RELYING ON PYE

Ten years ago, there were few ready-made two metre transceivers. Many of the new G8s got on the air by buying an old Pye rig originally designed for 'private mobile radio' use.

Second-hand Pye rigs are still very much around, and still offer a cheap way of getting on the air. In this article, which first appeared in Feedback, the journal of the Bury Radio Society, Malcolm Pritchard G3VNQ describes what's available and how to modify it for amateur frequencies.

A few years ago, the two-metre band was alive with amateurs using converted equipment on both AM and FM. Surplus radiotelephones were cheap, easily modified and produced a clean transmitted signal provided that the modulator and RF filtering had not been 'got at'. Nowadays activity has grown so much on 2 metres that synthesised equipment covering a wide range of frequencies is almost mandatory. It is possible to add synthesisers to ex-commercial equipment but the cost effectiveness against an equivalent 'black box' is doubtful.

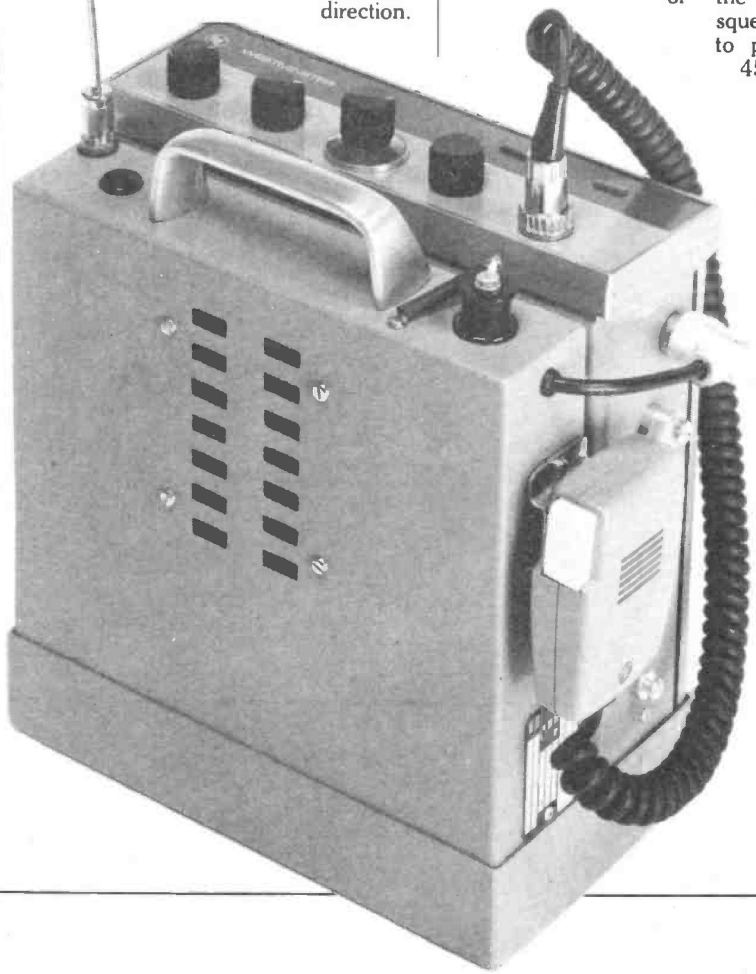
70 centimetres and 4 metres are somewhat different. Lower levels of occupancy mean that just a few channels are sufficient for local working. A good starting point is 70.26MHz (AM or FM) on 4m and 433.2MHz (FM) or your local repeater on 70cm. (Note that 433.2MHz is used by Raynet in some areas.)

Commercial equipment in this country is designed for various frequencies. Taxi-type radiotelephones may cover 'low-band' (66-88MHz, 'E' band), 'high-band' (148-174MHz, 'A' band) or UHF (440-470MHz, 'U' band). Split-frequency operation between base and mobile is the norm: typical bands are shown in Table 1. 'Midband', from 105 to 108MHz will be reallocated to broadcasting at some stage, so we can expect more surplus equipment from this direction.

VHF equipment (low, mid and high band) in the UK can be either AM or FM. Pye promoted AM for many years because of the ease with which channel spacing could be reduced. The current standard is a channel spacing of 12.5kHz, though older equipment may be encountered which is wider. UHF equipment is *always* FM and the current spacing is 25kHz. Older UHF equipment such as PF1 Pocketfones were 50kHz. The designations used by Pye are shown in Table 2.

Equipment for specialised bands is sometimes encountered. 'Air-band' sets for air-to-ground use 118-136MHz and are AM, single frequency working (not split). Marine VHF sets cover 156-158MHz and 160-163MHz on FM. Air band sets may appear with 25 or 50kHz channelling, while marine sets employ 25kHz spacing nowadays.

When buying a surplus set, bear in mind whether it is AM or FM, and whether the channel spacing will be satisfactory. Reception of ± 5kHz deviation FM signals through the narrow filters of a 12.5kHz channelling set will not satisfactory. Similarly, expect interference when receiving signals spaced 25kHz apart on a 50kHz channelling set. AM equipment *can* be converted to FM, but this becomes more difficult with recent equipment using higher frequency transmit crystals. Many AM Cambridges and Vanguards were converted to FM by modulating the 8MHz transmitter crystal oscillator and fitting a Garex adaptor board in place of the receiver squelch board to provide a 455kHz limiter and demodulator.



Left: Pye transceivers old and new. From left to right: Cambridge, with Pocketfone PF1 receiver and transmitter on top of it; Westminster; Pocketfone 70; Pilot. Far left: Westminster with portable rechargeable battery and aerial pack. The charger plugs into the Bulgin socket, shown here with the dummy plug inserted. Below: Pilot, the aircraft version of the Motafone.

The most useful item for anyone converting Pye equipment is a copy of the manufacturer's service manual or service sheet. These are clear and comprehensive, giving full alignment details, test points and component information for the different frequency bands. Places to enquire for manuals include your local radio club and dealers such as Garex who appear at the mobile rallies.

Quartz crystals can be obtained from the specialist firms advertising in the magazines. State the frequency/channel number/holder required *and* the equipment for which the crystals are needed. The reason for this is that crystal specifications differ for different equipment. A 'rock' which is suitable for a Japanese transceiver many oscillate on a different frequency in a Pye set.

Cambridge (AM10, FM10)

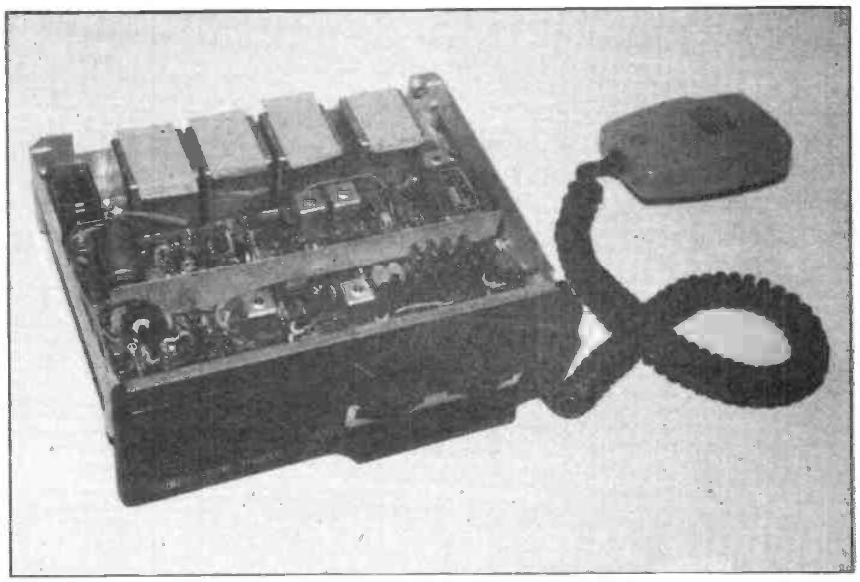
The Pye Cambridge was an early sixties design mobile transceiver with an all-transistor receiver. The transmitter was valved, using a QQV03/10 dual tetrode in the PA, with power supplied from a transistorised inverter. Power output was 5 to 7 watts for the AM version and up to 15 watts for the FM model. VHF sets were available in dashmount (suffix 'D') or boot mount (suffix 'B') versions. The UHF Cambridge was only available as a boot mount and used quick-heat TL1130 valves in the transmitter to provide 5 watts output. Bootmount transceivers were provided with a separate control box, microphone and loudspeaker linked to the main unit by a thick, multicore cable. The manufacturer's catalogue number on the identification plate can give useful information about a set's capabilities: thus an AM10DV is an AM dash mount Cambridge for 25kHz (V) spacing whilst an FM10BS/6 is an FM boot mount 12.5kHz 6 channel set. A U10BV is a 25kHz boot-mount type for UHF.

As already mentioned, conversion from AM to FM can be accomplished by applying audio to the 8MHz transmit oscillator. (Either the varicap diode on the crystal, or the oscillator screen). However, the deviation tends to be asymmetric and dependent on the crystal. A better approach is to rebuild with a valve or transistor phase modulator. A valve phase modulator employing a 12AT7 double triode appears in most of the RSGB handbooks. The receiver can easily be modified to FM by fitting a detector board as provided by Garex in place of the squelch board.

The VHF Cambridge receiver has two RF stages employing germanium PNP transistors. Sensitivity can be improved if these are replaced by more modern AF239 or AF279 types. Take care with the pin connections! When adjusting the cores on the RF board, remember to use the correct trimming tool (RS double ended blade type) and select the resonant position with the core nearest the chassis, not nearest the top.

Single channel sets can be converted to 6 channel if the sockets and trimmers are available - the holes are already punched. The dash-mount set is the easiest to convert: boot mounts used a remote-operated Ledex rotary switch, replaced in late models by solid-state switching.

Circuit boards from the Cambridge were also used in other Pye equipment such as the F27 base station. This was a



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rack or cabinet mounting high power mains transceiver producing 25 watts output from a QQV06/40A dual tetrode in the AM version.

Vanguard (AM25)

The original version of the Pye Vanguard (AM25B) was a large, boot-mounted set with a mostly valve transmitter and receiver. The high battery consumption on both transmit and receive means that this set is best avoided nowadays, unless it is being broken up for spares or made into a transverter.

The later, transistorised version (AM25T) is a better bet because it is virtually a high-power Cambridge, using the same boards in many places. The PA employed a QQV03/20A to give 17 to 25 watts output on AM. Some amateurs changed this to a QQV06/40A as used in the FM25B FM version to increase the available power. There is plenty of room inside the case for modifications and a loud hailer facility can be included. Conversion is along similar lines to the Cambridge.

Westminster (W15, W30)

In the lower power version, the Pye Westminster was an all solid-state transceiver employing silicon transistors.

The higher power version (W30) still used a quick-heat valve in the PA and was only available in boot-mount style. The W15 for VHF came in both dash-mount and bootmount forms, while the UHF version (W15U) was made in boot-mount only. Power outputs were similar to the corresponding Cambridge models, 5-8 watts AM, 30 watts high power AM, 15 watts FM, 4.5 watts UHF.

Up to 10 channels could be fitted with separate transistor oscillators provided for each frequency. Channel changing was accomplished by switching on the appropriate oscillator, making scanning a possibility. Increasing the number of channels fitted may entail obtaining or building new circuit boards.

The Westminster is still a reasonable set for 4 metres and especially for 70cm (check the second-hand prices). A few can still be heard on 2 metres despite the restricted number of channels available.

The open layout of circuit boards on either side of the chassis allows easy access for alignment and modification: tone bursts and preamplifiers are easily included. The UHF version has so much space inside that tales have been heard of Wood and Douglas synthesisers being fitted!

Receiver bandwidth is determined by two filters: a 10.7MHz crystal filter and a 455kHz sealed LC filter. The Westminster appeared in the late 1960s by which time channel spacing on VHF had been reduced to 12.5kHz; bear this in mind if attempting to convert to current amateur standards of 25kHz channelling and peak deviation of ± 5kHz on FM.

As with the Cambridge, Westminster circuit boards will also be encountered in base station equipment of similar vintage such as the F30 transmitter/receiver.

Bantam (HP1)

The Pye Bantam was a mid-to-late sixties design all-transistor VHF transceiver. The receiver uses germanium transistors and was similar to the Cambridge except that a 10.7MHz crystal filter was included. Also, the power supply will repay study! The transmitter incorporated silicon NPN transistors, ending up with a 2N3553 which produces a 1 watt output.

The Bantam could be fitted with up to three channels. Since the set was intended for portable operation, power was supplied by a built-in nicad battery pack or (more expensively) by U7 dry cells or mercury cells. There was a built-in telescopic antenna, or a flexible whip or wire antenna threaded through the carrying strap could be employed.

Layout was relatively open for a portable transceiver. There have been many Bantams modified for 2 metres (FM) or 4 metres (usually AM). Perhaps not as compact as an IC-2E, but a lot easier to work on!

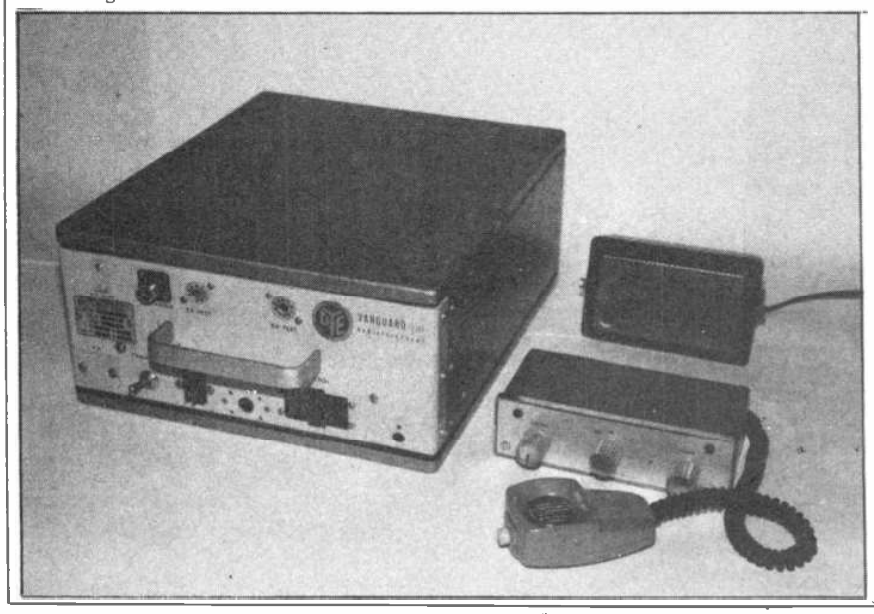
Table 1: typical frequency pairs

Band	Mobile transmitter	Base station transmitter
Low band	*71.5 - 72.8MHz*	*85.0 - 86.3MHz*
Low band	*76.95 - 78.0MHz*	*86.95 - 88.0MHz*
Mid band	*105.0 - 108.0MHz*	*138.0 - 141.0MHz*
High band	*169.85 - 173.05MHz*	*165.05 - 168.25MHz*
UHF	*447.5 - 449.5MHz*	*454.0 - 456.0MHz*

Various splits are used within 440-470MHz. There are also allocations below 430MHz

Table 2: Pye channel spacing designations

Pye designation	Channel spacing	Peak deviation on FM
'S' (Sharp?)	*12.5kHz*	*± 2.5kHz*
'V' (Very narrow?)	*25kHz*	*± 5.0kHz*
'N' (Narrow?)	*50kHz*	*± 15.0kHz*
'W' (Wide?)	*100kHz*	



Left: Boot mounting Pye Vanguard, with separate control box, microphone and speaker.

Pocketfone (PF1)

The Pye Pocketfone must be amongst the best value surplus equipment currently on sale with pairs advertised at £10 - £15. Of mid-60s vintage, the separate transmitter and receiver covered the (then) 450 - 470MHz UHF allocation. The transmitter radiated up to 100mW from its pop-up aerial, using a 2N3866 in the PA, while the receiver was dual conversion with a crystal filter on 10.7MHz (first IF) and a pulse-counting discriminator at the second IF of 100kHz. To cram all this into a hand-held set in the 1960s required some tight packing of miniature components, and one's first reaction on taking the covers off a PF1 is usually "strewth - where do I start?" Nevertheless, a great many Pocketfones have been converted for use on 70cm and they are especially useful for the local repeater if this is available at good strength. The receiver uses the loudspeaker grille as its aerial, so don't expect wonderful results. Some amateurs fit a BNC socket on the receiver for use with an external antenna or flexible whip.

The receiver audio on the built-in transducer is poor ('tinny' would be a kind description) but an external loudspeaker or headphones will improve matters.

Power is provided by nicad batteries, a short 9 volt one for the receiver and a longer 18 volt one for the transmitter. The quality of second-hand nicads can vary enormously depending on their past treatment so beware. A good receiver-battery combination should make a quiet ticking noise when switched on: this is the battery economiser circuit turning the receiver on momentarily to check for the presence of a carrier.

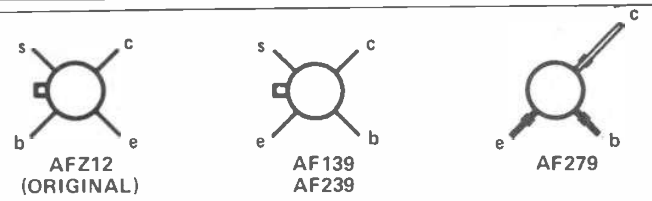
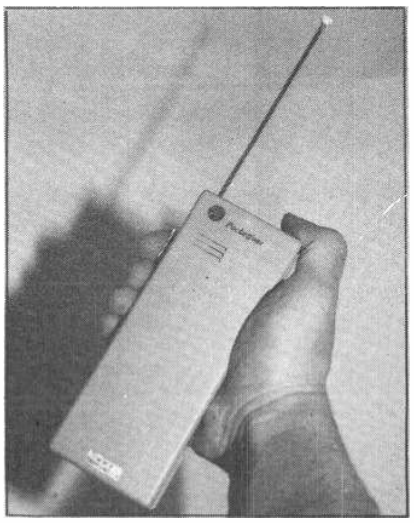


Fig 1: pin connections of transistors suitable for Pye Cambridge RF board to replace the original AFX12 (or similar) transistor, seen from above.

Standard sets can be aligned on 433MHz without too much difficulty (you may need your eyesight checking afterwards though!) The transmitter may need some more capacitance (5.6pF) across L4 before this inductor will resonate. The battery economiser should be disabled before attempting to align the receiver by shorting R51: full details are given in the manual. The receiver can be improved if the BF180 (or similar) in the RF stage is replaced by something hotter like a BFR34 - but beware of instability. The metal cover which has to be removed to gain access to the RF circuitry reveals the 85MHz 1st conversion crystal. The other crystal which is visible without removing the metal screen is the second conversion oscillator on 10.8MHz.

If the sets were originally assembled for 50kHz channelling (N), the crystal filter in the receiver will be a bit wide for the 25kHz spacing now in use on 70cm. However, in most cases this should not cause any problems. It will be more important to reduce the transmitter peak deviation from 15kHz to 5kHz: increase R9 to about 820k to accomplish this.



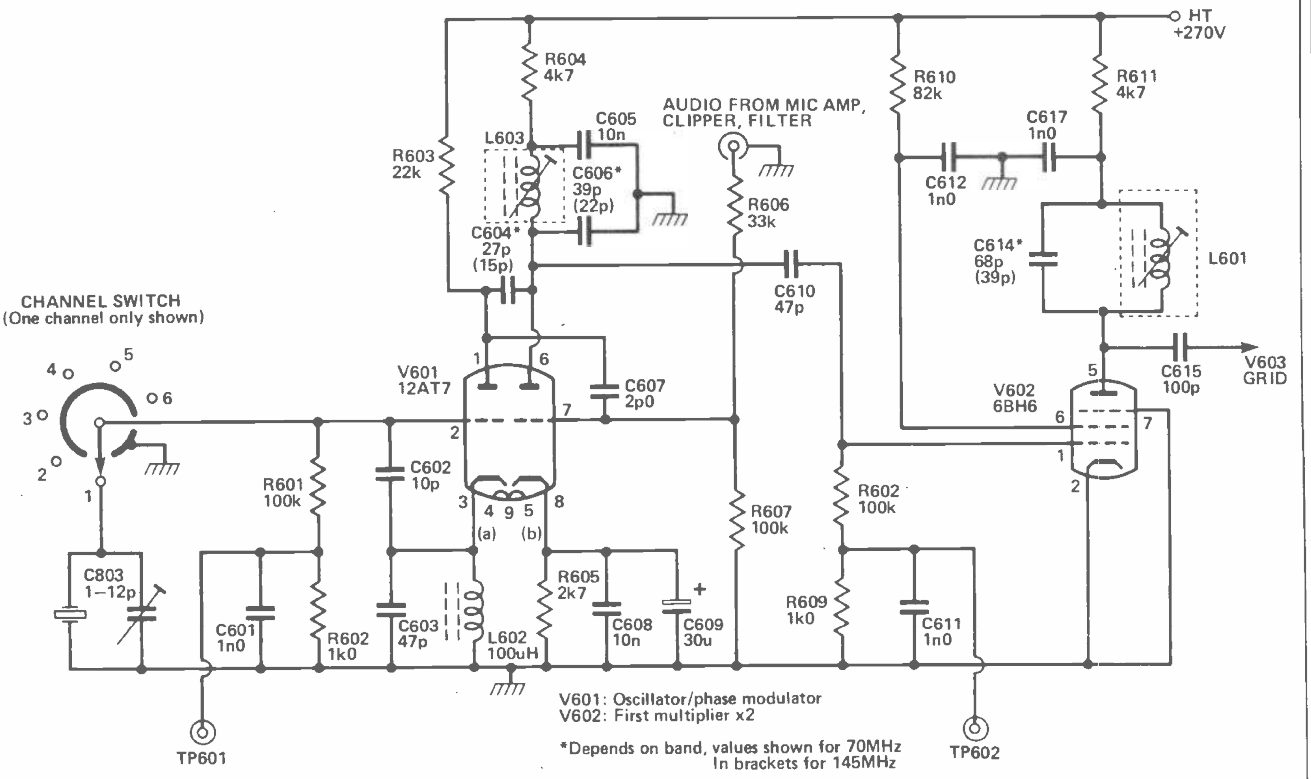


Fig.2: circuit diagram of the valve oscillator/phase modulator as used in the FM Pye Cambridge. It is possible to rebuild an AM Cambridge according to this circuit since the holes for an extra valve and RF coil are already punched the chassis. The FM Cambridge uses a higher multiplication for the transmit frequency than the AM version. On 144MHz, a 4MHz crystal is used and on 70MHz a 2.9MHz crystal is used. In both cases, output from V601 on the fundamental frequency is doubled by V602.

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The Pye equipment described up to this stage has all been finished in a pleasing two-tone Cambridge blue combination, hence the "blue box" nickname. Later models tend to be finished in black. Car touch-up paint and hammer-finish blue is ideal for making good scratches on earlier sets which have been knocked about by their previous owners. Soapy water and an old toothbrush will clean up control knobs in the filthiest state. One item which cannot be repaired easily is a damaged loudspeaker. Check before purchase if possible.

Pocketfone 70 (PF2)

The PF2 Pocketfone 70 is an early-to-mid 70s design portable set produced for VHF (AM or FM) and UHF FM. Taking the UHF version as an example, there were two separate models, the bodyworn (PF2UB) with a separate speaker/microphone and the hand-held (PF2UH) with the speaker/microphone built in. Up to three channels could be fitted and power was supplied by a nicad battery in a matching black plastic moulding.

Construction takes the form of a 'mother board' with numerous 'daughter boards' mounted at right angles. Alignment is fairly straightforward and should result in 0.5 watt output on UHF. There is room in the case for a miniature tone burst. An SPDT biased centre-off switch can be used to control the tone-burst and override the squelch.

Some UHF sets were fitted with an RF amplifier, but others fed the aerial directly to the hot-carrier diode mixer via a filter. A preamplifier would be worthwhile with the latter. (In fact, a preamplifier is worthwhile with most ex-commercial UHF equipment!) The PF2U IF stages operate on 23.455MHz and 455kHz, with a crystal filter at 23.455MHz.

Component density is high in the PF2 (like the PF1) with the added complication of daughter boards mounted side-by-side, and only thin sheets of 'Melinex' plastic to stop the boards touching one another. It seems to be a general rule that Pye equipment has got harder to maintain and modify as the years have gone by.

Motafone (MF5)

The Pye Motafone was an early 1970s low-power dash-mount transceiver which came in AM or FM VHF and FM UHF

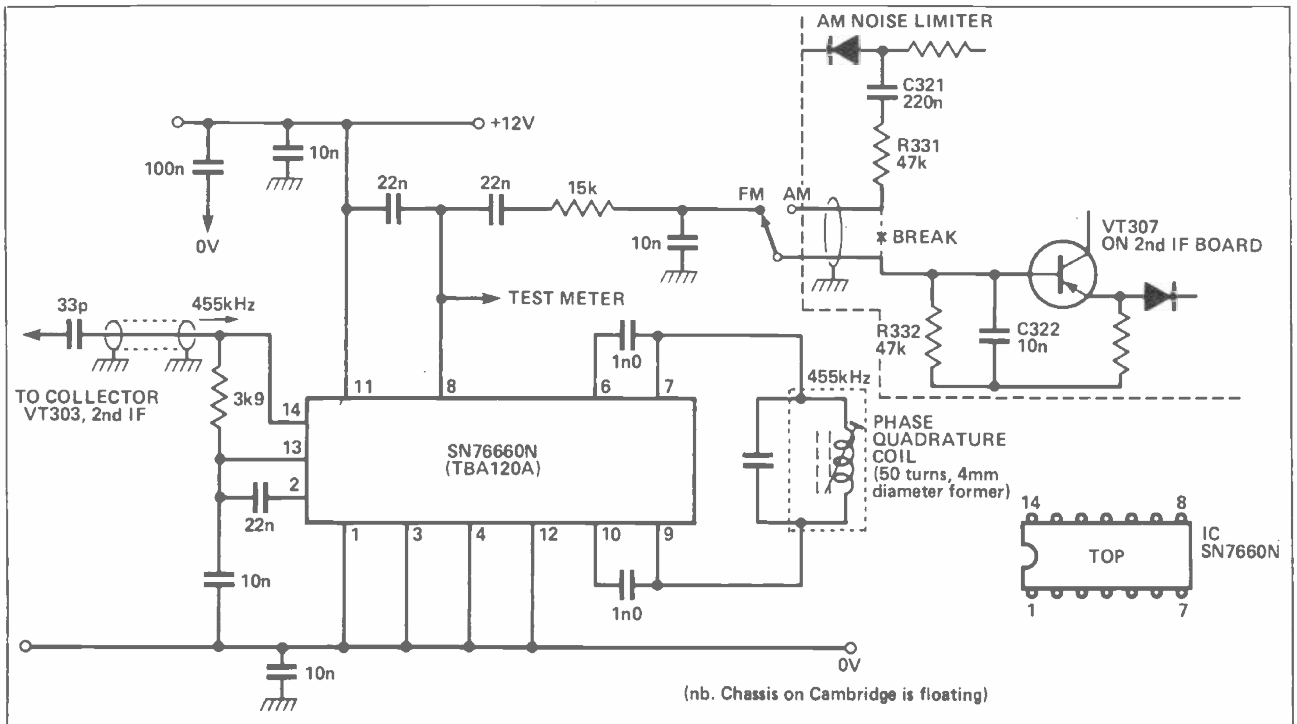

Fig.3: circuit of FM adaptor for AM Cambridge, allowing reception of FM signals. It uses a TBA120 integrated circuit as suggested by G3TDZ. IF signal at 455kHz is coupled in from the collector of VT303. The audio output after de-emphasis is passed to the emitter follower which follows the AM noise limiter. This allows the (carrier operated) AM squelch to continue operating on FM. Some operators find that the resultant lack of a squelch tail on FM is quite pleasant!

This adaptor could also be used with an AM Vanguard (AM25T) or AM Westminster.
With a 455kHz carrier injected, monitor the DC voltage on pin 8. Adjust the slug of the quadrature coil for a reading of 7 volts. As the carrier frequency moves either side of 455kHz, the voltage on pin 8 will swing up or down.

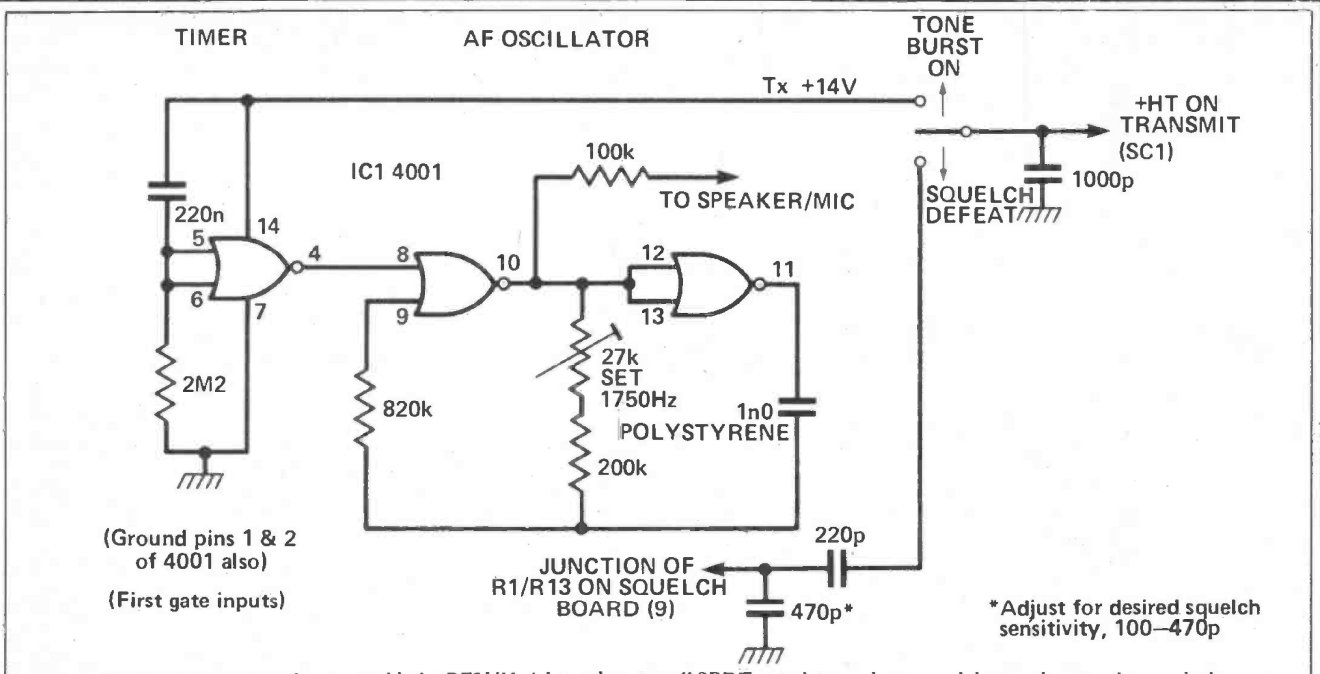

Fig.4: miniature tone burst suitable for PF2UH. A biased centre-off SPDT switch is used to control the tone burst and override the squelch. The capacitors (470, 220pF) can be soldered to the squelch board without removing it. The AF noise from the discriminator is attenuated by the 470pF capacitor to improve the threshold sensitivity of the squelch circuit. Switching in the additional capacitance is sufficient to open the squelch with no incoming signal. (Tone burst origin unknown - I think it came over the amateur grape vine!) NB Injecting square waves into the phase modulator is not recommended. If used as shown, the microphone amplifier circuit clipper/filter removes harmonics and the tone can be heard in the speaker/mic. A low-pass filter should be used if the signal is injected straight into the phase modulator.

versions. An air-band version was also produced known as the 'Pilot', with added luxury of a red warning light on transmit. The AM version produces 2.5 watts RF output using a series modulation arrangement with no modulation transformer. The FM version, which has the built-in loudspeaker mounted at the opposite end compared to the AM sets, produces 8 watts output or 5 watts on UHF. Three channels can be fitted, selected by the combined on/off channel switch.

The receiver RF section incorporates helical resonators in large aluminium cans, with a FET mixer (also a FET RF amplifier in the FM version). Integrated circuits are incorporated in the receiver for IF amplification and AF output. The squelch control is a preset mounted on the circuit board and is not available for adjustment by the operator.

A Motafone would make a good transceiver for 4 metres. The lack of channels would be a bit of a drawback on the other bands.

Best buys

Here are some examples of Pye sets which are good value in terms of suitability for use on the amateur bands:

1. Low band AM Westminster, Motafone, Pocketfone 70, for conversion to 70.26MHz AM. The current channel spacing of 12.5kHz is no problem on AM.

2. Low band 25kHz FM Westminster or Motafone for conversion to 70.26MHz or 70.45MHz FM. A multi.channel Westminster would be preferred.

3. Marine band Westminster etc. Marine band equipment covers 156 - 163MHz and retunes easily to 145MHz. The mode is FM and the current channel spacing of 25kHz is compatible with present amateur channelling.

4. UHF Westminster (preferably 6 or 10 channel) or Motafone for conversion to 70cm. The current UHF channel spacing is also 25kHz and compatible with amateur channels on 70cm. However, older equipment may have 50kHz filters fitted.

When comtemplating purchase of a piece of ex-commercial equipment, it is worth bearing in mind how much a comparable new transceiver would cost. This could be a 'black-box' or a kit. Remember to include the cost of a case, loudspeaker and microphone with the latter.