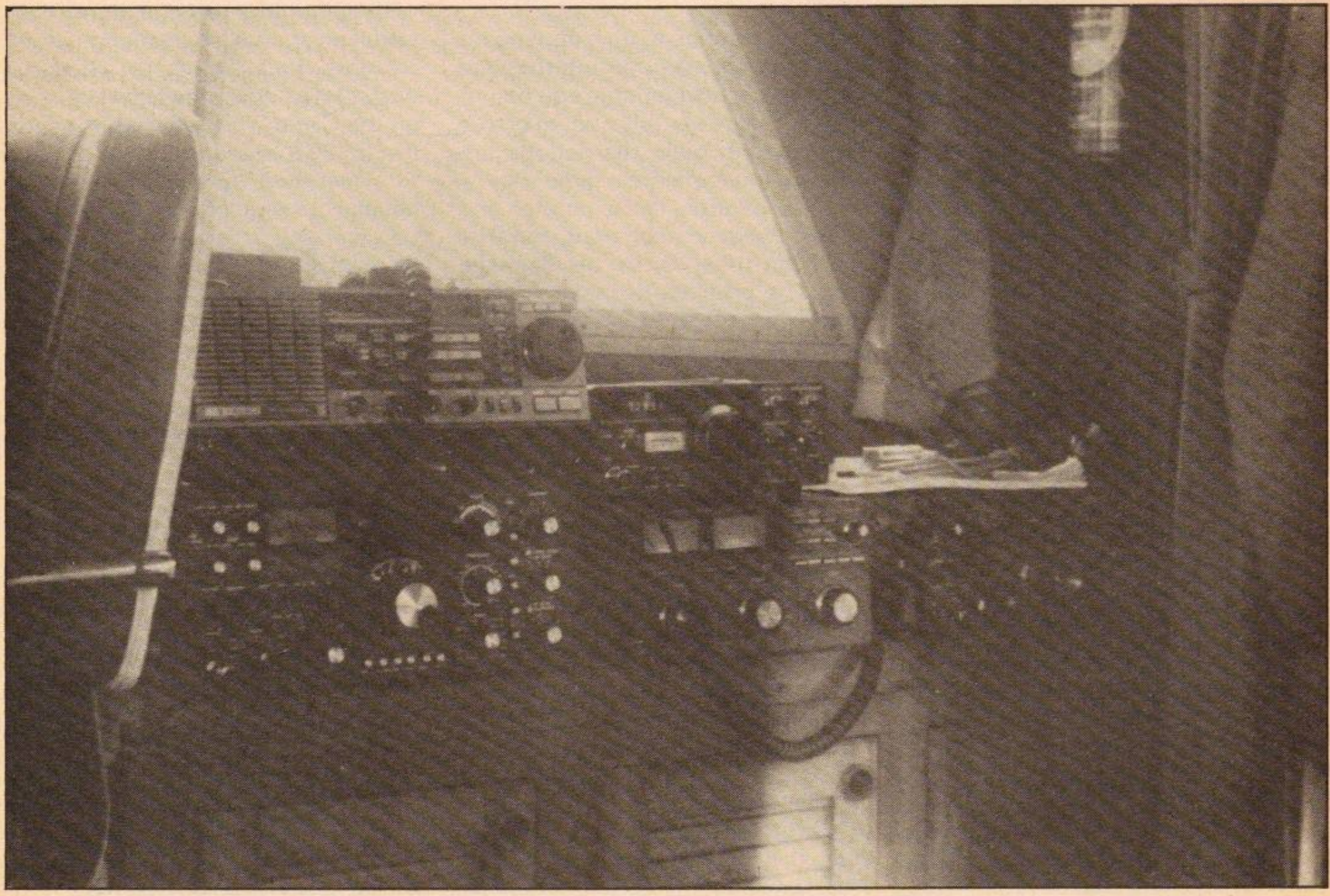
Using just 10W of power requires patience if you are not going to flatten the boat's batteries. Be more careful than usual in selecting a clear frequency and remember to emphasise the /MM suffix when trying to attract attention — it can be worth a couple of S-points! Once the station at the other end knows who you are you can be certain he will try and pull you through.

As far as equipment is concerned the main objective is that the shipboard electrics do not get overloaded. Run very heavy duty cables from the shack direct to the battery with a fuse adjacent to that battery for protection. Invariably you will have a separate battery for each engine and it is always policy to put the domestic load on one battery and leave the other battery free. This will ensure that you can start at least one engine in the event of a flat battery and the other can then be charged when under way.

Fitting an antenna on a fibre-glass boat can pose a problem. I have always solved this by using nylon tie wraps which can pass around the stub mast or fixing bracket and fix to a suitable stanchion on deck. The big advantage of this that the tie can easily be cut and the antenna removed leaving no visible or costly scars on your pride and joy. These tie wraps are immensely strong and I have not lost an antenna overboard yet.

With the accent on flexibility and minimal disruption to the interior fitting of the boat, I have never made a permanent installation of gear on board. The strong rubber straps used on roof racks are ideal for holding a lively transceiver down in a seaway.

Operation /MM can be a lot of fun. The restrictions are not severe and I hope that this article may serve to stimulate those who love messing about in boats but hate to leave the gear in the shack. Bon voyage!



**The author's /MM station with an FT901DM plus ATU, TS120S, FT225RD and R2000.**

# FUN TRANSMITTER FOR 20

QRP is one of the largest areas of growth in amateur radio. More and more people are finding it is possible to construct their own equipment without taking months building it or spending a fortune on components. The idea of building a "fun" transmitter in just a few evenings and putting it on the air for very little cost seems to be here again. Through this the amateur spirit is being put back into radio.

*In a successful attempt to re-discover the joys of low-tech DIY, Ian Poole, G3YWX, builds a transmitter virtually anybody could emulate.*

The first decision to make was the choice of band. Although most of the QRP operation seems to take place on 80 and 40 metres there was no question in my mind, as my favourite band is 20. From then on the circuit seemed to develop until finally it reached fruition.

The resulting transmitter does not possess any revolutionary features, nor does it have a large power output. It was designed purely as a "fun" transmitter to see what could be constructed using low power and to experience the thrill of working other stations on a truly home-brewed transmitter. In fact the results were quite encouraging. The little transmitter with its half-watt output made many contacts over distances which corresponded to more than one thousand miles per watt.

## The Circuit

The design was kept simple and uncomplicated in order to keep the construction as straightforwards as possible. The circuit in **Fig. 1** shows the design. It consists of a 2N2329 as the oscillator driving a VMOS FET as the output device. Then the signal is filtered after leaving the FET before it reaches the aerial.

The oscillator circuit is based around the Colpitts configuration which has always given me satisfactory results. A few component value changes and additions from those I usually use were made in order to optimise the performance for this particular application. One of these additions was to include a variable capacitor and coil between the crystal and earth. This combination of coil and capacitor enabled the frequency of the crystal to be pulled by as much as ten kilohertz. Any frequency shift of this nature is particularly useful as it enables the transmitter to be netted onto another

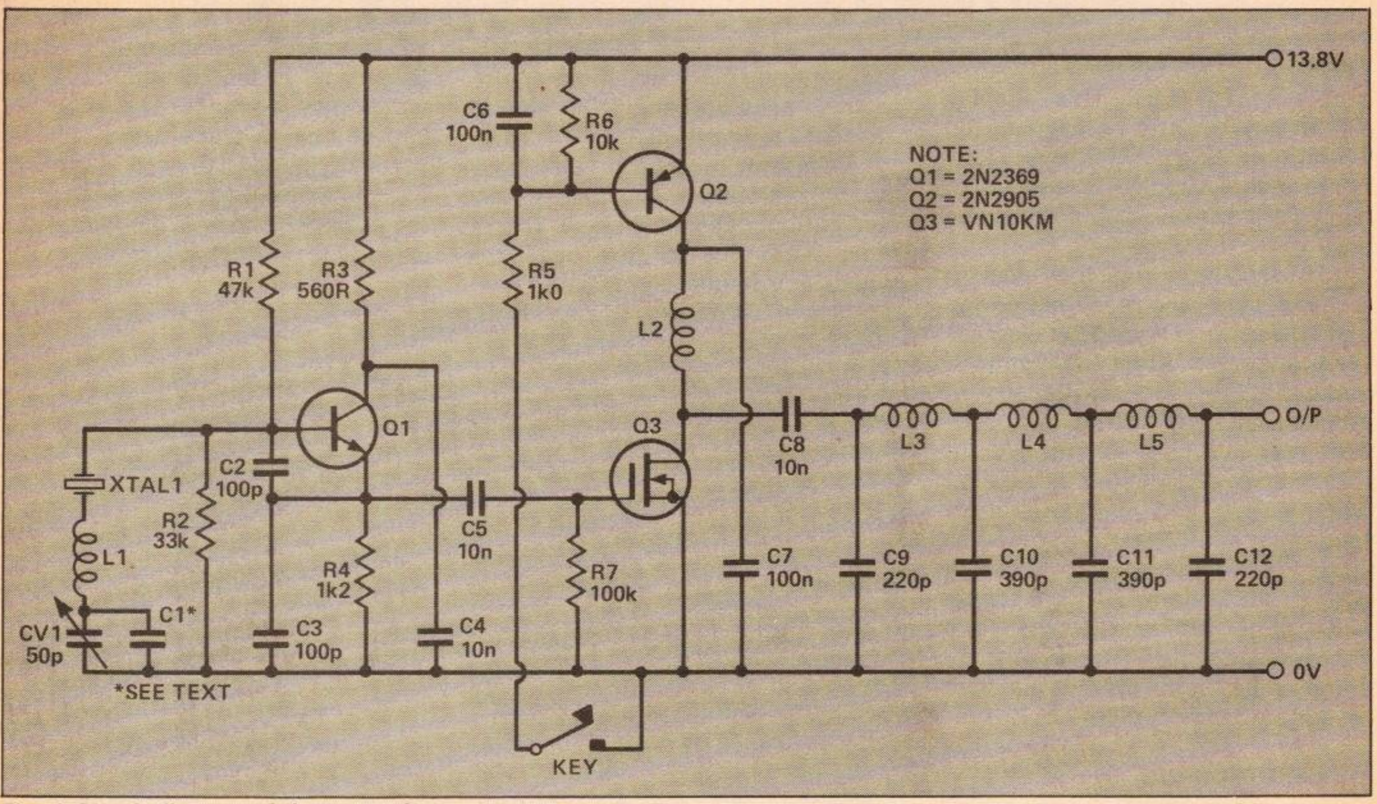



**Fig. 1 Circuit diagram of the transmitter.**

stations frequency to give a call rather than just having to call CQ.

The signal passes to the output stage which is based around a VN10KM VMOS FET. It was decided to use a VMOS device for three main reasons: the first is that the high input a VMOS FET offers would only marginally load the oscillator; the second is that it can withstand a fair degree of punishment; and the third and major reason was that I had not used a VMOS FET in a transmitter before.

The circuit for this stage is very simple. No impedance matching is provided between its output and the filter network because it presents a reasonable 50 ohm match. Any transformers would add complexity to the circuit and add little to the performance.

The keying is applied to this stage, using a series transistor in the supply to the FET. This enables almost any keyer to be used as the actual switching current is very low. Some signal shaping is applied to reduce any key clicks which may be present.

Finally the filter: this was in some respects the most interesting part to design. It is a seven-element Chebychev filter with a 0.1dB in-band ripple. This was chosen because it provides a large amount of out-of-band rejection coupled with low in-band loss. In addition to this the filter was designed to have a cut-off frequency of 17MHz, in order to allow sufficient margin for the component tolerances. These can be fairly large where the coils are concerned, because the permeability of the ferrite for the torroids can vary by quite a large degree.

## Components

It should not prove difficult to obtain most of the components used as they are stocked by most electronic components dealers. The only components they are unlikely to stock are the crystal and the torroid. The crystal can be obtained from Golledge Electronics, Merriott, Somerset TA16 5NS, who stock a wide range of crystals for QRP operators. Then the torriods can be obtained from SMC (TMP), Unit 27, Pinfold Workshops, Pinfold Lane, Buckley, Clwyd CH7 3PL.

## Construction

The construction of the circuit should present few difficulties. It could be built up on plain veroboard using a pin and wire technique like the prototype. Alternatively a small printed circuit board could be made up. If this is done then it is probably worth using double sided board, so that one side can carry the majority of the tracks and the other side is saved as an earth plane.

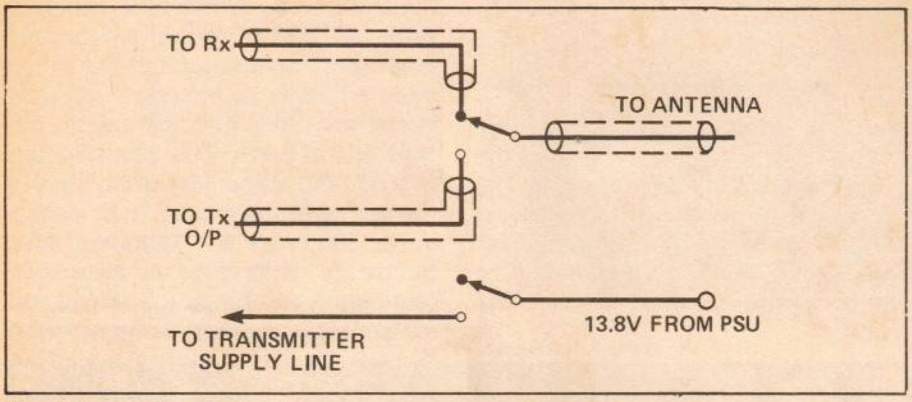



Fig. 2 Transmitter switching.

Whatever method is used care should be taken to keep interconnection reasonably short. This is most important for the oscillator where any undue pickup may give rise to chirp or instability. Additionally, if an earth plane is *not* used, the earth or 0V line should be kept as short as possible and not run all around the board. One way of doing this is to take the earth wire along the bottom of the board and connecting components either directly to it or by short wire links.

The coil winding is probably one of the more time consuming parts of the construction. However, with only five to be wound the task should not be too onerous.

The first coil is L1 in the oscillator. This is used to enable the crystal frequency to be pulled further than if only a capacitor was used. As such its value is not critical, but if it is too small then less frequency shift will be obtained, and if it is too large the oscillator may stop or not be controlled by the crystal. The optimum value for any particular transmitter layout and crystal can be found with a little experimentation, but 15 turns on a 4mm former is not a bad starting place.

The RF choke L2 for the output FET can also be wound. Ideally its value should be around 100 uH but this is not critical. A suitable choke can be made by winding seven or eight turns on an FX1115 ferrite bead.

Unlike the other coils those in the low pass filter are more critical. They each consist of 13 turns of enamelled wire. The winding should be spaced to cover about 90% of the former in order to reduce inter-winding capacitance. The windings can be held in place using tape or, better, by coating the coil in varnish.

Once the coils and the rest of the construction is finished the unit is ready to set up and try out on the air.

### Components list

| | | | |
|---|---|---|---|
| **RESISTORS** | | **INDUCTORS** | |
| R1 | 47k | L1 | see text |
| R2 | 33k | L2 | 100 uH (7 or 8 turns on FX1115 ferrite bead) |
| R3 | 560R | | |
| R4 | 1k2 | L3,4,5 | 13 turns on T50-6 core (see text) |
| R5 | 1k0 | | |
| R6 | 10k | | |
| R7 | 100k | | |
| | | **SEMICONDUCTORS** | |
| **CAPACITORS** | | Q1 | 2N2369 |
| C1 | approx 5p (see text) | Q2 | 2N2905 |
| C2,3 | 100p | Q3 | VN10KM |
| C4,5,8 | 10n | | |
| C6,7 | 100n | | |
| C9,12 | 220p | **MISCELLANEOUS** | |
| C10,11 | 390p | XTAL1 | 14.060 MHz crystal |
| CV1 | 50p variable | | (or see text) |

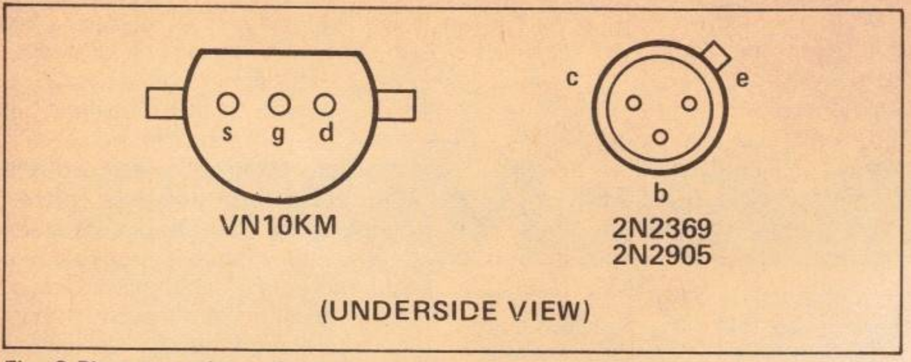



**Fig. 3 Pin connections of the semiconductors.**

## Setting up and operation

The transmitter required very little setting up as all the adjustments are associated with the crystal oscillator. Some experimentation can be done with the coil and capacitor to obtain the optimum amount of pull on the crystal. However, when doing this it should be remembered that if one is too ambitious problems can be encountered, as already noted. Another problem which can be found is that the output of the oscillator will fall off when the value of the variable capacitor becomes very low. This problem can be overcome by placing a small-value fixed capacitor across the variable one.

On test the prototype transmitter gave a good account of itself. It delivered about half a watt, which fell off if the supply voltage was reduced. Harmonics were found to be well down: the second harmonic was better than −45 dB down and all the other were lower than −55dB.

When the transmitter was put on the air some contacts were initially made using just a random length of wire in the loft. However, when a 20 metre inverted V was put up outside contacts were easier to come by and signal reports improved. This illustrates the need for a good aerial particularly for QRP operation.

Initially the transmitter was operated around 14.060 MHz, the QRP calling frequency on 20 metres. However it soon became clear that ordinary high-power stations could be contacted if they were strong enough and a selection of other frequencies would be useful. As a result a crystal for 14.030 MHz was bought to give a wider choice of frequencies and hence a wider choice of stations to call.

## Conclusion

This little transmitter was fun to design, build and operate. It claims no special features except that it is fairly simple, straightforward and cheap. It gave me a good re-introduction to QRP after several years of higher power operation. It also showed just what can be done with a small amount of RF and a certain amount of patience. Maybe it will stir a few others like myself to rediscover, or discover for the first time, some of the joy and excitement of QRP.

# HAM RADIO TODAY NEXT MONTH

## FIRST REVIEW IN EUROPE


### KENWOOD TM-221E

Another first for Ham Radio Today — we review the two metre mini-mobile due to be launched later this month.

### 144 TO 50 MHz TRANSVERTER

With sporadic E just over the horizon and 50MHz being opened up to class-B licensees, this band should see something of a renaissance. We look at one way to get onto this band, using a transverter from Microwave Modules — and it won't break the bank!

### TOP BAND ON A POSTAGE STAMP

You can get 160m into a pint-sized garden if you really try!

### CLUB NIGHT

Is your club welcoming? You may think it is, but how does it feel to a visitor?

# WHO WAS SAMMUEL MORSE

The name Morse conjures up many different ideas. There's the dreaded Morse test, or maybe the cacophony of noise which appears at the bottom end of the HF band, or perhaps just the idea of a lot of unintelligible dots and dashes. Whatever your thoughts, the original concept of communicating in this way was brought about by a remarkably talented man who would probably be unknown if the Morse code did not bear his name.

***We all know the name, but how many of us know anything at all about the man? Ian Poole, G3YWX, reveals the person behind the code.***

Comparisons have been drawn between Morse and the very much more famous Leonardo da Vinci because Morse was not only an inventor, but also an artist. Although his paintings are not so well known in Europe they have gained great popularity in his native America, where they are thought to be some of the best work to have been done there. In addition to all of this he was a leader with great drive. It is probably because of this that the Morse code and electric telegraph were credited to him; having conceived the ideas he pursued them vigorously, organising the finance and the companies to market them across the world.

## The Early Years

Samuel Finley Breese Morse was born in 1791. He lived in a small town in Massachusetts called Charlestown, and he was the son of Jedidiah Morse, a strict clergyman.

The young Morse started his education at Philips Academy in Andover (USA). He was not a good scholar and showed little interest or aptitude in most of his studies. After these first poor results he moved to Yale College, where he became interested in painting, at which he was very good. He also developed an interest in the subject of electricity, which was very new at this time.

He graduated from Yale in 1810 and took up a career as a clerk for a book publisher in Boston. He did not enjoy this work and soon decided to become an artist. In order to do this he went to England to study painting because he felt that the schools over here would be able to teach him more about art than any in America.

Morse studied in England for four years and returned home in 1815. Unfortunately he discovered that there was little demand for the 'historical' style of painting he had studied and he turned to portrait painting. With financial needs pressing he became an itinerant artist earning what little he could. However, after a few years his reputation grew and this enabled him to settle in New York City in 1825. During the next few years he was able to paint more in the style he liked, and it was at this time that he produced his finest work.

Whilst Morse's reputation as an artist was growing, new discoveries were being made in the field of electricity. In particular, the effect of placing a soft iron core into a coil were being investigated. This was to prove crucial to the invention Morse was to make a few years later.

## The Inventor

Despite the growth of Morse's career as an artist he never lost his interest in electricity and the new inventions surrounding it. He kept in touch with the new discoveries and inventions which were happening quite rapidly.

He visited Europe again, and

Samuel Morse working at New York University in 1837.

*Courtesy of Science Museum, London.*

during his return journey in 1832 he hit upon the idea of using a switch or contact and an electromagnet being used to send signals over long distances. One home, he started experimenting with different ideas, but his painting and teaching commitments meant that he was unable to spend much time on his new invention. Finally after three years he finished in his first working model — the first electric telegraph.

In 1837, Morse decided to give up his painting and teaching so that he could devote all his time to the telegraph system. However, a problem arose when a friend showed him a similar system which predated his own. This was a rather more cumbersome idea for a telegraph system which had not been fully developed, but it showed Morse that he had to finalise his own ideas as quickly as possible.

Realising the need for more people to work on his project, Morse enlisted the friend as a partner. Together they quickly devised a system of representing letters and numbers with a series of dots and dashes of varying lengths. This original 'Morse code' was used for several years before the version used today was substituted.

In order to make this invention a viable commercial proposition the two partners had to gain the interest of large institutions. Their first attempts with the American Congress failed so they took the idea to

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

**Fig. 1 The original version of Morse's code.**

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

**Fig. 2 The modified code, still in use today since its introduction in 1851.**

England where Morse had fond memories of his life as an art student. However, people here also failed to see the significance of Morse's invention.

Undeterred by his initial failures Morse tried again to obtain support from Congress, but on his own this time. Eventually he managed to obtain $30,000 to establish an experimental line between Washington and Baltimore. A year later the line was complete and on the 28th of May Morse himself sent the first message: 'What hath God wrought!'.

## Legal Battles

With the success of the Washington to Baltimore link Morse became involved in a number of legal battles with his former partner, as well as other inventors. These cases took many years to settle and finally ended when a hearing in the United States Supreme Court decided in his favour.

Whilst these battles were progressing, Morse continued to develop his telegraph system. Not only did he lengthen the lines and refine the operation, but he also carried out tests with new ideas, including submarine cables. He incorporated many of these new ideas into his system which grew at a remarkable rate in America and Europe.

This dramatic rise in business for Morse's telegraph system brought him great wealth. He was able to buy two large residences. One was in New York City, whilst the other overlooked the Hudson River and it was here that he spent most summers.

## A New Morse Code

It did not take too long for limitations to be found with the code which Morse had devised for his original telegraph system. It was found to be difficult to send, because some letters had spaces in the middle and others used different length dashes. The original code had no provision for any of the letters with accents commonly used in many European languages.

As a result, a new code was devised and introduced in 1851. This not only had provision for accented letters, but it was easier to send. The different length dashes were discarded and the dash was standardised as three times the length of a dot. Also the spaces within letters were removed and some symbols were changed so that longer or more difficult symbols were given to letters which were used less frequently.

Despite all these changes there remain large similarities between Morse's original code and the new one which is still used today.

## Old Age

Morse's invention had earned him great wealth. In his old age he enjoyed being a benefactor to colleges, churches and other Christian organisations. He also remembered his times as a poor itinerant artist and was frequently known to give money to others starting as he had done.

Morse lived until he was 80, dying in 1872. It is said that he wanted to be remembered for his invention of the telegraph, and this will always be true. However, his paintings are becoming increasingly popular and his reputation as an artist is growing.

# UPDATE · MICROCHIP
# MORSE DECODER

By adding a plug-in selector switch and a changing of EPROM program, the HRT Z80 decoder board (described in the January 1987 edition) can be made to decode several additional modes other than Morse code.

The Morse software is very compact at well under half a kilo byte, and there is ample room in the 2716 EPROM for an additional RTTY and ASCII receive option. Selection of the required mode is done by reading port A, which is configured by the software to give 8 inputs. A simple switch to ground on each input and a pull-up resistor of about 1 to 10k are all that are required. This can be built conveniently on a small piece of stripboard, using an eight-way DIL switch (which can be socket mounted if preferred), an in-line resistor pack, and a plug made from a 16 pin DIL header.

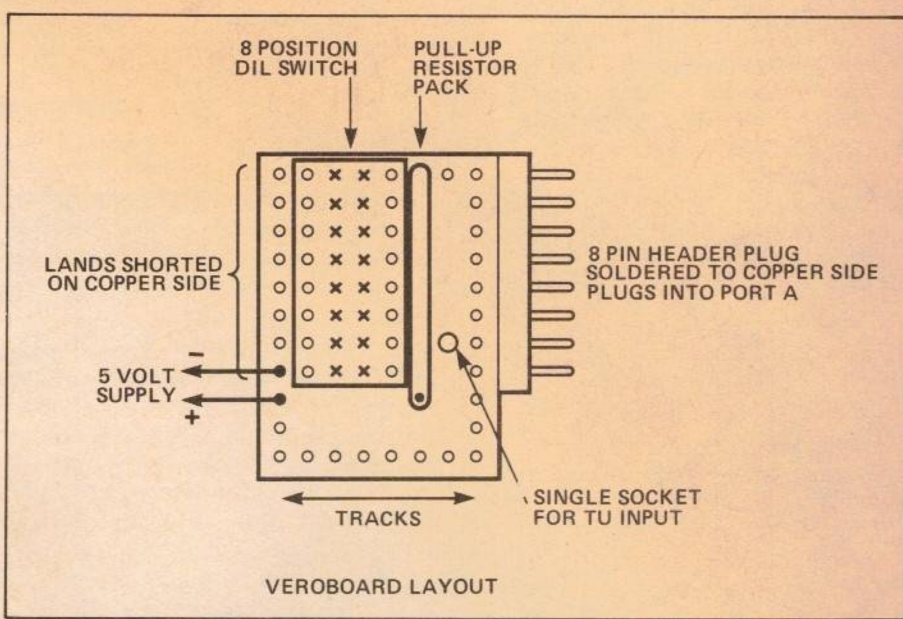



**Fig. 2 A possible layout for the switches and resistors.**

***Phil Green, G4PHL, adds a few ASCII bells and RTTY whistles to the Morse to Centronics decoder.***

A change of mode requires a reset or power off-on cycle, since port A is not continuously monitored by the program. After a reset, the new mode, clock rate and baud rate will be printed for reference. Note that since the TU input is to bit one (not zero!), no switch is needed on this pin.

The allocation of port A bits is shown in the Table. One of the switches allows the timing dependant routines to be adjusted to suit either a 3.579 or 4.000MHz clock oscillator crystal, allowing the most convenient crystal to be used. Bit zero (SW1) is unused, as is mode selection 4, and I hope that anyone with an interest in programming who produces a program for the board, will write to HRT so that we can produce a pool of useful software to be shared with other readers.

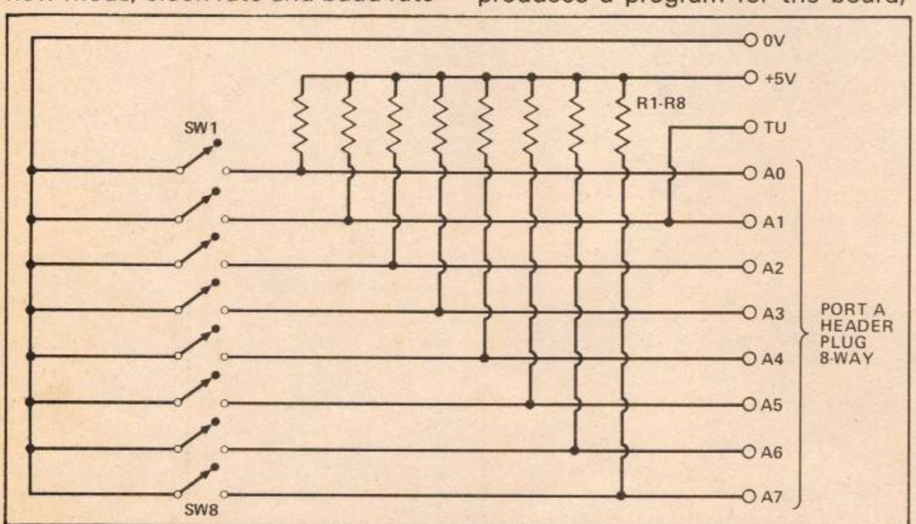



**Fig. 1 The resistors and switches needed to access the alternative modes.**

## The Terminal Unit

Much time has been spent trying to get reliable operation out of the built-in NE567 terminal unit on RTTY and ASCII. Unfortunately, it has proved barely adequate, as it was intended as a cost effective way to interface Morse only. However, with a little experimentation it is possible to get something out of it, although the author would recommend use of the ST5 TU with TTL output for consistent results.

An external TU is certainly necessary for ASCII as this uses CUTS tones (1200/2400Hz) at 300 baud. Standard tone frequencies used for RTTY are 1445Hz for mark (the standing condition when no information is being transmitted) and 1275Hz for a space. The on-board terminal unit can detect only one of the two RTTY tones, assuming that if one tone is absent, the other must be present. It cannot perform as well as, say, the ST5 or similar, but works pretty well on CW. Noisy HF signals are bound to cause trouble, unless some filtering is added.

The bandwidth of the NE567 is set by C5 on pin 2, and some experimentation here may give an improvement. Generally the higher the capacitance, the tighter the bandwidth. RTTY frequencies can be easily achieved by replacing resistor R7 (12k) with one of 4k7. In this case, the NE567 should be tuned to the lower pitched RTTY tone, 1275Hz. During a mark condition therefore the NE567 output will be high (out of lock, no tone detected), and during a space condition the NE567 will lock and drive its output low.

RV1 should be carefully set to tune the TU to 1275Hz, using either a counter on pin 5, or alternatively by beating pin 5 audibly with a known reference tone. Test tones can readily be generated with reasonable accuracy by most personal computers, using the SOUND or PLAY commands. The NE567 output, one for mark, and a zero for space, is then applied to the PIO input bit one as in the Morse code.

Another unknown when tuning an RTTY signal is its baud rate. On the HF amateur bands, 45.5 is the most common, but 50 is the norm for VHF. Most commercial news stations use 50 baud, but there are several at 75. Usually, experience will enable the user to estimate the baud rate by ear. Given the inherant tolerance of the start/stop teleprinter code, however, selection is not as difficult as it sounds!

## New Facilities

Baud rates of 45, 50, 56, and 75 are provided on RTTY, and 100 or 300 in ASCII mode (but note that some printers may not be able to cope with continuous data at 300 baud, there being no 'busy' lead. Automatic unshift-on-space is provided during RTTY reception, to prevent prolonged errors should a figure shift be induced by noise. The Morse software is unchanged from the original January article. Incidentally, the 300 baud to Centronics mode allows computers with only a serial port access to a parallel printer, but using the Microchip Morse Decoder to do this really is taking overkill to the extreme!

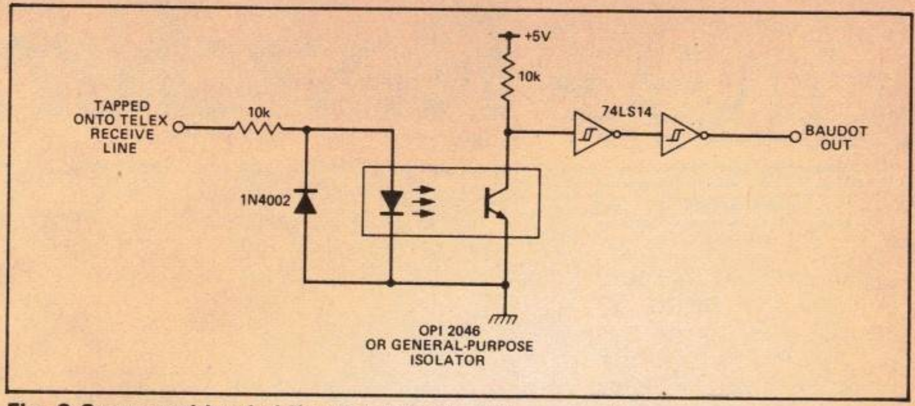



**Fig. 3 Suggested level shifter for telex to TTL conversion.**

Although the baudot to centronics mode will be used mostly for receiving radio-teleprinter signals, it is of course equally happy printing a 'land-line' telex, via a suitable level shifter (an opto-isolator is ideal). The prototypes proved invaluable in this mode, which, although limited to receive only, allows an inconspicuous printer to be located on the office desk for incoming telex calls. Signals are +/− 80 volts at 50 baud from the exchange (mark is −80) and a suitable interface circuit is shown in Fig. 3 since the module and printer are effectively in parallel with the main office teleprinter two paper copies are available.

As the reader will appreciate, some considerable work has gone into programming this little unit, and so the new software will be slightly more expensive at £5. For the same reason, no dump of the EPROM contents will be published. Anyone who has the 'Morse only' software can on return of the EPROM, have it updated to multi-code for a charge of £3. These are available from the author at 6 Yews Close, Worrall, Sheffield, S30 3BB.

## Gremlins Corner

Three gremlins crept into the original article, which were:

- The 'earthy' end of RV1 shouldn't be earthed at all. Cut the track between the NE567 pin 7 and RV1. The TU circuit diagram needs amending too.
- The TU input goes to bit ONE of the PIO port A, as in the diagram, and not to bit ZERO as on early PCB's. Move the link if necessary.
- The clock input to the PIO has been omitted from the circuit diagram, but the PCB is OK. PIO pin 25 should go to Z80A pin 6. The PIO should be a Z80A PIO, the 4MHz version.

| | SW8 | SW7 | SW6 | SW5 | SW4 | SW3 | SW2 | SW1 |
|---|---|---|---|---|---|---|---|---|
| SWITCH FUNCTIONS | | | ACSII BAUD RATE | CLOCK FREQ 0 = 3.579 1 = 4.000 | | | OPEN TU INPUT | SPARE |
| | MODE | | 0 = 110 1 = 300 | | RTTY BAUD RATE | | | |

CLOSED = '0'
OPEN = '1'
SW2 ALWAYS OPEN

MODE: 00 = MORSE, 01 = RTTY, 10 = ASCII, 11 = SPARE

RTTY BAUD RATE: 00 = 45, 01 = 50, 10 = 56, 11 = 75

**Table 1 The switch functions.**