Radio Constructor

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Editors :
ARTHUR C. GEE, G2UK W. NORMAN STEVENS, G3AKA

Advertisement & Business Manager :
C. W. C. OVERLAND, G2ATV

Editorial

That Receiver

Our good friend Mr. G. K. Macpherson could hardly have forseen the flood of correspondence that was to be the result of his letter in the October issue. We gave a few extracts from some of these letters in the last issue and from them it will have been noticed that various readers opinions were vastly at divergence with one another. Many readers, for example, favour coil turrets, some favour plug-in coils. Some want a fairly modest receiver, with hardly any "trimmings," others demand a receiver with S Meter, B.F.O., Crystal Filter, Phasing and other refinements that make a set a good communications type. In the matter of valves, we have had requests for the complement ranging from 5 valves to 15 valves!

From the study of all the letters we have received, it has become apparent that there is no definite "majority"; the various groups, when they can be so determined, appear to be equally well patronised. To come to the point, it seems that the need is not for one specific receiver but for many receivers of various shapes and sizes! It is obvious that one design will not find favour with anything like a large percentage of our readers, and the only course we can take is to do our best to provide, in future issues, constructional articles of such a range as to satisfy all the demands that need to be met.

No Mains

Mr. L. W. Kingsley of S.E. London is one of the thousands who have no mains and consequently has to rely on battery operated gear. He implores us not to forget such readers. Mr. Kingsley may rest assured that it is not our policy to pander to any one particular section of the constructing fraternity. We are well aware that even enthusiasts with mains seem to prefer battery to mains gear at times. In fact we know a reader, who, though he has AC mains, will only tolerate battery sets—he has more than 20 of them! These readers, and also those on DC mains (often sadly neglected), will be catered for in these pages.

Digging Deep

Reader Cecil Hall (Oldham) is anxious lest we should "dig too deep." He feels that any tendency to go "highbrow" should be curbed. We can assure Mr. Hall, and other readers who may be apprehensive, that the policy of this magazine is to present constructional and theoretical material with a main bias towards the average constructor. Although our aims are to cater mostly for the average enthusiasts it is only fair that the beginners and the more advanced should have their place in these pages. Of the two, we will tend to give the beginner preference, since he is the one who needs the guidance. The advanced constructor is not in such dire need of guidance, since, if he is advanced then he should "know the ropes" already.

Radio Conditions

From this issue, our feature "Radio Conditions" has been deleted. Readers have pointed out that such material is available, and in much greater detail, in our companion journal "Short Wave News" and that with so limited an amount of space at its disposal in the "Constructor" justice could not be given to it. One wag said that, as the average constructor never has a set in operation for more than a few days at a time, before rebuilding, the art of DX-ing never affects him! W.N.S.

NOTICES

THE EDITORS invite original contributions on construction of radio subjects. All material used will be paid for. Articles should be clearly written, preferably typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsman will redraw in most cases, but relevant information should be included. All MSS must be accompanied by a stamped addressed envelope for reply or return. Each item must bear the sender's name and address.

COMPONENT REVIEW. Manufacturers, publishers, etc., are invited to submit samples or information of new products for review in this section.

ALL CORRESPONDENCE should be addressed to "Radio Constructor," 57 Maida Vale, Paddington, London, W.9. Telephone CUN 6579.

AUTHENTIC AND UP-TO-THE MINUTE INFORMATION ON V.H.F., BROADCAST BAND AND AMATEUR ACTIVITES IS GIVEN IN OUR MONTHLY PUBLICATION "SHORT WAVE NEWS."

Radio Miscellany

By Centre Tap

READERS who can recall the early days of broadcasting will well remember the spate of aerial poles which sprang from almost every garden and chimney stack, usually badly erected and leaning and curving to every compass point, adding to the unsightliness of the already dingy views seen from the carriage window of our urban railway lines. To-day we have travelled to the other end of the cycle and the aerial mast, while not quite a rarity, is usually sufficient to arouse mild interest. As the commercial receiver became more and more sensitive, so did the aerial masts diminish in number, until to-day no one but the DX-er thinks in terms of high outdoor aerials.

Apart from the apparent needlessness of a big aerial there are other objections—the unsightliness if badly erected, the risk of damage if brought down by gale, the fear of it being struck by lightning, the flat-dwellers' lack of space, wired radio, the bother and expense, objections by landlords and the fact that it may restrict the positioning of the receiver to comparatively narrow limits. But the small outdoor aerial is by no means as obsolete as its apparent absence would suggest; at least, not for the listener who demands the best possible performance from his set.

With modern receivers local stations are receivable at considerable strength on a bit of wire draped round the picture rail or tucked under the carpet, and so in many cases such arrangements are expected to serve as a signal collector. The average listener does not stop to consider whether a better aerial is worth while.

Changing Conditions

Perhaps to-day we have become "utility conscious" and do not think of our receivers as being individual sets which were designed to operate under a given signal input, but just simply as a radio of some sort or other which happened to be available at the time we were in the market. Fifteen years ago the owner was proud of his set and would boast that his Beauko All-Mains 4 fetched in half-a-dozen stations at good strength with only a yard of flex as an aerial. To-day everyone seems to take that for granted and rarely bothers to rig up anything better.

Women especially, have a dislike of wires and can easily convince themselves that the aerial is not really necessary, particularly after hearing a receiver give an apparently satisfactory signal level from a short length of concealed wire. However, with the spread of television technique the tendency will no doubt be for the listening public to become aerial conscious once more.

The Ideal

For the best performance of normal broadcast receivers something between the extreme of a big outdoor affair and the scrap of wire under the carpet, is required. The big outdoor aerial is prone to introduce distortion through overloading, whistles due to strong unwanted signals and cross-modulation, in the simple tuning circuits found on all but the more expensive receivers. Check up on the current models for yourselves and see how few have an RF stage. The result will shake you if you haven't already considered it.

Too small an aerial means that the weaker stations will not be satisfactorily receivable, or if the gain is sufficient to bring the strength up the set noises (thermal agitation of the valves, etc.), will greatly increase. When only a weak signal is passed to the set the AVC is all out and the noise is equally fully amplified. The ideal to strive for is the highest signal to minimum noise relationship, and the listener who expects the best performance from his receiver should give greater consideration to his aerial system than is normally the case nowadays.

Lack of Standardisation

In the years immediately preceding the war there was a heavy decline in home construction. While the reasons for this were manifold, not the least among them was the complication of the receiver required to meet the crowded conditions of the ether. To-day the conditions are equally, if not more exacting, but the standard of knowledge among constructors is considerably higher and test equipment comparatively cheaper and more readily available. In the pre-war years it was the remaining constructors who took most readily to the 6.3 volt Octal range of valves. They were cheap (from a couple of shillings upwards) while the 4 volt types were several times that price, and they possessed the virtue of being made to a type instead of to each manufacturers ideas. Further the "one-shot" base appealed to one's good sense especially after handling valves with all sorts of odd bases. Finally it was the economy of heater current which made the strongest appeal as multi-valve circuits became possible without the need for big (and expensive) mains transformers.

Opportune Time

During the War, Service gear further popularised the octal range and today their use in broadcast receivers is becoming more common, yet British valve manufacturers blithely carry on making their old multiplicity of individual types with a range of bases from 4 to 9 pins in a variety of arrangements. Admittedly many of them are still required for replacement purposes, but surely the time has come to concentrate on **future** types and not perpetuate obsolete patterns. There is a definite tendency towards this but one could hope to see it more determined, particularly now export trade is so vital. Overseas purchasers want receivers using valves which are readily replaceable, and the international octal range best meets this requirement. Whether Empire or Foreign, a purchaser dislikes valves that may take weeks to replace, and when if he finds it **has** an equivalent (with a different and seemingly meaningless number) it may also mean changing the holder before it can be fitted. Many of the British valve type numbers give little or no clue as to their use, but once the key to the international range is learned, the number alone gives the most essential information at a glance.

Problem of Heater Current

Valves requiring 1 amp. each, restrict not only the size of the set at a given price, but also deprive it of many refinements. Desirable features such as RF stages, noise limiters, magic eyes, etc., have to be omitted from popular priced receivers because of the heavy drain on the mains transformer. This, too, helps to explain the monotony of the 4 plus 1 receivers at present available, and like all other well wishers to the industry I should like to see more energetic measures to clear up the valve position.

Looking Back

Thinking of valve types carries me back to my earliest days of radio, recalling memories of my first valve which was acquired in 1921 after a number of economies to justify such an expensive treasure. It was a Marconi "R." I believe the R stood for receiving valve but it couldn't have mattered much as it was the only sort of receiving valve. A triode in a handsome orange-tinted globe which shone like a beacon when supplied with 4 volts at 1 amp. My second was bought some months later—a Mullard—and together they lit up my massive 2-valver whose ebonite and wood covered 40 by 15 inches, like the pre-Shinwell Blackpool illuminations.

Opulence

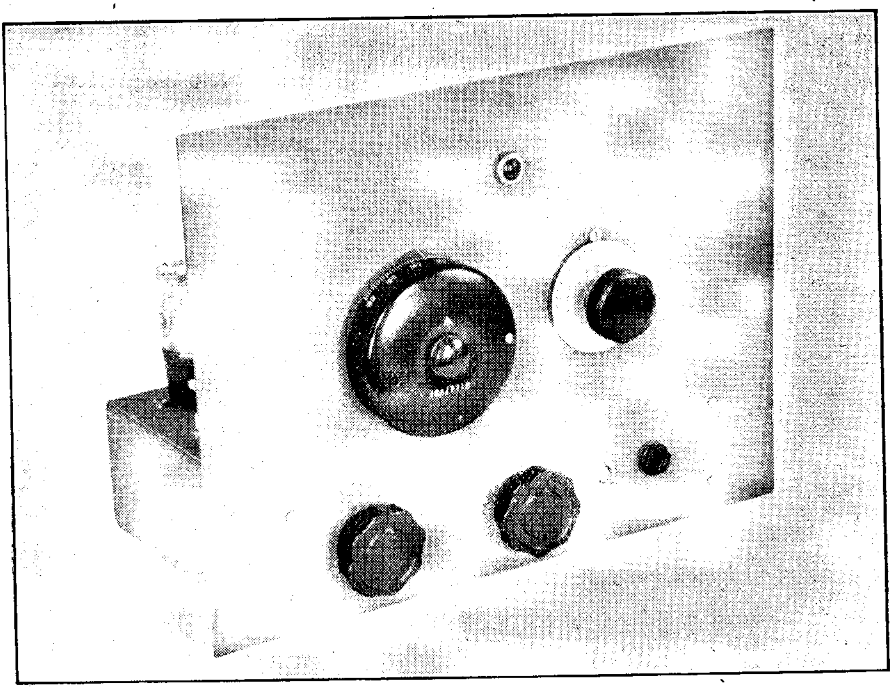
The Mullard too was an "only" type, and flourished under the name of ORA, to convey the information that it could be reasonably expected to oscillate, rectify or amplify. The super-het, by the way, was an old idea even then, but if you consider how many triodes would be needed to complete a super-het circuit made up from valves wolfing L.T. at an amp. apiece, you will see that it would have needed a big bank balance plus a private charging plant to run it. I need hardly add that I possessed neither so I had to be content with but two valves. Later, when broadcasting started, the crudest imaginable crystal sets became available at a mere £5 5s. each, with crystal, catswhisker and headphones extra. With such prices, as the owner of a two-valve set I was regarded as something of a plutocrat—the one brief period of my impecunious career when people have made **that** mistake.

Progress

I believe Cossors were the first to popularise the idea of using special types by sub-dividing their triodes which still remained the only type available for a year or two longer. Up to then we used "soft" valves for detectors. Their softness was proved by the brilliance of the blue glow when the H.T. was increased to 40 volts. At that time Dutch valves were highly esteemed for this attribute but unfortunately their filaments gave out after a few hours use. Cossors started putting a dab of green or red on the top of the glass envelope to indicate its suitability for detection or amplification and it was not until at least 18 months later that anything other than a triode came along.

Then came the screened-grid valve, which we elaborately mounted on its left ear carefully fitting the holder so that the screen through which it passed made an extension of the easily visible internal screen with the upper half ending up in the next compartment.

What a stride forward those early screened-grid types were! R.F. amplification with transformer coupled triodes was tricky to handle. It was by no means unusual to position odd pieces of metal at various points of the circuit until one managed to get some stability with a slight level of amplification. In those days one got a great thrill if anything worked at all—the rawest poked around by guesswork, the experimenter by trial and error while the experts argued their learned theories. Progress was erratic and each fresh development seemed to offer the most exciting possibilities. Today much of the pioneering spirit and excitement is lost, but radio is still great fun, even for the blasé old-timer.



Making a Start

No. 4 of a series of articles describing the progress of a newcomer to constructional work

By G3AKA

AT last the great day had come—George was about to see whether or not the 0-v-2 would function. With his customary lack of restraint, quite understandable, he was all for rigging everything up and switching on to search for DX. When we told him that, firstly, it might not work at all and secondly that the possibility of "blown" valves should not be overlooked, he was quite frankly puzzled, not to say disappointed. After it had been explained that, however careful one was in wiring a set and checking it afterwards, there was always the possibility that some elementary point had been overlooked or incorrectly wired he resigned himself to learn the procedure of testing a set.

First of all the batteries were connected, but with the valves taken out. This is a necessary precaution against a faulty wiring that may lead to a sad end to one or more valves. After connecting the batteries, the set was switched on and checks were made that the LT, HT and bias were getting to the right places at the correct potentials. The LT was tested by simply setting the test-meter to the 10v range and placing one probe to a negative filament pin and the other to a positive pin. Having discovered that the LT wiring was OK, attention was turned to the HT circuit. It should be remembered that HT— is **not** at earth potential, since automatic bias is used, and therefore the negative probe of the test-meter must be applied to the actual HT—line. With the meter on the 250v range (the lowest range above the 120v of the battery that we had) and the negative probe in position, the anode and screen of the output valve were checked. In both cases we were gratified to see the pointer flicking over. Further tests such as anode volts, etc., on the other valves were not proceded with at this stage, the main object being to ascertain that there were no short circuits liable to damage valves. With the probe still on the HT— line, the positive one was taken to various points where no HT reading should be obtained, i.e., to the positive filament terminals, and to the grids of the various valves. Having discovered that no HT short circuits were present, the next step was to check the bias supply.

George immediately took a reading from

the HT— line to the earth line (i.e. across the bias of the output valve) using the 10v range and found that the pointer moved backwards! He did not realise that bias is negative and as such the positive side is at earth potential. However, having reversed the probes we found that a reading of 4.5 volts was obtained. Many readers will wonder how it is that we obtained a voltage drop across R9/R10 when there was no current flowing through them (the valves not yet being plugged in). The answer is simply that in order to ensure that bias voltage was present, and therefore not yet being willing to insert the valves, we provided a safe equivalent in the shape of a resistor placed between HT positive and chassis of a value such that the resultant current flow (HT) approximated the total that would be taken by the valves. The value we used was 10000 ohms, which with our 100 volt supply gave a current of 10 mA. This resistor was of a rating of 2 watts.

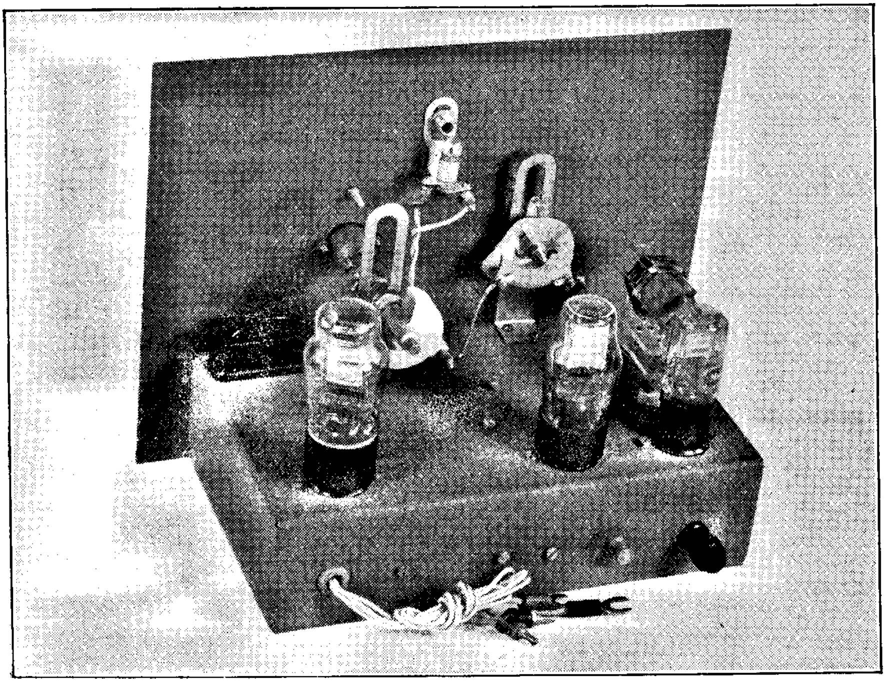
Having ensured that the voltages were in order, the valves were inserted. Tuning around produced a few very weak signals, and it was obvious that something was wrong somewhere. With R7 set at maximum (the volume control) the grid connection of the output valve was touched with a finger. Normally this should have produced a slight hum in the phones but in this case the reward was silence. Rechecking of the output stage wiring showed that the phones were wired to the screen-grid and the anode was taken direct to HT. In other words, the two leads were wired the wrong way round. After resoldering, results were much better, though signals were still rather weak. Turning towards the second valve, a quick check of the voltage on the anode of V2 showed that all was well in that respect. The reading obtained will depend upon the total HT voltage applied and on the sensitivity of the meter, but the main thing is to detect presence or absence of voltage. By touching the grid a fairly loud hum should be produced in the phones and the application of test prod to the anode should result in a click in the phones. In our case both these effects were noticed and so we turned our attention elsewhere. In passing, though, it might be well to mention the procedure if V2 should prove to be not operating satisfactorily. The current should be checked by inserting meter in series with HT positive and R5. If no current is indicated, the wiring should be thoroughly checked.

The last step in our valve testing was, of course, the detector. The voltage was checked and found to be in order. After that the finger-on-the-grid technique was tried and resulted in a healthy "squeal" in the phones, which is just as it should be. In other words, you not only get the hum from this stage but also high pitched squeal due to the valve going into oscillation. If, by applying this simple test, one gets "no joy" then currents and voltages should be checked, i.e. between HT positive and R4.

The detector stage is the most critical and the most difficult of all the stages to get working efficiently. All too often we hear "straight" receivers that, though they work, are hopelessly inefficient and all for the sake of a little experimenting and testing; the usual cause of trouble being the control of regeneration, or reaction. Quite often it will be found that the reaction winding is connected the wrong way round, which will result sometimes in no reaction at all or sometimes in very patchy and feeble oscillation. Investigation of the reaction control on our set showed that it was fairly good, smooth, but that there were occasional "dead spots" on dial readings where no reaction could be coaxed from the set. Another fault was observed, but this will be dealt with later on.

Here are some typical faults that may be found with reaction circuits. A howl may be experienced, which is due to the internal resistance of the HT battery. This is a point often overlooked, especially by beginners. The insertion of C12 is to help matters in this respect and our 0-v-2 had not suffered from the type of howl mentioned. As the HT battery develops a higher internal resistance, through normal useage, it becomes necessary theoretically speaking, to increase the size of C12, until such times as the resistance becomes so high that the operative function of C12 cannot cope with the situation. Another cause of howl could easily be caused by wiring in C11 the wrong way round. If the polarity of this capacitor were reversed, there would be a drop in applied bias and as a result—no bias but a nasty howl. Other types of instability, some of which we encountered, will be dealt with when we discuss the LF section again.

Getting back to our reaction again, it was agreed to make an all out effort to improve things. Since reaction was lacking only in certain parts of the spectrum (i.e. on certain parts of various coils) the RF choke came to mind as a possible culprit, since it may have been "peaky" or resonant thereby causing uneven reaction. Replacing of this component by a small resistor made no appreciable difference, however, and so it was exonerated. The combination R1/C4 was next tackled as



Rear view of the completed receiver

this has a great deal of bearing on reaction. Various values were tried for each component and we finally settled for 500 $\mu\mu F$ at C4 and 4 Megohms at R1. There were still, however, a few blind spots and the aerial series capacitor C1 was inspected. Roughly speaking, the lower the capacitance of this component the greater will be the reaction, or rather the less will be the aerial damping. Any aerial will "damp" a receiver to a certain extent, longer aerials being the worst offenders in this respect. Also, the higher the frequency, the greater will be the damping effect. To check this statement, one has only to set the receiver just into oscillation and then disconnect the aerial—an increase in depth of reaction will be noted. The aerial we were using was hopelessly inefficient and caused considerable damping, but we were determined to get the receiver working well under the most adverse of conditions. In order to obtain some degree of control, we replaced the fixed C1 by a small "preset" variable. This appeared to solve the problem satisfactorily and reaction was now obtainable throughout the entire range.

Tuning round, we came to the undisputed fact that signals were much too weak. Naturally, George was highly thrilled at even hearing the weakest suspicion of a station and we had great difficulty in pointing out that DX-ing must take a back seat until the set was fully doing of its best. The detector circuit appeared to be "lively," and so we concentrated on the LF stages. Current measurement in the anode circuit of V2 showed that hardly any was being passed, though the voltage readings were in order. As an experiment we changed over valves 1 and 2, with the result that no signals at all were audible! Putting two and two together, it was fairly obvious that V2 (the PM2HL) was extremely low in emission. Activities were suspended until a new valve was obtained and we were all agreeably rewarded with nice strong signals all round the band. What had been happening in the first place was that the detector was in order and working well, as was the output valve, but the first LF valve was merely acting as a "passer-on" of the detector output and was not amplifying at all.

Now that we had plenty of strong signals coming in, attention was turned to a fault that had become apparent. With the volume full on, a howl was generated as the reaction control was advanced. By turning down the volume this howl disappeared. It looked like bias trouble and so we again made sure that everything in that circuit was OK. Finally we cured the trouble by two alterations; firstly by disconnecting the "earthy" end of the primary of T1 from the bias line and taking it directly to chassis and secondly by adding de-coupling to the 1½v bias (by inserting a capacitor of 12 μF, 12v wkg. between the junction of R9/R10 and chassis). Becoming more critical now, we noticed some slight distortion on 'phone signals, and concentrated on effecting a cure.

There are many causes of distortion, some of which are due to incorrect bias, leaky capacitors or incorrect voltages. If the coupling capacitor between V2 and V3 (C9) was leaky it would cause a partial or complete cancellation of grid bias volts on the grid of V3 thereby causing distortion. Leakage in C8 would cause a low voltage on the anode of V2 with an attendant loss of gain and some distortion, not to mention the possibility of a burn-out of R5! Yet another capacitor could cause trouble if leaking. This is C7, and leakage there would partially neutralise or cancel out the bias to V2 thereby causing distortion. Leakage in C6 should not be overlooked as in this case a low voltage would be applied to V1 anode, a loss of gain would be appreciable with possibly no reaction and R4 would be in danger of being burnt out. Incidentally, the value of C10, across the phones, will affect stability of the output stage including that well-known menace—"motor-boating." An increase in the size of this capacitor may effect a cure.

We eventually traced our distortion to a faulty capacitor at C7. When replaced, all traces of distortion disappeared. It was obvious that George was straining at the leashes in order to don the phones and try to pull in all the DX he was sure was there for the asking. But we had not finished yet, much to George's annoyance! Having made sure that the set was performing as well as possible, the whole job was thoroughly overhauled for mechanical faults. This was prompted by certain irritating little crackling noises that made themselves known when the receiver was moved. Several things came to mind, notably a faulty resistor, a faulty winding in the transformer or just dry joints. The latter was the cause and we found two of them, one in the output stage and one in the anode circuit of V2. Resoldered, all traces of crackling disappeared.

After informing George that the set was now in full working order his first words were "Good! Now I can take the set home." He was sadly disillusioned, however, and it took much persuasion before he accepted the fact that one more lesson had to be learnt before he could start his DX career, namely: the operation of a short wave receiver. It was intended to incorporate operating notes with this instalment but space considerations dictate that we must wait until the next issue.

FROM THE MAILBAG

Dear Sirs,

You invite readers to state their views and wants, so here are mine:

(1) In a standard superhet an initial RF stage is often insufficient to pull in a desired station (in my case, the Scottish Regional) with reasonable certainty. The question then arises; two RF stages or two IF stages, or both? There does not seem to be a lot of information available on these points. Certainly there are circuits of communications receivers; but the issue is somewhat obscured by the special considerations of SW reception. I think, therefore, that some information on the pros and cons for the design of such stages would be acceptable.

(2) There seems to be a dearth of information concerning the use of double-diode RF pentodes as IF valves in superhets and as an RF plus detector in straight receivers. One or two diagrams and some text centred around say, the 6B8 valve would, I think, interest many.

(3) The published valve characteristics guides are now four or more years behind and it is difficult to obtain details of later types of valves. An occasional instalment of base diagrams and characteristics of such valves would fill a very real want.

(4) Regarding pentodes and tetrodes as triodes. As the octal range is deficient in output triodes, there seems to be a growing tendency to strap up pentodes to act as triodes. Many of us would like to know how and when the working figures of such popular valves as the 6F6, 6V6, 25A6, 6L6, etc., are affected by such treatment—with special reference to such things as optimum load, grid bias, anode voltages and power output.

Yours faithfully,
W. Mackintosh (London, S.W.15.)

(We are particularly anxious to receive articles on the subjects mentioned by Mr. Mackintosh. If any readers feel that they can adequately deal with any or all of the topics referred to we would be pleased to hear from them.—Ed.)

The Straight Receiver

Part 5. *By H. A. Emm*

R.F. Transformer Coupling

THIS method can be compared with that used in audio amplification, except that here no laminated iron core is used, because of the losses which occur at radio frequencies owing to hysteresis and eddy currents. Special powdered iron cores have been produced, which do not possess this disadvantage, and which do possess certain virtues, notably that of enabling a coil to be made of a given inductance with a lower RF resistance and a higher "Q" than a similar coil of the air-cored type. Such cores are not readily available at present to the constructor.

As shown in Fig. 8, the transformers are usually air cored, that is, they are wound on hollow formers made of a material such as ceramic trolitul, etc., which possesses high insulating qualities. The self-capacitance of the windings must be kept at a minimum, or losses will be incurred due to this capacitance providing a path of low reactance in parallel with the winding. This is generally achieved in practice by spacing the turns of wire and it has been found that a separation equal to the diameter of the wire gives optimum results. The absence of a core results in a lower degree of coupling being obtainable than in the case of an audio frequency transformer, but on the other hand, a looser coupling confers the benefit of greater selectivity. Another resultant effect is that the magnetic field is not so concentrated, and this means that precautions have to be taken, in the shape of thorough screening, to ensure that no interaction is caused with nearby components.

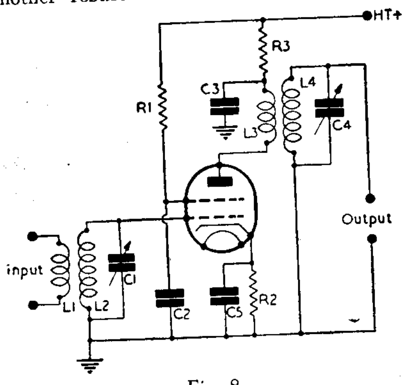


Fig. 8

In Fig. 8 the transformer consists of a primary winding L3, inductively coupled to a secondary winding L4, which is tuned by a parallel capacitance C4 to enable maximum gain and selectivity to be obtained at any given frequency. It will generally be found that an L3/L4 turns ratio of 1 to 2 or 3 gives most satisfactory results. The input circuit shown consists of a similar transformer L1-L2/C1, and here the same considerations apply.

The value of bias and decoupling resistances and capacitances in Fig. 8 depend on the same conditions as in the methods previously described. Due to the use of a transformer, no coupling capacitance and accompanying grid resistance are necessary in the input to the next stage, unless, of course, this happens to be a valve operating as a current-grid detector.

So far in this series, the operation of the essential stages in a straight receiver have been studied. In order to get the best performance out of a receiver, it must be flexible and fully under the control of the operator, and for this various refinements are needed.

Gain Control

Too low an input to the detector will result in inefficient rectification, hence the need for RF amplification, but too large an input will overload the detector and cause distortion. Obviously, it is an advantage if the detector input can be controlled, and so kept at an optimum value. There are several ways in which this can be accomplished. Reaction can be slackened off, incidentally improving quality in the case of telephony, but for CW reception this method has the fault of resulting in a decrease of selectivity. Another system that suggests itself is to limit the output from the aerial, by means of a series capacitance or a potentiometer, a practice that is used in some commercial receivers, but the snag here is that the RF stage is always working full out, so that the signal/noise ratio is adversely affected by cutting down the input.

Modern practice is to control the gain of the RF valve. This means that, for a given output from the RF stage, a larger signal input needs less amplification, and this results in less valve noise with a corresponding improvement in signal/noise ratio. The RF valve should be of the variable mu type, the gain of which is controllable over a wide range by varying the negative potential applied to the control grid. Most RF valves are designed to work with a standing bias voltage, obtained usually in indirectly heated valves by means of the current passing through a resistance in series with the cathode and HT—. If now a variable resistance is inserted in series with this bias resistance, then the bias voltage can be varied from a maximum value, determined by the total amount of resistance in circuit, down to the standing value required. In the case of directly heated battery valves, the bias potential is obtained either from a separate bias battery, or by passing through a resistance the total HT current of the receiver. In each case, the variable bias for the RF valve can be obtained from a potentiometer connected across the GB supply, but where this is a battery, care should be taken to insert a switch so that there is no constant drain on the battery when the receiver is not in use.

Another system, known as Automatic Volume (more correctly Gain) Control, consists briefly in rectifying part of the RF input, and applying the DC potential obtained across the rectifier load resistance as bias to the RF stages. To be really effective this system needs at least two, and preferably three, RF valves to be so controlled, so that it is rarely seen in straight receivers.

Often two audio stages are used following the detector in order to get adequate amplification of the weakest signals, and here there is a risk that the output from the detector may be sufficient, when the set is tuned to a strong local signal, to overload one of these stages, generally the second. For the same reason, earphones may be connected to the speaker terminals, causing a strong signal to be extremely uncomfortable to listen to. It is thus often advantageous to be able to control the input to the final stage, and, while there are several ways of doing this, the method used universally consists of feeding the control grid of this last valve from a potentiometer across the output from the previous stage.

(THE CONTROL OF RADIO TRANSMITTERS BY MEANS OF VOICE OPERATED RELAY—Cont. from p.124)

charged. Any attempt at smoothing the positive bias applied to V3 results in a time lag with consequent greater loss of the first part of the first syllable. A combined switch S1 and S2 is provided to remove C5 and R8 from circuit when sending morse. Relay 2 acts quickly enough to be unnoticeable on CW and enables one aerial to be used for reception and transmission.

Practical Hints

Relay 1 should have the contact gap set to the minimum possible distance. The contact carrier plate and R7 should be adjusted together for maximum sensitivity.

6J7 valves were used due to the fact that they were in the writer's possession, 6C5 or similar triodes would do equally as well.

The omission of C6 appears to result in erratic operation. When adjusting the apparatus, the modulator volume control should be set for full modulation when speaking closely into the microphone. The input volume control R1 should then be adjusted so that a fairly loud signal received on the loudspeaker just does not cause Relay 1 to operate.

If there is a tendency to "motor boat" when changing from transmission to reception, the contact carrier plate of Relay 1 and the resistor R7 should be adjusted to make Relay 1 slightly less sensitive.

It is important that the modulator should be hum-free. Any hum may trigger Relay 1.

Working the Station

It is suggested that the station answering a C.Q. should adjust its frequency close to that of the calling station and move to exactly the frequency of the calling station after establishing communication. This economises in available frequencies.

When answering a C.Q. it is helpful to keep pausing a few seconds for listening after giving one's call sign and adding the words "Break-in please," e.g. "G8XXX, G8XXX, . . . G8XXX, this is G8MU, break-in please." This method results in the more speedy establishment of communication and prevents unnecessary calling should the station calling C.Q. elect to talk to someone else.

Provided both operators are polite and do not speak when being spoken to, an ordinary telephone conversation can be carried on just as if there were no radio link. The precise adjustment of R8 is important for best results. The receiver must become sensitive quickly after ceasing to speak but the transmitter must have no tendency to switch off whilst speech is taking place.

Having once operated a station using voice control, any other method appears tedious and the lengthy time taken by stations not so equipped in changing from reception to transmission, is most apparent.

A Bass-Boost

for the 4-watt Quality Amplifier

By G. W. BOLTON

SINCE building the amplifier described in the October issue, various experiments have been made with boost circuits. Bearing in mind the fact that simplicity is the order of the day and that expense is to be cut to the minimum, the circuit of Fig. 1 was selected.

It will be understood that bass boost is essential, because though modern pick-ups of the moving coil variety have usually exceptionally clear low-frequency response, the recording characteristics have attenuation at the lower frequencies. The explanation of this is quite straightforward and may be explained in the following manner.

The cutting stylus in the recording head is restricted to the width of the groove and if the low frequencies were not attenuated the cutter would swing outside the limits of the groove, due to the larger movement at the base frequencies. If one watches the cone of the loud speaker it will be noticed that an increase of movement is readily apparent at the lower frequencies.

Referring to Fig. 1, it will be seen that the bass boost network has been placed after the input valve (VR55). The network in the original amplifier, consisting of R1, R2 and C1, provided a small degree of bass boost—sufficient to compensate for any speaker losses. This network can now be deleted and the input connected direct to the volume control potentiometer. The new circuit gives a boost of about 15 dB (about 10-1) which is slightly more than is required to compensate for the losses in re-

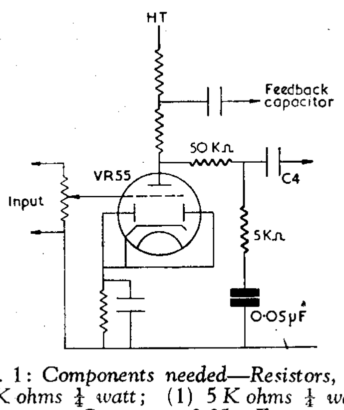


Fig. 1: Components needed—Resistors, (1) 50 K ohms ¼ watt; (1) 5 K ohms ¼ watt. Capacitor, 0.05 μF.

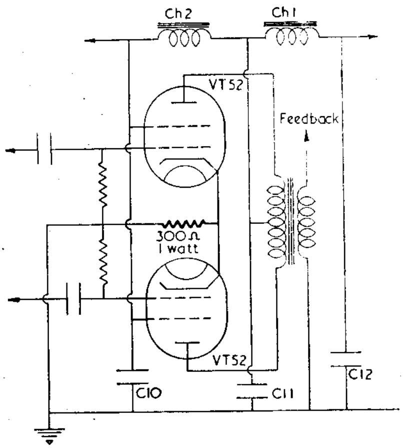


Fig. 2: Resistor required — (1) 300 ohms 1 watt

cording. However, when the losses in the output transformer are considered, and those of the speaker also, the compensation will be found to be just about right.

Whenever reproducing apparatus and quality are considered, the question of personal taste crops up. Some people prefer plenty of bass whilst others have a preference for lots of "top," the latter in the delusion that this constitutes high fidelity. Whilst we agree that top is required the fact that a good amplifier should have a good bass response also must not be lost sight of.

The circuit of our booster is very versatile, inasmuch as the varying capacitor values alter frequency and amount of boost. With the 0.02 μF capacitor, the boost starts at around 1000 c.p.s., increasing gradually to 250 c.p.s. and rising steeply to 30 c.p.s. By replacing the 0.02 μF by one of 0.05 μF capacitance the boost starts at about 500 c.p.s. and with a 0.1 μF capacitor the bass will increase very steeply from 250 c.p.s. The network of resistors and capacitors used in this circuit, resembling a potentiometer, shows an increase in impedance at the lower frequencies, thereby reducing top response, relative to the added gain at the bass frequencies.

A disadvantage that became apparent was that of loss of gain and in view of this it was decided to operate the output stage valves as pentodes, instead of as triodes. This conversion proved extremely satisfactory and the resultant gain considerable. The same voltages and output transformer were used since the matching remains 10000 ohms from anode to anode. Reference to Fig. 2 will show the modifications necessary to convert the VT52's to pentode output and it should be noted that it was necessary to replace the 220 ohm bias resistors by one of 300 ohm (1 watt) rating. Using a moving coil pick-up and full frequency range recordings the modified amplifier produced results that should satisfy even the most critical of enthusiasts.

The final point to be tackled was the question of handling large inputs, say from 1 volt and upwards. If inputs of this nature are likely to be encountered, the input stage may be deleted entirely and the volume control wired in direct to the phase inverter, as shown in Fig. 3.

The frequency response of the phase inverter and output stages is practically flat and would do justice to a real high fidelity tuner unit. A word of advice—it must be realised that the speaker plays an important part. Get the best one possible and use the largest baffle you can. Wood is scarce but you may be one of the lucky ones and able to cut a hole in a dividing wall, this proving a most effective baffle and enabling the full effect of the increased bass response to be enjoyed. It is only logical to use good speakers and baffles with high quality amplifiers since it is pointless to reproduce a full frequency range in the amplifier if the speaker cannot handle those frequencies!

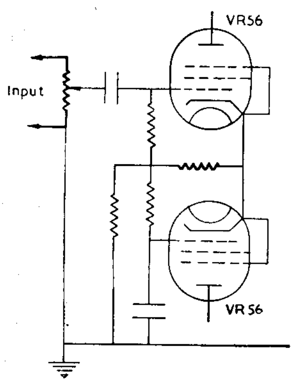


Fig. 3

Xmas 1947

THE EDITORS AND STAFF

take this opportunity of wishing readers wherever they may be, the best of luck for the coming year

CATALOGUE RECEIVED

From **Southern Radio & Electrical Supplies,** of 85 Fisherton Street, Salisbury, Wilts., comes a really well-produced and nicely illustrated 40 page catalogue which lists hundreds of components by well-known manufacturers. Apart from being a mere list, there is a deal of technical information about these components included. The items are coded, and the prices given in a separate list at the end, so that the catalogue can be easily kept up-to-date. The price is 9d., and readers should ask for catalogue No. 6.

THE EDITORS INVITE . .

- **Constructional articles suitable for publication in this journal. Prospective writers, particularly new writers, are invited to apply for our "Guide to the writing of Constructional Articles" which will be sent on request. This guide will prove of material assistance to those who aspire to journalism and will make article writing a real pleasure!**

- **Constructive criticisms and suggestions on the magazine. Let us know what you like and what you don't like.**

- **Details and, if possible, photographs, of your workshop or "den."**

The Control of Radio Transmitters

By Means of Voice Operated Relay

By JUSTIN C. EGERTON, M.A. (Cantab.) G8MU

Editorial Note.—Many readers will have heard G8MU's "Voice Controlled" phone transmissions on the 3.5 Mcs. band and they may have wondered how it was done! Justin Egerton describes his gear herewith and gives some hints on the operation of voice controlled carrier stations.

Introduction

THERE are many methods of switching transmitters by "Voice Control" and the one to be described is that in use at G8MU. No claim is made for originality, though there are several interesting features. "Voice Control" is certainly the answer to a lazy ham's prayer and a QSO can be carried on with the hands in the pockets once the other station has been tuned in. In addition, operating speed is improved, due to the fact that no switches have to be moved by hand. The master control of the unit is Relay 2 (see circuit diagram), so let's start by examining the functions of this relay.

The following is a list of the duties of Relay 2 in order of action:

1. To Desensitize the receiver to avoid damage when the transmitter is operating.
2. To change over the aerial feeders from receiver to transmitter.
3. To switch on the transmitter.

The operations are reversed when speaking ceases.

Circuit Details

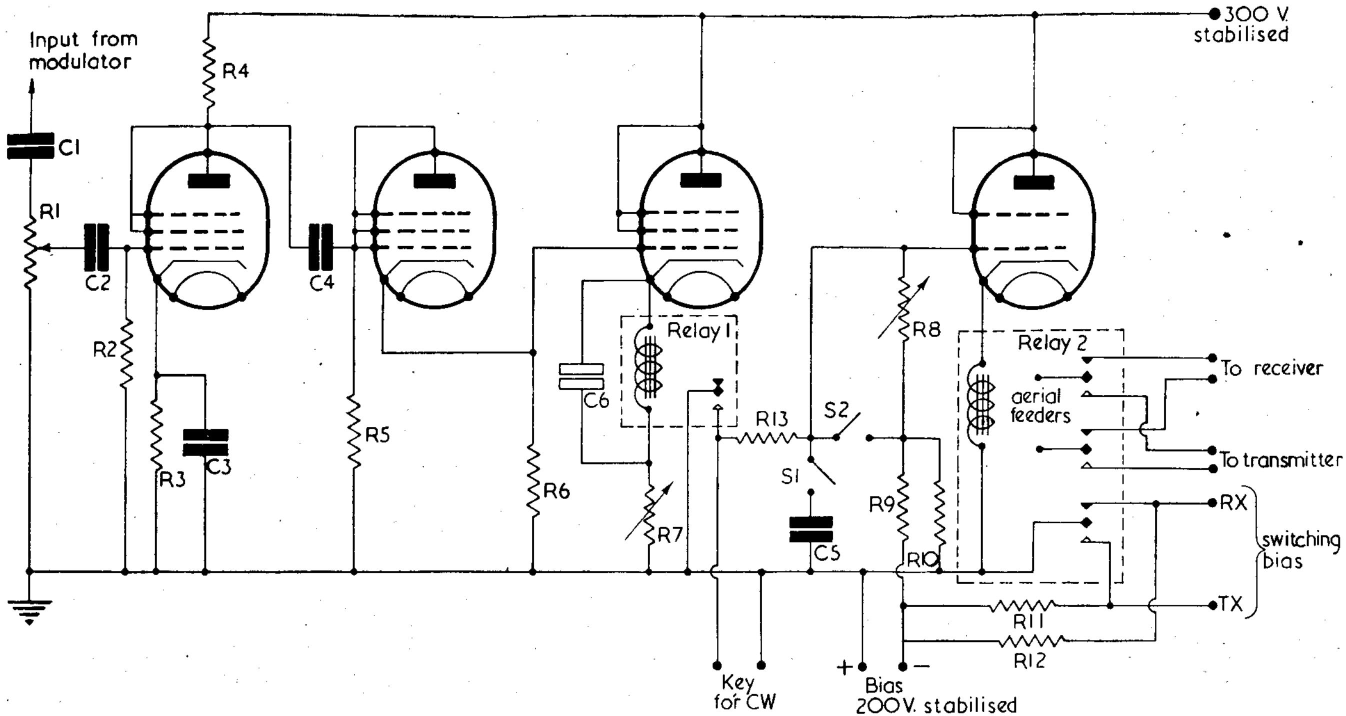
The input is taken from the anode circuit of one of the valves driving the Class AB 6L6G Modulator valves via the capacitor C1, the volume control R1 and the capacitor C2 to the grid of the combined Buffer and Limiter valve V1. If input is taken from the output of the modulator, the cessation of PA anode current when the transmitter is switched off, may cause "motorboating." The output from V1 is passed to the rectifier V2 and positive pulses of D.C. are fed to the grid of the control valve V3. A quick acting relay RY1 (Post Office Type "B") is connected in the cathode circuit of V3 in series with a variable resistance R7. When the contacts of Relay 1 close, the control grid of V4 is connected to earth via R13, allowing approximately 100 mA. current to flow through and operate Relay 2 connected in its cathode circuit. A capacitor C5 is connected in parallel with the grid of V4 through Switch contacts S1 and negative grid bias is applied via R9 and the variable resistor R8. R10 serves to reduce the 200 volts negative bias to approximately 57 volts. Higher negative bias is unnecessary and the lower value allows less current to flow through the contacts of Relay 1. Relay 2 has three 2-way contacts, two of which change over the aerial feeders from receiver to transmitter and the remaining contacts remove negative bias from the transmitter or receiver, whichever is required to be operative. The transmitter and receiver are switched off by the application of 200 volts negative bias through R11 and R12 respectively. The negative bias is applied to the grids of all valves in the transmitter and to the grid of the first valve of the receiver. In the case of the receiver, a capacitor of 500 $\mu\mu F$ is connected in the grid lead of the first valve to remove the A.V.C. bias and the 200 volts negative bias is applied through a 1 megohm resistor. This valve should also have the usual cathode bias, otherwise there will be no grid bias when Relay 2 removes the 200 volts negative bias.

Operation

Speaking into the microphone causes positive bias to be applied to the grid of V3, thus closing the contacts of Relay 1. This discharges the capacitor C5 through the resistor R13. R13 is inserted to limit the current flowing through the contacts of Relay 1, in order to prevent burning and consequent sticking. As long as C5 is kept discharged V4 passes current through Relay 2, placing the contacts in the sending position.

As soon as Relay 1 opens its contacts, C5 charges negatively through the resistors R9 and R8, cutting off the cathode current of V4 and allowing Relay 2 to move back to the receiving position. The time taken between the moment of cessation of speaking and the movement of Relay 2 is governed by the setting of R8. It will be noted particularly that no attempt has been made to smooth the positive bias applied to the grid of V3 from the rectifier V2, and in consequence, the contacts of Relay 1 will be continually opening and closing. The average negative charge of C5 will thus be kept very low by being repeatedly dis-

(Cont. on p.121)



R1	0.25 M-Ω	R6	1 M-Ω	R11	50000-Ω	C3	1 μF
R2	1 M-Ω	R7	10000-Ω	R12	50000-Ω	C4	0.01 μF
R3	500-Ω	R8	0-5 M-Ω	R13	100-Ω	C5	0.25 μF
R4	0.1 M-Ω	R9	50000-Ω	C1	0.01 μF	C6	25 μF
R5	1 M-Ω	R10	20000-Ω	C2	0.01 μF		

Relay 1 Post Office Type "B"
Relay 2 Relay from ex-R.A.F. transmitter with added contacts.

High Frequency Alternating Currents

By W. JORDI

FOR an understanding of the effects of high frequency currents, it is first necessary to consider the properties of self-induction, mutual-induction, and reactance. Let us, start by looking at the circuit shown in Fig. 1. We will denominate the constants in the usual manner, the E.M.F. of the battery by E, the resistance of the circuit by R, and the current flowing by I, these being interconnected as determined by Ohm's Law, viz.: E=I x R.

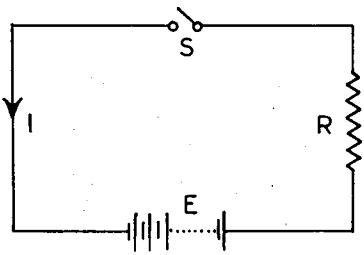


Fig. 1

When the switch S is closed a current will begin to flow in the circuit. It will not immediately reach a steady value, but will build up gradually; actually the time taken is a fraction of a second, but as in radio we are dealing with millionths of seconds it is long enough. Now, a current flowing in a conductor creates a magnetic field around that conductor, and as the current builds up to a maximum, so also will the magnetic field, as in Fig. 2. Where a conductor moves relatively to a magnetic field, or where, as in this case, a static conductor is in a field of changing intensity, then a voltage will be induced in that conductor. This induced E.M.F. is in opposition to the E.M.F. which is producing it, and the resultant current flows in opposition to the main current. When the latter reaches a peak value determined by the resistance R of the circuit, then the magnetic field also becomes stable and there is no further induced E.M.F.

The same cycle of events occurs when the switch S is opened, and the magnetic field collapses. Again we get the rapid change in

Fig. 2

the field strength, and the induced E.M.F., but this time the induced current flow is in the opposite direction, i.e., the polarity of the induced E.M.F. is such as to oppose the applied E.M.F. The whole effect is known as Self-Induction.

The unit of Inductance is called the HENRY, a circuit or coil having an inductance of one henry when an E.M.F. of one volt is induced by a current change in that circuit at the rate of one ampere per second. In the case just considered, we have been studying the effect of self-induction where the voltage applied was direct current, from which can be judged the importance of self-induction in radio transmission, when we are using very high frequency currents with rapidly changing magnetic fields.

From the definition of inductance given above, it will be seen that the induced voltage=L x rate of change of current, where L=inductance in henrys. The rate of change of current is dependent on the amplitude and angle velocity of the current, and for sine-wave current is equal to $2\pi fI$, where f=frequency of current in cycles per second. Therefore induced voltage $E = 2\pi f x I x L$. It will be seen that this equation is very similar to Ohm's Law. $2\pi fL$ being substituted for R, of which it is the equivalent in A.C. circuits, i.e., it represents the opposition of the circuit, or Reactance as it is known, to the flow of current.

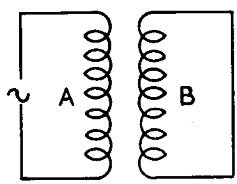


Fig. 3

Now let us study Mutual Inductance. Suppose we have two coils A & B arranged as in Fig. 3, and an alternating E.M.F. is applied to coil A, then a magnetic field of varying intensity will be created around that coil, as shown. This field will be cut by all or part of coil B, and in consequence an E.M.F. will be induced in this coil. The ratio of induced voltage to applied voltage is determined by the degree of coupling, which varies according to the spacing between the coils and the relative positions of their axes.

[redacted]

Resistance and Capacitance Boxes

By H. J. GIBBINS

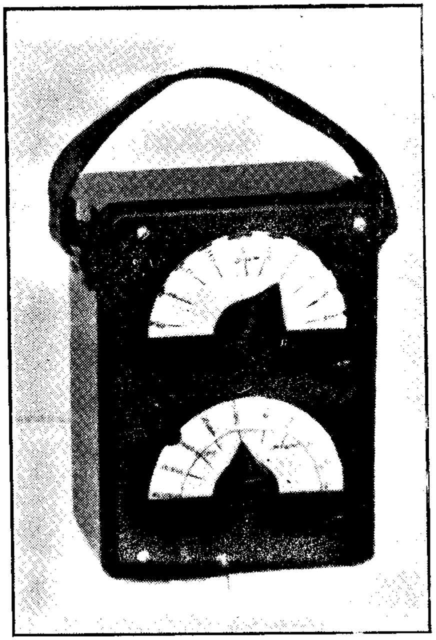
TWO very useful articles for the radio constructor and experimenter are the resistance and capacitance boxes. The writer has found the two models described to be a great asset in his radio work, especially in the field of radio service work. Firstly we will discuss the resistance box, the circuit diagram being shown in Fig. 1.

It will be seen that the "box" consists of two 10-point rotary switches, two toggle switches, four terminals and twenty resistors of assorted values. Basically, it will be seen that the device comprises two independent sections, each with its rotary switch and associated resistors. This is to allow each combination of resistors to be connected into the circuit as desired. Considerable experimenting has resulted in the useage of the following values, which seem to be the most useful ones for testing radio receivers:—

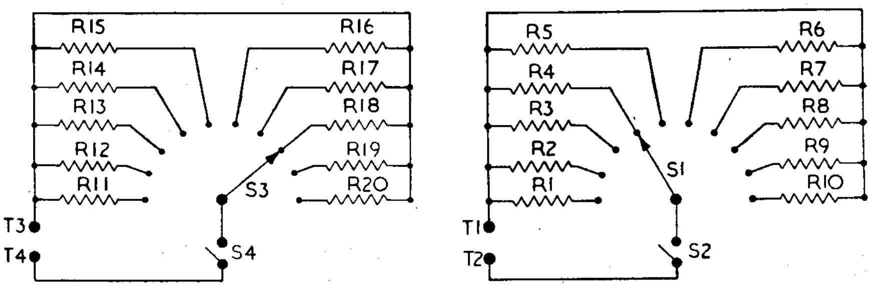
R1	50Ω	R11	10000Ω
R2	100 ,,	R12	15000 ,,
R3	150 ,,	R13	20000 ,,
R4	250 ,,	R14	30000 ,,
R5	500 ,,	R15	50000 ,,
R6	750 ,,	R16	100000 ,,
R7	1000 ,,	R17	250000 ,,
R8	2500 ,,	R18	500000 ,,
R9	4000 ,,	R19	1 M ,,
R10	5000 ,,	R20	2 M ,,

Resistors up to 100000 should be of 1 watt ratings, but the ones above this figure need only be of the ½ watt variety.

An extension of the use of this resistance box may be obtained by using precision resistors. If these are used then the box could be used for calibrating the multirange test-set. The various ranges could be switched in, one at a time, and the readings on the meter noted. From this, graphs can be made.



The Resistance Box



Arrangement of the Resistor Combinations

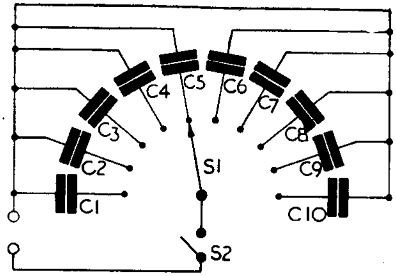
This resistance box, in conjunction with the capacitance box is invaluable to the experimenter since both pieces of gear provide a ready means of obtaining any combination of resistance and capacitance. The various ranges may be inserted in the circuit of the apparatus being constructed thus enabling the optimum values to be chosen for the permanent components. The value of this facility to the practical constructor is very obvious, and once having used these boxes they will remain a much used commodity in the workshop.

If it becomes necessary to use both resistance boxes together, in order to obtain more critical values, all that it is necessary to do is to join together terminals 2 and 3, leaving terminals 1 and 4 for the external connecting leads. The effect obtained is to place the two sets of resistors in series.

Capacitance Box

As will be seen from the diagram, the capacitance box is very similar in construction to the resistance box. The writer would suggest the following as being the most suitable values for general radio work:

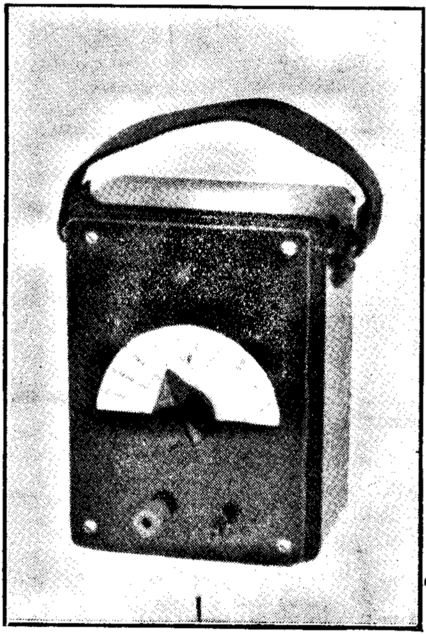
C1	100 $\mu\mu$F
C2	300 $\mu\mu$F
C3	500 $\mu\mu$F
C4	.001 μF
C5	.005 μF
C6	0.01 μF
C7	0.1 μF
C8	1.0 μF
C9	2.0 μF
C10	4.0 μF



Circuit for the Capacitance Box

Construction

Little difficulty is likely to be experienced with the construction of these boxes. In the models shown in the photos, a length of heavy copper wire was used as a main connecting line. The components were joined to this at one end and to the respective switch tags at the other, thus giving rigid construction—self supported. The only exception to this was in the capacitance box where the larger capacitors (C8/9/10) were fixed by the usual clips. The panels shown were made from ebonite sheet, which is easy to work and cut. Individual readers will have their own ideas of constructing the units. The ranges can be enlarged and extended, according to the type of work normally undertaken. Some may even prefer to incorporate both resistance and capacitance units in one large box, and this idea has distinct possibilities. Whatever the individual constructor decided there is no doubt that the resistance and capacitance boxes should be a feature of every constructors "den."



The Capacitance Box

Query Corner

A "*Radio Constructor*" service for readers

A Pre-selector

"I am told that the selectivity and sensitivity of an MCR1 ex-Government receiver may be improved by the use of a pre-selector unit. If you agree, can you suggest a suitable circuit and layout for such a pre-selector?"—Lt.-Col. G. B. Wilde, Yorkshire.

We heartily agree that the sensitivity, and the selectivity (and incidentally the signal to noise ratio) of a receiver may be improved by the use of a preselector. The unit described here employs two miniature battery pentodes in a two-stage circuit. Tuning is by means of a single control operating a two-gang capacitor, via a good quality slow motion drive. The coils are of the well-known "P" Series made by Wright and Weaire Ltd., to cover the waveranges 12-35m., 34-100m., and 200-557m., types PA4, PA5, and PA2 will be required. Band switching is by means of a two-gang, two pole three way wafer type switch. The gain of the amplifier is adjusted by means of a screen potentiometer in the second stage. All connecting leads should be as short as possible, and it is worth the small extra cost involved to use components of the low-loss type.

The layout sketched in Fig. 2, shows the general position of the major components, metal screens being interposed between the two sets of coils, the two valves and the two wafers of the wave range switch. The switch is mounted under the chassis and connected to the coils by means of short leads passing through rubber grommets located in holes drilled in the chassis.

It is preferable to use a separate L.T. supply consisting of a single dry cell (1.5 volts) whilst the H.T. voltage may be taken from the receiver with which the preselector is to be used. Alternatively if a separate low capacity H.T. battery is also used a compact self contained unit may be constructed. In either case the time spent in making this useful pre-selector will be amply repaid by the results obtained.

P.A. Tuning

"Could you assist me by answering a problem which is puzzling me? If a milliameter connected in the anode circuit of an R.F. power amplifier reads 20 mA. when the circuit is in resonance with no aerial connected, and 60 mA. when in resonance with the aerial connected, is it true to say that the power fed to the aerial is (60 − 20) × H.T. voltage?"—H. E. Gilbert, Leicester.

It is not possible to calculate the output power by this method as the anode voltage varies with the anode current, and the losses for no load and maximum load conditions are not identical. With no load connected to the tuned anode circuit the effec-

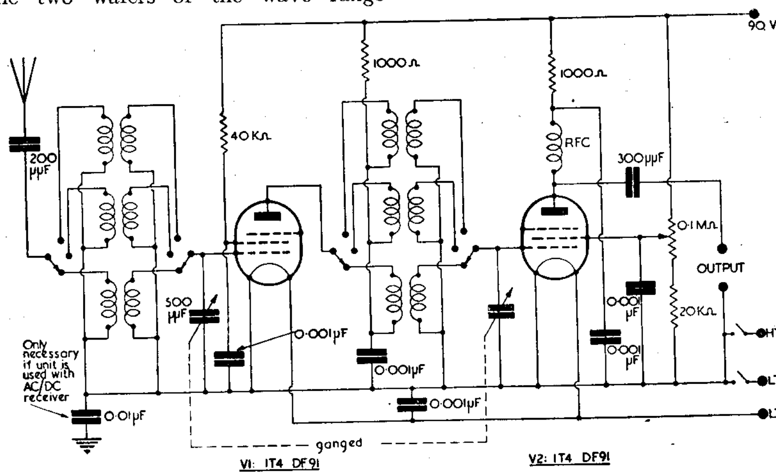


Fig. 1. A Two Stage preselector

tive anode load impedance is very high resulting in a large anode voltage swing for a relatively low anode current swing. Under this condition the power input to the valve is dissipated as heat at the anode, as radiation and as general circuit losses.

When a load in the form of an aerial is connected to the tuned circuit the effective anode load is considerably reduced, resulting in a much larger anode current swing for the same anode voltage swing. The power input to the valve is thus increased and most of this extra power is fed to the aerial. This query obviously arose because it was not appreciated that, under no-load conditions the tuned anode circuit presents a very high impedance to the valve, whilst when loaded the effective impedance is considerably reduced.

The output power may be calculated by multiplying the RMS value of the anode current swing by the RMS value of the anode voltage swing. To give a full explanation of this calculation, however, would require several pages.

Beam Aerials

"Can you recommend any explicit articles dealing with two and three element rotary beam aerials as used by American Hams?" — E. Bowler (address omitted).

We cannot do better than recommend you to read the chapter on Antennas in the Radio Amateur's Handbook published by the American Radio Relay League and obtainable in this country at 12/6 per copy.

Erratic Reaction

"I have an O-V-1 receiver, the first stage of which utilizes a Hartley circuit. The receiver is reasonably satisfactory, but the reaction is far from being smooth. Attached is the circuit diagram of the detector stage and details of the coils used."—A. E. Jeffreys, London.

Unstable reaction is undoubtedly one of the most frequently encountered snags in the construction of straight short wave receivers; the most common causes are:—

(1) Too tight a coupling between the feedback winding and the aerial or grid coil.
(2) The use of an unsuitable aerial which damps the tuned circuit.
(3) Ineffective or no decoupling of the anode circuit of the detector.
(4) Incorrect values of resistor and capacitor in the grid circuit of the detector.

With the receiver in question, the aerial was coupled to the top of the reaction winding thereby damping the feedback circuit. The type of aerial employed with this form of connection would undoubtedly have a very marked effect upon the operation of receiver, and it is possible that with a long aerial it would be difficult to make the detector oscillator. The remedy for this trouble lies in the use of a separate aerial coupling coil. The number of turns in the coupling coil should be approximately one-third of the number of turns in the main.

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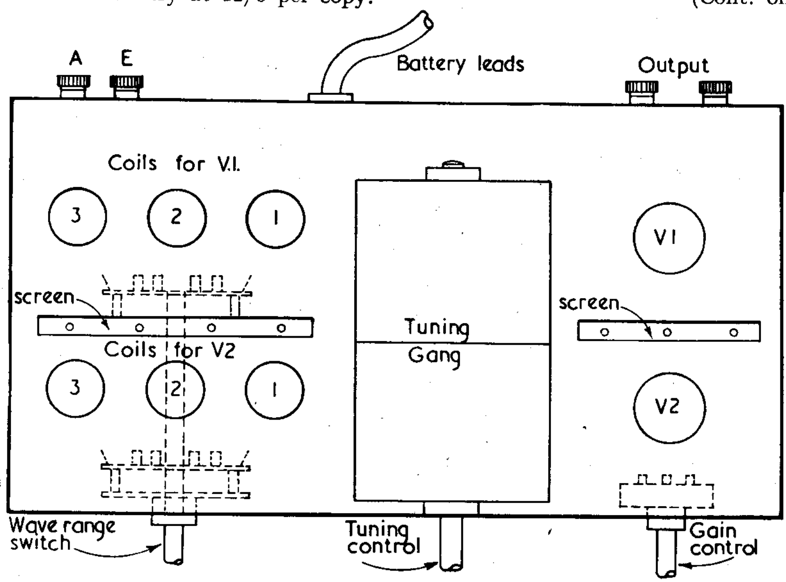


Fig. 2. Diagram showing the layout of principle components of the Preselector

A Three Valve A.C. Short Waver

By HECTOR COLE

THE receiver about to be described is of fairly orthodox design and was built by the writer as a stand-by receiver, for use when the main receiver is out of action through normal break down or through excessive "experiments" that the author, in common with most constructors, inflicts on his gear in moments of inspiration! However, though simple in design, this little receiver has proved its worth in pulling in the short wave stations, and for that reason has remained intact for some considerable time and will remain so indefinitely. For the constructor about to launch forth into the realms of building AC receivers, this one will be ideal as there are no "frills" liable to cause trouble to the neo-mains enthusiast.

The Circuit

The circuit is fairly conventional, consisting of an RF stage, a detector stage and one single output valve. The valves used are EF38, KTZ63 and 6V6 respectively, with a 5Z4G as rectifier.

Two aerial inputs are provided, one of which takes the aerial directly onto the coil and the other provides looser coupling by virtue of the trimmer C1. The RF stage is

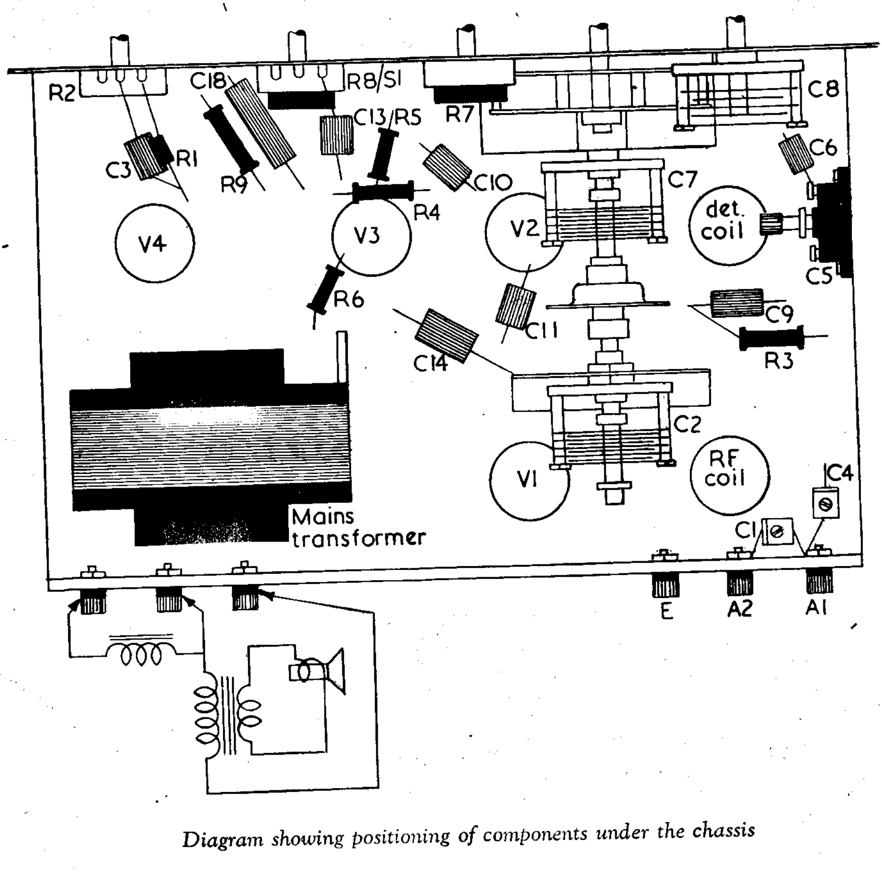
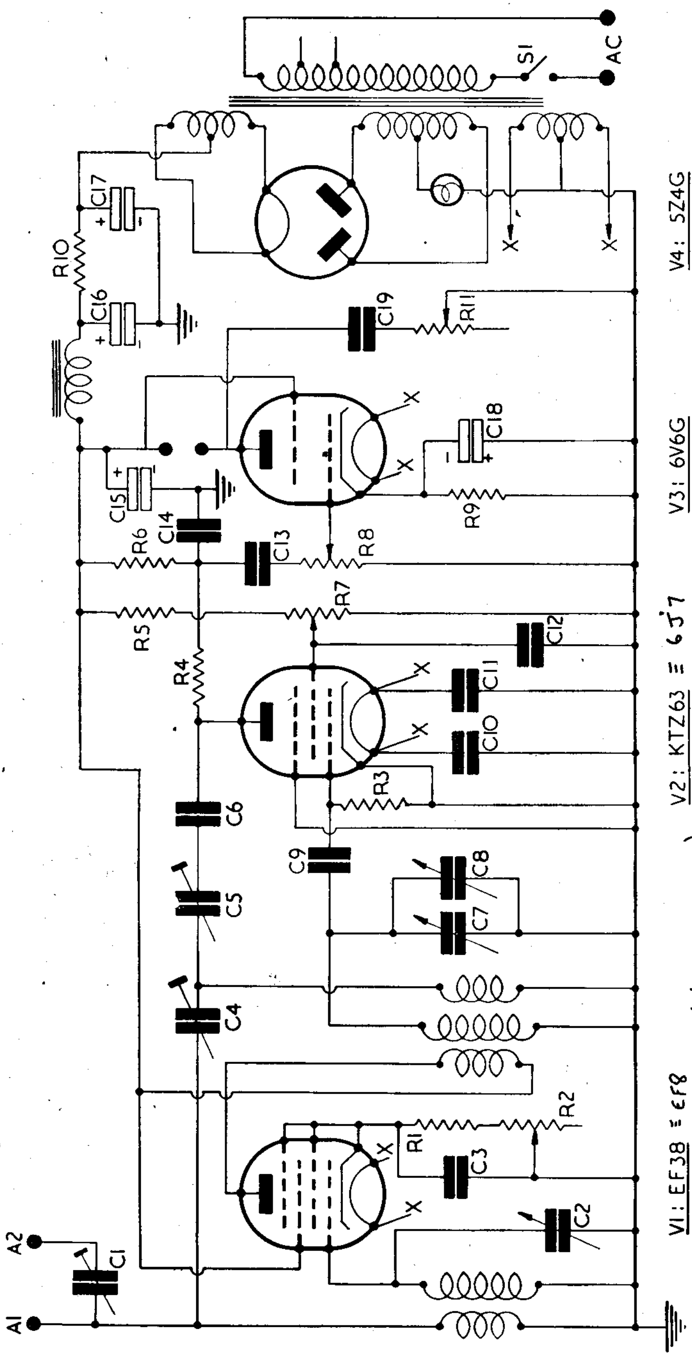


Diagram showing positioning of components under the chassis



List of Components

C1	Trimmer	C6	0.005 μF	C11	0.002 μF	C16	8 μF	R2	2000 Ω
C2	160 μμF	C7	160 μμF	C12	0.05 μF	C17	8 μF	R3	2 MΩ
C3	0.05 μF	C8	16 μμF	C13	0.05 μF	C18	25 μF	R4	10000 Ω
C4	40 μμF trimmer	C9	100 μμF	C14	500 μμF	C19	0.02 μF	R5	0.25 MΩ
C5	300 μμF	C10	0.002 μF	C15	8 μF	R1	40 Ω	R6	0.25 MΩ

R7	50000 Ω
R8	0.5 MΩ
R9	300 Ω 5 watt
R10	2000 Ω 10 watt
R11	10000 Ω

tuned by the combination of L2/C2, the latter **not** being ganged with the detector variable. The RF valve, EF38, has four grids, No. 1 being the control grid, No's 2 and 4 being joined together and taken to the cathode, and No. 3, being supplied with full HT. The bias circuit is provided with potentiometer R2, which acts as the RF gain control and of which more is said later on.

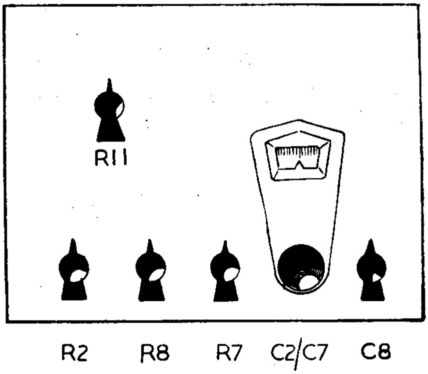
A feature that may be new to some readers is the incorporation of C4. The arrangement shown is very useful since it acts as a regeneration control for the RF stage and should be set at the position best suited for overall performance. This is a very simple refinement and will be found most helpful in getting the "last ounce" from the RF stage.

Coupling from the RF to Detector stages is of the "transformer" type—in other words a six-pin coil is used in the detector circuit, the output from V1 being induced into the grid winding L4 through L3. On the V2 grid circuit, bandspread has been incorporated, though the fairly flatly tuned RF stage does not really require this. The two capacitors C10 and C11 are fitted to the V2 heaters as a precaution against modulation hum, another little refinement that will add to the general performance of the set.

Reaction is effected by variation of the screen voltage of V2 which is carried out with the aid of potentiometer R7. The normal anode type of reaction is also available, though in place of the usual variable a small trimmer (C5) is used. This is merely for setting, and actual reaction is produced by the rotation of R7. This is a much better arrangement as the potentiometer-type reaction does not produce the wide variation of calibration as does the capacitor type.

The detector is coupled to the output valve through R4 and C13. The resistor R4 was found more satisfactory than an RF choke as the latter incline towards being "peaky." Volume is regulated by the potentiometer R8.

The remainder of the circuit is quite straightforward, though mention should be made of R10. As the transformer in use was of 350 volt rating, the HT had, obviously to be dropped. A simple Ohms Law calculation found the necessary value to be approximately 2000 ohms, with a 10 watt rating. If a 250 volt transformer is used, then the dropper will not be necessary. C19 and R11, between the anode and earth are, of course, the tone control components.

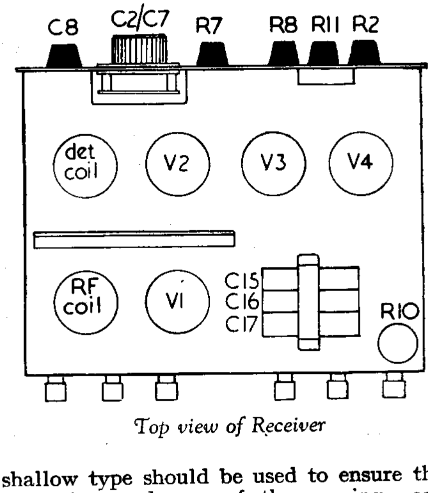


Front view of Receiver

Construction

The construction of the AC3, unlike the actual circuit, follows some rather unusual lines. The drawings accompanying this article will make the constructional details fairly clear, though perhaps a few words on some of the aspects will be of assistance.

The chassis, it will be seen, is placed high up on the panel, thus allowing the tuning capacitors to be placed underneath the coils and valveholders giving a compact layout and one which allows short grid leads. Once the chassis, panel, dial and valveholders have been assembled, the rest is perfectly straightforward. A point to watch is that the tuning capacitors are rather close to the valve holders and so the



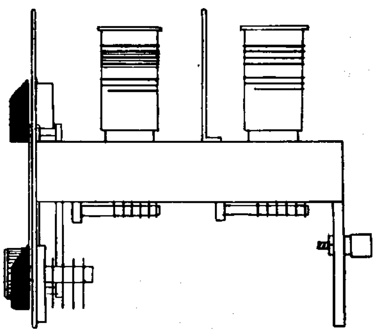
Top view of Receiver

shallow type should be used to ensure that there is no danger of the moving vanes coming into contact with soldering tags, etc. This fact should also be borne in mind if a dial other than that used in the original model is employed. If a different type of dial is used, place the dial to suit the capacitors and not vice versa.

The screen, which also serves as a bracket for the aerial tuning capacitor, should not be drilled for the aerial tuner until the dial and panel are assembled. In this way, the exact height of the front capacitor shaft can be measured and the screen marked accordingly.

Adjustments

After the wiring has been completed and the usual tests carried out, the capacitor settings have to be made. C4 should be slackened off until it uses only a fraction of its full capacitance (i.e. almost completely "out") and C5 should be set similarly. Then slacken the screws in the shaft coupler so that the aerial capacitor



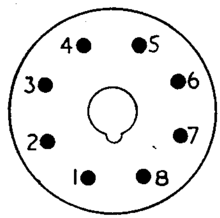
Side view of Receiver

can be rotated independently of the other, and fix a knob temporarily to it. When this has been carried out, set the panel trimmer to about half-way in and tune around until a station is received. Once a station has been tuned in, tighten up the screws in the coupling shaft—the receiver can now be said to be ganged up satisfactorily. As a final adjustment, C5 can be set in a position that will ensure smooth reaction control. Incidentally, the RF gain control should be set at not quite full "in" whilst these adjustments are being made to the receiver.

Coils

If the prospective constructor does not wish to use the set on medium waves, the capacitor C4 may be dispensed with entirely. However, on the medium wave band this capacitor is very useful both in respect of feed-back and selectivity.

Standard 6-pin coils are used for the short wave ranges, but as they do not cover the medium wave band 4-pin coils were used. These, however, required to be modified with an extra pin to be added. To enable this to be accomplished, a 6BA x ⅜in. nut and bolt was used, the bolt requiring very little filing to enable it to fit into the holder. To complete the modifications, two connections in each coil had to be changed. When carrying out these alterations a thing to watch is the possibility of the coils unravelling when unsoldered from the end of the pins—a very likely occurance. The answer is to solder the stray ends to a short length of thicker wire before attempting to re-connect.



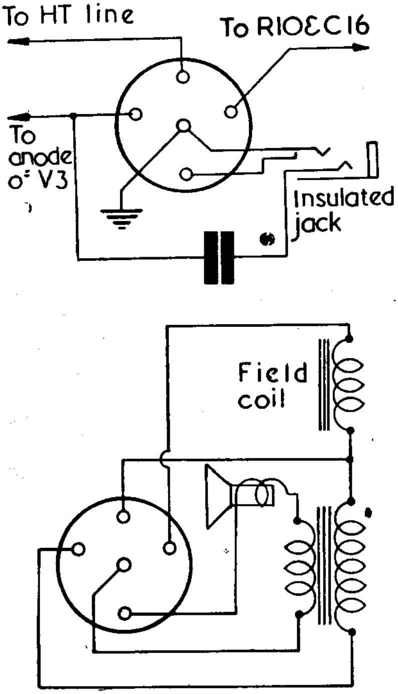
Base connections for EF38

(1) Grid 2; (2) Heater; (3) Anode; (4) Grid 3; (5) Grid 4; (6) Blank; (7) Heater; (8) Cathode; (Top Cap) Grid 1

Getting Results

When operating the receiver it will be found that C4 requires only a little of its capacitance since to increase it will have the effect of damping the receiver, particularly on the short wave ranges. A little experimenting will soon determine the best setting at which to leave this capacitor.

The operator may find that the RF gain control, when in certain settings, will produce a regenerative effect. On the medium wave band, this control can be set at minimum and on short wave ranges it can be turned "full on," this will increase the volume. It should be remembered, however, that when this control is full on, thereby effecting considerable gain, the regenerative effect is experienced which in actual fact is a case of instability of the EF38. Therefore, the RF control should not be used full out unless absolutely necessary. The EF38 is the most satisfactory valve to use in this position, but if for any reasons this valve is not obtainable an EF8 with adaptor may be used with a good degree of success. The adaptor will be necessary since a side-contact valve holder cannot be fitted without disturbing the whole layout of the receiver.



Speaker connections using jack and plug

PRINTED RADIOS

Grove Calkins, *Short Wave News* U.S.A. Correspondent, reports that a new system has been evolved in which wiring takes the form of a deposit of silver on a bakelite "chassis." Wires are made to cross over, where necessary, by means of grooves. The system results in a considerable saving in labour costs more than in material costs and is ideal for mass production. As far as the home constructor is concerned, we think it likely to be some considerable time before this new idea has any impact, though it has obvious possibilities in the direction of complete stage units ready wired, more particularly perhaps in the case of miniature gear.

(QUERY CORNER—Cont. from p.130)

coil. It should be interwound with the main coil, starting from the earth tap and winding towards the grid connection. This additional coil may conveniently be wound with a 30 S.W.G. enamelled double silk covered wire. The aerial coupling capacitor should be adjusted to give optimum results with the particular aerial in use with the receiver.

The H.T. voltage should be just high enough to permit steady oscillation over the whole wave range with the reaction control set to its maximum position. In the interest of general stability it is always desirable to decouple the anode circuit of the detector stage, the amended circuit diagram for this stage is shown in Fig. 3.

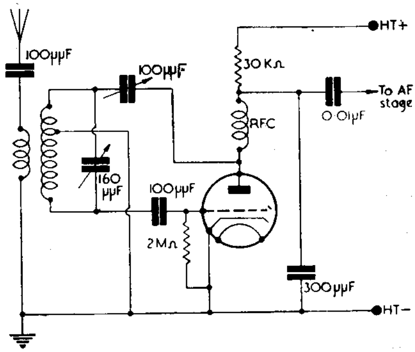


Fig. 3

"Query Corner" Rules

(1) A nominal fee of 1/- will be made for each query.

(2) Queries on any subject relating to technical radio or electrical matters will be accepted, though it will not be possible to provide complete circuit diagrams for the more complex receivers, transmitters and the like.

(3) Complete circuits of equipment may be submitted to us before construction is commenced. This will ensure that component values are correct and that the circuit is theoretically sound.

(4) All queries will receive critical scrutiny and replies will be as comprehensive as possible.

(5) Correspondence to be addressed to "Query Corner," Radio Constructor, 57 Maida Vale, Paddington, London, W.9.

(6) A selection of those queries with the more general interest will be reproduced in these pages each month.

Radio Amateurs' Examination

Report on the Examination held on Wednesday, May 14th, 1947

WE have just received from the City and Guilds of London Institute a report on the last amateurs' examination. A falling off in the percentage of passes is commented on and it is suggested that a number of persons had sat for the examination without adequate preparation. The majority of entries were found to be of extremely low standard and "from the phraseology and vocabulary used, and the general way in which the answers were given, it is apparent that a large number of entrants . . . had received little or no coaching for the Radio Amateurs' Examination." Below, we reproduce the paper set, and here are the comments on each individual question.

THE PAPER

1. An alternating voltage of 10 volts at a frequency of $\frac{100}{2\pi}$ Mcs. is applied to a circuit consisting of the following elements connected in series:—

(i) an inductance of 10 micro-Henrys,
(ii) a capacitance of 10 pico-farads,
(iii) a resistance of 10 ohms.

(*a*) What current flows through the circuit? *(5 marks.)*
(*b*) What voltage appears across the inductance? *(5 marks.)*

2. What is meant by the "selectivity" of a tuned circuit? On what circuit constants does it depend?
Why is this quality necessary in a receiver? *(10 marks.)*

3. What is understood by the term "C.W." and what special method is needed to detect C.W. signals? Describe a circuit arrangement which could be used for this purpose, illustrating your answer by a diagram. *(10 marks.)*

4. What is meant by modulation? Describe a method of modulating a typical low-power R.F. amplifier. *(10 marks.)*

5. What are the relative advantages and disadvantages of a variable-frequency master oscillator over a crystal-controlled oscillator for use in an amateur transmitter? Describe a variable-frequency oscillator of good frequency-stability. *(15 marks.)*

6. Describe, with the aid of a diagram, the circuit arrangement of a low-power crystal-controlled transmitter for the 58.5 to 60 Mcs. frequency band. *(15 marks.)*

7. Describe FOUR types of aerial commonly used for amateur transmission and how they may be coupled to the transmitter. What are their relative advantages and disadvantages? *(10 marks.)*

8. Condition 8 of the Postmaster-General's licence to establish an amateur wireless station stipulates:—

"Where the sending apparatus is not crystal-controlled there should be kept at the station . . . a reliable frequency meter of the piezo-electric crystal type or other type approved by the Postmaster-General, for measuring the frequency to an accuracy of not less than ± 0.1 per cent."

Describe an apparatus to meet the foregoing requirement. Illustrate your answer by a diagram and explain how the apparatus is used. *(20 marks.)*

Year	No. of Cands.	No. of Passes	No. of Failures	Percentage of Failures
1947	326	120	206	63
1946 (November)	216	150	66	30.5
1946 (May)	182	145	37	22.2

Details of Examinations held since commencement

(1) Few candidates attempted the question. Of those who did, less than half gave the correct number.

(2, 3, 4) Fairly well done by the better candidates.

(5) The essential points in the design of VFO's and frequency stability were not at all well understood.

(6) Many incorrect answers.

(7) Not well done. Methods of aerial coupling were dismissed very briefly.

(8) Very poorly done and few attempted the question. Those that did had a hazy idea of the subject.

AMATEUR RADIO EXHIBITION

The R.S.G.B. exhibition held at the Royal Hotel, Woburn Place, W.C.1, on November 19th-22nd, proved a very successful venture according to reports received from many of our readers who visited it, and we understand from the General Secretary, Mr. John Clarricoats, that it is proposed to hold another show next year. A full report will be found in the December issue of our companion journal, "Short Wave News."

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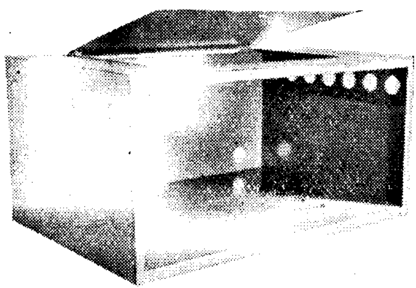

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Type 18 Mk.3—Canadian walkie-talkie transmitter and receiver covers 6 to 9 Mcs. **£3 10s.,** plus 10/- carriage and packing.

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R.1147—2½ metre battery operated receiver easily convertible to television reception. **30/-,** plus 5/- carriage and packing.

1½ amp rectifier—4/- each, plus 1/6 carriage and packing.

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Type 145—A.M. V.F.O. covering 2 to 7.5 Mcs. This is a wonderful bargain as it is just the job for transmitting. Unfortunately, we have no power packs, but there is little difficulty in constructing one. **£5 5s.,** plus 5/- carriage and packing.

Type 37—Oscillator—covering 22 to 80 Mcs., works straight off 200 to 250 volt mains A.C. **£6,** plus 5/- carriage and packing.

APW.6331—Modulator and mixer containing 18 valves **50/-,** plus 5/- carriage and packing.

W.1095—A battery operated absorption type wave meter operating on 1220 to 1540 and 2000 to 3410 kcs. Contains a dial reading 0 to 190 with a vernier scale, friction driven: and an 0 to 500 micrometer **37/6,** plus 5/- carriage and packing.

Type 526—Power-pack for C.R. Tube etc., by changing the present 80 volts 1000 cycles transformer for a mains transformer the unit can be used as a supply for various test gear, **45/-,** plus 5/- carriage and packing.

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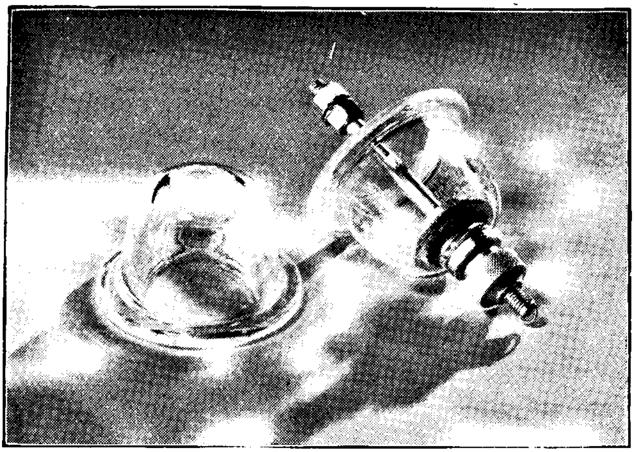

TRADE NOTES

Useful feed-through insulators offered by Mail Order Supply Co.

Selenium Rectifier

Messrs. Standard Telephones and Cables Limited submitted to us for inspection a selenium rectifier, type RD 18-9-1, price 7/6, as a possible substitute for the one used in the "Good Companion" receiver described in Vol. 1, No. 1, and for future receivers of a similar type. Some of the important features claimed for this rectifier are small size, unbreakable, light weight, good regulation, instant starting, simple mounting, suitable for inputs of 110 to 250 volts, only three connections, high output voltage and low wattage dissipation. From the practical point of view we wired this rectifier in place of the existing one in the "Good Companion" and found it to be wholly satisfactory. A technical bulletin is available from S.T.C. at Oakleigh Road, New Southgate, London, N.11.

Bulk-head feed-throughs

An item of interest to the transmitting readership are the pyrex feed-throughs now being offered by Mail Order Supplies. These are available in two types, with or without fixing bolt. The nut for fixing wire connection is prevented from being turned off the bolt by a small fitment. A good point is the fact that the fixing wire cannot be twisted when tightening up since the knurled nut slides a collar along the bolt thereby eliminating the twisting action normally encountered with such fittings. On the flange end, a spigot is provided for locating to a 2in. hole in the panel or wherever the feed-through is to be fixed. Although no actual means is provided for fixing the feed-through, three small clamps would prove satisfactory or indeed any other methods which come to mind. Where the bolt passes through the pyrex, two leather washers are provided which makes it completely watertight. A small pin, through the bolt, ensures that the bolt will not rotate when being clamped and tightened up.

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