Amateur RADIO

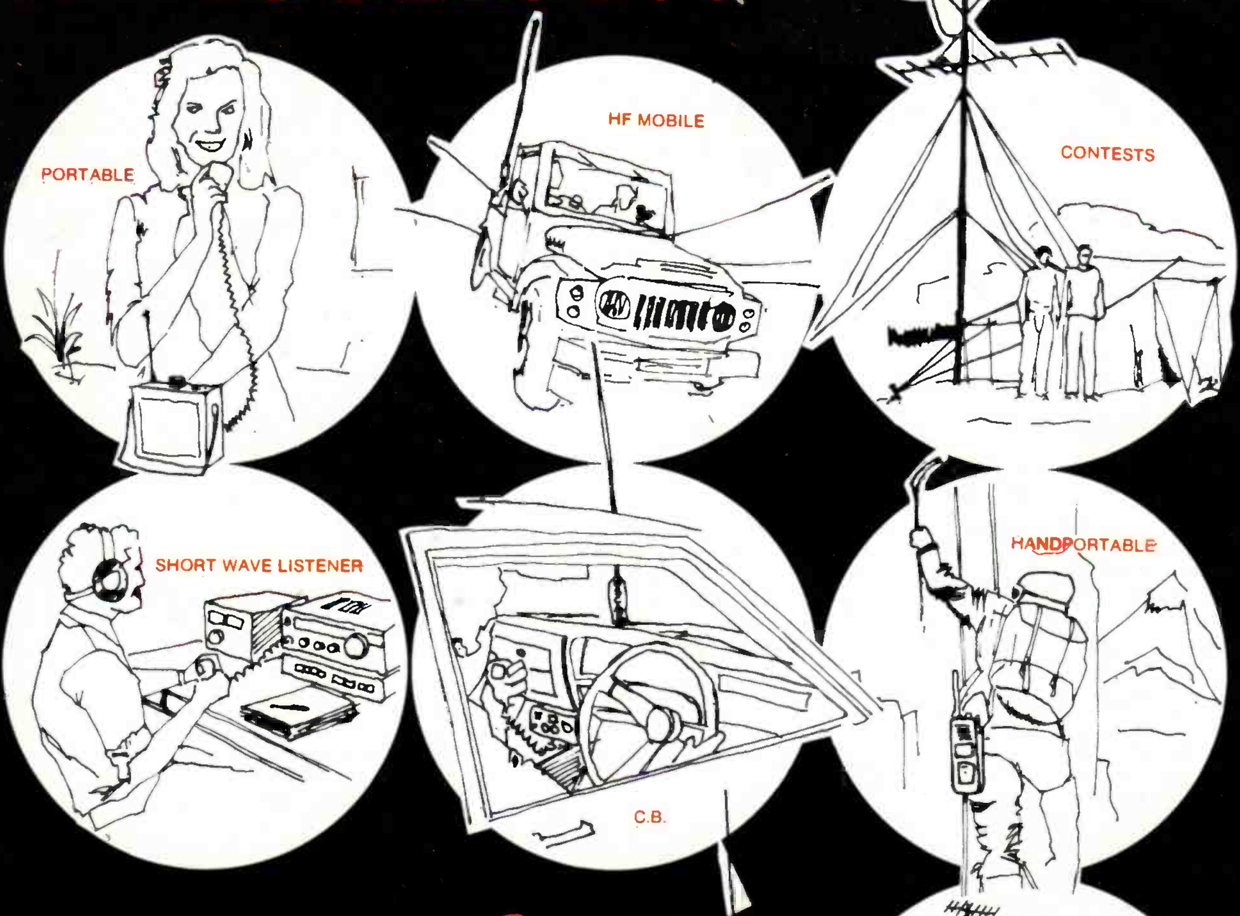
90p

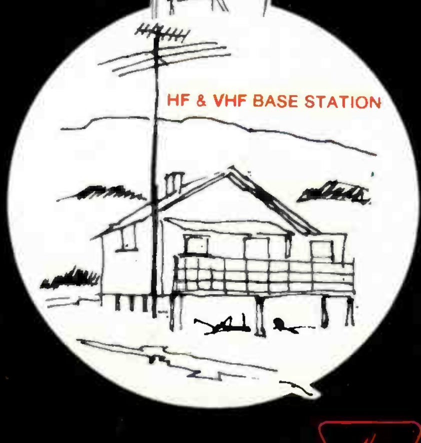
For all two-way radio enthusiasts

How to get started
Choose yourself a radio
Build your own rig
Bouncing signals off the moon

Understand circuit diagrams
Pass the Home Office test!
Friends across the world- how to make contact

Whatever your interests...





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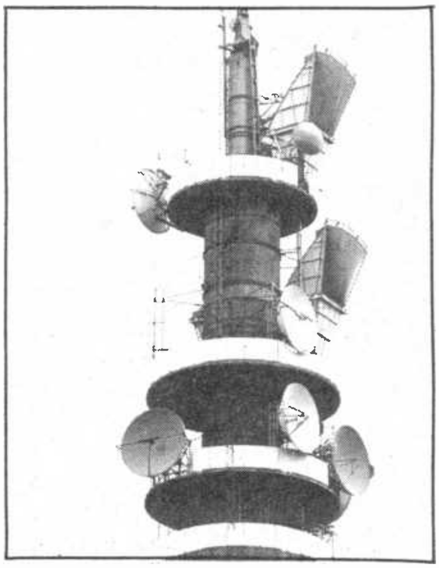
Amateur RADIO



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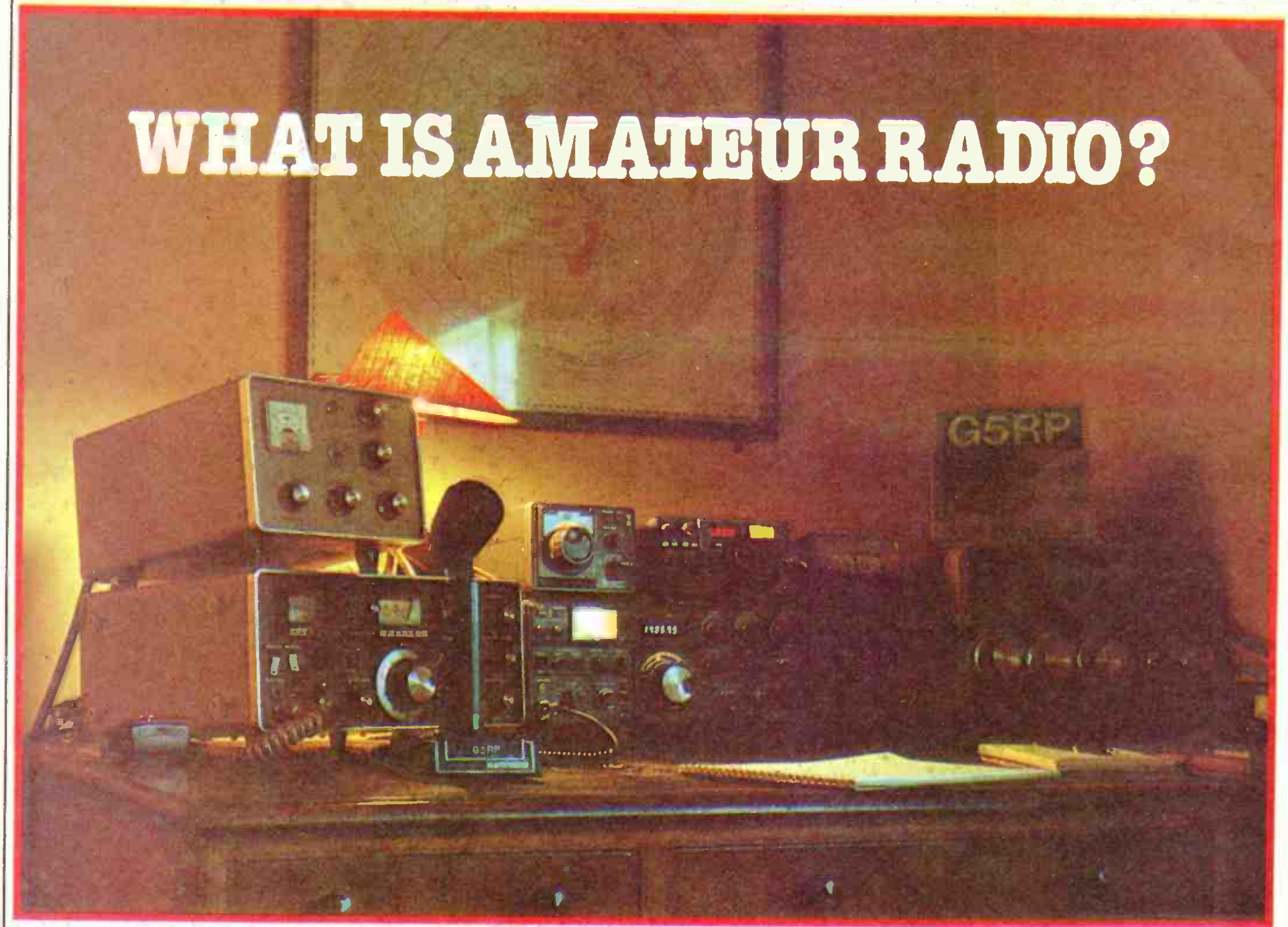
WHAT IS AMATEUR RADIO?



Briefly, it's two-way radio communication, but that's just the starting line. It is an exciting hobby, with many different aspects, levels of interest and degrees of sophistication. If you decide to take up amateur radio, beware — it could become a way of life! John Nelson describes this fascinating pastime.

Amateur radio is a lot of things; basically, it's a hobby about two-way radio communication but for many people it's almost a way of life. By way of introduction to this magazine, we'll be looking at something of what amateur radio is about.

The first myth to be dispelled is that it's anything to do with CB! With the legalisation of citizens' band radio in the UK, many people have a sort of hazy idea that amateur radio and CB are the same thing and that a "radio ham" is one of the strange body of folks who do either or both.

Newspaper editors are particularly good at this — if you see a headline like "Radio Ham Wipes Out Fire Brigade Airwaves" (shock horror story on page three) it usually turns out to be some clown running about fifty thousand watts of AM on 27MHz in the name of CB. A radio ham, God help us all, is said to be someone into amateur radio; no-one quite knows where the term originated, and most radio amateurs wish it would quietly return from whence it came. Tony Hancock is probably the man with the most to answer for in this matter, and although his Radio Ham sketch is undoubtedly funny it's got precious little to do with the real world of radio amateurs.

Both amateur radio and CB use radio for social purposes, but the resemblance ends right there. CB has a couple of bits of the radio spectrum allocated to it in the UK — it's intended as a short-range personal communications service using commercial equipment of low power and is restricted to simple types of antenna. In the UK as well as in America, CB has a faintly cult flavour. You almost get the feeling that the actual radio is secondary to the special jargon, and that it's more of a social phenomenon than a true hobby. It doesn't seem possible to make anything very creative out of it, and you can't really carry out much in the way of research into ways of improving it.

By contrast, amateur radio is very much more open-ended. You don't go into the Post Office and buy an amateur radio licence like you do in the case of CB. You have to pass an examination, as we'll see later on, and if you want to use the short-wave bands to talk around the world, you need to pass a Morse test as well. However, once you have the licence and the callsign that goes with it, provided you observe the terms of the said licence and don't wipe out every TV set for miles around, there's practically nothing you can't do.

For instance, you don't have to buy your "rig" (which is what amateurs call their equipment, and indeed have done so for years, long before the CB fraternity got hold of the word) — you can built it yourself, and it can be as simple or as complicated as you want it to be. Indeed, radio amateurs have often evolved ways of doing things that the professionals either thought couldn't be done or had tried and failed to do. You can be your own designer, chief engineer, trouble-shooter, aerial rigger, accountant (can you afford to build it that way, or should it be simpler . . .?), propagation expert and progress chaser ("hell, it's the contest at the weekend — better finish the thing today!").

You're not limited to what antenna you can use, and you can fill the back garden with all sorts of odd erections if you really want to. Alternatively, you can forget all the technical wizardry, and try and become the world's best radio operator. Some amateurs are just as good as the professional radio users when it comes to winkling out the weak signals from Wogga-Wogga or wherever.

23 bands

As a radio amateur, you've got something like 23 bands (or, if you like, parts of the radio spectrum, from the top end of the medium waves right up to those things they shoot off the top of the Post Office Tower — microwaves) to play with, and they can all be used for different things — from talking to Australia and New Zealand to chatting to your mate at the other end of the road.

You can chat away in Morse, or on teleprinter or TV, as well as any amount of different ways of transmitting ordinary speech. You can talk about practicallv anything, and if you want to you can chat about Dostoyevsky to an amateur in Moscow — I've done it. You can use a fair amount of power and in fact as far as the VHF and UHF bands are concerned there are only the broadcasters who'll have more of it than you will. And talking about VHF and UHF (or Very and Ultra High Frequency) reminds me that you can achieve distances on these bands that a professional VHF user wouldn't believe. You can bounce your signals off the moon, or off an aurora — and so on.

Amateur radio is a very diverse hobby underneath that one simple label, and no two amateurs are likely to be interested in the same things. There are specialist groups up and down the country, as well as several hundred clubs at the grass roots level, and they even have their own news broadcasts on a Sunday morning. No other hobby does that.

Radio amateurs have been around for a very long time indeed, and, we'll see later, the hobby has a very noble history. In the beginning, Marconi himself, who is generally (though inaccurately) acknowledged as the father of radio was an amateur in the sense that he wasn't interested in radio as a job or for the money but for the love of it — and, like amateurs in every other field, that's not a bad definition today.

An amateur, by definition, is someone who does it for love and not money, and it's funny that many "professionals" in the field of radio are licensed amateurs — they'll come home from their state-of-the-art electronic place of work and get a hell of a kick out of playing with some simple circuit or trying to make their old transmitter work better. Conversely, there's the schoolboy I know who's about to do his A-levels and is presently trying to make a high-power VHF amplifier for his transmitter — the Lord only knows how many hours he's spent trying to make it work even better than it already does, and if Marconi have any sense they'll snap him up the first chance they get . . .

In fact, in this electronic age of ours, it's that aspect of amateur radio that's the most interesting. Many people think at the outset that there's absolutely no way that they could pass any sort of technical exam — the thought of changing a fuse is enough to induce a brain haemorrhage, let alone the thought of building a radio transmitter. But as you take your first steps in sussing out how it works, you'll find you get more and more out of it, and things that sound like buzzwords in advertisements suddenly start to mean something.

Self-training

Amateur radio, like any other sort of radio, relies on the science of electronics for its basic principles, and electronics is the same subject whether they're in your rig or your washing machine. The amateur radio licence, which is issued by the Home Office in this country, says something about "self-training", and it's this aspect of it which is really at the core of the hobby.

We'll be going more deeply into the nuts and bolts of it all later on, but let's take a look at some basic points.

To become a radio amateur, you need to pass an exam and maybe a Morse test. When you've done that and satisfied the Home Office that you're a reasonably reliable and respectable citizen, they'll issue you with an unimpressive looking document which tells you in broad terms what you can and can't do, and on what bands you can or can't do them. At the top of it, there'll be a callsign. This is unique to you — no other amateur has it — and you use it in exactly the same way as any other radio station uses callsigns (unless you're a broadcasting station — they don't have them, so you can say you're one up on the Beeb!).

It's not at all like a "handle" on CB, which is something you allocate to yourself and which, presumably, you can change every hour, on the hour, if you want to — there's a book published which gives details of all the callsigns in Great Britain, so that if, for instance, you hear someone calling himself G4IQP, you can look him up and discover who he is and that he lives in Chichester. The "prefix" of the callsign — in this case, the G4 part of it — tells you that he's in England. If it were UA4IQP, you'd know he was Russian, or if it were XT2IQP you'd jump for joy and work him as quickly as you could because he's in Upper Volta, in Africa, and pretty damn rare, or "good DX", as amateurs say. DX is the Morse abbreviation for "distance", and in the early days the distance you'd worked was all-important.

Conversely, if you heard, for example, MX4IQP you'd probably laugh cynically to yourself because there ain't no such animal and it would be some twerp trying it on. You get it occasionally in the amateur bands and it's always some non-amateur playing silly b . . . ers. Callsign prefixes are allocated by the International Telecommunications Union, which is part of the United Nations, and G just happens to be a British prefix, so an amateur station is formally licensed in exactly the same way that a ship or an aircraft is, GIQP would be a ship's callsign, and GBCRX would be an aeroplane.

The point, as we've seen, is that amateur stations are taken as seriously as any other radio station and generally speaking are subject to many of the same rules and regulations.

True gentlemen

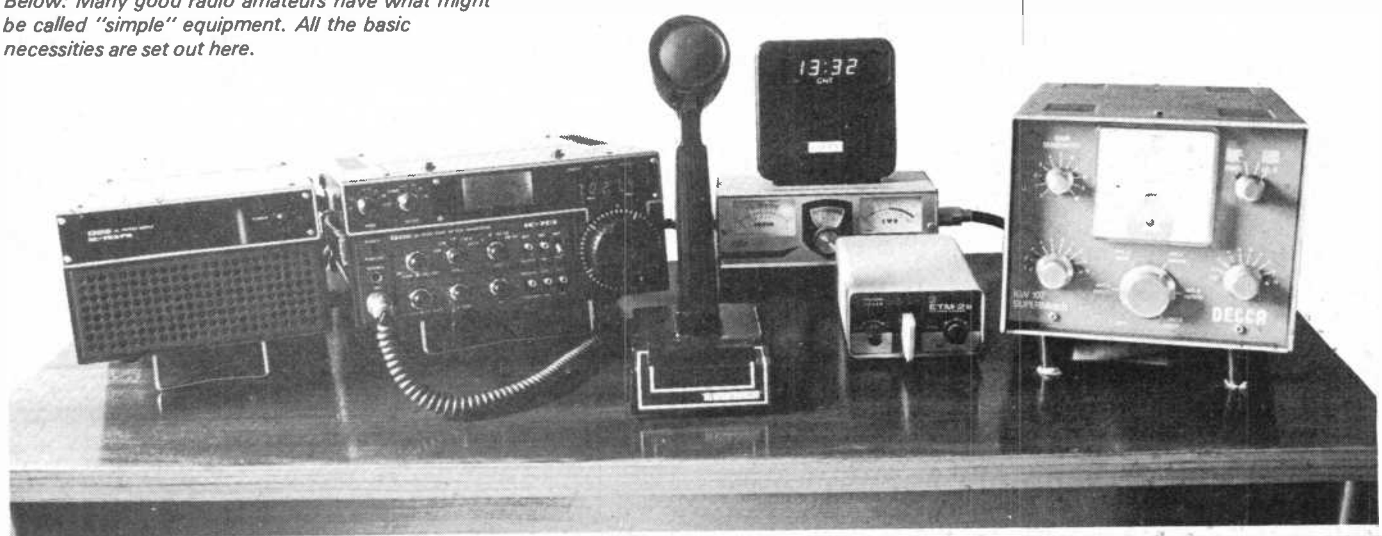
All of which is pretty incredible, actually. And the credibility of amateur radio is something to be proud of all the way. Given that every hobby has its quota of wallies (to borrow a CB expression — well, they borrow ours, so why not?), radio amateurs really are the last remnants of nature's gentlemen most of the time; they'll usually help each other no end when it comes to getting on the air and staying there, and there must be an incredible number of friendships all over the world that started in some chance conversation on the amateur bands.

When you think that, in general, all amateurs are equal — ie, a man's race, colour, creed or whatever don't matter a damn on the radio — that's got to be worth one hell of a lot for international relations and things. The amateur service has a strong tradition of self-regulation and, though the Post Office have the power to take an amateur station off the air, it happens once in the proverbial blue moon.

Radio transmitters can cause no end of shenanagins if they're not properly set up, which is why the exam includes some basic ground rules on interference and so on. Most amateurs can sort out any problems with their neighbours in short order, which again is why the authorities generally leave them to it.

Okay — so we've had a quick look at what amateur radio is about and what it has to offer. There's so much, you could write a book — er, well, that's what we have done actually . . .

Opposite page shows Ted Wake's good-looking desk-mounted set-up in Tony Large's "moody" lighting. . . Below: Many good radio amateurs have what might be called "simple" equipment. All the basic necessities are set out here.



AVAILABLE BANDS

Frequency bands MHz	Footnotes
1.81 — 1.85	2
1.85 — 2.0	2,4
3.5 — 3.8	2,9,11,16
7.0 — 7.1	9,11,12,16
10.1 — 10.15	1,16
14.0 — 14.25	9,11,12,16
14.25 — 14.35	9,11,16
21.0 — 21.45	9,11,12,16
28.0 — 29.7	9,11,12
70.025— 70.5	1,3
144.0 —146.0	9,11,12,16,18
430.0 —432.0	1,6,7,18
432.0 —435.0	1,10,18
435.0 —438.0	1,10,14,18
438.0 —440.0	1,10,18

Frequency bands in MHz	Footnotes
1240.0—1260.0	1,10,17,18
1260.0—1270.0	1,14,15,17,18
1270.0—1325.0	1,10,17,18
2300.0—2400.0	1,10,17,18
2400.0—2450.0	1,10,13,14,17,18
3400.0—3475.0	1,17,18
5650.0—5670.0	1,10,13,14,15,17,18
5670.0—5680.0	1,10,17,18
5755.0—5765.0	1,10,17,18
5820.0—5830.0	1,10,17,18
5830.0—5850.0	1,10,13,14,15,17,18
10,000—10,450	1,10,17,18
10,450—10,500	1,10,13,14,17,18
24,000—24,050	8,10,12,17,18
24,050—24,250	1,8,10,17,18
2350.0—2400.0	1,5,13,17,18
10,050—10,450	1,5,17,18
5755.0—5765.0	1,5,13,17,18
5820.0—5850.0	1,5,13,17,18

1. This band is allocated to stations in the amateur service on a secondary basis on condition that they shall not cause interference to other services.

2. This band is shared with other services.

3. This band is available to amateurs until further notice provided that use by the licensee of any frequency in the band shall cease immediately on the demand of a government official.

4. The type of transmission known as Radio Teleprinter (RTTY) may not be used in this band.

5. Use by the licensee of any frequency in this band shall be only with the prior written consent of the Secretary of State.

6. This band is not available for use within the area bounded by 53°NO2E, 55°NO2E, 53°NO3W and 55°NO3W.

7. In this band the power must not exceed 10 dBW erp (effective radiated power).

8. Use by the licensee of any frequency in this band shall only be with written consent of the Secretary of State and such consent shall indicate the power which may be used, taking into consideration the characteristics of the licensee's station.

9. Slow Scan Television may be used in this band.

10. High Definition Television (A3F, C3F, F3F, G3F) may be used in this band.

11. Facsimile Transmission (A3C, F3C, G3C) may be used in this band, with a bandwidth not greater than 6 kHz.

12. The amateur satellite service also has an allocation in this band.

13. This band is allocated to stations in the amateur satellite service on a secondary basis, on condition that they shall not cause interference to other services.

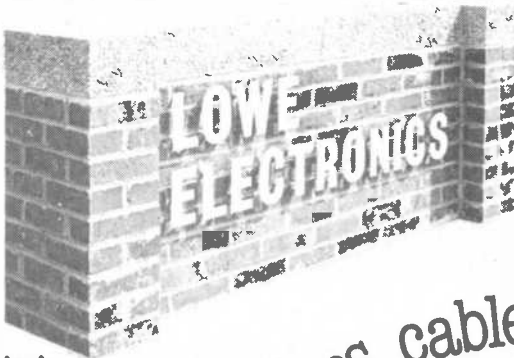
14. The amateur satellite service may operate in this band in accordance with International Radio Regulation 2741, viz: Space stations in the amateur satellite service operating in bands shared with other services shall be fitted with appropriate devices for controlling emissions in the event that harmful interference is reported in accordance with the procedure laid down in Article 22 of the Radio Regulations. (Administrations authorising such space stations shall inform the IFRB and shall ensure that sufficient earth command stations are established before launch to guarantee that any harmful interference which might be reported can be terminated by the authorising administration (see RR 2612)).

15. The use of the amateur satellite service in the following bands shall be limited to the direction stated below:-
1260-1270 MHz earth to space; 5650-5670 MHz earth to space; 5830-5850 MHz space to earth.

16. The bands allocated to the amateur service at 3.5, 7.0, 10.1, 14.0, 21.0, and 144 MHz may, in the event of natural disasters, be used by non-amateur stations to meet the needs of international emergency communications in the disaster area in accordance with regulations of the Radio Regulatory Department.

17. Since high intensities of RF radiation may be harmful, the following safety precaution must be taken: in locations to which people have access, the power density on transmit must not exceed the limits recommended by the competent authorities. Currently this limit is 10 mW/cm².

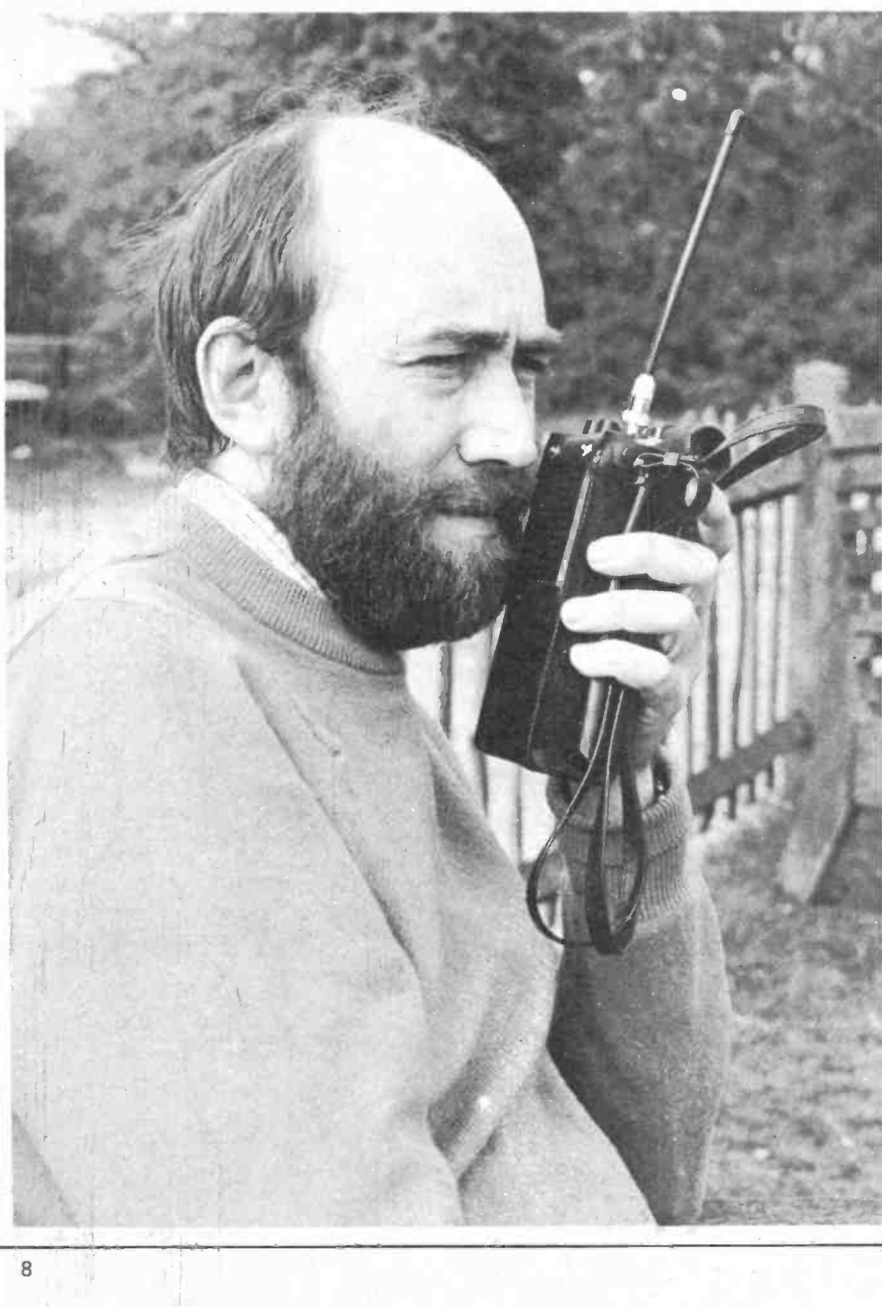
18. Data transmission may be used within the frequency bands 144 MHz and above provided (a) the station callsign is announced in Morse or telephony at least once every 15 minutes and (b) emission is contained within the bandwidth normally used for telephone.


LOWE
ELECTRONICS

Amateur options

How to choose yourself a rig. Here we review what equipment you'll need in order to get on the air. If you can't afford to buy new, there are some good secondhand receivers around if you take the time to look for them.

The author, John Nelson, tries out a hand-held UHF Yaesu transceiver.



As we've seen, the first step on the road to amateur radio is passing the test. But that's only half the story! Certainly the test gets you a licence to *transmit,* but a lot of amateur radio consists of listening to what's happening on the various bands and getting a feel for the procedures and so on.

In this section, we'll examine what you need to get into amateur radio, both before and after you take the test and review some of the more easily available equipment.

Basically, the first bits of kit you'll need are a receiver and an antenna (which is the general word these days for an aerial). You'll need them in order to listen to the various amateur bands and to get into the swing of how amateurs talk to each other, what distance and directions they can talk to and what bands will stretch from where to where. In fact, in the early days (and it's still true to some extent) many people became interested in amateur radio because they owned a o wireless which perhaps covered a few more bands than the usual domestic radio, or indeed which was intended for listening to short-wave broadcasts from all over the world.

The average domestic trannie isn't like the nice old valve sets of yore, and doesn't usually cover anything other than the domestic broadcast bands these days, so it's less true now, unfortunately. However, as we've said, many people come across these strange voices chatting to each other, usually about technical things or what the weather was like (which is about as near as it ever gets to Tony Hancock, by the way . . .) and wonder what it is.

They were, and are, radio amateurs; and even today there's a sort of apprenticeship that some people serve before they get the transmitting licence. They're known as Short Wave Listeners, or SWL's, and many of them start life as listeners to foreign broadcast stations before they become interested in amateur radio.

It's a good way to start, actually, because it'll (a) get you interested and proficient in the various procedures that amateurs use and (b) it'll teach you a hell of a lot about how to use a receiver. Which is where we come in really — a good radio receiver that'll cover the amateur bands is probably the best way to discover whether amateur radio really is for you, and it'll be a useful part of your station if you do get the licence.

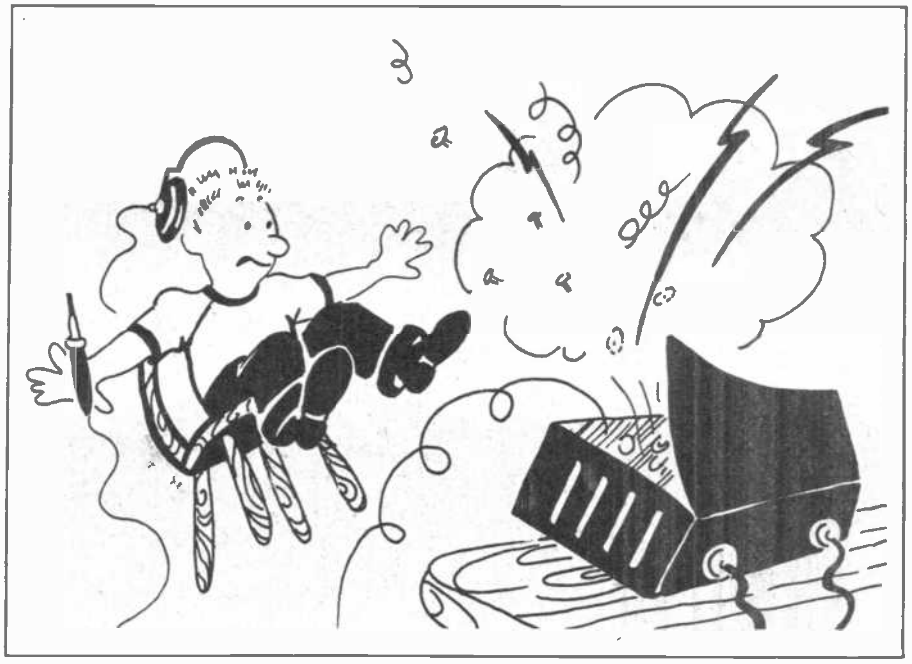
So what's available? Basically, there are three ways of doing it. The first is to buy something modern which is made for the job. The second is to get hold of an ex-Government or ex-military receiver, usually of some considerable vintage and weight, and the third is to build a simple one. Actually, we'll leave out the last option at this stage because if you know enough to build a receiver you're not very likely to be reading this part of the magazine . . . So we'll take the first option first.

A modern radio receiver for the short-wave bands (or, as they are also known, the high frequency bands) is a different animal from its ancestors of ten or twenty years ago. You can actually divide them into receivers meant for "general coverage" of all of the spectrum, which in practice means frequencies from about 1 to 30 MHz, or those meant just for the amateur bands alone. Because modern radio receivers of any complexity usually contain a devilish device called a synthesiser, most of them cover all the spectrum and do it very well. Some years ago a general-coverage receiver was a bit of a compromise but a synthesiser makes life easier for various reasons concerned with the way in which you tune it. So modern receivers, like the Trio R1000 and R600 and the Yaesu FRG7700 and FRG7 (the latter doesn't use a synthesiser in the usual meaning of the word but it handles in something like the same way) cover all the spectrum very well.

In the shortwave area from about 1 to 30 MHz there are currently seven amateur bands — it'll be nine at some point in the future when two bands at 18 and 24 MHz are released to the UK amateur — and any of these receivers will give good performance with quite simple antennas, usually a random-length piece of wire dangling from the back of the set and weaving its way down the garden. If you were to buy one of these tomorrow and tune around the various amateur bands (you'll find out exactly where they are and what they'll do later on in the magazine) you'd get a pretty good idea of what amateur radio is about if you used it at assorted times of the day for a month or so.

Modern receivers are essentially as easy to use as a domestic radio; although, like anything else, a bit of practice helps. You'll find this particularly true with amateur radio because the two most common ways that amateurs talk to each other (which are Morse and something called "single sideband" — don't worry about exactly how they work for now) are rather different from, say, domestic broadcast radio and they tune in rather differently on a receiver. Of course, the practice will help later on, especially when you start learning Morse — you'll find you'll learn a lot from using your receiver to pick out one Morse signal from several others and to keep it on tune, so to speak, quite apart from the matter of learning the Morse code itself. Anyway, a modern receiver is very easy to use. It'll cost you about £100-£200 for the good ones such as those mentioned above, although there are various lesser breeds available for less.

If you're a bit short of the readies, you can pick up various types of radio receiver secondhand (indeed, you can get any of the first category we've mentioned secondhand as well). They don't wear out in the usual sense of the word, and if you're just getting interested and you'd like to see what it's all about without spending a bomb, a secondhand FRG7 for £40 or so is a good



way to fly. The ones we have in mind, however, weren't made specially for the amateur market but for the professional one, and often you can find them going for the proverbial song.

A good case in point is a receiver known as an AR88. This animal was made by RCA for various military and commercial purposes before, during and slightly after the last war, and twenty years ago it was every amateur's ambition to own one. They weigh about seventeen tons (well — seventy pounds, but it *feels* like tons) and they're built like HMS Broadsword. They are, of course, full of valves and, rather like a vintage car, need to be driven rather than just steered up and down the bands. Actually, they work very well, and certainly in the lower part of the radio spectrum the AR88 will hear practically anything going.

A good one these days will cost thirty or forty quid, and many experienced amateurs still have one in the shack and wouldn't part with it for the world. If you can get the best out of an AR88, you'll learn a very great deal about using a radio receiver to its fullest extent and, in that sense, you'll be a radio operator instead of someone who just tunes in and sits back and lets it all happen . . .

Other radios of the same ilk are the HRO (still a good machine), the old R1155 (vintage 1943 or thereabouts, and quite likely to have flown in one of Bomber Command's Lancasters; not very good but you can still get them for a tenner or so) and various oddments like the BC348 (ex-USAF) and the 19 Set, which is late of Her Majesty's Government and pretty horrible. Slightly later devices are things like the Racal RA17, which are beginning to appear secondhand in some number for about £150; these will probably be ex-people like the BBC or GCHQ, and they'll see off any commercially built rig for the consumer market.

These are really in a slightly different ballpark, and you probably wouldn't buy an RA17 as your first rig. Mind you, with the exception of the very latest radios which today's amateur gloats over, (like the things you see in the radio room of a super-tanker) I'd back something like an RA17 against anything else, so if you end up putting a 56-element log-periodic on your house roof and make 49 Acacia Grove look like the German Embassy in London, you'll probably end up with a receiver of that sort of calibre . . .

The small ads in the back of the various magazines dealing with amateur radio (see later) are a good hunting ground for your first receiver, as are the numerous rallies held by various clubs up and down the country throughout the year. There's not a lot you can teach someone from a book about how to use it. You'll get the hang of it only when you plug in the mains and an antenna and get started.

So — that's the receiver. Let's assume that some months pass and you've sussed out when and what happens on the amateur bands, and you've taken the test and passed it. Now then; there are two options open to you. Just passing the test — it's known as the Radio Amateur's Examination, by the way — entitles you to what is known as a Class B licence, and this means you can transmit and receive *above* 144 MHz. This territory is known as VHF and UHF, and the rules of their game are rather different from those of the HF bands which you'll have been listening to. The other option is to pass the Morse test, which entitles you to a Class

A good set up, operated by Ted Wake, of West Hendred, near Oxford, who, incidentally, has one of the biggest collections of QSL cards we have ever seen.

A licence and the privileges of using the bands covered by your faithful AR88 or whatever.

Here again, the pattern has changed in the last ten years or so. Very few people did anything other than take the exam and the Morse test more or less simultaneously, and there were very few Class B licencees. Two things changed the picture a bit, which were (a) the release of the 144 MHz band to the Class B licencee and (b) the much greater availability of commercial equipment for this band in the last few years. Nowadays, there are rather more Class B licences issued initially than Class A, and people tend to go first of all for the B licence.

This is what has tended to cause the demise of the SWL. Receivers for 144 MHz and above are nothing like as common as they are for the lower-frequency bands, and although you can buy or build something called a converter to bring the 144 MHz band into the coverage range of an HF receiver, people don't seem to bother much.

Personally, I feel that this is a pity because the SWL learns a hell of a lot before he comes on the amateur bands, whereas many new Class B licencees haven't listened very much and seem to be lacking in some of the basic knowledge that helps the show along a bit. However, it's a free country, and they soon get the hang of it.

As we've seen, you need to decide whether you're going to be a Class A or a Class B licencee. The VHF and UHF bands have rather different attractions from the HF bits of the spectrum, and the feel of them isn't the same; in fact, people seem to be temperamentally attracted to one or the other almost from the word go. It's probably because the challenges each present, are somewhat different. Either way, however, you'll need different equipment. Typically, an HF band transmitter or transceiver (ie something combining the functions of transmitter and receiver) will cover the bands from 1.8 to 28 MHz, whereas equipment for the VHF and UHF bands tends to be for one band only. You can make an HF transceiver into a VHF or UHF transceiver, and this is covered in a later chapter, so in the beginning it's probably a good idea to try and decide in what direction your main interests lie before spending your money.

Don't think you have to buy *new*, by the way. Electronic equipment doesn't wear out in the same way that a car does, and there's a fair amount of it to be had secondhand. Since radio amateurs spend their lives communicating with each other, good and bad rigs tend to be well known to all and sundry so it's worth keeping an ear on what people are using. It's also a Good Idea to keep an eye on the various magazines (see later on for what they are) since they tend to carry reviews of equipment, antennas and so on.

Advertising, generally, can be trusted. It's a bit like hi-fi, although it's not so bad because amateurs are usually more technically qualifed than hi-fi users and aren't usually so emotionally attached to their gear. Beware of the advertiser who makes claims of whacking power output from linear amplifiers. They might be true if you assume a valve life of ten minutes, but which would cause considerable alarm and despondency in a 24-hour contest! Another good area for various creative manipulations of figures is in the noise performance of VHF and UHF pre-amplifiers; at this stage in your amateur career you might not know a GaAsFET UHF amplifier from a piece of Cheddar cheese, but it seems to be an area in which to watch out for outrageous claims. You'll usually find, however, that someone in your local club makes a speciality of something in particular, such as power amplifiers or preamps, and he'll usualy know what's possible and what isn't if you're not sure whether something is worth it.

Which brings us to another point. If you're thinking about becoming an amateur, or if you're a new one, do at least visit your local club. You'll find that they'll go out of their way to help the novice, and it'll be possible to see various bits of equipment that various members own and maybe to try them out. If the club is interested in contests, go out with them and watch the fun. They're usually good from the social angle as well as from the radio point of view, and you'll get a lot of experience of radio operating and how well various radios stand up to the hammering a contest represents.

You'll also find some friends who will help you put up your first antenna, get the rig working properly and generally help you through the first stages of putting your callsign on the air. Should you have problems with breakthrough on to your neighbour's stereo or the landlord's TV, you'll usually find some genius at the club who has green fingers as far as this minor problem is concerned. Some clubs have an interference squad, who have the necessary gear to fix a breakthrough problem fast. You'll find this a great help if you do get struck down by the breakthrough plague. It's well worth mentioning at this point that 95 per cent of all breakthrough problems aren't the fault of the rig; the standards of domestic TV and hi-fi manufacture in this area leave one hell of a lot to be desired, frankly, so don't feel ashamed or guilty if you run into breakthrough problems.

It's odds-on it won't be your fault unless you really are doing something peculiar, and it's unfortunate that it's sometimes very hard to convince people that the problem is due to their hi-fi or whatever and *not your rig*. You'd think it stands to reason that a hi-fi amplifier isn't designed as a radio receiver, and therefore by definition there's something wrong with the thing if it persists in relaying your CQ DX calls all over Schubert's Unfinished. Not so.

People get possessive about their domestic super stereo, and I've heard any amount of arguments along the lines of: "I paid £1,000 for this lot so don't tell me there's anything wrong with it matey!" There probably is, of course, mainly because the aforesaid super stereo hasn't been designed with radio waves in mind. Mercifully, they're often simple to fix -- if the neighbour will let you . . . It's probably better just to steer him gently in the direction of his local friendly dealer, because if you *do* fix it and it goes wrong for some completely unrelated reason a year later, it's ten to one you'll get the blame.

Anyway, hopefully it won't happen! To sum up, get hold of a basic receiver, do a lot of listening, learn a lot about aerials and what the various amateur bands will do for you, then decide whether or not you want to take the test. Then, specialise a bit but not too much; don't stick to one-band-one-mode all the time, but get your feet wet all round. Join your local club. Welcome aboard!

Top of the Icom range. This is their IC-730 which is small enough to be used mobile, while retaining most of the features of its big brother base station, the IC-720. Icom rigs are well designed, and have an excellent reputation.

The author's set up in North London. Again, an Icom (this time the IC-701) linked to a Decca KW107 Supermatch, and almost-inevitable mike, GMT clock, SWR and power meters and Morse key.

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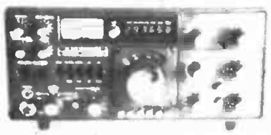

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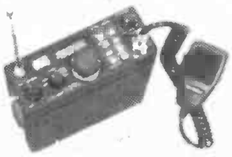

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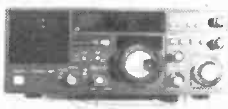

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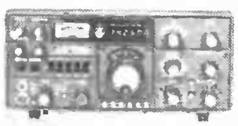

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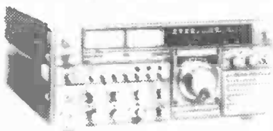

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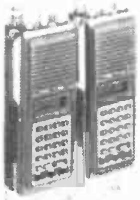

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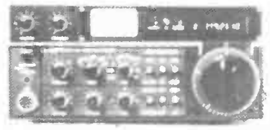

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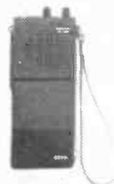

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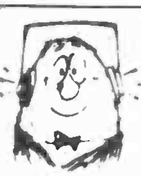

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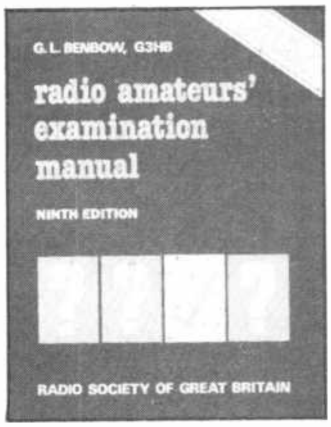
Books & magazines

Read all about it — there are many good and well-written books available that will provide you with all the information you want to know about amateur radio.

There are an enormous number of books on amateur radio, varying from the basic to the erudite. Some are good and some are almost unreadable. Probably the best place to start is with the Radio Society of Great Britain, who we've met before in these pages and will no doubt meet again — they're the people who represent radio amateurs in this country and of whom it's a jolly good idea to be a member.

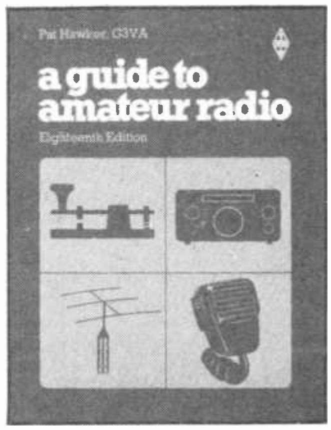
They publish some extremely good books for the beginner, and two of them should be in everyone's library — one of them is the *Radio Amateur's Examination Manual* and the other is called *A Guide to Amateur Radio*.

The first one takes you very gently through everything you need to know to pass the Radio Amateur's Examination, and it even includes a specimen exam



paper at the end, so that you can see how you're doing. Currently it costs £3.12 to non-members and £2.81 to members, and for the novice it's worth its weight in gold.

A Guide to Amateur Radio is just that. It's a sort of complement to the RAE Manual in that it takes you bit-by-bit through what amateur radio is about, rather in the same way as this publication is attempting to do. It is very good, although it isn't written in a lighthearted and sometimes humorous way like this magazine! It costs £3.09 to non-members and £2.78 to members — you'll note hereabouts that one of the benefits of RSGB membership is 10 per cent discount on books!



The RSGB also do a monumental tome known as the *Radio Communication Handbook* which contains just about everything you'd ever conceivably need to know about the electronic circuitry in amateur radio equipment. It's presently available as a paperback at £11.15 and £10.04 respectively, although by nature it's a two volume hardback; Volume 1 has just gone out of print and the Society are currently preparing the next edition.

Another RSGB publication that should be mandatory for the new amateur is their *Amateur Radio Operating Manual*. This is a sort of compendium of all the little things you sometimes need to know in a hurry, like the whereabouts of a station signing itself JT2, and how far ahead in time the South Pacific is. There's also a good section about basic operating which is nearly as good as the chapter on basic operating in this magazine.

The Society also publish other books of their own, as well as distributing all sorts of other goodies such as maps, car

stickers, repeater and beacon lists and logbooks. A list is obtainable from their headquarters at 35 **Doughty Street, London WC1N 2AE**, and if you're writing you can also ask for a membership form.

Turning to magazines, the RSGB has one which is sent to its members, and it's called *Radio Communication*. It's edited in a slightly old-fashioned style; some members swear by it and others swear at it, but it's the official organ of the Society and as such it does contain a good deal of topical information about the state of amateur radio and what's going on in its world. It contains some good equipment reviews and a lot of advertising, so it's certainly a worthwhile benefit of membership.

The independent amateur radio magazines are a varied lot. *Short Wave Magazine* has been around for nearly forty years. It's the oldest of the independents, and it used to be the most vociferous, although it isn't anything like as anti-establishment as it used to be. The monthly columns are very variable, although Norman Fitch's "VHF Bands" column usually contains a good deal of interesting material about the state of play above 50MHz. Technically, SWM is uneven; some of its technical articles are interesting and stimulating, and others are decidely boring, and its graphic style is incredibly Fifties. However, it's worth a look. *Practical Wireless* is also worth a look, although it doesn't seem to know quite what sort of magazine to be. The monthly HF bands column seems to induce a heavy bout of yawning in many people, and the VHF bands column usually confines itself to a review of what a few people on the South Coast have been up to. There's usually a mention of "Cmdr Henry Hatfield and his spectrohelioscope", which sets the tone of the piece — not, regrettably, much to do with what's happening on the VHF bands.

Technically, PW isn't bad although from the beginner's point of view there's never enough information about how the gear is meant to work. You don't get much of a feeling of any particular editorial stance from PW. This may or may not trouble you.

A newish magazine, *Radio and Electronics World*, isn't really aimed at the radio amateur. It does some thundering good reviews (which PW doesn't although they have some nice facilities — they could do a lot for the art of meaningful reviewing down at Poole) and some excellent technical pieces, although it makes the odd howler. Probably worth watching when it's sorted out what kind of magazine it's going to be. Like a number of other magazines in the same general field, such as *Electronics Today International*, it's more for general electronics than specifically the radio amateur at the moment.

Other than these, there are a number of American magazines available via the RSGB which you might find interesting. *QST* is the house organ of the American Radio Relay League, and as such contains a lot that isn't of much interest to the UK amateur. Worth a read though. *Ham Radio* is probably the best of the Americans for all-round reading, although its editorials sometimes seem to be a result of a brainstorm in the office rather than considered thought.

It's technically reasonable for simple things and occasionally has some extremely esoteric and difficult articles to keep you on your toes. Warning: American high-tech prose can be almost completely unintelligible . . . great stuff but bloody hard going!

I have a feeling that an amalgam of the best features of all the British magazines would be very good, but it doesn't exist. At the moment I'd suggest you try them all and see what turns you on. The books are the thing. Do get at least the first two we've mentioned, and you won't regret it. Then join the RSGB and take *Radio Communication*. That will give you the basic topical stuff, and one of the others should give you an alternative point of view should you need it.

Licensed to talk

That all-important piece of paper! What it says, and what it allows you to do, with what, and to whom — almost. . .

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AMATEUR RADIO CERTIFICATE

This is to certify that

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has taken the Radio Amateur Examination and the Post Ofice Morse Test and has qualified in the following subjects for the award of the Amateur Radio Certificate:

Elementary theory of radio communication
Knowledge of transmitting techniques
Knowledge of operating procedure appropriate to radio amateurs
Sending and receiving morse at the rate of 12 words a minute

Date. Signed. . . . .

NOTE: This certificate will not be regarded as exempting the holder from having to pass the Morse Test again if he applies for an Amateur (Sound) Licence more than twelve months after the date on which he passed the Post Office Morse Test mentioned above.

No.. . . . .

MP&T1 SEC/1238

It just so happens that in the last few months the normally placid state of the Radio Regulatory Division of the Home Office has been rather rudely shattered by some shenanagins to do with the amateur radio licence.

Without going into the high politics of it, the net result is that as of now, radio amateurs have a different licence from the one they've had for years! The main differences relate to the way in which the power you scatter to the four winds from your station is measured, and also the way in which the various modes of emission such as Morse, SSB and so on are stated and designated.

However . . . when you get your licence you'll find that it's a rather unimpressive-looking document which falls into two parts. The first bit is the licence itself, which gives your callsign, name and the address at which the station is to be established. It then goes on to say what you can transmit and from where; you can send "messages in plain language which are remarks about matters of a personal nature in which the licencee, or the person with whom he is in communication, has been directly concerned."

The next section discusses the limitations of the licence, and you'll note that "no message which is grossly offensive or of an indecent or obscene character shall be sent". So you can rule out sending Playboy centrefolds in full-colour fast-scan TV. There are also the various requirements regarding keeping a log and so on.

The other main part of the licence is called the "schedule" and in a sense it's the key to it all — it's also the bit that all the fuss was about recently. It lists the frequency bands in MHz which may be used, together with the power limitations that apply to that particular band and the classes of emission (ie Morse, SSB, TV, RTTY, etc), that may be used within that band.

There are also what are known as "footnotes" to any particular band, and there's a long list of these at the end of the schedule These relate to any special conditions which must be observed by users of that band. For instance, if we look at the band from 1.81 to 1.85 MHz we note that the appropriate footnote is no.2. Turning to footnote 2 we find that it says "this band is shared with other services". Which indeed it is, so you musn't clobber them with your transmissions. We also note that the power limitations on this band are 9 dBW carrier power at the antenna and 15 dBW pep for SSB.

As it happens, this is part of the New Look of the amateur licence, and it's just a slightly odd way of expressing power. If it confuses you, don't worry about it because it's confusing quite a lot of experienced amateurs!

You can't get very far in the electronic world without running into something called the "decibel", which is usually abberviated to "dB". This isn't the place to go into how the dB is used, but it's a basic way of expressing ratios. For example, if we take an amplifier of 10 watts and one of 20 watts, you can say that, because one has twice the power of the other, it is 3 dB more powerful since in simple terms 3 dB implies a doubling of something. 10 dB implies ten times, and, in fact 13 dB would imply 20 times — can you see why? 10 plus 3? Ah well — it doesn't matter.

The "dBW" of the licence schedule implies a fixed number of dB over a level of one watt, which is taken as the standard. So 3 dBW would be the same as 2 watts, for instance, and 10dBW would be 10 watts. 20 dBW would be 100 watts, which is the carrier power limit on many bands available to amateurs. As a matter of interest, 30 dBW would be 1,000 watts, which may help those with mathematical inclinations — hands up the man who said "ah, logarithms!"

Anyway, that's the dBW and if you still haven't got it sussed — it'll come when you start doing your RAE studies. For our 1.81-1.85 megahertz portion of the spectrum we see that the power limits are 9dBW for carrier and 15 dBW for SSB, being peak envelope power (it's all explained later). As a matter of interest, you might like to try and work out what these figures mean in ordinary boring watts. In case your brain won't have it, they're approximately 8 watts and 32 watts respectively.

Anyway, that's a quick look at the schedule. It's a very good idea to become familiar with it as fast as you can, for two reasons — you'll get asked questions about it when you do the exam, and it helps to know where the bands are for listening. We've listed them all here somewhere, but they're all mentioned in the Home Office's free book that we mentioned in "how to pass the test" or whatever the Editor has decided to call it!

The only other thing in the schedule is the various classes of emission, which here again you'll pick up as you go along. A key to what they all mean is given in the licence schedule, and you'll soon become familiar with them. You'll be using them in your logbook, by the way, since you're required to record what mode you were using for your contacts.

Keeping a log, by the way, isn't a boring chore that authority requires just because it's "authority" — you can have a lot of fun looking back through your log, as well as using it for more serious purposes like seeing whether a change to your antenna, for example, is getting you better or worse reports from particular parts of the world. It's also useful if you get accused of causing breakthrough. You can check whether of not you were actually operating at the time!

That's the licence. Now all you need to do is to get one of your own with your name, address and callsign on it . . .

Opposite page: THE Home Office Amateur Radio Certificate — many frame this well-earned piece of paper and hang it on their wall.

Left: Amateur Licence A will set you back a monumental £8 for the first one, and £8 on each renewal. Not much for the privilege of talking to the world. . . It sets out what you can and can't do in easy to understand language.

HOME OFFICE

WIRELESS TELEGRAPHY ACT, 1949

AMATEUR LICENCE A

SPECIMEN

Date of Issue .... **Fee on Issue** £8.00

Renewable .... **in each year** **Fee on renewal** £8.00

Call sign ....

1. (1) *Licence* ....

of ....

(hereinafter called "the Licensee") is hereby licensed, subject to the terms, provisions and limitations herein contained:

(a) to establish in the United Kingdom an amateur sending and receiving station for wireless telegraphy (hereinafter called "the Station"):

(i) At the above address

(hereinafter called "the main address") or

(ii) At any premises (hereinafter called "the temporary premises") or any location (hereinafter called "the temporary location") for separate periods none of which shall exceed four consecutive weeks; or

(iii) At any premises (hereinafter called "the alternative premises") provided that at least 7 days before the Station is established at the alternative premises notice in writing of the postal address of the alternative premises is given to the General Manager of the Post Office Telephone Area in which the alternative premises are situate or, in the case of the Channel Islands to the Director of the Telecommunications Board of the appropriate Bailiwick. The said General Manager or Director shall also be notified in writing when the Station is no longer established at the alternative premises; or

(iv) in any vehicle or vessel but not on the sea or within any estuary, dock or harbour;

(v) as a pedestrian;

(b) to use the Station for the purpose of sending to, and receiving from, other licensed amateur stations as part of the self-training of the Licensee in communication by wireless telegraphy;

(i) Messages in plain language which are remarks about matters of a personal nature in which the Licensee, or the person with whom he is in communication, has been directly concerned;

(ii) Facsimile Signals;

(iii) Radio Teleprinter Signals;

(iv) Visual Images;

(v) Signals (not being in secret code or cypher) which form part of, or relate to, the transmission of such messages, signals or images.

(c) to use the Station, as part of the self-training of the Licensee in communication by wireless telegraphy, during disaster relief operations conducted by the British Red Cross Society, the St John Ambulance Brigade, the Emergency County Planning Officer, or any police force in the United Kingdom, or during any exercise relating to such operations, for the purpose of sending to other licensed amateur stations such messages as the Licensee may be requested by the said Society, Brigade, Emergency County Planning Officer or police force to send, and of receiving from any other licensed amateur station such messages as the person licensed to use such other licensed amateur station may be requested by the said Society, Brigade, Emergency County Planning Officer, or such police force to send;

(d) to use the Station for the purpose of receiving transmissions in the Standard Frequency Service.

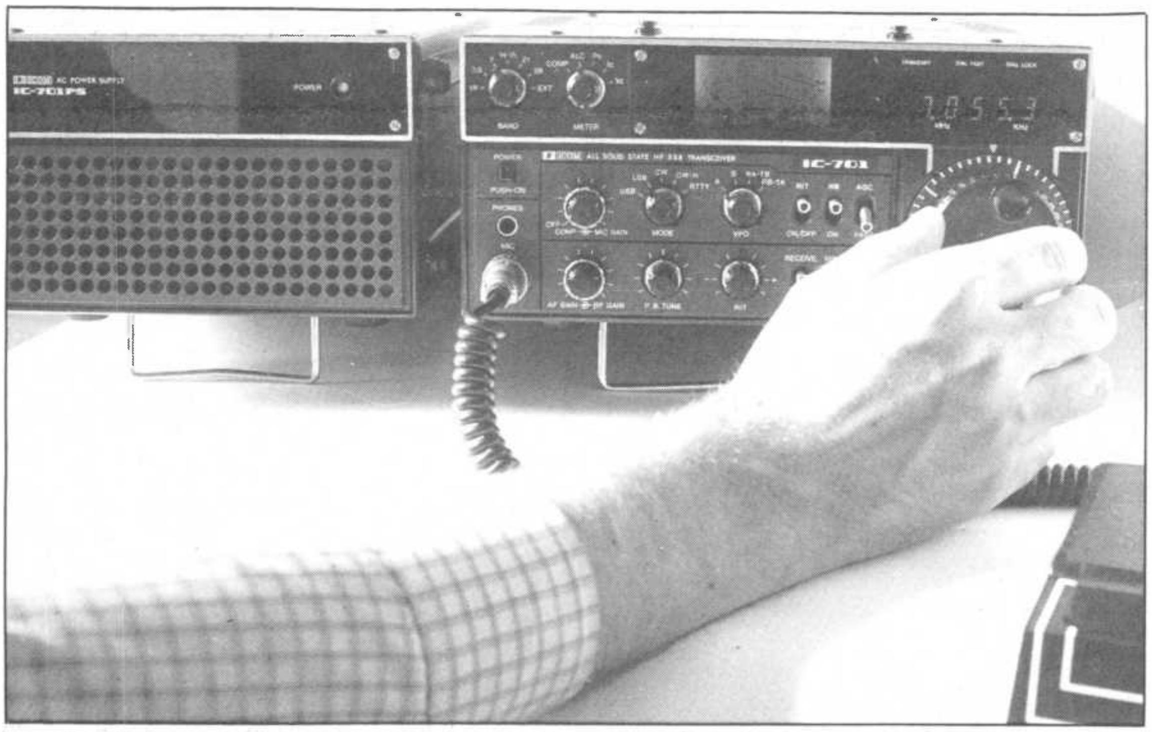
(2) Limitations. The foregoing Licence to establish and use the Station is subject to the following limitations:

(a) The Station shall not be established or used in an aircraft or a public transport vehicle.

(b) The Station shall be used only with emissions which are of the classes specified in the Schedule hereto and are within the frequency bands specified in the Schedule hereto in relation to those respective classes of emission, and with a power not exceeding that specified in the Schedule hereto in relation to the class of emission and frequency band in use at the time.

(c) The Station shall be operated only (i) by the Licensee personally, or (ii) in the presence of and under the direct supervision of the Licensee, by any other person who holds a current wireless telegraphy licence issued by the Secretary of State to use another amateur station or who holds an Amateur Radio Certificate issued by the Secretary of State.

1



GETTING ON THE AIR

Launching yourself into the ether. How to strike up your first conversation and what to expect in the way of calls, and answers. Codes aren't really that necessary — good old plain English will do, says John Nelson.

So — you've got yourself a rig and maybe a licence (although you may not have it yet). How do you set about getting on the amateur bands and using it?

It's actually quite difficult to describe it in cold blood, so to speak, since a lot of the operating practices and procedures used by radio amateurs will come to you with practice and experience. However, we can look at a few basics to get you on the right road: the rest is up to you, since the procedures you'll be using vary somewhat with what bands you're interested in and who you want to work. The RSGB devote a whole book to operating, in fact — it's called *Amateur Radio Operating Manual* and, as we've said elsewhere, every amateur should have a copy because practically everything you'll need to know from the point of view of actual operation is contained somewhere in its 202 pages.

Anyway, let's assume you've got your rig set up, switched on and connected to some sort of antenna. Rule No. 1 is LISTEN. Three-quarters of good operating is listening, for all sorts of reasons: one is that you can quickly get some idea of who is around, whereabouts signals are coming in from and what frequencies are clear if you yourself want to put out a call without clobbering anyone else. The Americans have a graphic expression for someone who doesn't listen before loosing off — they call him an "alligator" (i.e. all mouth and no ears) and it's much better not to be an alligator if you want the reputation of being a smart operator.

In previous years, most amateurs came from the ranks of so-called Short Wave Listeners or SWLs, and you always found that the best operators were those who'd spent an apprenticeship, so to speak, as a listener. It's ironic that although you pass an exam in order to be able to transmit, there's no mandatory requirement to have done any listening before you launch yourself into the ether, and in many ways I'd strongly recommend doing a lot of listening before you go in for the RAE.

Packed with signals

Anyway, the first essential is to be sure that you've read the instruction book or whatever of your rig so that you know what all the various controls do. Then, just sit down at it and spend some time tuning around whatever band interests you.
You'll find, for example, that the 28MHz band at midnight won't produce very much at all, whereas the 3.5 or 7 MHz bands on a Saturday afternoon will be absolutely packed with signals from one end to the other. Don't be afraid to try out various controls such as the RF gain or any filtering that the receiver may have; it's constant use of these that will in time give you the experience to know just what you can and can't do in getting rid of interference and so on. With a modern transceiver, especially, I'd reckon that it takes a fair time to learn to drive it really well, and no article can tell you how to do it — you've just got to try it out and get an unconscious feel for how to use it. You'll also find that listening around the bands will give you a pretty good idea of operating procedures themselves, and it's necessary here to be a bit discriminating. You'll hear good operating, poor operating and downright stinking operating, and it's a good idea to distil the best habits and forget the worst ones. Spurious-sounding jargon is best left to 27MHz CB; if you want to say "yes" there's no point in saying "that's a roger", for instance and neither is there any mileage in adding the word "there" to the end of practically every sentence as some amateurs do for some weird reason. Now every hobby has its private language, and indeed radio has a lot which is designed for good reasons such as brevity and intelligibility but words such as "roger" and "affirmative" do have quite rigid meanings and shouldn't be used in order to make you sound like a hot-shot operator 'cos that's the last thing they'll do. If anyone asks me on the air what my handle is, I tell them that it's chrome-plated and on the side of the linear: I do, however, have a name!!

So let's assume that you're tuning around and happen to hear something like this:

"CQ, CQ, CQ 40. This is G4XYZ, G4XYZ in Birmingham called CQ 40 and listening."

This is someone making what is known as a general call, or in other words an invitation to any station who might desire to engage in conversation with the proprietor of the callsign G4XYZ. "40" is the band he is on, and although he's not obliged to say it most amateurs do. He's also told you where he is, and he does this for several reasons. On HF, it might be that you want to talk to someone in Birmingham for, say, an award, or you want to find out how strong your signal is in the Midlands. On VHF and UHF it's a very good idea always to give your location because antennas for these bands tend to be very directional and you might want to "swing the beam", as they say, to get a better signal from him. Equally, it might be a fair distance from wherever you happen to be to Birmingham, and you might be that much more eager to work him if you've never heard a signal from that distance before. So it never hurts to announce where your station happens to be located, and it's especially important on VHF and UHF.

Let's assume that you keep listening, and you hear someone go back to our man in Birmingham, thus:

"G4XYZ, G4XYZ this is GM4ZYX, Golf Mike Four Zulu Yankee X-ray in Edinburgh calling, GM4ZYX calling G4XYZ and by."

So he's got a reply to his call, and it's a Scottish station. You'd have known that even if he hadn't said he was in Scotland because GM is the prefix for Scotland: if, say, our Brummie had been on 14 MHz and a station signing UK3XXX had gone back to him, you'd know straight away (or at least after reading the prefix list) that he was a Russian. "By" is short for "standing by", by the way.

The Golf Mike Four . . . bit is an example of the *phonetic alphabet*. You use this when you want to make your callsign, or anything else for that matter, especially clear, and you spell it out; you don't have to use the particular phonetic alphabet that's recommended but almost everyone does (see the list).

So, let's carry on listening:

"GM4ZYX from G4XYZ. Good afternoon and thanks for the call. You're a good signal here in Birmingham, your report is 5 by 9 with a bit of QSB. My name is Malcolm — Mike Alfa Lima Charlie Oscar Lima Mike — and the location here is the city of Birmingham. Wonder how you copy? GM4ZYX from G4XYZ, over."

Our bod in Brum has obviously heard the call and indeed is getting a good signal from Edinburgh. He's given him a report of 5 and 9; the "5" is his readability, and means he's perfectly readable, and 9 means a very strong signal. If our Scotsman had been rather a weak signal, perhaps lost under some interference, Malcolm might have given him a report of something like 4 and 5: this means that he copied most, but not all, of what he said and that his signal was on the weak side. A signal report of 1 is as low as you can go, and it means that the signal is about as strong as the noise.

Plain English

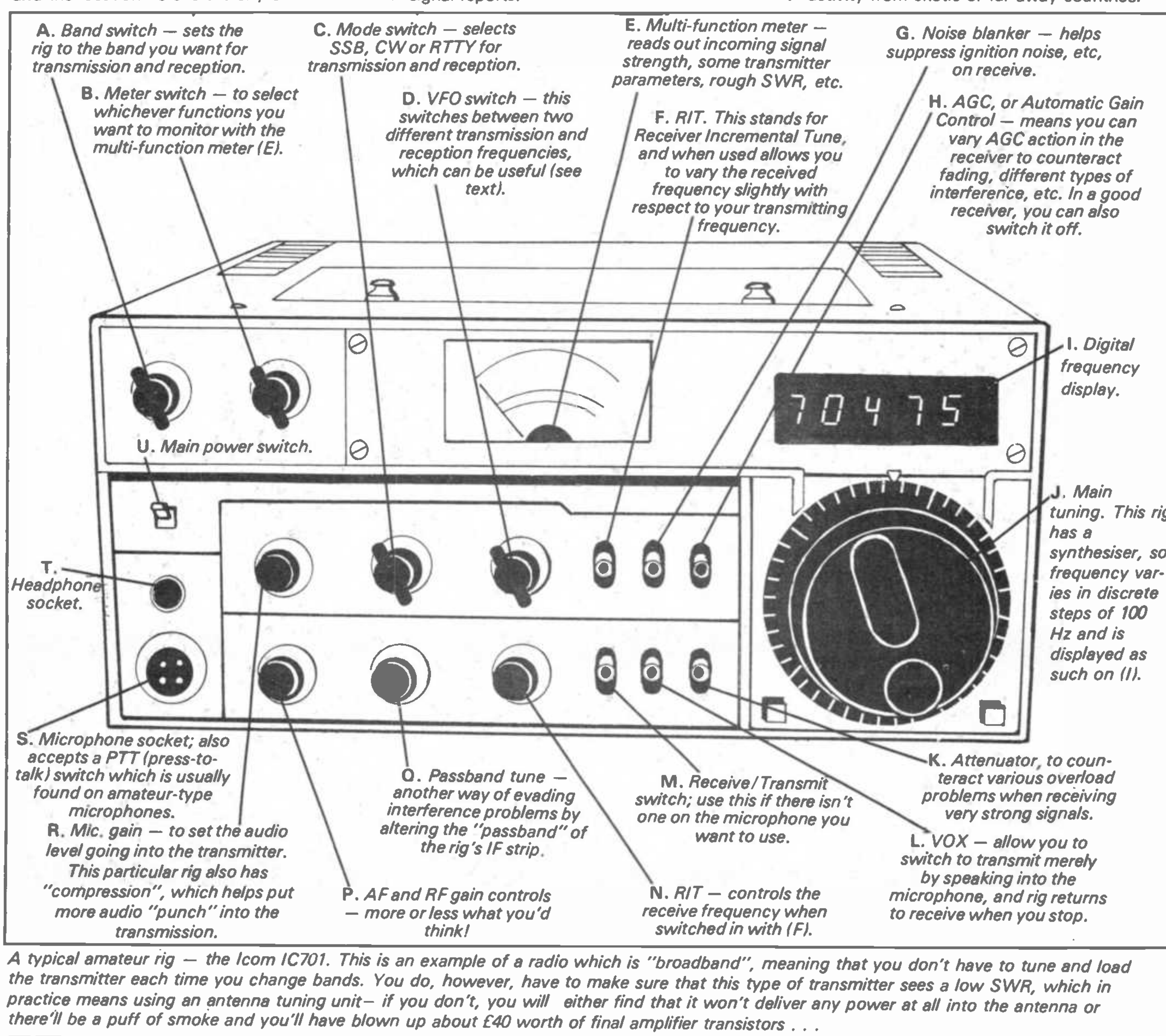
Most rigs have what is known as an "S-meter", which is calibrated in units. You'll find that these are practically useless for meaningful reports of signal strength and it's far better to give a report in line with what you're hearing. On some rigs, indeed, you'll find that a perfectly audible signal doesn't move the S-meter needle, so for goodness' sake *don't* make a berk of yourself and give someone a report of SO! Use the definitions as in our list, which have been agreed since time immemorial for all radio users and which more or less everyone understands — your S-meter may be useful for comparisons but it's most unlikely to mean anything useful for signal reports.

Our pal Malcolm also used a Q-code; he said that there was some "QSB" on the Scots signal. Strictly speaking, the Q-codes are meant for CW use only, or for when you're talking to someone whose English may not be too funky or who isn't a strong signal; he could just as easily have said "there's some fading on your signal", which is what QSB means. It's a common habit, but here again the best general rule is to use plain old boring English unless there's any good reason not to. Just because you're on the radio instead of chatting to the guy in the street, there's no need to come over all steely-eyed-radio-operator rapping out codewords: save the codes and the jargon for their rightful place if you can.

So on we go:

"G4XYZ from GM4ZYX — yes, all copied and you're also a good signal here in Edinburgh, about 5 and 7 to 9 with a bit of fading. My name is Bill — Bravo India Lima Lima — and the rig is an Icom IC701 running about a hundred watts to a dipole at about 40 feet above the ground. Weather's cold and windy, and I haven't heard much on 40 this morning; I was listening on 10 earlier and worked some W's but not a lot of DX around . . ."

And so on; he's given Malcolm a report and told him what sort of rig and antenna he's using, and also that he's spoken to some American stations on the 28 MHz band but there wasn't much in the way of amateur activity from exotic or far-away countries.



A typical amateur rig — the Icom IC701. This is an example of a radio which is "broadband", meaning that you don't have to tune and load the transmitter each time you change bands. You do, however, have to make sure that this type of transmitter sees a low SWR, which in practice means using an antenna tuning unit– if you don't, you will either find that it won't deliver any power at all into the antenna or there'll be a puff of smoke and you'll have blown up about £40 worth of final amplifier transistors . . .

GETTING ON THE AIR

From this point onwards, having got the pleasantries over with they'll talk about practically anything. Bill might be a railway enthusiast and lament about the demise of the Deltics, for instance — he might not talk about radio at all. Conversely, both of them might be avid DX chasers and talk about where they've worked recently. In other words you can talk about whatever you like. It's generally felt that amateurs don't talk about religion, politics or sex, and the licence states that you mustn't be obscene or talk about business matters; apart from these, you're quite free. However, bear in mind that a Russian amateur, for instance, probably isn't going to be able to talk about the finer points of antenna systems, for instance, because he won't know all that much English. You'll find a fair number of "rubber stamp" contacts, where you just exchange the basic details, on the HF bands, simply because of the language barrier. Conversely, you'll usually be chatting for hours with American stations for obvious reasons!

Anyhow, let's assume that our heroes have finished their conversation:

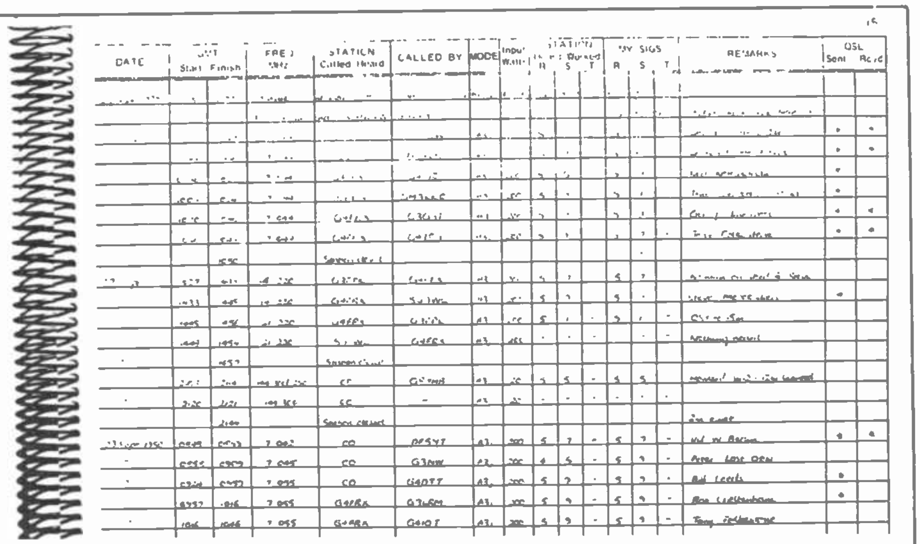
". . . OK Bill, well that's about it from me so I'll wish you all the best 'til we meet again. Thanks very much for a most pleasant contact and see you soon. GM4ZYX, this is G4XYZ signing and listening this frequency."

"Fine Malcolm, many thanks. G4XYZ, this is GM4ZYX off and clear and closing down. Bye bye."

In other words, they have ended their contact: Malcolm is listening on the same frequency in case another station wishes to call him, whereas Bill has decided to close down. If he hadn't, the usual convention is that the guy who was there first keeps the frequency — in this case Malcolm, because he called CQ in the first place — and Bill might have said something like ". . . this is GM4ZYX off and clear and listening ten up" or something similar. That way, anyone who wanted to call Bill could have done without clobbering Malcolm.

There are a few variations, of course. If you call CQ and it's your lucky day and you're called by someone such as JY1, who just happens to be King Hussein of Jordan, or a juicy DX morsel like VP5PAT in the Turks and Caicos Islands, you can bet your life that as soon as you've had your two penn'orth the ravening hordes will descend on the frequency and it's you who'll be expected to move.

In the matter of working rare DX — if you get a taste for it — there are all sorts of ways of doing it, some of which are more gentlemanly than others. We won't go into them here, since the noble art of DX-chasing needs about 10,000 words all to itself; you'll get the hang of it after a while. The main things to remember is that you'll be in competition with about three trillion other stations if the DX really is rare, and a "pile-up" can degenerate into a shouting match very quickly if everyone goes mad. Hunting DX requires a tactical approach and a lot of listening, to see how the quarry is playing it and how he answers calls. Then you've got to whip in and catch him: oh yes, me hearties, it's a noble game all right. If I had a quid for the hours I've spent after the rare ones — oh well, never mind . . . Back to basic operating, and don't worry about super DX yet. There'll be plenty of time later, and I can tell you about the afternoon I worked Chagos Island with only 50 watts to a dipole . . . SHUT UP AND GET ON WITH IT, NELSON!



Page of an amateur's log book.

Sorry. If you get called by a rare one, it's courteous to move off the frequency so that other people can have a lucky day as well.

We've just seen a basic contact take place, in which each station had a "monologue" for a minute or so and the other station listened to what he was saying; maybe he took notes, and you'll find it's handy to keep some paper and a pencil by the rig to note down anything you particularly want to reply to. You can, of course, have a snappier style of conversation with quicker "overs" — the only point here is that you must remember to give your callsign every now and then as required by the licence. Many rigs these days have a facility called "VOX" which means that they sit in receive and switch to transmit automatically when you speak into the microphone. This can be very useful if you're having a quick-fire coversation, especially on the HF bands when there's interference of one sort or another and you want to listen between sentences to be sure that the frequency is still usable.

Calling channel

So — when you want to go on the air, your basic options are either to call someone who is calling CQ or is just finishing with someone else, or to put out a CQ call yourself. If you're going to do the latter, do remember Rule 1 and LISTEN before you do your stuff to make sure that you won't wipe out some other bod who's having an innocent chat which you can't hear for some reason or other. It's usually best to ask whether the frequency is in use ("is this frequency in use please? from G4XYZ"), so that someone who is listening to another station inaudible to you can say "yes, thanks", meaning thanks for asking, and you'll have to find somewhere else.

Another thing, particularly if you're a Class B operator, is that there are set frequencies for calling CQ on the VHF and UHF bands — you make your initial call on these and then move off them for your contact. The reason for this is that the VHF and UHF bands are large by comparison with HF, and it's useful to have known spots where everyone can listen. In an opening or a contest, it's a different story, but for most of the time the calling frequencies are just what they say and you should always move well away from them for the actual contact when it's been established. One common error that new licencees make is to move only a few kilohertz away from the calling frequency, and then not to listen on it to make sure that someone else hasn't done the same five minutes before you and is still there! 144 and 432 MHz are big bands, folks, so don't be afraid to move 100kHz away if you're on the 144 MHz SSB calling frequency, for example. Equally, do ask whether the frequency is in use before you settle down for your natter; it only takes a second, and saves a lot of aggro. If amateurs made more use of the sentence "is this frequency in use please, from G4 - - -?" life on the bands would be a bit pleasanter than it is at times . . . so let's make it Rule 2!

One thing while we're on the subject of VHF and UHF operation is that it's not necessary to call CQ if you want to use a repeater (see the section on Mobiles and Repeaters if you're not too sure what a repeater is). It's enough to announce "G4XYZ listening through GB3BM" and wait for the repeater to send back a K; you can then sit back and see whether anyone is going to call you. The same is true of the FM simplex channels, certainly in busy areas; it's usually enough to say that you're "listening S20", which is the 144 MHz calling frequency, for example. As we've said, if someone calls you, you then pick a clear frequency away from the calling "channel" and off you go.

Well, that's an introduction to some very basic operating practices, certainly as far as speech is concerned. On Morse it's a somewhat different ball game, with all sorts of codes and abbreviations in use to make life easier. The basic format of the contact will be the same, however, and don't get put off by all the various codes and abbreviations you'll hear. You'll be surprised how quickly you pick them up, and you will certainly discover that Morse, far from being the anachronistic dinosaur you might imagine, is an extremely good method of communication for all sorts of things. It's possible, for instance, to have a CW contact with someone who doesn't speak a word of English, and it's almost uncanny how Morse will get you through when all else fails. However — we've discussed Morse in detail elsewhere; it's enough to say here that the procedures are broadly similar to those we've discussed.

So — that should at least get you into the swing of it. You can't do too much listening, actually, and it's much the best way to learn about how to operate if you can sort out the odd bad habits and make a mental note about how not to do it.

Now — did I tell you about the time I won the 144 MHz Open Contest with some superb DX-hunting? There I was . . . ah well. Good operating is a fine art and great fun — see you in the pile-up!

PASSING THE TEST

It really is easier than you might imagine

Okay — so you've had a listen on the amateur bands, messed about with various antennas, heard some interesting things and maybe joined your local club. You've decided that amateur radio is for you. What's next?

Two things, basically. You need, first, to pass the Radio Amateur's Examination, which is set by the City & Guilds of London Institute. And then, if you want a Class A licence, you'll need to pass a Post Office Morse test at 12 words per minute. So let's take a look at the exam (known generally as the RAE) and how to pass it.

You can obtain a little booklet free of charge from the folk who issue the licence in the UK. It's called *How to Become a Radio Amateur* and it's available from the Home Office Radio Regulatory Division, Licensing Branch (Amateur), Waterloo Bridge House, Waterloo Road, London SE1 8UA. The important points you'll find in it go something like this. Applicants for an amateur licence (whether it's for a Class A or a Class B licence) must be over 14 years of age and provide evidence of British nationality in the form of something like a birth certificate or a valid passport.

Specimen questions

Applications from a person under 18 have to be countersigned by a parent or a guardian. Applicants must also show that they have passed the RAE, which we'll get to in a minute. For a Class A licence, you must have passed the Post Office Morse test not more than 12 months before applying for a licence. This means that the usual thing is to pass the RAE first before going for the Morse in case you blow the exam (heaven forbid) and have to do the Morse all over again.

Getting back to the RAE itself, as we said it's run by the City & Guilds; if you write to them at the Electrical and Telecommunications Branch, 76 Portland Place, London W1N 4AA, they'll give you full details and a set of specimen question papers for a small fee. The exam itself is held twice a year, usually in May and December, and various centres around the country such as polytechnics and technical colleges are the place to go; here again C & G will supply you with a list of possibilities. The RSGB (Radio Society of Great Britain) also have two centres where you can take the exam — one is in London and the other in Derby — and they'll give you full details if you write to the Membership Services Officer at Headquarters, 35 Doughty Street, London WC1N 2AE.

Incidentally, whilst writing to them, if you're intending to take the RAE you should invest £3.12 in one of their publications. It's the *RAE Manual*, and it contains masses of material which will help you along. More of that later.

Right — so you've done the groundwork. The exam itself is in two parts. The first section is entitled "Licencing Conditions and Interference" and it lasts for one hour. There's then a 15-minute break before the next paper, which is on "Operating Practices, Procedures and Theory" — this lasts for 1¾ hours. The basic format of the exam is multiple-choice; the first paper contains 35 questions and the second one 60.

Hands up those who don't know what a multiple-choice exam is. A multiple-choice question consists of a sentence which implies or asks a question; in the RAE you then get four possible answers. Only one of them is correct, and you have to indicate which it is. So you might see something like this — don't worry about what the words mean for now, this is just the format of it:

Poor frequency stability of an amateur transmitter can result in:
(a) generation of parasitic oscillations
(b) a reduction in power output
(c) difficult adjustment of the power amplifier stage
(d) operations outside the amateur bands

As it happens, the answer is (d) and you'll have no difficulty with a question like that when you've read a few things up and got the idea. We've included a sample of the RAE in this article, and when you first look at it you'll probably feel like forgetting the whole idea and taking up something simple like brain surgery — but please don't!

It isn't a tenth as bad as it looks. Like any syllabus, it looks absolutely dreadful at first because nine-tenths of the words themselves are unfamiliar. If you get hold of something like the *RAE Manual* (and, as we've seen elsewhere, another good book to get is *A Guide to Amateur Radio*, also from the RSGB) and take it a bit at a time, it'll all become clear.

So let's have a look at both sections in a bit more detail. Licencing Conditions and Interference is about what it says it is really. There are various points about where you can use an amateur station, when you must send your call sign and so on. Interference is about things like spurious emission from your transmitter, how to cure breakthrough and the requirements for checking the frequency of your transmitter.

Basically, getting a grip on this section of the exam means knowing the licence conditions more or less off by heart, and it's just straight reading and learning. The transmitter interference bit needs a little more work; you'll have to master a few basic principles before you get to grips with what they're talking about, but here again the electronic principles involved are fairly basic and you'll get the drift of it after a while.

The second section is the technical one, and if you're new to the game it's where you'll have to do your homework. Now there are various ways of doing this. You can sit at home and plough through the textbooks, and if you have an academic bent and you're used to exams of one sort or another, you'll be able to learn a lot this way.

For the average man-in-the-street, that's probably doing it the hard way, and a lot depends on whether or not you know anything to begin with. It'll obviously take longer if, say, you don't know how to cope with a circuit diagram or if you haven't even a vague idea of how a radio receiver works, but either way many people who intend to take the exam do some study on a more or less formal basis — at a local technical college, for instance, or at an evening class somewhere.

Radio clubs

You'll also find that many radio clubs do some RAE lectures, and some of them set aside one night a week for a beginner's evening. This is another good reason for joining your local club right from the start of your career, even if you're not a very clubbable person as a rule — even if they don't do any formal lectures, you'll no doubt find someone who's at about the same stage as yourself and you can always fire awkward questions at each other over the beer and crisps.

Unless you're a Great Brain, I'd say that the worst way to attack the RAE is to sit down with some clever electronic textbook and solemnly wade through it from start to finish in the vague hope that some of it will stick. Your brain is a precision instrument and it won't take kindly to being used in this way. It'll retaliate by forgetting nine-tenths of what you read. Grab a couple of simple books, such as the *RAE Manual* and nibble at them as the mood takes you; the licencing bit is parrot-fashion but the technical stuff won't be familiar to you and you'll have to take it a bit at a time.

Try and make what you read last time tie in with what you're reading this time, and also have a go at using a circuit diagram right from the word go — even for the simplest things. You'll gradually find that things begin to make sense. Try reproducing simple circuits from memory — don't do it by remembering which line goes where but do your best to suss out what the various components on your diagram are supposed to do, and make it logical.

APPENDIX 1

Sample RAE questions

The following list of 40 sample items, prepared by the City and Guilds of London Institute, illustrate the kind of questions found in the UK Radio Amateurs' Examination, although not necessarily representative of the entire scope in either content or difficulty. A key to the correct answers is provided at the end of the section.

The RAE comprises two papers: 765-1-01 *Licensing Conditions and Interference* lasting 1 hour and containing 35 items (about 66 per cent on licensing conditions, 34 per cent on transmitter interference); and paper 765-1-02 *Operating Practices, Procedures and Theory* lasting 1 hour 45 minutes and containing 60 items (8 per cent on operating practices and procedures; 18 per cent on electrical theory; 12 per cent on semiconductors; 15 per cent on radio receivers; 13 per cent on transmitters; 24 per cent on propagation and aerials; and 10 per cent on measurement).

In the following sample items 1–12 cover syllabus sections for paper 765-1-01 and items 13–40 are applicable to paper 765-1-02.

1. The callsign prefix of the Isle of Man is
   (a) GM
   (b) GD
   (c) GI
   (d) GW.

2. The holder of an Amateur Licence A may only use signals which
   (a) are listed in the Radio Regulations
   (b) form part of, or relate to, the transmission of messages to and from amateur radio stations
   (c) are in codes and cyphers, which have been notified to the Secretary of State, Home Office or his agents, at least four weeks prior to their use
   (d) are recognized by the Secretary of State, Home Office as being necessary to the Amateur Service.

3. The maximum dc power input permitted on the 1·8–2MHz band is
   (a) 10W
   (b) 50W
   (c) 150W
   (d) 400W.

4. The Amateur Licence states that the Licensee shall test his transmissions for radiation of harmonics and other spurious emissions and record such tests in the log
   (a) once a month
   (b) once every three months
   (c) at the request of a Home Office official
   (d) from time to time.

5. Entries in the Station log book need not include
   (a) date
   (b) time of commencement of operation
   (c) signature of the Licensee
   (d) time of closing down the Station.

6. In the case of a prolonged contact amateurs in the United Kingdom should make a station identification at intervals not exceeding
   (a) 10 minutes
   (b) 15 minutes
   (c) 20 minutes
   (d) 30 minutes.

7. Poor frequency stability of an amateur transmitter can result in
   (a) the generation of parasitic oscillations
   (b) operation outside the amateur bands
   (c) a reduction in the power output
   (d) difficult adjustment of the power amplifier stage.

8. The radiation of harmonics from an amateur transmitter may be caused by
   (a) the power amplifier stage being over-driven
   (b) keying a high current circuit in the transmitter
   (c) the power supply to the driver stage being unregulated
   (d) rf being induced in the mains supply to the transmitter.

9. The circuit diagram shown in Fig 1 may be used to
   (a) detect the presence of harmonic radiation
   (b) ensure that an amateur transmission is free from frequency instability
   (c) check that the transmission is not unnecessarily broad
   (d) measure accurately the percentage depths of modulation.

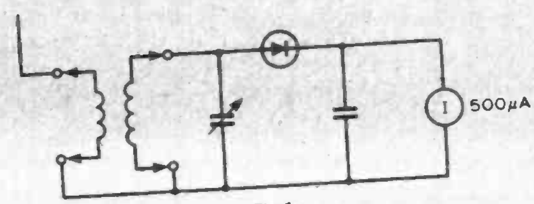


Fig 1.

10. A transmitter would be likely to radiate harmonics if
   (a) the supply voltage was unregulated
   (b) it was overmodulated
   (c) the output stage was overdriven
   (d) there were short-circuited turns in the aerial tuning unit.

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What you will find after a while is that you're learning a devil of a lot about the few basic circuits around which the vast majority of amateur radio gear is designed. If you can work out the basic elements of, say, a simple transmitter or a receiver, you'll find that things like it crop up over and over again.

If we look at something called an oscillator, for example, what you will find is about half a dozen basic ways to make an oscillator. These crop up in about a million different places in transmitters, receivers, power supplies and all manner of clever things — the thing is that the oscillator circuitry will be very like something you first learnt and it'll look familiar to you. Same with the various types of amplifier circuit which get used for things like microphones; there are heaps of ways of making an amplifier but you'll find that there are a few basic types, which start to look very familiar when you get the hang of them.

You'll then be able to say to yourself "Hmm — I wonder why *that* component is there — it's a bit different from the usual way of doing it. Let's see — ah yes, it must be doing *this* so that the amplifier can do *that*". Bingo — you're away.

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PASSING THE TEST

For God's sake *don't* try committing complex circuits to memory wholesale — you'll have mental indigestion and serve you right too. Take it stage by stage, don't rush yourself and always, always try and work out what each component is for in each basic stage of the equipment. When you read up about oscillators, for example, start with a simple well-known one like the Hartley oscillator circuit and try and follow how it works and why; then have a look at how you might use a Hartley oscillator in the early stage of a simple transmitter, for instance.

Let's spare a few words for mathematics. Many people tend to wince and talk about the weather when someone mentions maths, and it's an undeniable fact that there's a bit of it in the RAE. The reason is that there are some simple formulae which are pretty basic to electronics, and I really do mean simple. For instance, one of the basic facts in electronics (stated as Ohm's Law) is usually stated as a simple equation ($V = I \times R$; couldn't be much simpler).

Please don't be put off by a little maths because you'll find that the things you need to know are pretty elementary and, like everything else in electronics, highly logical and simple if you take them a bit at at time, and don't let yourself freak out the moment you see the word "square root" or symbols like pi or omega (π and Ω). They're only symbols, and you shouldn't let them get to you!

It'll then be time to go and take the exam. Now many people, be they never so brilliant, absolutely dread exams and think they're rather worse than having a leg removed without anaesthetic, and it may help to remember a few simple things. The first is that you're not on trial for murder, and you won't be hanged at dawn if you fail; it'll just mean taking it again.

You can fail in one section of the exam only and you need only retake that bit; not that you'll fail anyway if you've done the necessary graft and keep your cool. Many people who fail do so because they're afraid of failing and set themselves up for it, not because they don't know their stuff. So try saying to yourself if you're of a nervous disposition "Well, what the hell — I've done my best and I'm not going to get neurotic and anxious about it, so I'll just have a crack and if I fail, well, I'll just have to do it again. Which is boring, so I'll pass it first time and save the aggro."

The best thing, when you get there, is to read through the question paper a couple of times and get the feel of it; you'll inevitably spot some questions you know the answers to with no problem, so blaze away and do those first off. Then you can have a think about the ones which are a bit more awkward, and take your time a bit. You'll generally find that there are one or two which completely faze you — the best way with these is, having done the others, keep an eye on the clock and have a quiet wrestle with them.

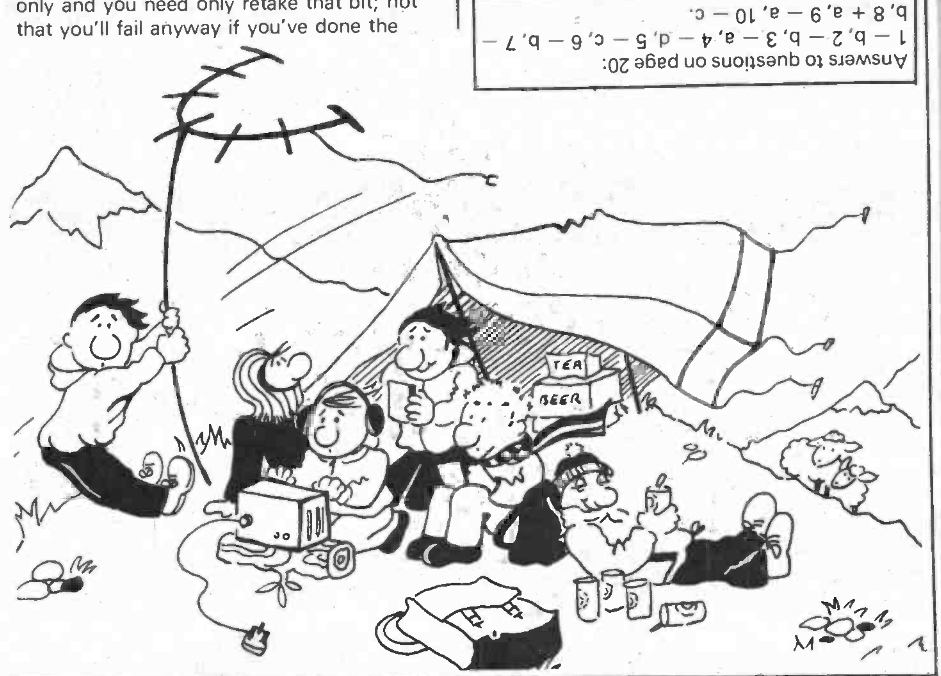
There aren't any trick questions in the RAE, and all of them should have a logical answer somewhere — just take your time and suss out what it is.

When you've finished, you'll have to wait a couple of months for the result — if you've passed, you'll receive something called a "pass slip" and this is the evidence the Home Office requires to say that you've passed the exam. They will then issue you with a Class B licence. If at some point within the last twelve months you've passed the Morse test as well, and enclosed *that* pass slip too, you'll get a Class A ticket. By the way, at the time of writing it'll cost you £8.

That's it really. To sum up — buy the *RAE Manual* and get the free book from the Home Office, take it nice and slowly and join your local club. When it comes to the exam, remember that you won't get your head chopped off if you fail, and then sit back and enjoy yourself. Yes, you can enjoy examinations, honest. Then when you get the pass slip, send it to the Home Office along with all the other gubbins they need, plus your cash — you're then about to become a licensed radio amateur.

You will find that one day, the magic licence falls plop on the doormat and, if you're like every other amateur I know, you'll be on the air about thirty seconds later . . . well done!

Answers to questions on page 20:
1 – b, 2 – b, 3 – a, 4 – d, 5 – c, 6 – b, 7 – b, 8 + a, 9 – a, 10 – c.



How it all started

The first amateur of them all was the man who started it all — no less than Marconi himself! Well — it's nearly true. Actually, in the sense that an amateur is someone who does something for love and not for money, Marconi was an amateur all right, and so were all the early pioneers. Amateurs as we know them got off the ground in the early years of this century, and many of the first discoveries in the new science of Wireless were made by amateurs. In the beginning, the experimenters used rudimentary apparatus of all sorts of shapes and sizes and operated more or less where they wished — you have to remember that the early "amateurs", although they weren't called that then, were active long before broadcasting of any kind started up, and indeed the world's first "broadcast" station started up for the sole reason that the experimenters wanted a station to be put on the air so that they could try out various ideas with their receivers! Actually, this station, which was located at Writtle, near Chelmsford, was a great success with everyone, and its chief engineer, a gentleman by the name of Eckersley, was invited to become Chief Engineer of the British Broadcasting Company when it was founded. Stand to attention and salute, you lot at the back . . . !

When broadcasting got going, of course, the amateurs were shunted off into the then unwanted wavelengths below about 200 metres, which the Great Brains of the day said were useless for anything resembling real communications. At that time, the state-of-the-art said that in order to talk to the more remote outposts of the Empire and to His Majesty's Ships (stand up and salute again, up grams Rule Britannia, etc, etc) you had to use longer and longer waves — the Wireless Stations of the day had antenna systems you simply wouldn't believe, hurling massive amounts of kilowattage into the ether and getting not very far. Can you imagine the shock and horror when the amateurs began talking in Morse to other experimenters all over the world, using flea-power and bits of wire for antennas? "Hrrumph — oh no, me dear feller, can't be done . . ." Well it was done, and the laugh was on the professionals — not, let it be said, for the first time!

Funnily enough, the same thing happened a few years later at the other end of the spectrum. The Experts had more or less written off frequencies above about 25 MHz as being absolutely useless for anything other than line-of-sight nattering over a few miles. Amateurs, however, had other ideas, and they were among the first to show that frequencies around 50 MHz could propagate for several hundred miles under the right conditions — they even evolved the right theories about how it was done.

There is a good book about the history of amateur radio. It's called "World at their Fingertips", and it was written by one of the great amateurs of all time, the late John Clarricoats, G6CL. You can get it from the RSGB, and if you want to get a vivid feel for what it was like in the early days, I'd strongly recommended it.

SHOPTALK

Equipment available today. From hand-held radios to full blown bench equipment, there is enough to suit all tastes and requirements. Here is a selection of things available in the shops currently.

If you take a look at any of the magazines which deal with amateur radio, you'll find a bewildering array of rigs, amplifiers, antennas, bits and pieces and the electronic equivalent of the kitchen sink! In this section we'll take a look at some of the ways in which you can spend money on your amateur radio station.

We'll assume that you're not an avid home-brewer and that it's the commercial gear you're interested in. The first thing to consider will be the rig itself, in the form of a transceiver or separate transmitter and receiver, and the type you buy will depend on what particular bit of amateur radio interests you. But we can divide complete radios into three basic sorts — the main station rig, something to use in the car — ie a mobile rig — and the common hand-portable.

To take the main rig first, this will be the heart of the station and it's worth giving a lot of time and thought to it. Even if you're a home-builder at heart you're likely to use a commercially built radio as the core of the station and build practically everything else. Now if you're a newcomer to amateur radio, it's likely that you won't have a vêry clear idea of what areas you want to specialise in, if any, and it's sensible to get hold of something that you can use for more or less anything. It may be, for instance, that you start out as a Class B licencee who has no intention or interest in the HF bands, and you might think that a rig covering 144 MHz and nothing else would be your best buy — however, if the joys of VHF wear off in a year or so and you decide that 1.8 MHz DX is your real interest in life, you'd probably lose a lot of money in chahging the rig.

Mostly Japanese

So one good idea might be to get hold of something which will always be usable no matter which bit of amateur radio you end up most keen on — and there's a lot to be said for beginning your amateur career with one of the many types of multiband HF SSB and CW transceivers which are available. If you're a Class B licencee, you can buy (or build) something called a **transverter**, which will take one band — usually the 28 MHz band — of your HF transceiver and convert it to 144 MHz or 432 MHz, both from the transmitting and receiving point of view; we'll discuss this in more detail in a minute.

Whether you buy new or secondhand, you'll find these days that most of the HF SSB and CW radios are Japanese.
There are three main types — those by Trio, Yaesu and Icom — and each maker tends to have something of a range of HF transceivers, from the simple to the positively baroque. Yaesu, for example, have made their FT101 series for many years now, and it's probably the world's most popular rig — the current one is the FT101Z, which costs about £550. Many amateurs started their careers with another popular Yaesu rig, the

Yaesu FRG7 communications receiver,. A good first buy for the newcomer, this design covers 1.6 to 30MHz using the well-tried Barlow-Wadley tuning system. Getting rather long in the tooth now, but still a good performer; many modifications for it have been published.

Trio TS830S — a typical upper-middle class HF SSB machine, developed from the very successful TS820. Very reliable and versatile; lots of facilities, excellent transmit strip but receiver lets the side down a bit . . . however, a pretty rig all in all.

Trio TR7800 FM mobile 144 MHz rig, featuring selection of frequencies via a "keypad" and the ability to re-tune via switches on the microphone; an extremely good performer, with full repeater and simplex facilities in a compact box.

TS530S — first cousin to the TS830S and a common first buy for the new G4. Pretty good all round, and good value for money, nice transmitted audio, new bands and very reliable.

Trio TS130S is a sort of transistorised variant of the TS530; the 130V is a lower-power version. Good middle-class radio for the newcomer.

Trio R1000 communications receiver. Extremely good for general HF listening, and full of useful features; a joy to operate and an excellent buy for the novice and expert alike. Covers all the HF spectrum with selection of tuneable 1 MHz bands and digital readout.

FT200, which isn't made these days although they're common enough secondhand; it was one of the most basic CW and SSB transceivers, although such things as strong-signal handling were a bit feeble by modern standards. The top of the Yaesu line is the FT1, which on the face of it has every feature you could conceivably want in a radio and then some. I feel it's positively OTT and that very, very few people could get the best out of such a behemoth!

Maybe this is a good time to make a few comments about commercial radios generally. The basic job of an amateur transceiver is to receive signals, often in the presence of unwanted and far stronger signals, to stay tuned to them and to present them to the listener; the transmitter has to put out a decent, clean signal that doesn't drift around and make life difficult for your fellow amateurs. To do these things is a matter of purposeful electronic engineering, and that is where the cash ought to go. You, the amateur, can do very well without digital displays, memories and all the rest of the fancy gubbins; those things are nice to have, assuming you can get the best out of them, but they should come a very long way behind the basic performance of the thing.

Good engineering

There is no point whatsoever in being able to recall a frequency out of a memory channel and being able to display it to 38 places of decimals if you can't hear the station in the rare country who is transmitting on the frequency because the receiver is letting in crud from adjacent channels or is being badly desensitised by your mate Fred up the road who is innocently transmitting on a completely different band!

In other words, if you're going to spend money on a commercial rig then for goodness sake spend it on good engineering rather than fancy bits that look nice in the lounge but which don't do the job when they're asked to. They may well massage your ego, but they probably won't help get the rare QSL on the wall . . .

Anyhow, the FT1 costs £1,295, and I sincerely hope it's worth it! Another rig costing round about £1,000 is the Drake TR7. It's American, and extremely good at almost everything, although it's rather different in "feel" from the average commercial radio. The main dealers in London are an outfit called Radio Shack Ltd, in West Hampstead; the main agent for Yaesu in the UK is South Midlands Communications Ltd, in Southampton, although many amateur radio dealers apart from them handle the Yaesu line.

Another well-known make is Trio, whose appointed distributor is Lowe Electronics in Matlock, Derbyshire. Again, there are several HF rigs in the Trio line, all of which have a good pedigree and which are nice to use; they also seem to have a very good reputation for reliability. Top of the Trio heap is the TS930S, which has only just been introduced so I don't know anything about it. The other common rigs from this maker are the TS830S at about £700 and the TS530S at about £540. The lowest-priced HF rig from Trio is the TS130V, which seems to be getting more common by the day.

The other main manufacturer of HF rigs is Icom, whose main distributor in the UK is Thanet Electronics. The IC720A is their HF base station, which in many ways is a very good transceiver indeed — not too many frills and pretty good performance. Mind you, it's more expensive than many at £883, and that doesn't include the power supply at £99 extra.

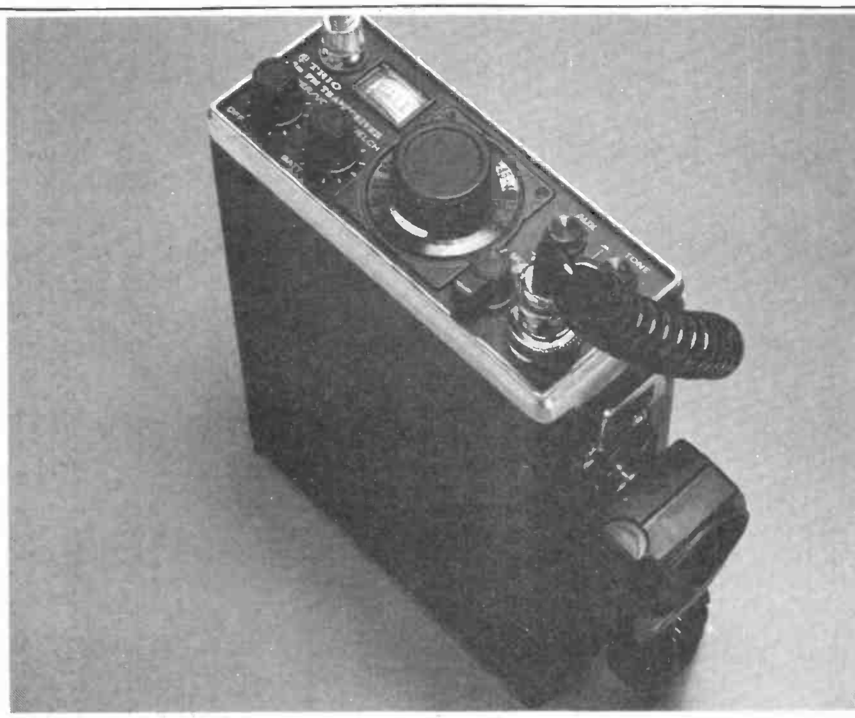
Advantages

So — pausing for breath after that little lot — they are the ones which may well catch the aspiring amateur's eye first. All of them in conjunction with a suitable antenna, will get you on the HF bands without more ado. But what if you're a Class B licencee? Well, there are two ways round this. All the makers we've mentioned, and a few more, make radios for VHF and UHF, and you could buy one of those. Most of them are what is known as "multi-mode", which means that in addition to SSB and CW they'll have FM and possibly AM as well.

That's certainly one way to go, but the other way, as we mentioned earlier, is to transvert from, say, 28 MHz to a VHF or UHF band. There are several advantages to this, one of which is that you'll not only have the VHF band you want — and indeed are licenced for — but you'll have the HF bands available for when you do the Morse test. Another is that HF-band transceivers often have more facilities than 144 MHz dedicated units, such as cleverer filters and extra VFOs (a VFO is a Variable Frequency Oscillator, which is the bit that actually does the tuning of both transmitter and receiver — an extra one can be very useful at times) and if you use a transverter you get all these facilities on whatever band you're transverting to.

A British company, Microwave Modules of Liverpool, is well-known for its transverters as well as for other things like solid-state VHF and UHF linear amplifiers, although a transverter is quite easy to build and is a

Icom IC2 144 MHz FM hand-held transceiver; a sparkling performer and very popular. Frequencies selected via thumbwheel switches on the top, and including full repeater access facilities.



Trio's TR2300 is a rather bulky 144 MHz hand-portable; 80 channels and about 1 watt output on FM, but there are easier ways of doing it these days and the basic design is a bit elderly. It produces lovely audio though.

Philips FM321 70 cm mobile rig — a very good performer and easy to use in the car, this machine will give 40 channels on 432 MHz and can be used for repeater working.

Trio R600 is a stripped-down R1000 with a few facilities but much the same performance; very good value for the new listener.

Yaesu's FT290R is a portable multimode 144 MHz transceiver. Works well, with lots of facilities, puts out about 2.5 watts. Nice if you're a new Class B licence who likes a bit of fresh air!

good project for the beginner who has some basic test gear and is willing to learn, or wants to learn, something about RF circuitry.

Turning to mobile rigs, there's a huge variety of them and all the makers we've mentioned produce them for the HF bands, 144 and 432 MHz. A mobile rig needs to be chosen on the basis of how easy it is to use whilst driving your car as much as anything else, and some of them have been hilariously bad in this respect — happily the major manufacturers seem to have got the message by and large these days! Since mobile working on VHF and UHF often involves using a repeater (see the chapter on mobiles and repeaters later on) it's worth making sure that the rig you're intending to buy has the appropriate features built-in and that, if you're thinking of taking your car to Europe, it'll handle the minor differences between the repeater system in the UK and those in some European countries.

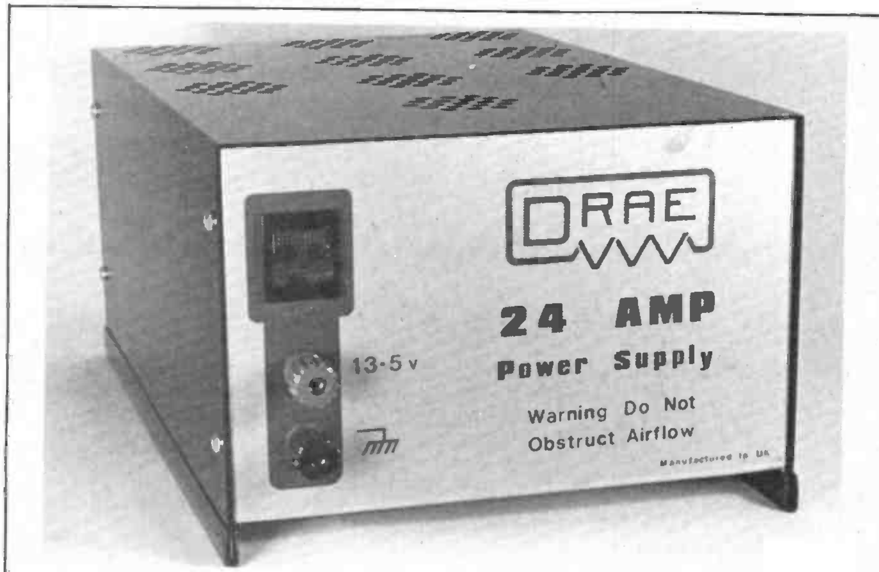
The hand-held portable transceiver is getting much more common on VHF and UHF in these days of an extensive repeater system, and there's a fair variety of models. Typical are the FT208 and FT708 (for 144 and 432 MHz respectively) from Yaesu, and Trio's TR 2500, all at a bit over £200 — you can select a frequency on a keypad, like that of an electronic calculator, and there's a digital display of frequency. Practically every "handy-talky", as one of the advertisements calls them, uses FM, although one or two makers do an SSB portable. As far as I know, no-one makes an HF hand-held, for the simple reason that HF antennas tend to be a bit more cumbersome than UHF antennas!

Anyway, that's a quick whizz round the commercial rigs. The main thing, if you can, is to try to decide what your amateur radio future is likely to be and then to have a careful look at the specifications before you even think about buying anything. Don't overlook the second-hand market — there's not much to wear out in an HF transceiver, and you might find a bargain. Don't forget, either, that there are many other types of radio, including what is known as a "general-coverage" receiver. Some of the real classics in this area were made for professional purposes before finding their way on to the amateur market, and their performance is likely to equal or exceed commercial equipment for the amateur market. You may even have come into amateur radio by listening on a short-wave receiver, and if it was one of the real classics like RCA's AR88 or the Collins 75 series, you'll probably never want to part with it. Old receivers are a fascinating side of amateur radio that we haven't, alas, the space to go into here.

The antenna is the next item, and here again there's a wide choice. To categorise it simply, most people build simple HF antennas out of bits of wire and learn a good deal by so doing; more complex HF antennas are usually bought commercially for a small fortune. On VHF and UHF, most people buy their antennas and there's a vast range depending on whether you have the space and the urge to work the best DX. On 144 MHz, for example, you can buy 16 and 19 element antennas which will do an excellent job of putting your transmissions into all sorts of unlikely places for about £35. One warning — the world of antennas is a bit like the world of hi-fi, and there are several ways of specifying the "goodness" of an antenna, some of which are more meaningful than others. Companies such as J-Beam, Tonna and HAG make decent VHF and UHF antennas and can generally be trusted as far as specifications go.

These, then, are the main things that are available. There are, of course, hundreds of accessories you can buy for your amateur station, some of which are more essential than others. If you're an HF operator, a device called an "aerial tuning unit" or ATU is probably going to be necessary, and companies such as KW Electronics make them although they're often made at home. Another important item will be an SWR bridge, of which more or less exotic versions are available from different manufacturers at more or less exotic prices!

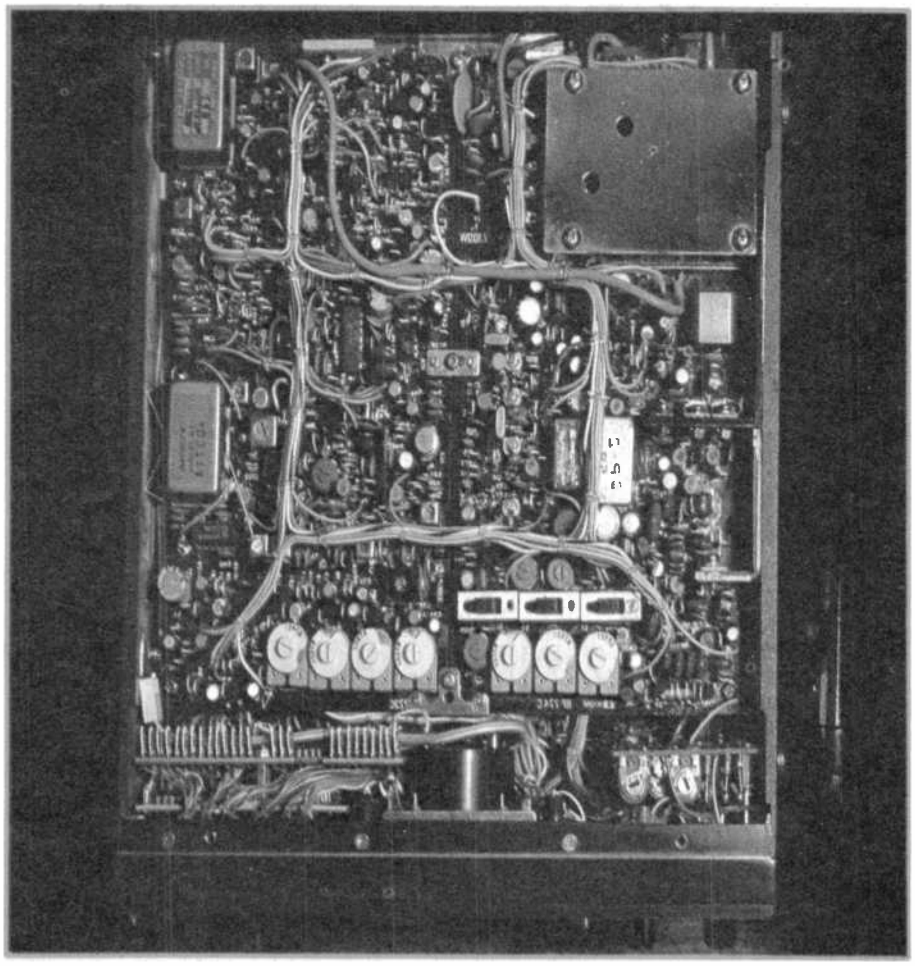
Probably the key to buying *any* amateur radio equipment is to bear in mind the job it needs to do and spend the money on that.



Much amateur radio equipment is designed for mounting in cars, and therefore operates from a 12 volt DC supply. When the user wishes to operate the equipment at home, he has to provide a stabilised regulated source of 12v DC at several amps. Whereas there are many cheap power supplies available intended for the CB market, these are not ideal for operating amateur equipment; should a component failure occur, the power supply can feed 25-30 volts to the equipment with disastrous results. One range of equipment that solves the problem is the Drae range of power supplies available from Bredhurst Electronics, The High Street, Handcross, West Sussex. These are British-made units sturdily constructed to high technical and safety standards, and incorporate over voltage crowbar protection, adjustable current limiting and surge protection.

Staying on the air

If it's working well, then leave it alone. But if your rig just sits there and glowers at you, it might need a little maintenance work. Here are some of the more common faults to be found with amateur radio equipment, and how to go about rectifying them.



Electronic equipment can be delicate, and care has to be taken with all repairs and maintenance. If in doubt about a particular course of action, check it thoroughly before you start.

Whether you've bought a gleaming new rig or whether you take a pride in building your own, there'll probably come a day when it suddenly decides it's not going to do its stuff anymore and sits glowering at you. In this section, we take a look at some basic ways to keep your station on the air.

Also in the catergory of "maintenance" come all those little chores like putting connectors on antenna leads and checking that the antenna presents the proper match to the transmitter. We'll look at those too.

Actually, "maintenance", in the sense that you maintain your car by eg topping it up with oil and water, checking the brakes, etc, isn't really required with most radio gear. In the earlier days, when most equipment used valves, it was a slightly different story because valves in one way are a bit like light bulbs — they start to wear out more or less as soon as you plug them into the rig and turn the power on. This being so, their characteristics start to change very slightly straight away, and in the course of a year or two you could get problems such as the receiver getting gradually less sensitive. Also, valves run hot; and heat tends to change the values of electronic components and generally mess things up.

With modern transistor gear, life's a lot easier. For a start, the only transistors which are likely to get hot will be those in the final amplifier stage of the transmitter; the rest of the gear will run practically stone-cold. Also, a transistor doesn't degrade as it gets older (well, the clever scientists argue a lot about whether they do or they don't but they certainly don't "wear out" like a valve does). Anyway, probably the best philosophy for "maintenance" in the sense you'd use the word for your car is don't — if all your gear seems to be working well, by far the best thing to do is to leave it alone.

However, electronic components, like everything else in life, aren't perfect, and they can quit on you without warning. Depending on what they do, this can mean anything from a completely dead rig to an intermittent fault that shows up every now and then. So let's have a think about how to find out what's happened.

The first thing to realise is that a modern commercial transceiver for the HF or the VHF bands is likely to be complex; even if you're a fairly hardened engineer, your first look inside a Japanese radio is likely to make you gulp a bit. There are two main reasons for this. One is that commercial gear tends to be complex anyway, but to make it worse it'll usually be squeezed into the absolute minimum size of box that the maker thought he could get away with. This on its own makes servicing pretty damn tricky, particularly since the fault always seems to be in the part of the circuit that means you practically have to reduce the rig to its component nuts and bolts to get at it.

The other big horror is that the Japanese, despite their propensity for extreme cleverness in their circuitry, seem totally unable to draw out a circuit diagram for it that's anywhere near comprehensible. They have a way of drawing diagrams that seems practically certain to drive the amateur stark raving bonkers when it comes to fixing the rig: no wonder the old amateur tradition of fixing it yourself seems to be somewhat on the way out.

One other minor spin-off from this is that because the modern commercial wireless is complex, some of the fixing can get very heavy if you don't happen to have about £300,000 worth of test gear knocking about.

So, all in all, many owners of commercial radio gear throw it straight back to the manufacturer if it goes wrong — and despite the fact that it doesn't seem very much in the amateur tradition to do so, there are sometimes good reasons. . . But let's look on the positive side now. How should you set about doing those odd little jobs, or finding the queer faults that crop up every other Tuesday?

If you're an avid home-brewer, you'll probably have an intimate and painful knowledge of the particular piece of gear that's playing up, so we needn't really consider you any more! If you've built the thing from an article in a book or a magazine, the man who wrote the article will usually give enough of a description of how it's supposed to work to give you at least a few clues.

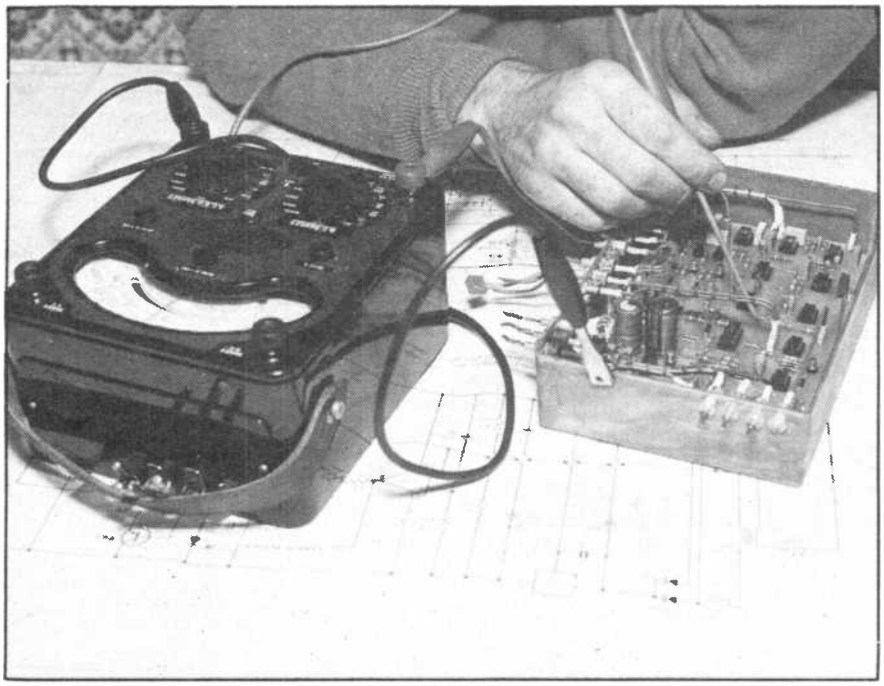
The most difficult scenario is where you're trying to come to grips with a commercial rig. The first thing to remember is that no matter how complex the radio is, you can divide it into separate stages that do different jobs; the type of fault should give you a clue as to where it is.

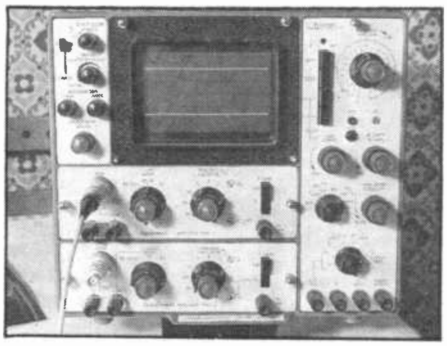
For example, let's pretend that you've just switched on and nothing happens — no lights, noises, plumes of blue smoke or whatever. Now this suggests that the fault is in something that's common to the whole radio, like the power supply to it or indeed the internal power department; maybe a fuse blew, for example, or maybe someone pulled the plug out. I know that's a rather extreme example, but if you were faced with this sort of problem, the point is that you'd be silly if you said to yourself "ah yes, it must be the synthesiser, or the third I.F. amplifier". Any fault-finding is just the application of pure logic — yes, I know it often doesn't seem that way, but it is, really. . .

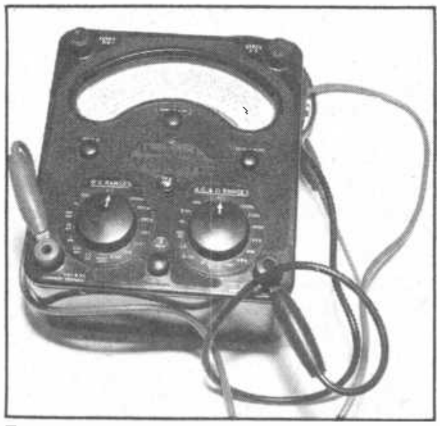
Anyway, let's assume you've decided whereabouts the fault is; now what? Well, the single most important thing to have around is your multimeter — this is the thing we talked about in the section on building your own gear. The beauty of this is that most manufacturers will give somewhere in their manual a table of voltage readings at particular points in the circuit under normal working conditions. If you have a look at the various conditions that your particular radio is producing, any significant difference between what should be happening and what is actually happening will tend to give the game away quite quickly. Some faults, though, take a bit more work — it may be that a call to the main agent for that particular rig will help because it's not unknown for manufacturers to modify circuits to get round a common problem. Or you may find that the particular problem you have is well known to the dealer and he will suggest any mods that need to be done.

One thing I've found over the years is that most problems are not the subtle ones that take hours to find and leave you cross-eyed; they're the things like wires falling off in the power leads, fuses that blow for no good reason and which don't quit when you change them (fuses *can* fail from sheer old age, although don't rely on this being the cause of your own fuse failure!) and sheer finger trouble. Modern electronic components, though not perfect, are much more reliable than those of 10 or 20 years ago.

What will, however, cause problems are things like the antenna plug coming adrift, leaving no load on the transmitter when you press the button. The one feature of transistors which you have to watch is that, unlike valves, they're extremely intolerant of abuse of any sort; so whatever you do, *don't* use a radio which has a transistor power amplifier with a suspect antenna or dodgy connectors and *do* use an SWR bridge to make sure that the antenna you use is a reasonable match to the transmitter's output. Modern transistor rigs usually do have some form of protection in this area, but it's by no means infallible. In general terms, the final power amplifier stage of your rig, if it uses transistors, is the most vulnerable stage and also likely to be the most expensive to fix if anything happens to it.







Top and above right: The multi-meter can check current, voltage and resistance. If you're at all serious, you can't do without one. Above left: The oscilloscope draws a picture of the wave form as it happens. They cost from about £15 upwards.

One other thing to watch, whilst we're in this area, is if you happen to use a rig employing valves. We're all so used to the age of the transistor radio in one form or another that it's easy to forget that valves, unlike the slivers of silicon, require high voltages. If you're new to the game, please remember that a power supply producing anywhere between 300 and 2,000 volts (the latter if you're into big linear amplifiers) is potentially lethal. A 300 volt shock from a radio-type power supply can kill you if you take it through your body in the wrong way (classically, the worst case is if you're holding one terminal of the power supply in each hand — the volts tend to find their way straight to your heart and stop it and, if it's a DC supply, you may even not be able to let go of it). 2,000 volts, even if it doesn't kill you, will throw you across the room if you so much as brush against it.

PLEASE follow the rules if you're ever working on anything which uses high voltages. I'd strongly suggest having some kind of "master switch" outside the shack which controls *all* the power to it and which is known to every member of your family; I'd also make sure that they knew what to do if I did get a bad electric shock. Without trying to be dramatic — if you don't know what to do if it happens, then stop reading this article, get yourself a book on first-aid in the event of electric shock and don't come back until you do know.

You can carry out a certain amount of what could be called "preventive maintenance", which is a posh way of saying any maintenance designed to pick up any little nasties before they happen. Many amateurs do so about once a year,and it consists of a thorough check of all connectors, plugs and wiring, from the mains plug to the antenna connector; it's also a good idea to measure the output of your transmitter on all the bands it works on and to check that the SWR to the antenna(s) is as low as it was when they were first put up. Most commercial beam-type antennas are manufactured from some sort of aluminium alloy, and industrial pollution can play havoc with them; it's not a bad idea to spend a spring Sunday taking the entire antenna system down and giving it a good clean-up.

At the same time, you can check that the connections from the feeder to the antenna itself aren't tending to vanish before your very eyes as corrosion gets hold of them; there are various sealants available which you can use to make a good job of keeping the rain out. If you have some sort of rotator for your antenna, it's a good plan to have a look at its connections as well and make sure that the cable feeding the power to it is in good shape.

Remember that if your antenna system comes crashing down you could be in for a hell of a lot of expense, not only in replacing it but the neighbour's greenhouse, cucumber frame or even his roof, so another aspect of maintenance consists of making sure that the insurance premium is paid . . .

But as far as maintenance is concerned, the pictures tell the story of some aspects of it. If you want to know more about it, remember that the more you know about what's going on inside your radio, the easier it'll be to fix it if it *does* hand in its dinner bucket at some unspecified time in the future, so have a look at its circuit diagram and the owner's manual and try to get a feel for which bits of it do what: you can learn a lot. There is also an excellent book available called "How to Troubleshoot and Repair Amateur Radio Equipment", published by Tab Books and available from the Radio Society of Great Britain, which is a very good guide to the problems and oddities that you tend to come across in fixing amateur radio gear.

Just to round off, we can consider some test equipment that you might find handy if you get interested in maintaining your own gear; actually, at this point, you find that home-building and looking after the equipment tend to merge into one thing. As we've seen, the first tool to get hold of is a decent multimeter which will measure voltage, current and resistance. It'll cost anything from about £20 upwards, depending on how elaborate and accurate it is, and it's the one bit of kit you really can't do without in any amateur shack if you intend to do your own fault-finding. For a close second, I'd strongly suggest a thing called an oscilloscope. This is a formidable name, and most of them look rather formidable, but an oscilloscope is really indispensable if you're intending to do any serious fault-tracing and fixing, especially in transmitters and receivers where there are high frequencies flying round all over the place.

What the 'scope does is draw you a picture of the waveform as it actually is happening at that point in the circuit you've connected it to — actually, it would take a book to describe in any detail what can be done with a 'scope, and in fact *Troubleshooting with the Oscilloscope,* again available from the RSGB, is such a book. You can pay anything from £15 to £30,000 for one, depending on what you want to do with it, and it takes a little time to learn how to get the best out of it. When you do, though, you'll wonder how you ever managed without one. At this stage I wouldn't bother about exotica like spectrum analysers, etc — if you feel you need one in your shack, you've (a) got no business to be reading this chapter, since if you own one you'll undoubtedly know how to use it — and that goes for other test gear too — and (b) if you get to the stage of needing a spectrum analyser, you're getting too clever by half!

So that's a quick look at maintenance in its various forms. It can be great fun; but one final thought — PLEASE be very wary indeed of (a) the mains supply and (b) any high-voltage system. That way, you'll live to win the next amateur radio contest!

The author, John Nelson, uses an oscilloscope to check a wave form. Once you've used equipment like this, you'l wonder how you ever managed without one.

MAPS and how to use them

Know who you're speaking to, and where they come from. Maps are necessary not only to locate your caller, but they also tell you in which direction to point your antenna.

Yes I *know* this is a publication about amateur radio. No, this section hasn't escaped from *Cartographer's Weekly* or something like that. Maps — three sorts in particular — are very useful for amateur purposes and in this section we take a look at the hows and whys of maps for amateurs.

There are three basic maps which are very handy to have around — two are really for the Class A man who's talking to the world on the HF bands and the other is for the VHF addict who is into working long distances on 144MHz and above — the Class B man in other words.

The first one to inspect is something called **World Prefix** map, and the RSGB, as well as a few other people, do one. It is a map of the world which uses the normal-type map projection but superimposed on all the countries are the various prefixes associated with that country. For instance, if you look at the South American area, you'll find that Argentina has the mystic letters "LU" written on it.

Since, as we outlined elsewhere, every country has its own individual prefix for its radio stations, which include amateur radio stations, you can quickly find what the prefix is for a country you're interested in working. In this case, you'd listen for a callsign beginning LU-something. Quite often, you'll find that a number follows the prefix, and this number can mean one of two things. In the case of Argentina, for instance, you might hear a station signing LU4 followed by three letters; the 4 means he's in a certain part of the country, and an LU3 would be in a different part.

In the case of the UK, however, the figure is associated with the class of licence held by the man who is using it. A G3 followed by three letters is a Class A licencee, as is a G4, whereas most G6 and G8 callsigns are class B. I say most because a G6 or G8 plus two letters will be a Class A licencee from way back. If you speak to one, consider yourself honoured 'cos he'll know what's what in amateur radio, and be able to help with any questions you might have.

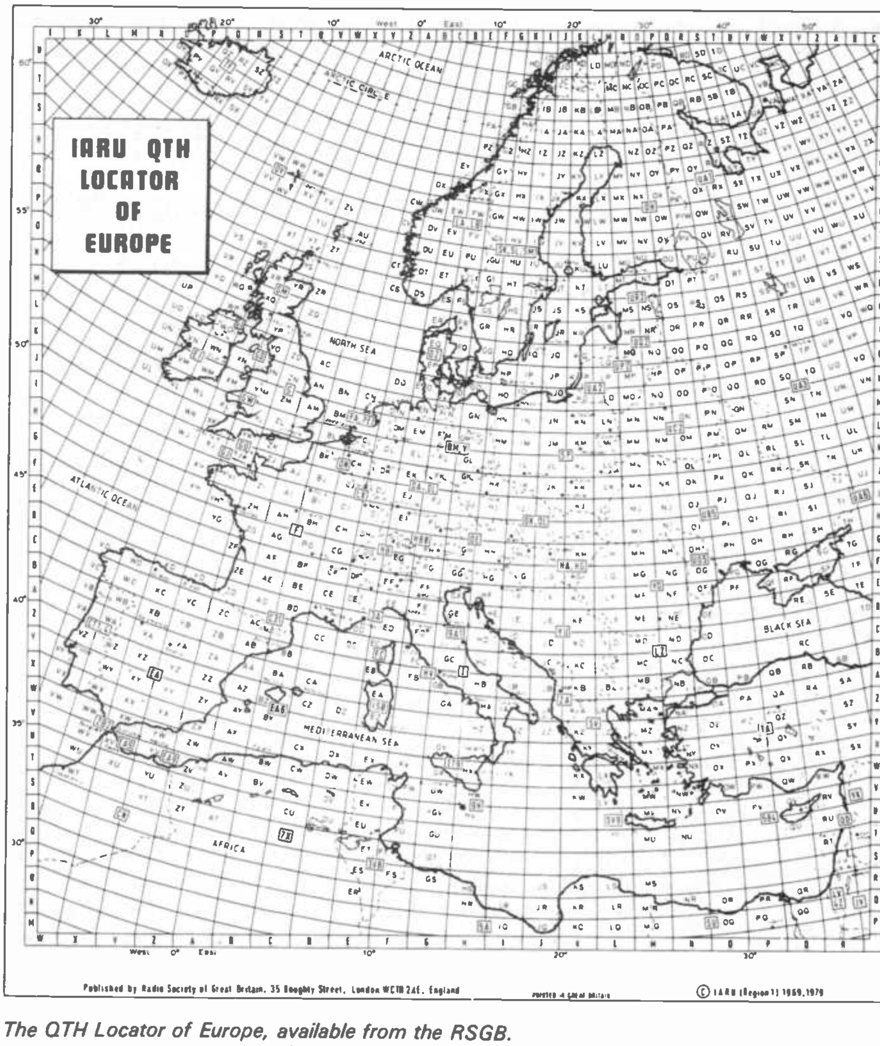
Anyway, that's the World Prefix Map. Another sort of map, which is called a **Great Circle** map, has a different use. Let's imagine that you have a very directional antenna on your roof and you wish to speak to your friend in Bombay. You have to decide which way to aim your antenna. Now if you look at the ordinary world map, such as the World Prefix Map, you might get the idea that India is sort of south-east of the UK; the problem is, of course, that a map like that has to be rather distorted in its spatial relationships because you're trying to represent a sphere (the Earth) on a flat piece of paper — something has to give, and in the case of the usual map (which has a projection called Transverse Mercator) it's the sense of direction. You might reach Madagascar if your believed this sort of map. But Bombay — no way!

But you really need what is known as a great circle map to sort out which way to beam from London. Believe it or not, India is more or less due east — and that's the way you'd have to beam your antenna if you wanted to talk about the music of Ravi Shankar with your man in Bombay. Some more examples — Brisbane is more or less due north-east from London and Perth practically due east. Montreal is on a bearing (that's a way of decribing direction precisely going clockwise from North and dividing it into 360 degrees, so that due east becomes 090, south 180, south-west 240 and so on) of about 292 from London, which is west-north-west, and Jamaica is roughly due west, or on a bearing of about 270.

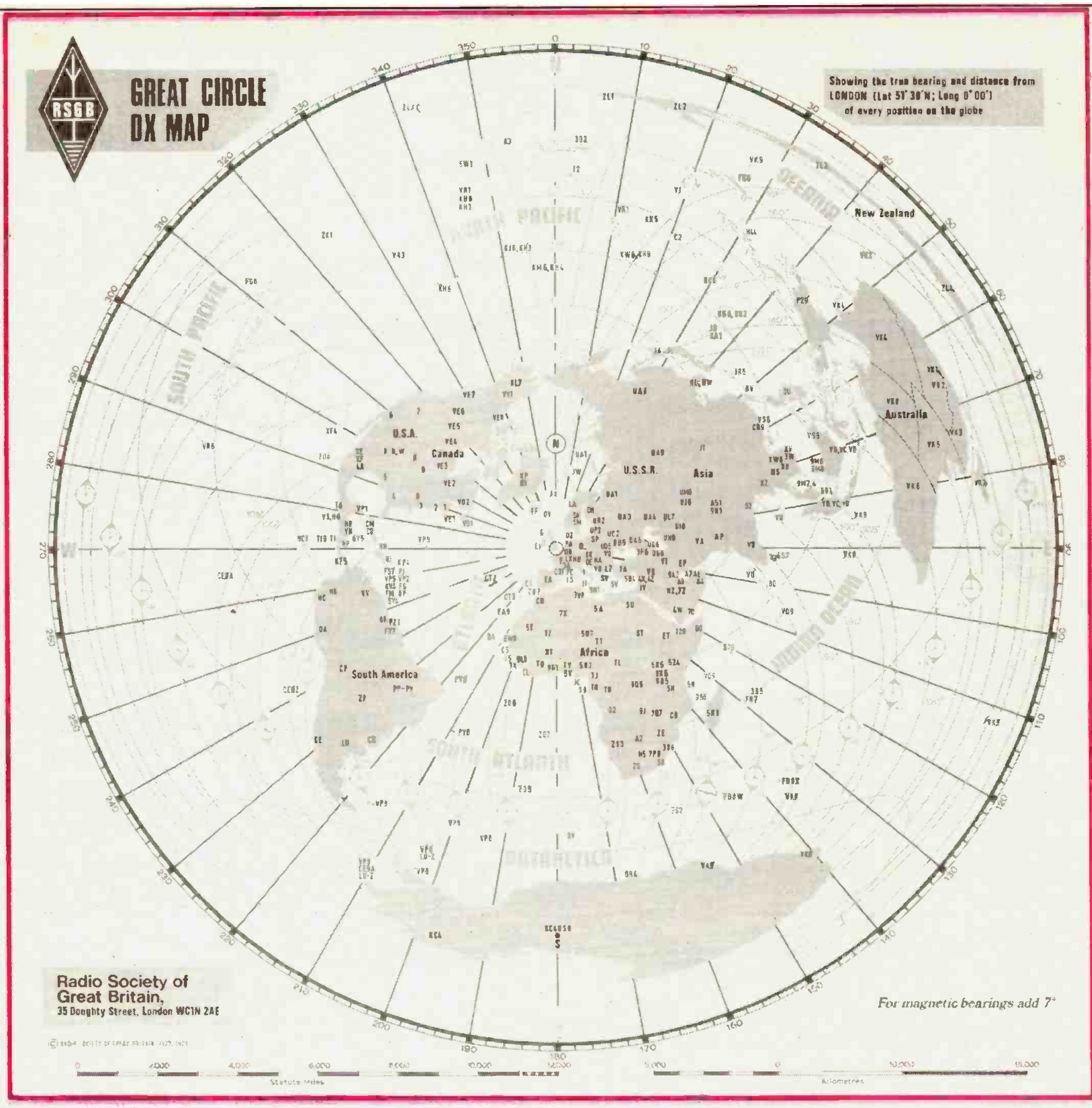
North is usually described as 360, by the way, and you count up from there, so that a direction fractionally east of north would be, say, 005. Would you believe that the easternmost tip of Russia is more or less due north of London? Well, it is, and a Great Circle map will tell you so.

A Great Circle Map is drawn for a particular reference point, and the RSGB's one is centred on London. The UK isn't large enough for it to make any significant difference for anywhere else in the UK, so don't worry if you happen to live in Lerwick or somewhere. No amateur antenna is *that* directional . . .

Anyway, that's the Great Circle map, and if you're lucky enough to have a directional antenna for the HF bands you'll soon find that you need it if you want to listen for a



The QTH Locator of Europe, available from the RSGB.



The Great Circle DX Map is a must for all amateurs — if only because you will need to know in which direction to aim your antenna if you want to speak to a particular person in a far away country.

particular area. Mind you, you'd be surprised at how quickly radio amateurs get an instinctive feel for this kind of thing. Mention, say, Chagos Island to the average man in the street and he'll gawp at you. Mention it to your average HF-type amateur and he'll say "Chagos? Oh yes, just off the southern tip of India, bearing — oh, about 105 degrees from London. Prefix? Er — VQ9, and they're in Zone 41." Does wonders for your geography, this hobby . . .

The other map is really for the VHF man. Given that the average halfway decent VHF or UHF antenna is highly directional, he'll need accurate headings so that he knows where to point it to talk to particular places. It's rather easier on VHF, since you don't need to know relative bearings for the whole world but just for the UK and some of Europe. The map you'll need if you want to hit the big-time on VHF and UHF is called a **QRA Locator Map** and this item does two jobs in one. It will give you directions for your antenna (or beam headings as they're known) but it will also do something else for you.

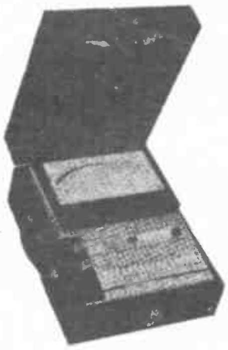
In the early days of VHF, you could get awards for how many counties you worked from your location, and in fact you still can. But you can also get awards for something else. These are called QRA squares, although there's a tendency to call them QTH squares which is a bit more correct, and you can describe any station by what is known as a QRA or QTH Locator.

This contains letters and figures of the form ZL40g, and that will tie down your location to within a square mile or so. Establishing your QTH Locator needs a knowledge of your latitude and longitude, and the RSGB's Locator Map has instructions on how to do it. Now the ZL bit identifies you as being in a particular area which is covered by two degrees of longitude and one of latitude — the numbers and the small letter subdivide it some more — and many VHF men like to "collect" QTH squares.

Some, of course, are easier than others. Much of London and the Home Counties fall within ZL and AL squares, for example, whereas there's only a tiny bit of land on The Lizard in Cornwall in XJ square, so anyone who goes down there with a halfway decent station will be sure to get plenty of takers for his CQ calls!

Expedition stations on VHF and UHF often go to out-of-the-way QTH locator squares in order to make them available to the DX fiends on these bands, and this can be a most interesting facet of the hobby.

That's about all there is to it as far as maps are concerned. As we've seen, you'll certainly find one or more of them useful. You will also, by the way, find a decent atlas worth its weight in gold, since quite often you'll hear someone on from somewhere you've never hear of — it's great to look in the atlas and nail it down and then to work out the distance involved on the big Prefix map. All part of the excitement of the amateur's wide world!



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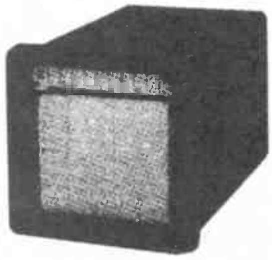

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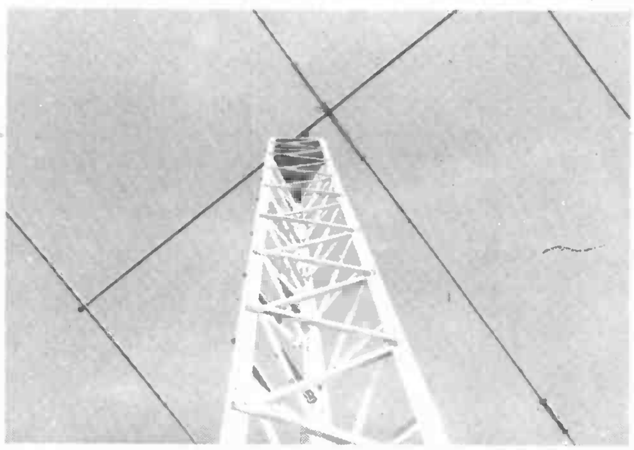

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CARD INDEX

QSL cards are not just to confirm that you've made contact — they are a challenging and enjoyable part of amateur radio.

QSL, in the Q-code list, means "I acknowledge receipt" — less formally, a QSL card is what you send to a station with whom you've been in contact to confirm the details — when you received it, on what band, how strong the signal was with you and so on.

QSL cards are fun to collect anyway, but they're essential if you're after one of the many awards in amateur radio. Because they represent some sort of proof that the contact did, in fact, take place, they're the main means of applying for an award. For one of the most famous, the DX Century Club or DXCC as it's known, you require all the QSL cards from a minimum of 100 countries on a special list.

If you're a member of the RSGB, you can save yourself a lot of hassle by using the QSL Bureau. This means that you send all your outgoing cards (i.e. those to stations you've worked) to a fixed single address and he deals with them. For receiving your incoming cards, you lodge some stamped and addressed envelopes with your sub-manager — this is someone who deals with all amateurs whose call-signs are in a specific block. He'll send you the cards as often as you specify.

That's about all there is to say, except that you'll find that sometimes you have to send outgoing cards to somewhere other than the bureau, especially in the case of rare DX stations who often have a manager of their own. Anyway, the illustrations will show the finer points of QSL cards — if you're a DX chaser, your main problem will be in getting them in!

AERIAL

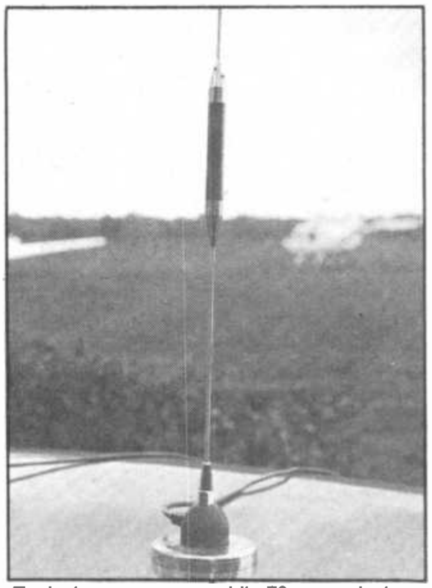
Your antenna should get launched in the direction extremely important part of can mean a good

Some would say that, however powerful your transmitter and however sensitive your receiver, neither of these is as important as one other main item — the antenna. In this section we'll have a little look at how the antenna (or, if you prefer the older term for it, the aerial) works and find out a little about why it's so important.

One word of caution before we kick off, though. Antennas are a subject which, like propagation, you can look at in two very different ways: you can fill pages and pages with equations, differential calculus and all manner of wondrous things that are fine if you happen to have a PhD in something or other but which don't help the likes of you and me. Conversely, you can take it from the ground upwards, a bit at a time, and suss out what's going on as you go. This is what we'll do here. As far as the RAE is concerned, you won't need to know anything much beyond the "elementary" class anyway, so that's more or less what we'll stick to.

Right — so where do we start? The idea of the antenna is to get the radio waves you've painstakingly generated in your transmitter launched towards wherever they'll do most good — viz the ionosphere if you're talking about the high frequency bands or into a nice directional beam a few degrees wide if it's VHF and UHF you're into. Conversely, you'll also want to make best use of the ripples in the ether that your mate in New Zealand or New Hampshire or even the other side of town has launched in your general direction. This gives the clue as to why the antenna is important, as we said in the beginning, because the most powerful transmitter in the world won't do its stuff if it's using the proverbial piece of wet string to radiate its power; and you'll find that those members of the amateur fraternity who are particularly interested in low-power work (there's even a club for them, called the G-QRP Club, and they're a mighty switched-on lot when it comes to amateur radio) tend to go for the best antennas they can because it's the only way to make the best use of their tiny transmitters. So the very first principle of antenna theory, to be firmly committed to memory, is that money and time spent on getting the best antenna set-up you can is never, ever wasted. Many new licencees don't see this and spend a bomb on a good transceiver or whatever without leaving more than about 20 pence in the budget for the antenna; nought out of ten for this, chaps. Rule one of antennas is go for the very best you can.

Which doesn't mean spending a fortune. As we've seen in several areas already, one of the beauties of the amateur licence is that it's so unrestrictive in many ways and antennas is another of them. The only factor to limit the antenna you want to use is you;



Typical mag-mount mobile 70cm vertical antenna — note the loading coil partway up the rod.

either in space for it or the cash for it if you want a 100ft tower and something looking like a refugee from Jodrell Bank on the top of it. Your bank manager might just fret a bit at the latter . . .

Anyway, back to business. The first question you might ask yourself is "well, my little trannie doesn't have an antenna, so what's all the fuss about?" Well, actually it does, although it isn't like the 50ft of wire down the garden that the old domestic "table model" sets had 30 years ago: it's a thing known as a "ferrite rod" and you can see it if you take the back off the set. It's used in the interests of portability more than anything else, and if you like you can think of it as being a long wire wound up round something which helps concentrate the radio waves into it. It isn't quite like that, but it'll lead us nicely into our next step.

The way an antenna of any sort works is to intercept the radio waves from Wogga Wogga or Wolverhampton or wherever so that they generate a voltage which can be applied to the circuitry of the radio and eventually emerge as somebody's dulcet tones. In other words, if your mate is talking to you on a frequency of 3.7 MHz, the idea is that at the terminals of the antenna (since an antenna is an electrical circuit, although it doesn't look like it at first) emerges as an alternating voltage at 3.7 MHz, which is modulated in whatever way your friend is using at the time.

Now it's true to say that almost any old bit of wire would do that, but the real object of the exercise is to get as many volts (or rather millionths of a volt, because they're the sort of levels we're talking about) as possible into the circuitry of your receiver as you can because that makes life easier both for the receiver and your ears. To see why this is, let's change the scenario a bit and say that your mate is on the other side of town and chatting on 144 MHz, which is a VHF band.

Now on VHF, the limit to the signals you'll be able to hear is set, amongst other things, by the amount of internal noise the receiver itself generates. All receivers generate some, because they can't help it, but on a band like the 3.5 MHz band the amount of noise coming in from things like thunderstorms, electrical equipment and so on will always be much more than the noise that the receiver itself makes. On the VHF bands this isn't true, and the weakest signal you'll be able to copy is one that's only a little bit stronger than the internally generated noise of the receiver. Now if we say that the amount of noise your receiver generates inside itself is equivalent to an incoming signal of one-millionth of a volt (or one microvolt, as it's known) it's obvious that you'll need at least a microvolt and a bit from your mate to be able to copy him. You might get this sort of signal from a simple antenna, but it would be much better for your receiver if, say, you could get ten microvolts into it because the signal would then be ten times stronger than the internal noise. You could do this by using a better antenna, or by increasing the height of the one you already have, and you'd find that listening to your mate would be a lot less of a hard job than if his signal were at about the same level as the noise. In technical terms, you've increased the signal to noise ratio: you'll come across this parameter many times as an amateur, and you may already be familiar with it if you're a hi-fi enthusiast. Since it's a ratio, it's usually expressed in decibels or "dB" (remember? we discussed those in another chapter) and in our example of ten microvolts of signal to one microvolt of internal noise, we've got a signal to noise ratio of 10 dB. This isn't much, and you'd find that it was a rather noisy signal to listen to for any length of time, but that doesn't matter for this example: the point is that however good your receiver is, it'll be the antenna that is responsible for a large part of how well you can hear your friend. One way of improving matters would be to buy or build an antenna with what is known as "gain" — we'll come back to this later.

For now, though, we'll return to the HF bands and the problem of our man on 3.7 MHz. What sort of antenna do we need?

Let's just briefly return to what we said about an antenna being an electrical circuit. It is indeed, in the sense that its function is to generate a voltage from the incoming radio wave and present it to the receiver. You can, in fact, divide the antenna world

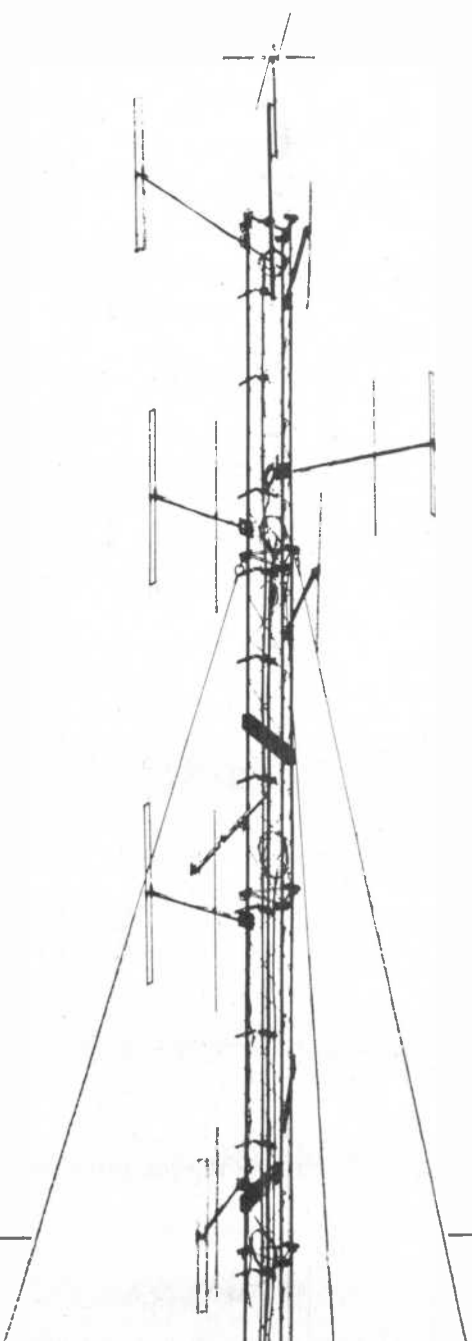
VIEWS

your transmitted radio waves where they'll do most good. An your radio equipment, the antenna or non-existent signal.

into two families, which are really just two ways of looking at how the volts are generated; they are "balanced" and "unbalanced" antennas, and every one falls into one or other category.

The "unbalanced" antenna simply means an antenna which uses the earth as the "other side", if you like, of the electrical circuit. The old-fashioned long wire down the garden is an unbalanced antenna, and you may remember that on the old table-model radio you had at home years ago, there was a prominent terminal on the back solemnly marked "Earth" or "Ground". If you didn't connect it, the results were usually worse than if you did, although some of them used the ordinary earth wire in the mains lead for the antenna's earth (which isn't a terribly good idea, but anyway . . .). In the amateur world, the "long wire" is still quite common for the lower-frequency bands like 1.8 and 3.5 MHz, and you'll inevitably find that the man using it has gone to some trouble over the earthing system for the "other half" of it. The same is true of another common type of amateur antenna, the vertical. A vertical antenna is always used over a good earthing system because it won't work very well if you don't; the reasons why are a bit beyond the scope of this article, but you could say that an inferior earth — for any unbalanced antenna actually, not just a vertical — introduces a resistance into the antenna circuit and that some of the volts induced in the antenna by the radio waves disappear into this resistance instead of into your receiver.

VHF beam antennas, with a "ground plane" at the top of the mast.



In practical terms, a long-wire antenna is just what it sounds like; a random length of wire which wanders down the garden or wherever for as far as possible. On the face of it it's dead easy, which is why many amateurs first try one when they get a licence: but there are a few snags, which we'll look at.

There are two main problems with any antenna. One is to make it match the transmitter, so that power can be delivered from the transmitter to the antenna and get radiated without wasting any of it. The other is to make it do that over as many frequencies as possible, because quite obviously you don't want to have several hundred pieces of wire draped around the garden and strangling the neighbours' cat every week if you don't have to. You'll want your long wire to work on as many bands as you can, in other words.

Now the snag is that in any electrical circuit you care to name, the *load* — whether it's a light bulb, a resistor or, as in this case, an antenna — has to suit the *generator* (ie in this case your transmitter). The technical term we'll have to get to grips with at this point is something called *impedance,* and all we need to be aware of for now is that it's measured in the same units as resistance. The unit of resistance is the *ohm,* and impedance is measured in ohms because it's a form of resistance. The *output impedance* (yes, I know it sounds a bit strange but stick with it — it's just a way of looking at something, and we don't need to go into exactly what at this stage) of your transmitter, or in other words the load it needs to see at the output, is about 50 ohms; that's actually a standard value for most transmitters, and it means that in order to get the power into the antenna with good efficiency, the antenna has to present about 50 ohms *load impedance* to the transmitter.

Now the impedance of an antenna is set by all sorts of things: what frequency you're using it on, how long it is, how high it is above the ground and so on. In the case of a random length of wire, the last thing you, as the amateur, are going to know is the impedance of the thing at a given frequency: as we'll see shortly, you may have a rough idea but there's no way under the sun that you could make an antenna of this type (or more or less any other type, come to that) and say to yourself "ah yes, that'll be an antenna of 50 ohms impedance". Even if your long-wire looks like 50 ohms to your 1.8 MHz transmitter, it sure as hell won't look anything like 50 ohms on, say, 3.5 MHz — it'd probably be more like 1,000 ohms, and your transmitter won't like that one little bit. You'd find that there'd be various symptoms of distress from it, such as flashes and bangs if it has a final amplifier using valves, or the protection circuitry would simply turn the transmitter off completely in a transistor transmitter; either way it's a no-no.

So you're going to have to use something to *transform* the impedance of the antenna, whatever it happens to be, into something which the transmitter can cope with in terms of load impedance. The magic "something" is a device called an ATU, and the letters stand for Antenna Tuning Unit. You can build them or buy them but either way you'll certainly need one if you intend to use a long-wire antenna. Its sole job in life, as we said, is to convert the antenna's impedance on a given frequency into a nice straightforward 50 ohms so that the transmitter can get the power it generates into the antenna with no fuss and bother.

If the antenna *doesn't* look like a 50 ohm load, what happens then? Well, some of the power gets reflected back down the cable which joins the transmitter to the antenna; again, the results of this are a bit outside the scope of what we're dealing with at this stage, but the transmitter won't really be very happy about the situation. The net effect is that you get what are known as "standing waves" on the cable, which don't in themselves matter very much at ordinary amateur-type power levels but which can mean various other problems rearing their heads. Which is where another piece of kit comes in; this is a device called the "SWR bridge". The SWR stands for Standing Wave Ratio, and an SWR bridge can measure the amount of standing waves on the cable as a function of the power that is actually being sent into it.

That by itself doesn't sound very interesting, but the point is that the lower the standing wave ratio, the better the match

AERIAL VIEWS

between the transmitter and the antenna must be: obviously, if there aren't any standing waves there can't be any reflected power and hence the antenna's impedance *must* be correct QED. So the SWR meter (it's usually pronounced "swer" in conversation) is an extremely useful gadget because it represents the quickest way of adjusting the antenna tuning unit for a good match between the transmitter and the antenna.

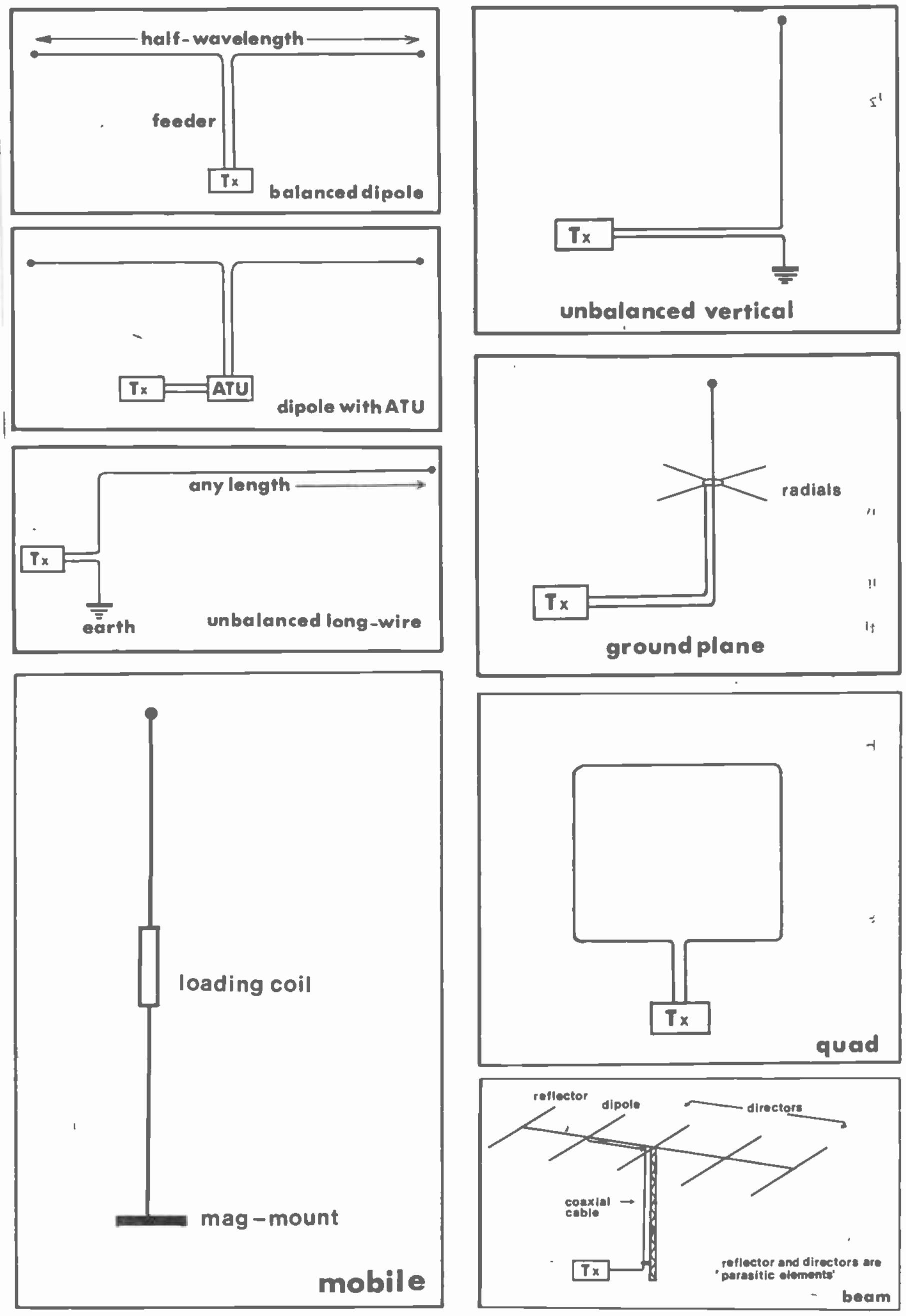
You may well find, in fact, that with a long wire antenna you need to re-tune the ATU if you shift frequency even within a band, let alone to to a new band, so an ATU is a necessity for this type of antenna. Actually, particularly for modern transmitters which use transistors, you'll probably find that an ATU is essential for almost any antenna you use: maybe we ought to look at this in a bit more detail.

A modern transmitter which is using a high-power final amplifier employing transistors is much more critical of the load impedance it sees than one using valves. There are various reasons for this, but you can take it as fact; you can also take as fact that transistor power amplifiers are about a million times more vulnerable than the valve equivalents. Manufacturers tend to make great play of the fact that their brainchild is "solid-state, no-tune broadband", which indeed is true insofar as the final amplifier, if it uses transistors, may well have no extra controls for tuning it up such as its valve cousin requires. The problem is that what the manufacturer doesn't say is that the amplifier may not need tuning but the *antenna* certainly will need a tuning unit in order to make it look like an acceptable impedance to the aforesaid transmitter. What he also doesn't tend to say is that if the transmitter sees the wrong load impedance it may well just quit; most modern transistor power amplifiers have some sort of protection against this condition but it's very far from being infallible, and as we've seen the transistor is nowhere near as rugged as the valve — result is usually an expensive disaster. I'd suggest that if you have, or are thinking of getting, a transmitter of this type, you *always* use an ATU and you *always* tune up at very low power.

Many commercial ATUs have a bult-in SWR bridge, or indeed SWR bridges are cheap, and they're certainly a wise investment. As we've seen, the idea is to get the SWR as low as possible. This isn't because there's any particular virtue in a low SWR as such (although amateurs argue for hours about this and seem to think there's some special merit in the fact that one antenna has an SWR of 1.2 to one whereas its rival can only muster 1.4 to one — which is baloney) but because a low SWR implies a good match of antenna to transmitter and general goodness, particularly if it's a transistor transmitter. Remember the old phrase which goes "a transistor is the fastest fuse known to mankind. . .!" As long as the SWR is below about 2 to 1, your transmitter ought to be happy, and there's no mileage whatsoever in spending a Saturday trying to get it any lower.

Anyway, back to antennas. The other family is known as "balanced" antennas, and all this means is that they don't depend on the earth as such for the other half of the circuit. The basic bog-standard balanced antenna is known as the "dipole" and in amateur circles they're normally referred to as "half-wave dipoles" because they're usually made to be half a wavelength long. For example, if you wanted a dipole for the 7 MHz band, you'd find out the wavelength corresponding to the frequency of the centre of the band, which is 7.05 MHz — it's actually about 40 metres, which is why the band is also known as "40" or the 40-metre band — and you'd then divide that by two and deduce that a 7 MHz dipole needs to be 20 metres, or about 66 feet, long. A dipole is fed in the centre, which means that each "leg" of our 40-metre dipole will be about 33 feet long.

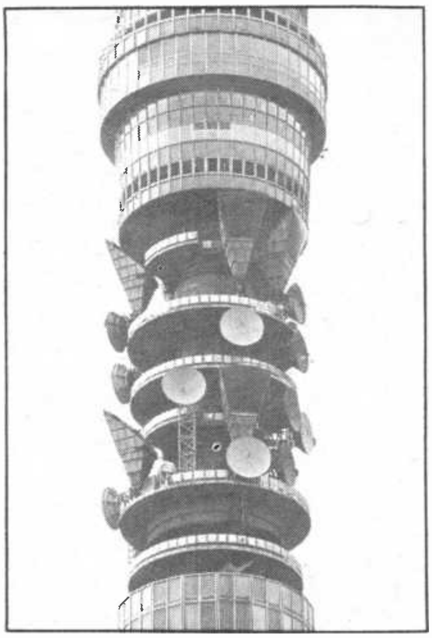
You might say "what's the point in cutting it to length and feeding it in the centre? Isn't the long wire simpler?" Well, it just so happens that a dipole (or any other antenna, come to that) which is cut to half-a-wavelength long will display a phenomenon known as "resonance" — as you go into elementary AC theory for the RAE, you'll discover that resonance is an extremely handy property, but for now we'll leave it — and that its impedance becomes quite predictable. At its centre, a half-wave antenna possesses a low impedance; it varies a bit with factors like how high off the ground it is, but you could say that it's in the low tens of ohms. Now since your transmitter's output impedance is very likely to be 50 ohms, you'll see that this is a useful property! It's useful, by the way, to note that a half-wave at resonance displays a very high impedance at its *ends,* so that if your long wire happens to be, for example, about 66 feet long, you're going to have to use an ATU to feed it. If it were 132 feet long, you might well be able to get it to work on 7 MHz by feeding it at its end and pruning its



These diagrams show the configurations of some of the most popular amateur-type antennas. See text for further information.

length to get a low SWR, and if you were only interested in the 7 MHz band that would be a good thing to do; your problems would start, as we've seen, if you wanted to try 14 MHz as well, 'cos the transmitter would simply refuse to co-operate.

The two simple antennas we've looked at — the long wire and the dipole — are the most simple, and every other antenna ever invented derives from one or other of them. Your domestic television antenna, for instance, is a derivative of the basic dipole; it's known as a Yagi, after its Japanese inventor, and Yagis of one sort or another are probably the most common antennas in the amateur world. They're almost universal on the VHF and UHF bands, and they're basically a dipole with extra bits added on. The "extra bits" are called "parasitic elements" and their function is to modify the radiation pattern of the simple dipole in such a way as to concentrate the radio waves into certain directions. On the 432 MHz band, where half a wavelength is about 35 centimetres, it's easy to add many elements to make a very narrow beam indeed, and it's this that gives the antenna "gain". You might read in the antenna's specification that, compared to a dipole, it will deliver 15 dB more signal to the receiver. 15 dB equates to about 31 times in power terms, so that's well worth having; also, you can say that the transmitter's output is multiplied by the same factor, so that a 10 watt transmitter produces just over 300 watts of what is known as *effective radiated power* or ERP for short. Obviously the power gain has to come from somewhere, and it comes from changing the figure-of-eight radiation pattern of the basic dipole into a much narrower "beam" of radio waves. The same principles apply, of course, on the HF bands, and indeed there are commercial Yagi antennas for 14, 21 and 28 MHz all in one. They're obviously much larger, because the wavelength of 14 MHz is about 20 metres, as opposed to 70 centimetres on 432 MHz and so the elements have to be much longer — 20 or so elements are quite practical on 432 MHz but a 20 element 14 MHz beam would be something of a monster . . .



Microwave dish and horn antennas.

Height is important for VHF, UHF and microwave antennas — hence the tower!

Anyway, that's a look at the antennas that amateurs use. As we've seen, the whole subject is very complicated, and you could fill a book — actually, there *are* some good books on antennas, especially the ARRL Antenna Book and the RSGB's new tome "HF Antennas for All Locations". Mind you, if you can fully understand the latter, you'd better explain it all to me. . .!

Diagrammatically speaking

There's nothing complicated about circuit diagrams. They are all made up of standard components, and are easily understood. Think back to when you first saw an Ordnance Survey map, or tried to ride a bicycle, or swim . . .

The first time you look at a circuit diagram of *anything* electronic, it's liable to induce something resembling a cardiac arrest; even if it's a simple piece of gear, a circuit diagram is likely to be more than somewhat unfamiliar. Mind you, if you think back to the first time you looked at an Ordnance Survey map. . .

We'll look at some of the basics of circuit diagrams in this article, and hopefully make some sense of them.

The first thing to remember is that a circuit diagram is just what it says — it's a diagram of the circuit of whatever it happens to be. It's called a circuit because in a sense that's what it has to be; the various voltages and currents present in different parts of the equipment all have to start and end at the same place. That's why every circuit diagram starts at one place and ends at another; if you like, it starts at the main source of power and ends where the power has been through all the components and is returned to a common point. If you think about a battery, for example, it has two terminals — a positive and a negative. Now, neglecting any amount of esoteric physics, you can say that the energy flows out of the positive terminal and back into the negative terminal, hopefully doing something useful while it's in transit, so speak.

Somewhere in the circuit diagram there'll be something that corresponds to the two poles of the battery; the bits in between can be as simple or as complicated as you like, but the start and finish are always there. So what about the gubbins in between?

The first thing to remember is that you can always reduce the most complicated circuit diagram into a number of simple stages which do one job each. Now if you unfold the circuit diagram of your new Japanese multiband HF rig it'll probably look completely unintelligible. If you try to take it in as a whole, then it will stay that way however clever you are. However, if you take it step-by-step (not that you can do that easily with a Japanese circuit diagram, but still. . .) you can build up a picture of what's going on.

Fine, you may say. But what the hell are all the funny symbols? Well, that's what we're coming to. Any electronic equipment is built up from standard components, and it's a bit like a language; there may be millions of words in it, but the average person probably doesn't use more than a few thousand of them. In a radio, for example, there may be about 50 different types of electronic component — things like, capacitors, resistors, transistors, diodes, relays, transformers, inductors, etc which get used over and over again; there may well be many types of component that aren't used. In other words, the complexity of the equipment isn't directly related to how many different sorts of component it uses but to how many of similar ones.

Now each type of electronic component has a **symbol** — that's to say that all the weird little squiggles on a circuit diagram imply a certain sort of component. There's a table showing the most common ones somewhere in ths article, and you can see some of them in use on our specimen circuit diagram. You'll note that the circuit uses two **transistors**, three **capacitors**, six **resistors** and a **switch**. There's also a line at the top of the circuit marked "+24V", which represents the point at which the energy comes into the circuit, and a point marked "OV", which is where the energy could be said to leave it — this point is connected to "earth", which is a way of saying a point of zero potential or no energy.

This circuit diagram actually shows an audio amplifier, of the sort you might use if the microphone you have doesn't give enough output for your rig, and you could quite easily build it up from the information given by the circuit diagram alone. The lines which join each component to the next one simply represent wires, and the diagram shows where you'd connect the **input** — which might be the microphone in this case — and where you'd connect the **output**, which is the piece of equipment you're using next in the chain, such as, in this case, a rig. You also know from the circuit which way to connect a battery (although you might not use a battery, of course; you might use a mains power supply, of the sort we've shown in the section on building it yourself). So — there it is.

Now without going into the detail of how the circuit works, let's see if we can get some idea of what the components are doing in the circuit and we'll find out if the diagram can tell us anything else. We can see that the input voltage comes into one part of the transistor (the thick vertical line inside the symbol — it's known as the **base** of the transistor) via a capacitor, and we see that against the capacitor symbol are the figures "220n". This is the **value** of the capacitor — it's a measure of what effect it will have in the circuit. The strange letters and figures by the transistor, in contrast, are simply its type number. In this circuit the transistors are both BC109 types. Actually, the "BC" bit does tell you something — these letters tell you that the transistor is made of silicon and that it's meant for audio, or low frequency applications.

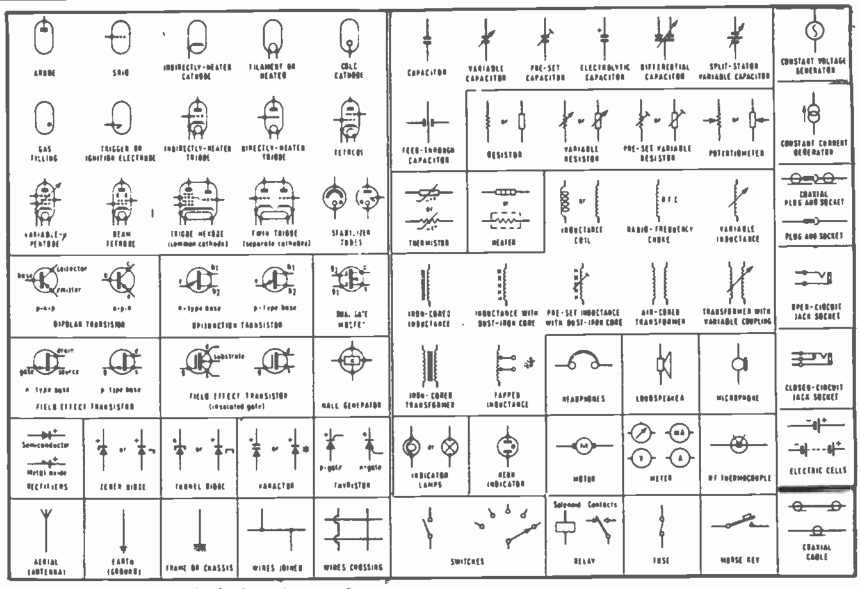
In fact, there are two common ways of describing any **semiconductor** device, such as a transistor, diode or thyristor. One is the method we've just seen, whereby there are five characters — the first two or three will be letters and the last three, or two, will be numbers. Examples are BC109 — a common audio-type transistor — BYX10, which is a rectifier diode and BT152, which is a thyristor. The other is a system where the first characters are 1N, 2N or 3N, followed by three or four numbers. Some examples of common ones are 1N4148, which is a small diode, 2N3055 — an audio output transistor — and 3N204, which is a device known as a **field-effect transistor**. If you're not happy about what any of these strange devices are, don't worry about it at this stage — all we're trying to do is see how to recognise them in a circuit diagram. All the clever stuff, like how they work, will come later.

Okay — back to the circuit diagram. The other components which feature in various places are those represented by the wiggly lines (although in modern circuit diagrams you'll also find them represented as thin rectangles). They're called **resistors**, and in this circuit there are six of them, labelled R1 to R6. Basically, resistors are used to set voltage levels required at different points in a circuit, and they're probably the most common electronic component. Against each one, you'll find its value — R6, for instance, is 560 and R1 is 1k, the "k" standing for "kilo" which is the Greek word for one thousand. The figures refer to units called *ohms,* which are the basic units of resistance — don't worry for now about what this means — and there are several ways of writing them. In older circuits, a value of ohms less than 1000, such as we see in R6 at 560 ohms, is just written as 560 — sometimes with the Greek letter omega (Ω) after the figures — omega is the shorthand symbol for ohms. In newer circuit diagrams it'll be written as 560R.

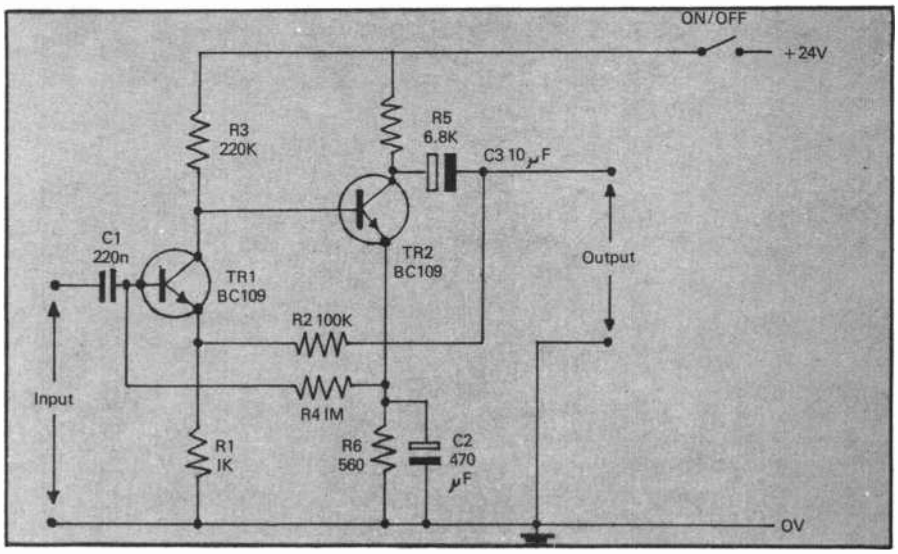
For a value of ohms larger than 1000, it'll either be written as on the diagram for R5 — 6.8K or K — or, again in newer diagrams, 6K8. Both mean a value of 6,800 ohms. For values in excess of one million ohms, such as R4 for example, they'll either be written as 1M or 1MO; a resistor having a value of, for instance, three million three thousand ohms would be written as 3.3M or M or alternatively 3M3. You'll sometimes see another figure after the value, in the form of "560R 10W" for example. The "10W" implies the **power rating** of the resistor, which in this case is 10 watts; if it isn't specified, the bog-standard resistor can be used, which is usually rated at ¼ or ½ watt.

Resistors and capacitors are probably the most common components in any piece of electronic equipment, and there are several sorts of them — we won't go into details here, but one thing about capacitors is worth noting. Certain types are what is known as **polarised**, which just means that they have to be connected into the circuit the correct way round with regards to the polarity of the voltage on their connections. If this is the case, it'll be shown on the circuit diagram, either with a small positive (+) symbol on one side of the capacitor or by using a special version of the symbol used for capacitors — see the table.

One other practical point about resistors is



Some common symbols for electronic components.



A simple two-stage transistor amplifier, as discussed in the text.

that most types don't have a value written on them in figures. You'll find that the type of resistor you'll come across most of the time has four or five coloured bands on its body. There's an acknowledged colour code for resistors, and after a little use you'll find it's second nature to pick up a resistor and say "ah yes, that's an 8.2K — that'll do".

Anyway, to get back to the diagram, what else will it tell us? Well, it will tell you practically everything you could wish to know about how the circuit works, what voltages you'd expect to find at what points and, as you become more experienced, it'll give you a quick insight into what might be causing a fault. Now without going into the technical details, since this article would have to fill most of the book if we did that, it's a bit difficult to explain exactly how to find out these things from the diagram, but you'll find that it comes with experience. Let's try a simple example, though, and I'll assume you're a little bit familiar with some very basic electronics such as Ohm's law — if you're not, just skip this next bit!

Let's assume that, for one reason or another, the amplifier we've built doesn't seem to be working properly, and we decide to get our testmeter out and have a look at various voltages which should be present in this bit of the circuit shown by our diagram. Now we know that the main supply to the circuit should be 24 volts and that the **emitter** and **collector** of both transistors are connected to the supply lines with resistors.

Our testmeter should show some volts between the emitter and earth, or "OV" on both of the transistors, and it should also show some volts as present between each collector and earth. Let's pretend that, for instance, there were no volts at all on the emitter of the first transistor. Now we know from the diagram that there jolly well should be because there's a path for current to flow from the 24 volt line through R3, the transistor and finally through R1 to earth, and certain voltages should appear at these points.

If there were no volts at all on the emitter of the first transistor, my first guess would be that R1 had turned its toes up and I'd change it. If that didn't fix the problem, I'd probably change the transistor next because I'd reckon that it had failed by going "open-circuit". Both these assume that I'd found some volts on its collector, by the way; if I hadn't and there weren't, I'd suspect either that R3 had quit on me or that the 24 volts weren't there. Actually, I'd have checked the presence of the normal operating voltage first; if you put 12 volts into this circuit instead of 24 it wouldn't work too well and that might explain the problem; that's why it says 24 on the diagram, to tell me what volts ought to be there to make if work properly.

That's a very simple explanation, and indeed if you know more than basic electronic theory you'll probably be chuckling a little. Never mind — remember what it was like when *you* first started!

CODES AND CALLSIGNS

BRIEFLY speaking, there are two systems you can use to make contact with another amateur radio station. One is to put out your call on a general basis (known as a CQ call), in the hope that someone will answer you, and the other is to call a specific station; this is usually known as "keeping a sked" or schedule. Another way is to wait until another station has finished talking, and then move in to re-make that contact.

Calling a specific contact can often work to your advantage because in advance you know the person you will be speaking to, the strength of the signal, and have some prior idea of what you will be talking about.

Always keep calls short and use the codes where applicable. On these two pages you'll find the international Q code, and the RST codes for signal reports. Where a Q code is transmitted in morse and intended as a question, always include a question mark afterwards.

RST CODE

Readability

R1	Unreadable.
R2	Barely readable, occasional words distinguishable.
R3	Readable with considerable difficulty.
R4	Readable with practically no difficulty.
R5	Perfectly readable.

Signal strength

S1	Faint, signals barely perceptible.
S2	Very weak signals.
S3	Weak signals.
S4	Fair signals.
S5	Fairly good signals.
S6	Good signals.
S7	Moderately strong signals.
S8	Strong signals.
S9	Extremely strong signals.

Tone

T1	Extremely rough hissing note.
T2	Very rough ac note, no trace of musicality.
T3	Rough, low-pitched ac note, slightly musical.
T4	Rather rough ac note, moderately musical.
T5	Musically modulated note.
T6	Modulated note, slight trace of whistle.
T7	Near dc note, smooth ripple.
T8	Good dc note, just a trace of ripple.
T9	Purest dc note.

If the note appears to be crystal-controlled, add X after the appropriate number. Where there is chirp add C, drift add D, clicks add K.

THE INTERNATIONAL Q CODE

Q signals taken from the official list widely used by radio amateurs.

QRG	Will you tell me my exact frequency? Your exact frequency is . . . kHz.
QRH	Does my frequency vary? Your frequency varies.
QRI	What is the tone of my transmission? The tone of your transmission is . . . (amateur T1-T9).
QRK	What is the readability of my signals? The readability of your signal is . . . (amateur R1-R5).
QRL	Are you busy? I am busy. Please do not interfere.
QRM	Are you being interfered with? I am being interfered with.
QRN	Are you troubled by static? I am troubled by static.
QRO	Shall I increase power? Increase power.
QRP	Shall I decrease power? Decrease power.
QRQ	Shall I send faster? Send faster.
QRS	Shall I send more slowly? Send more slowly.
QRT	Shall I stop sending? Stop sending.
QRU	Have you anything for me? I have nothing for you.
QRV	Are you ready? I am ready.
QRX	When will you call me again? I will call you again at . . . hours.
QRZ	Who is calling me? You are being called by . . . (on kHz).
QSA	What is the strength of my signal? The strength of your signal is . . . (amateur S1-S9).
QSB	Are my signals fading? Your signals are fading.
QSD	Is my keying defective? Your keying is defective.
QSL	Can you give me acknowledgement of receipt? I give you acknowledgement of receipt.
QSO	Can you communicate with . . . direct or by relay? I can communicate with . . . direct (or by relay through . . .).
QSP	Will you relay to? I will relay to . . .
QSV	Shall I send a series of VVVs? Send a series of VVVs.
QSY	Shall I change to another frequency? Change to transmission on another frequency (or on . . . kHz).
QSZ	Shall I send each word more than once? Send each word twice.
QTH	What is your location? My location is . . .
QTR	What is the correct time? The correct time is . . . hours.

Examples of how to use the codes are as follows: QRM means "There is interference". QRM? means "Is there interference?" While QRM5 indicates that there is "extreme interference". In this case, interference is measured as follows: 1 — very slight: 2 — slight; 3 — moderate; 4 — severe; 5 — extreme. Other codes, explained in the charts on these pages, explain the codes for readability, signal strength, and tone.

RECOMMENDED PHONETIC ALPHABET

A	Alfa	J	Juliet	S	Sierra
B	Bravo	K	Kilo	T	Tango
C	Charlie	L	Lima	U	Uniform
D	Delta	M	Mike	V	Victor
E	Echo	N	November	W	Whiskey
F	Foxtrot	O	Oscar	X	X-ray
G	Golf	P	Papa	Y	Yankee
H	Hotel	Q	Quebec	Z	Zulu
I	India	R	Romeo		

AMATEUR ABBREVIATIONS

AA	All after . . . (used after a question mark to request a repetition)
AB	All before . . . (see AA)
BK	Signal used to interrupt a transmission in progress
BN	All between . . . and . . . (see AA)
C	Yes
CFM	Confirm (or I confirm)
CL	I am closing my station
CQ	General call to all stations
DE	Used to separate the callsign of the station called from that of the calling station
ER	Here
K	Invitation to transmit
NIL	I have nothing to send you
NW	Now
OK	We agree (or It is correct)
R	Received
RPT	Repeat (or I repeat)
TFC	Traffic
W	Word(s)
WA	Word after (see AA)
WB	Word before

Informal amateur abbreviations

ABT	about
ADR	address
AGN	again
ANI	any
ANT	antenna (aerial)
BA	buffer amplifier
BC	broadcast
BCI	broadcast interference
BCL	broadcast listener
BCNU	be seeing you
BD	bad
BFO	beat frequency oscillator
BK	break-in
BLV	believe
BUG	semi-automatic key
CANS	headphones
CC	crystal-controlled
CK	check
CLD	called
CNT	cannot
CO	crystal oscillator
CONDX	conditions
CPSE	counterpoise
CRD	card
CUD	could
CUAGN	see you again
CUL	see you later
CW	continuous wave
DF	direction finding
DR	dear
DX	long distance
DXCC	DX Century Club
ECO	electron-coupled oscillator
ELBUG	electronic key
ENUF	enough
ES	and
FB	fine business
FOC	First Class Operators' Club
FCC	Federal Communications Commission
FD	frequency doubler
FM	frequency modulation
FER	for
FONE	telephone
FREQ	frequency
GA	go ahead, or good afternoon
GB	goodbye
GD	good day
GE	good evening
GG	going
GLD	glad
GM	good morning
GN	good night
GND	ground (earth)
GUD	good
HAM	amateur transmitter
HI	laughter
HPE	hope
HR	here or hear
HRD	heard
HV	have
HVY	heavy
HW	how
IARU	International Amateur Radio Union
II	repetition signal
INPT	input
LID	poor operator
LSN	listen
MNI	many
MO	master oscillator
MOD	modulation
MSG	message
MTR	meter (or metres)
NBFM	narrow band frequency modulation
ND	nothing doing
NR	number
OB	old boy
OC	old chap
OM	old man
OP	operator
OT	oldtimer
PA	power amplifier
PP	push-pull
PSE	please
PWR	power
RAC	rectified (raw) ac
RAOTA	Radio Amateur Old Timers' Association
RCC	Rag Chewers' Club
RCVR	receiver
RPRT	report
RX	receiver
SA	say
SED	said
SIG	signal
SKED	schedule
SN	soon
SRI	sorry
SSB	single sideband
STN	station
SUM	some
SW	short-wave
SWL	short-wave listener
TFC	traffic
TKS	thanks
TMW	tomorrow
TNX	thanks
TRX	transceiver
TV	television
TVI	television interference
TX	transmitter
U	you
UR	your
VFO	variable frequency oscillator
VY	very
W	watts
WAC	Worked all continents
WID	with
WKD	worked
WKG	working
WL	will or well
WUD	would
WX	weather
XMTR	transmitter
XYL	wife
XTAL	crystal
YF	wife
YL	young lady
73	best regards
88	love and kisses

MORSE CODE

What it is, how it works, and why you need it

Morse — now what's that doing in this age of microprocessors? And why do you need to pass a test in it to use the HF bands? Let's take a closer look between the dots and dashes.

Probably everybody knows that Morse is a way of communicating information with a sequence of dots, or short bursts, and dashes which are slightly longer — we've all seen the spy movies where the man signals to his mate armed with nothing more than a pocket torch. Maybe you even learned the Morse code when you were young. It's the sort of thing the Scouts go in for, for instance. So why is it still important in amateur radio?

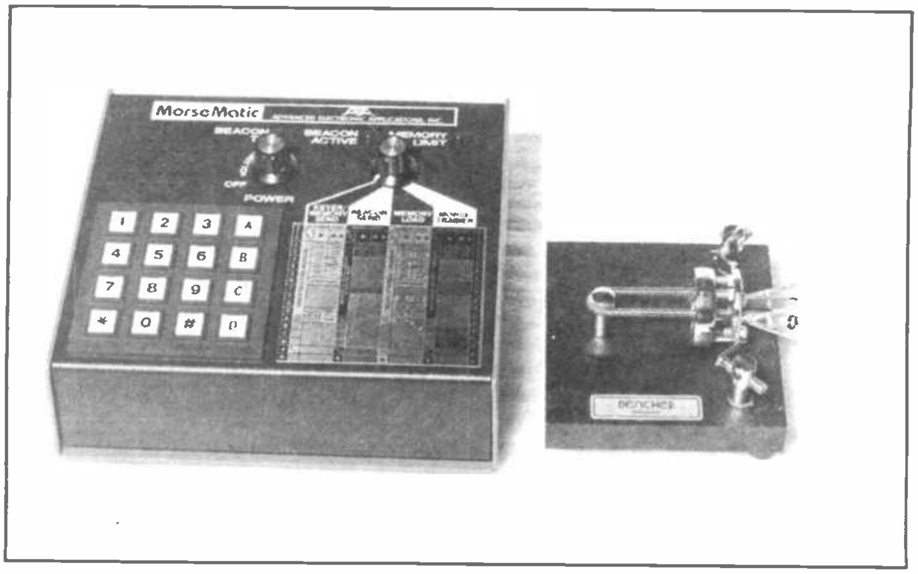
Basically Morse offers two things. A transmitter which can be used to send Morse code is the essence of simplicity, since all you need to be able to do is to turn it off and on (by means of a "Morse key" — see practically any war film ever made if you're not sure what one looks like) and in electronic terms, this is a doddle; a transmitter which is required to send your dulcet tones on their merry way is inevitably a bit more complicated. To put it a bit more formally, you don't need to modulate the carrier wave — you just need to switch it on and off. Admittedly, you do need a little extra gubbins in the receiver, but that's no real problem.

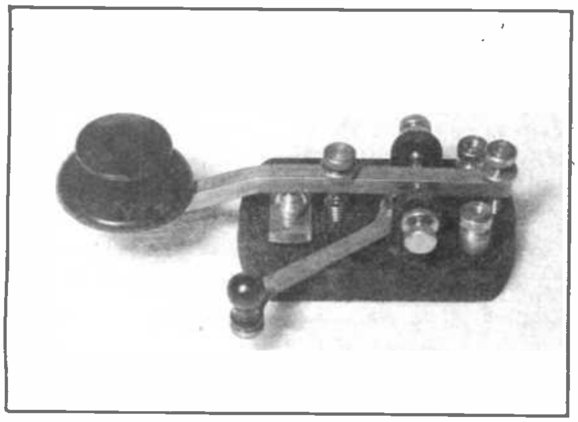
The other thing about Morse which makes it still a very popular mode amongst the amateur fraternity is that it will get through where other signals won't. Now if you are interested in DX, for example, this is important because you may often be in the situation whereby you can *just* about detect that he is there but you can't really get the information you want like how strong your signals are with him and where to send the QSL card. This is the time to forget the microphone and resort to the Morse key, because it will probably get you there. The reasons for this are quite complicated, but they're true. Only the other week I was trying to have a contact with a station in Southern Ireland on 144 MHz SSB. I could just about understand his callsign, and I could hear odd fragments of mine, but I couldn't copy his location or my signal report. However, when we switched to Morse (or CW, as it's often called; it stands for Continuous Wave, which is just an old-fashioned reference) we had about a ten-minute contact with no real problems,

The only problem with Morse is learning it — and this is why some amateurs feel that to have to pass a Morse test in order to be able to use the HF bands is a bit silly in this day and age. There are arguments for and against keeping this requirement, but irrespective of these, the facility of knowing and using it when it's necessary seems to be very handy. It's also a good part of the "self-training" bit of the licence. It *is* true to say that some people do have problems when it comes to learning to decode the meaning of the dots and dashes coming out of the speaker, and there's no real substitute for practice. Most amateur radio clubs have Morse practice sessions at some of their meetings, and there are some very clever aids available — some of them will send you random Morse characters, and a couple will even send you a character and then a synthesised voice tells you what was sent!

Different people learn Morse in different ways, and a little listening around and talking to a few amateurs will soon help you find your best way. It'll then be time to take the test, and you can do this at several places — the little book which we've mentioned before that's available from the Home Office Radio Regulatory Division or from the RSGB gives a list and even contains an application form. And when you pass the test, don't heave a big sigh and forget it all — Morse is a very useful weapon to have in the armoury and even if you intend to stick to VHF and UHF the Class A licence will open the door to things like meteor scatter and aurora (which the propagation article tells you about, but basically they're *the* way to work the really exotic stations on VHF).

So don't look down your nose at Morse. It's extremely useful, and besides that it can be very satisfying. Some of the newer amateurs think that it must take ages to spell out everything in Morse, but there are many abbreviations in common use and some of them are given here. Do try it — you may find the first few hours of learning are a bit of a struggle but it really is worth it in the end!





Above: Two modern Morse keys; on the left is the all-singing and dancing MorseMatic device and on the right is one of the simplest coil-sprung keys. Left: One of the originals.

BUILD YOUR OWN RADIO

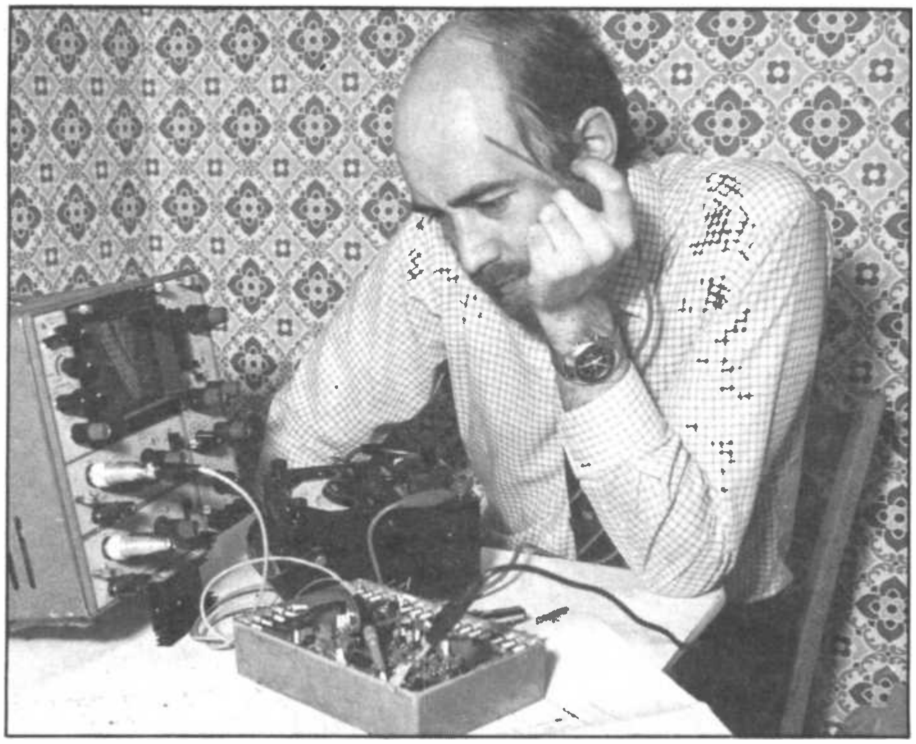
More and more amateur radio enthusiasts are assembling their own transceivers (and other equipment) from parts available over the counter at specialists shops. A home-built rig can be much more satisfying to use, says John Nelson.

As we've seen in our bit of potted history, in the beginning — when 2LO ruled the waves and it was Wireless (not this new-fangled radio) — you just had to build it yourself.

There just wasn't any other way; whether you wanted to build your own transmitter so that you could chat to some like-minded gentleman on a Sunday morning or whether you wanted to listen to Dame Nellie Melba. In the beginning, it was the cat's whisker, or the new peculiar state-of-the-art device known as the valve. You could buy all sorts of bits and pieces from a shop selling "wireless parts" and they'd probably charge your batteries for you as well for 6d.

It's all a far cry from £1,200 worth of FT1, for which all you need is an antenna and a mains plug so that you can fire the thing up — and very, very few of today's amateurs would even think of trying to build radios as complicated and clever as some of today's amateur transceivers.

However, one of the great things about the amateur licence is that, once you've got it and assuming you adhere to the basic necessities, you can either go out to the local emporium and buy the latest all-singing all-dancing "Wonder Wireless Mark 3" (and, believe me, even trying to follow the circuit diagram, let alone make sense of how it works is a bit like trying to sort out London Transport's bus timetable). Or, alternatively, you could build yourself a simple one or two-valve transmitter and a really simple receiver and get on the air for the cost of a few salvaged bits and pieces. Okay, so you won't have digital readout or 12 memories or 400 watts of single sideband but you *will* learn a hell of a lot.



Having built it, it's got to be checked. Here, the author is trying to fathom out why something isn't quite right . . .

Daunted by the theory?

Most amateurs sit somewhere between the two extremes. Let's assume that you're the ordinary guy in the street who doesn't have a Ph.D in solid state physics but who has read a few books and passed the Radio Amateur's Examination. As yet, you aren't too sure what a synthesiser does (relax — neither do a lot of amateurs) and you're still maybe a bit daunted by the theory bit. What you probably do for your first rig is to go out and buy something. Basically, you decide what you can afford and what sort of gear you'll need and you get it. Fine. Probably 90 per cent of radio amateurs have commercial gear, in the shape of a transceiver of some description, as the heart of the station, simply because it can't be denied that you get a lot for your money and it'll get you on the air without too much messing around.

Let's say that, after a while, you read a few magazines and you work a few stations, and you think to yourself "hmm — I could really find a use for a low-voltage power supply" (or an RF monitor, or an audio preamplifier 'cos your microphone hasn't got enough output to drive the rig properly — they're just a few examples). Now — to take the case of the power supply, for instance — sure, you could go out and buy one. But you might see a design in a magazine which seemed to do what you wanted it for, and in which the designer has explained in simple language how it works. You might then think "ah well, I'll have a go at this — it looks OK, and maybe I could add a few meters or lamps or something".

So you could go to a "rally" where the traders have some superb bits and pieces at very low prices (we'll say more about rallies later — they're the home constructors' best friend) and get what you need — you can then follow the instructions and build it. And, brother, you'll feel great when it does its stuff.

It's not that it'll cost you less — it's that you've built some part of your amateur station and breathed life into it *with your own efforts.* You will also have gained some insight into just how a low-voltage power supply or whatever does its stuff, and you never know when that's going to come in useful. You might even get passionately interested in power supplies and end up designing them yourself five years hence, but that's another story!

So that's one reason for home-brewing — it's the old creativity bit (and it probably *will* be cheaper to build it yourself anyway!) Another very powerful reason is that sometimes building it yourself is the only way to get exactly what you want. Let's say, for instance, that you get very interested in DX and you decide that you would like a linear amplifier so as to bang a bit more power into the sky and smash through the pile-ups when the guy in Market Reef or wherever comes on. Now big linears cost the proverbial arm and leg; at today's prices, all the copper and steel in the transformer costs a fortune, the fancy cabinet-work won't be far behind and the whole affair is likely to cause deep QSB in the wallet. Actually, a commercial linear is likely to be a bit of a compromise in some ways, but we'll leave that aside for now.

This is where the home-brewing comes in, and there are literally hundreds of designs for big linears in the magazines and textbooks. You can find a design to suit the exact requirement you have, whether it's a simple transistor affair for VHF or UHF of a super-clever distributed amplifier for the HF bands complete with automatic antenna tuning, clever power supplies to protect the valves and the Lord knows what else. You can pick up mains transformers for a song, whereas they'll make your bank manager's eyes water if you buy new ones of any great size, and in general terms I'd reckon that you could build a decent linear amplifier for about a tenth of what you would pay in the shop for it. And here again, at the end of the day, you'll have learned an enormous amount about high-power amplifiers and how to get them to work.

Okay — so whether it's a multi-band transceiver or a little power supply, where do you start?

Preferably somewhere near the bottom. Amateur radio, like any branch of electronics, can be as simple or as complicated as you want it to be and, if you're not a specialist and you're just getting your feet wet, it's best to take it slowly and learn a bit at a time. You'll need a few tools to start with, like small screwdrivers, cutters, pliers, a soldering iron (*not* the type you shove in the fire and brand the dog with — a small electric one rated at about 15 watts will do for most things at this stage) and maybe a few household-type tools like drills, vice etc. The kitchen table will do just fine for simple projects, although it's very useful to have something like an Anglepoise if you're working on rather miniature circuits — it'll help you spot odd bits of solder that are bridging a couple of points that shouldn't be bridged, etc.).

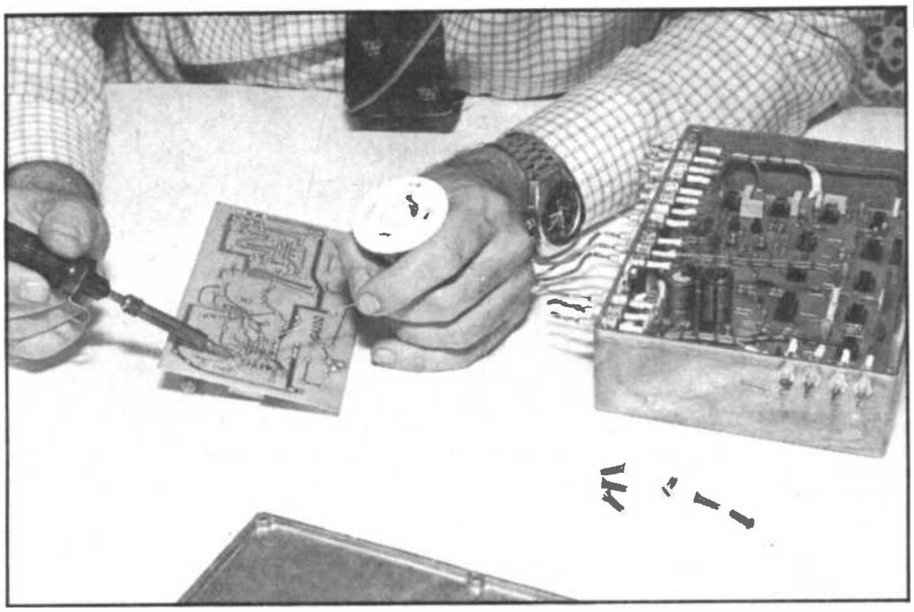
Printed circuits

Which brings us to a little item called a **printed circuit board**, usually shortened to PCB. A PCB is what commercial gear is usually built on if it's reasonably good-quality — it consists, basically, of a sheet of something like glass-fibre which is covered with a very thin layer of copper. If you coat the copper with something known as "resist" and then dunk the board in a thoroughly nasty chemical called ferric chloride, you'll find that the copper which didn't have resist on it will have vanished while that which did is (surprise, surprise) still there.

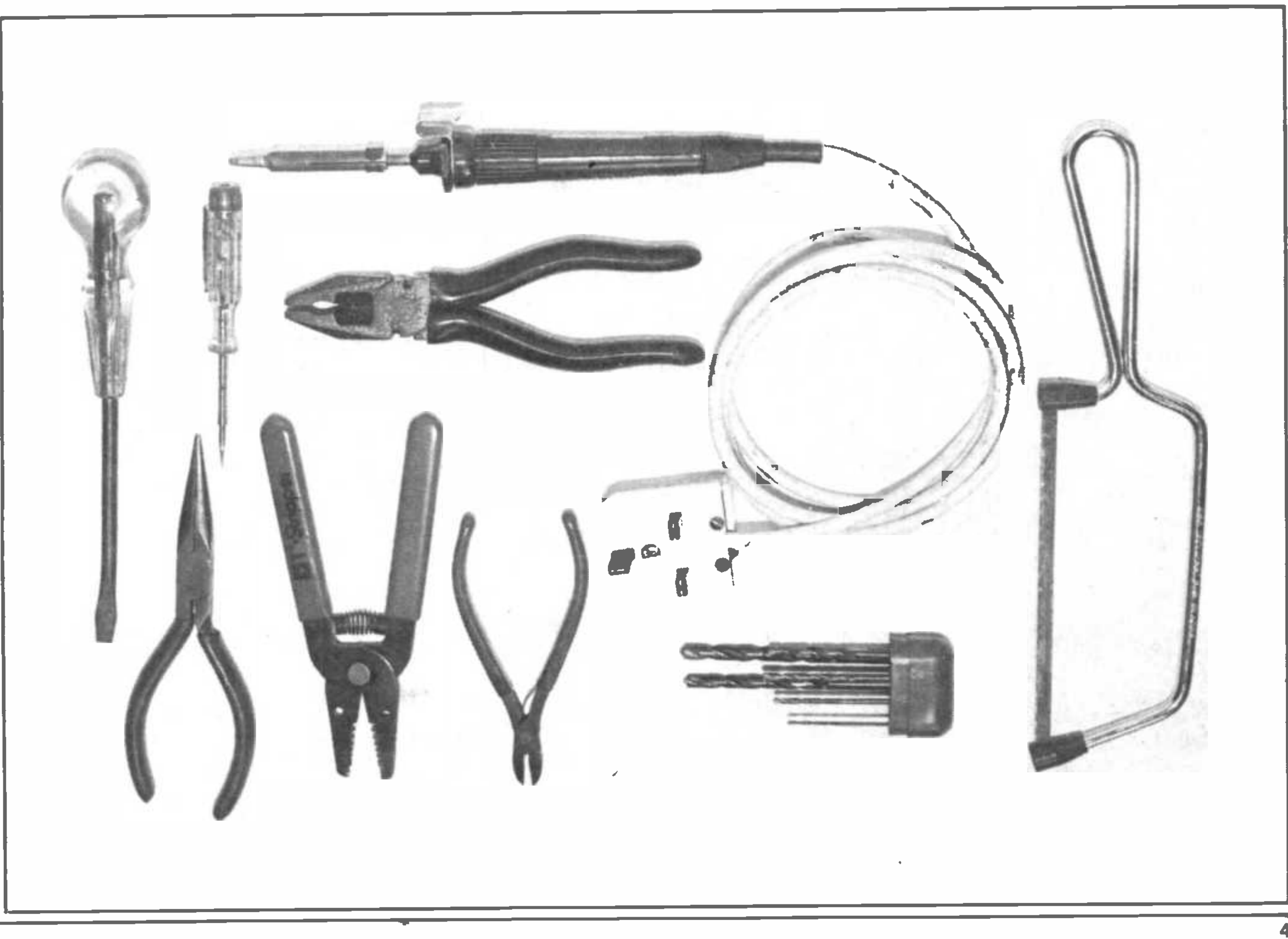
So if you take a simple electronic circuit such as we've shown below and draw the interconnections between the components on the copper in resist, you'll end up with a board which has on it the wiring between the components. All you need to do then is to drill the holes for the component leads and solder them to the board. Hey presto — there's the piece of gear.

Now PCBs are all very well but they tend to put beginners right off because they can be time-consuming to lay out, etch and drill — besides which, if you've goofed and got it wrong, it means making another one. So certainly for your first attempts at making anything, I'd forget all about printed circuit boards, unless, that is, you find a project for which someone will supply boards ready-made.

Okay — let's look at something in detail and run through how we might build it ourselves. Modern electronics using transistors need low-voltage direct current to run them — you *could* use batteries but it's rather better to have a mains-driven power supply available so that you don't get stuck at the wrong moment with a flat battery and also so that you can have some protection



Above: Soldering components on to a printed circuit board. Practice soldering and get it off to a tee before you work on the PCB. Below: Basic equipment needed in order to build your own radio, or carry out proper maintenance: screwdrivers, pliers and cutters, drills, soldering iron, and hacksaw.



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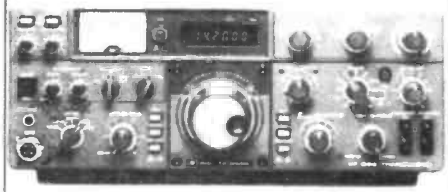
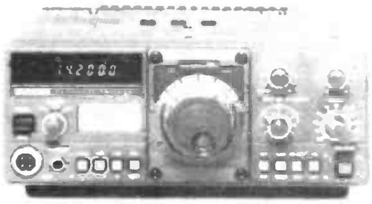


TS830S Brief Specification

Frequency Range:	9 bands, 160m-10m
Modes:	CW, USB, LSB
Final Power Input:	220 watts PEP (SSB) 180 watts DC (CW)
RX Sensitivity:	0·25μV at 10dB S/N
Catronics' Price:	£694

TS130S

WITH NEW BANDS



TS130S Brief Specification

Frequency Range:	8 bands, 80m-10m
Modes:	CW, USB, LSB
Final Power Input:	~200 watts PEP (SSB) ~160 watts DC (CW)
RX Sensitivity:	0·25μV at 10dB S/N
Catronics' Price:	£525

25W PEP version also available TS130V at £445

NEW TR2500

2M SYNTHESIZED PORTABLE

TR2500 Brief Specification

Frequency Range:
144-146MHz
Mode: FM
RF Output Power:
HI 2·5W, LO 0·3W
Sensitivity:
0·2μV for 12dB SINAD
Display:
LCD (4 digit)
Memories:
10 built in
Scanning:
Band or Memories
Catronics' Price: £207

TR7730

2M COMPACT TRANSCEIVER

TR7730 Brief Specification

Frequency Range:	144-145·995MHz
RF Output Power:	HI = 25W, LO = 5W
RX Sensitivity:	0·25μV for 12dB SINAD
Memories:	5 (scanning)
Autoscan:	5kHz or 25kHz
Repeater shift:	+/- 600kHz
Microphone:	500Ω with UP/DOWN + PTT
Catronics' Price:	£247

TS530S

BUILDING ON SUCCESS

TS530S Brief Specification

Frequency range:	9 bands, 160m-10m
Modes:	CW, USB, LSB
Final Power Input:	220 watts PEP (SSB) 180 watts DC (CW)
Receive Sensitivity:	0·25μV at 10dB S/N
Catronics' Price:	£534

TR9000

2M COMPACT ALL MODE

TR9000 Brief Specification

Frequency Range:	144-146MHz
Modes:	USB, LSB, FM, CW
RF Output Power:	10 watts
Sensitivity:	SSB/CW 0·25μV for 10dB S/N FM 0·25μV for 12dB SINAD
Frequency Control:	Digital, phase locked VCO
Memories:	5 built in
Scanning:	Auto 25/12·5kHz/100Hz
Catronics' Price:	£359

NEW TS780

ALL MODE 2M + 70CM

TS780 Brief Specification

Frequency Range:	144-146MHz 430-440MHz
Mode:	SSB (USB, LSB), CW, FM
RF Output Power:	10 watts. Only for FM: 10W (HI) Approx. 1W (LOW)
Sensitivity:	SSB/CW 0·2μV for 10dB (S+N)/N FM 1μV for 30dB (S+N)/N
20dB quieting (FM):	Less than 0.4μV
Catronics' Price:	£748

TR8400

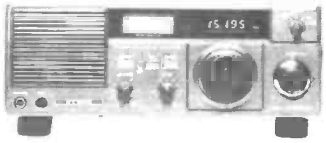
70cm FM SYNTHESISED MOBILE

TR8400 Brief Specification

Frequency Range:	430-439·975MHz
Channel Spacing:	25kHz
RF Output Power:	10W (HI) or 1W (LO)
RX Sensitivity:	0·4μV for 12dB SINAD
Memories:	5 (scanning)
Repeater shift:	±1·6kHz
Catronics' Price:	£299

NEW R600

COMMUNICATIONS RECEIVER



R600 Brief Specification

Frequency Range:	150kHz-30MHz
Modes:	AM, USB, LSB, CW
Sensitivity:	~2MHz 5μV 2MHz~ 0·5μV for 10dB S+N/N on SSB
Digital Readout:	to 1kHz
Catronics' price:	£235

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BUILD YOUR OWN RADIO

against any errors in your building in the shape of short-circuits or transistors wired up the wrong way round (and don't think you'll be immune — we *all* have aberrations).

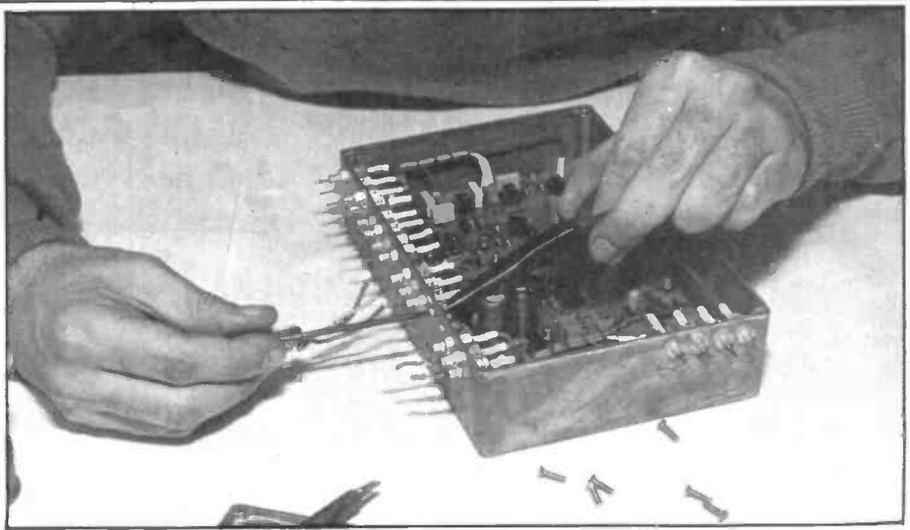
Elsewhere in this worthy publication, you'll find an article on how to find your way around a circuit diagram, and if you're not sure exactly how it works and what all the squiggly lines represent it'd be a good idea to have a quick read of it so that all the symbols on the diagram shown here make some sense. The diagram shows a 12 volt 5 amp power supply which is "regulated" — that's a way of saying that the output stays 12 volts however much current you draw from it up to the limit of 5 amps, which is a useful feature for various reasons which needn't trouble us right now. As you can see from the diagram, it basically consists of a mains transformer, which converts the 240 volts of the mains supply to round about 12 volts, a rectifier to convert the alternating current of the mains into direct current (i.e. the kind of current that a battery gives), a smoothing capacitor to smooth out the ripple which a transformer and rectifier inevitably produce and a clever little thing called a regulator to make sure that the output stays at 12 volts at any value of output current up to 5 amps.

Shorting together

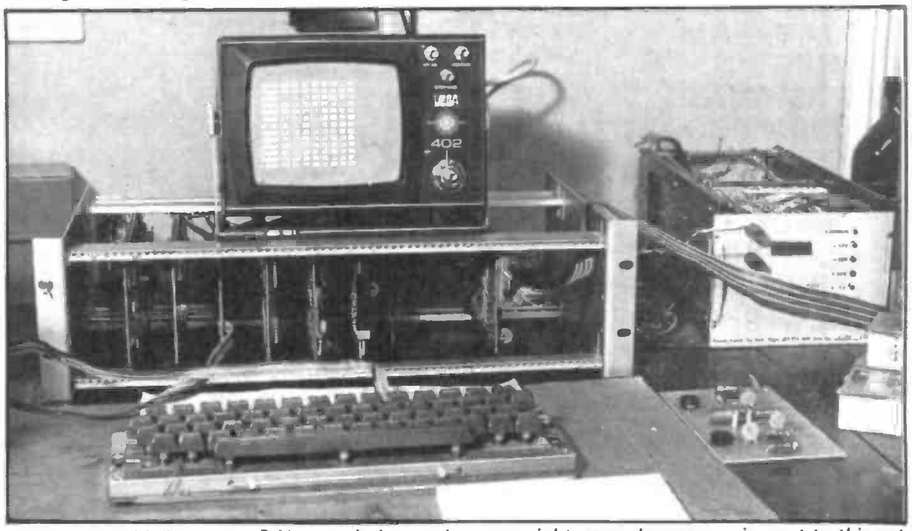
As far as technical explanations go, don't worry about how the regulator works — it's an example of what is known as an "integrated circuit" and the innards of it don't matter — all you need to know is what you can do with it. There are a couple of other little items, like a switch to turn it on, a couple of lamps to show that it's working and a meter to show how many amps you're asking it to supply. The regulator we're going to use has a feature called "current limiting", which means that if you ask it to supply more current than it's rated for (5 amps for this particular type) it'll politely decline and stop producing any output at all — you then have to find out what's going on. Usually, it means you've wired something wrongly or a bit of solder or whatever is "shorting" things together by accident. There are also a couple of fuses, just in case something goes 'orribly wrong inside the unit.

So — how do you set about getting the bits? Well, there are several ways; there are various shops which will supply the parts brand-new, and one excellent mail-order supplier I'd recommend is Maplin Electronics — they advertise in this magazine, and they do loads of goodies by mail-order via a good thick catalogue. Alternatively, you can go to a rally, of which there are many up and down the country each year, and have a look at what the various traders are offering.

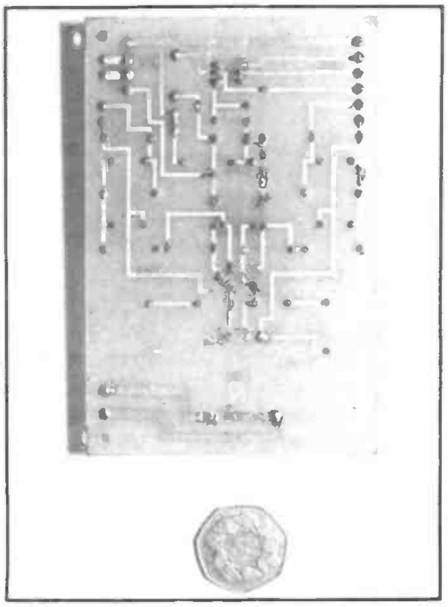
Now one of the things that home-building has going for it is that you can often get hold of ex-Government surplus components which are beautifully made and which would cost a bomb if you had to buy them new in the shops. Not only ex-Government items either; all sorts of electronic industry firms get rid of their surplus bits and pieces to traders, and a look around at a rally will usually produce the parts you want at incredibly low prices. A really nice transformer for this sort of project might set you back a couple of quid, whereas a new one of the same rating would probably cost more and might not be quite as nice



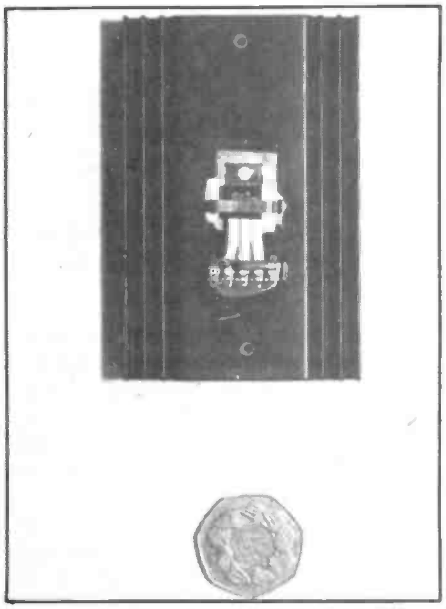
Putting the finishing touches to a power supply.



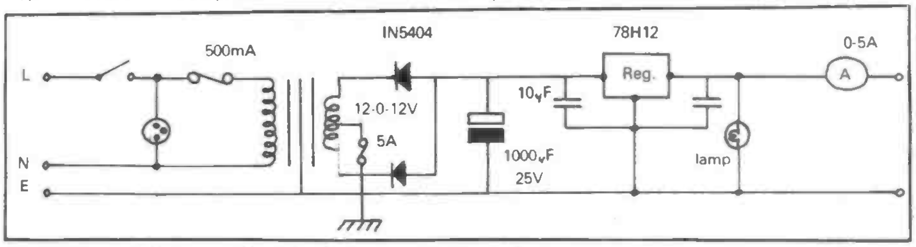
Not quite in this league yet? Never mind, one day you might upgrade your equipment to this set up — a computer tied into an amateur station.



Typical amateur-made printed circuit board.



A power semi-conductor on its heat sink.



To find your way round this diagram — see the main text.

BUILD YOUR OWN RADIO

simply because it's a commercial item built down to a price.

A major rally, like the RSGB's yearly extravaganza at Alexandra Palace in London, should produce all the bits for this sort of project for about a fiver, and that includes a nice box to put it in.

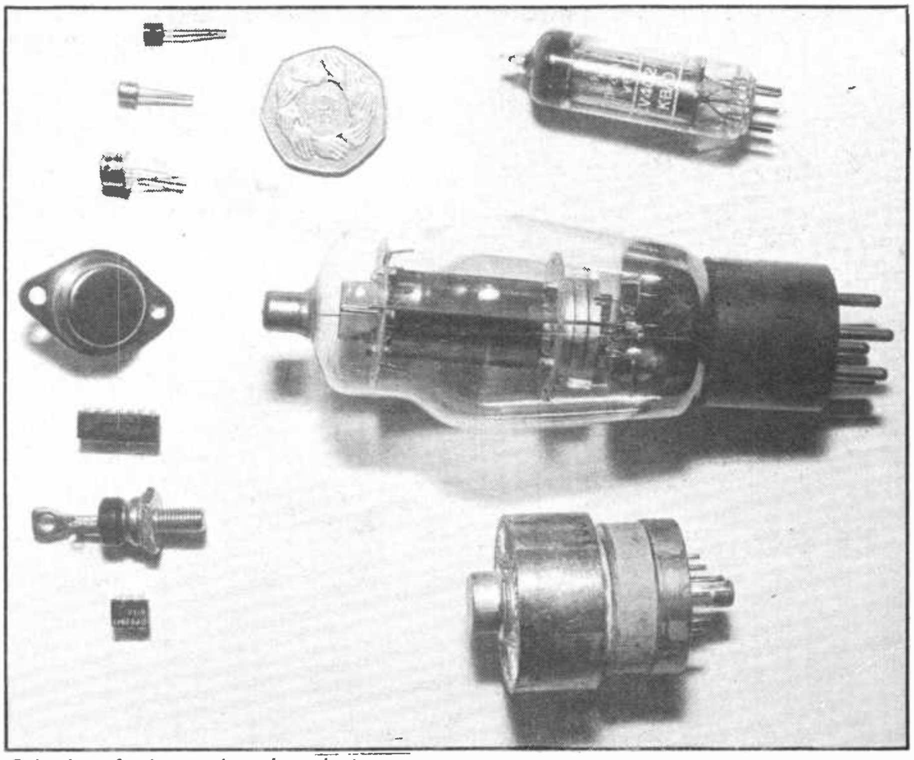
So — let's begin. The first step is to get all the bits together and decide how they're all going to fit. Then drill holes in suitable places on the front panel of the box you got for 50p at the rally for the switches, lamps, meter and fuse holders. Having done that chore, you can start building. We're not using a printed circuit board for this design, so you'll need some wire to join up the various components, following the circuit diagram as though you were a rally driver following a road map to see where you're going. Remember that you'll need to get the rectifiers and the smoothing capacitor the right way round, since you'll need to know which is positive and which is negative — you can damage these parts if you get it wrong, so watch it!

One other point is that you'll need something called a heat sink to mount the regulator on because although it's designed to get rather warm in use it'd get very hot — too hot — if you didn't help it keep its cool somewhat. So it needs either to be mounted to a metal chassis (this can be the box that your power supply lives in if it's a metal one of some sort) or to a separate piece of metal if it's a plastic box. A metal one would be much better, actually, for any power supply because you can then *earth* the metalwork to keep everything nice and safe in the event of a fault inside it — personally, I wouldn't use anything other than a metal box for any power supply which was connected to the mains, and I'd make jolly sure that the green lead in the mains cable was securely bonded to the box. As we've said, the box will do nicely for a heat sink in this case, although there are specially designed ones for use with higher-power systems of one sort or another.

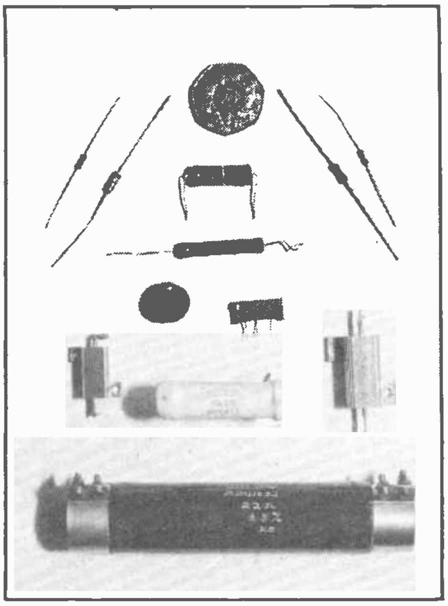
How to solder

When you solder wires to each other, or to a terminal, always use the iron to heat the thing you're soldering to and run a little solder on to it first. Then bring up the wire or whatever and solder it on. It's easier to see it in the pictures than to describe it!

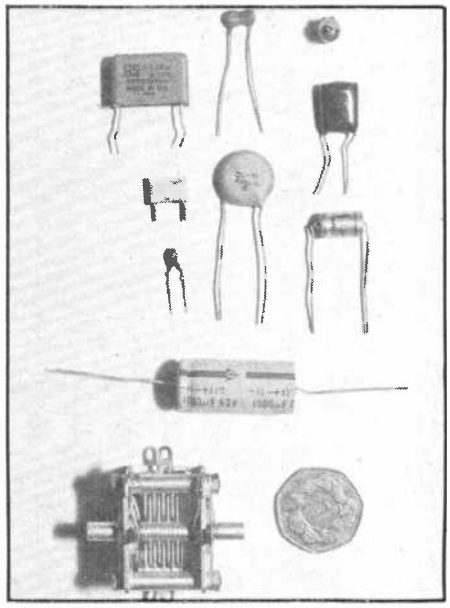
So — having got it all together, you're ready to test it — and this brings us to another indispensible item for the home-brewer. It's a thing called a **multimeter**, and it's used for measuring three basic things — volts, amps and ohms. Volts are a unit of potential difference; if you like, the pressure in a water-pipe that pushes the water out of the tap. Amps are a measure of current, which you could liken to the amount of water which actually flows through the tap in pints per minute or litres per second or something with a given pressure (or voltage) behind it. Ohms are the unit of what is called **resistance** — there isn't really a watery analogy for this one unless you think about sticking your finger over the tap and limiting the flow somewhat, which is vaguely similar to inserting resistance into an electrical circuit. Anyhow, a meter which will measure these things on various switched ranges is quite cheap and extremely useful.



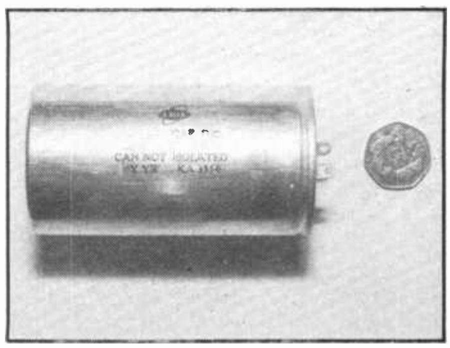
Selection of valves and semi-conductors.



Different types of resistors.



Various capacitors.

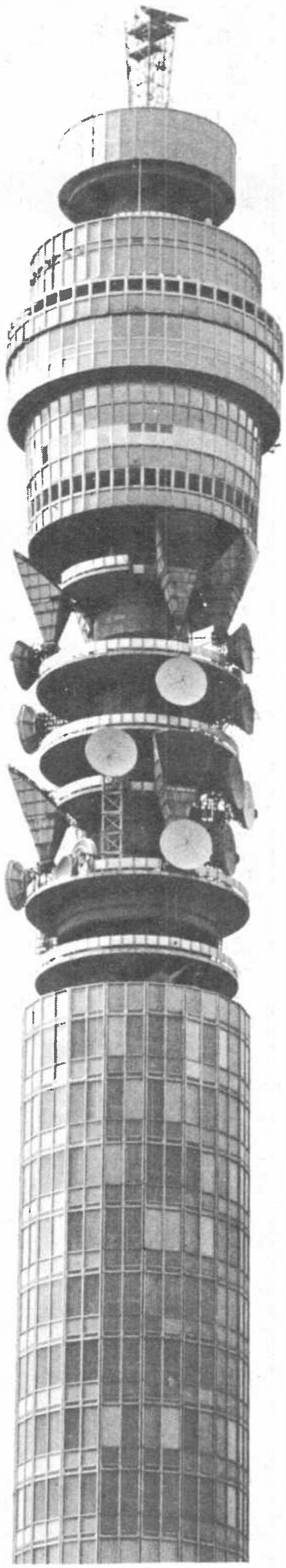


Electrolytic capacitor.

In this case, assuming we've got the power supply together, the first thing to do might be to measure the resistance between the brown and the blue conductors in the mains cable leading to it. With the switch off, there shouldn't be any reading on the scale, and it should fall to a low value (*not* a dead short!) as you flip the switch. This shows that there probably won't be a loud bang when you plug it into the mains for the first time and switch on . . . The next step would be to switch your meter to a convenient "volts" range and hang it across the output of the unit. You can then put the plug in and switch on. The lamps should light and the meter indicate 12 volts. Hey presto — welcome to the ranks of the home-builders!

You could do another test, which is to switch the meter to a high current range such as 10 amps and connect it straight across the output of the unit. It should read about 5 amps, which shows that the regulator is doing its thing and preventing any problems should you accidentally stick your screwdriver across the output or something. If the regulator didn't do it for you, you'd either blow the fuses or zap the rectifiers (which would also blow the fuses) which is pretty boring either way.

So — there you are. Now about that big linear . . .!



From Morse Code - to UHF and television

In about a million easy stages. John Nelson sums up how amateur radio began, and describes the different modes by which we can talk to each other.

One of the great things about the amateur licence is that, once you've got it, there's an enormous amount you can do with it. Let's take a look at what you can transmit and receive, and have a little tour round the amateur's world.

In the beginning, the very first way of sending any kind of signals was Morse code; you know, those dots and dashes bleeping away. Indeed, up until the thirties, it wasn't quite the thing to use speech on the radio unless you were the British Broadcasting Company, and radio amateurs in those days referred to it rather disparagingly as "phone". Samuel Morse ruled OK, and it still is a joy to watch somebody who's good sending and receiving Morse.

There's a whole section about Morse later on, but it's very far from dead and indeed as we've already seen, you need to pass a test on it if you want to use the HF (or High Frequency) bands — that's the part of the radio spectrum between 1.8 and 29 MHz as far as the radio amateur is concerned. If you've forgotten what a MHz is, go to the back of the class!

Morse is the easiest mode to make a transmitter for, basically because you only need to be able to turn the transmitter on and off. To transmit speech, which was the next step, you needed a bit more circuitry. "Speech" in the early days was a system called "amplitude modulation" which is just a grand way of saying that you varied the power in the basic radio wave in time with the pattern of the speech. Well, sort of.

Amplitude modulation, or AM, was the first system invented to transmit speech over radio, although another system known as "frequency modulation" wasn't all that far behind. In this latter system, the frequency of the basic radio wave is waved about a little, again according to the pattern of the speech. That's a rather evil over simplification, but it's more or less true.

So AM and FM were the two basic systems in the early days and both are still used in radio. Broadcast transmitters in the long and medium wave part of the radio spectrum us AM, as do people like civil aviators and police on VHF and UHF. By contrast FM is used by the broadcasters on the VHF bands (known as Band 2 and meaning that area from 88 to 108 MHz on your radio dial) and the vast majority of "private mobile radio" users.

As far as amateurs are concerned, AM is almost dead. There are several reasons; it takes up a lot of space in the radio spectrum, you tend to need rather bulky circuitry to generate it and worst of all, on a crowded band (like most amateur bands) there are problems with interference. This latter is because the basic radio "carrier", or the basic wave that the transmitter generates, is always there in an AM system, and if you get a couple of stations using AM within a few kilohertz of each other, the carriers will beat together to produce an ear-splitting whistle. This is why a medium-wave radio on the broadcast bands often sounds awful after dark! The HF amateur bands used to sound this way, only more so. Sometimes it was a miracle that anyone ever "worked" anyone else . . .

By contrast, FM is probably the second most common method of transmitting speech on the amateur bands (we'll get to the most common in a minute). This isn't true on the HF bands, but on VHF and UHF it's very much *the* mode. There are several reasons for this, and in some ways they're the same reasons that the Government specified FM for citizens' band. For a start, the interference problem disappears; due to a little phenomenon called the "capture effect", you'll usually only ever hear one signal at a time on a given channel in an FM receiver, unless the stations are of roughly equal strength. Also, the FM system is very insensitive to external noise; if the receiver's properly designed — you can sit in the middle of a thunderstorm and you'll hear nary a noise in an FM receiver, whereas you sure as hell will on AM.

There are two other good things about FM — one is that you're a lot less likely to run into massive TVI problems with high-power FM than you were in the old days using lots of wallop on AM. This is because a steady carrier is rather less likely to cause problems with TV or hi-fi than one which is constantly varying in level, although to be fair you can't always put your hand on your heart and say that an FM transmitter won't cause breakthrough problems, period. FM-type breakthrough isn't anything like as obvious as other sorts; maybe that's the fairest way to put it. The other great thing about FM is that it takes precious little circuitry to generate it; to produced decent-quality AM usually implies a fair amount of heavyweight ironware and so on. And indeed if you look at the amateur AM transmitters of 20 years ago, they tended to give a strong feeling of being about to fall through the floorboards.

Most popular system

So what's the most popular system used to transmit speech on the amateur bands? It's actually a version of AM known as Single Sideband, or SSB for short. It isn't new and, although opinions differ, certainly a variant of it was in use in a few places just after World War 1. Let's take a look at it in some detail.

We said earlier that you produce AM by effectively varying the power in the basic radio wave generated by the transmitter; in fact this is true, but it's not the whole story. If you decide to come over all mathematical, you can resolve an amplitude-modulated radio wave into three main parts; the **carrier**, the **upper sidebands** and the **lower sidebands**. We can take a simple example. Suppose we generate a basic radio wave on a frequency of 1 MHz and then modulate that with a tone (or if you prefer, a whistle) which has an audio frequency of 1 KHz or 1000 cycles per second. What you would, in fact, end up with would be three quite separate radio frequencies of 1 MHz, 1 MHz plus 1 kHz and 1 MHz minus 1 kHz; that's to say the carrier, the upper sideband and the lower sideband. If you modulated the transmitter with two tones, there would be five frequencies present in the transmitter's output in the same way — two upper sidebands, two lower sidebands, and the carrier.

If you now connected a microphone to the transmitter and spoke into it, at any given instant there'd be the carrier, a band of several radio frequencies *slightly above* the carrier frequency that corresponded to the instantaneous frequencies present in your speech and a similar band of frequencies *slightly below* the carrier. So, once again, you'd have the carrier, the upper sidebands and the lower sidebands.

Now then. We can see that the carrier (remember, that's the basic radio wave that the transmitter generates) is always there. But what does it do? Well — not a lot. In an AM radio, the carrier serves as a sort of baseline to tell the radio that it's tuned to this frequency, the sidebands will all be in their proper place and you can then comprehend them as speech; again that's a big oversimplification but it's sort of true. So — can you possibly do without that carrier? You have to put at least half the power of an AM transmitter into the carrier, and yet when all's said and done it merely goes along for the ride. You could quite happily do without it if you make the receiver capable of finding its own baseline, so to speak, against which to handle the sidebands which are actually what's carrying the speech.

Lot of sense

That's really the important point. All the speech, music or whatever it happens to be is conveyed in the *sidebands* in an AM system; all the carrier does is to tell the receiver where to start. And considering that (a) half of your power goes into it and (b) it's the carrier that's responsible for all those whistles and howls you hear in an AM receiver, it makes a lot of sense to try and suss out a way of doing without it. Actually it's no real problem provided that as we've seen, you put some extra circuitry into the receiver so that it knows what you're after. It makes a whole lot of sense to do it there rather than when you generate and transmit it.

Okay — this system is actually used for a few things, and double sideband suppressed-carrier, as it's known, can actually be used by amateurs, although in practice it very rarely is. Why's that?

Well, since we've enthusiastically abolished the carrier — and with it a lot of interference and hassle — let's have a look and see if we can do without anything else while we're at it.

Remember we said that in an AM system you ended up with a carrier and two sidebands — the upper and the lower? Now the only difference between the upper and the lower sidebands in an AM system is that one lot are above the carrier frequency and the other lot are below it — they're both carrying the same information and they both reflect the instantaneous speech content at any given moment. So, why do we need both of them? Well, we don't. We can quite happily remove one set of sidebands — the upper set or the lower, according to taste — and we've still got all of the basic information.

In other words, we've removed two thirds of the AM signal — the carrier and one sideband — and we're still managing to transmit our speech or whatever. Now there are several spin-offs from this. For a start, if you only have to transmit one set of sidebands instead of two plus a carrier, that means that you can put all your available power into those sidebands instead of having to spread it around between a carrier and two sets. In fact, to put some figures on it, 50 per cent of the power of an AM transmitter has to go into its carrier, leaving 25 per cent each for the upper and lower sidebands. In other words, you're wasting threequarters of the transmitter power for things that you don't really need to get the message over. So in an SSB transmitter, all the power that's available can be used for the one set of sidebands — which is another way of saying that all your "urge" goes where it'll do most good.

Another beauty of SSB is that it uses less of the spectrum, or if you prefer, more stations can fit into a given band. If you go back to our example above, you'll see why. The AM system required a frequency range of 1 MHz minus 1 kHz to 1 MHz plus 1 kHz — making a grand total of 2 kHz. If you translate that into the case of speech, where we usually transmit a band of frequencies which range from about 300 to 3,000 cycles, or 0.3-3 kHz, that means that the *bandwidth* of an AM speech transmission is 6 kHz. In other words, you need 6 kHz of radio space to transmit your speech.

If, however, you phase out the carrier and one set of sidebands (let's say that in our example we remove the lower sidebands) this gets cut nicely in half because you'll only transmit the set of sidebands corresponding to 300 to 3,000 cycles per second higher than the carrier frequency, or a bandwidth of a bit less than 3 kHz — 2.7 kHz to be exact. Compare this with the 6 kHz of AM and you'll see that that's a reduction well worth having, quite apart from removing that dirty great carrier that sits there doing nothing. Incidentally, that's the reason why amateurs don't make much use of double sideband (Remember? That's when you just abolish the carrier and leave both sets of sidebands to be transmitted). You don't save anything on bandwidth. There's another reason, connected with the receiver itself, but we'll leave that for now.

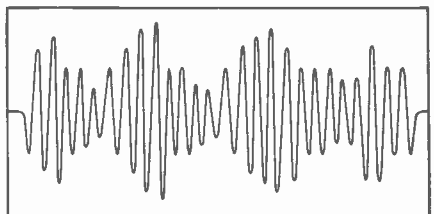
Cutting down the bandwidth has another advantage in that you can also cut down the bandwidth that the receiver needs to cope with; that's easy to do, and it makes the whole system a lot less likely to pick up other signals, noises off, etc. In fact, a modern SSB transceiver tends to use the same part of the circuit for removing one set of sidebands on "transmit" and defining the required bandwidth on "receive" — it's that part of the set known as the "filter" and the vast majority of commercial gear uses something called a "crystal" or "mechanical" filter for this job.

A lot of the fine art of receiver design goes into this bit of the circuit, incidentally, and there have been whole books on filters of one sort or another for SSB. They're the heart of a modern rig and the filtering arrangements are what you pay quite a bit of your cash for.

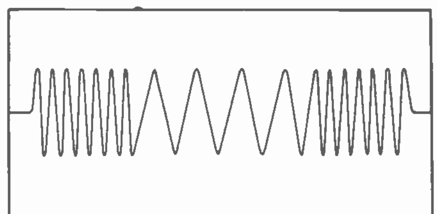
Yet another advantage of SSB is that it's not quite so prone as AM to being hacked about by the general vagaries of the ionosphere (see chapter on "Propagation" for more about how the ionosphere works). Since there's only one set of sidebands, the intelligibility of an SSB station can often be better than that of an AM station because there aren't two sets of sidebands plus a carrier tending to fade at different rates at different times. This situation can often cause an AM receiver to give up and go home, while SSB is hardly affected.

Incidentally, this point about bandwidth gives the clue to why Morse is so very good under poor conditions. Because all you do is switch the carrier on and off — you haven't really got any sidebands to fret about — the receiver can be made very selective indeed because the transmitted bandwidth of Morse is very narrow. So you can set the receiver up to respond just to the Morse signal and ignore other signals which might only be a short distance away from it and which you don't want to hear. All you're interested in knowing is that the carrier is there and is being keyed, and your filter can be designed so that it will respond to very narrow signals such as Morse and slice out anything else. Since this narrowing of bandwidth also has the effect of letting in less noise from the rest of the receiver, it also means that a weak Morse signal will appear to be that much stronger than the equivalent SSB signal under the same conditions.

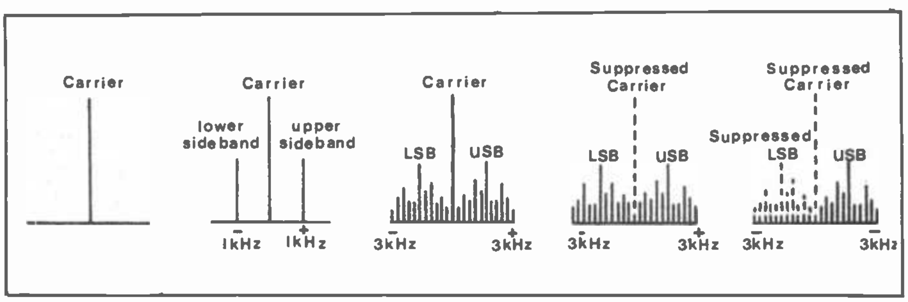
OK — so that's how we transmit speech in the amateur bands. That's not the end of the story, however. Another very popular mode of transmission on the amateur bands is something called RTTY; this stands for Radio



AM-amplitude modulation



FM-frequency modulation



Diagrams illustrate the AM and FM wave forms, and how the single sideband radio wave is comprised. Note that SSB uses less of the spectrum in that only one of the bands (here, the upper sideband) is utilised to carry the message. Both the lower sideband and carrier are suppressed.

From Morse Code to UHF and television

Teleprinter Teletype and it is just about what it says it is. A teleprinter is the thing that sits in some offices churning out reams of paper with messages on, and making one hell of a racket whilst it does so. The Post Office call it Telex. In many parts of the world, Telex links are made via radio, and amateurs do the same. In basic terms, a teleprinter can be hooked into a transmitter in two ways. Unlike Morse, where the transmitter is either on or off, the two states in teleprinting require the transmitter to be doing something all the time. These two states are known as "mark" and "space" and the letters are formed from various combinations of marks and spaces. Now either two slightly different frequencies can be used for the mark and the space, or two different audio tones can be used to modulate a single carrier. The first is known as frequency-shift keying (FSK) and the second is called AFSK, or audio frequency-shift keying.

True FSK tends to be more common on the HF bands, and it can easily be generated by a normal SSB transmitter by inserting audio tones which correspond to mark and space — thinking back to our dissertation on SSB, you'll remember that this will produce two slightly different radio frequencies. AFSK, on the other hand, is often used on the VHF and UHF bands to modulate an FM carrier: theoretically an AFSK system is less effective under weak-signal conditions than FSK, but it's still popular. This is possibly because the bit of gubbins used to decode the marks and spaces back into letters — known as the *terminal unit* — is easier to build for AFSK, and isn't quite so critical to use.

Banished

RTTY tends to be either something you're not at all interested in or else it dominates your amateur life completely. With the advent of microprocessors and visual display units, and also the rise of the home computer, it seems that interest in RTTY is increasing. The reason for this is quite simple; teleprinters are great fun but they're (a) big and (b) amazingly noisy — probably the best way to get yourself banished from the lounge to the garden shed is to announce casually to your wife that you've just picked up a lovely old Creed 7B and it won't take up *that* much space, darling. The modern electronic keyboard and screen may be a bit less fun but it does mean that you can enjoy the pleasure of teleprinting in relative peace and quiet.

RTTY addicts have a specialist group to help them on their way, and they're always pleased to receive new members. The secretary is **Ted Batts, G8LWY** at **27 Cranmer Court, Richmond Road, Kingston, Surrey.**

Another mode which is becoming more popular is television. Now basically there are two sorts of television; one that's very much like the broadcasters use and another one which was invented by amateurs themselves. Let's take a look at the first one.

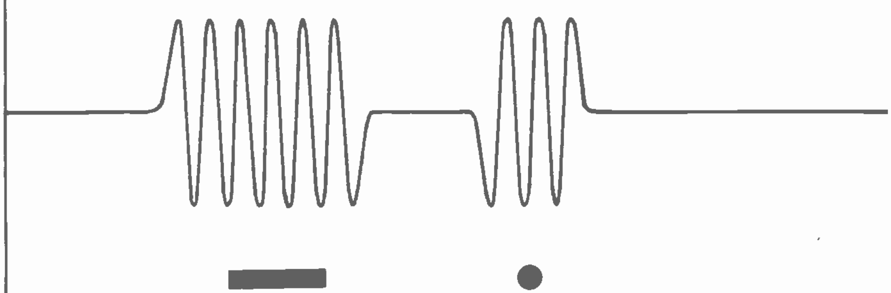
When we talked about "bandwidth" earlier, we said that speech generally occupies somewhere in the region of 3 kHz of bandwidth — in other words, a frequency range of about 300 to 3,000Hz, or cycles per second. Now the fundamental problem with broadcast-type TV is that, compared with ordinary speech-type transmission, it absolutely eats bandwidth; for broadcast video, you're looking at a bandwidth of zero to about 5.5 MHz. This is why TV has to be broadcast on VHF and UHF, where there's sufficient space for it — the entire medium wave is only about 1 MHz wide, and in terms of the amateur HF bands broadcast-type TV is an absolute non-starter. No amateur band below 432 MHz is anything like 5.5 MHz wide, so you couldn't fit even *one* television channel into it!

However, on frequencies in the UHF range — in amateur terms, the 70 cm and 23 cm bands — there is sufficient room for this type of TV (which is usually known as fast-scan to distinguish it from slow scan which we'll get to in a minute) and indeed there's a fair amount of it about. You can transmit TV that's every bit as good quality as the Beeb's — even in colour!

However, as we know, VHF and UHF won't get you round the world, and unfortunately, fast-scan TV and the HF bands, which will get you round the world, just aren't compatible. Amateurs are ingenious, however, and developed a way round this, which is known as slow-scan. Basically, the reason that broadcast TV swallows such an enormous bandwidth is that there's a lot of information in a TV picture which, to convey the illusion of motion, has to be "updated" 25 times a second.

If, however, you only update the picture once a minute, for instance, bingo! You can fit TV into the same bandwidth as speech. It wouldn't do for a torrid scene in Dallas or a car chase, but it's just fine for amateurs who want to send still pictures to each other. Imagine the ease of showing your contact the circuit diagram of the rig that's giving you a problem, for example, or a photo of the wife and kids. Like RTTY, TV is an ever-growing mode and more people get hooked every day; also like RTTY, there's a specialist group (the **British Amateur Television Club**, chairman **Mike Crampton, 16 Percival Road, Rugby, Warwickshire**) who have a good deal of information available to help the newcomer.

So — there are some of the modes that radio amateurs use. You'll find that there are many different ways of talking to people, and all sorts of other, experimental things like can play with such as data transmission, various pulsed transmission modes and something called "fax", which is short for "facsimile"; you can use this to send and receive such things as circuit diagrams, drawings and written words of one sort or another. All part of the radio amateur's wide world; the only problem is deciding which is for you!



morse (letter 'n')

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

(0 is sometimes sent as one long dah and 9 as dah dit)

Punctuation

Question mark	di-di-dah-dah-di-dit
Full stop	di-dah-di-dah-di-dah
Comma*	dah-dah-di-di-dah-dah

*Sometimes used to indicate exclamation mark.

Procedure signals

Stroke	dah-di-di-dah-dit	Wait (AS)	di-dah-di-di-dit
Break sign (=)	dah-di-di-di-dah	Preliminary call (CT)	dah-di-dah-di-dah
End of message (+ or AR)	di-dah-di-dah-dit	Error	di-di-di-di-di-di-di-dit
End of work (VA)	di-di-di-dah-di-dah	Invitation to transmit (K)	dah-di-dah

Note also procedure signal used by many amateur stations inviting a named station only to transmit: KN dah-di-dah-dah-dit.

One dah should be equal to three dits.
The space between parts of the same letter should be equal to one di (dit).
The space between two letters should be equal to three dits.
The space between two words shold be equal to from five to seven dits.

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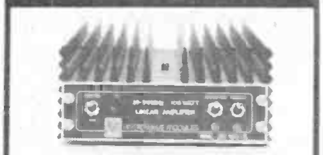
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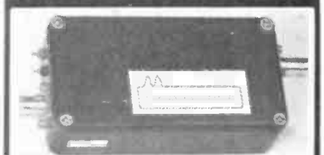
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MOBILES AND

Amateur radio isn't just talking from your converted front room or "shack". With a "mobile" rig the world is at your fingertips — but don't begin transmitting while parked by the petrol pumps!

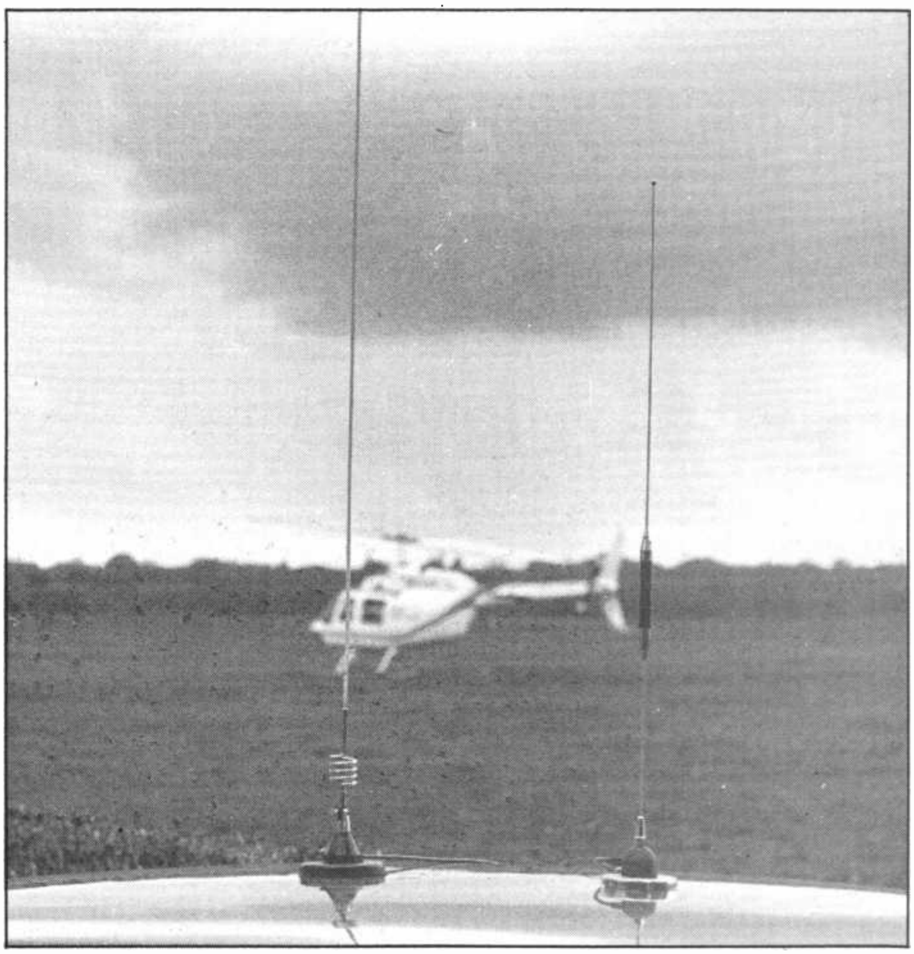
So far, we've concentrated on the basic elements of amateur radio, particularly in the area of the home station and how to get it going. It's time now to spread our wings a bit (well, sort of — amateurs can't use radio in aircraft, alas, in this country!) and look at what happens when you take your rig for a ride, so to speak.

Radio amateurs were allowed the privilege of operating mobile in the fifties, although you had to apply for a separate licence in those days and pay an extra 3/6 or whatever it was. Then as now you just used the normal callsign "Stroke M", so that if you were G6XYZ you became G6XYZ/M or, in conversation, "G6XYZ Mobile". Nowadays you don't need a separate licence for things like mobile operation (or, come to that, for television — you even had a different callsign for that once upon a time, for some obscure reason) and it's a very popular part of the hobby.

As always, you can split it for practical purposes into HF and the rest. HF antennas for mobile use are practically always verticals of one sort or another, using the car's structure as a rather imperfect earth. This type of antenna is inherently rather "narrow-band", which is another way of saying that you'll need to tune it up with some care to make it match your transmitter properly (see the chapter on antennas for why this is) and that you will probably have a rather restricted frequency range over which it can be used unless you have an ATU of some sort. However, results are often extremely good if you really want to talk to someone in Japan whilst driving through South London in the rush hour!

With the availability of small commercial rigs using transistors, the normal 12 volt battery supply of the car is quite usable for HF mobile work, provided that you bear a few things in mind. One is that if you're running the average 100 watt radio, your battery drain will be pretty high — it's probably not very wise to sit up on Dartmoor in some pleasant spot chatting to all and sundry only to find at home time that you've completely flattened the battery and you can't start the car . . . Another is that the average family passion wagon is, electrically speaking, rather noisy, and you'll find that suppression of all the various electrical services can be extremely difficult. It's probably a good idea to think about having a really good go at the entire car's electrics if you're seriously contemplating HF mobile operation, and if your pet machine doesn't have an alternator fitted as standard, or it was made before the alternator era, it might be a good plan to fit one. It'll help the battery, and alternators these days seem to make less row in the rig than generators do.

One other important thing about mobile operation, on the HF bands or on any other bands come to that, is DON'T transmit if you're sitting in a filling station and your passenger, say, is happily refuelling whilst you're yacking. To my knowledge there haven't been any accidents yet but one of these days there will be because it only takes a tiny spark, maybe as the antenna touches some overhead metalwork, and there's likely to be one hell of a bang. Likewise, if you happen to work in an oil refinery or something similar, it'd probably be a good idea to forget about amateur radio until you're well on your way home. In this technological world of ours there are all sorts of electronic whatsits that just might be sensitive to RF fields from a mobile antenna, and a bit of common sense might well go a long way towards stopping a potential problem. There was a case in America recently where some explosives in a quarry went bang for no obvious reason, and it turned out to be an amateur chatting to someone a few hundred feet away — worth keeping in the back of the brain cells, that one.



Two mobile antennas (or is it antennae?) which are magnetically mounted on a car roof. Note the loading coil in the centre of the antenna on the right.

Tie-clip mikes

One general point, before we pass on to other ways of going mobile, is that the ordinary hand-held microphone isn't a very good idea in a car, given that you have to steer, change gear, etc, as well as drive. Some people use small "tie-clip" microphones for mobile work, and others mount something on the structure of the car itself. There doesn't seem to be a universally used solution to this problem, however, and the man who invents one will probably make a small fortune!

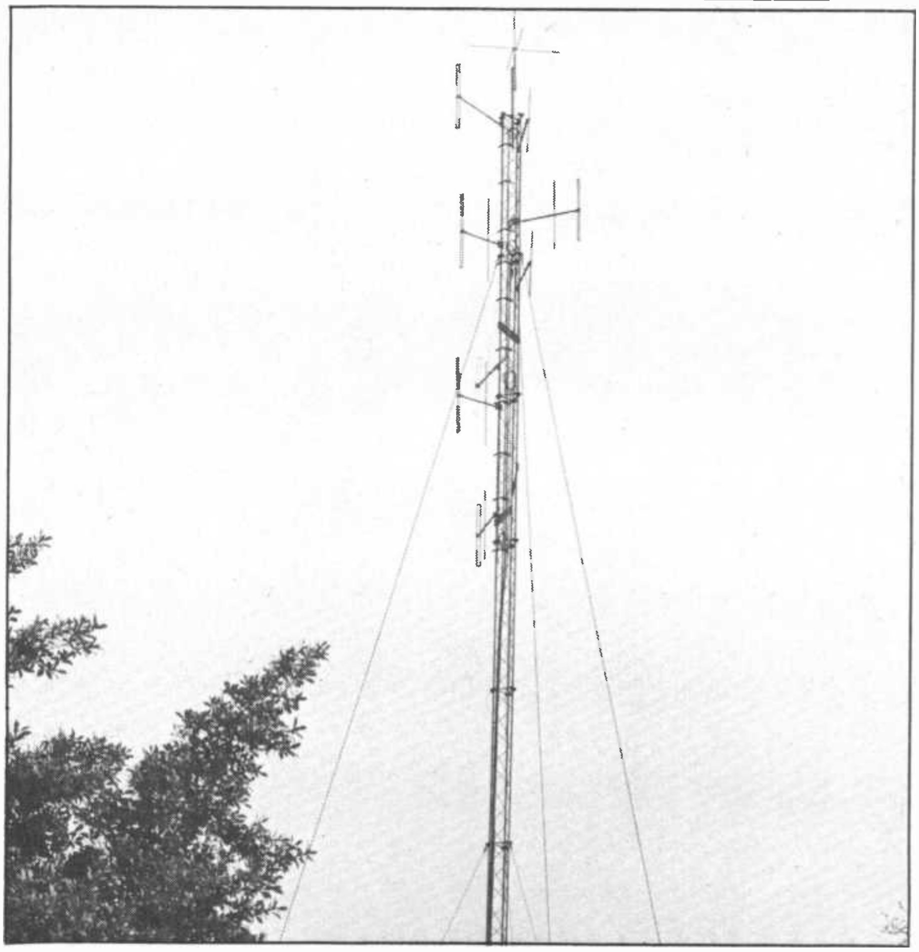
Anyway, that's a bit about HF operation. What is more popular, however, is operation on the VHF and UHF bands, and there are several reasons for this. One is that a lot of folk who use amateur radios in the car are happiest to have relatively short-range contacts, and they can often get information about traffic conditions and so on. Another is that antennas for VHF and UHF mobile work are a lot less trouble than HF mobile ones, which are often conspicuous, not all that efficient and likely to fall foul of the nearest local railway bridge if you're not careful. VHF and UHF mobile antennas are usually "whip" aerials of one sort or another, using the car body as a ground plane and often mounted by a whacking great magnet on to the car roof — this means that you can take them off when you've finished for the day.

However, the range of VHF and UHF under ordinary circumstances of mobile use isn't exactly huge, and it's very variable depending on where you are. Obviously if you're way up in the Welsh hills you'll be able to work for miles and miles, but round London you'll be very lucky to be able to work more than a mile or so. At least, this was the position until relatively recently, when along came something called a *repeater*.

The basic concept of a repeater is quite simple. As we've seen, if you're trying to talk to your mate in his car from your firm's van,

REPEATERS

Repeater stations have increased your range and made it possible to speak to people otherwise out of reach. This is how they work — they're meant mainly for mobiles and hand-helds but they can also be used by base stations.



A typical repeater antenna.

you're not going to manage very much in terms of range; in London, a mile or two would be good going. However, let's suppose that instead of chatting to each other on the same frequency, you decide to use your local friendly repeater. Your local friendly repeater consists of a receiver, a transmitter and one or two antennas, the whole shooting-match connected together and placed in the highest possible local spot. It works something like this.

You transmit on one frequency. The repeater's receiver copies your signal very nicely because it's nice and high up, and it supplies your received signal to the repeater's transmitter. This transmits on a slightly different frequency from that you're transmitting (and it's receiving), and your mate picks up the signal from it — it's nice and strong, of course, because it's nice and high, unlike you who are stuck in the Euston Road or wherever. Bingo — your range extends more or less to that of the repeater, which is going to be good because it's high up.

That's more or less what a repeater does — the idea came from the professionals and was adapted by amateurs for their own purposes. There are various other things we'll need to know about them, but that's the basic idea.

You might think that one snag in this idea would be that any signal that happened to be on the frequency would get repeated, even if the user didn't require it. Repeaters in the UK require a short burst of audio tone at the beginning of the transmission in order to switch on the repeater transmitter; this is known as the *toneburst*. Once this has been done, other stations don't have to have a toneburst because the repeater stays on until the last signals have been transmitted through it; it then closes down until someone brings it up again.

All repeaters are allocated a call sign, which is sent in automatically generated Morse every now and then. Repeaters in the UK have a callsign format GB3--, where the last two letters may give some idea of the location. GB3WL is in West London, for instance, and GB3UB is the University of Bath.

Let's take a look at how to find your local repeater. The vast majority are on the 144 and 432 MHz band, although some proposals have been put forward for repeaters on the 1.3 GHz band and indeed one or two are actually operational. On 144 MHz, the input frequencies for repeaters are spaced at intervals of 25 KHz starting at 145.000 MHz — this is Channel R0, and its corresponding output is on 145.600 MHz. Channel R1 has an input frequency of 145.025 MHz, with an output of 145.625 MHz — and so on up to Channel R7, which is 145.175 / 145.775 MHz. In other words, there are eight repeater channels in the 144 MHz band, and you talk to them on a frequency 600 kHz lower than your signal comes out of them. On the 432 MHz band it's the same sort of deal; the channels are again 25 kHz apart, although there is 1.6 MHz between the input and the output as opposed to 600 kHz in the VHF system. There are 15 channels, beginning at RB0 and going up to RB14. RB0 has its input at 433.000 MHz and its output on 434.6 MHz, for example, and the next one up would be RB1 on 433.025 / 434.625. So that if you're wondering whether there's a UHF repeater you can use, you can look at the list and say to yourself "ah yes, there's GB3LW on channel RB6"

Dial it up

Now all these megahertz and channels may be a bit hard to swallow, and you might be wondering "well, how the hell do I tune my transmitter to 433.150 MHz and my receiver to — er — what was it? — RB6 erm — that's 433.15 plus 1.6 — er — 434.750 MHz?" Well, you can relax quite a lot, because the vast majority of modern mobile-type rigs make life very easy for you: actually, if you asked the average amateur mobile operator what the input frequency of RB11 was, he'd probably have to think quite hard and work it out as well! Which isn't a reflection on him. Almost all current radios for mobile use incorporate a frequency synthesiser, which is quite happy to generate any frequency it's told to at any offset between transmit and receive. Also, many of them don't carry frequency indications as such but give a readout in channel numbers — so that if, for instance, your local repeater is on channel RB14, you simply dial it up and the rig does the rest. The same is true,incidentally, for what is called "simplex" working, which is when you and your friend are talking on the same frequency; on VHF and UHF, there are so-called "simplex channels" which are, again, 25 kHz apart. On 144 MHz they run from S11 on 145.275 MHz to S23 on 145.575 MHz, and on 432 MHz they go from SU15 on 433.375 MHz to SU20 on 433.500.

Repeaters work on FM only, and the simplex channels I've just mentioned apply only to FM; this is agreed as part of something called the *bandplan,* which isn't part of the licence but which has been evolved as a rational way of using the VHF and UHF bands. You'll pick up the details as you go along, but certainly for mobile work you'll need to know what you can expect to find and where. Your popularity rating will decline about as fast as solar activity is declining at the moment if you insist on having a simplex QSO with your mate on the repeater's output frequency, for instance.

The repeater network in this country is extensive, both on VHF and UHF, and there aren't all that many places where you can't get into some repeater or other. Indeed, on UHF at least, the repeater network has grown rather more quickly than the users, and you can almost always chat away for quite some time before anyone else comes on. It's always a good idea when using a repeater, by the way, to leave a pause between the end of your mate's transmission and you pressing the button; most repeaters

MOBILES AND REPEATERS

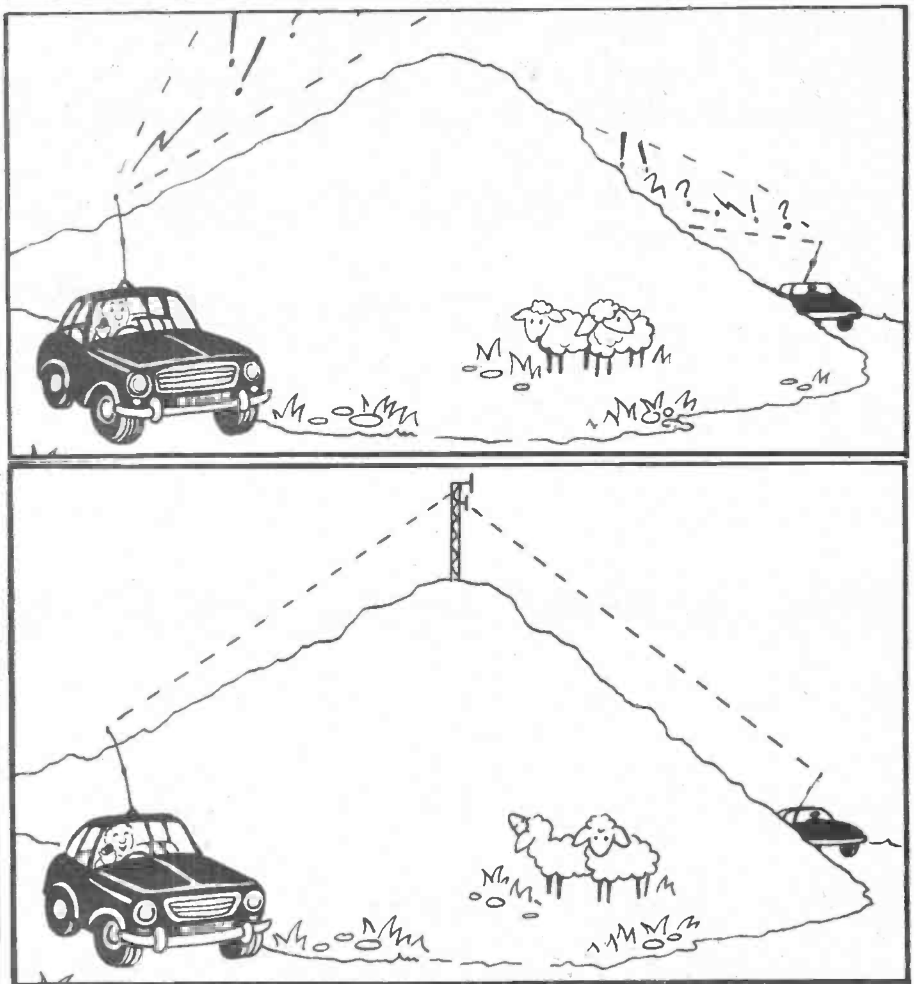
send a "K" in Morse between overs (K is the Morse signal for "go ahead" and that's why repeaters use it) and you should always pause between the K and starting you own over. This is so that someone else can call in if he needs to, either if he just wants to join the conversation or if there's a problem of some sort.

Which brings us to another point. Obviously there are times when someone needs to use the repeater urgently — say, for instance, he's come across a road accident. If this happens, SHUT UP unless you can help. I know we're amatuers but in this sort of situation it's necessary to forget that and be professional in your operating. Unless you're the only other person on the repeater, or you're sure you can contribute to the situation, for goodness sake *don't* do anything other than keep your trap shut and listen to see if you can do something. Emergency situations are another of those areas where the credibility of the amateur service is at stake, quite apart from people's lives, so if in doubt belt up. Conversely, if you're the man who has to do the job, take the details and talk to whoever it is — police, ambulance, whatever. There is an organisation called RAYNET, which is the Radio Amateur's Emergency Network, and it'd certainly be a good thing to join them if you feel you'd like to get involved in this area of amateur radio; contact the RSGB and they'll put you in touch with the appropriate man in your area.

One at a time

The repeater network is meant for mobiles and portable stations with hand-helds. It isn't meant for fixed stations, for obvious reasons, but you occasionally get a group of them sitting on the repeater for hours and hours when they could perfectly well work each other simplex — God knows why they do it, but most of them seem to be the older amateurs who haven't sussed out exactly what repeaters are meant for. If you're a fixed station, it's best to forget about repeaters unless you yourself want to work your friend who's mobile or wandering around with a little hand-held. You'll find that the best operators always listen on the repeater's input channel when they've got in contact with whoever it is they want to talk to, and if they can hear each other simplex they'll zoom off without more ado. It's a very good habit to get into, and most rigs can listen on the repeater's input at the flick of a switch — so if you're just getting started in the world of mobiles and repeaters, do try and cultivate that little flick of the switch. Only one mobile at a time can use the repeater, remember, and if it's not necessary for you to use it (i.e. if you can hear whoever you want to on simplex) then leave the machine for the man that can't hear his mate without it.

Very unfortunately, just to finish the topic of repeaters, it's in this area that amateur radio has its equivalent of CB's "wallies". Some repeaters suffer from jamming of one sort or another, both from the odd amateur who is violently anti-repeater for some reason or another but more usually from the twerps who get their kicks from interfering with other people's pleasure. Whatever the psychoanalytical realities of the situation, the best thing to do if you run into this problem is keep your cool and ignore them completely. Most of the culprits are known to the authorities, but a combination of the fact that the Wireless Telegraphy Act isn't exactly helpfully worded when it comes to prosecution, and also the fact that the Post Office apparently don't have enough staff to deal with the problems, makes it a problem that amateurs have been living with for some time. The obvious solution would be to take the repeater off the air, but the trouble with that idea is that it gives the anti-repeater brigade exactly what they want without any of the usual democratic processes — not the best way to live in 1982! Hopefully the legislation will be changed soon, so that the menace can be removed. In the meantime, the best advice is to ignore it all and on no account enter into a conversation with some twit making provocative remarks, etc — quite apart from the fact that you're encouraging him in his idiocy, it's against the terms of your licence to talk to anyone other than a proper licenced amateur on the air.



With and without a repeater station. Top: Radio waves don't pass through hills and mountains too well. Above: Now, with a repeater, life gets a lot easier . . .

So — that's a quick look at the mobile aspect of amateur radio. Actually, there's nothing quite like it for making a boring journey on the motorway pass by at high speed. I drove from London to Yorkshire last year with a little mobile rig in the car; I was chatting to various people practically all the way up the M1, using various repeaters, and as well as passing the time of day and learning about any tiresome traffic situations I spoke to an old friend I hadn't seen for years, arranged to buy just the transformer I needed for a big linear I had in mind at the time and got directions almost to the door of where I was going. I was almost sorry to end that journey, which is in strong contrast to how I usually feel about driving on motorways! Great stuff, this radio . . . .

BOUNCING SIGNALS OFF THE MOON

. . .or off the trails left by meteor showers, an aurora, satellites, the troposphere, and so on. Long distance conversations find many ways of getting from A to B.

We've seen elsewhere in this literary masterpiece how radio waves do their stuff and get from place to place — well, how they usually do anyway. In this section we'll take a look at some of the more esoteric ways you can get your signals from Point A to Point B: there are quite a few of them and they'll be an interesting contrast these with the more usual modes.

A lot of them involve the VHF and UHF bands, and this is where the action is these days as far as many amateurs are concerned. As we've seen, VHF and UHF signals tend to behave in the same way as light does: they're good for what could broadly be called "line-of-sight" and a bit more. Or at least that's what the professionals will tell you in the textbooks. When you get a good "opening" or "lift" on 144 MHz and the band is full of German stations, you could be forgiven for thinking that maybe they didn't quite explain how *that* worked . . .

"That" is known as "tropo" which is short, for "tropospheric". The troposphere is a section of the earth's atmosphere, and just occasionally you get certain kinds of weather that cause what pilots and meteorologists call an *inversion*. When this happens, VHF and UHF waves, instead of shooting out from the earth in straight lines and never being seen or heard again, become *refracted* and get returned to earth, usually a fair distance away. What you usually find in a VHF opening is that you can hear stations from certain areas extemely well even though they may be five or six hundred kilometres away. A good tropo opening happens several times a year, although an enhancement of normal VHF conditions in some direction or other is quite common: you'll usually find that it's related to weather, and the best VHF DX chasers are usually pretty good at meteorology as well!

Another interesting VHF propagation mode is known as "Sporadic E". This is quite wierd, and happens at fixed times of the year: the sporadic E season usually starts in May or June and goes on till about mid-August. You remember that we talked about the E layer in the propagation section? Well, under normal circumstances there's no way that this layer will reflect signals at frequencies as high as 144 MHz, so that the Elayer isn't normally of any interest at all to the VHF man. However, for reasons which we still don't really understand, intense ionisation from the sun makes parts of the E layer able to reflect 144 MHz signals almost perfectly. What happens is that you can be in the middle of chatting with your mate on the other side of town and he suddenly gets blotted out by an incredibly strong station in Hungary or Italy: somewhere, in other words, within single-hop E-layer range such as you get every day on the HF bands. Sporadic E happens fast and disappears just as fast, so you'll need to be a smart operator to make it work for you — one good plan during the season is to listen on the VHF FM broadcast band to see whether there are strong signals from the Continent filling it from one end to the other. By itself this doesn't mean that Sporadic E will happen on 144 MHz because the broadcast band is a fair way below it in terms of frequency: however, if there is any Sporadic E in Band 2 (88-108 MHz) it's certainly worth firing up the 144 MHz rig and listening for signals. Last year, a station in Israel was worked from Southern England on 144 MHz Sporadic E, so great things can happen.

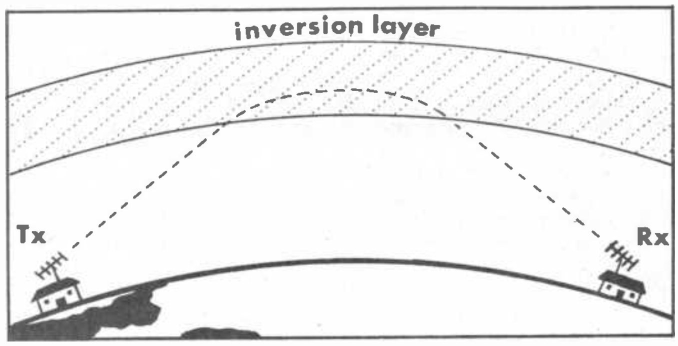
You'll find that a quick exchange of callsigns, signal reports and QTH locator is all there's time for: *don't* tell the man in Budapest the story of your life or whatever since the openings are brief and unpredictable and everyone wants a look-in. Also, you don't need high power except to be first in the pile-up; the first time you hear a Sporadic E signal you'll think that it's some sort of joke because the signals are so strong. It isn't — grab it quickly before the ionised layers go away as quickly as they came.

Another odd mode of propagation at VHF is *aurora*. The way in which radio auroras form is exceedingly complex and still not fully understood but it's connected with major events on the sun hurling out charged particles which interact with the earth's magnetic field to produce a sort of reflecting curtain. Visually this is the Aurora Borealis, or Northern Lights, but a visual aurora doesn't always imply a radio aurora and sometimes you get an auroral opening without being able to see anything. The auroral "curtain" itself forms in high latitudes, and it's often the stations in Scotland and the north of England that get the best openings: the idea is to beam somewhere in a northerly direction and listen. It can be very eerie, actually: because of the way the curtain is formed and signals reflect from it, the normal phase relationships in speech get completely messed around and you'll hear a station sounding as though he's whispering in a very hoarse voice. Morse signals, which work much better than SSB during aurora, stop being the usual keyed tone and turn into what sounds like someone rubbing on sandpaper. The whole effect is decidely peculiar, and I well remember the first auroral opening I ever heard — it was late at night and I was wearing headphones, and the sound of all these signals whispering in the receiver nearly freaked me!

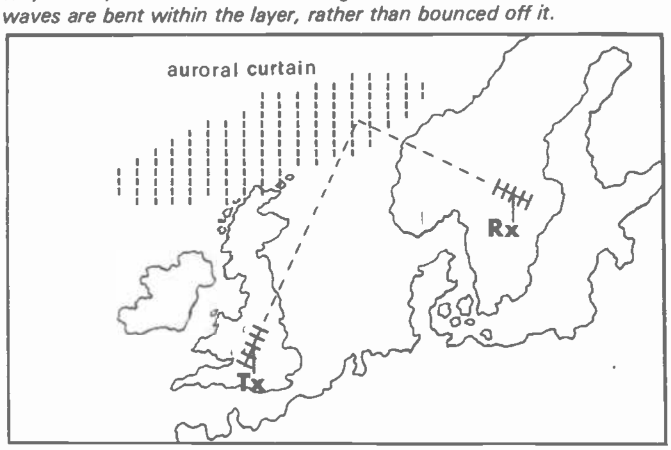
The stations you'll hear during an auroral opening vary according to how widespread it is: for the average station in the south of England it'll be Scots and Northern Irish amateurs, together with perhaps Swedish and Danish stations, that you're most likely to hear. If it's a very good opening there'll be stations from all over the shop. You'll have to point your antenna in all sorts of unlikely directions to get the best signals, but from the point of view of DX a good aurora is quite an experience.

Some auroral contacts have been made at 432 MHz but not very many. Also, the effect works extremely well on the 70 MHz band, although unfortunately there aren't all that many stations to work since that band is confined to the UK and one or two other places only. 70 MHz, by the way, is also fun during a Sporadic E opening, and you can work stations in Gibraltar — which has a 70 MHz band — with ease.

As we've said, CW is a very much better bet than SSB in an



Much closer to the earth than the D, E, F layers, the inversion layer will, in fact, refract VHF and UHF signals back to earth. Here, the waves are bent within the layer, rather than bounced off it.



Where an auroral curtain forms, and how waves will bounce off it.

auroral opening because for SSB to work at all you have to speak slowly and clearly; if there are more than one or two stations calling someone, life gets almost impossible. FM is practically a non-starter for serious auroral work; aurora is very much for the man who can work SSB and CW. Generally speaking, high power is handy to have around during auroras, although I know two people who have had auroral contacts whilst running low-power mobile!

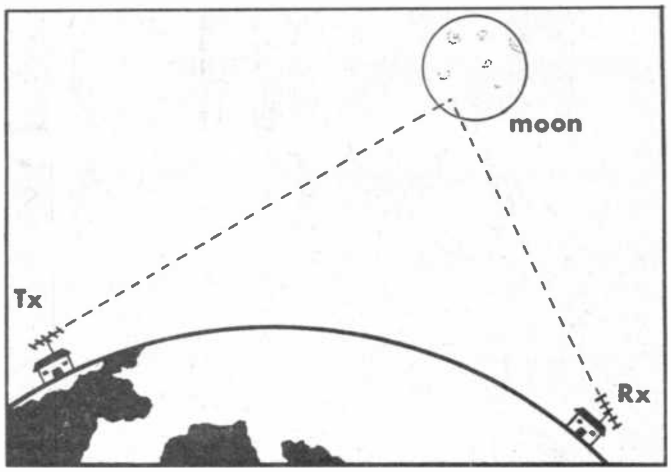
There's no set season for aurora, although autumn is usually a good time for the best ones. Because it's a solar-related phenomenon, you can often reckon that there'll be another aurora 28 days after the first one although it's usually weaker. In an auroral event, you'll often find that it has two "phases" with a break of an hour or so in between. Murphy's Law says that the second phase of an aurora will start about midnight just after you've worked some good DX, decided it's time to go to bed and turned everything off: Murphy's Second Law states that the second phase will always produce four new countries that you needed, at enormous strength. And Murphy's Third Law dictates that your mate will ring you at work the day after, crowing about the great DX he worked whilst you were curled up in your duvet snoring . . .

Ah well — you can always get your own back by trying some meteor scatter! This is another VHF technique that's becoming very popular these days, but it requires some fairly sophisticated techniques and very good operating discipline. Basically, meteors which enter the earth's atmosphere burn up and leave ionised trails behind them — it's possible to bounce VHF signals off these and to achieve pretty enormous ranges. You can either do it with high-speed Morse or, though it's more difficult and you're liable to shout yourself hoarse, with SSB. A lot of meteor-scatter work is arranged before-hand with a station you want to work, and you agree on frequencies and times and stick to them. There's a good chapter on MS operation in the *Amateur Radio Operating Manual* and it's a very good idea to wise up on it before having a go, because otherwise you can ruin other people's arrangements with consummate ease.

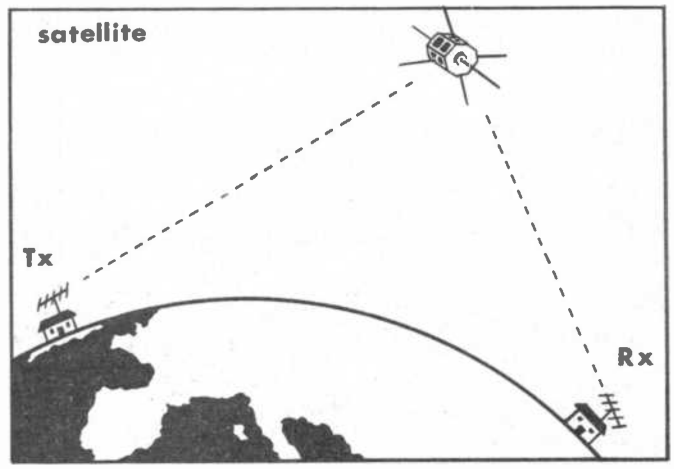
There are known times when there are "meteor showers", which offer the best chances of success — these are known by such names as the Quadrantids, Perseids, etc, which are the parts of the sky that the meteor shower appears to come from. You can arrange "skeds" with stations in particular areas you want to work beforehand, and there's a regular "net", or group of interested parties, that meet on 14.340 MHz or thereabouts to discuss such matters. Alternatively, there is a certain amount of "random MS", complete with its own calling frequency and so on, and this is well worth a listen at the appropriate times. Please, please, *don't* be tempted to have a go without boning up on the procedures, though, because MS is a pretty subtle business and the techniques are fairly complicated; your need to go about it in the right way. For real success, you'll need stacks of power, a good antenna system and something rather better than the usual commercial receiver in terms of sensitivity: you'll also need some way of generating and decoding high-speed Morse. However, it's not half as daunting as it sounds, and well worth a try — provided, that is, you know the form.

Getting even more esoteric, you can operate through one of the amateur satellites. Satellite operation is a big area, and there simply isn't the space to go into the nuts and bolts of it here: the basic idea is that you transmit to the satellite on one band (the "uplink") and receive on another (the "downlink"). At present, there are no less than three Russian satellites, as well as two of our own, available to radio amateurs, and there's an organisation known as AMSAT which looks after everything pertaining to the satellite operator's world. The British branch of this outfit is very efficiently run by Ron Broadbent, G3AAJ, and a stamped and addressed envelope to him at AMSAT-UK, London E12 5EQ will bring vast amounts of data about amateur satellites and how to use them. There are also regular nets for those interested in satellites; they're run by AMSAT-UK on 3.78 MHz at 10.15am on Sundays and 7pm every day of the week. Some news is also given on the RSGB news bulletin service under the callsign GB2RS on a Sunday morning, although the AMSAT nets are a better bet for all the facts and figures. They're always pleased to hear from newcomers, and they have some pretty clever ideas for extending the satellite service in the years to come.

Probably the most advanced and difficult VHF propagation technique is that known as *moonbounce*, or EME (which stands for Earth-Moon-Earth). Believe it or not, this is just what it says it is — it's a matter of launching your signals on VHF or, come to that, any frequency higher than 144 MHz, and relying on reflection from the Moon to bounce them back to practically any spot you like on earth. Put like that it doesn't sound too difficult, but the problems are formidable. For one thing, the "path loss", or the amount of power and antenna gain you



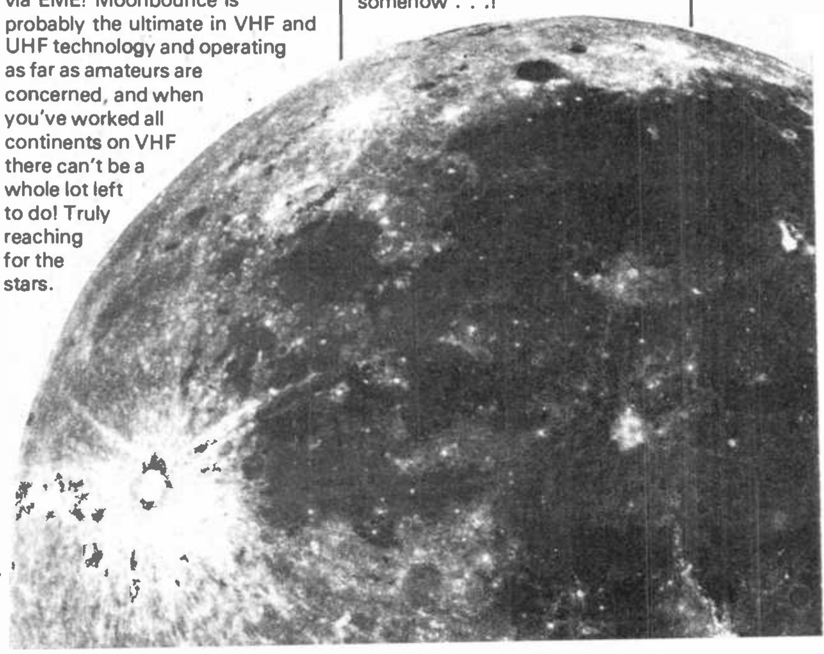
Bouncing signals off the moon is a glamorous possibility, but you'll need stacks of power, and Jodrell Bank in the garden shed. . .



If you're a flat earth fan, you won't believe in the necessity for satellites!

need to have any chance at all, is very high in terms of the normal-type amateur station — certainly on 144 MHz you'll need the full legal limit plus a pretty good antenna system. Even with that, the signals you'll receive won't exactly be rock-crushing; the Moon is a pretty dismal reflector of radio signals, and you'll need a very senisitive and stable receiver in order to stand any chance at all. Mind you, there is an award known as Worked All Continents, which HF operators usually go for; some people have achieved this on 144, 432 and 1296 MHZ via EME! Moonbounce is probably the ultimate in VHF and UHF technology and operating as far as amateurs are concerned, and when you've worked all continents on VHF there can't be a whole lot left to do! Truly reaching for the stars.

So — those are a few of the exotic ways of speaking to like-minded folk on all sorts of unlikely frequencies. The beauty of all of them is that your success is purely in your hands; working the weak CW stations in a big aurora, or cracking the pile-up in a VHF tropo opening, isn't something you can learn from a book or buy, and I'll bet when you've done it you'll sit back with a warm glow on your face from ear to ear. Great stuff. Now, I'll just pop out to the garden: there must be a way I can get that 40 foot dish antenna up and running somehow . . .!



KEEP AHEAD WITH THE NEW FT-102!

Once again YAESU lead the field with the exciting new FT-102 HF transceiver– no other manufacturer offers so many innovative features.

Better Dynamic Range
The extra high-level receiver front end uses 24 VDC for both RF amplifier and mixer circuits, allowing an extremely wide dynamic range for solid copy of the weak signals even in the weekend crowds. For ultra clear quality on strong signals or noisy bands the high voltage JFET RF amplifier can be simply bypassed via a front panel switch, boosting dynamic range beyond 100dB. A PLL system using six narrow band VCOs provides exceptionally clean local signals on all bands for both transmit and receive.

Total IF Flexibility
An extremely versatile IF Shift/Width system, using friction-linked concentric controls and a totally unique circuit design, gives the operator an infinite choice of bandwidths between 2.7kHz and 500Hz, which can then be tuned across the signal to the portion that provides the best copy sans QRM, even in a crowded band. A wide variety of crystal filters for fixed IF bandwidths are also available as options for both parallel and cascaded configurations. But that's not all; the 455kHz third IF also allows an extremely effective IF notch tunable across the selected passband to remove interfering carriers, while an independent audio peak filter can also be activated for single-signal CW reception.

New Noise Blanker
The new noise blanker design in the FT-102 enables front panel control of the blanking pulse width, substantially increasing the number of types of noise interference that can be blanked, and vastly improving the utility of the noise blanker for all types of operation.

Commercial Quality Transmitter
The FT-102 represents significant strides in the advancement of amateur transmitter signal quality, introducing to amateur radio design concepts that have previously been restricted to top-of-the-line commercial transmitters; far above and beyond government standards in both freedom from distortion and purity of emissions.

Transmitter Audio Tailoring
The microphone amplifier circuit incorporates a tunable audio network which can be adjusted by the operator to tailor the transmitter response to his individual voice characteristics before the signal is applied to the superb internal RF speech processor.

IF Transmit Monitor
An extra product detector allows audio monitoring of the transmitter IF signal, which, along with the dual meters on the front panel, enables precise setting of the speech processor and transmit audio so that the operator knows exactly what signal is being put on the air in all modes. A new "peak hold" system is incorporated into the ALC metering circuit to further take the guesswork out of transmitter adjustment.

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The propagation explanation

Here, we condense about 20,000 words into two pages. Propagation is as difficult and complicated as you want it to be — but briefly it is how a radio wave travels from one point to another, something like dropping a pebble into a pond and watching the ripples move outwards. But that's only the beginning, as you'll find out. . .

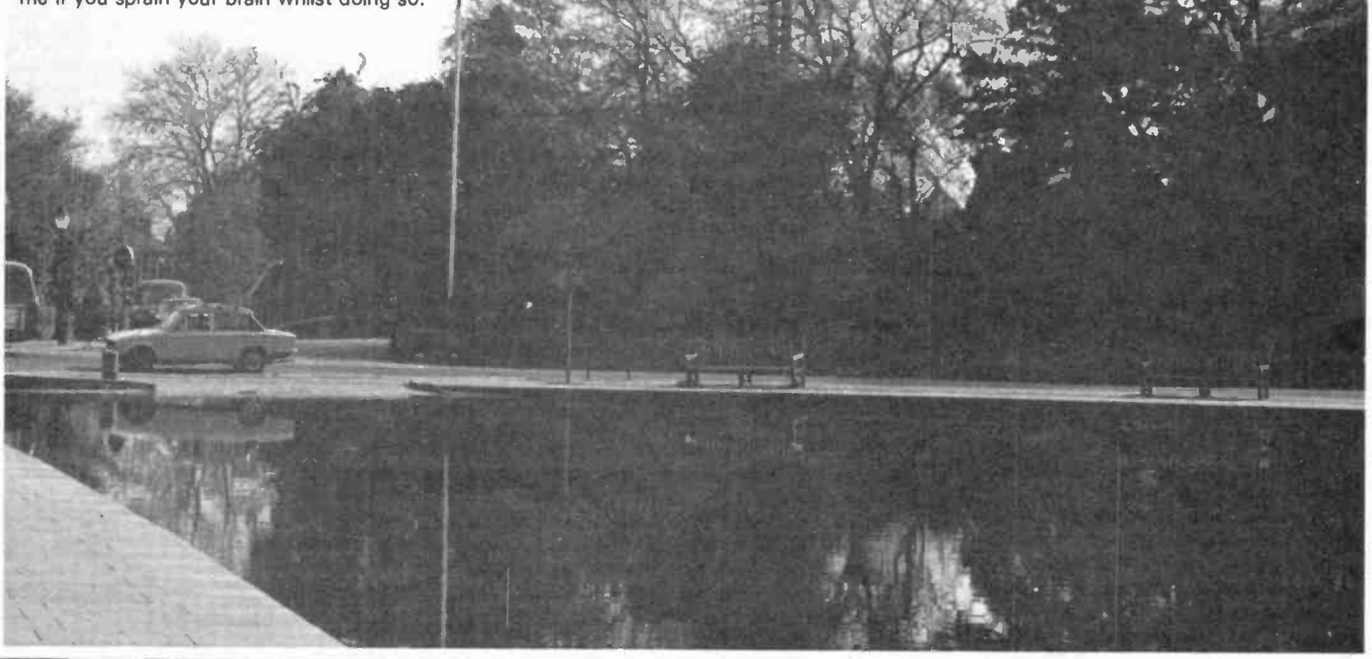
No, Brian, it's *not* about how to cultivate your roses or even how to increase your family. Propagation is the science of how a radio wave gets from one spot on Earth to the other, or from one side of Birmingham to the other. Actually some would call it black art, not science!

The trouble with propagation as far as radio waves are concerned is that it's actually horribly complicated, difficult and, in some cases, even the clever folk can't explain everything about it. If you read the average book about radio wave propagation, you'll quite probably end up with a stinking headache after 10 minutes or so because it'll go off into all kinds of horrible things like the impedance of free space or something — *not* the kind of thing you'd talk about at the vicarage tea party.

What we'll do in this bit of the magazine is to take a look at how radio waves do their thing in a very simple way; you'll find that the Radio Amateur's Examination requires you to know only the simple stuff, and it's just as well too . . . if you want to know propagation in detail you'll have to read one of the books, such as the *Radio Communication Handbook,* and don't blame me if you sprain your brain whilst doing so.

Ever since radio began, there have been many attempts to explain how radio signals found their way from the transmitting antenna to the bit of wire in the back of your wireless; some of them are more convincing than others. But let's start at the very beginning — if you have a local pond or lake of some kind, go down to it on a calm day and drop a brick into it. You will find that ripples spread out from the centre of where you dropped it, and they'll keep spreading until they reach the side of the pond (if it isn't Loch Ness and you used a reasonably large brick, that is). You could say that the waves you created when you dropped the brick *propagated* through the water and finally reached the shore.

Right. Well, radio waves basically propagate in something like the same way through the atmosphere, although the parallel isn't all that good because radio waves propagate quite happily in a vacuum. In the early days, it was thought that there



was an invisible medium (corresponding to the water in our example) through which radio waves could travel — it was known as the "ether". According to Science, it ain't so and they'll give you all sorts of mind-bending definitions of what a radio wave does propagate through and why; well, you can quietly forget all that for the moment.

It's quite handy to pretend that the old idea of the ether is true because for a simple explanation of propagation it's as handy as any and it won't lead us into 34 pages of formulae every time you make a simple statement.

Okay then. Radio waves generated by the transmitter, and radiated by the antenna, ripple their way along like the ripples in the lake. And, although in the case of our lake, there was only one sort of ripple, for the purposes of radio we can say that there are two sorts. They're called the **ground wave** and the **sky wave** and they're both radio waves, but we need to keep them in mind because of how they propagate. The ground wave is actually made up of three different components but don't worry about that at the moment; the thing to remember is that the ground wave is basically any wave that hasn't been reflected from anywhere else before it arrives at the receiver antenna — the "anywhere else" means things like reflecting layers above the earth (the dreaded **ionosphere**) or whatever.

Clutter things up

Now it's obvious that if you're trying to talk to your friend in North London from your house in South London, the ground wave in some form or another is going to be the thing that'll do the trick for you. This will be true for practically any of the amateur HF bands, which, if you remember, are those between 1.8 and 28MHz. In fact, the ground wave (or, to be exact, that bit of it called the surface wave, but having read that I suggest you forget it straight away — it'll only clutter things up) gets less strong the higher in frequency you go. On the lower-frequency amateur bands like 1.8 and 3.5MHz the ground wave tends to roll on for miles and miles, but on 28MHz it can be hard to get from one side of town to the other.

The usual propagation mode on 27MHz CB is ground wave, which is why the range is what it is — of the order of a few miles. It's interesting, by the way, to note that adding more power won't help all that much. People tend to think that if you double the power you use, for example, you'll double the distance you can work, but it isn't so.

If you grab hold of a short wave receiver and listen on the lower-frequency bands, what you'll hear in daylight will be what you might call local and semi-local stations — that's to say, on 1.8MHz it'll be those between about 50 and 100 miles away and a bit farther on 3.5MHz. The predominant mode of propagation of signals from their transmitter to your wireless will be ground wave, certainly in the case of 1.8MHz. On 3.5MHz however, you'd think that because the ground wave tends to get less strong with increasing frequency (see above) you'd hear stations from less far away than you would on 1.8MHz. But — we said earlier ". . . a bit farther". Why is this? (I warned you it got a bit complicated!)

Well, it's all down to the ionosphere. Ground wave propagation is one thing, but the vast majority of amateur signals aren't propagated on ground waves apart from on that lowest-frequency band of 1.8MHz in daylight. Obviously signals from Australia aren't propagated that way on 28MHz, for instance, because, as we've already seen, the ground wave on 28MHz probably won't get you from London to the Home Counties, let alone London to Wogga Wogga. So how's it done?

Remember we said earlier that the ripples from the transmitting antenna could be divided into the **ground wave** and the **sky wave**? Now the sky wave is the bit that interests us for long-range chats such as those between London and Australia, and in a minute we'll see how it works.

Previously, we mentioned a thing called the ionosphere, and most people have some idea of what it is. Basically, that big yellow ball of fire in the sky does some pretty clever things apart from giving us a nice tan in summer and forgetting to shine when we're thinking of lazing on the beach. The sun actually gives us a tan because it throws out vast amounts of ultra-violet radiation which our bodies try to protect themselves against by producing a pigment, melanin, which happens to be dark; well, on the way to increasing the sales of Ambre Solaire, that ultra-violet has had some pretty interesting effects on a region which sits between about 60 and 500 kilometres above the earth.

It has caused a process called **ionisation** to occur up there, and it means, briefly, that there's a layer around the earth which has the interesting property of being able to reflect radio signals and return them to whence they came.

Actually, there are three! If you were to jump in NASA's Space Shuttle and head vertically upwards, at a height of 60 or 70 kilometres you'd come to something called the **D-region**. Now unlike the two others this one is a region and not a layer, because its limits aren't so easy to define; it also doesn't do any reflecting at all but rather the reverse!

During the day the D-region is what stops medium wave transmitters being heard for more than a few tens of miles — it absorbs the sky wave from the antennas at, for instance, Radio 210 in Reading and makes it almost impossible to hear it in London. From the amateur's point of view it means that the only signals you'll hear on 1.8MHz in daylight will be ground wave ones. As we'll see in a moment, there are layers which could reflect 1.8MHz signals, but the D-region being the first the sky-wave signals get to, soaks them up before they get a chance to reflect off the next one up.

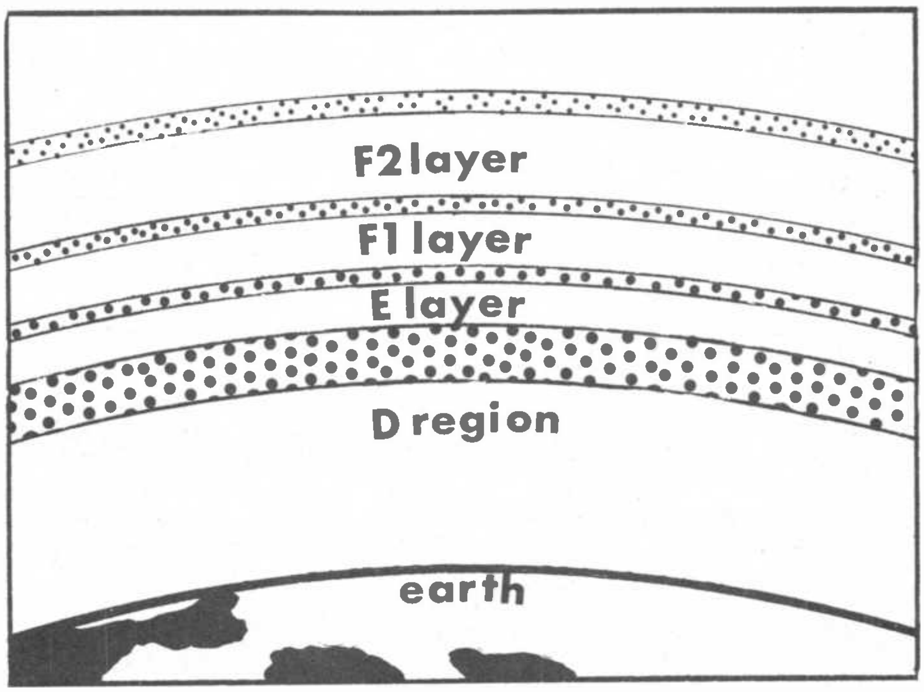
Without going into heavy formulae (whole books have been written on the D-region, so we can't do more than grasp the basic principles of it) the absorption effects vary with frequency in the same way that the ground wave does but the other way round. This is why you can hear 3.5MHz signals in daylight from rather greater distances than 1.8MHz ones; the ground wave is less strong at 3.5 MHz but attenuation from the D-region is less on the higher frequency so that waves can bounce off our next layer up, so to speak.

Whistles and grunts

This is the **E-layer**. It sits at about 120km above the earth and unlike the D-region, is our first true reflecting layer. Like the D-region, though, it's present during daylight hours only — both of them cease to exist at night because the sun isn't there to do its ionising bit, which is why medium wave radio after dark tends to have a dramatic increase in its range; there's no D-region to absorb it before it can get to a layer and, since the E-layer is slower to disappear than the D-region, medium wave (and, come to that, 1.8 and 3.5MHz amateur signals) come in much more strongly and from more faraway places after dark.

This is fine for amateurs but not so good for broadcasters — this little problem is why the medium wave is full of whistles and grunts from Albania and suchlike after the sun goes down.

The E-layer, like the D-region, has effects which vary with frequency. Its effects, like those of the other layers, also vary with other things, notably the sun's activity. Old Sol has, basically, an 11-year cycle between very active and very lazy, and this is called the **sunspot cycle**. There's also a 28-day cycle in there somewhere, which produces other effects and, once again, there are whole textbooks on this subject — in a nutshell, this is why radio conditions vary from week to week and year to year.



HF (High Frequency) signals can travel the world by bouncing off these layers. See the text for more details. VHF and microwave signals, however, won't. They'll pass straight through.

The propagation explanation

To give one example, we've just gone past the peak of the last solar cycle, and the sun has been doing its thing to a great degree. Basically, the higher the solar activity, the higher the frequency that will be reflected from the other layers (the F1 and F2 layers, which we'll get to in a tick and which do all the really long-distance stuff) and this is why 27MHz CB has been getting round the world for the last couple of years.

27MHz is a high frequency in terms of the HF bands, and it takes a lot of solar activity to support long-distance communication on it. So those folk who "skip-talk" to the States and wherever won't be able to do it in a few years' time because the sun will be somewhat on the decline on its 11-year cycle and 27MHz CB will be back to ground wave. The same is true of the 28MHz amateur band, by the way; right now you can work the world with a few watts and a length of wet string on 28MHz, but we'll back to nattering across town in a few years' time, alas.

Solar cycle

Anyway, back to the layers (it's getting to sound like a Neapolitan layer cake up there. . .). As we said, the other two are the F1 and F2 layers, at about 220 and 500km respectively, and largely because of their height and because they can last for nearly 24 hours, they're what support the really long-distance communications.

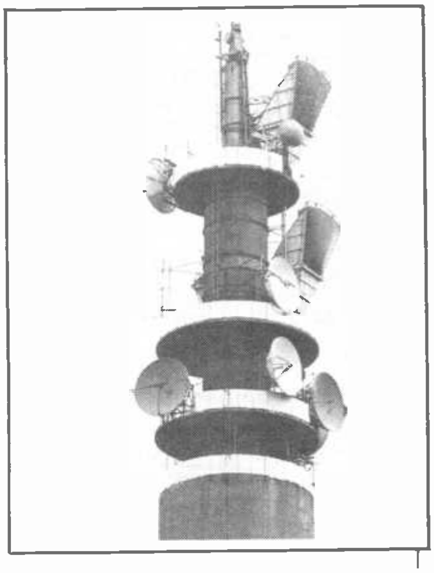
However, as we said above, it all depends on the point in the solar cycle we're at. Right now, the two high-frequency bands — 28 and 21MHz — are "open" for noticeably less time per day than they were at this time last year and it'll go on getting worse for the next few years.

That's a quick look at the layers of the ionosphere that make world-wide amateur radio possible, but we'd better have a glance at one or two other things. Fading, for instance. You'd think from what we've already said that a layer is just a layer and that it sits there quietly reflecting your signals — well, life's never that simple, is it? Actually, they are pretty turbulent places, and you'll find that if you're listening to a distant station on the higher frequency bands, there's a fair amount of fading and general noises on the signal. This is for several reasons.

One of them is the effect of the earth's magnetic field on the structure of the ionospheric layers; another of them is caused by the path length of the signal within the layer varying with frequency so that you get a kind of hollow "phasing" on the signal as the different radio frequencies that make up the signal get absorbed or reflected at different rates. Another type happens when you're hearing both the ground wave and the sky wave in your receiver; the layers tend to shift around a bit and the length of the path of the sky wave to and from the layer varies too. When this happens, you get alternate adding and subtracting of the sky wave to and from the ground wave, and the net result is severe fading.

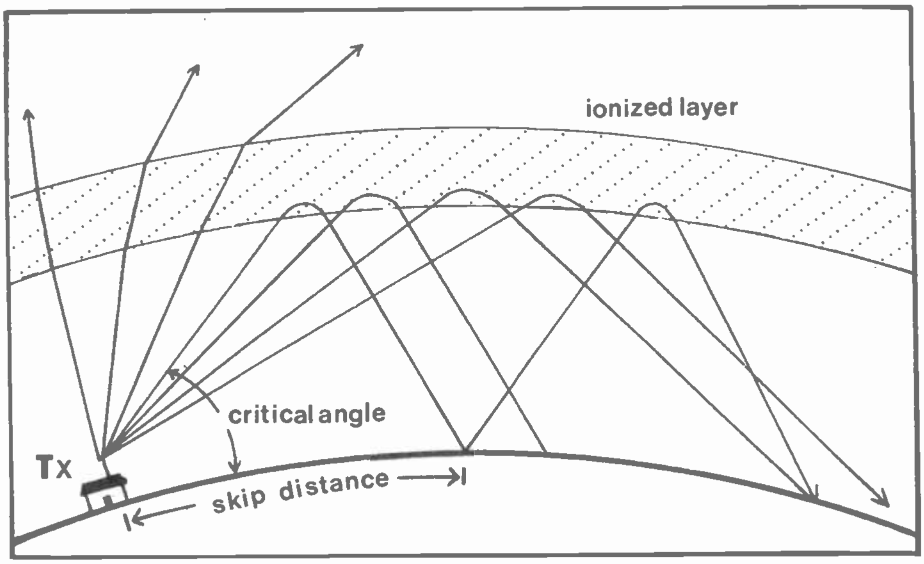
You sometimes hear an echo on a high-frequency signal. This is because it takes more than one "hop" (as the jump from earth to the ionosphere and back again is known) to travel the longest distances, and sometimes the wave will hop several times round the world so you hear first the signal from the man at the far end followed by an echo as the wave carries on over your head, so to speak, and comes back for a second go. You can also hear an echo if the signal gets to you by two different routes, which are usually known as **short-path** and **long-path** respectively.

However — life is already complicated enough, and the whole subject of propagation, although fascinating, gets exceedingly complicated if you go much further than the basics. The textbooks will go into all the delights of maximum usable frequencies, smoothed sunspot numbers and skip distances, and our little diagrams show some of the factors; if you decide to get to know more about it all, good luck to you!

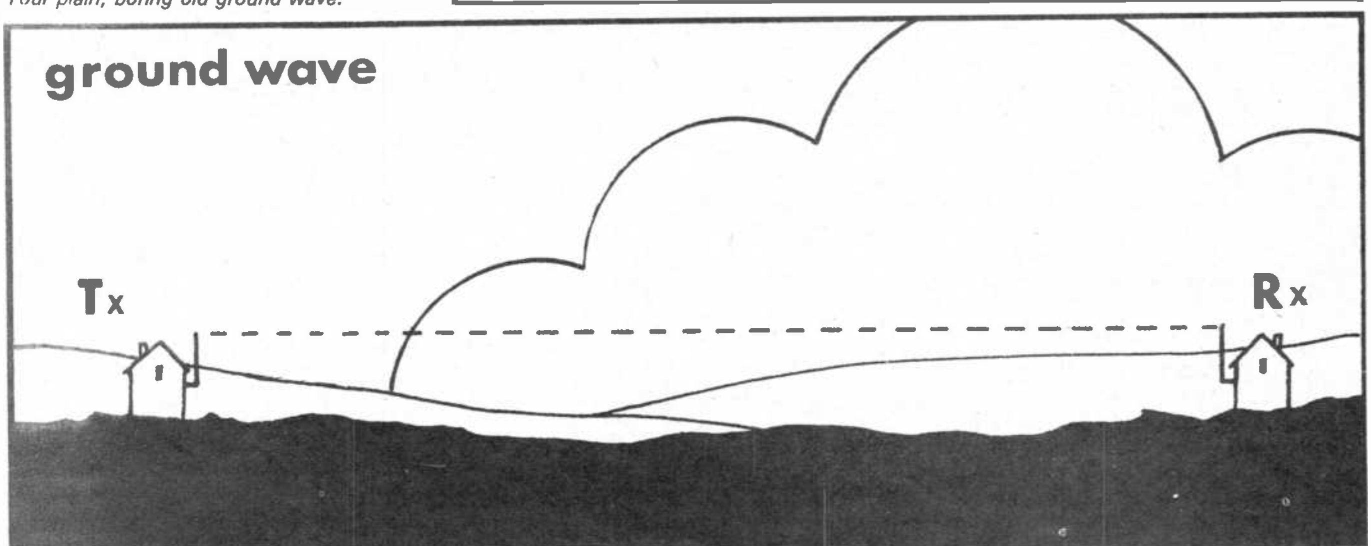


Above: It looms large and is imposing, the Stokenchurch antenna tower. But it's only a repeater for the London Post Office Tower, handling microwave trunk calls to and from the west of the country.

Below: What radio waves do when they reach an ionised reflecting layer. Receivers within the skip distance won't hear your signal, of course.



Your plain, boring old ground wave.



WHAT ABOUT THE FUTURE?

Five years ago the microprocessor was the bee's knees. Now it's as common as the proverbial. So how about the Gallium Arsenide Field-Effect Transistor then? And what would you do with one if it sat in your back garden? Here's what Amateur Radio thinks will happen in the future . . .

This bit of the book was being written with the aid of the solid-state turbocharged 3,300 horsepower crystal ball; most unfortunately the dilithium crystals deteriorated rather more rapidly than we thought they would and so it's back to old-fashioned guessing.

One thing about electronics is that it's incredibly difficult to predict what will be possible or commonplace in five or ten years. Five years ago the microprocessor was a gleam in the radio designer's eye, and nowadays you find them everywhere from amateur rigs to door chimes; the same is true of such exotic semi-conductor devices as the GaAsFET (standing for Gallium Arsenide Field-Effect Transistor) which you now find in VHF and UHF pre-amplifiers with any pretence to breeding. It's really almost impossible to predict advances in technology itself, since the pace of development is so very rapid: and the amateur tradition is to make use of new devices in ways which perhaps aren't the obvious ones. The GaAsFET, for instance, was really meant for very low-noise amplification of microwaves (frequencies above about 1000 MHz) but in the amateur world they seem to have established an niche for themselves at rather lower frequencies. Given the increasing commercialism of amateur radio, new devices seem to creep into amateur rigs quite quickly, and it's noticeable that manufacturers from Japan, at least, don't seem to keep one model in production for more than a couple of years. No doubt there are marketing reasons for this, but it's amazing that this year's wonder wireless will often be replaced later by one that's similar but has more features costing less.

You find, however, that the laws of physics don't change, and there are only so many ways of making an HF SSB transceiver; this being so, the improvements tend to be in the form of new bands, more memories for frequencies and more dials and levers rather than in drastic changes to the basic technology. This "technology trap" isn't unique to amateur radio, but amateur radio has it to a marked degree in the same way as hi-fi or consumer electronics in general do. Which is a good reason for buying a rig which does its stuff well from the radio point of view and resisting being seduced by fancy gadgets; you won't find you get gripped by the urge to trade up every couple of years, and you might just get on with amateur radio instead of falling into the hi-fi trap and fretting more about the specification of the amplifier than what sort of performance the musicians came up with.

As far as the future of amateur radio itself is concerned, the omens do look quite promising in some ways. One thing which comes to mind is that many radio amateurs are also interested in home computing and messing about with the microprocessor, and the two hobbies do have a lot to offer one another. Since computing involves that interesting bit of electronic science known as "digital" circuitry, it's probable that digital tansmission of data between your home computer and your mates, as well as actual digital modulation techniques of one sort or another, will become more common. The possibilities are enormous, and certainly one might expect to see amateur versions of techniques such as PCM (Pulse Code Modulation, which is what people like the Beeb use for high-quality links) around in a few years. The facilities for pulse transmission already exist in the amateur licence, and you can transmit various forms of data on frequencies as low as 144 MHz.

In the big wide world outside, one noticeable trend is that radio is tending to go higher in frequency as more satellites are launched and the requirement for HF systems of one sort or another get less. This being so, two things are happening in the amateur world. One is that as surplus equipment and technology become available, amateur interest in microwaves is on the up-and-up and there have already been some remarkable achievements in this sphere. The other is that extra bands become available in the HF

Home brew. Three keyboards, two screens and a lot more add up to a computer tied into an amateur radio station.

WHAT ABOUT THE FUTURE?

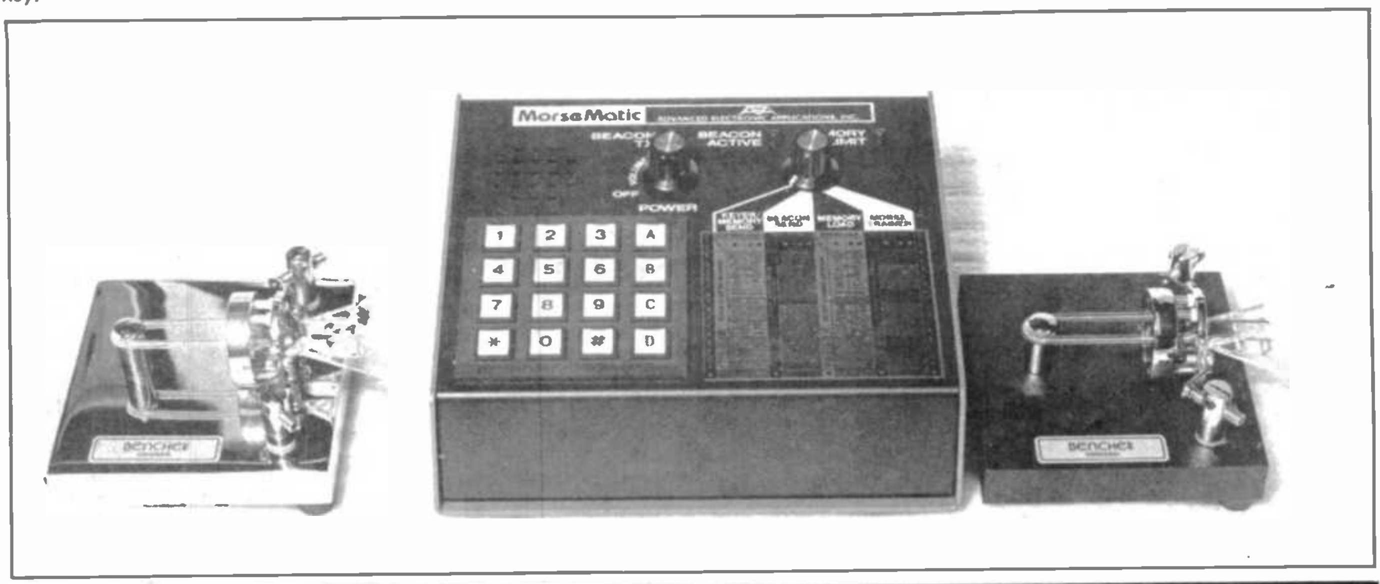
WHAT ABOUT THE FUTURE?

spectrum. Three new bands were negotiated for amateurs in 1979, which on the face of it is slightly surprising given that pressure on the radio spectrum is always very high and, particularly for broadcasters who use the HF spectrum for their overseas services, there's never enough space. As we've said elsewhere, the RSGB deserve thanks for their part in this: the thing is that in the future, as more and more radio services move from HF to satellites, more of the HF spectrum just might become available to amateurs. It would be ironic if this happened, since we'd be back to the early days when amateurs were given all of the frequencies above about 1.5 MHz because it was thought they were useless for anything else. It's not that the short waves are useless for professional-type communications, but as you may have discovered by now in your listening you can't always rely on propagation conditions on HF staying solid and reliable for any length of time. If you want 100 per cent reliable links to the other side of the world, you wouldn't use high frequency radio and put your trust in God and the ionosphere; you'd use a satellite in one form or another.

Amateurs, of course, have satellites of their own, and this trend will no doubt continue. Some people think that it's getting away from classical amateur radio and more towards pure communications, and there's something in this in the same way that some amateurs don't feel that repeaters are somehow in the spirit of the game. Perhaps the best view is that it all depends how you use them; obviously one doesn't want to see amateur radio become nothing more than a cheap substitute for the telephone system, and it's all a matter of balance. You have to remember that three-quarters of the joy of amateur radio lies in making some of it yourself and putting some of your own creativity into it — you can't really do that if you buy a rig from a shop and call up any other amateur in the world via a satellite. That's getting uncommonly close to a more sophisticated version of citizens band radio and missing the point of what amateur radio is about.

Perhaps to some extent it's inevitable, since there's not much for the amateur to discover on his kitchen table that the professionals haven't sussed out years ago; it's not like the early days, when you might well find out something that the clever men in their laboratory didn't even suspect. So the real discoveries are likely to be in areas such as propagation, where we're very far away from knowing all there is to know about it. The beauty of radio amateurs in this area is that there are a lot of them, and they can pool their observations and add to knowledge on a large scale. One type of propagation, known as Sporadic E, is still a mystery in many ways, and radio amateurs have contributed a good deal to what knowledge we do have about it: one of these days the amateurs will come up with the right answer.

However, all these things are to do with the technology. People don't change all that much, and in one way it would be nice if the future didn't produce changes in such areas as the friendliness and comradeship that amateur radio can bring. Hopefully, the next fifty years or so will still show that amateurs are renowned for all sorts of positive things like helping their mate get on the air and all the other little courtesies that have been around for a long time. Essentially, amateur radio is about people talking to each other at least as much as it's about the technology that enables them to do so, and it'll change if and when basic things about humanity change. At the present time, amateur radio reflects a lot of good things about people, and one can only hope that it will still be doing that fifty years hence — whatever the technology brings to it.



Sit back and enjoy it. An automatic Morse unit which, among other things, can send a pre-written message automatically at the press of a single button. On either side are two versions of the simplest modern Morse key.

WHAT ABOUT THE FUTURE?

It was once called the London Wireless Club

The RSGB, or the Radio Society of Great Britain, exists to serve the interests of radio amateurs in the UK. That's a pretty broad statement of what it does, but we'll take a look at how it does it and what it can do for you.

The Society was founded in 1913 as the London Wireless Club, and it changed its name in 1922 to the Radio Society of Great Britain. Nowadays it has just under 32,000 members, of which not all are licenced and of whom some live overseas. The basic administration is by a Council, which is elected by the membership; there is a structure of Area Representatives and Regional Representatives in all parts of the country, and a full-time professional headquarters staff to look after the day-to-day running of things.

It's a bit hard to know where to start in describing what the Society does, because it does one hell of a lot; a valid criticism of the RSGB, in fact, is that it doesn't tell the members just how much it does do and how hard it works! One of its basic tasks is to deal with the licencing authority, which in this country is the Home Office; both senior staff and volunteers meet the Home Office regularly to liaise in matters that affect the radio amateur from a licencing point of view. A good example of what the Society can do in an emergency happened a few months ago, when the Home Office issued out of the blue a completely new schedule to the amateur licence; they hadn't consulted the Society, and the schedule was an unworkable mish-mash of errors, ambiguities and general nonsenses. A good old British cock-up, in fact. The RSGB practically blew a fuse, and the headquarters staff, together with volunteers from various Society committees, didn't see much of their homes and beds for a fortnight while the whole sorry mess was sorted out. In fact, the new schedule was sprung on the world on February 12, 1982, and a brand-new replacement (which we now must work to, and is one hell of a lot better than the first one) was brought into play on April 16, 1982. Two months of hard work went into that lot, and whichever

The RSGB is the governing body of amateur radio in Britain. It's also there to help with problems you might have, advise on wavebands and procedure, and look after the privileges of the amateur

you look at it the RSGB did a good job in solving the problem.

That's a pretty dramatic example, and the RSGB doesn't have to do that sort of thing too often! More often it's a matter of day-to-day liaison about things that crop up.

You could divide the work of the RSGB into "business" and "membership services" if you like, although the lines blur in some places. The "business" part of it comes in things like publishing; as we've seen in various chapters, they publish a wide variety of books for the amateur which cover a multitude of different topics. They also publish their monthly magazine, *Radio Communication*, which is sent to all members. On the business side, you could also count organising various exhibitions, such as the National Amateur Radio Exhibition at Alexandra Palace and the VHF Convention which has, for the last couple of years, taken place at Sandown Park. A lot of work goes into these, and if you're new to amateur radio they're well worth a visit — you can go to the RSGB stand and have a chat with the various committee members and headquarters staff, as well as buy books and various other odds and ends like their repeater and beacon lists. These are updated about once a week, so they're a good buy if you're an avid mobile fanatic or DX chaser.

News bulletin

Mention of beacons and repeaters leads us on to the fact that these, too, are dealt with by the Society. Basically, the repeater itself is built and run by a local group, but the Society are the licence holders for all beacons and repeaters and they do all the co-ordination and planning required via a body called the Repeater Working Group. If you want to start a repeater in your area, they're the people to contact. Here again, all the licensing side of it is dealt with by the Society, who submit proposals to the Home Office.

There are a lot of other things they do in the "membership services" category. One of them is the organisation of the weekly amateur radio news bulletin, which is broadcast on Sunday mornings by various readers up and down the country under the common callsign GB2RS. Related activities are the origination of news material for the IBA's Oracle service, and a relatively new news service called Headline News. This is a three-minute news bulletin which is obtainable by dialling 01-837 4118; it gets changed every Tuesday and Friday most of the time, although when something dramatic like the Home Office schedule snafu crops up, the message gets changed whenever the situation changes and there's some more news to report.

The QSL Bureau is another RSGB-administered service, which means that you can send your cards out and get them back for the price of the odd stamp for the envelopes. This is the service that practically all members use, and it's certainly better than solemnly sending cards to everywhere by air mail!

Many of the major contests are organised by the Society, in the shape of the appropriate committee. Details of when they take place (and who has won them) appear in Radio Communication and on GB2RS.

Another important membership service is insurance for amateur radio equipment, which can be difficult to arrange through your normal policy. There's a superb scheme available to RSGB members which even covers things like mobile rigs and hand-helds.

Basically, the RSGB is administered by its Council, through the medium of a large number of specialised committees who deal with everything from Propagation Studies (which is highly scientific and clever and gives papers at professional conferences) to Education, who liaise with the City and Guilds as far as the RAE is concerned. Along the way there are groups such as the Repeater Working Group, the Forward Planning Group and committees for practically anything you could think of. Some people groan when they hear the word "committee", and the one problem with the large number of committees is that some things can take absolutely ages to deal with. However, at least it's a democratic society and, provided you're reasonably sane and have been a member for three years, anyone is quite at liberty to stand for Council and get stuck in instead of standing on the sidelines muttering.

Rapidly growing

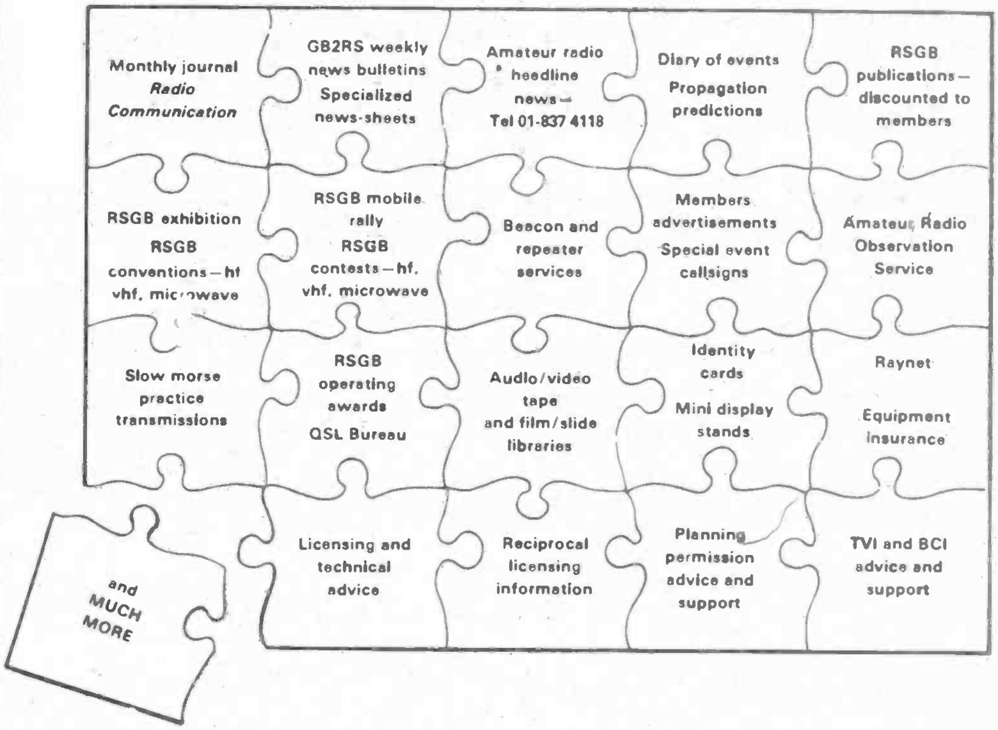
In actual fact, the Society has grown enormously in the last few years, in the same way that amateur radio has; they have some very good in-house data processing these days, which help, but they are presently searching for a new headquarters which will allow them to expand somewhat and bring in a few more people to cope with their workloads. The Society is constantly seeking to introduce new services for its members and improve the lot of radio amateurs in the UK, but if membership continues to grow at the same rate as it has in the last few years, they'll need to take over Centre Point. It seems to be generally agreed that their present headquarters at 35 Doughty Street, London WC1N 2AE — which is where you write, or go to buy your books — is about seventeen times too small for the amount of work they do.

The wider international role of the Society ought to get more publicity than it does. Every so often there are major international conferences to decide on the future of the radio spectrum, and because the pressure on a valuable natural resource like the radio frequencies that are usable for various things is so high, it's essential that a national society — acting in harmony with its licencing administration, as well as other national societies — is there to look after the interests of radio amateurs. At the last epic, which was the World Administrative Radio Conference in Geneva in 1979, the amateurs gained three new allocations in the HF spectrum, as well as others in the microwave region. This represented nothing short of a major triumph for amateur radio, given that every user of radio was begging and pleading for more room!

The RSGB — probably like any other national society for any other hobby — gets a lot of flak from its members about this and that; very little of it has much justification in the wider context of the things it does for amateur radio in the UK and indeed in the world at large. It would certainly be a good move to go round to their London HQ and see what they get up to; you'll find people who care passionately about their hobby and work very hard indeed to look after the privileges accorded to the radio amateur.

We've only skimmed the surface in this article, but every radio amateur ought to join and see for him or herself!

RSGB gets it together



ICOM

TRIED, TESTED AND TRUSTED

See revue in February Radd.Comm.

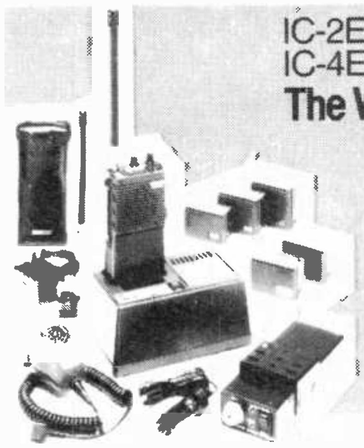
IC-720A
Possibly the best choice in HF. £883.inc.

The main problem that the amateur of today has to deal with is deciding just which rig out of the many excellent products available he is going to choose. Technology is advancing at such a rapid rate and getting so sophisticated that many cannot hope to keep up. Some go too far!

Perhaps one way of dealing with the problem is to look at just what each model offers in its basic form without having to lay out even more hard earned cash on "extras". The IC-720A scores very highly when looked at in this light. How many of its competitors have two VFOs as standard or a memory which can be recalled, even when on a different band to the one in use, and result in instant retuning AND BANDCHANGING of the transceiver? How many include a really excellent general coverage receiver covering all the way from 100kHz to 30MHz (with provision to transmit there also if you have the correct licence)? How many need no tuning or loading whatsoever and take great care of your PA, should you have a rotten antenna, by cutting the power back to the safe level? How many have an automatic RIT which cancels itself when the main tuning dial is moved? How many will run full power out for long periods without getting hot enough to boil an egg? How many have band data output to automatically change bands on a solid state linear AND an automatic antenna tuner unit when you are able to add these to your station?

Well you will have to do quite a bit of hunting through the pages of this magazine to find anything to approach the IC-720A. It may be just a little more expensive than some of the others – but when you remember just how good it is, and of course the excellent reputation for keeping their secondhand value you will see why your choice will have to be an IC-720A!

IC-PS15 Mains PSU £99



IC-2E £159.inc.
IC-4E £199.inc.
The World's most popular portables & now the marine version IC-M12

Nearly everybody has an IC2E – the most popular amateur transceiver in the world – now there is the 70 cm version which is every bit as good and takes the same accessories. Check the features.

Fully synthesized – Covering 144 – 145.995 in 400 5KHz steps. (430-439.999 4E)
Power output – 1.5W with the 9v. rechargeable battery pack as supplied – but lower or higher output available with the optional 6v or 12v packs. Rapid slide-on changing facility.
BNC antenna output socket – 50 ohms for connecting to another antenna or use the Rubber Duck supplied (flexible ¼ λ whip – 4E)
Send/battery indicator – Lights during transmit but when battery power falls below 6v it does not light, indicating the need for a recharge.
Frequency selection – by thumbwheel switches, indicating the frequency. 5KHz switch – adds 5KHz to the indicated frequency.
Duplex simplex Switch – gives simplex or plus 600KHz or minus 600KHz transmit (1·6MHz and listen input on 4E)
Hi-Low switch – reduces power output from 1.5W to 150mW reducing battery drain.
External microphone jack – if you do not wish to use the built-in electret condenser mic an optional microphone speaker with PTT control can be used. Useful for pocket operation.
External speaker jack – for speaker or earphone. This little beauty is supplied ready to go complete with nicad battery pack, charger, rubber duck.

A full range of accessories in stock.

		£ p
ICML1	10W mobile booster for IC2E	49 00
BP5	11.[illegible] battery pack	30 00
BP4	Empty battery case for 6 x AA cells	5 80
BP3	Standard battery pack	[illegible] 70
BP2	6.[illegible] pack	22 00
BC30	Base charger for above	39 00
BC25	Mains charger as supplied	4 25
DC1	12 volt adapter pack	8 40
HM9	Speaker microphone	12 00
CP1	Mobile charging lead	3 20
IC1 2 3	cases	each 3 60

All prices include VAT

The IC4E is going to revolutionise 70 CM!

ICOM

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Please note: Access Barclaycard owners – goods must be sent to address registered with credit card company

Remember we also stock Yaesu, Jaybeam, Datong, Welz, G-Whip, Western, TAL, Bearcat, RSGB Publications.

See us at LONGLEAT June 27

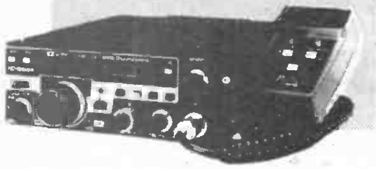
ASK ABOUT THE NEW RANGE OF CUE DEE ANTENNAS....the winners in recent tests!

IC-290E £366./IC-490E £445.inc.

Multimode mobiles

290E-144-146 MHz/490E-430-440 MHz

The best pair since Erica's!

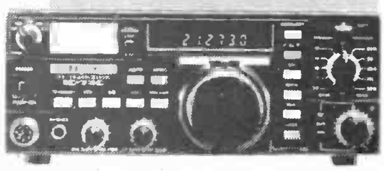


IOW RF ouput on SSB, CW and FM. Standard and non-standard repeater shifts. 5 memories and priority channel.

Memory scan and band scan, controlled at front panel or microphone. Two VFO's LED S-meter 25KHz and 1KHz on FM-1KHz and 100KHz tuning steps on SSB. Instant listen input for repeaters.

IC-730 **The best for mobile or economy base station**

£586.inc.



ICOM's answer to your HF mobile problems – the IC-730. This new 80m-10m, 8 band transceiver offers 100W output on SSB, AM and CW. Outstanding receiver performance is achieved by an up-conversion system using a high IF of 39MHz offering excellent image and IF interference rejection, high sensitivity and above all, wide dynamic range. Built in Pass Band Shift allows you to continuously adjust the centre frequency of the IF pass band virtually eliminating close channel interference. Dual VFO's with 10Hz and 1KHz steps allows effortless tuning and what's more a memory is provided for one channel per band. Further convenience circuits are provided such as Noise Blanker, Vox, CW Monitor, APC and SWR Detector to name a few. A built in Speech Processor boosts talk power on transmit and a switchable RF Pre-Amp is a boon on todays crowded bands. Full metering WWV reception and connections for transverter and linear control almost completes the IC-730's impressive facilities.

IC-251 £499.inc.
IC-451 £630.inc.

Great Base Stations

ICOM produce a perfect trio in the UHF base station range, ranging from 6 Meters through 2 Meters to 70 cms. Unfortunately you are not able to benefit from the 6m product in this country, but you CAN own the IC-251E for your 2 Meter station and the 451E for 70 cms.

Both are really well designed and engineered multi-mode transceivers capable of being operated from either the mains or a 12 volt supply. Both contain such exciting features as scan facilities, automatic selection of the correct repeater shift for the band concerned, full normal and reverse repeater operation, tuning rate selection according to the mode in use. VOX on SSB continuous power adjustment capability on FM and 3 memory channels. Of course they are both fitted with a crystal controlled tone burst and have twin VFO's as have most of ICOM's fully synthesized transceivers.

IC-24G

Low-priced mobile

£169.inc.

The famous IC-240 has been improved, given a face lift and renamed the IC-24G. Many thousands of 240's are in use, and its popularity is due in part to simplicity of operation, high receiver sensitivity and superb audio on TX and RX. The new IC-24G has these and other features. Full 80 channels (at 25kHz spacing) are available and readout is by channel number – selected by easy to operate press button thumbwheel switches. This readout can clearly be seen in the brightest of sunlight. Duplex and reverse duplex is provided along with a 12½ KHz upshift, should the new channel spacing be necessary.

Well worth thinking about!

IC-25E

The Tiny Tiger

£239.inc.

Amazingly small, yet very sensitive. Two VFO's, five memories, priority channel, full duplex and reverse. LED S-meter. 25KHz or 5KHz step tuning. Same multi-scanning functions as the 290 from mic or front panel. All in all the best 2M FM mobile ICOM have ever made.

Tono RTTY and CW computers

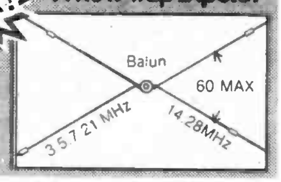
7000E-£550/9000E-£650inc.

The TONO range of communication computers take a lot of beating when it comes to trying to read RTTY and CW in the noise. Others don't always quite make it!

Check the many facilities offered before you buy – especially look at the 9000E which also throws in a Word Processor. Previous ads have told you quite a lot about these products – but why not call us for further information and a brochure?

LOOK!

A new Trap Dipole!



The MT-240X Multi-band trap dipole antenna (80m – 10m) is a superbly constructed antenna with its own Balun incorporated in the centre insulator with an SO239 connector. Separate elements of multi-stranded heavy duty copper wire are used for 80-40-15 and 20-10 Metres. Really one up on its competitors. £49.50 inc. VAT

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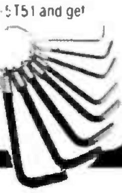

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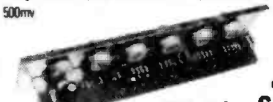

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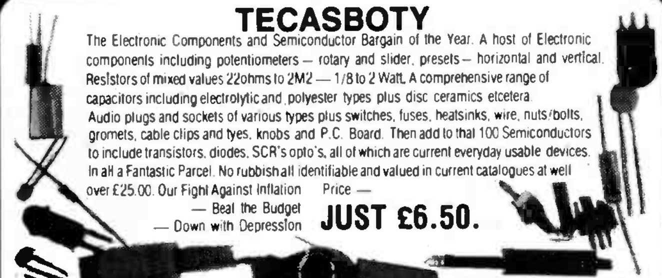

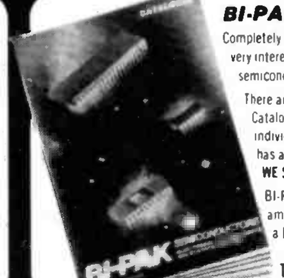

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