The Radio Modernisation Manual

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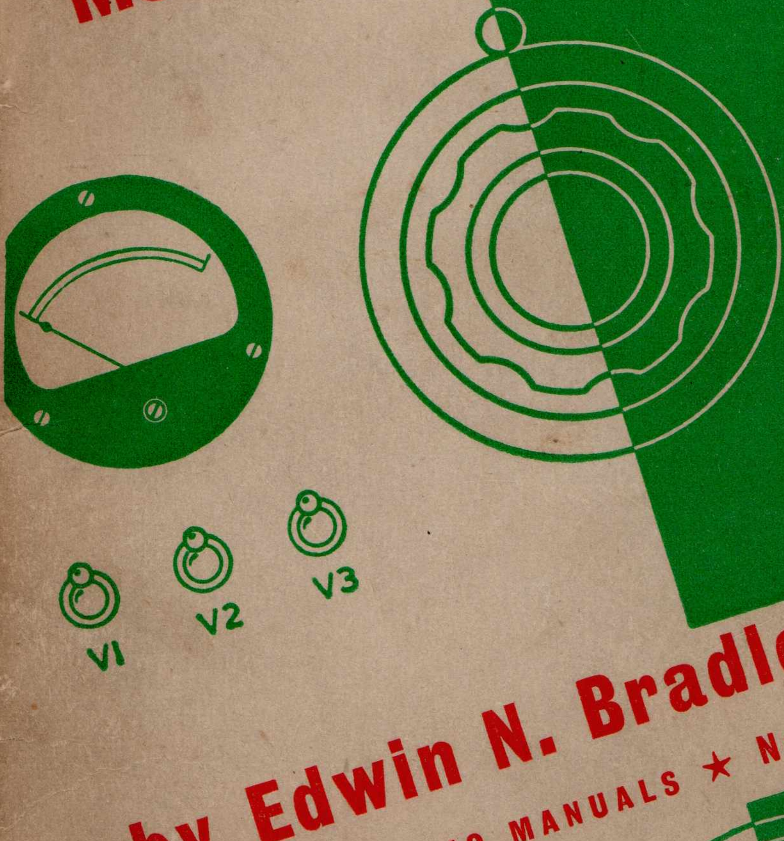

by Edwin N. Bradley

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CHAPTER 1

NEW SETS FOR OLD

Now, probably more than at any other time, old radio sets are being used throughout the country in great numbers. The shortage of receivers through the war years is far from being made good, and whilst new sets of excellent design and quality are now available, recent increases in both price and taxation make these beyond the reach of many pockets. Families who renewed their radio receivers regularly—an excellent scheme both for quality in listening and the stimulation of trade—are no longer able to do this, and as a result there are possibly thousands of sets literally at their " last gasp," deficient in selectivity, range, volume and tone.

It is with the hope that this book will assist home constructors and experimenters to give a new lease of life to such old receivers that *The Radio Modernisation Manual* is published.

Renewing an existing set is, in some ways, an even more interesting task than the building of a new receiver. No matter how many instructions and ideas may be given there must always remain a good deal of initiative on the worker's part. He must decide what section or sections of the receiver are most in need of renovation, how the changes are to be carried out, how the work is to be fitted into the space available, and so on, but at the same time this need deter no prospective amateur constructor whilst receiver modernisation is an excellent starting point for the younger reader who wishes to learn, through practice, his way into the fascinating hobby of Radio.

It is forgotten all too often, in these days of commercialisation, that radio began with the amateur and the whole grounding of the science is on the work of those who, in a sense, made radio a hobby.

When an old receiver is to be modernised, adapted or, perhaps, even rebuilt, the first step is to decide on what are its desirable features, in order that these may be maintained, and in what ways it is lacking and requires improvement. The most obvious defects will be those attaching, in general, to the audio amplifier section of the set—poor tone or actual distortion with, perhaps, annoying cracks or breaks on treble notes or transients with, perhaps, " tizzings " due to dirt in the loudspeaker gap or resonances within the receiver cabinet and parts. Secondly, it will be noted whether the selected station is tuned sharply and without interference — it may be that there is adjacent channel interference with a neighbouring signal or an annoying background to the desired programme. After this test on the local stations which, after all, are the most important ones from the reception point of view and which will provide by far the greater part of the programmes heard through the receiver, the set should be tuned through its wave-ranges, preferably at a good reception time such as the late evening, in order that its overall range and selectivity may be checked. This test often shows up several defects. Heterodyne whistles over the whole band, a breaking into oscillation at the high frequency end of the long wave band and similar results all indicate that the receiver is due for attention.

Again, does the receiver cover all the desired programmes and tuning points ? A midget AC/CD set in the London area, for example, gives adequate coverage on its one wave range but in several parts of the country the Light Programme can hardly be heard on 261 metres and is subject to very serious fading. In the author's receiving location the A.V.C. of a receiver needs to be a good deal more effective than in many areas owing to serious fluctuations in signal strength, which are both seasonal and immediate. Periods of garbled, unintelligible speech and " drain-pipe " music cannot, of course, be combated for these are due to phase shift interferences between incoming waves and defy any method of correction apart from a large and complicated diversity aerial system.

Is it required to cover the short waves, and if so, on what frequency bands?

Is it desired to use the receiver for gramophone reproduction?

Is the receiver to be fitted with extension speakers using lines run to other rooms, and if so, is remote control desirable?

All these and many more questions are immediately brought up and greater renovations and adaptions still are often necessary when the receiver is moved from one reception area to another. As a further example the case of a simple T.R.F. receiver built by the author may be mentioned. In the London area it gave excellent service on the Brookmans Park stations—for which it was designed—but when moved to a coastal location it proved of no use whatever, being subject to serious interference from high-powered telegraphy shore-to-ship transmitters. At the same time its conversion to a superhet circuit was neither difficult nor expensive, for few parts were scrapped and not many new components were needed.

A new set of valves alone can sometimes give an entirely new life and tone to a receiver but the slow deterioration of old valves quite often masks the inadequacy of an outdated circuit to cope with modern and changed conditions. Replacing an output valve alone will often result in improved tone and hum reduction but replacing the entire set of valves just as often shows that the receiver is inselective and, bearing in mind the increased efficiency of modern valves, unstable.

Loudspeaker design, too, improves with the years, and a replacement here is often beneficial. The great majority of modern speakers have improved characteristics from the point of view of tonal reproduction, but no less important are the changes in physical design—dust and dirt traps, for example, which can eliminate a great deal of trouble.

Last, but not least, a change in the appearance of a cabinet is often beneficial although this to all intents and purposes is a matter of psychology rather than one of radio engineering, and personal taste must always be the deciding factor. So far as the present writer is concerned he would never make changes in the appearance of a cabinet constructed of well-selected grained wood given, when new, a limed or matt finish, for such a cabinet steadily improves with age, taking on a pleasant dull gloss, although a highly polished cabinet showing, as it does, every mark and scratch, he considers well hidden and disguised with a carefully applied coat of bright enamel. Such a finish gives a very modern appearance and can be applied to tone with the room in which the receiver is situated, though enamel will not suit every cabinet. It is a finish most suited to smaller receivers. Bakelite or plastic cabinets wear well in almost all cases, resisting scratching and marking strongly, but there can be little doubt that they are not ideally suited as baffle boards for loudspeakers, the final function of the receiver cabinet, and if a new wooden cabinet can be obtained to replace them the change is often beneficial from every aspect.

The foregoing paragraphs give, then, the barest outline of the suggestions for renovation work covered in this Manual. Before enlarging, however, it will be as well to give some little space to a consideration of the tools and instruments which are needed and desirable.

The tools for modernisation work are, as might be expected, comparable with those required for service work.

Screwdrivers of assorted sizes, preferably with longish shafts; long-nosed, round-nosed and cutting pliers; a set of spanners covering from 0 to, say, 10 B.A. and, if possible, a set of Whitworth spanners also; at least one good adjustable spanner with square and unmilled jaws; soldering equipment of the best quality that can be afforded, a Solon iron, for example, and Ersin Multicore solder; chassis punches covering normal valveholder diameters (common size for octal holders, $1\frac{1}{8}$in.) or a tank cutter which, with a brace and chuck, will cut holes in various chassis materials from about $\frac{1}{2}$in. to 2in. diameters; a wheelbrace and assorted drills; these form the basis of the tool kit.

Rather more requires to be said on the subject of instruments.

Radio modernisation is not service work and provision for rapid fault finding is usually not required. Nevertheless making an improvement in one section of a receiver sometimes shows up a fault or weakness at some other point in the circuit—a common instance is where the addition of a further audio stage reveals that the detector has insufficient R.F. filtering—so that one or two instruments should be to hand if only as a means of checking over working voltages and general conditions. It is suggested, therefore, that a multimeter and a signal generator form an indispensable nucleus of the testgear required.

Multimeters can be either bought or made, and since several circuits are given in other publications of Messrs. Bernard's range—in the *Radio and Television Laboratory Manual*, for instance—details are not given here. Several signal generator circuits have also been published, but since the Technical Staff of Messrs. Bernards receive quite a number of queries concerning such gear it is thought as well to show a circuit with component values, and to give some notes on the calibration of the instrument.

A commercial signal generator is, of course, an invaluable acquisition but a home built generator, if made carefully and with good components, can be just as useful especially in modernisation work. The circuit of Fig. 1 gives both straight audio and a modulated or unmodulated R.F. output using only a single working valve and rectifier. Even the rectifier and mains transformer could be eliminated by the use of an AC/DC circuit and metal rectifier, a method which some Readers have asked might be shown, but it is the writer's firm opinion that all test gear of this nature should be completely isolated from the mains supply.

Workers who have a D.C. mains supply must, of course, have their generators connected directly to the mains, but an isolated A.C. operated generator may be connected to any type of receiver with no chance of short circuits or damage.

It is also stressed that a new valve, or a valve in good condition, must be used. In one or two cases complaints concerning poor operation of a generator have arisen only because an old triode-heptode—probably taken from a receiver after years of wear—has been expected to give strong R.F. and audio oscillation. Poor emission with a corresponding drop in mutual conductances within the valve may well prevent the generator from working at all.

In the generator of Fig. 1 simplification is achieved by providing only three tuning ranges which nevertheless cover the short, medium and long wavebands of the great majority of receivers, together with the normal I.F. range of ordinary superhets, whilst the output attenuator is of the simplest type possible. Straight output or output via an artificial aerial is provided. Either direct or slow motion tuning may be used. If a normal sized mains transformer is used the whole instrument can easily be built up on to a standard 9½in. x 4½in. x 2in. chassis, this chassis being enclosed entirely in a metal box, or having a metal screening cover built over it. The screening must be as effective as possible, the chassis and cover or box being well bonded together, so that stray signals are cut down.

Screening and construction in general is also simplified by making the artificial aerial integral with a feeding lead. The A.A. is contained within a probe-like box of 1in. diameter thin walled copper or brass tubing about

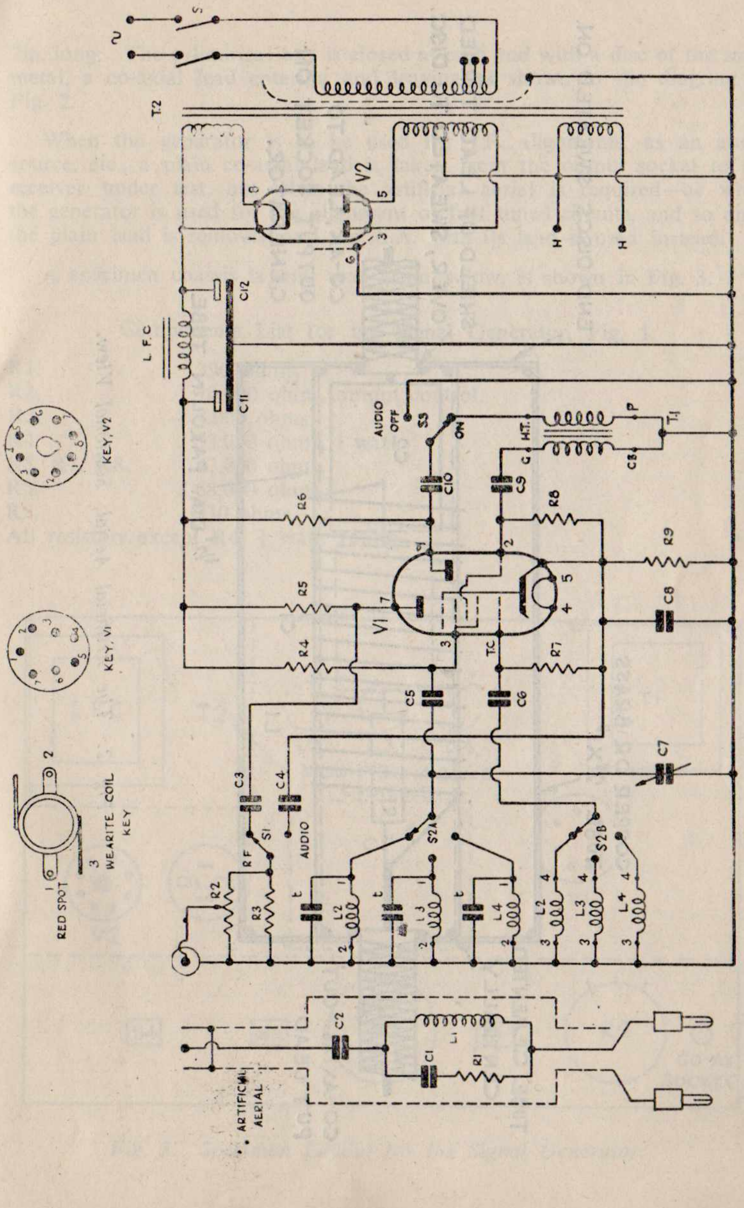


Fig. 1. The Signal Generator.

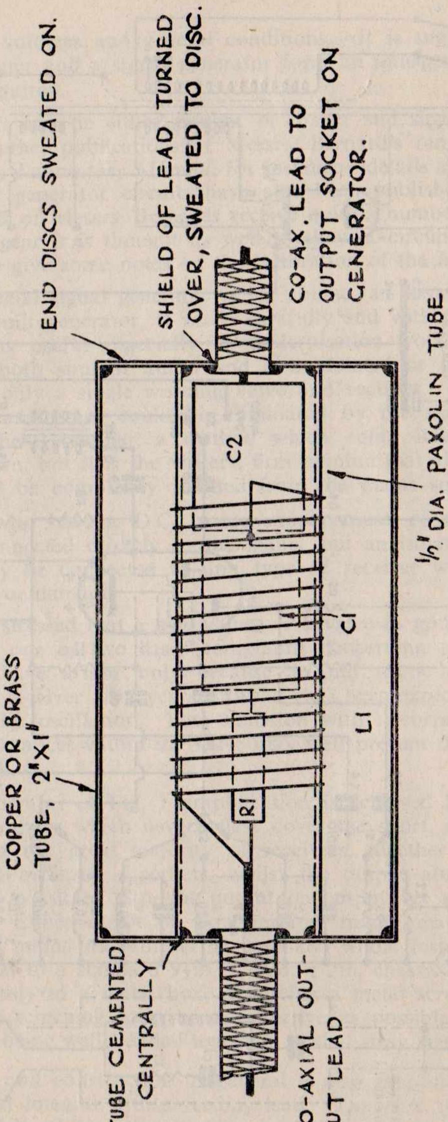


Fig. 2. The Artificial Aerial; Sectional View.

2in. long. The cylindrical box is closed at each end with a disc of the same metal, a co-axial lead entering and leaving as shown in the diagram of Fig. 2.

When the generator is to be used for I.F. alignments, as an audio source, etc., a plain co-axial lead is taken from the output socket to the receiver under test, but when the artificial aerial is required—as when the generator is used for the alignment of first tuned circuits, and so on—the plain lead is removed and the A.A. with its lead is used instead.

A specimen chassis layout, seen from below, is shown in Fig. 3.

Components List for the Signal Generator, Fig. 1.

R1,	390 ohms.
R2,	10,000 ohms. output control.
R3,	1,000 ohms.
R4,	33,000 ohms, 1 watt.
R5, R7, R8,	47,000 ohms.
R6,	68,000 ohms.
R9,	330 ohms.

All resistors except R4, ½ watt. rating.

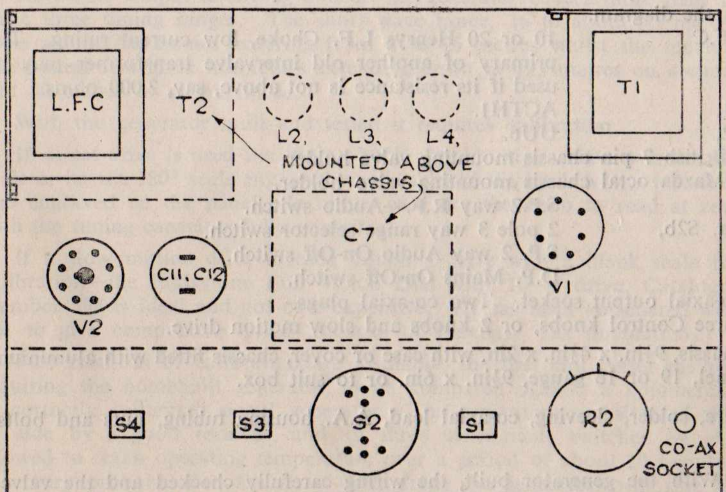


Fig. 3. Specimen Layout for the Signal Generator.

C1,	0.0004 mfd. Mica.
C2,	0.0002 mfd. Mica.
C3, C8, C9,	0.001 mfd. Mica.
C4, C10,	0.1 mfd. Tubular, 350 v.w.
C5,	0.01 mfd. Tubular, 350 v.w.
C6,	50 pfs. Silver-Mica.
C7,	0.0005 mfd. Variable Tuner. Use good make (Polar, etc.), of panel mounting variable capacitor.
C11, C12,	8 Plus 8 mfds. 450 v.w. Electro'ic.
t, t, t,	30 pfs. Trimmers. Fixed trimmers may be used or screw-adjusted postage stamp trimmers provided for exact range setting.
T1,	3:1 or 5:1 Intervalve transformer.
T2,	230—250 volts primary. 300—0—300 volts Secondary. 4v. 1—2 a. 4v. 1—2 a. H.T. current is low, and a 50 or 60 mAs. secondary is more than adequate.
L1,	60 turns 28 S.W.G. enam. ½in. diameter paxolin tube, closewound to 1in. long.
L2,	Wearite PHF3. 16—50 metres.
L3,	Wearite PHF7. 250—750 metres.
L4,	Wearite PHF1. 750—2,000 metres.

Connect L2, 3 and 4 as shown by the Coil Key and numbered connections on the diagram.

L.F.C.	10 or 20 Henrys L.F. Choke, low current rating. The primary of another old intervalve transformer may be used if its resistance is not above, say, 2,000 ohms.
V1,	ACTH1.
V2,	UU6.

1 British 7 pin chassis mounting valve holder.
1 Mazda octal chassis mounting valve holder.

S1,	S.P.2 way R.F.—Audio switch.
S2a, S2b,	2 pole 3 way range selector switch.
S3,	S.P. 2 way Audio On-Off switch.
S4,	D.P. Mains On-Off switch.

Co-axial output socket. Two co-axial plugs.
Three Control knobs, or 2 knobs and slow motion drive.

Chassis, 9½in. x 4½in. x 2in. with case or cover, chassis fitted with aluminium panel, 19 or 16 gauge, 9½in. x 6in. or to suit box.

Wire, solder, sleeving, co-axial lead, A.A. housing tubing, nuts and bolts, etc.

With the generator built, the wiring carefully checked and the valves inserted, first check its operation on audio. Switch S3 On, S1 to audio, and connect headphones across the output at the output co-axial socket.

Turn R2 up to full, when a loud note should be heard in the 'phones. The note ideally should be at a frequency of 400 cycles but the actual frequency will be set by the characteristics of the intervalve transformer used as T1. This component may be tuned however by the use of a capacitor connected across either winding, the capacitor being chosen experimentally.

With the audio section working satisfactorily remove the 'phones and couple the output via the plain co-axial lead to the A.E. terminals of a receiver. Switch on the set and tune to the middle of the medium waveband. Switch S1, on the generator, to R.F. and S2 to the medium band, i.e., its central position. Rotate C7, when at one setting of the generator tuning a loud clear note should be heard in the receiver.

It is barely possible that on one waveband or other of the signal generator the received note will be harsh and broadly tuned. This indicates that the signal generator is " squegging " and the cure is to reduce the amplitude of oscillation by inserting a low resistance in series with the appropriate grid coil. The resistance will have a value between about 50 and 500 ohms, the final value being determined by experiment, and the resistor should be connected between the grid coil of the offending inductance and that coil's contact on S2b.

Squegging should not occur since the value of C6 has been carefully chosen by trial to give the correct amplitude of oscillation.

Harmonic output is strong, and so the generator covers more than its basic three tuning ranges. The short wave range, 16 to about 50 metres, gives second harmonics covering from 8 to 25 metres whilst the medium wave band also gives harmonics extending down to 125 metres on seconds and 80 metres or so on thirds.

With the generator built and tested it requires calibration.

If direct drive is used the tuning knob should either rotate over a 180° scale or have a 180° scale engraved on the skirt of the knob with a reference line engraved on the panel. In either case, set the knob to read at zero with the tuning capacitor fully unmeshed.

If a slow motion drive is used obtain a drive with a blank scale for calibration—the Eddystone Full Vision Dial with 10—1 drive, Catalogue Number 598 is ideal and not over-expensive. (It has been considered wise not to give components prices because of Purchase Tax fluctuations.)

Two methods of calibration are available, the first and better method requiring the homebuilt generator to be compared against a commercial or correctly calibrated signal generator. The generators are situated side by side by a good receiver, and all three instruments switched on and allowed to reach operating temperature over a period of about 20 minutes. It is very probable that the stray fields from the generators will give all the signal strength required, but if not then they must both be coupled into the receiver A and E terminals through their respective artificial aerials.

Each generator must be run at as low a level as possible.

To calibrate, proceed as follows. Tune the receiver to, say, 1 Mc., 300 metres. Tune the commercial generator to 1 Mc. and, if necessary, correct the receiver tuning so that the generator note is tuned-in exactly. It must be realised that the receiver is not the calibrating medium, it is only an indicator, and theoretically no tuning scale is needed on the receiver.

With the commercial generator and the receiver tuned to exactly 1 Mc, switch off the audio modulation so that the note in the receiver loudspeaker ceases, switch off the audio modulation of the home built generator, switch S2 to the medium waveband and tune the home built generator until its carrier beats with that of the commercial generator, causing a heterodyne howl. Continue the tuning; the howl will drop in pitch until it is inaudible. If the home built generator is tuned further the howl will again be heard rising in pitch as the two generators come out of tune.

When the howl is inaudible the home built generator is exactly in tune with the commercial model and its scale may be calibrated at that tuning point as 1 Mc.

Switch on the audio modulation of the commercial generator and tune it to the next desired point—say 1.2 Mcs.—retuning the receiver until its note is heard once again.

Switch off the audio, and tune the home built generator until once more the zero beat note is obtained. The home built generator is now tuned to 1.2 Mcs. and its scale may be calibrated with this figure.

Continue, using this method, over the three wavebands of the home built generator until all the desired points are calibrated. The calibration takes some little time and patience but excellent accuracy is attainable.

If no commercial or calibrated generator is available then once again a receiver must be used as the indicator but the standard frequencies will have to be obtained from broadcasting stations. A very useful frequency list, suitable for generator calibration, is given in the " International World Radio Station List " No. 84, published by Bernards (Publishers) Ltd., London, W.6.

The best way of using such a list is as follows:—

Tune the receiver on the appropriate band to a series of stations whose exact frequency is known. With the station tuned, tune the signal generator, warmed up as before and with audio modulation switched on, until the generator note is centred dead on the station, tuning first the set and then the generator through each one of the frequencies chosen.

The station frequencies can then be shown as the points on the Y axis of a tuning graph, the dial readings of the generator being shown as points along the X axis, and a specimen graph is shown in Fig. 4. Other frequencies required from the generator may then be read off the graph.

The only real difficulty occurs when the Intermediate Frequency range is reached at the high capacity end of the medium waveband of the

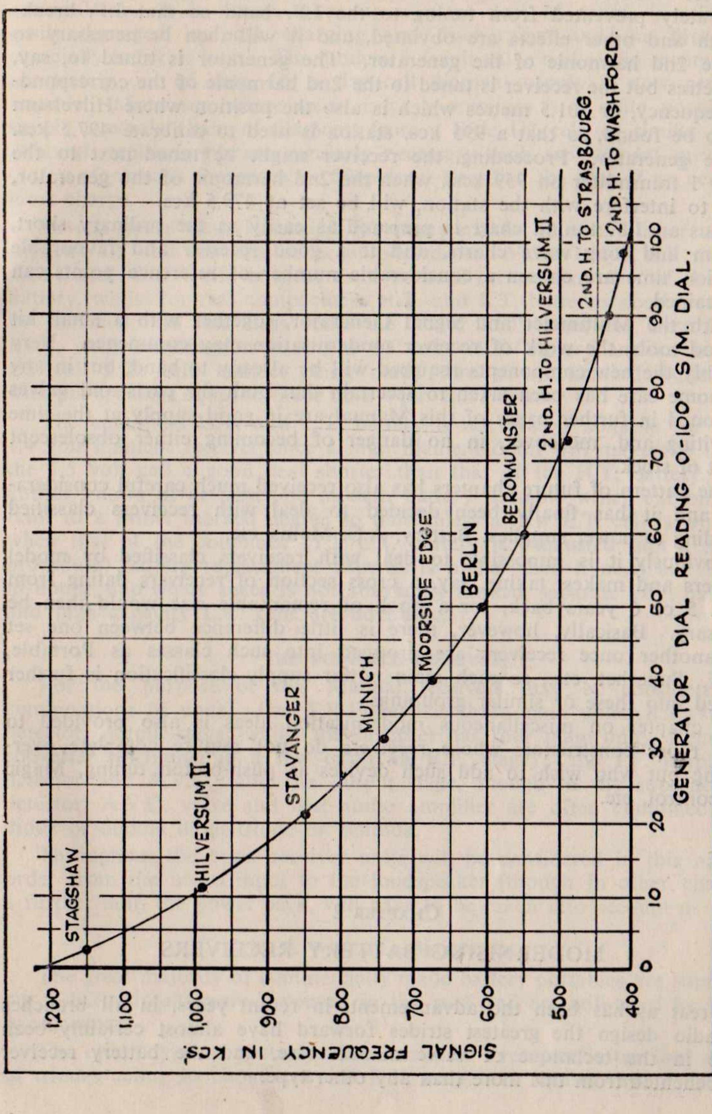


Fig. 4. Specimen Signal Generator Tuning Graph.

generator under discussion (450 kcs.—666.6 metres). Receivers are deliberately prevented from tuning to the I.F. band so that I.F. break-through and other effects are obviated, and it will then be necessary to use the 2nd harmonic of the generator. The generator is tuned to, say, 603 metres but the receiver is tuned to the 2nd harmonic of the corresponding frequency, or 301.5 metres which is also the position where Hilversum 2 is to be found, so that a 995 kcs. station is used to calibrate 497.5 kcs. on the generator. Proceeding, the receiver might be tuned next to the Nancy 1 transmitter on 959 kcs., when the 2nd harmonic of the generator, tuned to interfere with the station, will be set at 479.5 kcs.

Thus an I.F. tuning chart is prepared as easily as the ordinary short, medium and long wave charts, and if a good receiver and favourable reception time are chosen a considerable number of reference points can be obtained.

With the Multimeter and Signal Generator, together with a small kit of good tools, the work of receiver modernisation may commence. Very probably the new components required will be already to hand, but in any case some care has been taken to ascertain that both the parts and valves mentioned in further pages of this Manual are in good supply at the time of writing and, moreover, in no danger of becoming either obsolescent or out of stock.

The pattern of future chapters has also received much careful consideration, and it has finally been decided to deal with receivers classified according to power supplies: Battery, A.C. Mains, etc.

Obviously it is impossible to deal with receivers classified by model numbers and makes, taking, say, a cross section of receivers dating from about 5 or 6 years back, for a book of remarkable size would then be necessary. Basically, however, there is little difference between one set and another once receivers are grouped into such classes as Portable, T.R.F., Superhet, etc., so each main power supply classification is further divided into these or similar groupings.

A chapter on miscellaneous modernisation ideas is also provided to assist those constructors whose receivers do not require complete over-hauling but who wish to add such devices as push-button tuning, Magic Eye control, etc.

Chapter 2

MODERNISING BATTERY RECEIVERS

Great as has been the advancement, in recent years, in all branches of radio design the greatest strides forward have almost certainly been made in the technique of valve manufacture, and the battery receiver has benefited from this more than any other type.

One of the greatest drawbacks to the old-fashioned battery set is the accumulator. It is heavy, takes up a great deal of room, is relatively easily damaged in both charging and discharging, and the first cost, especially today, is high. The modern 1.4 volt valve makes the accumulator completely out of date, for a dry cell filament supply is now perfectly feasible. Moreover, where space is at a premium it is quite possible to supply a whole chain of filaments from a little U2 cell, or similar, when although replacements are regularly necessary each replacement means an outlay of perhaps fourpence or fivepence—less than the cost of an accumulator charge.

In less space than is needed for many makes of accumulator a high capacity 1.5 volt cell can be accomodated—the Vidor L5049 cell may be mentioned—with a life as great as or perhaps greater than that of the H.T. battery, whilst for real compactness H.T. and L.T. batteries combined may be obtained. In this class come the Vidor L5054 and the Ever Ready B103, each combination having a 90 volts H.T. battery and an isolated 1.5 volt L.T. cell, contact being made through a standard 4-pin plug with pin spacings equal to those on a 4-pin valve base.

The combined H.T. and L.T. battery is not always suitable for every 1.4 volt filament receiver since a high filament drain will make the life of the 1.5 volt cell a good deal shorter than that of the H.T. battery. The author knows of at least one modern battery portable which exhibits this fault to a rather marked degree so that unless a new L.T. cell is wired in when that of the combined H.T./L.T. battery is exhausted (not a simple procedure) battery replacement expense is higher than it need be. When in doubt, and where space is not absolutely limited, separate H.T. batteries and high capacity L.T. cells are advisable.

THE PORTABLE RECEIVER.

For the purpose of this Manual receivers may be considered as combinations of units. The T.R.F. set has three main units, R.F. stages; detector; output stage; whilst the superhet has four main units, frequency converter (including in a few cases an R.F. stage); the I.F. amplifier; detector and A.V.C.; and the output stage, though in the superhet the detector, A.V.C. valve and first audio amplifier are often combined in a diode or double diode-triode or pentode.

Throughout the book receiver units will be considered in this natural order from the aerial input to the loudspeaker (though in other chapters a further unit, the power pack, will have to be taken into account as well).

T.R.F. PORTABLE RECEIVERS.

The great majority of commercially made battery portables are superhets but T.R.F. circuits were favoured in the past and are still used by home constructors.

The oldest type of portables, the " suitcase " receiver, often had a pair of triodes acting as choke coupled R.F. amplifiers feeding into a detector and L.F. amplifier. Only one tuned circuit was used, coupled into the grid of the first R.F. triode, though reaction might be supplied from the detector valve. This set—with which very little can be done today for it requires complete re-building and even the case is far too large for a modern receiver—developed into a circuit using a tetrode or pentode as the first tuned stage and R.F. amplifier feeding into a detector triode with reaction over the second stage of tuning.

With two stages of tuning the portable's efficiency rose by a marked degree—and it became an inconvenient type of receiver so far as the home constructor was concerned, and has remained inconvenient ever since.

The whole trouble lies in the fact that the first tuned circuit of a conventional portable receiver consists of a frame aerial tuned by one section of a ganged capacitor, the second tuned circuit consisting of an ordinary coil tuned by the second section of the capacitor. For anything like efficiency the two tuned circuits must be in gang—i.e., the two very differently shaped coils must behave alike over the whole frequency range of the set, and this means that even if the two coils are brought to the same inductance value by bridge adjustments this is no guarantee that they will tune alike, for the stray capacitances of one coil will almost certainly be very different from those of the other.

(The problem, incidentally, also appears in the portable superhet. Here the "aerial" coil is the frame aerial and the oscillator coil is the normal type.)

There are, therefore, two different ways of treating the R.F. and detector units of a T.R.F. portable. If the selectivity and sensitivity of the receiver are reasonably acceptable the original frame aerial and tuning coil—assuming the normal two tuned circuits—may be left exactly as they are and the general performance of the set improved by switching over to new valves.

If, however, the set is inselective or insensitive a new tuning system, as well as new valves, will be needed. It is also worth while, in this case, to consider whether a change over to a superhet circuit is a simple matter. using the present cabinet, chassis, etc.

NEW VALVES.

Valves with 1.4 volt filaments may be obtained in either American or British ranges, the two types being in many ways very similar. The British 1.4 volt valves may also be obtained with either pressed glass bases to fit B7G holders, when the valves usually become the smallest parts of the receiver, or with International octal bases, the valve then being normal in size.

On the score of performance there is little to choose between the larger and smaller British types. Filament current is the same, 0.05 amp. for R.F. and general purpose types and 0.1 amp. for output types although several of the output valves have centre-tapped filaments for use either on a 3 volt 0.05 amp. circuit or a 1.4 volt 0.1 amp. circuit.

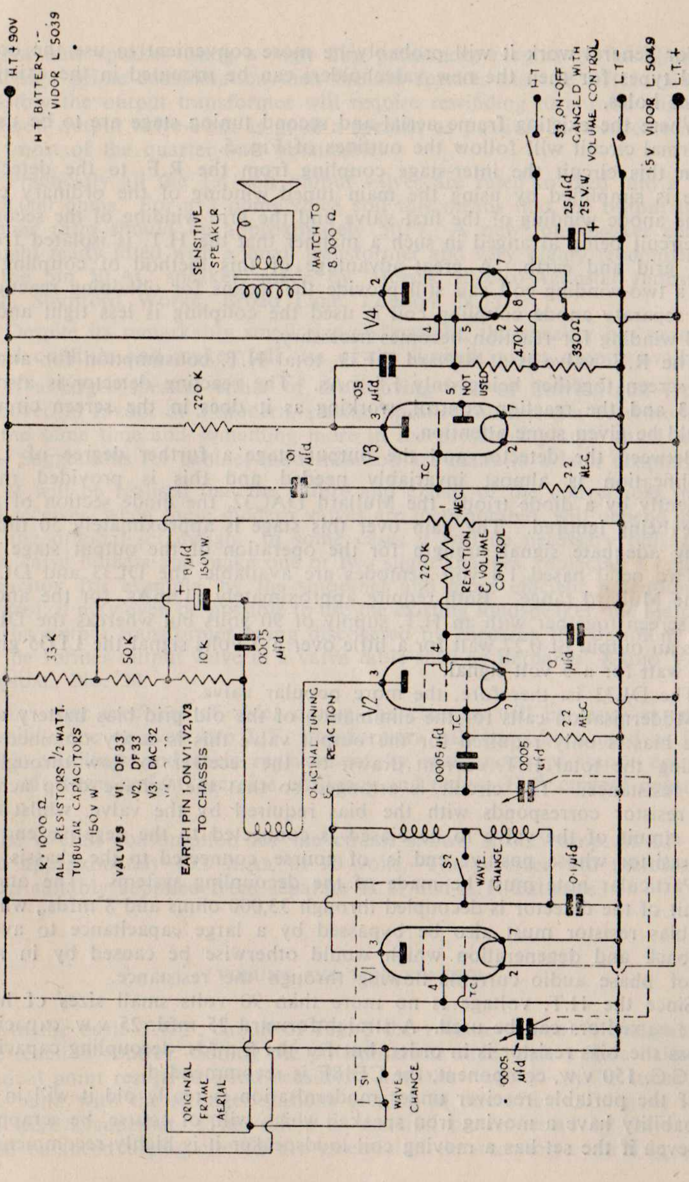


Fig. 5. Modernised T.R.F. Portable, using Original Tuning System.

For general work it will probably be more convenient to use the octal based types for then the new valveholders can be mounted in the existing chassis holes.

Where the existing frame aerial and second tuning stage are to be used a normal circuit will follow the outlines of Fig. 5.

In this circuit the inter-stage coupling from the R.F. to the detector valve is simplified by using the main tuned winding of the ordinary coil as the anode winding of the first valve and the grid winding of the second, the circuit being arranged in such a manner that the H.T. is isolated from both grid and earth. A great advantage of this method of coupling is that a two-winding coil can still provide the means for obtaining reaction; if a separate anode coupling coil is used the coupling is less tight and a third winding for reaction becomes necessary.

The R.F. valve is a Mullard DF33, total H.T. consumption for anode and screen together being only 1.5 mAs. The reacting detector is also a DF33 and the reaction control, working as it does in the screen circuit, should be given some attention.

Between the detector and the output stage a further degree of L.F. amplification is almost invariably needed and this is provided most efficiently by a diode triode, the Mullard DAC32, the diode section of the valve being ignored. The gain over this stage is approximately 50 times, giving adequate signal strength for the operation of the output stage.

Two octal based 1.4 volt pentodes are available, the DL33 and DL35, in the Mullard range. Both require approximately 11 mAs. for the anode and screen together with an H.T. supply of 90 volts but whereas the DL33 gives an output of 0.27 watt for a little over a 3 volts signal the LD35 gives 0.24 watt for a 5 volt signal.

The DL33 is, therefore, the more popular valve.

Modernisation calls for the elimination of the old grid bias battery and since bias is only required for the output valve this is easily obtained by causing the total H.T. current drawn by the receiver to flow through a low resistance. The circuit is arranged so that the voltage drop across the resistor corresponds with the bias required by the valve, whilst the grid circuit of the valve to be biased is connected to the negative end of the resistor whose positive end is, of course, connected to the chassis.

Particular note must be made of the decoupling systems. The anode circuit of the detector is decoupled through 33,000 ohms and 8 mfds., whilst the bias resistor must also be bypassed by a large capacitance to avoid feedback and degeneration which would otherwise be caused by in and out-of phase audio currents flowing through the resistance.

Since the H.T. voltage is no more than 90 volts small sizes of high value capacitors can be used. A straightforward 25 mfd. 25 v.w. capacitor across the bias resistor is in order, but for the 8 mfds. decoupling capacitor a T.C.C. 150 v.w. component, the CE18F is recommended.

If the portable receiver under modernisation is really old it will in all probability have a moving iron speaker which will, of course, be scrapped, but even if the set has a moving coil loudspeaker it is highly recommended that a new speaker using a high flux permanent magnet be installed. If cost is a prime consideration then the old speaker may be left in place—possibly the output transformer will require rewinding to a ratio suited to the new output valve—but as good a speaker as possible is needed to make the most of the quarter-watt obtainable.

Practically all the 1.4 volt output valves are rated to feed into a load of 8,000 ohms. For a 3 ohms voice coil this means that the output transformer ratio should be approximately 50:1. A new loudspeaker can be bought ready fitted with a small transformer and very highly recommended is the 5in ELAC speaker, made by Messrs. Electro-Acoustic Industries, Ltd., Stamford Works, Broad Lane, London, N.15.

Despite its remarkably small size and weight, the speaker has excellent tonal qualities and makes full use of the limited power output available.

If a larger speaker either of the moving iron or moving coil type is removed in favour of a modern, smaller speaker the fret can be remodelled at the same time and something more in the present-day style fitted to the set. Suggestions for cabinet modernisation are made in a later chapter.

It will be realised that the nature and extent of the conversions in the old receiver, when these modern valves are incorporated, will depend solely on the original set design. In some cases it will be necessary only to fit new valve holders and make one or two slight changes, replacing a reaction capacitor, for example, by the smoother and more efficient potentiometer control; it may even be possible to use the existing loudspeaker, the matching of the output transformer being discovered by checking the optimum load of the former output valve in a valve table such as Bernards' RADIO VALVE MANUAL, No. 30.

In other receivers of older design the changes will be more extensive. Possibly one or even two L.F. transformers will have been used as inter-valve couplings and their replacement by resistance-capacitance coupling will cut down weight, increase efficiency and reduce H.T. current consumption.

The overall consumption for the circuit shown is 0.25 amp. at 1.5 volts and approximately 13.5 mAs. at 90 volts. The receiver will therefore be most suitably supplied from separate H.T. and L.T. batteries.

VOLUME AND TONE CONTROL.

In the basic T.R.F. circuit of Fig. 5 the volume control is integral with the reaction control. Setting the potentiometer slider arm a little below the critical point results in good sensitivity and the receiver can be tuned over the band with the stronger stations coming in one after another as if the set were a superhet. (This refers to the trial model tested by the author; well balanced tuning circuits are essential if the reaction control is not to be adjusted with every move of the tuning knob.) On the strong stations retardation of the reaction control gives complete volume control and on the weaker stations the reaction control can be advanced to bring up the volume.

If a tone control is thought desirable this is best incorporated directly between the anode of the output valve and the chassis, using a 0.01 mfd. capacitor and a 50,000 ohms variable resistor in series.

This completes the full modernisation of an old circuit where the tuning system is in good shape.

A NEW TUNING SYSTEM

In cases where the tuning system of the old portable receiver is no longer satisfactory the conversion is bound to be a rather more involved task. Possibly the frame aerial is the only tuned circuit in the set or it may be that an old-fashioned and inefficient coil is used as the second tuned circuit. In the first case the remedy would seem to be the addition of a further tuned stage, whilst in the second case it might be thought that substituting a modern coil for the old coil would effect an improvement. In both cases, however, the very considerable difficulties of alignment of the two tuned circuits immediately arise.

The author has performed several experiments in an endeavour to design a frame aerial which can be easily duplicated from instructions and which will match well with a commercially marketed coil, but in no case has he been completely satisfied with the results achieved. Two methods are available, either the frame aerial may consist of a single medium wave winding with a "scramble" wound long wave coil on a small former switched in series with the frame for long wave tuning, or the frame aerial may be wound with the complete tuning coil for both medium and long wavebands. There is little doubt that the second method has much to recommend it—long wave pickup, using the first method, is very poor in poor reception areas—and the most promising results so far obtained were with a frame aerial wound on a plywood rectangle whose outside dimensions were 11in. long by 8¼in. high the rectangle or winding space being 2in. deep.

On this frame were wound 18 turns of 28 S.W.G. D.C.C. wire, taking up rather less than ½in., for the medium wave winding, the long wave winding consisting of these 18 turns in series with a further 75 turns of 30 S.W.G. enamelled wire, this second winding taking up roughly an inch of space, giving about ¼in. margin all round the frame. In each coil the turns are wound touching.

This frame aerial appears to match reasonably well with a Wearite PHF1 as the long wave coil and PHF2 as the medium wave coil in the second tuned circuit.

The size of frame quoted will not suit every receiver, however, nor would it be possible to give details for all the frame sizes that might be found. The worker who is remodelling an old portable with inefficient tuning is therefore strongly advised to make a really clean sweep of the old-fashioned gear and methods and to rebuild the receiver as a superhet. The details are as those given under the heading of " Superhet Portables " below.

Nevertheless it may be desired to keep to a T.R.F. circuit for one reason or another, and then the circuit of Fig. 6 is recommended. This is very similar to the circuit of Fig. 5, but the tuning arrangements are changed, the frame aerial being scrapped and ordinary coil tuning used for both the first and second stages. In place of the frame aerial is used either a " sheet " or a " wound " aerial.

A " sheet " aerial consists of a metal plate as large as can be accommodated within the receiver cabinet, a sheet of metal foil being perfectly suitable. A " wound " aerial consists of a winding arranged in the form of a square spiral as shown in Fig. 7, this winding being made on the backboard or rear cover of the cabinet and of a size, once again, as large as can be accommodated. If the cabinet has a fibre backboard this should be replaced by a board of plywood cut and finished to the same size, the aerial being wound round 15 or 20 small brass brads driven in along each diagonal of the backboard equidistantly.

Whether a " sheet " or " wound " aerial is used provision can be made for connecting in an external aerial, a very desirable asset for poor reception areas, and in either case two methods of connecting the aerial to the set are available, denoted by the aerial sockets " 1 " and " 2 " of Fig. 6.

Connecting the aerial to socket " 1 " makes for selectivity and simple coil alignments, whilst using socket " 2 " means that some re-trimming of the first coil will be necessary, but the signal strength will be considerably enhanced. It is therefore intended that the aerial socket shall be chosen to suit the area where the receiver is in use and the set aligned with the aerial connected in the chosen manner.

With either aerial an external aerial can be added through a 0.0001 mfd. capacitor. If socket " 2 " is used the connection of an external aerial will make further trimming adjustments necessary; if socket " 1 " is in use retrimming may or may not be necessary, depending on the characteristics of the external aerial.

The recommended coils are those made by H. C. Atkins Laboratories, these coils having adjustable iron dust cores so that very close alignment between the two tuned circuits is possible. For the R.F. and detector stages respectively, Red No. 1 and White No. 1 coils are used for long wave tuning and Red No. 2 and White No. 2 for medium wave tuning. Red No. 1's and No. 2's may also be used throughout, since the Red type coils give excellent reaction in the detector stage.

The wave ranges covered are 800 to 2,000 metres, using No. 1 coils, and 200 to 550 metres using No. 2 coils. The coils should be obtainable

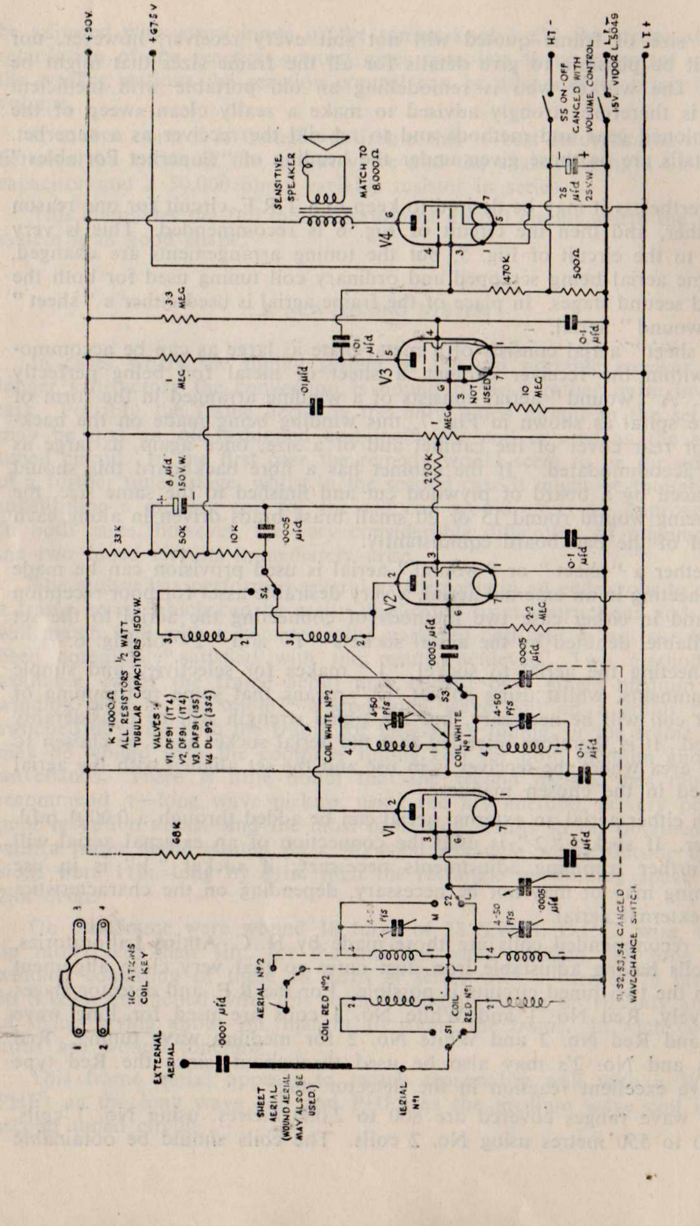


Fig. 6. Modernised T.R.F. Portable, using New Tuning System.

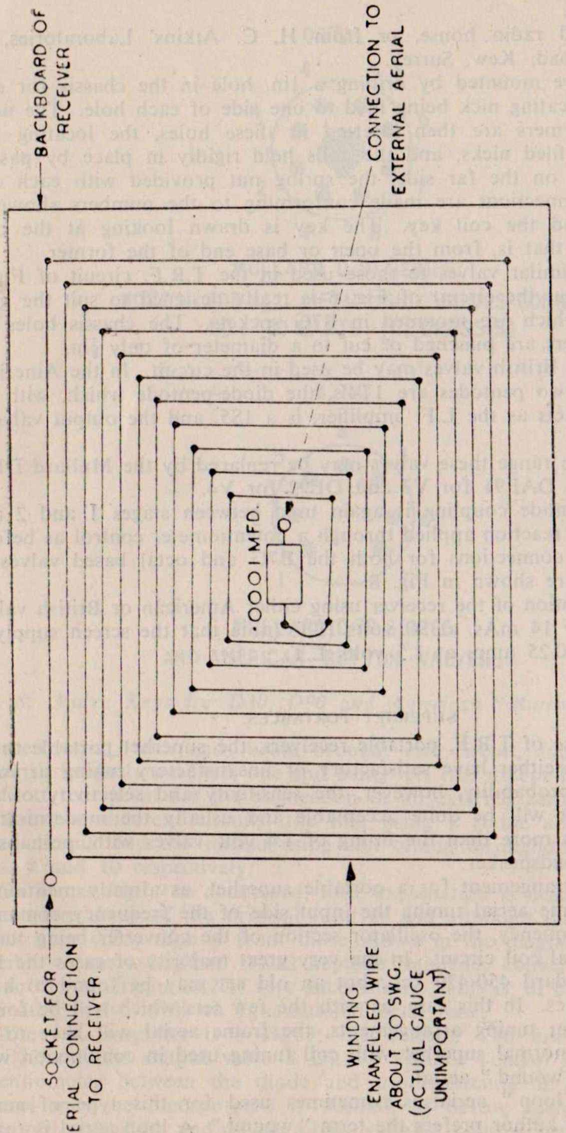


Fig. 7.. The "Wound" Aerial.

from any good radio house, or from H. C. Atkins' Laboratories, 32, Cumberland Road, Kew, Surrey.

The coils are mounted by drilling a ¼in. hole in the chassis for each coil, a small locating nick being filed to one side of each hole. The necks of the coil formers are then inserted in these holes, the locating pips locking in the filed nicks, and the coils held rigidly in place by passing over the necks on the far side, the spring nut provided with each coil.

The coil connections are made conforming to the numbers shown in the diagram and the coil key. The key is drawn looking at the coils from " below," that is, from the open or base end of the former.

If desired, similar valves to those used in the T.R.F. circuit of Fig. 5 may be used, but the circuit of Fig. 6 is really designed to suit the glass based valves, which are mounted in B7G sockets. The chassis holes for these valveholders are punched or cut to a diameter of only ⅝in.

American or British valves may be used in the circuit. In the American range the first two pentodes are 1T4's, the diode-pentode which, with the diode ignored, acts as the L.F. amplifier, is a 1S5, and the output valve is a 3S4.

In the British range these valves may be replaced by the Mullard DF91 for V1 and V2, DAF91 for V3 and DL92 for V4.

The tuned anode coupling is again used between stages 1 and 2 and the detector has reaction applied through a potentiometer control as before.

Valveholder connections for both the B7G and octal based valves so far mentioned are shown in Fig. 8.

The consumption of the receiver using either American or British valves is approximately 14 mAs. at 90 volts H.T. (note that the screen supply is 67.5 volts) and 0.25 amp. at 1.5 volts L.T.

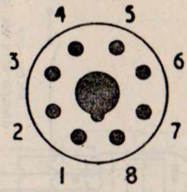
SUPERHET PORTABLES.

As in the case of T.R.F. portable receivers, the superhet portable to be modernised may either have satisfactory or unsatisfactory tuning arrangements. In all probability, however, the sensitivity and selectivity of the superhet receiver will be quite acceptable and usually the modernisation work will be no more than the fitting of 1.4 volt valves with, perhaps, a more efficient loudspeaker.

The usual arrangement for a portable superhet, as already mentioned, is to have a frame aerial tuning the input side of the frequency converter to the signal frequency, the oscillator section of the converter being tuned by a conventional coil circuit. In the very great majority of cases the I.F. will be the standard 450-470 kcs., but an old set may be found to have an I.F. of 110 kcs. In this case, as with the few sets which will be found to have inefficient tuning arrangements, the frame aerial will have to be scrapped and a normal superhet with coil tuning used in conjunction with a " sheet " or " wound " aerial.

(The term " loop " aerial is sometimes used for this type of aerial winding, but the author prefers the term " wound." A loop aerial is really

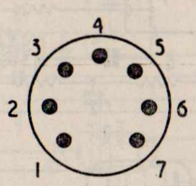
OCTAL.



MULLARD D 30 SERIES.

NOTE :– FOR ALL METALLISED VALVES CONNECT. NO. 1 TO EARTH (I.E. CHASSIS)

B.7.G.



MULLARD D 90 SERIES AND AMERICAN "BUTTON" VALVES.

Fig. 8. Valve Keys for D30, D90 and American "Button" valve series.

a tuned aerial, both ends being brought into circuit, and the "wound" aerial is definitely untuned, one end being left free except for the provision made at that point for the connection of an external aerial.)

The two different circuits, the first using a frame aerial as the first tuned circuit, and the second using coil tuning throughout, are shown in Figs. 9 and 10 respectively.

So far as Fig. 9 is concerned, little explanation is needed. The tuning circuits are those of the original receiver and although the exact arrangements may differ slightly from those shown in the diagram, it should be possible to use a Mullard DK32 heptode frequency converter (corresponding to the American 1A7G) very successfully. This is, of course, a 1.4 volt 0.05 amp. valve with an International octal base.

The I.F. amplifier is a DF33; the detector and first audio stage a DAC32 and the output valve a DL33. Volume control is via the usual potentiometer between the diode and triode circuits of V3 and a tone control may be incorporated if desired, as before mentioned, using a 0.01 mfd. capacitor and 50,000 ohms variable resistor between the anode of V4 and earth.

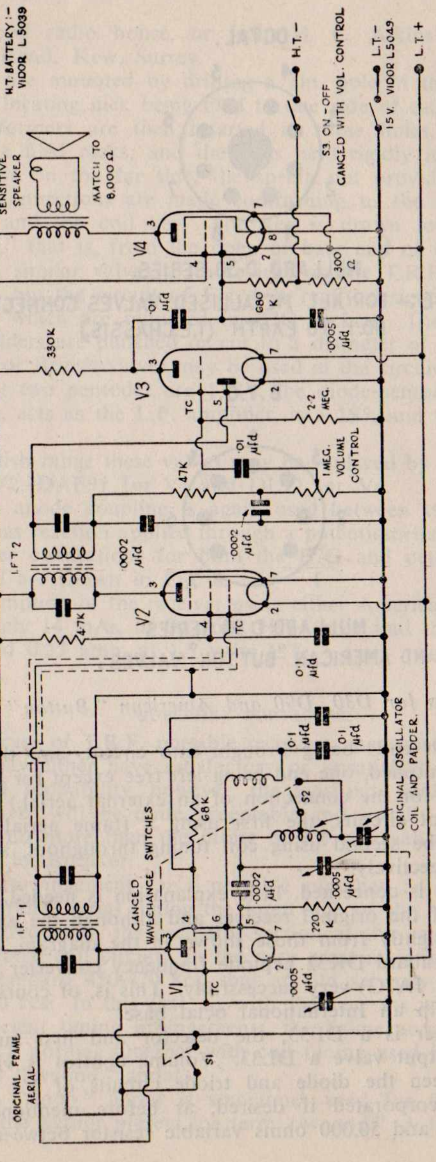


Fig. 9. Modernised Superhet Portable, using Original Tuning System.

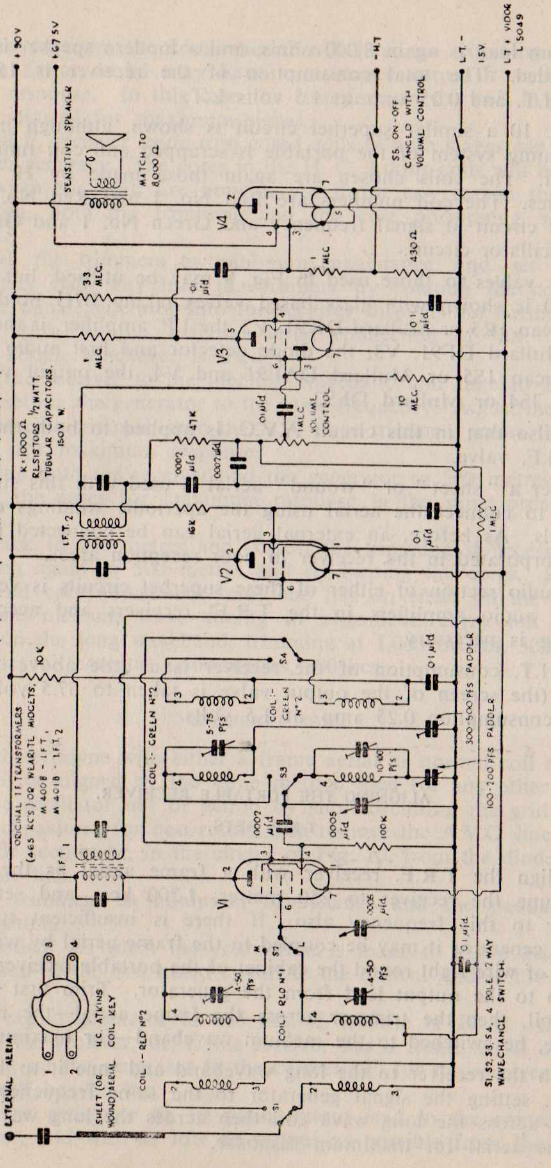


Fig. 10. Modernised Superhet Portable, using New Tuning System.

Optimum load is again 8,000 ohms, and a modern speaker is definitely recommended. The total consumption of the receiver is 15 mAs. at 90 volts H.T. and 0.25 amp. at 1.5 volts L.T.

In Fig. 10 a similar superhet circuit is shown, although in this case the old tuning system of the portable is scrapped and coil tuning is used throughout. The coils chosen are again those made by H. C. Atkins Laboratories. The coil numbers are Red No. 1 and Red No. 2 for the first tuned circuit at signal frequency and Green No. 1 and Green No. 2 for the oscillator circuit.

Similar valves to those used in Fig. 9 may be utilised, but the circuit of Fig. 10 is shown with glass based valves taking B7G holders. V1 is the American 1R5 or Mullard DK91, V2, the I.F. amplifier, is the American 1T4 or Mullard DF91, V3, the diode detector and first audio pentode is the American 1S5 or Mullard DAF91 and V4, the output valve is the American 3S4 or Mullard DL92.

Note also that in this circuit A.V.C. is applied to both the converter and the I.F. valve.

Whether a " sheet " or " wound " aerial is used with this superhet it is advisable to connect the aerial using the aperiodic windings on the first tuned coils. As before, an external aerial can be connected in with the aerial incorporated in the receiver in poor reception areas.

The audio section of either of these superhet circuits is very different from the audio amplifiers in the T.R.F. receivers and accordingly no decoupling is necessary.

The H.T. consumption of the receiver is a little above 16 mAs. at 90 volts (the screen of the output valve is taken to 67.5 volts) and the filament consumption 0.25 amp. at 1.5 volts.

ALIGNING THE PORTABLE RECEIVER.

T.R.F. SETS.

To align the T.R.F. receiver with a frame aerial as the first tuned circuit, tune the receiver to 250 metres, 1,200 kcs., and set the signal generator to this frequency also. If there is insufficient stray pick-up from the generator it may be coupled to the frame aerial by winding about six turns of wire right round the cabinet of the portable receiver, connecting this loop to the output lead from the generator. Trim first the detector tuning coil, then the trimmer across the frame aerial—the receiver will, of course, be switched to the medium waveband—for maximum signal.

Switch the receiver to the long waveband and tune it to 1,000 metres, 300 kcs., setting the signal generator to the same frequency. Trim the trimmers across the long wave coil then across the long wave section of the frame aerial for maximum response.

In some receivers the frame aerial will have no trimming capacitors; indeed, the frame aerial may have a resistance across it to broaden its frequency response. In this case the trimmers on the coil in the second stage are adjusted for maximum signal.

The T.R.F. receiver using iron cored coils in both stages can be aligned with greater accuracy. The cores in the H. C. Atkins coils will be cemented in place when the coils are bought, but if for any reason this seal has been broken, both the trimming and the core positioning will require adjustment.

Open all the trimmers to minimum capacitance and set the cores approximately half way into the formers by rotating the core screws. Couple the signal generator into the receiver through the Artificial Aerial, connecting this to the external aerial connection of the "sheet" or "wound" aerial, whichever is used.

Switch the receiver to the medium waveband and tune to 250 metres, 1,200 kcs., setting the generator to the same frequency. Adjust the trimmers, first the detector trimmer, then the R.F. stage trimmer, across the medium wave coils for maximum response.

Now tune both the receiver and the generator to 500 metres, 600 kcs., and adjust the cores for maximum response in the same order, detector first.

Tune back to 250 metres and correct the trimming if necessary, afterwards tuning again to 500 metres and readjusting the cores. Repeat the trimming and core adjustment until one has no effect on the other.

With the medium wave tuning in alignment, carry out the same procedure on the long waveband, trimming at 1,000 metres, 300 kcs., and adjusting the coil cores at 1,500 metres, 200 kcs.

SUPERHET SETS.

A superheterodyne with either a frame aerial or normal coil as the first tuned circuit is aligned by the same method used for any other superhet. First set the oscillator out of action by short-circuiting the grid coil with a 0.1 mfd. capacitor ; for best results also remove the A.V.C. line from the A.V.C. diode section or, in the circuit of Fig. 10, from the diode detector, and earth the line.

Set the trimmers to minimum capacitance and the padders to the midway position.

If convenient, as when the connection is made to a top grid, remove the connection of the first tuned circuit to the control grid of the frequency converter.

Set the signal generator to 465 kcs. if Wearite or H. C. Atkins coils are used in the receiver, or, if the receiver has a frame aerial as the first tuned circuit, set the generator to the correct I.F. for the receiver. In most cases this will be 465 kcs.

Couple the generator by its plain output lead to the control grid of the converter, and with as low an output as possible from the generator tune the I.F. transformers to give maximum response, trimming first the winding connected to the detector and working back towards the converter anode circuit.

Remove the generator lead from the control grid of the converter, restoring the top cap if this was removed.

Remove the short-circuiting 0.1 mfd. capacitor so that the oscillator works normally. Connect the generator through the artificial aerial to the A and E terminals of the receiver or, if a frame aerial is in use, couple the generator in with a few turns of wire round the cabinet.

Switch the receiver to the medium waveband and tune it to 200 metres. If no calibrated dial is fitted, set the ganged tuning condenser almost to minimum capacitance and calibrate the receiver on a cardboard scale as the alignment proceeds, marking the wavelengths in with pencil.

Set the generator to 200 metres, 1,500 kcs., and trim the medium wave oscillator trimmer until the signal is heard with maximum volume. Bring up the volume by trimming the first tuned circuit.

Tune the receiver and generator to 500 metres, 600 kcs. (on an unmarked scale the ganged condenser should be set to about four-fifths of its maximum capacitance), and pad the oscillator padding capacitor until the signal is heard. The tuner should be "rocked," i.e., turned slightly back and forth, as this adjustment is made.

Retune to 200 metres and retrim both the oscillator and first tuned circuit.

Retune to 500 metres and reset the padder as necessary.

Repeat the last two operations as often as necessary until they cease to have any mutual effect. The generator output should always be kept as low as possible.

With the medium waveband in alignment the whole trimming and padding procedure must be repeated on the long waveband. Trim at 1,000 metres, 300 kcs., and pad at 1,500 metres, 200 kcs.

THE NON-PORTABLE BATTERY SET.

When the home battery set is to be modernised, considerations of weight and space are a good deal less important than in the case of the portable receiver. Accumulators for the L.T. supply can be used with no more bother than that caused by the necessity for recharging, and whilst 1.4 volt filament valves are every bit as efficient as 2 volt valves in the R.F., I.F., detector and audio stages of the battery receiver a considerably greater output power can be obtained from some types of 2 volt output valves, notably with a Q.P.P. double pentode such as the Mullard KLL32.

Greater output means greater H.T. current consumption, however, and when the battery receiver is to be modernised the whole question of H.T. supplies should be reviewed. The increase in battery prices makes the running of a large battery receiver an uneconomical affair and any method of reducing the current consumption or, alternatively, of obtaining the H.T.

current from a more economical source will effect a very considerable saving over a period of time.

Quite a number of battery receivers are to be found in houses where an electricity supply has now been installed, the old battery receiver having been given a new lease of life by the addition of an H.T. eliminator and trickle charger. The combination is wasteful and inefficient; for a slightly greater current consumption the benefits of a modern mains set could be enjoyed. If the price of a mains set is thought to be too high, possibly a mains receiver could be built into the battery receiver cabinet by an amateur constructor, but this cannot very well be classed as a modernisation job.

Disregarding mains supplies the battery receiver can draw H.T. current from three types of source, all finally dependent on battery power. First, of course, the H.T. dry battery, expensive but convenient and with a reasonable life. The author does not favour the wet H.T. battery, a collection of small accumulator cells, even if such batteries become available again, for experience seems to show that wet H.T. batteries need constant care and attention with perpetual recharging if they are to be of any use at all, whilst they take up a great deal of space. Gassing, the throwing off of acid spray, creep, corrosion and similar troubles are also all too likely.

The second possible source of H.T. current is a vibrator unit, though here either a 4 or 6 volt battery is needed to drive the vibrator pack. If separate grid bias is provided the receiver valves may draw their filament current from one cell of the vibrator battery, but it is usually more satisfactory to use a separate L.T. cell. Messrs. Masteradio Ltd., of Fitzroy Place, London, W.1, have recently produced their 6A H.T.P., a pack sized 7in. x 5½in. x 3in. to supply 120 volts at 10 mAs. from a 6 volt source, whilst details may be obtained from Messrs. Bulgin & Co., Ltd., By Pass Road, Barking, Essex, of their E.K. series of vibrator eliminators run from either a 4 or 6 volt driving battery.

Two-volt vibrators are now also obtainable, and at the time of writing complete 2 volt vibrator packs, made for Canadian "Walkie-Talkie" radios, are to be found on the surplus market. These packs give an output of 90 or 180 volts at 35 mAs., with 1.5 volts for the 1.4 volt type of battery valve.

If high capacity accumulators are used with vibratory power packs too frequent recharging is not needed but at the same time the provision of a really heavy duty 2, 4 or 6 volt battery is no small matter. The system commends itself chiefly to country dwellers who can sometimes recharge such batteries on farm plant.

The third possible source of H.T. power is a motor-generator or "rotary transformer." Here again the difficulty of providing a driving battery arises and although there are at present a great number of rotary transformers on the surplus market, some priced as low as 10s., it must be admitted that a great majority require 12 or 24 volts driving and give outputs of up to 400 volts so that they are far from suitable. Nevertheless, one model sold by Messrs. Premier Radio, of Fleet Street, London, E.C.4, is rated for an output of 180 volts at up to 30 mAs. for a 6 volts input. A low tension 4 volt output is also provided but if this were neglected the input current would drop and the unit could then satisfactorily be run from a 6 volt battery.

It would appear possible for an amateur who is expert in motor repairs to rewind such a rotary transformer to run from the 2 volt accumulator feeding the receiver filaments but undoubtedly the current consumption would then be high.

Whatever the source of H.T. it is as well to design for low current demands whenever possible and with modern 2 volt valves this is not too difficult; indeed a 4 valve superhet with an output of 0.34 watt (Fig. 11) can be designed with L.T. and H.T. demands of 0.38 amp. at 2 volts and about 12 mAs. or a very little more at 135 volts respectively. This compares very well with the consumption of the smaller 1.4 volt filament valves and shows conclusively that a saving in space must generally be paid for by increased H.T. demands.

When a home battery receiver is to be modernised the only circuit which really needs consideration is that of the superhet receiver. The T.R.F. receiver designed round mains valves can be used very successfully in the home as a "quality" receiver, but the battery T.R.F. set needs reaction if gain is to be worthwhile and the consequent deterioration of tone is nowadays unsatisfactory. When a T.R.F. receiver is to be dealt with its conversion to a superhet may seem a heavy task but in reality the work is far from difficult and the resulting new set will cost a good deal less than a commercially made model. Many of the components of the old set can be employed—almost all the resistors and capacitors (though a careful check should be made to ensure that the tubular and electrolytic, if any, capacitors are still in perfect condition; poor components must be scrapped); the valveholders, ganged tuning condenser, the chassis and the cabinet itself with, possibly the loudspeaker—all these parts and, possibly, more, can appear in the modernised receiver. The conversion to a superhet really calls for new coils, a new wave-change switch, a pair of I.F. transformers and a set of new valves. If the valves in the old receiver are in good shape and the set includes an R.F. pentode and an output pentode, these valves might be used as the I.F. amplifier and output valve respectively, of the new receiver. In this case the I.F. amplifier stage circuit of Fig. 11 may still be used—it should suit any R.F. pentode of normal characteristics—and the only change necessary so far as the output stage is concerned will be to supply the correct grid bias. If the old valve type is retained here then the old loudspeaker will also serve so long as it gives satisfying results both on the score of volume and tone.

It will be seen from Fig. 11 that Wearite P type coils are chosen for the new tuning system. Whilst some excellent coilpacks are available, and will be discussed in detail later, the author prefers the use of individual coils when building a battery superhet. The Wearite coils are chosen not only on account of their high efficiency but also by virtue of the fact

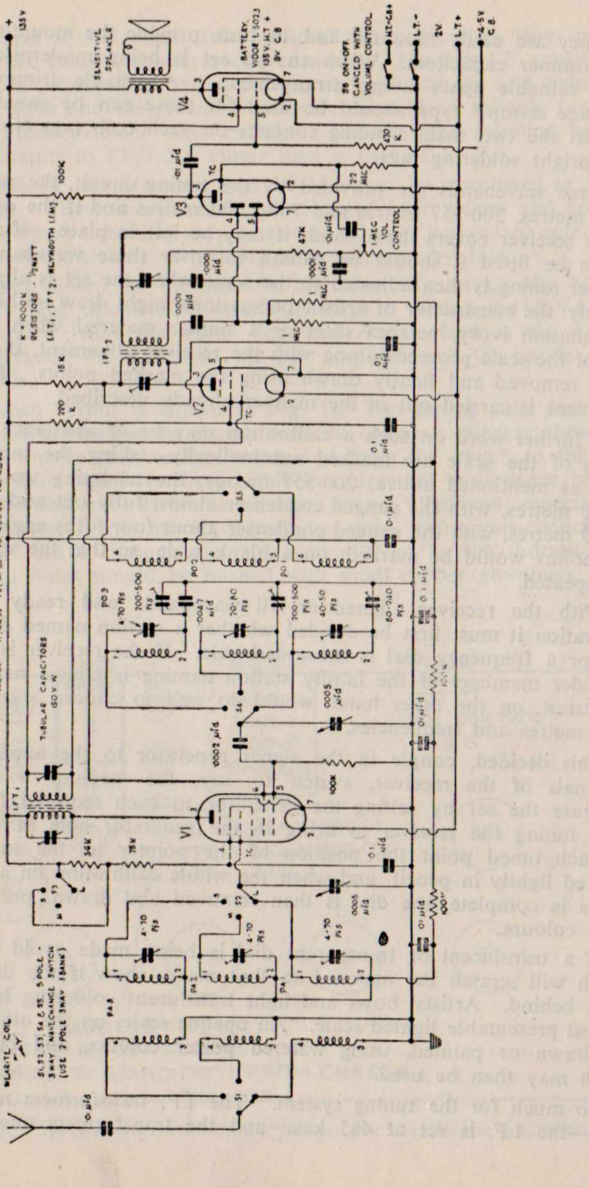


Fig 11. The Home 2-volt Superhet, using New Tuning System.

that they are easily mounted and, in turn, provide the mountings for the coil trimmer capacitors. When an old set is being modernised this can be a valuable space-saving arrangement. Adjustable trimmers of the "postage stamp" type should be used for these can be sweated directly between the two main winding contacts on each coil, tags Nos. 1 and 2, the upright soldering tags.

Three wavebands are provided by the tuning circuit, the ranges being 16-47 metres, 200-557 metres and 700-2,000 metres and if the original scale of the receiver covers these bands it may be left in place. If a new scale has to be fitted it should be chosen to cover these wavebands and the receiver tuning is then adjusted to the scale when the set is aligned ; alternatively, the constructor of artistic persuasions might draw up his own scale on imitation ivory, perspex sheet or a similar material when the calibration of the scale proceeds along with the receiver alignment, the scale then being removed and finally drawn using the marked points. The receiver alignment is carried out in the manner already described.

A further word on such a calibration may be of assistance. Two end points of the scale are marked automatically—taking the medium waveband as mentioned above, 200-557 metres, the trimming would be done at 250 metres, with the ganged condenser almost fully out and the padding at 500 metres, with the ganged condenser about four-fifths engaged. These two points would be marked, on a blank scale, so that the settings could be repeated.

With the receiver aligned on all wavebands and ready for further calibration it must first be decided whether a station named dial, a metre dial or a frequency dial is most desirable. If the receiver is to be used by older members of the family station naming is almost necessary ; the enthusiast, on the other hand, would do well to choose a calibration in both metres and frequencies.

This decided, couple in the signal generator to the aerial and earth terminals of the receiver, switch to, say, the medium waveband, and calibrate the set by setting the generator to each required frequency in turn, tuning the receiver to bring in the generator note at each setting. At each tuned point the position of the pointer on the tuning dial is marked lightly in pencil, and when the whole calibration on all the wavebands is complete, the dial is then removed and drawn, preferably with good colours.

If a translucent or transparent dial is being made avoid using a pen which will scratch the material so that marks show if the dial is lighted from behind. Artists' bows and light translucent colouring help to make a most presentable lighted scale. An opaque scale, on the other hand, can be drawn or painted, using watered poster colours, and bows, pen or brush may then be used.

So much for the tuning system. The I.F. transformers must suit the coils—the I.F. is set at 465 kcs.—and the transformers must have high efficiencies and at the same time be small in order that they may be fitted on to the chassis without undue crowding. The first I.F. transformer should have a " flying lead " from the top of its can as the grid connection to the I.F. valve and the second transformer should be suitable for feeding into a diode detector—this usually means that the coupling between the tuned circuits in I.F.T.2 is closer than is that of I.F.T.1.

Weymouth I.F. transformers type I.F.M.2 may be mentioned as a very suitable type. These transformers are trimmed from below and are conveniently mounted since they may be positioned over a standard octal valve hole (1⅛in.) in the chassis with fixing centres spaced by 1½in.

The valves chosen for the superhet circuit of Fig. 11 are the Mullard K.30 series. The double-diode-triode in stage 3 allows the A.V.C. line to be separated from the audio line, and A.V.C. feed is via a small capacitor between the anode of the I.F. amplifier and the anode of the A.V.C. diode.

A specimen layout is shown in Fig. 12. The tuning coils and wave change switch are below the chassis with the tuning condenser above, and the leads from the coils to the switch and from the switch to the tuner must be as short and direct as possible in order that any chance of feedback is minimised and, at the same time, the set alignment, especially on the short waves, is not made difficult by stray wiring capacitances and inductances. Leads through the chassis should go by the shortest route, and the drill holes should be bushed with small rubber grommets.

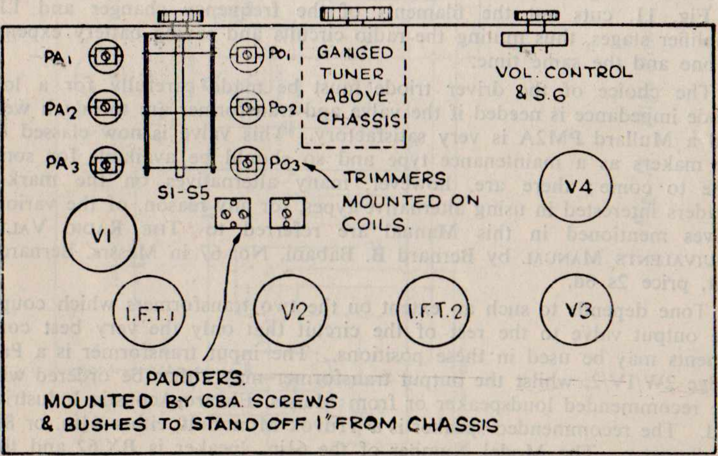


Fig 12. Specimen under-chassis layout for the Home Superhet.

HIGH POWER OUTPUT STAGES.

Possibly one of the greatest drawbacks to the battery receiver is the restricted output. For this reason it is not worthwhile to make provision for gramophone reproduction in the ordinary receiver, although there is little doubt that electrical reproduction would often be preferred to mechanical reproduction if worthwhile output could be obtained from a battery output stage or amplifier fed from a pickup attached to a spring gramophone motor.

The Mullard KLL32 double output pentode makes gramophone reproduction possible—or gives much better output from an ordinary set—without too high a demand on the H.T. battery. The current demand of the valve fluctuates as with any quiescent push-pull output stage, the current for no signal being rated at about 4 mAs. with a total anode and screen current for full signal input of 22 to 23 mAs. The output is rated at 1.2 watts with total distortion of less than 3 per cent., so that if the stage is fed from a high capacity H.T. battery and coupled really accurately to a first-class sensitive speaker, really good results are possible.

A balanced input to the pentode grids is required and so the output valve is shown, in Fig. 13, coupled via a transformer to the driver triode, this triode being coupled by a tone control net work to the first audio stage. It will be noted that the circuit really commences with the d.d triode of Fig. 11, this receiver circuit having a tone control and gramophone pickup switching added, but the circuit as it stands may be used as a battery amplifier, the diodes on the KBC32 being then neglected. Note that the gramophone switch, when this stage is added to the receiver of Fig. 11, cuts out the filaments of the frequency changer and I.F. amplifier stages, thus muting the radio circuits and saving battery expense at one and the same time.

The choice of the driver triode must be made carefully for a low anode impedance is needed if the valve and transformer are to match well, and a Mullard PM2A is very satisfactory. This valve is now classed by the makers as a maintenance type and so should be available for some time to come ; there are, however, many alternatives on the market. Readers interested in using alternative types, for any reason, of the various valves mentioned in this Manual are referred to THE RADIO VALVE EQUIVALENTS MANUAL by Bernard B. Babani, No. 67 in Messrs. Bernards' List, price 2s. 6d.

Tone depends to such an extent on the two transformers which couple the output valve to the rest of the circuit that only the very best components may be used in these positions. The input transformer is a Partridge 2W/IV/2, whilst the output transformer may either be ordered with the recommended loudspeaker or from Messrs. Electro-Acoustic Industries, Ltd. The recommended speaker is a Truvox Monobolt, either 6½in. or 8in. in diameter. The Model Number of the 6½in. speaker is BX 62 and that of the 8in. diameter model BX 82. Messrs. Truvox Engineering Co., Ltd.

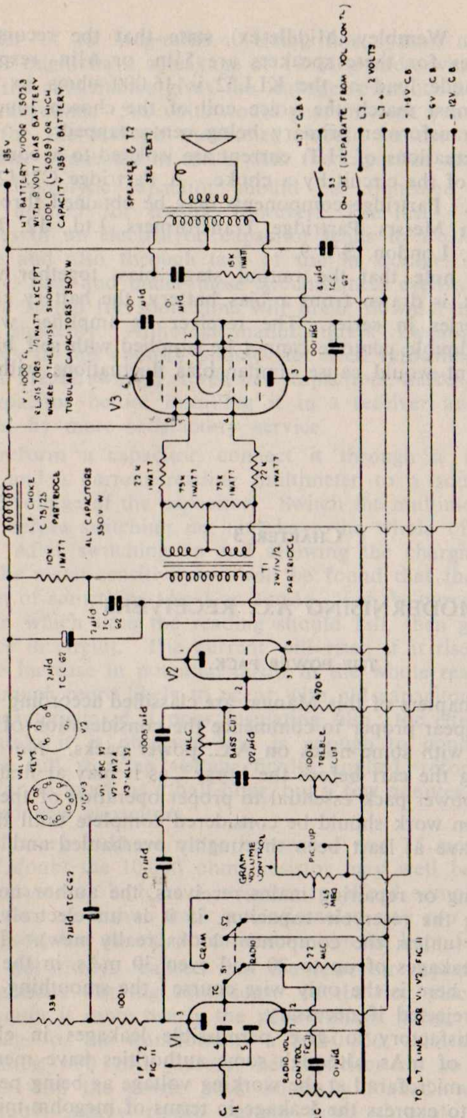


Fig. 13. High Power Battery Amplifier or Output Stage.

(Exhibition Grounds, Wembley, Middlesex), state that the recommended baffle board apertures for these speakers are 5½in. or 6¾in. respectively.

The anode to anode load of the KLL32 is 16,000 ohms so that the output transformer must match the voice coil of the chosen loudspeaker into this load, the transformer primary being centre-tapped.

Note that the fluctuations of H.T. current are isolated to a considerable extent from the rest of the circuit by a choke. A Partridge C75/25 choke is ideal for the work. Partridge components may be obtained through any good dealer or from Messrs. Partridge Transformers, Ltd., 12, Peckford Place, Brixton Road, London, S.W.9.

As a last point, note that the output stage bias, together with the bias for other stages, is drawn from a bias battery, the battery consisting of two 9 volt batteries in series. The receiver or amplifier which incorporates a Q.P.P. double pentode cannot be supplied with self bias since the fluctuating current would cause similar bias fluctuations with serious distortion.

CHAPTER 3

MODERNISING A.C. RECEIVERS

THE POWER PACK.

Since the main chapters of this Manual are classified according to power supplies it would appear proper to commence the consideration of modernising A.C. receivers with some notes on A.C. power packs. Nor is this a question of "putting the cart before the horse" as it may at first appear; not only is a good power pack essential to proper operation of the receiver, but no modernisation work should be considered complete until the power pack components have at least been thoroughly overhauled and, if necessary, renewed.

When modernising or repairing mains receivers, the author now makes a habit of renewing the reservoir capacitor, if it is an electrolytic, without even testing it (unless the component looks really new). Test after test showing D.C. leakages of up to 20 and even 30 mAs. in the reservoir proved that renewal here is the only wise course; the smoothing capacitor is tested and only rejected if necessary.

It is hardly satisfactory to give permissible leakages in electrolytic capacitors in terms of mAs. although some authorities have mentioned a figure of ½ mA. per microfarad at the working voltage as being permissible. A better method is to express the leakage in terms of megohm-microfarads and it may be said that a new electrolytic capacitor should have a value of the order of 10 Meg-mfds. Using this system an 8 mfds. 500 v.w. capacitor might have a leakage of 10 Meg-mfds. which, dividing the leakage by the capacitance gives the leakage resistance at the working voltage as 1.25 megohms. 500 volts would pass through this resistence at 0.4 mA. which, for the leakage mentioned, would be the current shown on a milliameter connected in series with the capacitor and a 500 volts source.

No electrolytic capacitor should be connected up in this straightforward manner for testing, however. The insulating film between the electrodes of an electrolytic capacitor tends to weaken both through age and use and also through lack of use in storage. The leakage current, therefore, rises and under these circumstances even a new capacitor which has been stored for some time will break down if the working voltage is applied suddenly. Although manufacturers' literature states that stored capacitors in this country should not need reforming the author, after a series of breakdowns in stored new capacitors, makes a point of reforming each capacitor before installing it in a receiver and has certainly been rewarded by more satisfactory service.

To reform a capacitor, connect it through a 10,000 ohms variable resistor and a current reading multimeter to a source of power at the working voltage of the capacitor. Switch the multimeter to a high current reading before switching on, and have the whole of the 10,000 ohms in circuit. After switching on and allowing the charging surge to pass, increase the meter sensitivity—it will be found that the capacitor is passing a current of something like 1 or 2 mAs. Let the current flow for 5 minutes or so, in which time the reading should fall, then gradually decrease the resistance in circuit. The current will rise ; if it rises much more rapidly than the increase in potential throw in the whole resistance again rapidly. This is much more likely to occur with old capacitors than with new and is a characteristic of a poor insulating film ; the effect will be recognised immediately it is observed and is enough to condemn the component. With the full working voltage finally applied, reforming current can be passed for as much as a half-hour, but a few minutes is generally sufficient for stored new capacitors.

Satisfactory leakages range between 5 and 15 megohm-microfarads. In cases of doubt the 10,000 ohms resistor may well be replaced by a variable resistance as high as 1 megohm to afford complete protection to the milliameter. A carbon track potentiometer may run warm when used for this purpose, but an old potentiometer can be kept for the task.

It is not always realised that the reservoir capacitor has to withstand very strenuous working conditions. In the first place, the voltage across the capacitor is more nearly the peak voltage rather than the R.M.S. output voltage of the transformer—a 350-0-350 volts transformer will thus place almost 490 volts across the capacitor on no load and well over 400 volts with the power pack normally loaded—whilst in addition to this a fairly heavy ripple current flows through the capacitor as it receives pulses of charge.

The ripple current is difficult to measure with ordinary instruments but it may be taken as roughly equal to the direct current supplied to the receiver from the power pack so far as a full wave rectification circuit is concerned. The ripple current rating of the reservoir capacitor should, therefore, be 100 mAs. for safety, and if a small capacitor is used as the reservoir, even though rated up to the applied voltage, there is a grave possibility that it will overheat and break down at some time, ruining the rectifier valve and transformer too unless the circuit is fused.

Wherever possible, therefore, the reservoir capacitor should be rated at 500 volts working for the average mains transformer with a ripple current rating of 100 mAs., though the normal rating for general purpose electrolytics is 450 v.w. Many manufacturers offer a choice between plain foil and etched foil electrode capacitors; for the reservoir position plain foil components should be chosen.

(Foil etching is a method whereby the electrode area is increased with a consequent saving in space for equal capacitance over the plain foil capacitor).

For the larger receiver separate reservoir and smoothing capacitors are strongly recommended.

When an energised loudspeaker, acting as the smoothing choke, is to be replaced, it is recommended that a permanent magnet speaker be used, an ordinary L.F. choke being fitted to take the place of the field winding. The choke should have a current capacity of 100 mAs. or more, a usual inductance value of 20 Henrys being found suitable in most cases, whilst if the resistance of the choke is less than that of the old speaker field a series resistor may follow the choke to drop the voltage input to the receiver circuits. Nevertheless, when using modern valves a smaller voltage drop over the smoothing system may well be beneficial for the receiver will then have a greater driving voltage and a consequent increase in output. At the same time this will show up any tendency to instability especially if valves with greater amplification are used as, for example, I.F. amplifiers.

When modernisation is thorough and 6 volt valves are to be used in what was a 4 volt valve receiver the mains transformer will have to be renewed. Transformers can, of course, be re-wound but a new one should be bought. The 6 volt valve type is recommended not only because of the extremely wide range of valves using 6 volt heaters but also because of the lower heater consumption. On an average the 6 volt valve heater consumes about 1.9 watts against the 4 watts or so of the 4 volt valve which represents a real economy in all ways—smaller transformer loadings giving better regulation in the power pack, smaller losses in the heater wiring and less heavy cable and, often very important, less dissipated heat within the receiver cabinet.

For any normal transformer 6 volt valves in the receiver mean a 5 volt rectifier in the power pack, and highly recommended is the Mullard GZ32. Heater rating, 5 volts at 2 amps., with a D.C. output of 250 mAs. with 350 volts on each anode, using the normal capacitance input smoothing

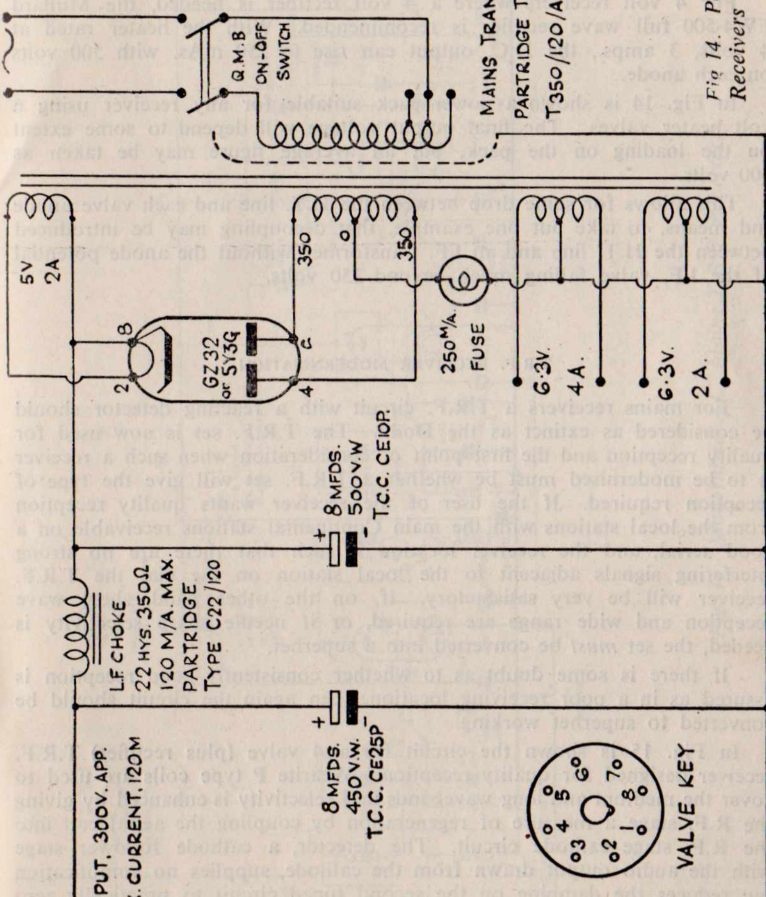


Fig 14. Power Pack for A.C. Receivers using 6 volt valves

circuit. With a choke input to the power pack, the rating naturally rises, but this type of operation chiefly interests the constructor of amplifiers and need not be treated here. If reservoir capacitances greater than 8 mfds. are used a limiting resistance must be included in series with the reservoir, 50 ohms for 16 mfds. and 100 ohms for 32 mfds. For all ordinary purposes an 8 mfds. capacitance will serve.

For 4 volt receivers where a 4 volt rectifier is needed, the Mullard FW4-500 full wave rectifier is recommended. With the heater rated at 4 volts, 3 amps., the D.C. output can rise to 250 mAs. with 500 volts on each anode.

In Fig. 14 is shown a power pack suitable for any receiver using 6 volt heater valves. The final output voltage will depend to some extent on the loading on the pack, but an average figure may be taken as 300 volts.

This allows for some drop between the H.T. line and each valve anode and means, to take but one example, that decoupling may be introduced between the H.T. line and an I.F. transformer without the anode potential of the I.F. valve falling much beyond 250 volts.

T.R.F. RECEIVER MODERNISATION

For mains receivers a T.R.F. circuit with a reacting detector should be considered as extinct as the Dodo. The T.R.F. set is now used for quality reception and the first point of consideration when such a receiver is to be modernised must be whether a T.R.F. set will give the type of reception required. If the user of the receiver wants quality reception from the local stations with the main Continental stations receivable on a good aerial, and the receiver location is such that there are no strong interfering signals adjacent to the local station on the dial the T.R.F. receiver will be very satisfactory. If, on the other hand, short wave reception and wide range are required, or if needle sharp selectivity is needed, the set *must* be converted into a superhet.

If there is some doubt as to whether consistently good reception is assured as in a poor receiving location, then again the circuit should be converted to superhet working.

In Fig. 15 is shown the circuit for a 4 valve (plus rectifier) T.R.F. receiver designed for quality reception. Wearite P type coils are used to cover the medium and long wavebands and selectivity is enhanced by giving the R.F. stage a measure of regeneration by coupling the aerial coil into the R.F. stage cathode circuit. The detector, a cathode follower stage with the audio output drawn from the cathode, supplies no amplification but reduces the damping on the second tuned circuit to practically zero so that the circuit efficiency is high. At the same time the high degree of negative feedback across the cathode resistor of 47,000 ohms—for all

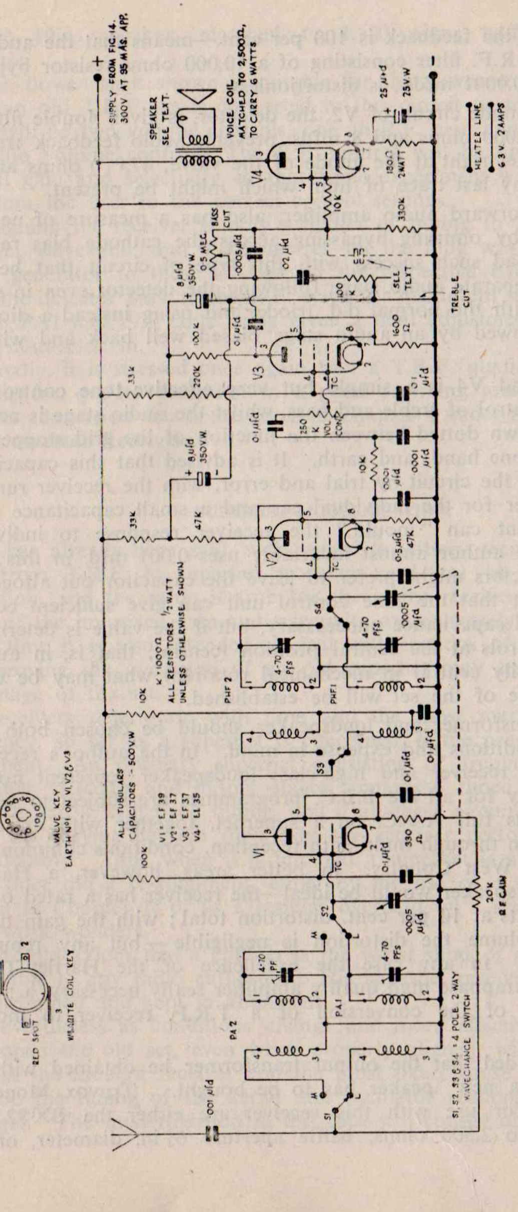


Fig. 15 Modernised A.C. Mains T.R.F. Receiver.

practical purposes the feedback is 100 per cent.—means that the audio input to V3 via the R.F. filter consisting of a 10,000 ohms resistor bypassed on either side by 0.0001 mfds., is distortionless.

Note that the anode circuit of V2, the detector, is given double filtering. The first filter, 33,000 ohms and 8 mfds. prevents audio feedback troubles and the second filter right at the anode of the valve, 47,000 ohms and 0.5 mfd., takes out any last trace of hum which might be present.

V3, a straightforward audio amplifier, also has a measure of negative feedback applied by omitting bypassing across the cathode bias resistor. The author has had such success with this type of circuit that he now prefers to use a separate audio stage following the detector even in superhets, dispensing with the normal d.d. triode, and using instead a diode or double diode followed by an audio stage biased well back and with no cathode bypassing.

Between V3 and V4 is a simple but very effective tone control unit giving separate control of treble and bass, whilst the audio stage is normal. A capacitor is shown dotted between the junction of the grid stopper and grid leak, on the one hand, and earth. It is advised that this capacitance be introduced into the circuit by trial and error, with the receiver running. Quality is a matter for the individual ear and a small capacitance introduced at this point can " mould " the receiver response to individual requirements. The author almost invariably uses 0.001 mfd. in this position, other constructors might prefer to leave the capacitor out altogether. It may be thought that the tone control unit can give sufficient control to render this fixed capacitance unnecessary, but if the value is determined with the tone controls at the central position (central, that is, in audible effect, not necessarily central in mechanical rotation) what may be called the " normal " tone of the set will be established.

The output transformer and loudspeaker should be chosen both with local reception conditions and expense in mind. In the author's reception location a quality receiver and high-class loudspeaker represent nothing but waste of money for all the B.B.C. programmes are subject to serious fading, which needs full A.V.C. on a superhet, together with extremely bad phase distortion through multi-path reception, conditions common to a great part of the West Country. In better areas, however, a Hartley-Turner Model 215 speaker would be ideal—the receiver has a rated output maximum of 6 watts at 10 per cent. distortion total; with the gain turned down to room volume the distortion is negligible — but any reputable speaker will serve. In any case the excellence of the Hartley-Turner speaker makes a paraphase high quality amplifier really necessary, a matter beyond the scope of the conversion of a T.R.F. receiver to modern standards.

It is recommended that the output transformer be obtained with the loudspeaker when a new speaker has to be bought. Truvox Monobolt speakers suitable for use with this receiver are either the BX 82 8in. speaker, matched to 2,500 ohms, baffle aperture 6¾ in. diameter, or the

BX 102 10in. speaker, matched to 2,500 ohms, baffle aperture 8¾in. diameter.

The power pack shown is suitable for the power supply.

If an old T.R.F. set is converted to this circuit or to a similar circuit, there will be two volume controls, one an R.F. gain control and the other an audio volume control. The R.F. control will be found to affect both overall gain and selectivity so that some experiment will be necessary to accustom the user to the correct control settings.

Aligning the receiver is only a matter of tuning to 250 metres on the medium waveband, and 1,000 metres on the long waveband, setting the signal generator to these settings on the respective bands, and trimming from the detector back to the R.F. stage for maximum signal, the trimmers on the PA1 and PA2 coils being given a final adjustment with the proper aerial connected in.

Finally, it is stressed once again that a T.R.F. quality receiver is only suitable for quality reception in a good receiving area. Further T.R.F. receiver conversion details are given in Chapter 4 under the general heading of " Universal Receivers."

SUPERHET MODERNISATION.

It has already been said, with regard to battery receivers, that conversion from T.R.F. to superhet working need not be too expensive an operation, and the same is true for the mains receiver whilst the advantages of the improved gain and selectivity are extremely desirable. At the same time it is also intended to deal with sections of superhet receivers —improving the operation of an old superhet may entail work on only one stage of the set.

Receivers deteriorate with time and the most marked falling off in efficiency, so far as a superhet is concerned, is the progressive drift from alignment. An ordinary superhet consisting of frequency changer, I.F. amplifier, detector and output stages contains 6 tuned circuits, two with variable and 4 with fixed tuning, and if all these circuits fall out of alignment by varying degrees obviously the receiver performance will suffer considerably. Thus, when it is felt that a superhet is not working as well as it once did a re-alignment, either by the use of a signal generator as shown in Chapter 1, or as a general overhaul by a service engineer, may well work wonders.

The old axiom that a cobbler is the worst shod of men should not be applicable to any radio enthusiast. His superhet receiver should regularly be retrimmed and kept in alignment.

Nevertheless as conditions change and more effective components are developed the old set, even when properly aligned, will show up poorly against the modern receiver and the most likely cause of the discrepancy will be the tuning of the aerial and oscillator sections of the frequency changer. The modernisation in this case will consist of the fitting of new tuning coils in place of the old ones, and the operation has been made practically effortless by manufacturers of modern coil packs.

Of the various coil packs inspected and tested by the author he unreservedly recommends the "Q" Coilpack for all normal superhets. The "Q" Coilpack may be obtained from dealers or direct from Messrs. Northern Radio Services, 66, Parkhill Road, London, N.W.3, and the popular model, Type H.O. covers the ranges 15.5-52 metres, 200-590 metres and 800-2,000 metres.

Type Ex has two short-wave ranges, 13-35 and 34-120 metres with the medium band of 200-590 metres, whilst Type TB covers from 70-230 metres, 200-590 metres and 800-2,000 metres.

The outstanding characteristics of the "Q" Coilpack are its efficiency with its surprisingly small size. The coils are wound on midget dust cored formers, the cores being adjustable, and, complete with wavechange switch and trimmers, also the A.V.C. bypass capacitor the whole unit measures no more than 3½in x 2in. x 2in. It will, therefore, fit into the coil space of practically any superhet, and the pack is fixed by the single retaining nut on the wavechange switch, the old switch being removed from the receiver and the pack being inserted and bolted on in its place. The nut makes the common earth connections and, therefore, must contact the receiver chassis.

Connections to the coilpack are taken to five soldering tags which are coded in the accompanying drawings supplied with the pack. In Fig. 16 the pack circuit is shown, the coded connections being taken to a typical frequency changer stage.

The Intermediate Frequency of the "Q" Coilpack is the normal 465 kcs., so that it may be fitted into practically any superhet (except very old models which may have an I.F. in the region of 110 kcs.) with no other circuit changes.

The range of the "Q" Coilpack will suit the majority of tuning scales but should a new scale be needed—as, for example, when the old scale of the receiver shows only the medium and long wavebands—the new scale should be obtained from a good dealer who will know of a component marked with suitable ranges. So many scales are obtainable, marked in so many ways, that specification of one particular type would be of little use.

Here, again, the opportunity arises for the artistically minded constructor to produce his own scale.

In the majority of cases the new coilpack will give a greatly improved performance, especially when the receiver is fairly old, and where the I.F. transformers are of an outdated pattern—with air cores, for example—it is recommended that these be changed also. Weymouth I.F. transformers of the types P1 or P2 are recommended. The P1 transformers will give a little more gain than the P2 type, other things being equal, but there will consequently be a somewhat greater change of feedback with the former transformers. If there is any reason to suspect instability over the I.F. stage, the P2 transformers should be used.

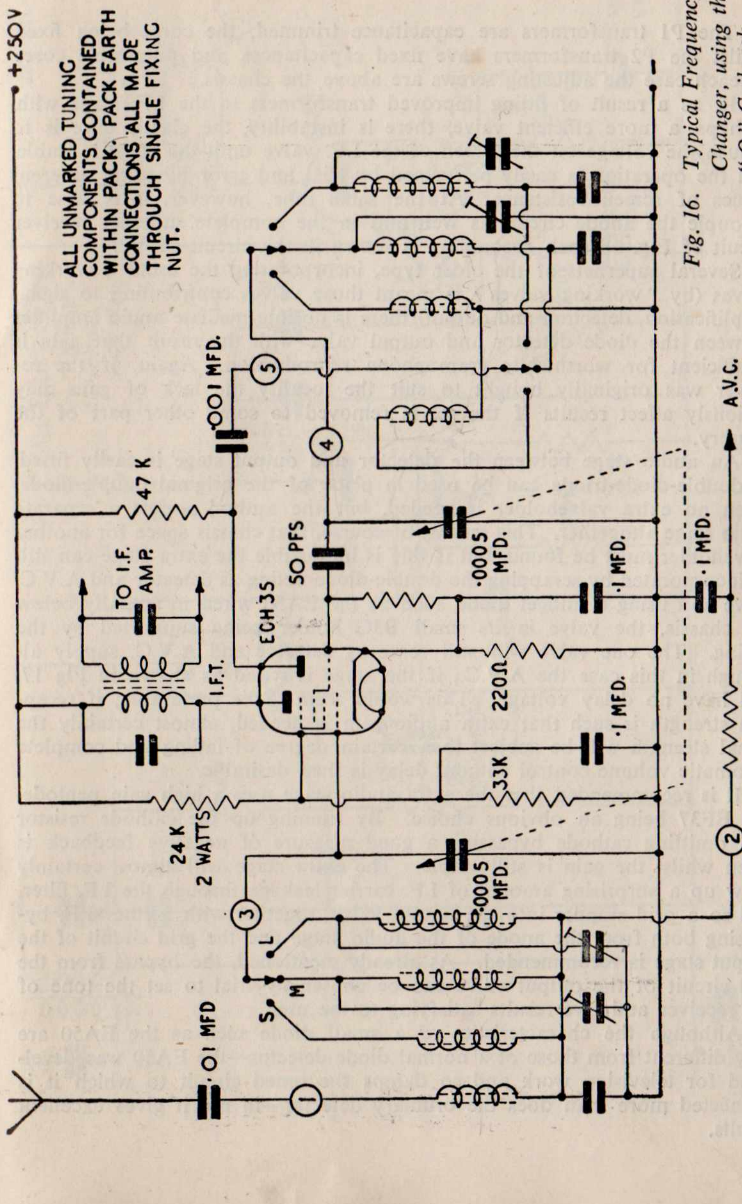


Fig. 16. Typical Frequency Changer, using the "Q" Coilpack.

The P1 transformers are capacitance trimmed, the cores being fixed, whilst the P2 transformers have fixed capacitances and adjustable cores. In each case the adjusting screws are above the chassis.

If, as a result of fitting improved transformers to the I.F. stage with, perhaps, a more efficient valve, there is instability, the classic cure is to reduce the voltage on the screen of the I.F. valve until the stage is stable, and the operation is easily performed by trial and error by using different values of screen resistance. At the same time, however, it is wise to decouple the anode circuit as well and in the complete superhet receiver circuit of Fig. 18 such decoupling is shown in the circuit of V2.

Several superhets of the older type, incorporating the usual 4 working valves (by " working valves " is meant those valves contributing to signal amplification, detection and output) there is no intermediate audio amplifier between the diode detector and output valve with the result that gain is insufficient for worthwhile gramophone reproduction. Again, if the receiver was originally bought to suit the locality the lack of gain may seriously affect results if the set is removed to some other part of the country.

An audio stage between the detector and output stage is easily fitted. A double-diode-triode can be used in place of the original double-diode, when no extra valveholder is needed, but the author prefers a separate audio stage altogether. This means, of course, that chassis space for another valveholder must be found, but if this is impossible the extra stage can still be incorporated by scrapping the double-diode acting as detector and A.V.C. valve and using a midget diode such as the EA50 wired in actually below the chassis, the valve in its small B3G holder being supported by the wiring. The one valve will still serve as detector and A.V.C. supply although in this case the A.V.C., if the stage is wired as shown in Fig 17, will have no delay voltage. This would seem to be preferable; if reception strength is such that extra audio gain is needed, almost certainly the signal strength will be subject to a certain degree of fading and complete automatic volume control without delay is then desirable.

It is recommended that the extra audio stage uses a high gain pentode, the EF37 being an obvious choice. By running up the cathode resistor and omitting cathode bypassing a good measure of negative feedback is given whilst the gain is still ample. The extra stage will almost certainly show up a surprising amount of I.F. carrier leakage through the I.F. filter, and so a grid stopper into the output valve, together with further I.F. bypassing both from the anode of the audio stage and the grid circuit of the output stage is recommended. As already mentioned, the bypass from the grid circuit of the output valve can be chosen by trial to set the tone of the receiver and give results satisfying to the user.

Although the characteristics of a small diode such as the EA50 are very different from those of a normal diode detector—the EA50 was developed for television work and so damps the tuned circuit to which it is connected more than does the ordinary detector—in use it gives excellent results.

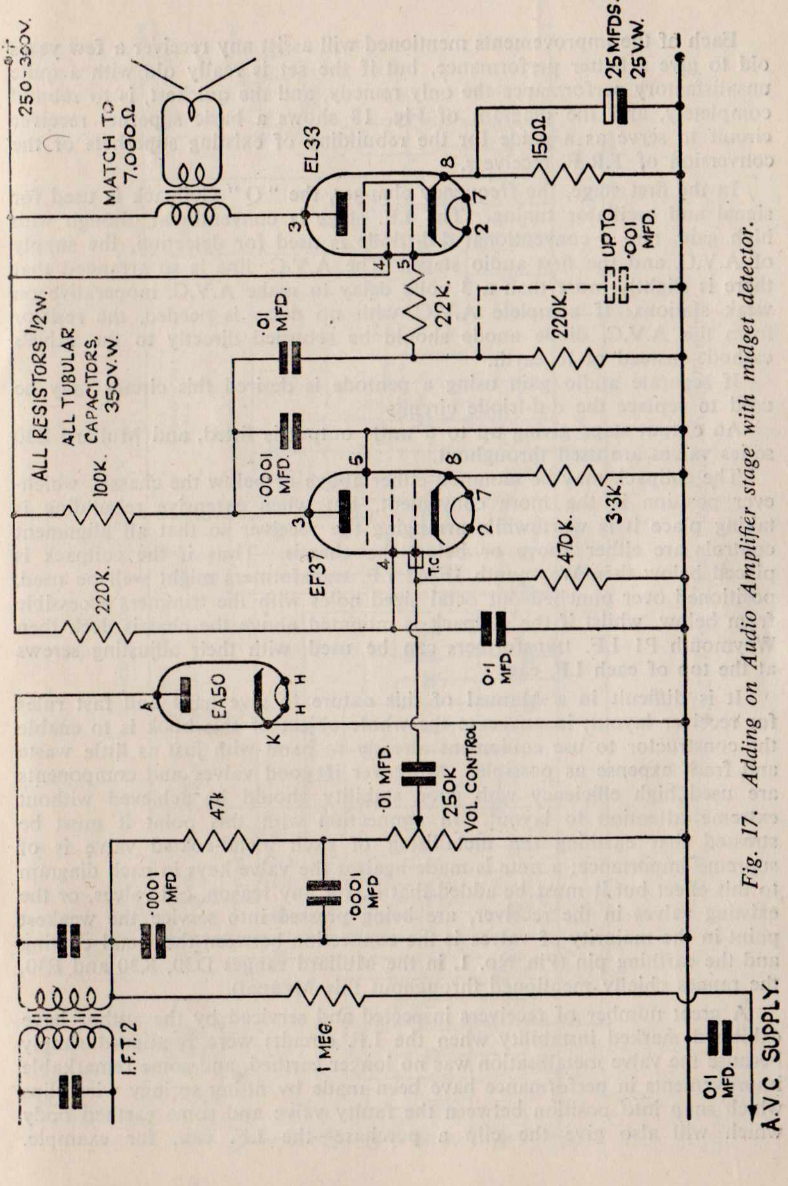


Fig. 17. Adding on Audio Amplifier stage with midget detector.

Each of the improvements mentioned will assist any receiver a few years old to give a better performance, but if the set is really old with a quite unsatisfactory performance the only remedy, and the quickest, is to rebuild completely, and the diagram of Fig. 18 shows a basic superhet receiver circuit to serve as a guide for the rebuilding of existing superhets or the conversion of T.R.F. receivers.

In the first stage, the frequency changer, the "Q" Coilpack is used for signal and oscillator tuning. The I.F. stage is conventional, though with high gain, and a conventional d-d-triode is used for detection, the supply of A.V.C. and the first audio stage. The A.V.C. line is so arranged that there is slightly more than a 3 volts delay to make A.V.C. inoperative on weak stations If complete A.V.C. with no delay is needed, the resistor from the A.V.C. diode anode should be returned directly to the valve's cathode instead of to earth.

If separate audio gain using a pentode is desired this circuit may be used to replace the d-d-triode circuit.

An output stage giving up to 6 watts output is fitted, and Mullard E30 series valves are used throughout.

The coilpack may be mounted either above or below the chassis, whichever position is the more convenient, but when extensive rebuilding is taking place it is worthwhile arranging the receiver so that all alignment controls are either above or below the chassis. Thus if the coilpack is placed below then Weymouth IFM2 I.F. transformers might well be used, positioned over punched out octal sized holes with the trimmers accessible from below, whilst if the coilpack is mounted above the chassis deck then Weymouth P1 I.F. transformers can be used, with their adjusting screws at the top of each I.F. can.

It is difficult in a Manual of this nature to give hard and fast rules for receiver layout; in any case the whole object of this book is to enable the constructor to use equipment already to hand with just as little waste and fresh expense as possible. Moreover if good valves and components are used high efficiency with good stability should be achieved without extreme attention to layout. In connection with this point it must be stressed that earthing the metallising of each metal-coated valve is of supreme importance; a note is made against the valve keys in each diagram to this effect but it must be added that if, for any reason, old valves, or the existing valves in the receiver, are being pressed into service the weakest point in the majority of valves is the connection between the metal coating and the earthing pin (Pin No. 1. in the Mullard ranges D30, K30 and E30, the ranges chiefly mentioned throughout this Manual).

A great number of receivers inspected and serviced by the author have exhibited marked instability when the I.F. circuits were re-aligned simply because the valve metallisation was no longer earthed, and some remarkable improvements in performance have been made by fitting springy wire clips which snap into position between the faulty valve and some earthed body which will also give the clip a purchase—the I.F. can, for example.

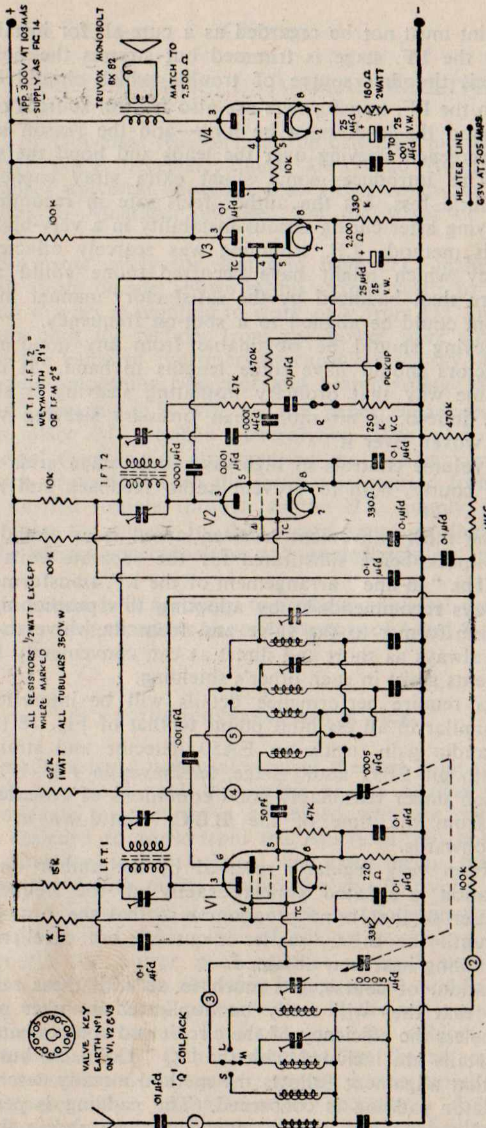


Fig. 18. Basic Circuit for Mains Superhet Modernisation.

Naturally this hint must not be regarded as a cure-all for instability which shows up when the I.F. stage is trimmed but stresses the point that the valve screening is the first source of trouble which should be checked.

Long leads to the I.F. transformers are also fruitful sources of feedback. If for some reason the leads must be long—and the reason should be a good one—use screened sleeving over the leads and bond the screening to the chassis. This introduces some slight extra stray capacitance and, possibly, some little loss, but the author feels safe in recommending the use of such sleeving after curing serious instability in a very-high-frequency superhet by this method. I.F. trimming was scarcely affected and any loss of efficiency which might have occurred (none could actually be traced) was more than balanced by the satisfactory manner in which the whole I.F. system could be aligned to a spot-on frequency.

Screened sleeving should be obtainable from any good radio store, and all constructors should have some lengths to hand. It is used and fitted in the same way that ordinary insulating sleeving is slipped over bare wires and, indeed, is no more than ordinary sleeving with a light screening mesh woven over it.

Leads from volume controls to high-gain audio stage grids should also be screened, of course, both to prevent audio feedback and to minimise hum pick-up.

In general the most convenient receiver layout is as already shown in Fig. 12, the coilpack being substituted for the separate coils and wave-change switch. The " in-line " arrangement of the I.F. transformers and I.F. amplifier is always recommended; by adopting this positioning the leads from the first transformer to the valve and from the valve to the second transformer are always as short and direct as can conveniently be arranged and the components assist in each other's shielding.

Readers who require performance details will be interested to learn that a receiver similar in all essential points to that of Fig. 18 (the receiver had a greater audio gain, using an EA50 detector and straight A.V.C. valve feeding into an EF37 audio stage, as shown in Fig. 17), has given excellent reception under reasonably good conditions of American medium wave stations, from the time of the B.B.C. shut-down at 11.15 p.m. approximately, onwards.

WCBS has been very regularly received by the author on an indoor aerial. This station is situated almost exactly on the frequency of the London transmitter of the Home programme so that the American station is heterodyned until the B.B.C. carrier is cut off, but excellent reception with only slow fading has been obtained.

Receiver location, of course, has much to do with these results and it is not expected that they will easily be duplicated in other parts of the country; nevertheless the efficiency of the circuit and components is proved.

Alignment details are included with the " Q " Coilpack, but in general it may be said that alignment follows the method already described except insofar as oscillator padding is concerned. The padding is performed by adjusting the coil cores: fixed padding capacitors are used in the coilpack.

CHAPTER 4

MODERNISING UNIVERSAL RECEIVERS

AC/DC or Universal receivers can be classified in three broad groups, the universal T.R.F. receiver, almost always an American type midget set, the midget universal superhet, also either American or owing much, in its design, to American practice, and the larger or British universal superhet.

Receivers made solely for operation from D.C. mains are now rarely seen, and so all the circuits shown in this chapter relate to AC/DC receivers. Nevertheless if a set is required to work only from D.C. mains it is merely necessary to omit the rectifier from the power pack circuits shown here and reduce the value of the reservoir capacitor to, say, 4 mfds., retaining the choke and smoothing capacitor and heater voltage dropper.

For D.C. working it is wise to use paper capacitors throughout the receiver in place of specified electrolytics. The electrolytic capacitors of a universal receiver are protected by the rectifier; in a D.C. set they have no such protection when the rectifier is omitted from the circuit and the mains carried straight through as the H.T. supply, and if the set is connected into the mains in the wrong sense so that the polarity is reversed the electrolytic capacitors will immediately be ruined and the set damaged.

For this reason it is as cheap to make a universal receiver as to build a D.C. receiver with expensive paper capacitors of 4 and 8 mfds. capacitance.

THE UNIVERSAL POWER PACK.

When modernising a universal receiver the first point to note is whether a line cord was used, and the rating of the rectifier valve. In many universal midgets the rectifier is combined with the output pentode and the set is designed to work from the American 110 volts supply, a line cord, or extension to the original line cord being fitted to make the receiver suit the British mains supply of about 230 volts.

Whatever the make of set that is to be modernised or improved the author has only one stock piece of advice concerning line cords—scrap them. Rebuild the power pack so that a good rectifier and separate output valve are used, thus obtaining better output, and in place of the line cord use a regulator lamp or barretter. If the set is such a midget that these improvements cannot be fitted into the cabinet the writer feels strongly inclined to say, quite seriously, that the set could be scrapped too. Miniaturisation is, in many respects, a very good thing when used with a purpose; when miniaturisation becomes a fad likely to affect adversely the performance of a receiver, it is a good thing no longer.

If, then, the receiver case is so small that a barretter cannot be used, and a combined rectifier-pentode must be employed as the output—power supply stage then the power pack and output stage of the receiver must be left alone, and a line cord must be used to drop the mains supply voltage both to the required limit for the heater chain and rectifier anode supply.

Half wave rectification is used in any universal receiver and this results in the ripple current through the reservoir capacitor rising to a higher figure than is the case with full wave recification, for in the universal receiver the reservoir capacitor, receiving only one charging surge per cycle instead of two surges, discharges to a greater extent between charges. The reservoir capacitor in a universal receiver is therefore working under really difficult conditions and this is shown very clearly if a bulb rated at about 6 volts 0.3 amp. is connected in series between the rectifier cathode and reservoir capacitor—that is in the line through which both the receiver and ripple currents are drawn. With the set loading up the power pack by about 80 mAs. the 300 mAs. bulb will be found to light brilliantly, a graphic demonstration of the true working conditions.

A great improvement can be made, without introducing any extra hum, by using a 47 ohms surge limiting resistor in the reservoir circuit, and in the Universal Power Pack circuit, shown in Fig. 19, both the limiter and the bulb are retained. The bulb now serves as a fuse bulb; even with the limiter in circuit it will still light, though much less brilliantly.

A barretter is recommended in place of either a line cord or voltage dropping resistance of the adjustable type, not only because the barretter is more easily mounted and dissipates heat more evenly but for the very important reason that the barretter is self-adjusting. No setting of a sliding arm is needed when the set is first built or converted, the barretter is simply plugged in and the valve heaters are supplied correctly, whilst mains fluctuations and similar variations in supply voltage are all absorbed in the heater chain and the constructor has no worries about either over-or-under running of the valves.

Most highly recommended are the Phillips " Miniwatt " Regulator Lamps series. For the receivers using Mullard AC/DC valves the Miniwatt C1C, fitting an ordinary 4-pin valveholder, will suit many sets since it has a voltage range of 90—230 at a current of 0.2 amp.

Constructors who so far have had no experience of barretters will find one or two notes on their use of assistance. The barretter consists of a fairly tall cylindrical glass envelope mounted on a normal valve base, the " filament " or resistive element running up and down on supporting arms. The filament is usually of iron wire in an atmosphere of hydrogen; such an arrangement passes a constant current with remarkably wide variations of voltage across its terminals. Barretters are therefore made to pass the

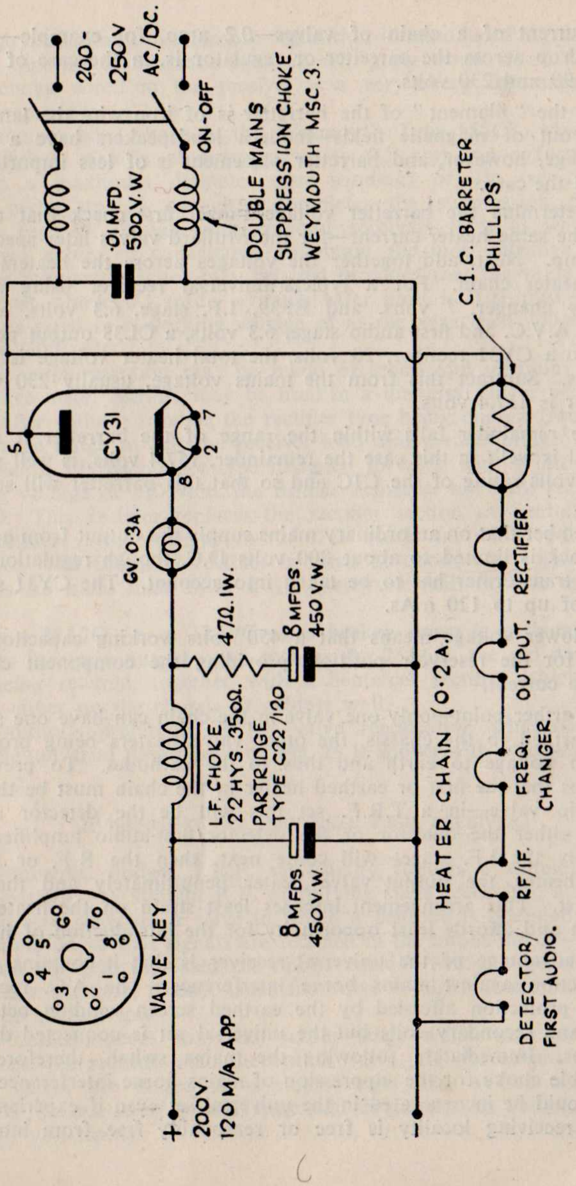


Fig. 19. A Universal Mains Power Pack.

heater current of a chain of valves—0.2 amp. for example—when the voltage drop across the barretter or regulator is, in the case of the C1C, between 90 and 230 volts.

Since the "filament" of the barretter is of iron wire the lamp should be kept out of magnetic fields—modern loudspeakers have a very low flux leakage, however, and barretter placement is of less importance than was once the case.

To determine the barretter voltage range, first check that all valves require the same heater current—for the Mullard valves later specified, this is 0.2 amp. Next, add together the voltages across the heaters in series in the heater chain. For a typical universal receiver using a CCH35 frequency changer, 7 volts, and EF39, I.F. stage, 6.3 volts, an EBC33 detector, A.V.C. and first audio stage, 6.3 volts, a CL33 output pentode, 33 volts, and a CY31 rectifier, 20 volts, the total heater voltage is obviously 72.6 volts. Subtract this from the mains voltage, usually 230 volts—the remainder is 157.4 volts.

If the remainder falls within the range of the barretter it is desired to use all is well; in this case the remainder, 157.4 volts, is well within the 90—230 volts rating of the C1C and so that this barretter will suit the set perfectly.

Remember that on an ordinary mains supply the output from an AC/DC power pack is limited to about 200 volts D.C. though regulation is good since no transformer has to be taken into account. The CY31 supplies a current of up to 120 mAs.

The lower voltage means that a 450 volts working capacitor is quite suitable for the reservoir position, providing the component can accept the ripple current.

One further point—only one valve in the chain can have one side of its heater earthed to the chassis, the other valve heaters being progressively higher in voltage to earth and thus to the cathodes. To prevent hum this means that the first or earthed heater in the chain must be that of the first audio valve—in a T.R.F. set this will be the detector and in a superhet either the detector or the detector/first-audio amplifier. Conventionally the I.F. stages will come next, then the R.F. or frequency changer heater, the output valve heater penultimately and the rectifier heater last. This arrangement imposes least strain on the heater-cathode insulation and affords least opportunity for the introduction of hum.

A disadvantage of the universal receiver is that it contains, of itself, no protection against mains borne interference. The A.C. receiver has excellent protection afforded by the earthed screen winding between the primary and secondary coils but the universal set is connected directly to the mains. Immediately following the mains switch, therefore, should be a double choke for the suppression of mains borne interference and this choke should be incorporated in the universal set even if experience shows that the receiving locality is free or reasonably free from interference.

Until much-needed anti-interference legislation is introduced there is every indication that the interference problem will grow worse in all areas and a mains choke wired in the receiver is a very cheap insurance against ruined programmes.

The recommended choke is the Weymouth Type MSC3, which has a double winding capable of carrying up to 0.5 amp. on a former 1¼in. long with a maximum diameter over windings of ⅞in. so that little space is taken up. A capacitor completes the suppression circuit as shown in Fig. 19, though with different receivers it is as well to test one or two values of capacitance to obtain the most effective filtering. A mica or tubular capacitor may be used provided that the value does not rise, at most, above 0.1 mfd.—a much safer limit is 0.01 mfd.—and the capacitor is rated at a working voltage of at the very least 400 volts and, preferably, 500 volts.

At this point mention may be made of metal and selenium rectifiers. A half wave metal rectifier may be used in a universal set in place of the valve rectifier without trouble, the rectifier type being chosen from Messrs. Westinghouse range to suit the receiver load and mains voltage, but when the receiver is of the midget type designed to work with a line cord and a receiver voltage of 110 volts the Brimar Sentercel selenium rectifier may be useful. This rectifier replaces the rectifier section of pentode output-power rectifier valves such as the 25A7G which are notoriously difficult to replace. The Sentercel rectifier is rated at about 110 volts and since its size is no more than 2½in. x ¾in. square it will fit into most small cabinets.

When a 25A7G—or a 12A7G—has broken down it is therefore often simpler to fit a new output valve such as the 25A6G, the old output valve socket being rewired, together with a Sentercel rectifier which may be mounted either on the chassis or cabinet wall.

The author's preference is for valve rectification wherever possible, and so the universal power pack of Fig. 19 is shown with a rectifying valve.

MODERNISING THE UNIVERSAL T.R.F. RECEIVER.

The universal midget T.R.F. set usually follows a simple and well-marked pattern. A straight R.F. amplifying stage feeds into a tuned bias or anode bend detector, a stage in which a pentode is operated in a non-linear condition so that signals are rectified in the anode circuit—a positive charge on the grid increases the anode current whilst a negative charge causes little decrease, if any, since the valve is highly biased already and the anode current low.

This detector feeds into the output stage which may or may not incorporate the rectifier with the output valve. If the output and power rectifier valves are united in a single stage then, as has already been explained, the set is of totally American origin and is designed to work from 110 volt mains.

The universal midget T.R.F. receiver is fairly modern and since it is built up, in the great majority of cases, to fit closely into its cabinet there is little work that can be done. One outstanding point requires mentioning, however—since the receiver is American or its design owes much to American practice it will almost certainly tune over the medium waveband only, and this means that in several districts the receiver will be unsuitable for good steady reception of the Light programme on 261 metres. The 1,500 metres transmission of the Light programme is intended for wide coverage, and it will often be found desirable to make the set tune over the long waveband not only for this programme but also for reception of Luxembourg, the meteorological reports on 1,224 metres from Airmet, Leningrad, Berlin, etc.

It is scarcely possible to give hard and fast rules for the addition of long wave tuning to the midget T.R.F. set for so much depends on the chassis space available. A midget wavechange switch will have to be mounted on the front edge of the chassis, the cabinet being drilled with a ⅜in. or ½in. hole for spindle clearance, and probably the best plan is to remove the medium wave coils, replacing them with two waveband coils. The Weymouth coils type CT2W2 are recommended for this type of conversion, and the circuit, using these coils, of the new tuning arrangements is shown in Fig. 20. The coils are sold in pairs, the H.F. transformer coil having a reaction winding included. This winding is, of course, ignored.

The most commonly found layout is the aerial coil mounted behind the variable tuner above the chassis with the detector or H.F. Transformer coil below the chassis, the two coils thus being sufficiently screened one from the other. The low working voltage of the H.T. line also greatly assists in the prevention of feedback. The Weymouth coils require only a double pole on-off switch for wavechanging; this should be of the rotary type and if any feedback occurs as a result of running the leads from the two coils in proximity at the switch the lead from one or both coils may be screened.

Common valve types are a 6D6 as the R.F. amplifier followed by a 6C6 as the bias detector, these valves having 0.3 amp. heaters and fitting 6-pin UX sockets. More efficient valves could be fitted but this would mean a change in heater current rating with the consequent difficulties of replacing the output-power rectifier valve, so the old valves may be retained or, if a replacement is necessary and the 6-pin UX valves are unobtainable (in actual fact they should still be found in good supply) the octal equivalent of the valves, a 6J7 in each position, should be used, the valveholders being replaced or the 6J7's being fitted with adaptor bases.

No coil key is needed for Fig. 20, the Weymouth coils have numbered tags. Trimmers integral with the variable tuning condenser should be found capable of bringing both medium and long wavebands into trim, the trimming being carried out with the set switched to the medium band

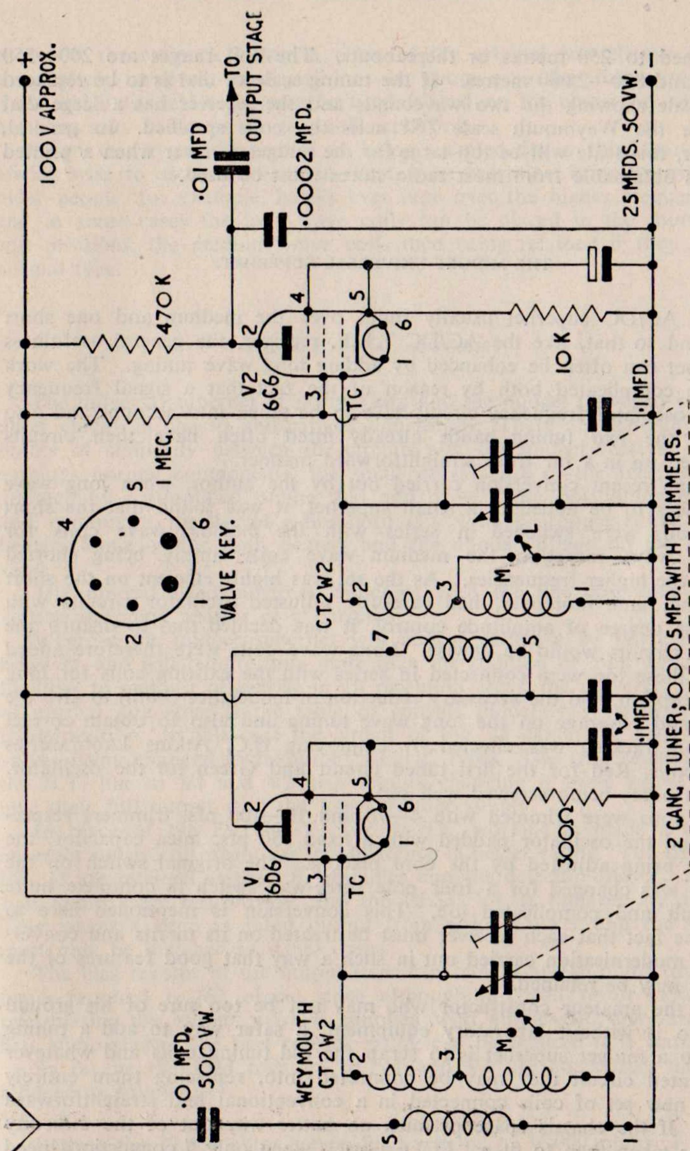


Fig. 20. Adding Longwave Tuning to the Midget T.R.F. Receiver.

and tuned to 250 metres or thereabouts. The coil ranges are 200—550 metres and 800—2,000 metres. If the tuning scale or dial is to be replaced by a scale showing the two wavebands and the receiver has a large dial aperture the Weymouth scale TS1 suits the coils specified. In general, however, this scale will be too large for the midget receiver when a printed scale as obtainable from most radio stores must be used.

THE MIDGET UNIVERSAL SUPERHET.

The AC/DC superhet usually tunes over the medium and one short waveband so that, like the AC/DC T.R.F. receiver, the general usefulness of the set can often be enhanced by adding long wave tuning. The work is more complicated both by reason of the fact that a signal frequency and an oscillator frequency circuit have to be taken into account and also because the two tuning bands already fitted often have their circuits connected up in a far from straightforward manner.

In one recent conversion carried out by the author, when long wave tuning was to be added to a small superhet, it was found that the short wave coils were switched in series with the medium wave coils for medium wave reception, the medium wave coils simply being shorted out for the higher frequencies. As the set was highly efficient on the short waveband, and, moreover, had carefully adjusted oscillator circuits with a precise degree of amplitude control, it was decided that to disturb the existing circuits would be unwise. Long wave coils were therefore added so that these too were connected in series with the existing coils for long wave reception, and the necessary reduction in inductance (both) to give the usual band coverage on the long wave tuning and also to obtain correct oscillator tracking was effected by employing H.C. Atkins Laboratories No. 1 coils, Red for the first tuned circuit and Green for the oscillator, the dust cores being screwed well out.

The coils were trimmed with 4—70 and 10—100 pfs. trimmers respectively and the oscillator padded with a fixed 150 pfs. mica capacitor, the padding being adjusted by the core placing. The original switch on the receiver was changed for a four pole three-way switch to complete quite a difficult and complicated job. This conversion is mentioned here to stress the fact that each receiver must be treated on its merits and conversion or modernisation carried out in such a way that good features of the receiver may be retained.

For the amateur constructor who may not be too sure of his ground and who is without laboratory equipment, a safer way to add a tuning range to a midget superhet is to scrap the old tuning coils and whatever complicated circuit they may be connected into, replacing them entirely with a new set of coils connected in a conventional and straightforward circuit. If the chassis space permits, no better way out of the difficulty could be taken than to fit a "Q" Coilpack when only 5 connections need be made, the coilpack fitting in place of the original wavechange switch. Very often, however, there will not be room even for this very small pack, and individual coils must be used, placed on the chassis in whatever positions may be found to give sufficient room.

When this type of receiver is being adapted for a third party it is always wise to ascertain whether short wave reception is really needed—older people, for example, hardly ever tune over the higher frequencies—and in some cases the long wave coils can be placed in the short wave coil positions, the medium wave coils then being retained if they are of normal type.

THE UNIVERSAL SUPERHET.

The universal superhet of normal size and the midget universal superhet differ chiefly in chassis and cabinet dimensions. There are generally many points of similarity between the circuits and the midget receiver usually employs normal components, the small overall size of the receiver being attained by a simplified tuning dial and drive, close positioning of parts and, commonly, the use of a line cord as a voltage dropper either for the heaters alone or for both heaters and the anode voltage on the rectifier valve.

The normal sized superhet dispenses with the line cord and uses a voltage dropping resistor or a barretter.

Whereas the midget superhet will almost certainly be fairly modern, however, and will require little more than the addition of long wave tuning facilities to make it of service in all reception areas, the universal superhet of normal size—that is the table or console model—may need extensive modernisation. In this case the circuit of Fig. 18 cannot be bettered, the valves being changed in favour of AC/DC types. The feed resistors from the H.T. line to V1 and V2 also require changing if these valves are to give their full output with the lower voltage supply.

In place of the ECH35, V1 for AC/DC working is made a CCH35, an exact equivalent except for the difference in heater rating. The EF39 and EBC33 are retained as the I.F. amplifier and the detector—A.V.C. and the first audio stage respectively, and the EL33, V4, is replaced by a CL33. This means a drop in rated output from 6 to 4 watts, and the speaker must now be matched to 4,500 ohms.

The bias resistor of the output stage can remain at 180 ohms (the exact figure required is 167 ohms) since although this will result in a slight over-biasing the output valve is supplied with ample grid drive from the first audio stage. The bias resistor rating can be reduced to $\frac{1}{2}$ watt.

So far as the feed resistors to V1 and V2 are concerned, these are reduced as follows :—

V1.

Reduce the 30,000 ohms screen feed resistor to 16,000 ohms, 1 watt.

Reduce the 15,000 ohms decoupling resistor to 4,700 ohms.

Reduce the triode anode feed resistor, 68,000 ohms, to 30,000 ohms, ½ watt.

V2.

Reduce the present 100,000 ohms screen feed resistor to 62,000 ohms, ½ watt.

Reduce the 10,000 ohms anode decoupler to 2,200 ohms.

NOTE :—If desired, the decoupling resistors in the anode lines of V1 and V2 may be omitted altogether, along with the 0.1 mfd. decoupling capacitors.

The power pack circuit of Fig. 19 will operate the converted universal superhet very satisfactorily and, with the CY31 rectifier heater added to the receiver's heater chain the total heater drop is then 72.6 volts, requiring 157.4 volts to be dropped from the usual mains voltage of 230 volts. The C1C barretter in the Miniwatt series is therefore ideal.

UNIVERSAL RECEIVERS—THE LOUDSPEAKER.

Quite a number of universal receivers, both of the normal and midget sized types, will be found to have energised loudspeakers. In some cases these speakers will have been specially made to suit the receiver model, in other cases standard models of well known makes will be employed. In receivers dating from a few years back it will be wise to replace these energised speakers by permanent magnet models which will be more sensitive and in all probability will give a reduction in hum.

At the same time the change from speaker field to choke smoothing will result in a lower voltage drop on the H.T. line, and when the maximum voltage obtainable is a bare 200 volts reducing the drop is of some importance.

Nevertheless there may be occasions when it is desired to use an energised loudspeaker as a replacement in a universal receiver. If the field is of low resistance it may be connected in place of the L.F. choke shown in Fig. 19, but if the field is of high resistance, or if the avoidance of voltage drop in the smoothing circuit is of some importance then the loudspeaker may be separately energised. This is accomplished by using a double rectifier valve, one half of the valve supplying the receiver through a low resistance choke and the other half of the valve supplying the loudspeaker alone.

A suitable valve is the Mullard CY32 with a heater consumption of 0.2 amp. at 30 volts, and the power pack circuit for separate speaker energisation is shown in Fig. 21.

The resistance in series with the speaker field must be chosen to regulate the current through the field. A high resistance speaker should be used in this circuit—a low resistance speaker could be employed to replace the choke—and for general purposes a safe speaker field current may be

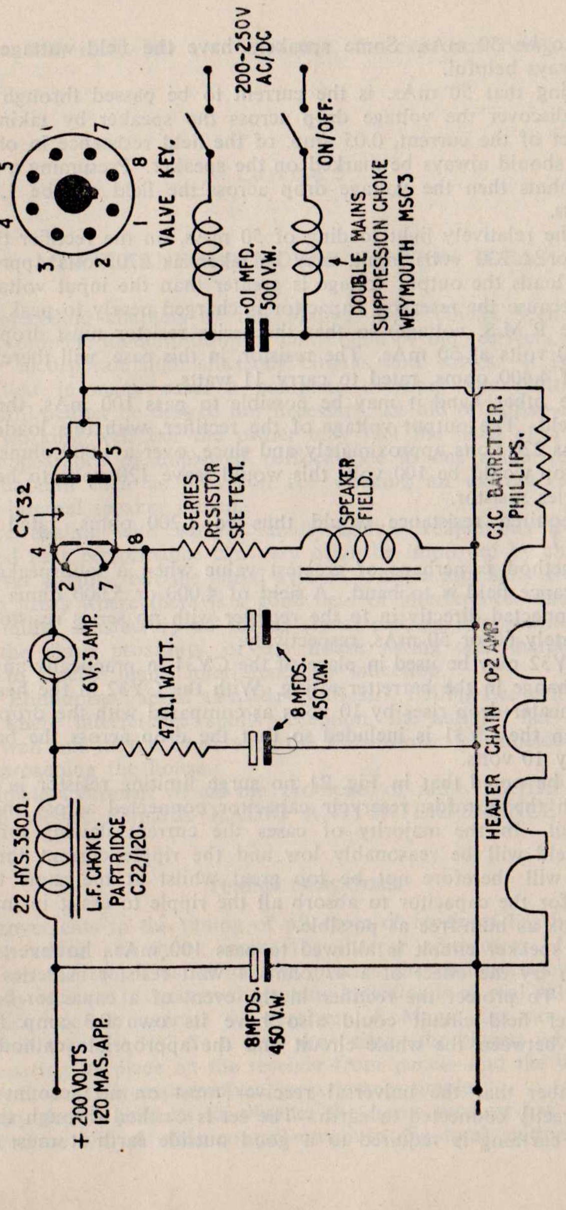


Fig. 21 A Universal Power Pack with separate speaker energisation.

assumed to be 50 mAs. Some speakers have the field wattage marked; this is always helpful.

Assuming that 50 mAs. is the current to be passed through the field winding, discover the voltage drop across the speaker by taking this as the product of the current, 0.05 amp. of the field resistance in ohms. The resistance should always be marked on the speaker. Presuming a resistance of 1,000 ohms then the voltage drop across the field will be 1,000 x 0.05 or 50 volts.

With the relatively light loading of 50 mAs. on the rectifier the output voltage, for a 230 volts input, may be taken as 270 volts approximately (for light loads the output voltage is greater than the input voltage to the rectifier because the reservoir capacitor is charged nearly to peak potential, not to the R.M.S. voltage) so that the series resistor must drop approximately 220 volts at 50 mAs. The resistor, in this case, will therefore have a value of 4,400 ohms, rated to carry 11 watts.

On the other hand it may be possible to pass 100 mAs. through the speaker field. The output voltage of the rectifier, with this loading, could be taken as 220 volts approximately and since, over a 1,000 ohms field, the voltage drop would be 100 volts this would leave 120 volts to be dropped by the series resistor.

The required resistance would thus be 1,200 ohms, rated to carry 12 watts.

The method is perhaps of greatest value when a loudspeaker with a high resistance field is to hand. A field of 4,000 or 5,000 ohms resistance can be connected directly in to the rectifier with no series resistor, to pass approximately 60 or 50 mAs. respectively.

The CY32 may be used in place of the CY31 in practically any receiver with no change in the barretter rating. With the CY32 in the heater chain the total heater drop rises by 10 volts as compared with the drop over the chain when the CY31 is included so that the drop across the barretter is reduced by 10 volts.

It will be noted that in Fig. 21 no surge limiting resistor is shown in series with the 8 mfds. reservoir capacitor connected across the speaker field circuit. In the majority of cases the current flowing through the speaker field will be reasonably low and the ripple current through the capacitor will therefore not be too great whilst at the same time it is desirable for the capacitor to absorb all the ripple to assist in making the speaker flux as hum-free as possible.

If the speaker circuit is allowed to pass 100 mAs., however, it would be wise to try the effect of a 47 ohms 1 watt resistor in series with the capacitor. To protect the rectifier in the event of a capacitor breakdown the speaker field circuit could also have its own 0.3 amp fuse bulb connected between the whole circuit and the appropriate cathode on the CY32.

Remember that the universal receiver must on no account have its chassis directly connected to earth. The set is earthed through the mains; if further earthing is required to a good outside earth it must be made through a 0.01 mfd. 500 v.w. capacitor, the capacitor being in perfect condition.

CHAPTER 5

MISCELLANEOUS MODERNISATION IDEAS

The preceding chapters of this Manual have chiefly been concerned with the complete modernisation or conversion of old receivers so that the sets may incorporate high efficiency circuits and valves. It is, however, realised that in many cases a complete overhaul and refitting of the receiver will neither be desired nor necessary; an old or not-so-old receiver may be working well but the owner may feel the need of a change of cabinet appearance or improved performance in one single respect or a simple adaption such as provision for working an external loudspeaker with the internal speaker muted.

Before dealing with various small receiver adaptations it should be mentioned that performance can very often be improved by changing, not the receiver circuits, but the aerial system. This is especially true in noisy reception areas where there is a good deal of interference. Indoor aerials may be quite satisfactory so far as signal pick-up is concerned but they are in the close proximity of the house wiring and therefore ideally situated to receive mains interference by induction.

An " Eliminoise " aerial as made by Messrs. Belling-Lee will be of great benefit where interference spoils reception, the aerial " flat top " being erected well out in the open with the transformer fed shielded downlead only approaching the house.

Complete treatment of all the problems of radio interference will be found in Messrs. Bernards' RADIO ANTI-INTERFERENCE MANUAL.

TUNING INDICATORS.

Improvements to the tuning of all types of receivers has been covered, but with added selectivity comes the sharper adjustment of the tuning control on the set. This, of course, pleases the enthusiast but so far as the family receiver is concerned a tuning indicator is of real value especially when older people operate the receiver. A Magic Eye can be fitted to any superhet with A.V.C. in a very short time—the biggest job is choosing and preparing its place on the receiver front panel—and the wiring, either in an A.C. or Universal receiver, is extremely simple.

If any doubts exist as to whether the home receiver has A.V.C.—few superhets are without this control—tune to the local station and, in an interval between programmes or announcements, listen to the background noise, which in all probability will be no more than a quiet hiss. Next tune to a point between stations and, without varying the volume control, listen again to the background noise which is now unaffected by any station operated A.V.C. If the background noise increases the receiver has A.V.C.

A highly recommended Magic Eye is the Mullard EM34. The only components required for the tuning indicator are the Eye itself, an octal valveholder, two 1 megohm resistors and a few lengths of wire and sleeving. A metal bracket to hold the Eye, in its socket, in the required position may be bent up from sheet brass or any other material to hand.

The circuit into which the Eye is connected is shown in Fig. 22. The two resistors may, of course, be mounted directly across the valveholder, the target connection, Pin No. 5, acting as the anchoring point both for

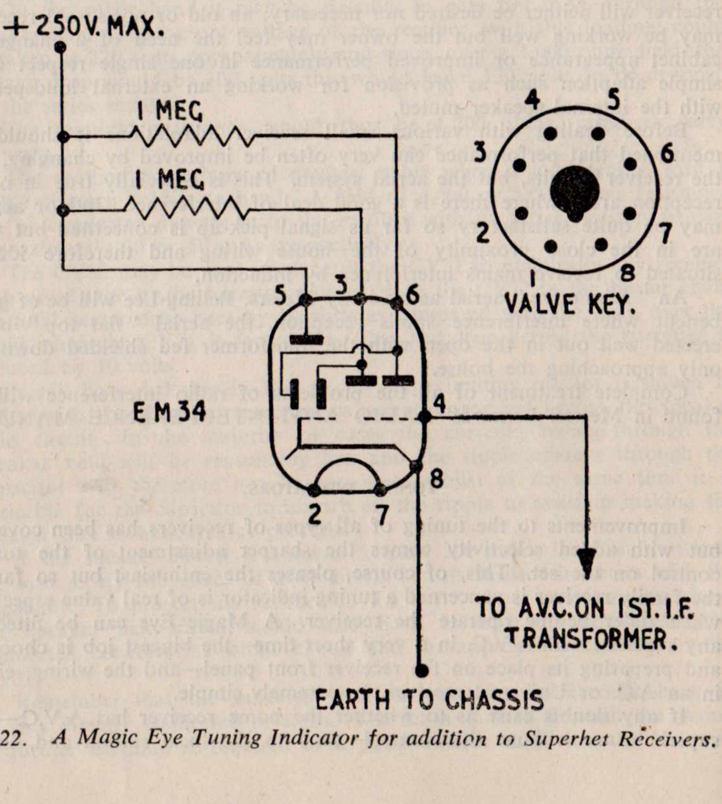


Fig. 22. A Magic Eye Tuning Indicator for addition to Superhet Receivers.

these resistors and for the H.T. line. If the receiver H.T. is greater than 250 volts then a dropping resistor between Pin No. 5 and H.T. may be used. The total H.T. current consumption of the Eye is approximately 1 mA. so that to drop, say, 50 volts from a 300 volt line making the supply to the whole Eye circuit 250 volts, a 50,000 ohms ½ watt resistor would be required. In this case some bypassing from Pin No. 5 to earth would be advisable; a 0.1 mfd. 350 v.w. capacitor would serve.

The grid of the Eye is connected directly to the A.V.C. line after the normal smoothing circuit and the ideal connecting point for this purpose is provided by the secondary winding of the first I.F. transformer in practically any superhet. Connect the grid of the Eye to the I.F. transformer connection to the A.V.C. line.

Heater requirements are 6.3 volts at 0.2 amp. In an A.C. receiver the Eye heater will thus be connected directly across the heater line at any point or across a spare heater winding on the transformer if one is provided.

In a universal receiver the heater chain must be broken and the Eye heater connected in series with the rest of the heaters. The maximum heater-cathode voltage permissible is 100 volts and so a suitable point for the inclusion of the Eye heater is between the I.F. valve heater and the output stage heater. The barretter will automatically regulate itself to the new voltage drop; if a dropping resistor or line cord is used the resistance in either case must be reduced by 31.5 ohms.

The cathode of the Magic Eye is taken directly to the negative line of the receiver—that is, direct to the chassis.

The Eye should not be bolted finally into place until it has been tested with the receiver in action and the positioning of the shadows taken into account. The usual mounting position has Pins No. 1 and No. 5 in the vertical plane.

ADDITIONAL R.F. AND I.F. STAGES.

A superhet receiver with a modern coilpack as the tuning stages should have sufficient selectivity to prove suitable for all ordinary purposes, with sufficient gain for any reception area if plenty of audio amplification is provided. The constructor interested in long range reception sometimes feels the need for further R.F. or I.F. gain, however.

Increasing the audio gain in a receiver is of value only when the required station is received fairly well by the tuned sections of the receiver; a faint audio signal after detection can be amplified up to audibility even though first-class tone cannot be expected under those conditions.

The signal must be in evidence, however, and the receiver's limit is reached when the signal, after detection, is too faint or too submerged in the unavoidable receiver noise (valve hiss etc.), to make high audio amplification worthwhile.

To improve on this state of affairs a further stage, either R.F. or I.F., may be added to the set. If greater selectivity is required—as will be the case at the high frequency end of the short wave band for the suppression of image interference—the added stage should be an R.F. tuned stage. If greater pre-detector gain with a slight increase in selectivity—or equal selectivity—is needed, then a further I.F. stage should be added.

The addition of an R.F. stage to a receiver is no small matter and is attended by several difficulties. In the first place the tuning condenser, in all likelihood a two gang component, must be replaced by a three gang condenser in order that the new stage may be tuned. The added coils for the first stage must be in exact alignment with the existing coils so that if a coilpack is used as the frequency changer tuning arrangement this pack will require substitution either by a larger pack with R.F. stage tuning or by separate coils.

Finally there will be the question of coil mountings on the chassis and the avoidance of feedback.

An additional R.F. stage is therefore not recommended, at least so far as the ordinary receiver is concerned. Adding an I.F. stage is a much simpler matter.

Room must be found on the chassis for a further I.F. transformer and valve. The transformer must, of course, tune to the present receiver I.F., which should be about 465 kcs.; all transformers have a range of adjustment allowing them to be tuned to either side of this frequency by adequate amounts. To prevent the chance of feedback the transformer must be well shielded whilst its " Q " or efficiency need not be too great. A high " Q " will result in a very sharply peaked response curve over the whole I.F. amplifier and the receiver's tone will then be lacking since the high frequencies will be cut by the reduced sideband response.

A suitable transformer is the Weymouth P2 with flying lead, and a Mullard EF39 as the additional amplifier is a suitable valve. The new stage should be introduced between the present I.F. amplifier and the frequency changer, the existing first I.F.T. thus feeding into the new EF39 and the new I.F.T. feeding into the grid of the existing I.F. valve.

The circuit for the additional stage is shown in Fig. 23. Note the decoupling applied both to the screen and anode circuits; should there be any feedback trouble, which will depend chiefly on component spacing and positioning which must finally be decided by the chassis arrangements, it must be countered by experimental increases first in the screen resistor and then, should this prove ineffective, in the decoupling resistor.

The grid and anode wiring of the new stage must be short and the two circuits isolated, for feedback over the stage itself is possible. Such feedback is utilised in communications receivers and controlled by variation of the cathode bias resistor, a 5,000 or 10,000 ohms potentiometer being used as the cathode resistor, to sharpen the response of the I.F. amplifier, but this is not desirable or necessary in a broadcast receiver.

The new I.F. stage is brought into alignment with the existing I.F. amplifier by re-aligning the circuit in the usual way with a signal generator.

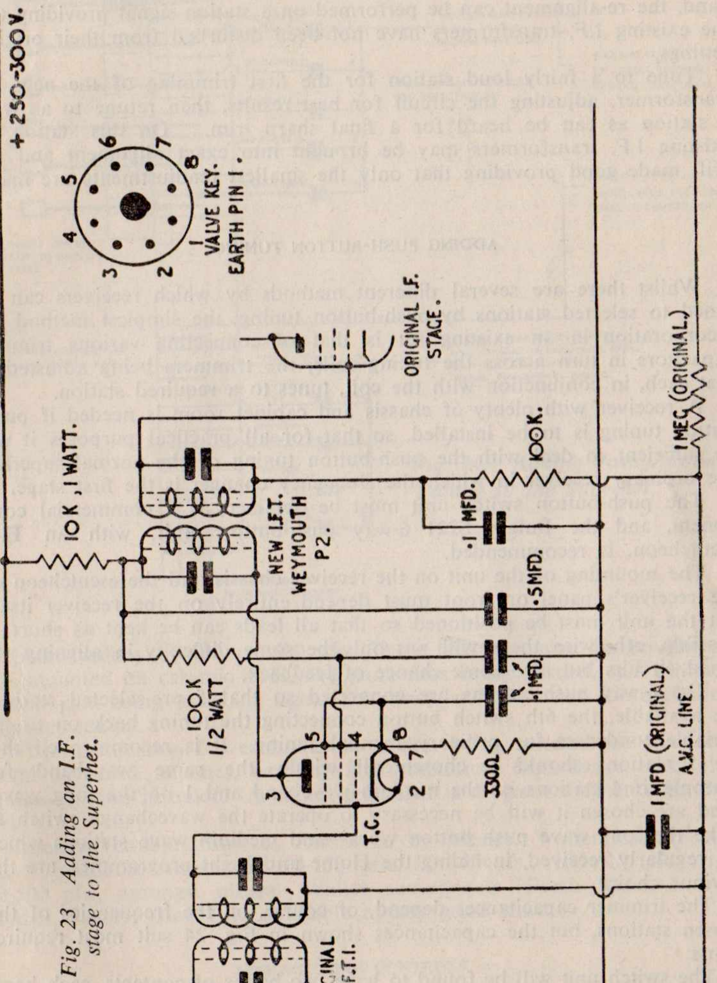


Fig. 23 Adding an I.F. stage to the Superhet.

If the exact receiver I.F. is not known, or if a signal generator is not to hand, the re-alignment can be performed on a station signal providing that the existing I.F. transformers have not been disturbed from their original settings.

Tune to a fairly loud station for the first trimming of the new I.F. transformer, adjusting the circuit for best results, then retune to as weak a station as can be heard for a final sharp trim. On this station the existing I.F. transformers may be brought into exact alignment and any drift made good providing that only the smallest readjustments are made.

ADDING PUSH-BUTTON TUNING.

Whilst there are several different methods by which receivers can be tuned to selected stations by push-button tuning, the simplest method for incorporation in an existing set is that of connecting various trimmer capacitors in turn across the tuning coils, the trimmers being adjusted so that each, in conjunction with the coil, tunes to a required station.

A receiver with plenty of chassis and cabinet room is needed if push-button tuning is to be installed, so that for all practical purposes it will be sufficient to deal with the push-button tuning of the normal superhet, the ordinary receiver in which the frequency changer is the first stage.

The push-button switch unit must be obtained as a commercial component, and the Bulgin S221 6-way push-button unit, with an E.10 escutcheon, is recommended.

The mounting of the unit on the receiver chassis and the escutcheon on the receiver's panel or front must depend entirely on the receiver itself, but the unit must be positioned so that all leads can be kept as short as possible, otherwise there will not only be some difficulty in aligning the tuned circuits but also some chance of feedback.

The 6-way push-buttons are connected so that 5 pre-selected stations are available, the 6th switch button connecting the tuning back on to the variable condenser for ordinary manual tuning. It is recommended that the 5 stations should be chosen all within the same waveband—for example, if 4 stations on the medium waveband and 1 on the long waveband are chosen it will be necessary to operate the wavechange switch to make the long wave push button work—and medium wave stations which are regularly received, including the Home and Light programmes, are the obvious choice.

The trimmer capacitances depend, of course, on the frequencies of the chosen stations, but the capacitances shown in Fig. 24 suit most requirements.

The switch unit will be found to have two banks of contacts, each bank consisting of six sets of three contacts per set. The connections from these contacts to the trimmers and coils in the superhet are shown in the diagram.

In all ten trimmers are needed, four with maximum values of about 200 pfs., four with maximum values of about 300 pfs. and two with

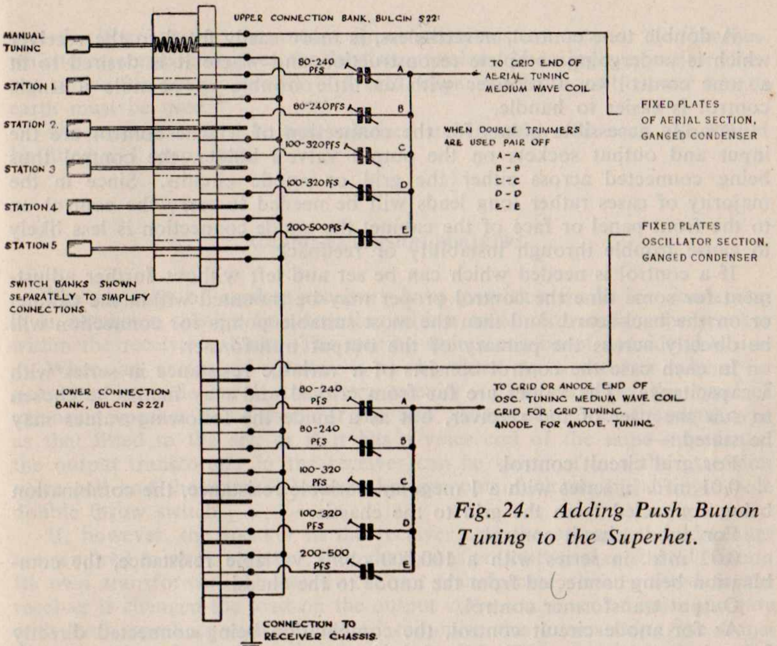


Fig. 24. Adding Push Button Tuning to the Superhet.

maximum values of 500 or 600 pfs. These trimmers may be bought as pairs mounted on ceramic beds, five pairs thus being needed, one trimmer of each pair being used for signal frequency and the other for oscillator frequency tuning.

When the station for each button is first being selected the trimmers should be tuned together, working from minimum capacitance, until the required station is tuned. A signal generator is of great assistance in this work.

Excellent double trimmers are made by Messrs. Walter Instruments, Ltd. Obtainable ranges are 40-150 pfs., 80-240 pfs., 100-320 pfs. and 200-500 pfs., amongst others. Walter components (Garth Road, Lower Morden, Surrey) should be available at any good store.

ADDING TONE CONTROLS.

In the diagrams illustrating the circuits described in earlier chapters a double tone control is shown, with variable bass and treble attenuation (Figs. 13 and 15), and such a double tone control may be fitted to any receiver including a first audio amplifying stage before the output valve.

A double tone control, nevertheless, is more easily fitted to the receiver which is undergoing complete reconstruction and where it is desired to fit a tone control to a receiver with as little trouble as possible a single control is easier to handle.

Readily accessible points for the connection of a tone control are the input and output sockets on the output valve's holder, the control thus being connected across either the grid or anode circuits. Since in the majority of cases rather long leads will be needed to carry the control on to the front panel or face of the cabinet the anode connection is less likely to cause trouble through instability or feedback.

If a control is needed which can be set and left without further adjustment for some time the control proper may be mounted within the cabinet or on the backboard, and then the most suitable points for connection will be directly across the primary of the output transformer.

In each case the control consists of a variable resistance in series with a capacitance. The values are far from critical and may finally be chosen to suit the user of the receiver, but as a guide the following values may be stated :—

For grid circuit control.

0.01 mfd. in series with a 1 megohm variable resistance, the combination being connected from the grid to the chassis.

For anode circuit control.

0.02 mfd. in series with a 100,000 ohms variable resistance, the combination being connected from the anode to the chassis.

Output transformer control.

As for anode circuit control, the combination being connected directly from the anode to the H.T. side of the output transformer primary winding. Reducing the variable resistance to 10,000 ohms, for this method of connection, might also be tried.

GRAMOPHONE REPRODUCTION.

Pick-up sockets may be fitted to any receiver which has a stage of audio amplification before the output valve, and for the most satisfactory results it is suggested that the double-diode-triode circuit be changed to that shown in Fig. 18. This permits of the output stages being switched in for gramophone playing alone; in some receivers the pick-up is connected across the volume control with no provision for muting the radio circuits so that the receiver must be detuned from any station.

If an electric motor is to be fitted to the receiver, or is to be used in a separate cabinet on the same power line a synchronous motor (for A.C. circuits, of course) should be chosen whenever possible, for then there will be no chance of interference. On D.C. circuits a commutator motor is necessary and in this case a capacitance up to 2 mfds. in value, and of adequate working voltage (1,000 v.w. is definitely desirable) can be connected either across the motor input terminals or across the brushes. whichever connection gives the best suppression. If a single capacitor does not suffice for quiet operation a 2 mfd. capacitor from each power line to earth must be used.

The capacitors must be non-polarised and in series with each one should be fitted a 1 amp. fuse.

ADDING EXTENSION SPEAKERS.

The majority of modern receivers have provision made for connecting in an extension speaker line, together with a switch for muting the speaker within the receiver cabinet. The muting switch can be of considerable use.

When an extension speaker is to be fitted to a receiver where no provision is made for it the extra circuits will depend on the type of extension speaker to be used. If the new loudspeaker is of the same type as that fitted to the set, or if it has a voice coil of the same impedance, the output transformer in the receiver can be switched into the extension voice coil and the internal loudspeaker cut out of circuit by a single pole double throw switch.

If, however, the speaker in the receiver and the extension loudspeaker are required to work together, then the extension loudspeaker should contain its own transformer. Unless the output transformer already fitted to the receiver is changed the load on the output valve can never be quite accurate with both speakers switched in; to minimise the mismatching the transformer ratio of the extension speaker transformer may be high so that the new impedance " seen " by the output valve is high.

The extension speaker wiring should be carried out carefully. When the extension speaker voice coil is brought into circuit, with no fresh output transformer, the impedance of the line will be added to the low impedance of the voice coil with corresponding losses along the line, so that in this case the wiring should be for low voltage-high current, the leads being as thick as possible. Good flex may be used. When, however, the extension speaker contains its own output transformer the line will behave as a high voltage-low current line, and in this case line capacitance will be of some importance. A double line with the wires well separated may be used but the alternative method, that of using a single line to one side of the extension speaker, completing the circuit through earth, can also be tried. This method should not, of course, be used with AC/DC receivers but only with receivers isolated from the mains by a transformer or with battery sets.

Different methods of connecting the extension speaker are shown in Fig. 25. Note that when the extension speaker contains its own matching transformer the muting arrangements on the set's internal speaker provide for the switching in of a dummy load.

The tone of reproduction can sometimes be improved, in an old receiver,

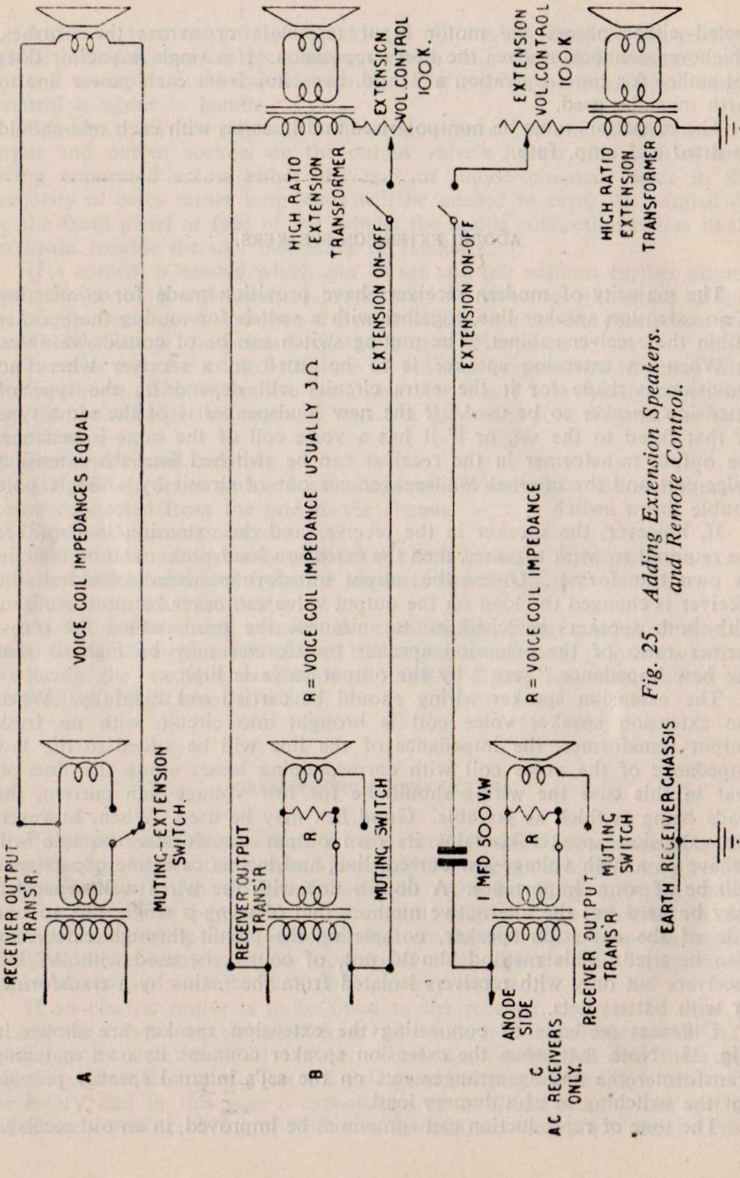


Fig. 25. Adding Extension Speakers. and Remote Control.

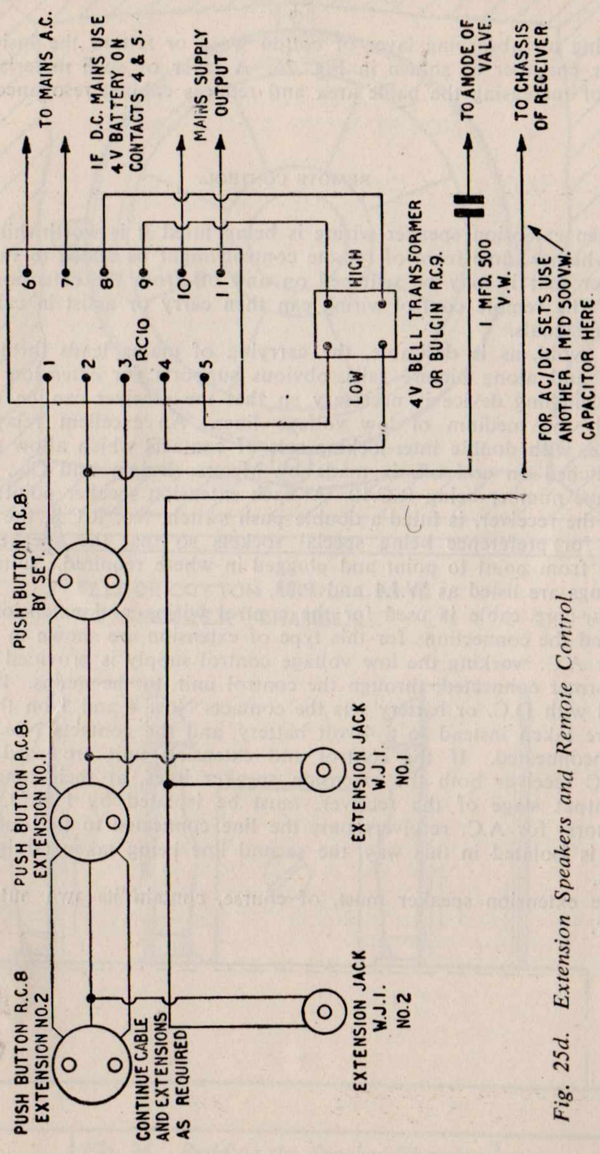


Fig. 25d. Extension Speakers and Remote Control.

by fitting an absorbing layer of cotton wool or felt to the inside of the speaker chamber as shown in Fig. 26. A layer of such material has the effect of increasing the baffle area and reduces cabinet resonances.

REMOTE CONTROL.

When extension speaker wiring is being fitted it is worthwhile to consider whether some form of remote control might be added to the receiver in order that it may be switched on and off from the extension speaker point. The remote control wiring can then carry or assist in carrying the speaker signals.

To avoid, as is desirable, the carrying of mains leads through door-frames and along picture rails, obvious supports for extension wiring, a relay switching device is necessary so that the receiver can be controlled through the medium of low voltage lines. An excellent relay for the purpose, with double inter-locking sets of contacts which allow the set to be switched on and off, is made by Messrs. Bulgin and Co., Ltd., the catalogue number being R.C.10. At each extension speaker point, and also beside the receiver, is fitted a double push switch, No. R.C.8, the extension points for preference being special sockets so that the speaker can be carried from point to point and plugged in where required. Suitable jacks and plugs are listed as W.J.1 and P.23.

Four-core cable is used for the control wiring and extension speaker line, and the connections for this type of extension are shown in Fig. 25 d.

For A.C. working the low voltage control supply is provided by a bell transformer connected, through the control unit, to the mains. If the unit is used with D.C. or battery sets the contacts Nos. 4 and 5 on the control unit are taken instead to a 4-volt battery, and the contacts Nos. 8 and 9 left unconnected. If the control and extension unit are used with an AC/DC receiver both the extension speaker lines, at their junction with the output stage of the receiver, must be isolated by 1 mfd. 500 v.w. capacitors; for A.C. receivers only the line connected to the output valve anode is isolated in this way, the second line being taken straight to the chassis.

The extension speaker must, of course, contain its own output transformer.

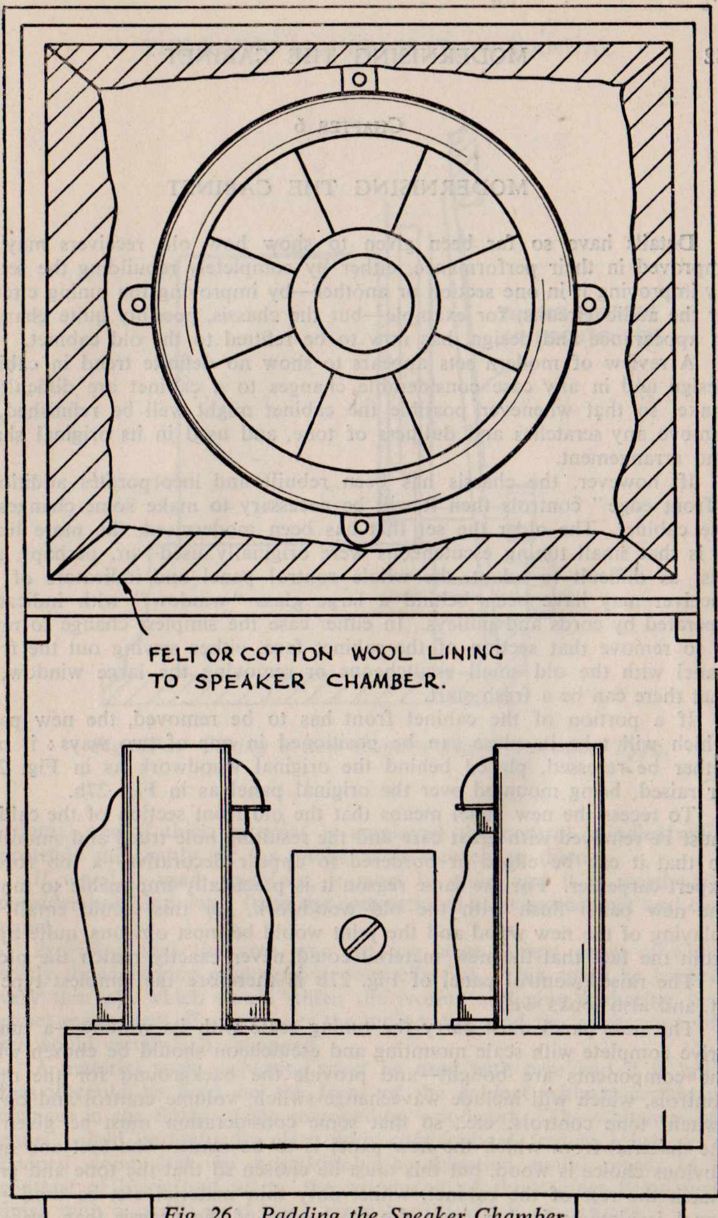


Fig. 26. Padding the Speaker Chamber to Improve Tone.

CHAPTER 6

MODERNISING THE CABINET

Details have so far been given to show how old receivers may be improved in their performance, either by completely rebuilding the set or by improving it in one section or another—by improving the tuning circuits or the audio circuits, for example—but the chassis, possibly quite changed in appearance and design, has now to be refitted to the old cabinet.

A review of modern sets appears to show no definite trend in cabinet design and in any case considerable changes to a cabinet are difficult to make, so that whenever possible the cabinet might well be refinished, to remove any scratches and dullness of tone, and used in its original shape and arrangement.

If, however, the chassis has been rebuilt and incorporates additional "front edge" controls then it will be necessary to make some changes to the cabinet. The older the set that has been modernised, the more likely it is that small tuning escutcheons were originally used—or, perhaps, and just as difficult to adapt, the whole control panel and indicators of the receiver may have been behind a large glass "window," with indicators operated by cords and pulleys. In either case the simplest change to make is to remove that section of the cabinet face, either sawing out the front panel with the old small escutcheons or removing the large window, so that there can be a fresh start.

If a portion of the cabinet front has to be removed, the new panel which will take its place can be positioned in one of two ways: it may either be recessed, placed behind the original woodwork as in Fig. 27a, or raised, being mounted over the original panel as in Fig. 27b.

To recess the new panel means that the old front section of the cabinet must be removed with great care and the resulting hole trued and smoothed so that it can be edged or bordered to appear decorative—a job for an expert carpenter. For the same reason it is practically impossible to mount the new panel flush with the old woodwork, for this would entail the inlaying of the new wood and the joint would be most obvious, quite apart from the fact that the new material could never exactly match the old.

The raised control panel of Fig. 27b is therefore the simplest type to fit, and also looks well.

The new panel must carry the tuning scale with its window—a tuning drive complete with scale mounting and escutcheon should be chosen when the components are bought—and provide the background for the other controls, which will include wavechange switch, volume control and on-off switch, tone controls, etc., so that some consideration must be given to the material from which the new panel is to be made. The first and most obvious choice is wood, but this must be chosen so that the tone and grain match the rest of the cabinet, whilst only thin material can be used—the panel is already further from the front edge of the chassis than was the

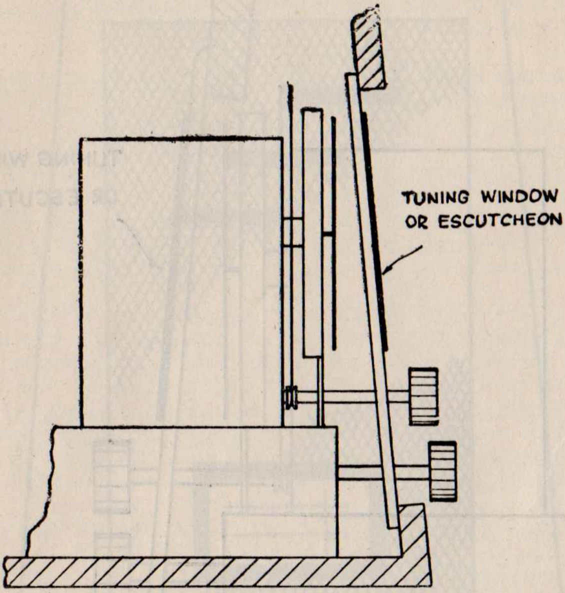


Fig. 27a. Fitting a new Control Panel, Recessed Type.

original and if thick material is employed the control spindles will not protrude sufficiently for the knobs to fit securely to them.

If wood is used, therefore, it must be thin, and it is worthwhile to consider breaking away from the conventional all-wood cabinet and control panel.

Providing that the area was not too large a new panel of white or softly toned ivorine might prove very effective. This could be backed by very thin ply which would stiffen the ivorine and give anchoring for the panel escutcheon, if used, over the tuning dial, and the appearance of the set would certainly be changed.

A material such as ivorine must be used with care and it is unlikely that it could be used on the front of the cabinet without certain other changes in the finish of the surrounding woodwork. The whiteness of the panel would undoubtedly clash with conventional french polish or even grained wood, and the most suitable combination would appear to be a contrast of black and white, the woodwork of the cabinet being given a finish with a really good black enamel with a high gloss finish.

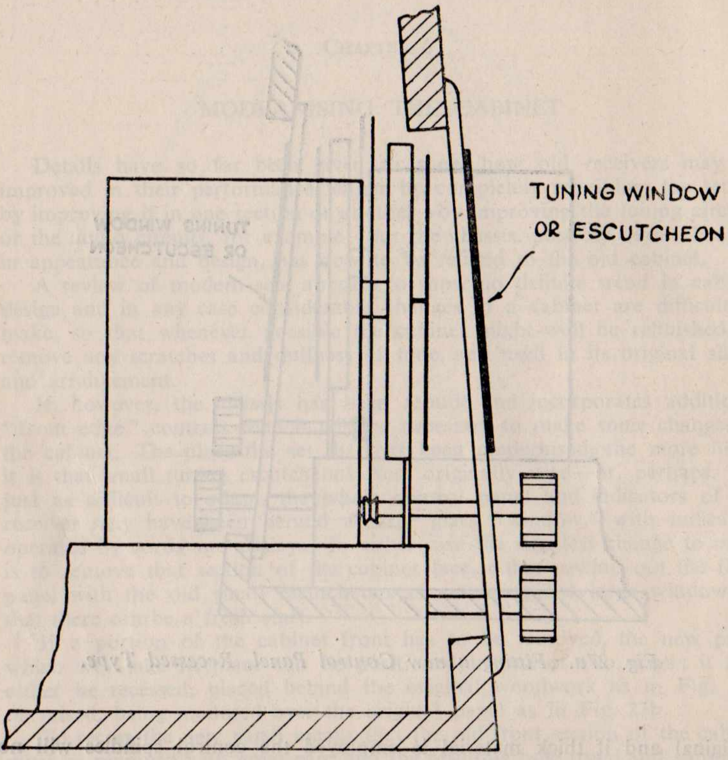


Fig. 27b. Fitting a new Control Panel, Raised Type.

Another scheme which has much to commend it is to give the whole cabinet a fabric front. This is, perhaps, more effective on horizontal rather than on vertical cabinets, but in either case if the work is carried out with care and a really suitable material is used—a close weave of "tweedy" stuff—a highly modern cabinet is the result.

To fit a fabric front, an example being shown in Fig. 28, an overlay of thin plywood is first cut out, this overlay being of a size which will completely cover the old speaker aperture and the hole where the old control panel has been cut away. In the template are cut holes to correspond with the speaker aperture and tuning window and the thin wood is then covered with the material, a turn-over of at least half an inch being

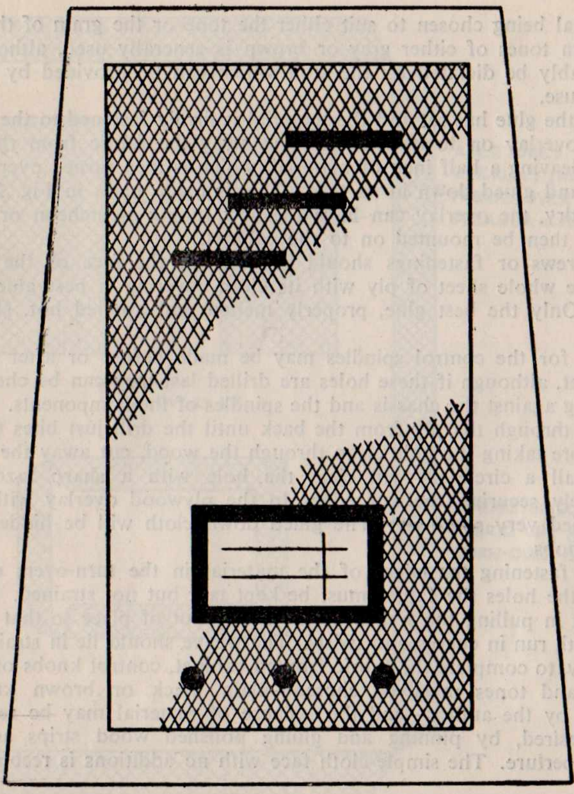


Fig. 28. A Cabinet with a Fabric Front.

allowed at each edge. When the material has been arranged to the best advantage, with the weave in the direction which gives the best effect, the material may be fastened to the back of the overlay with good hot glue. Make sure that no glue gets on the face of the material, or seeps through via the turn-over.

Any raised work on the face of the cabinet must now be removed so that the new overlay can be bedded on to a plane surface. Before the overlay is fitted the receiver cabinet must be given any refinishing that might be necessary. A stained or polished surround is suitable in this case, the material being chosen to suit either the tone or the grain of the wood. Material in tones of either grey or brown is generally used, although this will probably be dictated by the stuff which can be provided by the lady of the house.

When the glue has set and the material is firmly fastened to the overlay, turn the overlay on to its face and cut away the fabric from the tuning aperture, leaving a half inch of material, which is then turned over through the hole and glued down in its turn. This is made plain in Fig. 29. With this glue dry, the overlay can have the new tuning escutcheon or window fixed and then be mounted on to the cabinet.

No screws or fastenings should be seen on the face of the overlay, and so the whole sheet of ply with its cloth covering is best glued to the cabinet. Only the best glue, properly melted and applied hot, should be used.

Holes for the control spindles may be made before or after fixing to the cabinet, although if these holes are drilled last they can be checked for positioning against the chassis and the spindles of the components. In either case drill through the ply from the back until the drill just bites the cloth, then, before taking the hole clean through the wood, cut away the material in as small a circle as will clear the hole with a sharp razor blade, immediately securing the cut edges to the plywood overlay with further glue applied very sparingly. The glued down cloth will be hidden by the control knobs.

When fastening the edges of the material in the turn-overs or at the edges of the holes the fabric must be kept taut but not strained. Straining will result in pulling the weave of the fabric out of place so that the lines of the cloth run in curves and twists. The weave should lie in straight lines.

Finally, to complete the fabric fronted cabinet, control knobs of suitable patterns and tones must be chosen—plain black or brown knobs are preferred by the author—and the expanse of material may be relieved, if this is desired, by pinning and gluing polished wood strips across the speaker aperture. The simple cloth face with no additions is recommended, however.

INTERIOR WOODWORK.

The only interior carpentry which may be needed when the modernised set is fitted back into the old cabinet is a new baffle board for a new loudspeaker.

In many receivers the loudspeaker is fitted to a heavy board which, in turn, is screwed to the interior of the cabinet, and apart from the stout mounting which this provides for the speaker itself it also allows of a large cloth covered aperture in the front of the cabinet. When the speaker is renewed the original baffle may prove to be of a size unsuited to the new speaker, and a new board must be fitted.

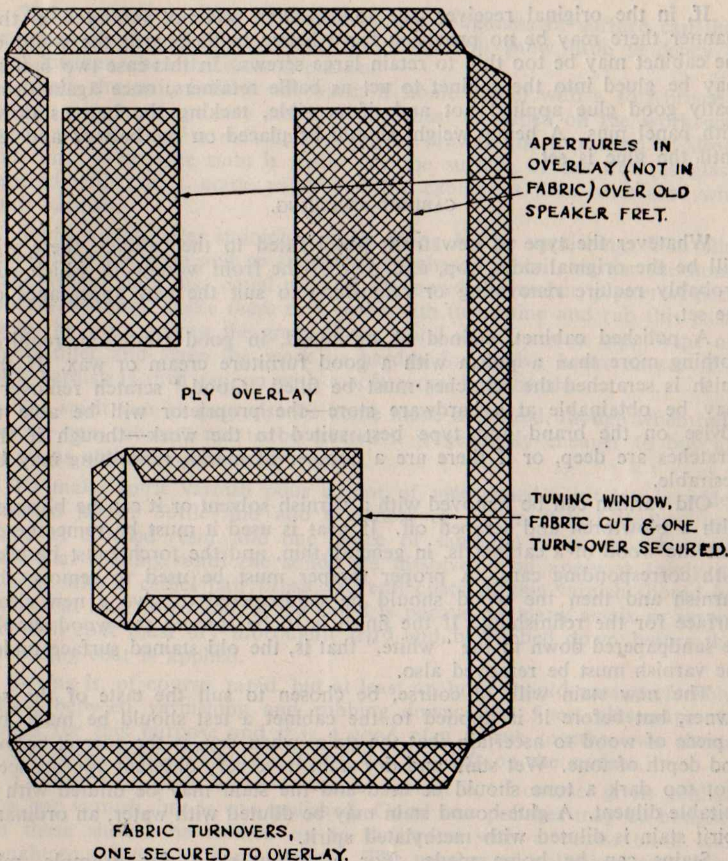


Fig. 29. Fastening the Fabric to the Overlay.

The thickness of the wood may be judged from the old board and the aperture must be cut to suit the new speaker. The board is screwed to the interior of the cabinet so that it is very firmly fastened and at the same time it is good practice to sandwich a piece of thin felt between the board and cabinet. Two broad strips of felt, one at either end of the board, suffice. The fixing screws pass through the felt strips.

If, in the original receiver, the loudspeaker was not mounted in this manner there may be no provision for a heavy baffle board; the wood of the cabinet may be too thin to retain large screws. In this case two battens may be glued into the cabinet to act as baffle retainers, once again using really good glue applied hot and, if possible, tacking the battens down with panel pins. A heavy weight should be placed on the battens and left until the glue is set.

CABINET FINISHING.

Whatever the type of new front panel fitted to the cabinet, there will still be the original sides, top, and part of the front woodwork which will probably require renovating or refinishing to suit the new appearance of the set.

A polished cabinet, stained or unstained, in good condition, requires nothing more than a polish with a good furniture cream or wax. If the finish is scratched the scratches must be filled. Good "scratch remover" may be obtainable at a hardware store—the proprietor will be able to advise on the brand and type best suited to the work—though if the scratches are deep, or if there are a number of marks, refinishing may be desirable.

Old varnish can be removed with a varnish solvent or it can be blistered with a blowtorch and scraped off. If heat is used it must be remembered that the wood of a cabinet is, in general, thin, and the torch must be used with corresponding care. A proper scraper must be used to remove the varnish and then the wood should be sandpapered to give a new clean surface for the refinishing. If the finish is to be smooth the wood should be sandpapered down to the "white," that is, the old stained surface under the varnish must be removed also.

The new stain will, of course, be chosen to suit the taste of the set owner, but before it is applied to the cabinet a test should be made on a piece of wood to ascertain that the stain, when dry, is the correct colour and depth of tone. Wet stain and dry stain have very different appearances. Not too dark a tone should be used and the stain may be diluted with a suitable diluent. A glue-bound stain may be diluted with water, an ordinary spirit stain is diluted with methylated spirit.

Stains can be home made. For a walnut stain, for example, mix powdered vandyke brown with liquid ammonia to make a paste and dilute this with warm water to the desired shade. Liquid glue is added hot to this stain as a binder, a dessertspoonful of hot melted glue to a half pint of the stain being the correct proportion.

When soft woods are stained the fibres of the wood swell and stand out, then, when the work is smoothed down, the stain is "cut through" at some points and a patchy finish is the result. This swelling of the wood fibres can be overcome to a great extent by pre-swelling the wood, sponging it down with really hot water and allowing it to dry before staining.

The resulting swelling of the fibres and roughness of surface can then be removed with glass-paper and the wood will show little tendency to swell further when the stain is put on.

Apply the stain (whilst still warm if home made) with a soft brush, a rag, or a sponge, and any surplus stain must be wiped off the work with light applications of a soft fluffless rag to prevent the formation of drops and runs. When the stain is really dry the surface of the work is glass-papered with No. 1 grade paper and the cabinet is then resurfaced with spirit varnish.

Some woods, after staining, require filling before varnishing. The filler depends on the stain and so should be purchased to suit, or, for the home made walnut stain, use equal parts of dry powdered umber, plaster-of-paris and dry whiting. Make these to a paste with turpentine and rub this paste on to the work against the grain of the wood with a coarse rag. Wipe off excess filler and leave the work to harden for twelve hours or so. The spirit varnish is then put on with a soft camel hair brush.

The spirit varnish may also be home made if desired, though when only one or two cabinets are to be treated it is generally cheaper to buy all the stains and varnishes ready made.

To make spirit varnish pour a pint of methylated spirit into a wide-mouthed jar or bottle and add 6 ounces of brown flaked shellac, one ounce of crushed resin, and one ounce of sandarac (a gum). Stir, with occasional shaking, until the solids are dissolved, and apply as thinly as possible with a camel hair brush. Several coats of this varnish should be applied, at least three and, if the wood is porous, as many as six or seven, and each coat must dry thoroughly hard and be rubbed down before the succeeding coat is applied.

Drying is, of course, rapid, but at least an hour should pass, preferably longer, between varnishing and rubbing down. The finest glass-paper is needed for this purpose and it is a good plan to rub together two sheets of fine grade paper till only a little " bite " is left on the surface.

A nicely built plain wood or veneer cabinet is, of course, given neither stain nor varnish, but is wax polished. Good wax polishes may be bought, and these should be rubbed on to the wood with a coarse cloth and brought to a finish by hard rubbing. The number of polishings to obtain the required finish depends on the wood, but the final dull gloss imparted by the wax polish is an excellent finish.

Some woods, especially American Walnut, may be oiled with raw linseed oil (if obtainable !) before being wax polished, and it is common practice to oil stained mahogany or oak. The oil is wiped over the work with a rag.

An oak cabinet can be fumed and wax polished though the fuming is a process suitable for new wood only, of course. To fume oak, enclose the cabinet in an airtight container such as a trunk or chest with two or three open saucers of full strength liquid ammonia, leaving for 12 hours. The wood may be wax polished or finished with spirit varnish.

To enamel a cabinet—a process which can give extremely effective results if the colour is chosen to suit the room and the cabinet is not too large—first clean the old surface from the wood and glass-paper the cabinet down to smoothness. Any faults, cracks or holes must be filled with beeswax.

The best enamel must be used, and stirred very well before being applied, and the work should be done, for preference, in a warm atmosphere.

No endeavour should be made to change the dilution or the colour of the enamel with ordinary spirits or diluents; the colouring must be put on direct from the tin. Apply the enamel with a fine brush; if a good covering enamel is used a single coat will suffice to give a smooth glossy surface.

Little can be said concerning french polishing. The process gives a very fine finish to a cabinet, but true french polishing is an expert's job; the polish, as applied, dries very rapidly and the secret of success with this process is in the continual figure-of-eight or circular rubbing, by means of which the surface is gradually covered with polish.

The polish, as bought, is applied by soaking a pledget of cotton wool or a flannel rubber in the polish, this soaked material then being wrapped in rag or sometimes in calico soaked in linseed oil, the polish thus being forced through the cloth from the soaked material within by the continual rubbing and pressure.

Several applications of the polish are made, each coat, when hard, being rubbed down with very fine glass-paper. The last two coats are applied with no intermediate rubbing.

Notes

Notes

BERNARDS RADIO BOOKS

FOR THE HOME & AMATEUR CONSTRUCTOR

4.	Radio Pocket Book ...	1/-
30.	Radio Valve Manual	3/6
37.	Manual of Direct Disc Recording	2/-
41.	Wireless Amplifier Manual	2/-
42.	Shortwave Radio Handbook	2/-
43.	Modern Radio Test Gear Construction	1/6
44.	Radio Service Manual	2/6
45.	Radio Reference Handbook	12/6
48.	Radio Coil and Transformer Manual ...	2/-
52.	Radio Tuner Unit Manual	2/6
53.	Radio Constructors' Manual	3/-
54.	Radio Resistor Chart	1/-
55.	Handbook of Radio Circuits No. 2	2/6
56.	Radio Aerial Handbook ...	2/6
57.	Ultra Shortwave Handbook	2/6
58.	Radio Hints Manual	2/6
59.	Television Construction Manual	3/6
60.	Radio Repairs Manual	2/6
61.	Amateur Transmitters' Construction Manual...	2/6
62.	Car and Portable Radio Constructors' Manual	2/6
63.	Radio Calculations Manual	3/6
64.	Sound Equipment Manual ...	2/6
65.	Radio Designs Manual	2/6
66.	Communications Receivers' Manual	2/6
67.	Radio Valve Equivalents Manual	2/6
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69.	Radio Inductance Manual...	2/6
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71.	Modern Battery Receivers' Manual	2/6
72.	Experimental Circuits Manual ...	2/6
73.	Radio Test Equipment Manual ...	2/6
74.	Radio Valve Applications Manual	5/-
76.	Radio Anti-interference Manual	2/6
77.	Walkie-talkie Construction Manual	2/6
78.	Radio and Television Laboratory Manual	2/6
79.	The Radio Modernisation Manual	3/6
81.	Using Ex-Service Radio Apparatus	2/6
82.	AC/DC Receiver Construction Manual...	2/6

Other Titles in Preparation

International Radio Tube Encyclopædia
Television Servicing Manual
Radio Test Meters and their Construction
The Miniature Radio Equipment Construction Manual
The Midget Radio Construction Manual
Radio Valve Selection Guide