A MODERN HOMODYNE RECEIVER

Part 1

By
G. W. Short

Recent interest in 'direct conversion' receivers has prompted our contributor to offer his own design. In this month's article he discusses the background to homodyne reception, leading up to the basic mode of operation employed in his receiver. In the concluding article, to be published next month, the receiver will be described in full.

Direct Conversion Receiver

is a fairly recent term though, strictly speaking, it might be applied to any type of receiver which converts the incoming signal directly to audio. On this basis even a crystal set would qualify, but in fact the term is usually restricted to receivers in which the audio is recovered with the help of an oscillator.

REACTION CIRCUIT

The simplest and earliest of this type of direct conversion receiver was the homodyne'. In its original form, described in 1924 by F. M. Colebrook, who became Director of the National Physical Laboratory, it was just a triode detector with 'reaction' (Fig. 1). The reaction was set to make the circuit oscillate strongly. As many readers will have discovered for themselves, when a signal is tuned in with such an oscillating detector there is first of all an ear-splitting howl caused by the incoming carrier beating with the local oscillation. Then, as the circuit is adjusted closer and closer towards 'zero beat', a point is reached where the beat note suddenly disappears, and the incoming programme is heard, rather faintly and with background hiss but otherwise with good quality.

What has happened is that the local oscillation has become locked to the incoming carrier. The combined signal is then an ordinary a.m. signal with an abnormally strong carrier - the result of the local oscillation which, being now synchronised, adds to the signal carrier. The net result is an a.m. signal with a low depth of modulation, which makes for low distortion of the detected audio. The background hiss arises from the same cause as the background hiss of a c.w. receiver when the b.f.o. is switched on or any sensitive receiver tuned to an unmodulated carrier. That is, the carrier or local oscillation beats with any r.f. noise close to it in frequency, giving a.f. noise at the output of the detector.

Colebrook's homodyne was a very simple affair, but it did embody the important principle of a local oscillation locked in frequency to an incoming carrier. All modern direct conversion a.m. receivers use this principle, though the means by which synchronism is obtained may be very different from Colebrook's direct-injection method.

The knowledge that an LC oscillator can be synchronised in this way predates Colebrook's homodyne by a small period. A little over a year earlier, Appleton (the ionosphere researcher) had written a learned paper...
on the subject. Some of his co-workers had actually used Colebrook’s method of reception.

Despite this promising beginning, the homodyne never became popular. This may seem strange in the light of present-day interest, but it should be remembered that the superheterodyne method of reception had already been invented and seemed to be the answer to all the problems of the day, since it gave high gain, good selectivity, and a simple method of automatic gain control.

In any case the domestic t.r.f. receivers of the twenties and thirties were often operated as homodynes... and very unpopular they were when this was done. In those days of long outdoor wire aerials, an oscillating detector first stage acted as a local c.w. transmitter producing, when off tune, annoying whistles in neighbouring sets. The outdoor aerial also brought with it a particular disadvantage. When it swayed in the wind, the resulting variations in capacitance to earth tended to throw the receiver out of synchronism.

THE SYNCHRODYNE

As Colebrook had realised, the homodyne method of reception can give greatly enhanced selectivity. The way in which it does so is not very obvious from the original circuit, but it becomes clear when one examines the much improved form of the technique known as the ‘synchrodyne’ (Fig. 2).

In the synchrodyne the path of the incoming signal is split into two separate branches. One branch goes straight to the demodulator, that is, the circuit which carries out the direct conversion to audio. The demodulator is driven by an oscillator, and the other branch of the signal path goes to this oscillator: this is the synchronising path and its job is to injection-lock the oscillator to the incoming carrier of the wanted station.

Now, the demodulator, although usually regarded as a detector (and in certain forms called a ‘product detector’), is in reality a kind of frequency changer. The unorthodox thing about this frequency-changer, however, is that, unlike the one in a superhet where the oscillator is on a completely different frequency from the signal, here the oscillator is on exactly the same frequency. The ‘i.f.’ output is at the difference frequency between signal and local oscillation, but the difference frequency is zero! This does not mean that there is no output but that the output is at zero frequency, or d.c.

Not very useful, you may think. But this is where the nature of an a.m. signal comes into the picture. An a.m. signal has a carrier and sidebands. The oscillator in a synchrodyne is locked to the carrier frequency, so it is the carrier frequency only which gives a d.c. output. The sidebands, being on slightly different frequencies, give beat-frequency outputs. It just happens that the beat frequencies are the original modulation frequencies, so that the output of the demodulator consists of the original audio modulation frequencies which constitute the programme.

To take an actual example, suppose the carrier frequency is 200kHz, modulated by a.f. at 1kHz. There are in consequence the usual two sideband frequencies, one at 199kHz and the other at 201kHz. Both these beat with the local oscillation on 200kHz to give 1kHz, i.e. the original modulation. The same thing happens with any other modulating frequency, and for any mixture of frequencies which form a voice or music signal.

What happens to unwanted frequencies on other channels? The carrier of an adjacent channel, say 209kHz, gives an output from the demodulator of 9kHz. This is a whistle at a relatively high audio frequency, and is rejected by the low-pass filter which follows the demodulator, whose cut-off frequency can be set at, say, 5kHz. It will be clear that signals on channels above 209kHz, such as 218kHz, come out at still higher frequencies and are also rejected. What about unwanted channels on lower frequencies? If the next lower channel is at 191kHz it gives a beat at 9kHz, which is also dealt with by the low-pass filter. Any still lower channel comes out, once again, at a higher difference frequency and is likewise eliminated by the filter.

We therefore have the delightfully simple situation that, so long as the local oscillator stays locked to the wanted carrier, unwanted signals on any other frequency are eliminated. There is no possibility of ‘second channel’ (image frequency) breakthrough as in a superhet. Note, too, that the selectivity comes from the demodulation process: even r.f. tuning can, in theory, be dispensed with!

OSCILLATOR STABILITY

The problem, of course, is to keep the oscillator synchronised, and we must now look at this requirement.
more closely. Common sense suggests that the stronger the synchronising signal the easier it should be to lock the local oscillator. This is true, and it provides a starting point for an estimate of the stability needed from the oscillator.

Careful tests will show that even when the tuning is shifted a little to one side or other of the correct point the oscillator remains locked. The stronger the signal, the more detuning can be tolerated. This would be great if all one needed to do were to tune in to strong stations, but in the real world it is necessary to pluck a weak signal from a surrounding array of strong ones, each eager to jump in and take over. In theory, it is indeed possible to stay locked to the wanted weak carrier when there are strong unwanted ones nearby. To do it, you must increase the amplitude of the local oscillation. This makes it harder to lock, but it turns out that a weak signal tuned in ‘right on the noise’ can then dominate a strong one slightly off tune. The price demanded for this performance is great stability of frequency.

If the local oscillator were absolutely stable it would not be necessary to lock it at all. One would just set it to the right frequency and sit back. Unless the transmitter frequency drifted the receiver would stay tuned indefinitely. Unfortunately, absolutely stable oscillators just do not exist, so locking is necessary. If drift is very low, the locking signal need only be small, which is what we want.

How stable must the oscillator be? Suppose, to begin with, that we are in the rather favourable situation of having to lock to one signal when another, of exactly equal strength, is 10kHz away. Now let the oscillator drift, but without loss of sync. If it drifts towards the unwanted carrier, a point will be reached at the half-way mark between the two stations where there is an even chance that the unwanted carrier will take command. In other words, the natural, unlocked frequency must not drift by more than half the channel spacing, in this case by 5kHz.

So far we haven’t specified what the carrier frequency is. When we do, we find we have come to the crux. If the wanted carrier is 500kHz, then the allowable drift in this case of 5kHz amounts to one part per 100. Not a very difficult requirement to achieve. But what if the carrier were 5MHz? A drift of 5kHz is now 1 part in 1,000. And at 50MHz, a stability of 1 in 10,000 is required, or 0.01%. Clearly, life gets harder as one goes up the frequency scale.

Next, look at the unfavourable situation where the unwanted carrier is not equal in strength to the wanted one but 100 times stronger. The oscillator must be 100 times more stable than before, and this calls for a drift of less than 1 part in 10,000 at 500kHz, 1 in 100,000 at 5MHz, and 1 in a million at 50MHz. Clearly, the synchronyone is a receiver for lowish frequencies, or quick hands on the tuning control, or oscillators of exceptional stability.

The original synchronyone designs, published in 1947, were for medium wave receivers. Their originator, D. G. Tucker (now Professor of Electrical Engineering at Birmingham University) had a background in line communications engineering and a special interest in the rectifier types of modulators and demodulators, such as the ring modulator, used in carrier telephony. These have the degree of linearity between input signal and output which is required in the synchronyone, and were used in the most successful version, though Tucker did also produce a simple version using a triode-hexode frequency changer instead. The synchronyone created a stir when it first appeared, but subsequent research by Tucker showed that between 1924 and 1947 there had been a number of patented circuits which embodied the essential principle of separating the synchronising path from the main signal path.

INTEREST REVIVES

The most obvious attraction of the synchronyone (and homodyne, which can be regarded as a synchronyone whose functions are all mixed up in one circuit) is its ability to provide high selectivity without the use of a lot of tuned circuits. There is, however, another less obvious attraction. It can be called in as an ally against what many communications engineers have come to regard as the last great enemy — intermodulation. In a shortwave receiver, the aerial tuned circuit cannot be made selective enough to get rid of strong interfering stations somewhere in the band to which it is tuned. The result is that the first stage of the receiver, usually an r.f. amplifier, is presented with a mixture of weak and strong signals. Since no amplifier is perfectly linear the consequence is that the weak ones have the modulation of the strong ones impressed upon them, and no amount of subsequent filtering (in i.f. stages, for example) can then get rid of the interference.

In a direct-conversion receiver, all the selectivity is obtained in one stage, the demodulator. And in the demodulator, the strongest signal, the signal which overrides all others, is of course the local oscillation. By dispensing with r.f. amplification and feeding the input signals straight to a demodulator supplied with a good strong local oscillation there is a sporting chance that cross-modulation will be greatly reduced. This is of particular interest on the amateur bands, where there may be very strong interfering signals from broadcast transmitters or the amateur in the next street. Another encouraging fact is that for single-sideband suppressed carrier reception, now popular with amateur transmitters, a small frequency error at the local oscillator is permissible. Given a stability which confines drift to a few tens of cycles during a ‘contact’ there is no need to attempt precise synchronisation, which is just as well, since in a suppressed-carrier system there is no carrier to provide a locking signal. (It is possible, at the expense of great complexity, to derive one from the audio output, but that's another story).

IMPROVING THE HOMODYNE

In general, however, we are interested in receiving ordinary double sideband a.m. signals with carrier and all. In this case it is absolutely necessary to synchronise the oscillator. For most purposes we need some r.f. amplification as well.

The original homodyne did give some protection against cross-modula-

A view inside the homodyne receiver. Signal pick-up on medium and long waves, and on two short wave bands, is provided by a ferrite rod aerial.
tion, by making the local oscillation the strongest 'signal' around. But it provided no r.f. amplification. What is needed, then, is a circuit which preserves the simplicity of the homodyne but gives r.f. amplification as well. A way of achieving this is shown in Fig. 3.

In Fig. 3, signals are tuned by an aerial circuit, amplified by an otherwise untuned r.f. amplifier, and passed to a detector. So far all we have is a simple t.r.f. receiver. This is turned into a homodyne by introducing regenerative feedback (reaction) from amplifier output to the aerial circuit. This feedback takes place via a limiter. The job of the limiter is twofold: to suppress the modulation of the fed-back carrier and to prevent the amplitude of oscillation from getting too large. What is fed back, when the circuit is oscillating strongly, is a more or less unmodulated carrier of fixed amplitude.

Provided that the fed-back carrier is not so strong that it overloads the amplifier any other signals present will still be amplified in the normal way, except that cross-modulation may be discouraged by making the oscillation stronger than any other signal.

No means of controlling regeneration (other than the limiter) are shown in Fig. 3, but it is very easy to add an attenuator between the limiter and the tuned circuit. Once this is done it becomes possible to set the circuit so that it acts either as a simple non-regenerative receiver with no 'reaction', or as a normal reacting t.r.f., or as a fully oscillating homodyne. For most purposes the ordinary regenerative t.r.f. condition is adequate, since it provides enhanced gain and selectivity without the need for the critical tuning of a homodyne. But when conditions are bad, with a strong interfering station or stations in the band, the superior selectivity of the homodyne is worth the trouble of the careful adjustment which this mode of reception calls for. Single-sideband transmissions can also be received, if the tuning is fine enough, once the knack of hitting the right tuning point is acquired. Readers who have not tried s.s.b. reception before are warned that it takes some practice!

(To be concluded)
A MODERN HOMODYNE RECEIVER

Part 2

By

G. W. SHORT

In this concluding article our contributor deals with the construction of his homodyne receiver. Also described is a suitable a.f. amplifier, together with details showing how this amplifier and the homodyne receiver may be assembled to form a complete receiver with loudspeaker output.

COMPLETE CIRCUIT

The complete circuit of a modern homodyne receiver on the lines discussed last month is shown in Fig. 4. This is basically a two-stage r.f. amplifier, tuned at the input only, and driving a double-diode detector, D3, D4, which acts as a demodulator when the receiver is made to behave as a homodyne. A single a.f. stage completes the circuit as shown here, but of course a separate power amplifier must be used for loudspeaker reception.

In Fig. 4 the aerial tuned circuit is given by C1, C2 and whatever inductance is selected by wave-change switch S1. L1 and L2 are medium and short wave coils on a ferrite aerial rod offering, with a 500pF tuning capacitor, ranges of 500 to 2,000kHz and 3.5 to 10MHz respectively. When S1 is set to the 'L.W.' position, loading coil L3 is inserted in series with L1, whereupon the range covered is 150 to 500kHz. Similarly, setting S1 to 'S.W.1.' causes loading coil L4 to be inserted in series with the ferrite rod short wave coil, L2, whereupon the range covered is 1.6 to 5MHz. C1 is a "fine tuner" with a capacitance of 5pF, and is helpful for final tuning of short wave signals. The aerial tuned circuit arrangements are discussed in more detail later.

The r.f. amplifier (TR1, TR2) calls for a little explanation. A junction f.e.t. is used in the input stage. This produces little r.f. gain in itself, but simplifies the band-switching by making it possible to dispense with the usual tapping on the input coil and to connect the whole aerial tuned circuit directly to the amplifier. Most of the actual gain comes from TR2,
Fig. 4. The complete circuit of the modern homodyne receiver. This can receive a.m., c.w. and s.w. transmissions.
The inside rear of the complete receiver. The homodyne board is to the right of the tuning capacitor, and its screen and the transistor holder for TR1 can both be seen. The 1000uF capacitor is to the immediate right of the homodyne board. The a.f. amplifier board appears between the battery and the front panel, being obscured here by the battery.

The inside rear of the complete receiver. The homodyne board is to the right of the tuning capacitor, and its screen and the transistor holder for TR1 can both be seen. The 1000uF capacitor is to the immediate right of the homodyne board. The a.f. amplifier board appears between the battery and the front panel, being obscured here by the battery.

a u.h.f. p.n.p. germanium type which works well in this direct-coupled 'complementary-cascade' type of circuit.

The limiter (D1, D2) is a simple back-to-back pair of diodes, driven by a high enough resistance (R6) to ensure good clipping and at the same time prevent the limiter from loading the input to the detector. The regeneration control is RV7, an ordinary carbon track potentiometer with a metal case which is earthed to 'keep the r.f. inside'.

At lowish frequencies the amplifier has 360° phase shift, because there are two inverting stages, and so the output is in phase with the input. This means that the feedback path should not introduce further phase shift, since this would begin to bring the feedback signal towards an out-of-phase condition, and give negative instead of positive feedback. For this reason the regenerative path on long and medium waves is completed via a resistor, R1, which introduces no phase shift. This resistor is given a high value to avoid damping the input tuned circuit excessively. On short waves there is an appreciable amount of phase shift in the amplifier, and the output is no longer in phase with the input. Above about 2MHz, therefore, feedback is taken increasing by way of a small capacitance, given by Cx, which bypasses R1. It is convenient to use for Cx a twisted-wire capacitor, i.e. the capacitance is provided by two pieces of insulated connecting wire twisted together. The capacitance is then easily preset by twisting or untwisting to achieve the required condition of just enough feedback to enable the circuit to be brought into oscillation at all points in the tuning range.

The function of RV4 is to set up the current in TR2 for optimum results. In the prototype, this is given (with RV7 adjusted to give zero regeneration) when TR2 passes 3mA, as indicated by a drop of 3 volts across R5. However, it may be found desirable to experiment a little and try results with different values of current in TR2. RV4 should be initially set up for the 3mA current then, after experience with the receiver has been obtained, the effect of different currents in TR2 between the limits of 1 and 4mA can be checked. It is necessary to provide some means of adjustment here because the current taken by different specimens of 2N3819 in the TR1 position will vary. The voltage drop across R2 and hence the base voltage of TR2 is dependent upon the current drawn by TR1.

The audio frequency low-pass filter is a very simple RC affair whose components are C6, R9 and C7. The d.c. load for the detector/demodulator is R8. This resistor has been deliberately given a rather low value (10kohms) for the type of detector used here. The effect is to increase the damping of the amplifier output as signal strength builds up, which is the right condition for smooth reaction.

Volume control RV10 is followed here by one stage of a.f. voltage amplification, TR3. It is intended that the a.f. output will be used to drive a conventional loudspeaker amplifier. It is, however, possible to use the audio output of TR3 for headphone reception, provided that sensitive high-impedance phones are used. (Rather greater volume will be obtained by connecting high-impedance magnetic phones in place of R11.)

The total current consumption of the receiver, with RV4 set for 3mA current in TR2, is of the order of 4mA. However, this is liable to vary a little with different specimens of the 2N3819.

FREQUENCY COVERAGE

It will be clear to experienced constructors that the circuit lends itself to the reception of any tuning range within reason by the simple process of switching in appropriate ferrite aerial coils.

Ordinary grades of ferrite are not much good above about 2MHz, but special h.f. rods are made which operate well up to about 20MHz. The prototype uses a special h.f. rod, 6j in. by $\frac{1}{3}$ in. in diameter, which is suitable for medium and long waves as well as the short wave ranges covered. The ferrite rod coils (L1 and L2 in Fig. 4) are designed to be tuned by 365pF, but by using a 500pF tuning capacitor the coverage can be extended down to nearly 450kHz on medium waves, which makes it possible to use the receiver as part of the i.f. chain of a conventional superhet. When L3 is in circuit, as is given by setting S1 to 'L.W.', the receiver can also tune through the conventional superhet intermediate frequencies.

Short-wave coverage as is given by L1 on its own, is some 3 to 11MHz with 365pF tuning and 3.1 to 10MHz with 500pF, but in both cases the high frequency limit depends entirely on the minimum capacitance of the tuning capacitor and the circuit strays, and will usually extend well beyond the conservative 10 or 11MHz limit just quoted. At the high frequency end of the 'S.W.2' band it is possible, in the London area at least, to receive a number of broadcasting stations. Towards the low frequency end (employ a 500pF tuning capacitor) it is also possible to receive s.s.b. amateur transmissions on the 80 meter band.

The ferrite rod assembly, ready-wound with L1 and L2 fitted, is available from Amatronix Ltd., 396 Selsdon Road, South Croydon, Surrey, CR2 0DE. The ferrite rod for the 'S.W.1' loading coil, L4, is also available from this source. It consists of 20 turns close-wound of 22 s.w.g. enamelled wire on a $\frac{1}{4}$ by $\frac{1}{8}$ in. piece of rod. Loading coil L3 is simply a Rapanco r.f. choke type CH1.

CONSTRUCTION

The complete receiver, as illustrated in the photographs, consists of the homodyne receiver proper plus an additional a.f. amplifier feeding a small speaker. It is not necessary to use this particular a.f. amplifier, since the homodyne section will work into any suitably amplified headphones. The homodyne receiver is built on its own circuit board, this coupling by wires to the external components, which consist of S1 and the aerial tuned circuits, R1, Cx, RV7 and RV10. The complete receiver could, if desired, be built on a smaller baseboard and with a smaller panel with the a.f. amplifier and speaker omitted. Other variations are
that when the circuit boards are screwed down to the baseboard the strands are sandwiched firmly in place.

Constructors who prefer to use conventional metal chassis for their projects can, of course, adapt the methods shown here for this type of construction. A metal panel, common to the chassis, will still be necessary, to counteract 'hand capacitance' effects.

The top, sides and back of the cabinet are made in one unit, using particle board for the sides, plywood for the top, and hardwood for the back, the assembly being strengthened by corner braces glued in place.

**RECEIVER CIRCUIT BOARD**

The r.f. amplifier has a gain of several hundred at the lower frequencies and it is necessary to construct it carefully. Those who avoid unwanted feedback which, even if it does not cause instability, will spoil what should be a very smooth reaction control. Unwanted feedback can take place from the amplifier to the tuned circuit. This is avoided by a combination of screening and distance, the latter being ensured by keeping the base of TR1 reasonably well spaced from the collector of TR2 and all associated components. In the receiver in the photographs the 'danger area' of the circuit board is in effect sandwiched between an 'earth plate', given by the aluminium foil covering the baseboard, and a top screening plate which is just a piece of tinplate closely covering TR2 and associated components, including the diodes. The screen appears, in the component layout given in Fig. 6, between the dashed lines AB and CD. The screening plate is 'earthed' to the negative supply line by soldering it to two of the pins which support the negative line wiring. Note that the positioning of the circuit board relative to tuning components and regeneration potentiometer RV7 has been chosen so as to minimise stray coupling. The component layout also enables resistor R1, with its attendant capacitor Cx, to be suspended in the air, making it as direct a connection as possible between RV7 and the tuning capacitor.

The receiver board measures 4½ by 2½in. and has the layout given in Fig. 6. It should be noted that the a.f. output coupling capacitor, C12, is omitted in the layout, since the loudspeaker amplifier used here already has an equivalent component. If in other designs incorporating the homodyne receiver it is desired to retain C12 on the board, this can be done by increasing the length of the board by ½in. to accommodate it.

Anchorages points to which components are soldered may be soldered on the board which consists of hardboard at each connection point. The heads are cut off, leaving about ½in. of stem projecting, and the pins are then tipped before wiring-up begins.

Constructors are advised not to deviate from the layout shown. This method of construction is to trace the layout, lay the tracing over the circuit board, and drive pins through the junction points on the diagram. The diagram then forms an on-the-spot wiring guide.

Constructors who prefer to use perforated board should select a piece with 0.1in. hole pitch.

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![Fig. 5. The dimensions and control spindle centres of the prototype front panel. The height of the hole for C2 may vary for different tuning capacitors and should be marked off with the aid of the capacitor itself.](image-url)
A transistor holder (Eagle type TS10) was used for the f.e.t. in the receiver in the photographs, the f.e.t. being plugged into this after soldering had been completed. This protects the f.e.t. from the possibility of high voltages on the soldering iron bit breaking down its internal gate insulation. However, the f.e.t. could be wired in directly if precautions are taken during soldering. A suitable precaution consists of making the soldering iron metalwork common with the negative line of the receiver (say, by earthing both to the same point) and keeping the receiver switched off whilst soldering.

If a mains power unit is used, make sure that the output is really smooth. If further a.f. stages are driven from the same supply watch out for audio feedback, which can cause the receiver to 'moan' as the reaction is turned to the critical point. A 1,000μF electrolytic capacitor across the 9 volt supply prevents this from occurring. In the present design such a capacitor is added externally to the boards, being connected between the negative line of the homodyne board and the positive line of the amplifier board. It appears in the amplifier circuit of Fig. 7.

A.F. AMPLIFIER

The a.f. amplifier employed in the overall receiver is, as already mentioned, not a part of the homodyne circuit proper, and any other a.f.
amplifier could be used instead. For completeness, nevertheless, the present amplifier will next be described.

The amplifier circuit is given in Fig. 7 and it has the advantage of offering a low battery consumption, the quiescent current being approximately 0.8mA only. The input signal is applied to the base of the BC169C, whose collector couples to the base of the first 2N4289. This drives the BC168B and 2N4289 in the complementary Class B output stage. Two silicon 'bias diodes' (available, as is the BC168B, from Amatronix Ltd.) keep the output transistors conductive for the zero signal condition, and these couple to the speaker, which may be 75Ω or 80Ω. The speaker employed in the prototype was a 75Ω 2fln. unit (which is also available from Amatronix Ltd.). Feedback to the BC169C is taken from the junction of the 1kΩ and 10Ω resistors across the speaker, and it will be noted that this particular part of the circuit exhibits a considerable economy in components. It is desirable that the 250µF 16V capacitor be a Mullard miniature electrolytic component, as its internal series resistance was taken into account when the feedback component values were calculated. As already stated, the 1,000µF capacitor across the supply lines is only required to reduce the risk of feedback to the homodyne receiver. If the amplifier were used on its own for a different application the 1,000µF capacitor could, in most instances, be omitted.

In the present design the amplifier is assembled on a piece of hardboard measuring 2½ by 3½in. and uses domestic pins for anchorage points on the same manner as with the homodyne receiver board. Components are laid out along the board in roughly the same order as they appear in the circuit. The 1,000µF capacitor is not mounted on the amplifier board, but is external to both board and the homodyne board. It appears between the homodyne board and the battery, and is clearly visible in the photographs showing the interior of the overall receiver.

OPERATION

Operating a homodyne takes a little getting used to. The background hiss and the howls during tuning-in may be rather off-putting at first, but do not be discouraged! You will be surprised at the stations it can pull in once you have learned to use it. Here are a few general tips and guide lines:

1. If the circuit is detuned a little, but not far enough to lose synchronisation, the audio output falls and becomes distorted. The best tuning point is usually nearer one edge of the locking band than the other.

2. Loss of sync. may occur momentarily during deep modulation troughs, giving a rasping quality. This is a sign that the circuit is slightly off tune or that a.f. signals are getting back into the r.f. amplifier.

3. Loss of sync. may occur if the signal fades. The best strategy is usually to let well alone until the signal fades up again.

4. It is an advantage to use the lowest practicable level of oscillation. If you have to increase the level to override a strong signal in the next channel turn up the reaction until the intelligible breakthrough turns into unintelligible 'monkey chatter'. This is as far as you need go. However, when receiving s.s.b. signals the question of synchronisation doesn't arise, so in this case the best level of oscillation is set by other factors. First, the level must be at least high enough always to exceed the incoming signal, otherwise intelligibility will suffer. Secondly, it turns out with this receiver that it is possible so to set the regeneration that a useful increase in signal amplification can be had even with the receiver oscillating. On weak signals this is what dictates the maximum level which can usefully be set up. (If strong s.s.b. signals are being received you may as well turn the regeneration right up and so get the maximum selectivity from the outset).

As a final point, Fig. 8 shows received frequencies corresponding to the 0 - 100 scale of the slow-motion tuning drive employed with the prototype. It must be emphasised that this diagram, which applies to a 500µF tuning capacitor, is intended for guidance only, and it should not be assumed that receivers built up to the circuit will exhibit exactly the same frequency/scale relationship. Nevertheless, the diagram will still be of assistance since it gives the constructor an approximate idea of received frequencies on the four bands covered.