CHRISTMAS DOUBLE NUMBER

1/6

MODERN WIRELESS

Vol. VI. No. 7. DECEMBER, 1926.

CONTENTS

VOL. VI. MODERN WIRELESS No. 7

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RADIO PRESS LTD., BUSH HOUSE, STRAND, LONDON, W.C.2. *Telephone:* City 9011

If you had met Scott-Taggart—

SUPPOSING a month ago you had been on your way to a dealer to buy a valve and you had met Scott-Taggart. If he had recommended a certain valve as ideal for your purpose, would you have taken his advice? Supposing he had said: "When you get it, I shall be happy to test it out thoroughly and, after I am satisfied it is up to standard, give you a personally signed certificate to that effect," would you have accepted this offer?

You would not consciously have analysed the reputation he has built up as the best-known expert on valves in this country. You probably did not even know that his books on the subject have been a guide to over 500,000 readers of them. It might flash across your mind that he was the head of the great Elstree Laboratories and the keenest of critics of valves and apparatus. How far would his opinion have influenced your judgment? Would you have put his recommended and tested valve in your valve holder with confidence?

To-day you have actually to answer this question. John Scott-Taggart has relinquished all his former activities to produce the best valve he can. It is available in every type, and the designer personally *initials every box to certify that the S.T. valve inside has been tested dynamically (i.e., under actual operating conditions) under his own supervision.*

You are about to buy a new valve. Let it be an S.T.—the valve which, as its dynamic curve shows, gives high amplification and wonderful purity of reproduction. Thanks to the torodium filament and the high constant vacuum, its performance will be maintained, for S.T. valves are built—like the Pyramids—to last.

S.T. Valves are now on Sale! In case of any difficulty or when seeking advice on types to use in your set write to us or call. All valves will be sent by post and will be insured by us against breakage. C.O.D. orders executed on receipt of post-card. For types and prices see pages 701 and 702.

S.T. Ltd., 2, Melbourne Place, Aldwych,
London, W.C.2
(Next to Australia House.)

The "Puramusic"

By C. P. ALLINSON, A.M.I.R.E.

This five-valve receiver employs two stages of high-frequency amplification and two stages of L.F. magnification. It has been designed to give the best possible reproduction from the local station or 5XX, but will, in addition, receive other British and Continental broadcasting.

ON the night of the concert which was broadcast recently from the Albert Hall some friends dropped in who were anxious to hear the programme. At the end of the evening one of them (a noted musician) turned to me and asked: "How is it that your set sounds quite different from any I have ever heard? I have never yet listened to a wireless receiver that gives the same depth of tone, the same variation in colour and the same detail that yours does.

"Listening to-night, I could pick out the different instruments and their various themes, while their peculiarities of tonal colour came through in a most realistic manner. In fact, your set is a musical instrument and not just a mechanical device, as some wireless receivers seem to be."

As you can guess, I was pleased at the praise given by my friend. At the same time I felt that I had certainly earned it, for that particular receiver was the outcome of much experimental work. The loud-speaker used was a Celestion, and the purity and volume obtained with it left little to be desired.

The Set

The "Puramusic" receiver which I am going to describe to you in this article is the direct descendant of the set which I have had in use at home for the last two or three months. It is an improvement on it in many ways, and the primary consideration has been to obtain the purest and most faithful reproduction of speech and music.

COMPONENTS REQUIRED

One Panel 26 in. by 7 in. by $\frac{3}{16}$ in. (American Hard Rubber Co.)
One Cabinet for same with 12 in. deep baseboard. (Peto Scott Co., Ltd.)
One Two "gang" condenser .0005 and geared dial. (Wilkins & Wright.)
One Variable condenser .0005. (Wilkins & Wright.)
Five Clearertone Valve Holders. (Benjamin Electric Co.)
Three H.F. Transformers Split Secondary type and bases. (Collinson Precision Screw Co.)
Two Wire wound resistances 100,000 ohms. (Varley Magnet Co.)
One Tapped L.F. Choke. (Beard & Fitch.)
One Resistance 250,000 ohms. (Varley Magnet Co.)
Two Neutralising condensers (one baseboard and one panel mounting). (Burne-Jones & Co., Ltd.)
Five Baseboard mounting variable filament resistances. (Lissen Limited.)
One Grid condenser and leak (.0003 and .25 megohm). (Dubilier Condenser Co., Ltd.)
One Grid leak .25 megohm and holder. (Dubilier Condenser Co., Ltd.)
One .0002 fixed condenser. (Dubilier Condenser Co., Ltd.)
One .01 mica condenser and two 2MF Mansbridge type Condensers. (Telegraph Condenser Co.)
One .002 and one .006 fixed condensers. (Dubilier Condenser.)
One Panel mounting milliammeter 0 to 20. (A. F. Bulgin & Co.)
Two "Decko" dial indicators. (A. F. Bulgin & Co.)
One Stud switch. (Bowyer Lowe, Ltd.)
One Double circuit jack. (Bowyer Lowe, Ltd.)
One Single filament control jack. (Bowyer Lowe, Ltd.)
One jack switch and a phone plug. (Bowyer Lowe, Ltd.)
Ten Indicating terminals. (Belling Lee, Ltd.)
One Potentiometer. (Lissen Ltd.)
One Igranic variable resistance, one megohm. (Igranic Elect Co.)
Four Grid bias battery clips. (A. F. Bulgin & Co.)

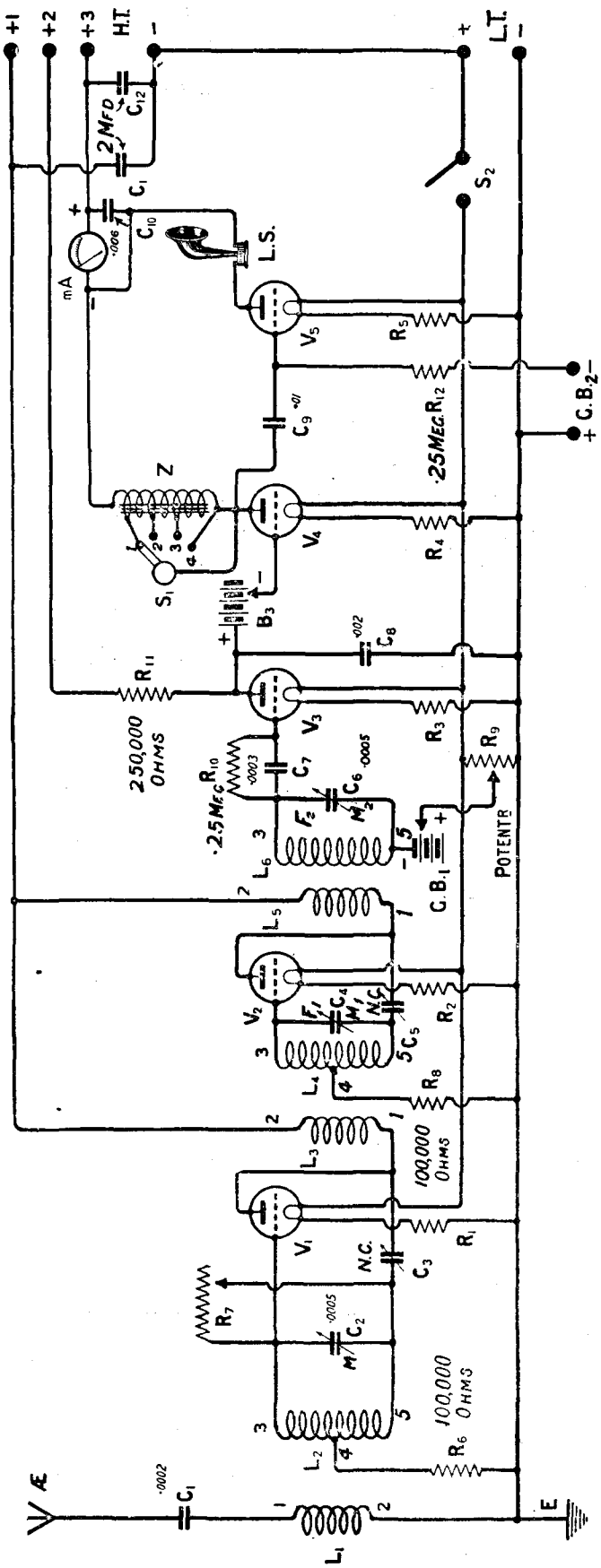


Fig. 1.—The simplified theoretical circuit diagram. R_7 is a volume control, and the pitch may be raised or lowered by means of the switch S_1. The Jack switching is shown in a separate diagram.

THE "PURAMUSIC"— *(continued.)*

It is over two years since I first started on the quest for the ideal receiver, and I finally came to the conclusion that two receivers are necessary—one designed purely for work on the local station and one for distance work—that is if loud-speaker reception of distant stations is desired, for the local station set can usually be so arranged that transmissions other than the local one may be received on the headphones.

Early Experiments

The first set I made with a view to improving the musical value of my receiver was a resistance-capacity coupled one; but in those days wire-wound resistances were not available and the result was that after about three months use the receiver began to get noisy and all enjoyment was lost.

The Prince Circuit

When the Prince "trigger" circuit first came out I was greatly struck by its possibilities and found that it was capable of giving an extraordinarily pure output. I felt, nevertheless, that there was still room for improvement, and, after much experiment, arrived at the final design described in this article.

Outstanding Features

This set is designed solely for the consistent reception of the local station at distances up to 50 or 60 miles. The outstanding features of the receiver are: the purest possible reproduction of speech and music whether one or two stages of low-frequency amplification are being employed; consistent reception at distances of 50 or 60 miles (under favourable conditions far greater ranges can be achieved) by the inclusion of two stages of high-frequency amplification; the elimination of reaction in the detector circuits since this can be one of the most general sources of distortion; the use of a lay-out that shall give the utmost stability, and the use of a modern neutralised H.F. circuit which shall ensure that the set be capable of stability under practically all conditions.

In order, however, that those who are keen on distant reception may have the opportunity of searching for stations other than the local one, one of the neutralising con-

THE "PURAMUSIC"—(Continued)

densers has been mounted so that it may be controlled from the front of the panel.

Distant Reception

In actual practice it has been found that with only a twenty-foot aerial it is possible to receive a considerable number of distant and foreign transmissions without the H.F. neutralisation being touched, and many of these have been clearly heard on the loud-speaker.

Among them I may mention such transmissions as Brussels, Birmingham, Frankfurt, F.P.T.T., Belfast, Rome, Breslau, Münster, Dublin, Hamburg, Bournemouth, Hanover, Elberfeld, and others that were not identified.

I would emphasise again, however, that this receiver is intended to be used for the reception of the local station with the utmost clarity and purity, and the "DX fan" is advised to turn elsewhere for his requirements.

The Lay-out

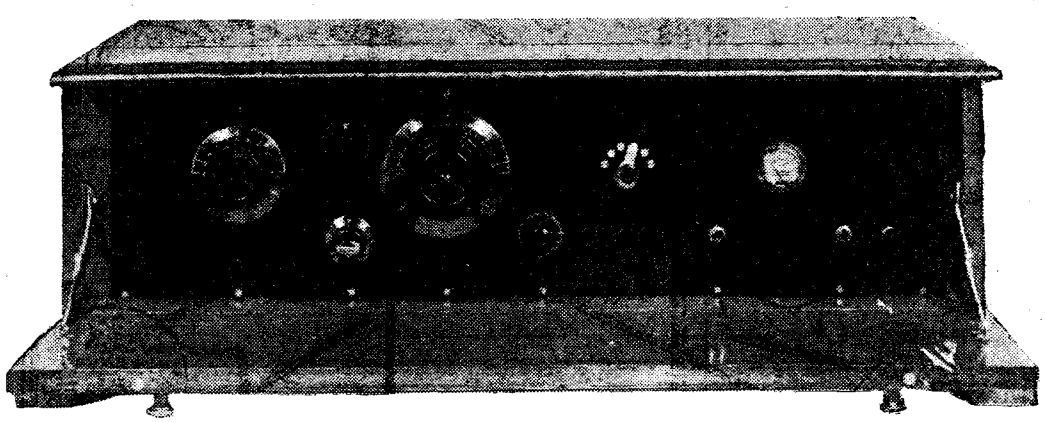
As will be seen from the photographs the receiver is handsome in appearance.

The large dial near the centre of the panel is a "gang" condenser by means of which the second H.F. and detector circuits are tuned. Since the first H.F. valve is coupled to the aerial it is somewhat liable to differ in its readings from the other two circuits, and a separate control has therefore been thought advisable; incidentally, it is rather more economical. Between these two dials are the volume control (above) and the second neutralising condenser (below).

On a level with this latter but on the other side of the gang controlled condenser is a potentiometer; while to the right of this is a stud switch which enables a certain degree of pitch control to be obtained, *i.e.*, the pitch of the output may be raised or lowered at will. A small milliammeter is seen to the right of this, and this will be found an extremely valuable refinement especially with the particular circuit employed. Below this are the two output jacks and the filament switch.

Baseboard Components

The photographs taken of the back of the panel show the lay-out that has been worked out for the receiver, and the reader should specially note the disposition of the three inductances. These have been placed at the apices of an equilateral triangle so that the coupling between each one and the other two is the same. This is largely responsible for the extreme stability of the receiver, and I found that it required only the smallest amount of neutralising capacity in either stage entirely to stabilise the set. To one side of the "gang" condenser will be seen four small batteries. The functions of these will be dealt with in a later paragraph; while



The set incorporates a milliammeter which enables "blasting" to be detected and eliminated.

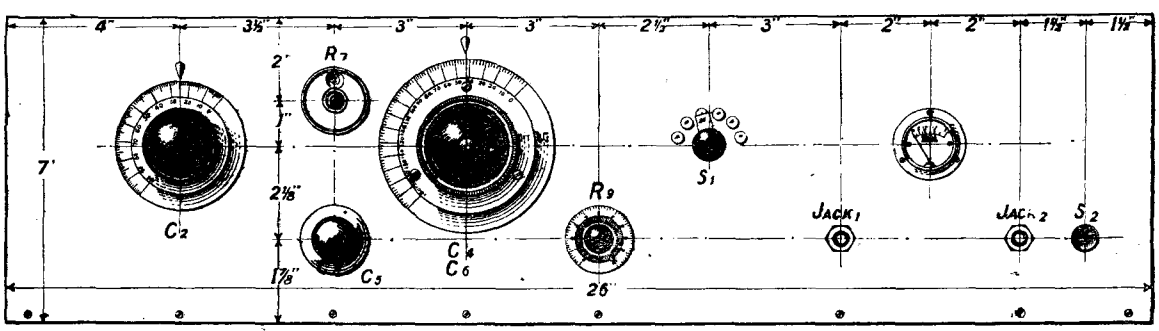


Fig. 2.—The panel-drilling diagram. Blue print No. 1881 may be obtained free of charge.

THE "PURAMUSIC"—(Continued)

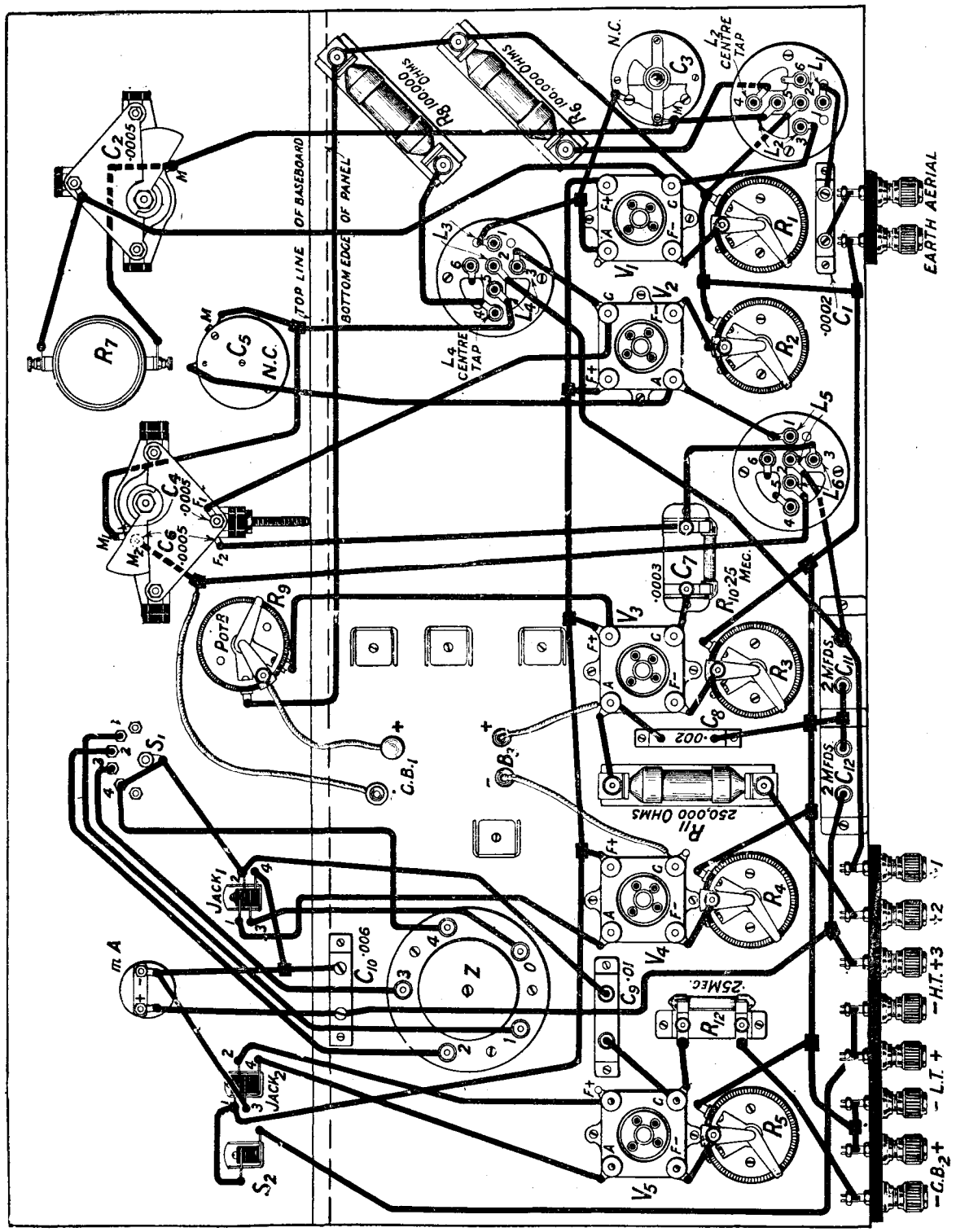


Fig. 3.—The two H.F. circuits are controlled by means of a "gang" condenser, while the aerial circuit utilises a separate control. Blueprint No. 188b may be obtained full size.

THE "PURAMUSIC"—(Continued)

to the left of these (looking at the set from the rear) will be seen the special choke employed for the last stage of L.F.

The Circuit

The theoretical circuit diagram in shown in fig. 1, from which it will be seen that the two H.F. stages employ a well tried and proved circuit. The centre-tapped grid coil method of neutralisation is employed. A point of interest is the aerial coupling. In order that the gang control should not result in any appreciable loss in efficiency the primaries of the H.F. transformers employ fairly tight coupling; in fact they consist of 35 turns placed at the grid end of the secondaries, and so placed as to give tight magnetic coupling. It was desired to use the same arrangement on the aerial side so that all three coils should be interchangeable but, with the primary connected directly to the aerial circuit, it was found that the coupling was too tight.

Coils

Coils with smaller primaries were therefore tried, but it was found that the best results were obtained with the 35 turn primary with a fixed condenser of .0002 placed in series with the aerial lead. It may be found with a full-size aerial, mine is a smallish one, that a .0001 will be better. The value of this condenser is only found to be important, however, when distant stations are being received, and on the local station does not appear to matter to any noticeable extent.

The Detector Valve

We now come to the most important point in this receiver, the detector and first low-frequency valves. The value of R_{11} has been chosen as 250,000 ohms, and with this value an excellent degree of amplification is obtained without the size of the coupling battery being made too great. If a higher resistance is used, say, about 2 megohms, a greater degree of amplification is obtainable, but the circuit at once begins to get critical in adjustment again, and I therefore decided that the added ease in handling was worth the slight loss in volume.

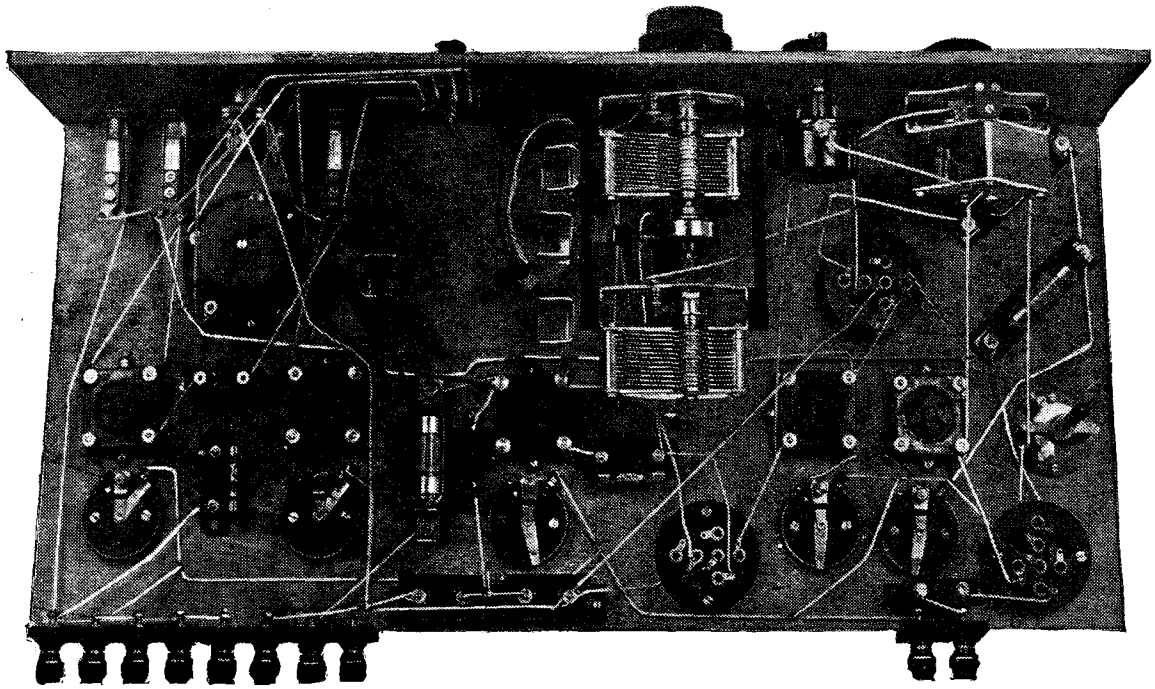
Batteries

The batteries seen at the back of the panel are the detector grid battery $G.B_1$ and the coupling battery B_3 respectively. The coupling battery consists of three 9 volt units connected in series, only a single one being required for the detector.

The second stage of L.F. is choke-capacity coupled for the reasons stated earlier in the article. The choke is provided with four tappings which are taken to a stud switch so that by including more or less of this impedance the pitch may be lowered or raised. Care should be taken to connect the switch as shown, so that that portion of the choke which is not being used is short circuited. If this is not done little control over the pitch will be obtained.

The milliammeter (which is shunted by a condenser C_{10} of .006 capacity) placed in the L.F. H.T. lead will be found of great value in getting the best out of the L.F. side of the set, and it will be referred to in the instructions for correctly adjusting the receiver.

The volume control R_7 is placed across the first grid circuit and will be found of use where the output from the local station is found to be a little too weak on one stage of L.F., and a little too strong



In laying out the components on the baseboard adequate space should be left for the four grid batteries.

THE "PURAMUSIC"—(Continued)

For assistance in wiring up the jacks a sketch is shown in fig. 4, which shows the connections for each tag. It is important that no mistake be made here or else the switching operations which it is intended shall be carried out by the jacks will not be done correctly, or else the H.T. may be shorted through the phones or loud-speaker.

Resistances

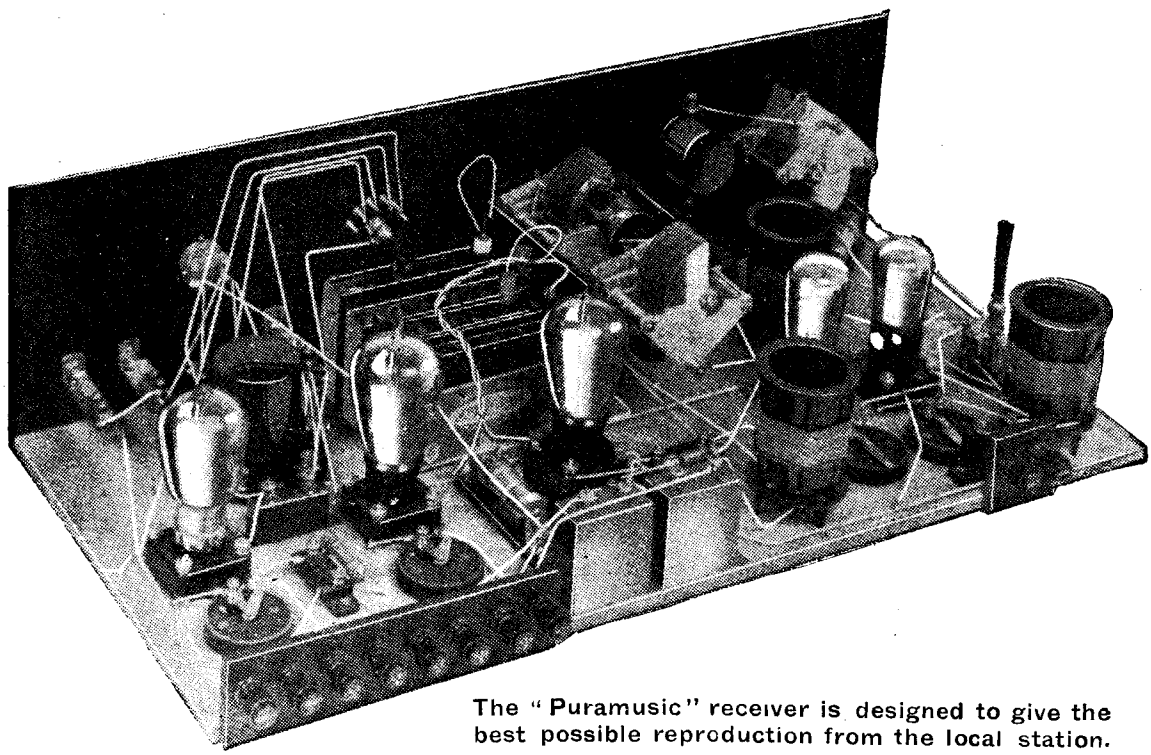
The choice of filament resistances has now to be decided on, and these may be obtained either in 30 ohm or 7 ohm types. I have used the 7 ohm resistances, but where it is desired to use an assortment of valves, say, .06 for the H.F., a G.P. for detector and small power valves for L.F., then it is advisable to obtain the 30 ohm resistances, since these enable a large selection of valves to be employed. It should be noted that this resistance is too low, however, to enable .06 valves to be used with a 6 volt battery; for this purpose a 50 ohm resistance is required.

The detector grid and L.F. coupling batteries are held in clips on the baseboard, and these should not be put into position till the potentiometer has been wired up, and care should be taken to see that none of the other leads will run foul of these batteries afterwards.

After the wiring is completed it should carefully be checked and then tested out in the usual manner for correctness on both the H.T. and L.T. sides.

Aerial Test

The set can now be placed on aerial test. Insert the valves, connect the batteries, connect aerial and earth and plug the loud-speaker into the first jack. First turn on the L.F. valve only and note the current shown on the milliammeter when the correct normal grid voltage is applied to the grid of the L.F. valve by means of the battery $G.B_2$. With most small power-valves this will be between 7 and 9 volts, preferably the latter value. If the current (a plate voltage of 120 being used on the L.F. valve) is in the neighbourhood of 3 to 5 milliamps. the setting is correct. Now plug in about 1½ volts negative on the detector grid battery $G.B_1$ and switch on this valve, the potentiometer being placed central, and connect the detector H.T.+ lead to a tapping of about 40 volts. It will now be found that the plate current has risen and the coupling battery B_3 should therefore be readjusted till the current is reduced to normal. At this point it should be found that a slight scraping sound is heard over a certain range of movement on the potentiometer slider. The local station may now be searched for.



The "Puramusic" receiver is designed to give the best possible reproduction from the local station.

Neutralising

Having found it the set may be stabilised. Turn out the first H.F. valve and place the first neutralising condenser at its minimum value. Tune in the station to its loudest and increase the value of this condenser till the station becomes very weak or even inaudible, retune and if necessary readjust the neutralising capacity. Do the same with the second H.F. It will be found in many cases that the value of the neutralising condensers can be considerably reduced in practice without the set going into oscillation, and the second

THE "PURAMUSIC"—(Continued)

on two; it also has another use which will be discussed later.

Components

The components required to construct this set are given on another page, and provided that parts of equal quality are used it is not necessary to adhere exactly to the makes given. I would like to urge the constructor, however, not to depart from the *values* given, especially as regards the detector and first L.F. circuits.

Drilling and Mounting

The only point in mounting the components on the panel (the first step in constructing this receiver) is cutting the hole for the milliammeter. This is most easily done with a washer cutter, but if one is not available it may be done by marking out the circle of ebonite that has to be removed and drilling a number of small holes so that their edges just touch the circumference of this circle. They are then joined together with a small file and the centre piece of ebonite knocked out. The sharp points of ebonite on the inside of the hole are then smoothed off with a small half-round file, and the meter can then be mounted by means of three 6 B.A. screws and nuts.

A little difficulty may also be found in mounting the Indigraph dial on the volume control, and the best way of doing this is to place a drop of Chinese white on each of the two small projections which fix the casing of the indicator so as to prevent its rotating, and then drop it over the spindle carefully in the correct position. The white will then make two small marks showing where the holes should be drilled. A suitable size drill is about a 6 B.A. clearance.

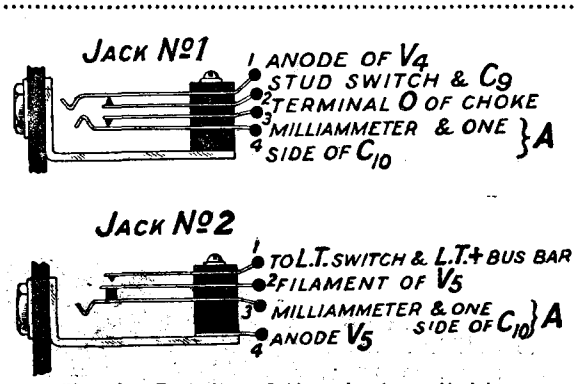


Fig. 4.—Details of the Jack switching arrangements.

The "Gang" Condenser

It will be noticed that it is necessary to support the "gang" condenser, and an examination will show a hole drilled in the bottom ebonite strip that runs lengthwise along this instrument. By placing a length of screwed rod through this with a large washer and nut on the under side the nut may be screwed up till the weight of the condenser is taken by the rod.

(*Continued on page 765.*)

WIRING INSTRUCTIONS

Join contact 3 of Jack 2 to — of m A: — of m A to one side of C10: same side of C10 to contact 4 of Jack 1.

Join + of m A to remaining side of C10: same side of C10 to H.T. + 3: H.T. + 3 to one side of C12.

Join terminal 0 of z to contact 3 of Jack 1.

Join terminal 1 of z to contact 1 of S 1.

Join terminal 2 of z to contact 2 of S 1.

Join terminal 3 of z to contact 3 of S 1.

Join terminal 4 of z to contact 4 of S 1: contact 4 of S 1 to arm of S 1: arm of S 1 to contact 2 of Jack 1: contact 2 of Jack 1 to one side of C 9.

Join contact 1 of Jack 1 to A of V 4.

Join one side of S 2 to contact 1 of Jack 2: contact 1 of Jack 2 to F + of V4: F + of V 4 to F + of V 3: F + of V 3 to one side of winding of R 9, and F + of V 2: F + of V 2 to F + of V 1.

Join contact 2 of Jack 2 to F + of V 5.

Join contact 4 of Jack 2 to A of V 5.

Join remaining side of S 2 to L.T. +: L.T. + to H.T. —.

Join G B 2 + to L.T.—: L.T.— to one side of R 5, R 4, C 8, C 12, C 11, R 3 and to Earth: Earth to one side of R 2: same side of R 2 to one side of R 1: same side of R 1 to contact 2 of L 1, and one side of R 6: same side of R 6 to one side of R 8: same side of R 8 to remaining end of winding of R 9.

Join contact 5 of L 6 to M 2 of C 6, and join flex lead with wander plug on end to M 2 of C 6 for G B 1 —.

Join F 2 of C 6 to one side of C 7 and R 10: same side of C 7 and R 10 to contact 3 of L 6.

Join M 1 of C 4 to moving plates of C 5: moving plates of C 5 to contact 5 of L 4.

Join F 1 of C 4 to G of V 2: G of V 2 to contact 3 of L 4.

Join one side of R 7 to moving plates of C 2: moving plates of C 2 to moving plates of C 3: moving plates of C 3 to contact 5 of L 2.

Join remaining side of R 7 to fixed plates of C 2: fixed plates of C 2 to G of V 1: G of V 1 to contact 3 of L 2.

Join fixed plates of C 5 to A of V 2: A of V 2 to contact 1 of L 5.

Join contact 4 of L 4 to remaining side of R 8.

Join contact 1 of L 3 to A of V 1: A of V 1 to fixed plates of C 3.

Join H T + 1 to remaining side of C 11: same side of C 11 to contact 2 of L 5, and contact 2 of L3.

Join remaining side of R 6 to contact 4 of L 2:

Join contact 1 of L 1 to one side of C 1.

Join other side of C 1 to Aerial.

Join remaining side of R 1 to F — of V 1.

Join remaining side of R 2 to F — of V 2.

Join remaining side of C 7 and R 10 to G of V 3.

Join remaining side of R 3 to F — of V 3.

Join A of V 3 to one side of R 11, remaining side of C 8, and join flex lead with wander plug on end for B 3 + to A of V 3.

Join flex lead with wander plug on end for G B 1 + to moving arm of R 9.

Join remaining side of R 11 to H. T. + 2.

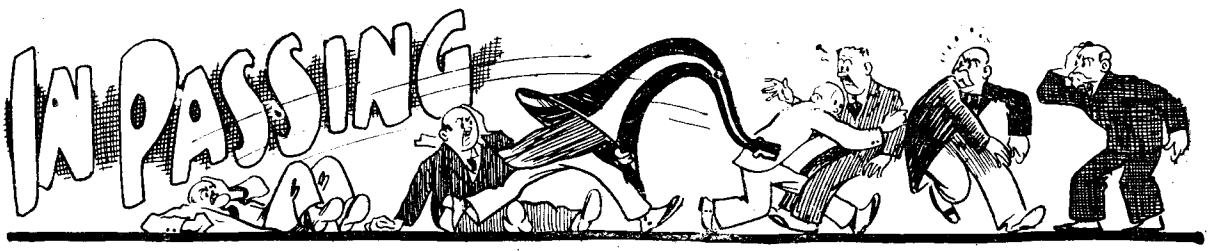
Join flex lead with wander plug on end for B 3 — to G of V 4.

Join F — of V 4 to remaining side of R 4.

Join G B 2 — to one side of R 12.

Join other side of R 12 to G of V 5: G of V 5 to remaining side of C 9.

Join remaining side of R 5 to F — of V 5.



"I FEEL," remarked the General, as we sat round the table at the meeting of the wireless club, "that the club should mark the festal season in some way this year. It is now nearly five years since we began our meetings, and though we have had picnics and outings in the summer time we have not so far had much in the way of a celebration at Christmas or the New Year. Has anybody any suggestions to offer?"

"I propose . . ." cried Admiral Whiskerton Cuttle, springing to his feet and sitting down again with a thud. Of course, he insisted that it was I (note the purity of my English; intimate association with B.B.C. announcers now makes it impossible for me to write "it was me") who had tied his bootlaces together. I explained that if I was responsible I was in no way to blame. On stooping down to adjust one of my own laces I had felt upon the floor what I took to be stray leads. Naturally, I had knotted them together, for I have always been a tidy person. Being, as you know, the soul of politeness I promptly got under the table and untied the knot.

. . . To teach the fellow a lesson . . .

A Proposal

Whilst I was there I observed long ends dangling from Poddleby's boots, and just to teach the fellow a lesson I knotted *them* round the leg of the table. Having been properly soothed, the Admiral rose once more to his feet, though this time he was careful not to leap. "I have a proposal to make," he said, "which I am sure will be welcomed by every member of the club. But meantime let me remind you of the wonderful record of toil, of endeavour, of progress, that has marked our five years' history."

I knew that once he was launched on a topic like that the Admiral was good for at least half an hour. Feeling that I should be able to follow him better if I had something to lean upon, I drew his chair gently towards me and placed my elbows on the back of it. Having given a detailed description of the club's doings from the day of its foundation, the Admiral at last got his suggestion off his chest.

"What I want to propose," said he, "is that we should have a New Year's dinner, followed possibly by a smoking concert."

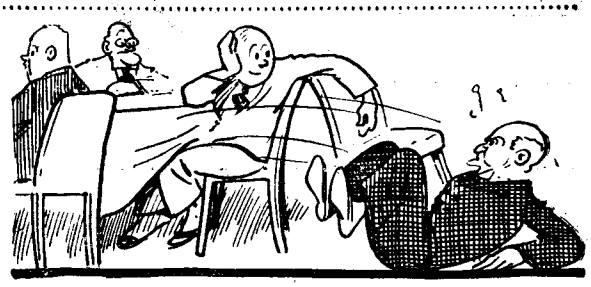
The proposal was received with salvoes of applause and the Admiral sat down feeling that he had made a real hit.

A Hit

He certainly made one in sitting down, for so carried away was I by his oration that I quite forgot to replace his chair and he smote the floor with a bump that shook the building to its very foundations. I sprang to the rescue, and arrived face downwards upon the prostrate Admiral. That idiot Snaggsby, who was sitting on my left, had, if you will believe me, perpetrated the fourth-form schoolboy trick of tying *my* bootlaces together. Luckily I knocked all the wind out of the Admiral, who was therefore unable to say anything. We picked him up and put him in his chair, everyone patting him on the back and telling him how they appreciated his brain-wave about the dinner. This so mollified our naval member that when his powers of speech returned his desire to say things had entirely left him.

A Slight Interruption

A motion that there should be a New Year's dinner was put up by the General and carried by acclamation.



. . . He certainly made one real hit. . .

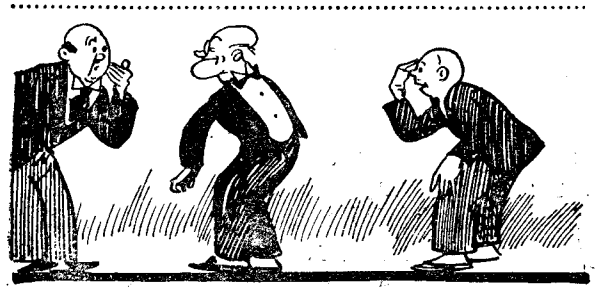
"The next thing," said our chairman, "is to choose a committee who will be responsible for the financial and other arrangements. I offered myself at once for the post of treasurer. The General was just dipping his pen into the inkpot to write my name down when Poddleby heaved himself on to his hind legs. In some unaccountable way the table was drawn violently towards him and he violently towards the table. He arrived face downwards upon it, his right ear catching the inkpot and overturning its contents upon the General's new Tattersall waistcoat. With a neigh of wrath the General started backwards, flinging away from him his quill pen which stuck, like one of Cupid's darts, into the back of Winklesworth's hand. During the backward movement of his chair its legs came into contact with the leads running to our new giant loudspeaker which toppled from its pedestal, the bell of the trumpet completely bonnetting Professor Goop. Thus rudely awakened from a reverie in which he had been plunged the Professor ducked violently forward, propelling the table into the briskets of Dipples-

IN PASSING — (*Continued*)

wade and Bumpleby Brown, who were opposite him.

An Uproar

In a moment the whole meeting was in an uproar. Some told their neighbours at the tops of their voices exactly how to disarm the Professor, who was inflicting with his trumpet as many casualties as were once caused by the jawbone of an ass; others merely received swats from this novel but effective weapon and collapsed in heaps upon the floor. With my usual presence of mind I switched off the lights and retired hastily into the street. At the end of about half an hour when silence betokened that the combatants were exhausted I ventured back and turned them on once more. Most of the members, not excluding the chairman, were, I must admit, looking a little secondhand.



. . . He'd decided to dress always that way. . .

High Finance

"And now," I said, with a bland smile, "and now that you have quite worked off your high spirits, let us get down to real business." In a trice (whatever a trice may be) the meeting was reconstituted and before you could have said "gridleak" we were hard at it discussing the arrangements. Much to my disgust I was not appointed treasurer, for there seemed to be a feeling that it would be scarcely fair to ask me to undertake any financial responsibilities in connection with the club at a time when I should clearly have my hands full of private problems, such as persuading my landlord that I could not possibly pay the rent until I had satisfied the demands of the income tax man, and proving to the income tax fellow that I would most willingly give him a cheque were it not for the fact that I must write one for my landlord in order to preserve a roof over my head. It is surprising to find how considerate one's fellow-members can be at times.

The Arrangements

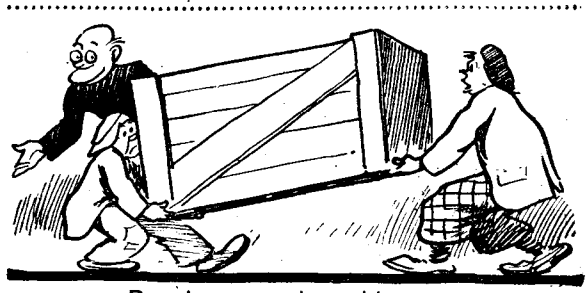
We had hoped to hold our dinner on December 31st so that we could see the New Year in properly, singing "It Ain't A Gonna Rain No Mo'" with crossed arms and all that kind of thing. It was found, however, that Mr. Snuffham, the proprietor of the "Plate and Grid," little Puddleton's most fashionable hostelry, had arranged a dance for that night and that all the *élite* of Little Puddleton had already purchased tickets. Even though we are well south of the border we do not like throwing money away. Nearly every other night in December appeared to have been already appropriated for some festivity or other, so we were forced to choose the one vacant evening, which was in the middle of the month. This was a little disappointing, but as Snaggsby pointed out, it did not really matter so long as the right spirit was there. If we held our New Year's dinner a fortnight or so early it would give the world yet another proof that Little Puddleton is never behind the times. Considering that I was not on the committee the arrangements for the dinner were made with surprisingly few hitches, and Poddleby, who was appointed treasurer, made the accounts balance without making nearly so much use as I should have done of that very handy item "sundries."

A Novel Costume

On the great night we assembled prepared to do full justice to the occasion, there was an air of suppressed excitement about it all, for Professor Goop had promised us a surprise later in the evening. In point of fact he provided us with several, not the least of which occurred when he threw off his overcoat and displayed his costume; his head seemed to have become turned straight round, so that he was looking backwards. I learnt later that Mrs. Goop had just installed one of those mirror combinations which enable you to see your back when the glasses are set at a certain angle. Finding them in this position when he went up to dress, the Professor had been a little puzzled, and to make things come right he put on the whole of his clothes, including his boiled shirt, his collar and his tie, back to the front. He was, however, so pleased with the new arrangement, owing to the accessibility of his coat-tail pocket, that he told us that he had decided always to dress in that way for the future. Another great advantage, he told us, is that it makes the insertion of one's back collar stud a matter of supreme ease.

One for the General

The next surprise was that received by the General, who owing to the possession of a gouty toe kicks off his right shoe whenever possible. Forgetting that little Bingo was not present the Professor had manœuvred a choice selection of turkey bones, trifle and plum pudding under the table, most of which had come to rest in the General's empty shoe. The expression which spread over the General's face was worth seeing and the expressions which flowed from his lips were distinctly worth hearing, though they were in Hindustani, when he essayed to replace his footgear in order to rise to propose the royal toast.



. . . Bearing a vast packing case. . .

(*Concluded on page 761*).

DIRECTION FINDING AT SEA

By Lt.-Col. CHETWODE CRAWLEY M.I.E.E.

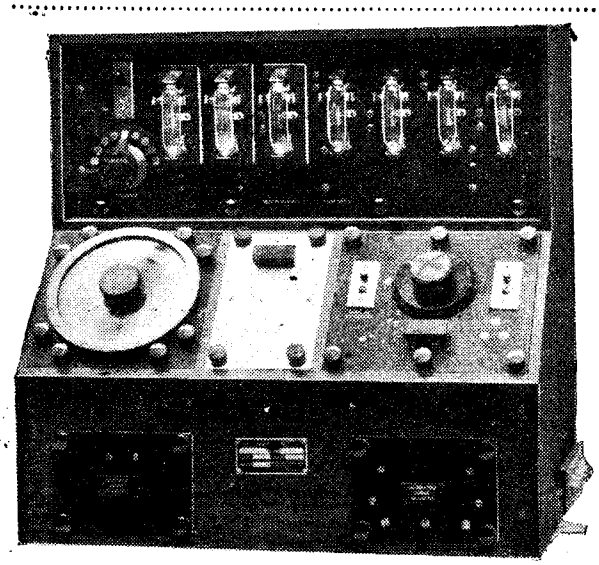
The vast strides which have been achieved by wireless direction finding and its great value to navigation are not generally appreciated by the broadcast listener. In this article, by one who is an acknowledged authority on the subject, some very interesting details are given of this important branch of commercial radio.

IT is generally known in a vague sort of way that wireless was used in the war for directing Zeppelins in their visits to this country, in locating the whereabouts of submarines and even in obtaining exact knowledge of the movements of the German Fleet just before the battle of Jutland, but few outside a small circle of technical experts know what is being done now in this most important application of wireless signalling.

Two Methods

In general there are two alternative methods by which a ship can obtain its bearing from a land station. In the first method the ship transmits wireless signals, and the land station by means of special receiving apparatus determines the direction from which the signals arrive, that is, the direction or bearing of the ship from the station. In the second method the station transmits wireless signals, and the ship determines its bearing from the station.

Both methods can now be relied on technically to give results accurate enough for navigational purposes on the assumption that the signals travel in a straight line from the transmitter to the receiver. Over great distances, however, the signals do not travel in a straight line, and in consequence no reliance can be placed on long-range bearings, especially at night time. But, fortunately, long-range bearings are not required for navigational purposes, except very occasionally as a rough indication of direction, so we can pass on at once to the results which can be obtained at short ranges.



The Marconi direction finding equipment utilises low capacity tubular valves of the V24 and Q type.

Short-Range Data

A considerable amount of data is now available in connection with this short-range work on waves between 400 and 800 metres, and it has been proved by experience that for distances up to about 100 miles by day and 50 miles by night over sea the bearings obtained are quite accurate enough for all practical purposes. When land intervenes, the distances over which bearings can be taken as reliable are reduced, especially at night.

Local Sources of Error

The formation of the land, too, affects the path of the waves, the flatter and more open the better, especially near the receiving station. There is apt to be refraction when the waves pass from the sea to the land, and vice versa, and for this reason lines of bearing which are nearly parallel to a coastline are unreliable. These coastal errors cannot be allowed for as they vary with the wavelength and the range. Finally, local causes of error may arise, but the main fact is that if apparatus, as now designed, is properly fitted and intelligently

DIRECTION FINDING AT SEA—*(Continued)*

operated it can be relied upon to give bearings accurate enough for navigational purposes up to ranges of 50 to 100 miles.

Directional Reception

It is of interest to review briefly the methods adopted for taking bearings. For directional reception a special receiver and aerial system are required, and there are three principal types.

In the *fixed double-loop system* the aerial consists of two vertical loops in planes at right angles to one another, and in the receiving apparatus a coil is rotated by which the strength of the received signals is varied. The direction from which the signals come is determined by the position of the coil when the signals are heard weakest.

In the *rotating double-loop system* two small loops are employed, placed at right angles to each other. One of the loops is connected to a switch whereby its connections may be reversed. Bearings are taken with this apparatus by rotating the whole system until a point is found at which the reversal of the second loop, by means of the switch provided, produces no effect.

In the *rotating single-loop system* a simple frame aerial is rotated and the direction from which the signals come is determined by the position of the frame when the signals are heard weakest.

These three systems are used respectively by the Marconi Company, the Radio Communication Company and Siemens Bros.

Relative Accuracy of Installations

The accuracy of bearings obtained by directional apparatus installed at coast stations suitably situated is of a high order over short ranges of 50 to 100 miles, when errors should never exceed two degrees except in those cases where the operator is aware that the bearing is unreliable and can so inform the ship. The three Post Office direction-finding stations have been giving a total average of about 350 bearings a month to ships since January, 1925, and none of these has been shown to be inaccurate.

Equipment on Ships

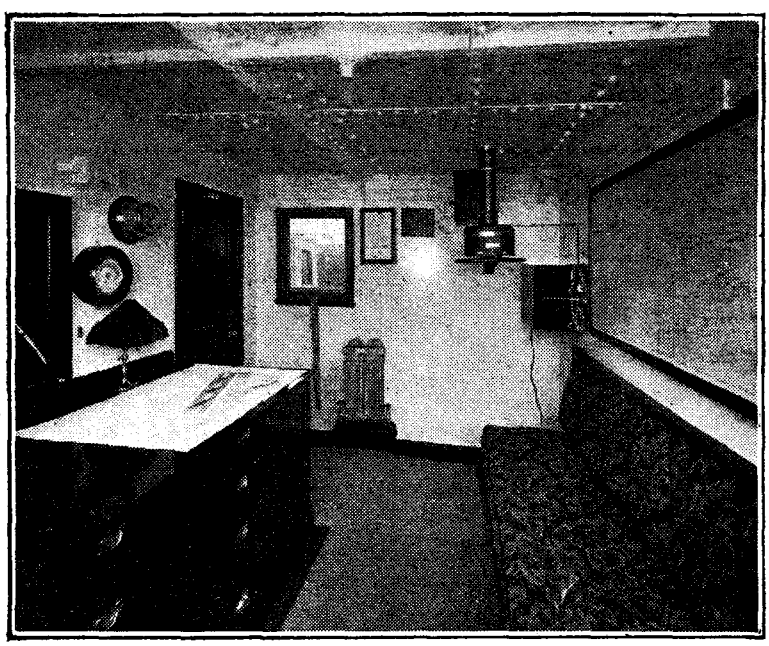
In ships there are greater difficulties to be overcome, but the very fact that some 300 British ships are now fitted with directional receiving apparatus shows that it is really of great value, and this means that a high standard of accuracy is maintained under ordinary sea-going conditions. One of the difficulties that ships labour under, compared with coast stations, is that errors may be introduced by changing the position of guys, derricks, etc. There are also fewer opportunities of taking check bearings on known fixed wireless stations, and, in addition, errors may arise due to the necessity of having to refer the observations taken to the position of the ship's head as shown by the compass at the moment when the observation was taken.

A New System

Recently Mr. Watson Watt and Mr. Herd, of the Radio Research Board, have designed a form of directional receiver which, when further developed, may prove of great value to ships. It is, indeed, the nearest approach to a wireless compass yet produced, as it is a direct-reading instrument which can be used by the navigator on the bridge. This is still, however, in the experimental stage, and it is generally agreed that the directional instruments now on the market are best operated by a skilled wireless telegraphist.

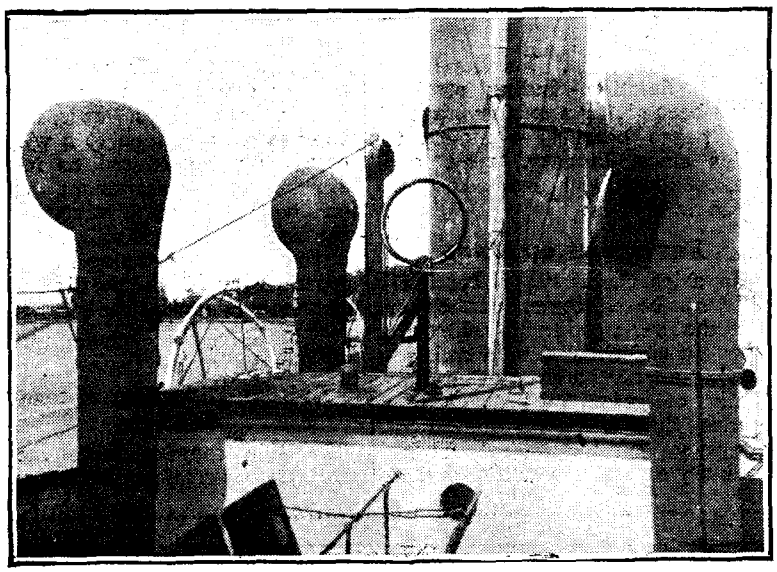
British Direction Finding Stations

In this country there are at present four stations which are installed with apparatus for determining the lines of bearings of ships, the Lizard and Niton on the South coast, Cullercoats and Flamborough on the East coast. The Lizard is a naval station, but is available for giving bearings to merchant ships; the other three are Post Office stations, which are specially established for the use of merchant ships. The Lizard station works on the 800 metre wave, the others on the 600 metre wave, and a new 600 metre station is in course of erection at Mablethorpe to replace the Flamborough station. A charge of five shillings is made for each bearing given to a ship. These stations are very carefully



In this photograph of a ship's chart room the D.F. apparatus may be seen in the further right-hand corner.

DIRECTION FINDING AT SEA—*(Concluded)*



The frame aerial used on a ship is quite small. Above may be seen the Siemen's type, which takes the form of a ring.

calibrated every year, and bearings are only given to ships in sectors wherein the station is known to give accurate results.

Which Method is Better ?

As opposed to the purely technical advantages of installing directional apparatus at coast stations there are other aspects which show the advantages of having the apparatus in ships. In the first place, if a mistake is made it is made by the ship, and it is obviously much better for the responsibility to be with the ship than with the station. Then, again, every wireless coast station and every ship fitted with wireless becomes a potential beacon station, that is to say bearings can be taken on any station or ship which is transmitting wireless signals.

This is, of course, an advantage of the greatest importance, and there have been many cases already where ships in distress have been located and succoured by ships fitted with directional receivers. But over 90 per cent. of the British ships which are fitted with wireless are not fitted with directional apparatus, some for financial reasons and others because technical conditions are not suitable, and for these it is essential that direction-giving stations should be maintained at suitable places on the coast.

Abroad, especially in the United States, a number of wireless beacon stations have been specially erected on shore to facilitate the navigation of narrow waters, such as straits and estuaries. These stations send distinguishing signals for definite periods at stated intervals throughout the twenty-four

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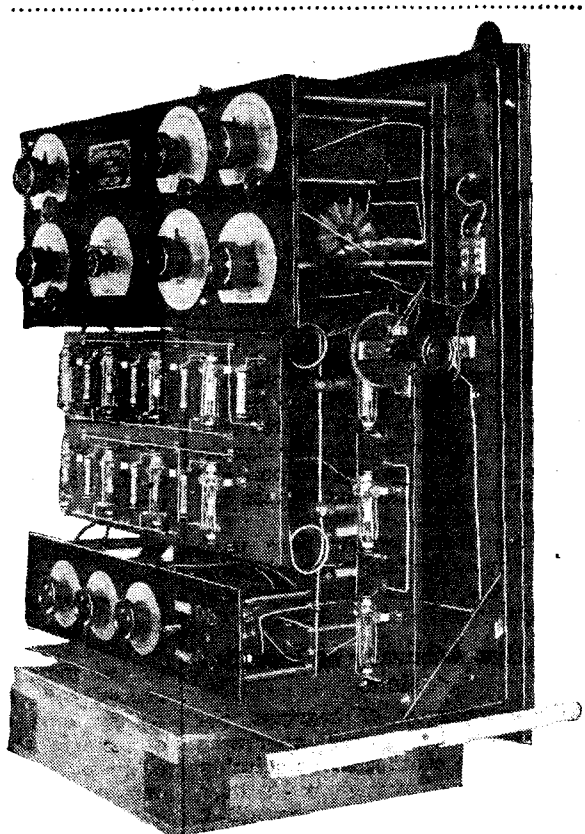
One of the Siemen's D.F. receivers with the cover removed. The depth from back to front is only about eleven inches.

❖❖❖❖❖❖❖

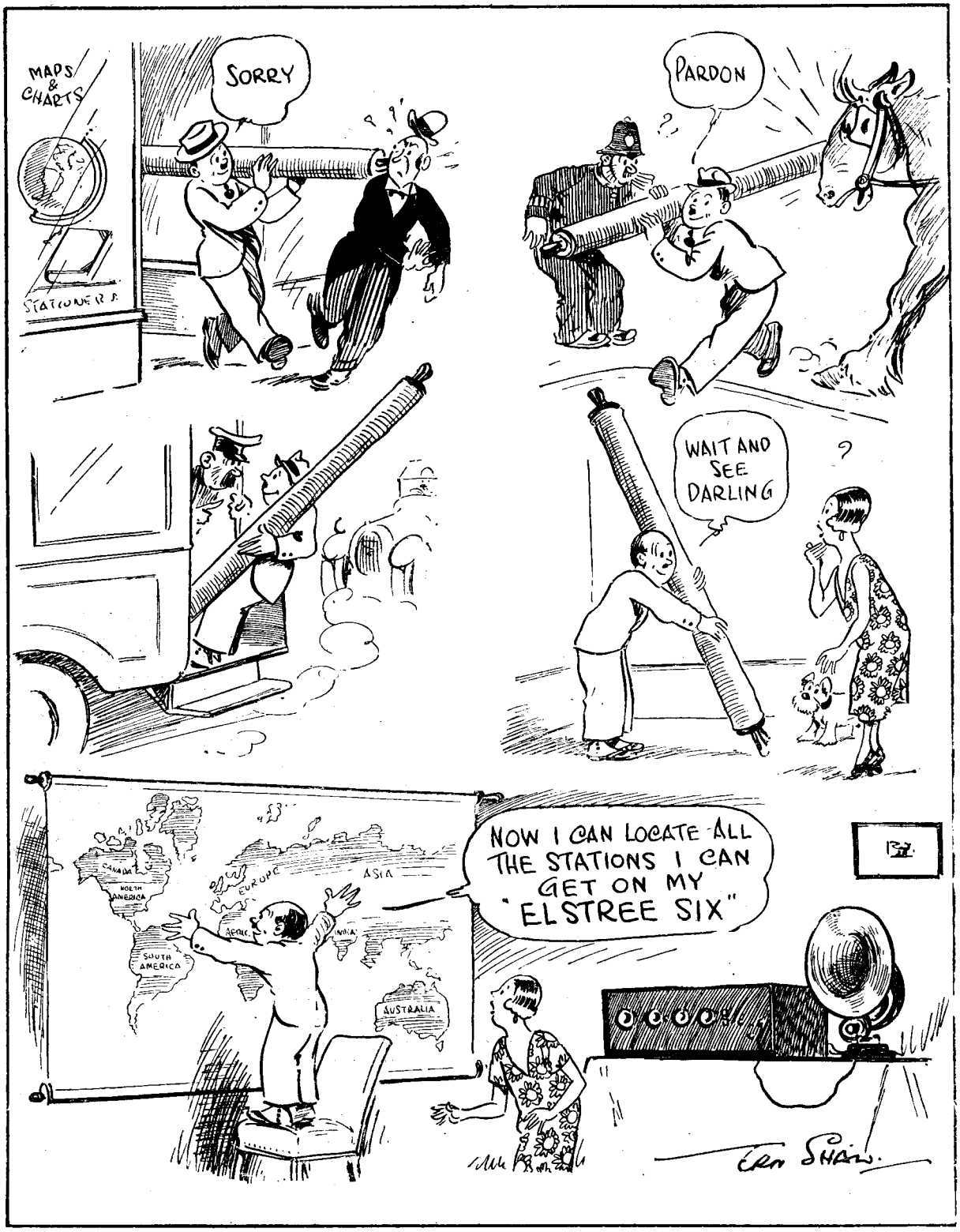
hours. The wavelengths employed are usually about 1,000 metres and the radius of action of the stations is confined to about 50 miles to a ship fitted with a simple directional receiver. These beacon stations have proved very useful to ships fitted with directional apparatus, that is to say, mainly the large cargo ships and passenger lines.

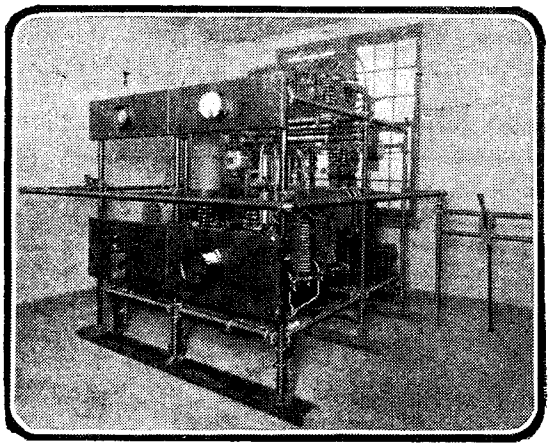
Directional Beacons

The beacons so far considered transmit waves in all directions and are therefore only of use to ships fitted with directional receivers, but there are other forms of beacon which when developed may prove of much greater value as they could be used by ships which are only fitted with ordinary wireless receiving sets. These beacons consist of directional transmitters. In one form the transmissions take place from two aerials alternately, and if the ship hears signals of equal strength from each aerial it knows that it is on a line of bearing which bisects the angle between the aerials. This system, which is used in the United States, but to a very limited extent, has a range of about 100 miles and is only of use for a ship which wishes to proceed on a direct course to or from the beacon station.



ROUND THE WORLD ON THE "ELSTREE SIX"





WHAT DISTORTS DISTANT RECEPTION?

By Capt. H. J. ROUND, M.C., M.I.E.E.

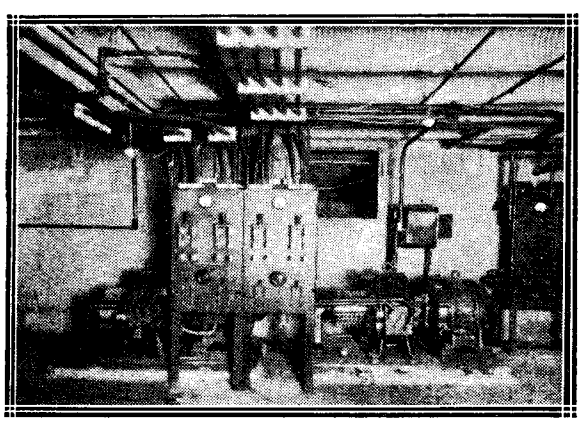
Have you ever noticed the curious distortion which occurs during the reception of certain distant stations? Those who are short-wave enthusiasts will no doubt have wondered why KDKA and other American stations suffer in this respect. This article, written by the well-known Chief of the Research Department of Marconi's Wireless Telegraphy Co., will enable the reader to gain a clearer understanding of this puzzling phenomenon.

ONE of the recent discoveries in wireless telegraphy and telephony — particularly in wireless telephony — has been the necessity for maintaining a great constancy of wavelength, and this for reasons other than the perfectly obvious ones of prevention of interference with other stations. This latter, of course, is a matter of great importance, but in the main the comparative constancy, *i.e.*, one's wave must not move outside certain limits, is quite sufficient, but such a constancy as this implies is by no means the type of constancy that is required for the working of telephony in particular.

A Curious Phenomenon

Some years back it was noticed in certain long distance receiving experiments when the stations being received were power stations, such as Carnarvon, Radio-Paris, New Brunswick, Bordeaux, that when the receiver was placed in some position in which the transmitter was at a distance of say, one-third of the way round the globe in one direction and two-thirds in the other direction, over a long period of the daytime, a very curious phenomenon resulted. These stations, of course, transmitted ordinary Morse telegraphy and very frequently this came through perfectly clean, readable Morse, and there was essentially no difference in the reception at that distance than at a distance of a few miles from the transmitter, except the strength of the signals, but at other times of the day a curious phenomenon occurred of unreadable Morse.

Some experiments at once indicated that what was happening was that two sets of signals were being received at the same time, one coming the short way from the transmitter and the other coming the long way.



The curious phenomenon which the author deals with is particularly noticeable in the case of reception from American short-wave stations.

A Suggested Explanation

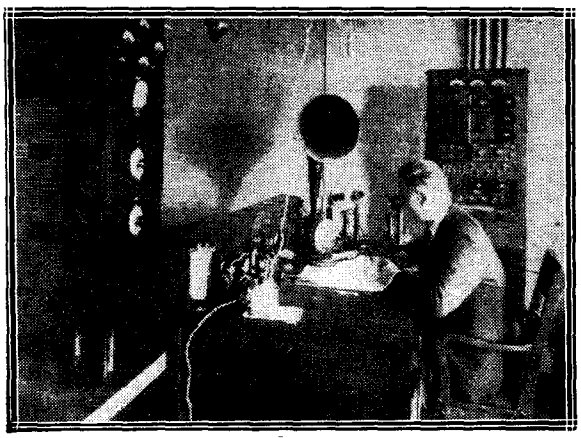
Now superficially it does not seem that this should produce any extraordinary result; the difference in time that the wave takes to travel one way or the other is so very short that no effect should have been noticed. What was this peculiar unreadability due to then?

At first it was suggested that the atmosphere or some other factor was continuously varying the speed at which the waves were travelling so that sometimes they would be opposing one another and sometimes adding, but further experiments indicated a much simpler solution of the phenomenon. The giant stations sending out the signals were slightly varying their wavelengths.

Wavelength Regulation

A station such as Radio-Paris, which is fed from an alternator and in which the signalling is performed by throwing a load off and on to alternator, is very difficult to maintain absolute constancy in its frequency.

Let us take it that the transmitter sends a short dash. At the beginning of the dash the speed of the alternator will be at its highest; at the end of the dash the speed will be dropped. If the dash is long enough the speed will no doubt get quite steady, but in the initial condition just after the key has been depressed the speed is varying,



One of the causes of signal strength variation is the fact that the wavelength does not remain absolutely constant.

WHAT DISTORTS DISTANT RECEPTION?—*(Continued)*

which means that the frequency of wavelength being transmitted is varying. Now if this is taken in conjunction with the fact that the wave has to go two-thirds of the way round the world one way and only one-third the other way, it is fairly easy to see that the receiver is really receiving two different wavelengths at the same time. Two different wavelengths mean beats and thus we get a chopped up beating signal readable only if we can reject one or the other set of signals.

If we could find other cases where signals are arriving at the receiver by two different lengths of paths or possibly several different lengths of paths and at the same time the frequency of the transmitter is varying, we should probably get a similar effect.

Night Reception

The transmission of broadcasting is naturally more important in the nighttime than in the daytime, and at night we are now practically certain that at least at medium distances, such as 100 to 300 miles, part of the transmission arrives at the receiver directly, and part of it arrives due to some peculiar reflection at the upper layers of the atmosphere, so that at the receiver we have two sets of signals coming in at the same moment.

Now, if these signals always arrived by the same length of path and the transmitter wave was absolutely constant there is no reason to suppose that they would not always add more or less the same way, but suppose we could vary rapidly the length of one of the paths, the result would be a varying strength of signal, due to the fact that the two waves would sometimes add and sometimes subtract; or suppose the paths remained the same length and we varied the wavelength, then we should get the effect of receiving two slightly differing waves at the same time, and instead of a constant signal we should get one either rapidly or slowly varying.

Another Effect

Of course, it is quite easy to see that even if the wavelength does remain constant, if we shift the position of the receiver for even quite a short distance, if one of the sets of received signals is coming at an angle downwards and the other set is coming horizontally, then the receiver will in certain cases get signals added, and in other cases there will be a subtraction, and if now we imagine we have two receivers at same distances from one another and the wavelength is varied in some way at the transmitter, the result will be variations on the two receivers which are by no means synchronous.

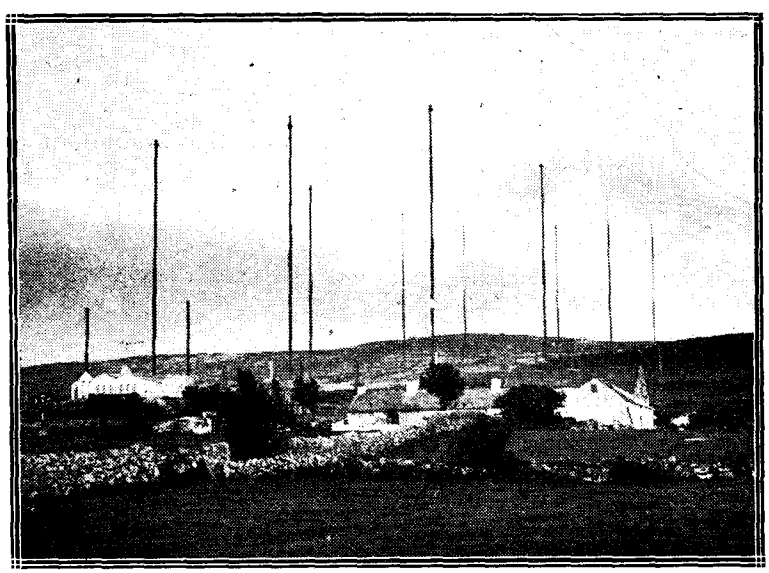
Telephony

Let us consider the constant transmitter as being a telephone one, and that it is being modulated with a simple musical note. The result of this modulation, as is well known, produces three wavelengths, one of which is known as the carrier wave, the other two being the side waves.

Now in this case again, except in so far as the reception of the side bands of the carrier wave may not be of the same ratio as they were transmitted, there will be no serious effect, because the result in one's receiver will be the same musical note as was transmitted.

Two Musical Notes

If the transmitter is modulated with two musical notes at the same time, again these musical notes will be received in their original purity via this double path, but they may not be in exactly the same ratio of strength as they were transmitted. The chances, however, are owing to the fact that there are two side waves for every note, that this strength difference will not be excessively marked ; but now



Signals from the high-power Morse station at Carnarvon, in certain parts of the world and during certain hours, have been found to be unreadable.

WHAT DISTORTS DISTANT RECEPTION?—*(Concluded)*

suppose that in the act of modulating our transmitter, some defect of the transmitter causes the carrier wave to wobble in wavelength at the frequency of the modulation the result at the receiver will be very complicated. Of course, actually there will be modulation of strength as well as this modulation of wavelength, but for the sake of simplification of the problem, let us consider that we can eliminate the alteration of amplitude and let the alteration only wobble the wavelength and let that wobble of wavelength be very small indeed.

Tuning

Now at the receiving end you are tuned with a receiver which has a resonance curve. If that resonance curve is fairly flat this slight change of wavelength will not be noticed as a change of amplitude, so that you will not hear it, but if the receiver is extremely sharply tuned you would get a musical note. If at the same time we permit the transmitter to have an amplitude modulation as well, we should be liable to get these two notes adding or subtracting, depending upon the position on the resonance curve we were actually situated at.

Amplitude Changes

This effect can actually be noticed near an old-fashioned transmitter in which no care has been taken to prevent the carrier wave varying with the modulation, but let us suppose that our receiver is a fairly flat tuned one, and going back to the case where our modulation is now producing wave wobble and not amplitude wobble, it is easy to see that, due to the two paths of reception, the wave wobble will be converted at the receiver into an amplitude wobble, and this effect could take place apparently with comparatively small change of wavelength—so small that it is almost undetectable by any other method.

If on top of this reception by wave wobble we have ordinary reception due to amplitude modulation, and we combine the two effects and imagine it not only happening with the carrier wave but the side waves doing it as well, one can easily understand how quite unintelligent speech and music can arrive at the receiver.

At the French broadcasting station, Radio-Paris, the system employed renders it a very difficult matter to keep the frequency constant.

Short Waves

These effects, I believe, were first noticed on short waves, such as 100 metres in some experiments of my own over the North Sea in 1921. They were afterwards observed on broadcasting in cases where the transmitter was not provided with a master oscillator, and they have been observed by a very large number of people on the trans-atlantic wavelengths such as the broadcasting from KDKA. In the case of these shorter waves it is probably not entirely sufficient to keep the wavelength constant by means of a master oscillator owing to the fact that some reaction from the main transmitter to the master oscillator is liable to occur and the recent introduction of tuning fork and crystal control is giving a much better solution of this difficulty.

Slow Variations

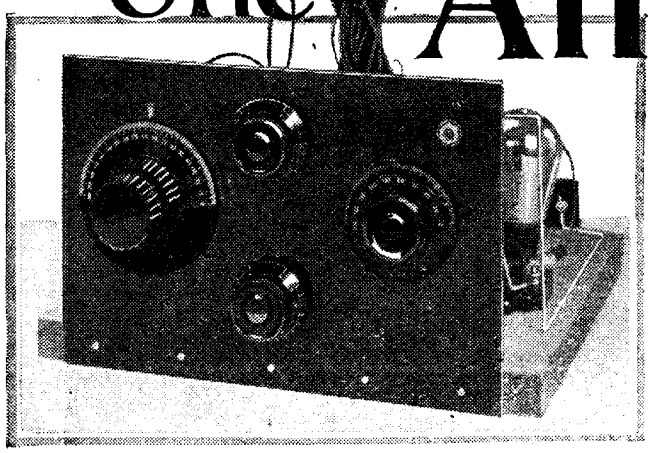
It is not quite certain yet, however, whether the whole of the distortion of the long distance telephony is due to this wave wobble. As I explained at first it is possible for the different frequencies to come in at the wrong amplitude, but this is not liable to do more than make the quality slightly peculiar. Slow variations of wavelength due to other causes than modulation are liable to produce fading results other than those which would be produced by the slight change of lengths of the paths of the different rays. In fact, for telegraphic purposes, it is found a slight advantage to permit a wave wobble, so that if at any moment any one wavelength happens to be just balanced out at the receiver another wavelength is arriving which is of good strength.

Morse Reception

Those who are in the habit of receiving Morse on short waves over long distances will have noticed that there seems to be considerably greater steadiness of the wobbly waves than of the pure continuous waves. This seems, however, to be rather a crude solution of the fading problem. It would probably be nicer to send two waves each pure and going near together and arrange the receiver to receive both. They can be put sufficiently near to be considered as one wavelength.

Such a solution for telegraphy is also possible for telephony.

The "America Two"



By GEORGE T. KELSEY

Full constructional details of a two-valve set for short waves which is simple to make and which requires no great skill in operating. In the early tests, which were conducted under average conditions, nine American stations were received in twelve minutes on this receiver!

THE number of stations which are now sending telephony on the waveband between 25 and 80 metres render a description of a short-wave set of interest not only to the keen experimenter, but to those whose activities in the past have been confined to stations on the broadcast band. From opinions expressed by colleagues interested in radio the chief objections to listening on short wavelengths appear to be the Morse code and the late nights, or perhaps it would be more correct to say the early mornings, necessary.

These then, and others who think the same will doubtless be interested to hear that there are quite a number of telephony stations to be heard on almost any Sunday morning, and again on Sunday evening, between six and eight p.m., mostly amateurs, of course, but, nevertheless, very interesting.

Stations Heard

To give some idea of the capabilities of a short-wave set under fairly good conditions an extract from a log of stations received with the "America Two" is given. Not less than 17 American stations, two of which were telephony, were received in quite a short time late one Saturday evening.

The short-wave station of WGY, which has an independent call sign of U—2XAF, was heard on this particular evening sufficiently clear to pick out noises in the hall, the transmission being relayed from a public hall in Buffalo.

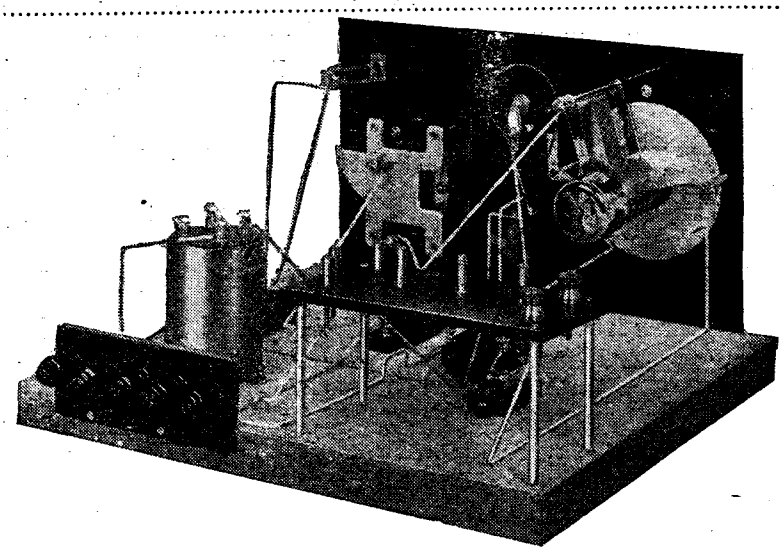
Easy to Construct

Perhaps many would-be constructors imagine that to receive on short-waves calls for the use of complicated apparatus. Such is not of course the case, and providing care is used in the construction, no difficulties whatever are likely to be experienced.

Using the Cross-Coil

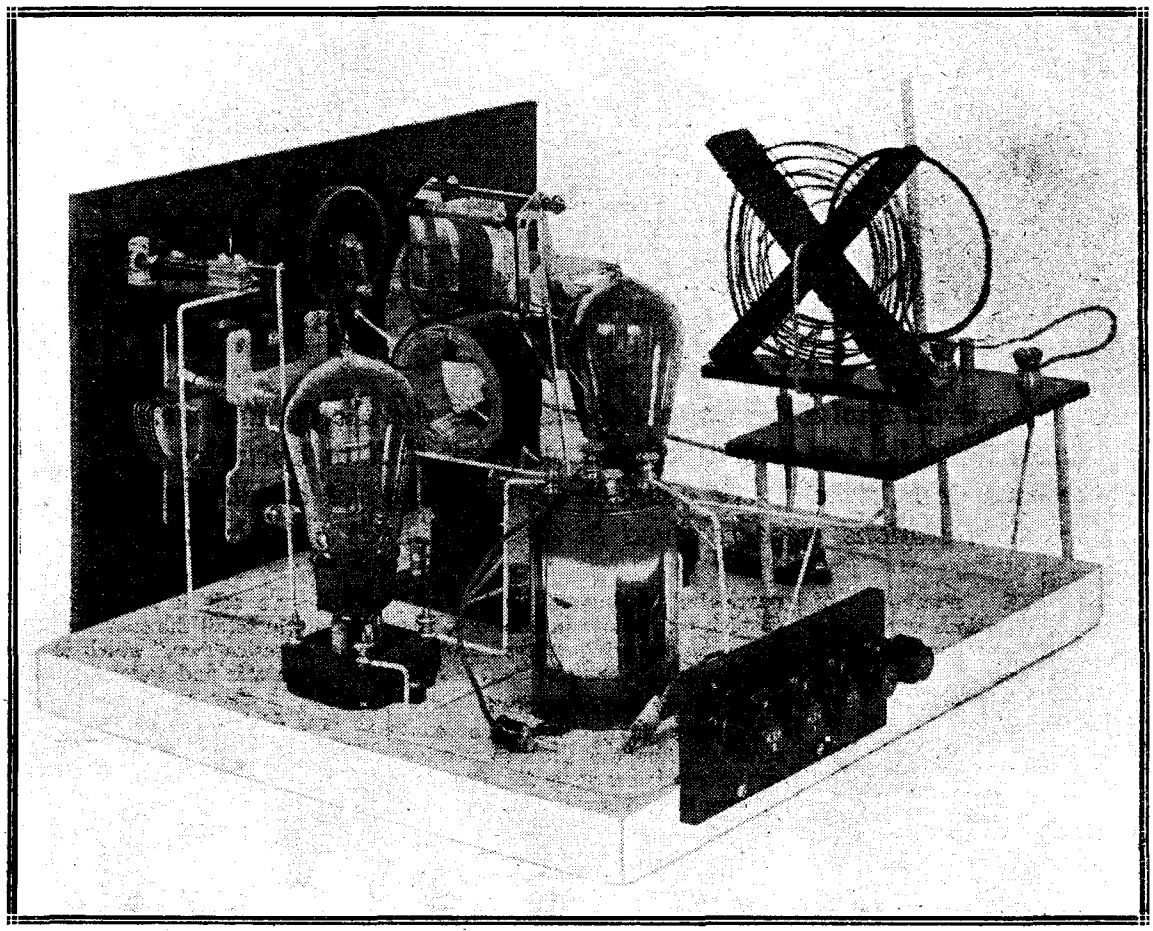
Without going any further into the many advantages of having a short-wave set, it is proposed to describe in detail the construction of the "America Two," which is illustrated on this and following pages.

First a few words about the general design of the set. As is probably known, short-wave coils do not consist of many turns of wire, and in view of the ease with which coils can be wound on an "X" former the employment of the cross-coil in the present receiver is a useful feature. Incidentally, coils wound in this fashion are very efficient, as may be gathered from the results which have been obtained on this set.



The short-wave coils are mounted in the three sockets at the end of the special panel.

THE "AMERICA TWO"—(*Continued*)



The "America Two" finished, with coils and valves in position. Notice the plug-in coil which functions as an H.F. choke.

Another point, and one which has been observed in order to keep the cost down, is that in the original set no cabinet has been used.

The circuit is quite straightforward, a plug-in coil being used for the radio-frequency choke.

Components

The components required, together with the makes used in the original set, have been listed all together elsewhere in the article for the convenience of readers when ordering. There is no reason why components different from those specified should not be used, providing they are of reliable manufacture, but in any case, the condenser tuning the grid coil requires to be of the slow-motion type. The very careful tuning

Extract from Log on Saturday and Sunday, November 6th and 7th

Calls heard :—
U : 3TR, U : 3AUV, U : 3BA, U : 8AHK.
U : 2TO, U : 8CCQ, U : 3CJN, U : 2TP.
U : 1CKP, U : 2CNS, U : 1ASU, U : 1CJH.
U : 8BUY, U : 1XV, U : 8MC.
P : 3FZ.

Telephony heard from :—
Berlin (159°).
U : 2XAF (WGY) (45°).
KDKA (163°).

British telephony heard :—
G.5UW (Wolverhampton).
G.6TX (Epping, 3½ watts).
G.5DT (Crayford).
G.5TZ (Isle of Wight).

Cards will be exchanged with any of the above who care to QSL to the author.

THE "AMERICA TWO"—(*Continued*)

necessary to tune in a station on short waves calls for the use of a condenser upon which very minute adjustments are possible.

Drilling the Main Panel

When all components have been gathered together, drill your main panel to conform with the dimensioned drawing shown in Fig. 3. It should be remembered, of course, that if you are scribing your panel on the back (the correct way) that the layout shown should be reversed.

With the panel drilled, before mounting any components thereon, fix it to the baseboard. The thickness of this latter is such that ample support is obtained without the use of panel brackets. The panel components may now be mounted and also those which are secured on the baseboard. It would perhaps be as well to mention at this juncture that the arrangement adopted in the original set has been carefully worked out and should be closely followed.

The Sub-Panel

No doubt the fixing of the sub-panel on which the coils are carried, does not look to be an easy job; even so, it is certainly not difficult. Drill first the holes required in this sub-panel, the positions of which can be obtained from the wiring diagram, after which proceed with the mounting as follows: If Glazite is to be employed as in the original set then in each packet will be found a wooden packing rod, which, cut into suitable lengths, suits admirably for mounting purposes.

Failing this, then some round wooden rod about 3-16 in. in diameter should be obtained. The actual mounting consists of holes drilled into the sub-panel into which are wedged four legs of equal length, say, about 3½ in.

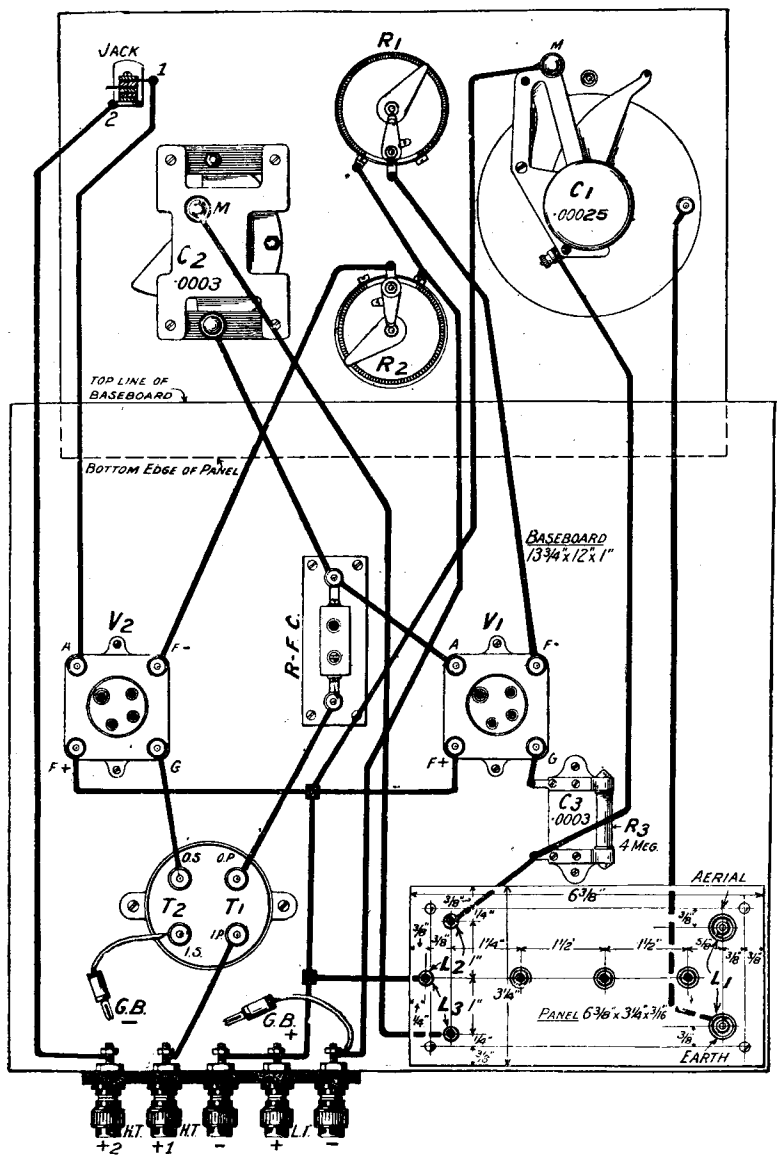


Fig. 1.—When it is desired to make the special sub-panel, all dimensions for drilling can be obtained from this figure. (Blueprint No 186b.)

WIRING INSTRUCTIONS

Join fixed plates of C 1 to one side of C 3, R 3, and to top socket on sub panel.

Join remaining side of C 3, R 3 to G of V 1.

Join F — of V 1 to one side of R 1.

Join F — of V 2 to one side of R 2.

Join remaining sides of R 1, and R 2 together, and to L.T. — terminal.

Join moving plates of C 1 to F + of V 1, and V 2, to centre socket on sub-panel, and to L.T + terminal.

Join L.T. + terminal to H.T. — terminal.

Join bottom socket on sub-panel to moving vanes of C 2.

Join fixed plates of C 2 to one side of R.F. choke and to A of V 1.

Join remaining side of R.F. choke to O.P on transformer T1, T2.

Join I P on transformer T1, T2 to H.T. + 1 terminal.

Join O.S. on transformer T 1, T2, to G of V 2.

Join A of V 2 to contact No. 1 on jack.

Join contact No. 2 on jack to H.T. + 2 terminal.

Join pieces of flex equipped with wander plugs to I. S. on transformer T 1, T 2 and to L.T.— terminal.

Join C 1 condenser screen to Earth terminal on sub-panel.

THE "AMERICA TWO"— *(continued).*

Corresponding holes are drilled in the baseboard in the position indicated, into which the "legs" of the sub-panel are wedged, but prior to finally mounting, the necessary sockets and terminals should be secured in position. The rods at each end, when it is desired to finally mount the panel, should be coated with a strong glue so that once in position the platform will remain quite secure.

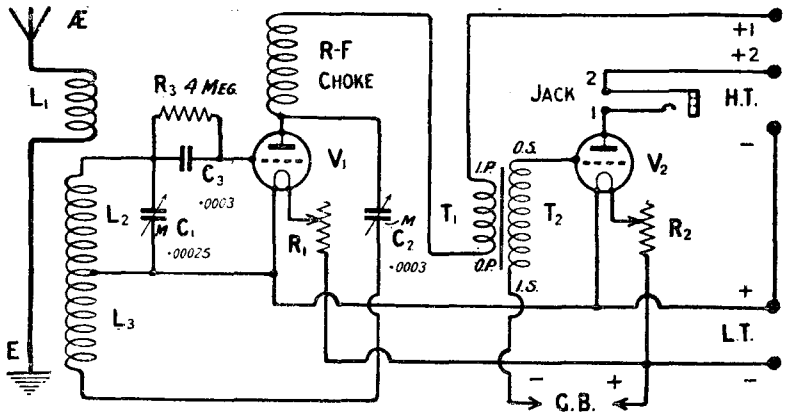


Fig. 2.—The special home-made "cross-coil" used in this receiver is represented at L_2, L_3.

COMPONENTS REQUIRED

One Ebonite Panel, 8 in. by 12 in. by $\frac{3}{16}$ in. (American Hard Rubber Co., Ltd.)

One Oak Baseboard, 13¾ in. by 12 in. by 1 in.

One Variable Condenser, S. L. F. type ·00025. (Ormond Engineering Co., Ltd.).

One Square-Law, low-loss Condenser ·0003. (Ormond Engineering Co., Ltd.).

Two "Etherplus" Anti-Vibratory Valve-holders. (M. & A. Wolff.)

One Grid-Condenser and Leak, ·0003 and four megs. (Dubilier Condenser Co., Ltd.).

One "Eureka Concert-Grand," L. F. transformer, first stage. (Portable Utilities Co., Ltd.).

Two Filament Rheostats, 30 ohms each. (L. McMichael, Ltd.).

One Baseboard Coil Mount. (Beard & Fitch).

One Single Circuit Open Jack, and Plug. (Ashley Wireless Telephone Co.).

Five Belling Lee Terminals, marked L.T.+, L.T.−, H.T.−, H.T.+1 and H.T.+2. (Belling & Lee, Ltd.).

"Cross-Coil" formers. (Burne-Jones & Co., Ltd.).

One "Decko" Dial Indicator. (A. F. Bulgin & Co.)

Some valve, sockets and pins, piece of Ebonite 6¾ in. by 3¼ in., and smaller piece for terminal strip 5 in. by 2 in.

Two terminals, type W.O.

Glazite. (London Electric Wire Co., and Smiths Ltd.)

Wiring-Up

The wiring is perfectly straight forward, and as an additional guide the point-to-point connections are given in writing. It is essential that all joints and connections should be thoroughly sound, since the set is to be used for receiving really high-frequencies, and a bad joint may offer a very high resistance.

Terminals are not provided for the grid-bias battery, and in their place flex connections terminating in wander plugs are used, as is indicated in the wiring diagram.

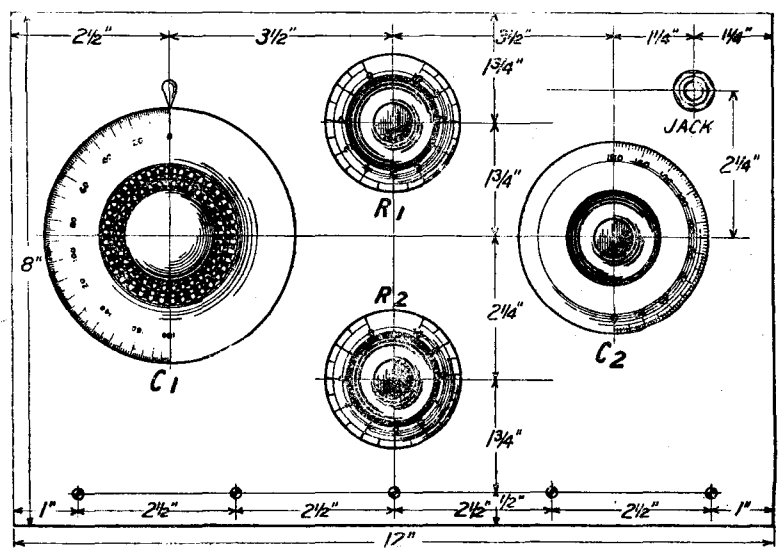


Fig. 3.—The drilling dimensions of the front of panel of the "America Two." This is free Blueprint No. 183a.

Making the Cross-Coils

There now remain the coils to be made to complete the receiver.

To start with, wind on twelve turns of No. 22 enamelled wire in the following manner: Secure one end of the wire to the hole drilled near the centre of the former for this purpose, and missing the first slot from the centre in each arm, wind on three turns spaced about ⅛ to ¼ in. apart. Proceed by winding on three further spaced turns in the next slot.

The Filament Tapping

With the first six turns on the former a tapping should be made, after which continue by winding on a further six turns, putting as before three spaced turns in each slot.

The method of mounting the coil can best be followed from the detailed drawing, three valve pins and a piece of ebonite being used. It should be noted that the pin connections must be made in such

THE "AMERICA TWO"—(Contd.)

a manner that when the coil is plugged into its sockets, the grid winding L_2 consists of the outer winding.

The size of the aerial coupling coil to give the best results is really a matter for experiment, but a start can be made by winding, say, six turns of No. 22 enamelled wire on an approximate diameter of 3 in. This is best done round a jug or similar "former," the winding being held together when removed from the "former" by thread.

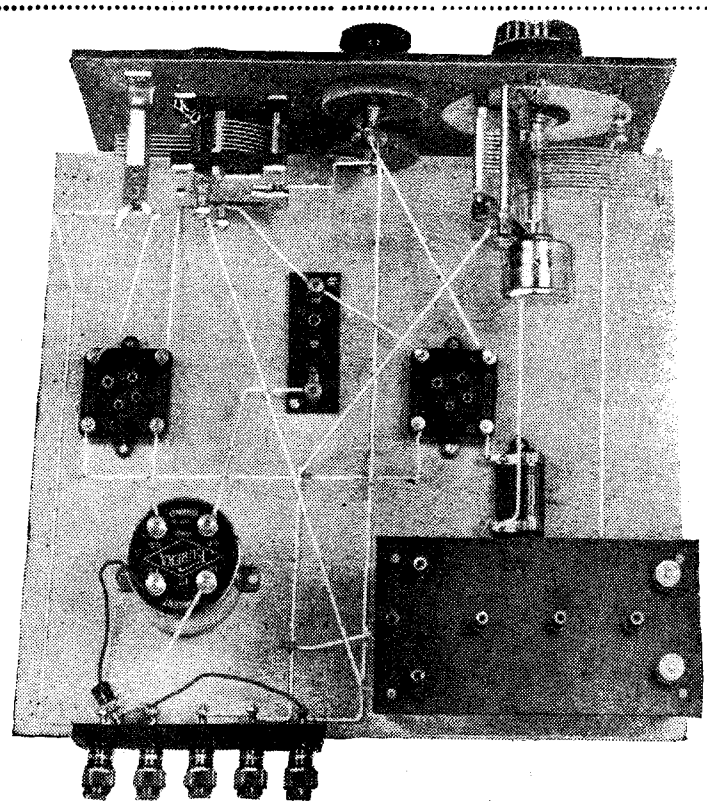
This coupling coil should be tied on to a piece of stick cut at one end so that it will just fit into any one of the three valve sockets on the sub-panel.

Early Tests

No aerial or earth will be required for the early tests, and accordingly, connect up the batteries and insert necessary valves and the cross-coil. It is advisable to connect up the L.T. battery first to test if the filament circuit is correct.

Regarding valves to use, any general purpose dull-emitter may be used for V_1, while a valve of the small power variety may be used for V_2. For these tests an H.T. voltage of 36 volts should be used on V_1, and, say, 80 volts on V_2.

With the 'phones connected, insert a No. 60 coil in the radio-frequency choke socket (the one used in the original was a Lissen, although any reliable make will do). Turn on the two valves and with the reaction condenser (C_2) at its maximum capacity and the grid tuning condenser (C_1) at its minimum setting touch the grid socket of the cross-coil. If a sharp "click" is heard upon touching *and* withdrawing the finger, then the set is oscillating and the grid tuning condenser should be moved from its minimum to its maximum position, applying the finger test periodically during the process. A click upon touching but *no* click upon withdrawing the finger from the socket mentioned is an indication that the set has stopped oscillating, and accordingly the voltage on the anode of the detector valve should be increased. Generally speaking, however, 30 to 36 volts will be sufficient for V_1.



The disposition of components on the baseboard has been carefully worked out, and readers are recommended to adhere to the original.

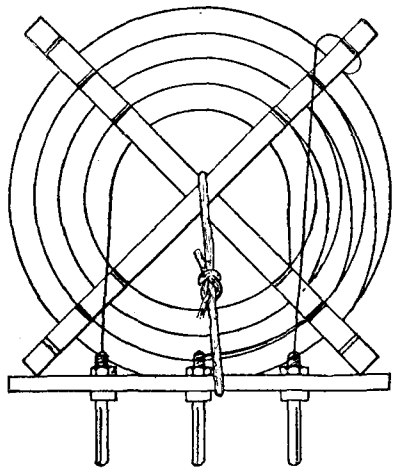


Fig. 4.—String is used to mount the "x" coil on to the home-made plug-in base.

Using the Aerial

The receiver is now quite ready for use, and in fact it is quite possible that some C.W. signals have already been received during the early tests without any aerial or earth attached!

Connect the aerial and earth leads to the appropriate terminals on the sub-panel and also connect to these two terminals the two ends of the coupling coil. Now place the coupling coil as near to the grid coil as possible, but at some point (depending upon the size of the aerial) the set will stop oscillating and so, of course, the aerial coil must be kept just sufficiently far away to allow the receiver to oscillate quite normally.

Searching

With the set just oscillating, very *slowly* turn C_1 until a carrier wave, or if you can read Morse, until a C.W. station is heard. In the case of the carrier wave of course this should be resolved by decreasing the capacity of C_2 until the set just stops oscillating.

When the band covered by the six-turn coil has been "explored," a further coil can be made by winding, say, 24 turns on another former, taking the tapping at the centre as before.

The Reaction-Condenser

It may be found when receiving telephony stations on short-waves that "hand-capacity" effects on the reaction condenser are rather noticeable, in which case an extension handle should be fitted.

In conclusion, readers' results and experiences with the "America Two" would be interesting.

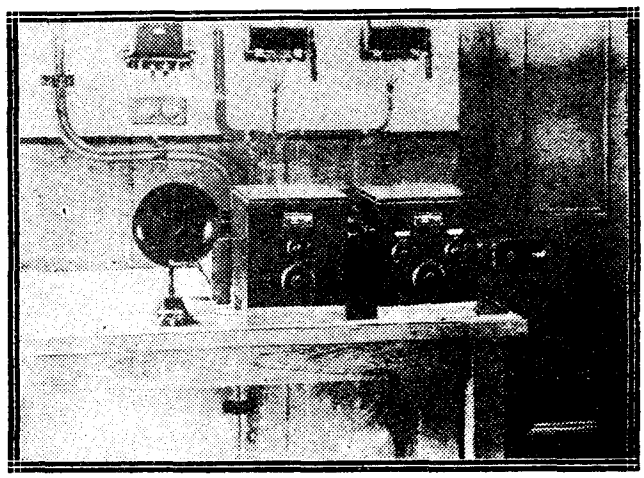
RANDOM NOTES

By A. V. D. HORT, B.A.

THE proposal for a radio university, which was mentioned in these notes last month, is to be discussed by a special committee. Not much can be done until the problem of providing alternative programmes has been satisfactorily settled, so that listeners can have free choice between entertainment and instruction.

It would appear that the education of those who are of "school" age is not so desirable as adult education. Though the subject is certainly controversial, it appears doubtful whether any extensive programme of lectures to fit into the curriculum of existing schools can do much real good. Merely talking to a class, whose members have no opportunity of asking questions as and when ideas and difficulties occur to them would be a poor and inadequate form of "teaching." Occasional lectures on special subjects are perhaps worth while, especially since prominent men, who are specialists in their own particular line, are by means of broadcasting able to talk to thousands of school children, whereas they could not find the opportunity to visit personally more than a small number of schools.

SOME comprehensive scheme of adult education appears much more feasible, and there can be no question that the experiment is at least worth trying. There will always be those who will say "We don't want more talks," but the development of the alternative programme system will enable them to satisfy their own needs. To use broadcasting, which can reach so many people at such small cost to themselves, merely as a means of providing entertainment, would be wasting the opportunity which exists of establishing a service of national utility.



According to reports the commencement of the new "Beam" Service between Bodmin and Canada suffered an interuption of service, due, it was stated, to "fading." The above photograph shows the apparatus used in checking up the constancy of the transmission.

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IN the plea which was put forward a few weeks ago for Government control of television apparatus and its practical use it was claimed that the development of this invention might easily lead to chaos and disaster. It is to be presumed that the risk attendant on the widespread use of television would be that of being "overlooked" during a private "view" of a friend. It certainly would be disconcerting to think that some complete stranger might be able to see you and your surroundings, happening to stumble on the wavelength which you were using.

It appears that the impression was created in some quarters that anyone with television receiving

RANDOM NOTES — *(Concluded)*

apparatus would be able to look into the houses of his friends (and enemies) as freely as though he were at their windows. If such was the true state of affairs, and no television transmitter were needed at the other end, the best place for the whole invention would be the bottom of the sea!

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THE "Phonofilm," which can now be heard and seen by the public in London, is undoubtedly effective. The system used is no novelty; a demonstration was given in this country three years ago. A sensitive photoelectric cell converts the "shaded" sound record on the edge of the ordinary kinematograph film into electrical energy, an amplifier subsequently supplying sufficient value for the loud-speaker.

The synchronisation of sound and action is to all intents and purposes perfect; it flavours of the uncanny at the first hearing. A good deal remains to be done, however, in the matter of reproduction. The films "heard" recently were distinctly "wooden" in tone, and gave rather the effect of a very well synchronised film and gramophone record. Musical instruments tended to lose their distinctive quality, though speech was not affected to the same extent.

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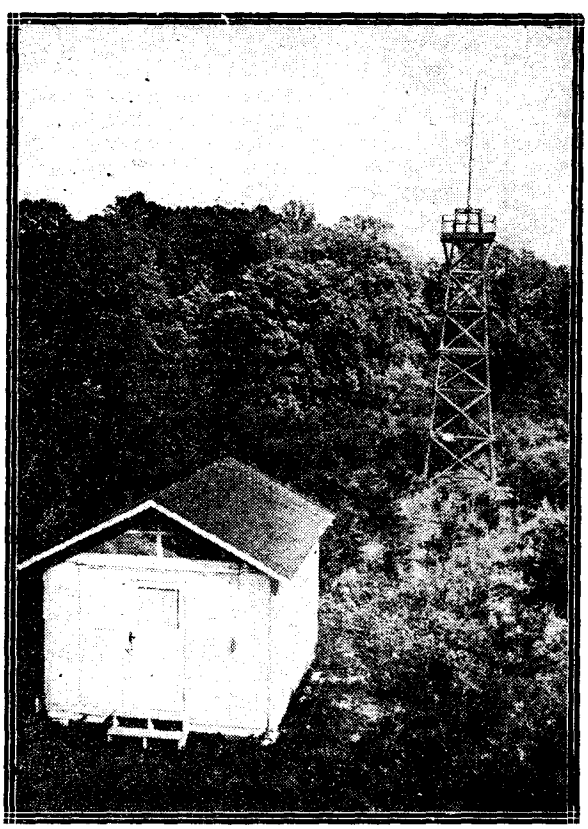
ACCORDING to a statement made by Mr. J. Walsh, Free State Minister for Posts and Telegraphs, a complete broadcasting service is to be developed in the Irish Free State. The ideal which the B.B.C. set before themselves of giving the possibility of crystal reception to the whole country is to be pursued in the Free State as well. It is expected that the complete system of stations will be working in about fifteen months.

Under the new wavelength scheme, the Cork station has been allotted the wavelength of 400 metres, sharing this wave with nine other stations in different parts of Europe.



The radio hut and one of the aerial masts of the Bureau of Standards' laboratory at Kensington, Maryland. The laboratory is intended for the study of "fading" and static disturbances.

IT is curious that at least one country in Europe, namely Greece, has as yet no broadcasting service. As to the reason for this state of affairs one can only speculate, but perhaps the Greeks have the glories of the past too much in their hearts to face the prospect of erecting an aerial on the Acropolis at Athens!

The number of people who own sets in Greece cannot be large, since the regulations are severe. Amateurs are allowed to work transmitting and receiving apparatus below 300 metres, but a range of only about 25 miles is permissible. Receiving permits are also issued to Hellenic citizens only, but frame aerials must be used; the wavelength range must not go above 2,000 metres and sets which can oscillate are forbidden. What a paradise for the owner of a "Solodyne" on holiday!

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ALTHOUGH no definite dates have yet been fixed, it seems likely that some attempt will be made to exchange programmes with America this winter. Mr. David Sarnoff, of the Radio Corporation of America, paid a visit to this country earlier in the year, and negotiations for the experiment were commenced at that time.

One of the American short-wave stations will probably be picked up by the B.B.C. and relayed to listeners, while Daventry will provide programmes for the U.S.A. It will be interesting to see how the long and short waves compare in reliability, fading, and freedom from distortion.

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A NOTABLE achievement celebrated last month was the completion of the equipment of London hospitals with wireless installations. It is stated that since May, 1925, 122 hospitals have been fitted with wireless, the apparatus including 479 loud-speakers and 13,456 pairs of head telephones. These figures apply to London only; many hospitals in the provinces have been similarly equipped.

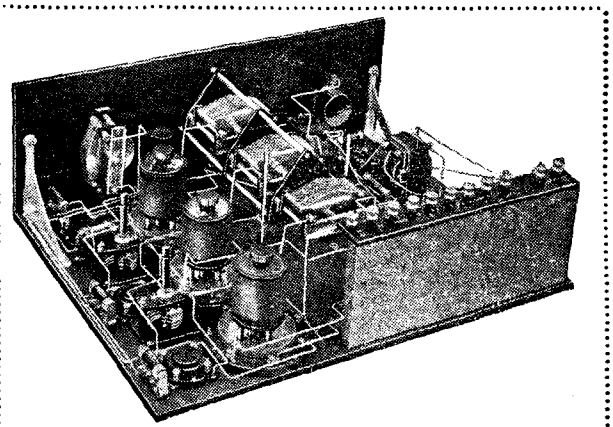
THE "SOLODYNE" AT ONE MILE FROM 2LO

Some experiences with the well-known Elstree Star set close up to the local station.

AMATEURS who live at a distance of 10 miles or so from their local station probably have little idea of the conditions for reception prevailing much closer in. The writer is situated about one mile north of the 2LO aerial, and with an aerial of only moderate efficiency, about 80 ft. long, one-third of this length being indoors, can almost hear the London programmes without a receiver!

Actually a single valve with the aerial and earth connected to grid and filament respectively will bring in 2LO at reasonable telephone strength, though it requires a No. 35 coil to tune the aerial properly to 2LO's wavelength. A good crystal set will give signals which are audible on a loud-speaker, though of course not exactly what is usually described as "loud-speaker strength." Again, signals can be made comfortably audible on an L.F. amplifier with the detector valve switched out.

It will be obvious from this that the cutting out of London in order to receive other stations is a considerable problem.



The Elstree "Solodyne" with the coil screens removed.

The Original Set

An opportunity to try the Elstree "Solodyne" under these conditions was welcomed, the set used being the original set made at Elstree and exhibited at Olympia. The valves used were of the 6-volt type.

Balancing

When the set was connected up, the "gang" control tuning condenser was not correctly balanced, and the neutralising of the H.F. stages had to be carried out. Rough balancing of the tuning condensers brought in 2LO at overpowering strength. Neutralisation was carried out with the greatest of ease, no difficulty being experienced in finding "silent points" on the neutralising condensers. On rotating the tuning dial after this with the reaction condenser at a minimum, it was found that oscillation occurred between 0 and 5 degrees. No alteration was made to the neutralising condensers, however, and in fact this was not necessary, since when the triple condenser was correctly balanced the set was perfectly stable over the whole range.

Reaction Control

The balancing operation needed some care; it was actually carried out on the transmission from Newcastle. When once the correct settings for the condensers had been secured, it was found that the reaction control, which previously had been inclined to be "ploppy," became delightfully smooth, a considerable build up in the signal strength of distant stations being possible with its aid.

Aerial Tapping

The aerial was tried both on A_1 and A_2 terminals, and the end variable condenser set to suit in each case. The A_2 terminal proved the best, so that the condenser was finally adjusted for this tapping.

Searching

Searching was carried out as far as possible without recourse to the carrier wave method. By setting the reaction condenser suitably, station after station could be located. Telephones were not used at all, the loud-speaker, of the paper diaphragm type, being situated about 6 ft. away, at the other side of the room.

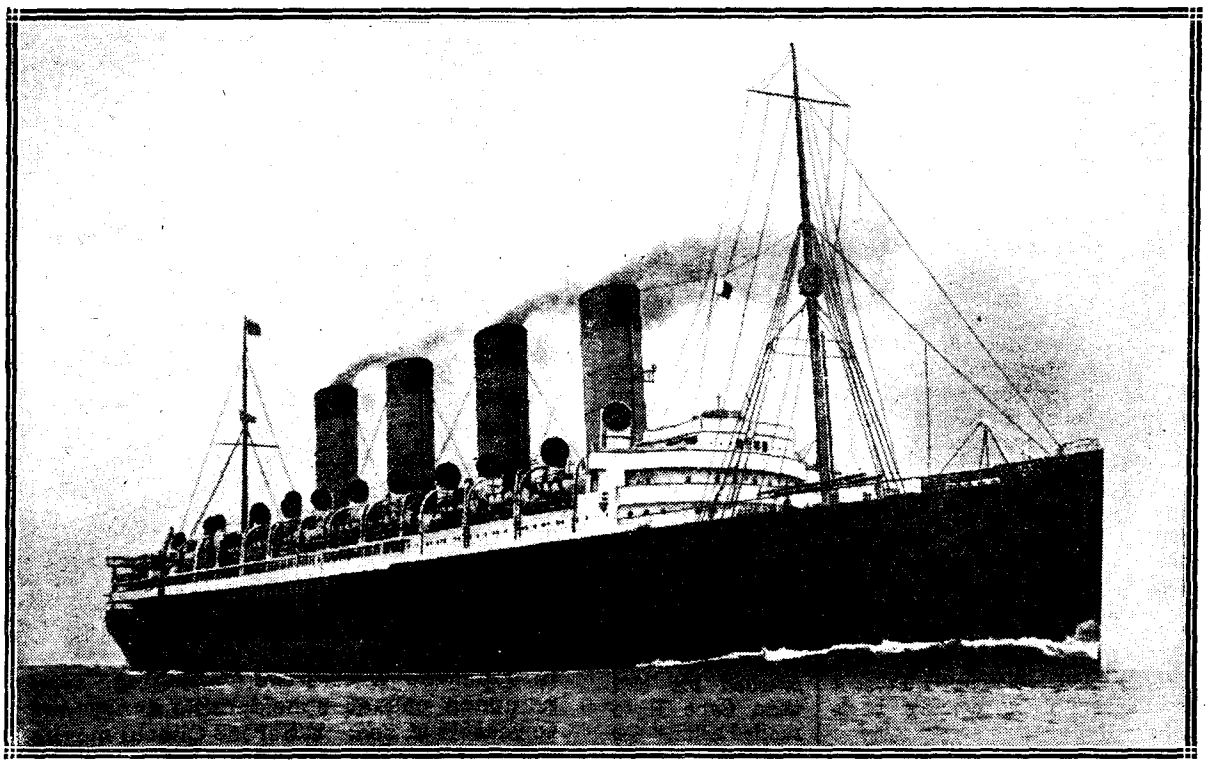
Distant Reception

After half-an-hour spent in identifying some of the distant stations, the ability of the set to cut out 2LO was tested. This station was strong at 40 degrees on the dial, being then, of course, far too loud for a small room, except with the volume control set for minimum strength. At 35 and 45 degrees only a faint trace of 2LO could be heard, Bournemouth (46 degrees) being tuned in quite free of London. Manchester could be heard through London, but the latter practically drowned the more distant station.

During the evening 27 stations were identified on the loud-speaker, more than half of these giving really excellent volume, making it possible to get the full enjoyment from any one of a wide selection of B.B.C. and foreign programmes. When a station had been found, a slight increase in the reaction condenser and the very slight re-adjustment of the tuning control brought up the signal strength in a remarkable manner.

It was found to be worth while to spend some time in accurately setting the sections of the "gang" condenser in tune, since both the signal strength and the control of the set were much improved.

A. V. D. H.



"THERE IS NOTHING NEW . . . ."

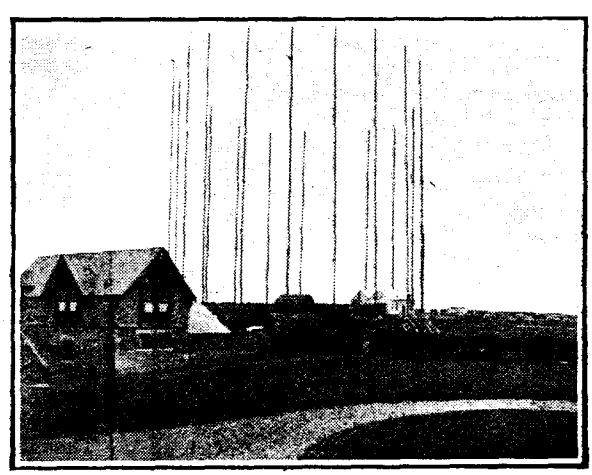
Although we are accustomed to regard "fading" and freak results as being phenomena essentially connected with broadcasting and short wave work, they were actually observed in the very early days of wireless and were responsible for many extraordinary results at sea.

THERE is no doubt that readers of MODERN WIRELESS are familiar with what has become popularly known as "fading," yet not always was this same effect known by that name.

Those readers who have listened on short waves or those who are in the habit of tuning-in the Continental stations will have already experienced that peculiar effect of a signal dying away to inaudibility, in some cases, and feeble strength in others, and the slowly coming back to normal; indeed in many cases increasing in strength to a volume above normal.

An Early Experience

In the days before the war this same effect was often observed by ships at sea, though the signals were of course morse symbols; all ships in those days worked upon a wavelength of approximately 600 metres, and it was possible with an ordinary receiver to hear several ships working at the same time, some of the vessels being west, others east, and still others north and south. Many times in the North and South Atlantic Oceans one could listen to a ship, say, several hundred miles away in an easterly direction when suddenly this would fade away to very feeble strength, while there slowly came into audibility a vessel which previously was beyond audible range. Thus a sort of swinging or see-saw effect could be often observed and usually the dying away and increasing signals were from vessels in opposite directions.



When the old station at Poldhu was working, ships at sea sometimes had to contend with very severe fading during the reception of Press news. This effect was most marked in mid-Atlantic and appeared to be shared equally with the station at Cape Cod.

Long Wave Effects

When the old Poldhu station used to send out Press news to ships on a long wavelength one used often

"THERE IS NOTHING NEW . . ." *(Continued)*

to find that in mid-Atlantic his signals would fade away and then return in a most exasperating manner, and though experienced in receiving under these conditions it was not always that Poldhu could be read without losing some of the news.

On the American side of the Atlantic a station named Cape Cod used also to send out news and at certain periods of this station's and Poldhu's transmissions the two would be working at the same time though not upon the same wavelength. On one occasion the writer tried the effect of tuning in Cape Cod during a time when Poldhu was just about to fade, and strangely enough Cape Cod was increasing in strength; some little time later Cape Cod began to fade, whereupon Poldhu was found to be coming back again.

A Rare Occurrence

An interesting feat in connection with fading was performed in the winter of 1914, during the month of March, when the late *Lusitania* was about to leave the River Mersey on her trip across the Atlantic, and though the performance was then unique it has been repeated many times since by other stations. The *Lusitania's* operator noted that signals were really good on the particular evening, when suddenly he heard the station at Cape Race call a vessel somewhere in mid-Atlantic.

As there appeared to be no one working in the immediate neighbourhood the operator of the *Lusitania* defied all rules and regulations and called Cape Race in a wild hope that he might be heard. No sooner had he finished his call than Cape Race replied asking for the usual particulars exchanged between ship and shore on their first establishing communication. The exchange of signals was kept up for some minutes before Cape Race faded away for good, but since the *Lusitania* was then only fitted with the relatively insensitive instrument known as the magnetic detector, it is rather wonderful that she could even hear Cape Race at all.

In Japanese waters the "swinging" phenomenon causes considerable annoyance to vessels at sea. Whereas Choshi may be in the 'phones one minute, Penang may be there the next, even though the receiver be untouched.

In the Mediterranean

Another interesting pre-war experience was the peculiar behaviour of the station at Lizard Point towards ships trading between ports in the Mediterranean and Adriatic Seas. Though for the most part this station was inaudible there were times when the signals would become audible and then slowly build up into really loud volume; so much so in fact that stations much nearer were often jammed out.

At the top of the Adriatic, off places such as Fiume and Trieste, the Lizard was always in night range so far as reception was concerned, and one could hear him first fading away and then increasing in strength with extraordinary rapidity, though there appeared to be no systematic time period either for the duration of the fading or time between the end of one fading and the beginning of the next. Though there were several other United Kingdom stations which could be heard, none seemed to fade as did the Lizard in this particular locality.

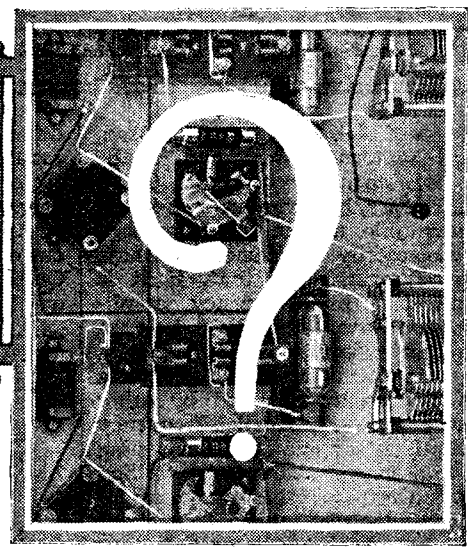
In the same part of the world one could also hear the station at Cadiz working sometimes at really loud strength and slowly dying

(*Concluded on page 747.*)

In the Adriatic, signals from the shore station at Lizard Point would rise and fall in volume on most nights in a manner peculiar to this station.

WHAT ARE THE LIMITS OF H.F. AMPLIFICATION

By J. H. REYNER, B.Sc. (Hons.) A.M.I.E.E.



How far can high-frequency magnification be developed? Will the long-range set of the future employ an increased number of H.F. stages? In this interesting article Mr. Reyner deals with some of the difficult problems with which set designers are faced.

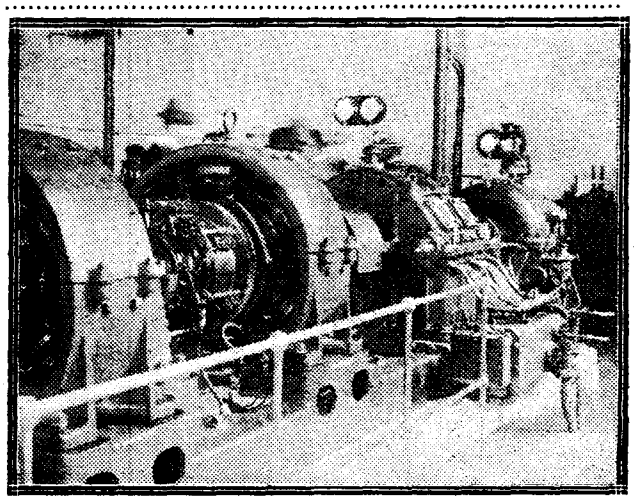
A QUESTION which will have been raised in the minds of almost every wireless enthusiast within the past year or so is how far the lines of high-frequency amplification can satisfactorily be developed. Is there any limit to the useful amplification which we can obtain at high-frequencies, or will developments in the future lie in the direction of increasing the number and the efficiency of the high-frequency stages of amplification.

Commercial Services

This is a problem which has only recently become of importance in the broadcast world, although it has been encountered and discussed in other spheres of radio activity for some time. The commercial wireless services working on medium frequencies up to about 100 kilocycles (operating on a wavelength of 3,000 metres or over) utilised high-frequency amplification with a reasonable degree of efficiency many years ago. At such frequencies the problem of high-frequency amplification is not quite so difficult as on the higher frequencies which are usually used over the broadcasting band.

Parasitic Oscillations

Recently the further experience which has been obtained, coupled with the discovery of one or two sources of unsuspected trouble, such as parasitic oscillations, have led to the development of amplifiers which are capable of operating efficiently, even on the high frequencies of the order of 50 to 100 kilocycles or more such as are used for broadcasting purposes. With these receivers some excellent results have been obtained and altogether the reception of distant stations with a modern receiver is a matter of considerable ease and does not require careful and expert adjustment.



High-frequency stages were employed many years ago on wavelengths such as those used by high-power transmitters. The problem at such frequencies is not so difficult as it is on the shorter waves.

Selectivity

At the same time we are enabled to obtain a considerable degree of selectivity by a suitable design of the actual high-frequency amplifier, and we are rapidly approaching a point where the selectivity and the signal strength are beginning to become close to the actual ideal requirements.

Experiments which I myself have carried out quite recently indicate that the methods of high-frequency amplification which we are at present adopting are capable of being extended to several stages more than we are adopting at present. Certain minor factors which are of comparatively small importance when only two stages are utilised, become troublesome as we increase the number of stages, but methods have been devised of combating these.

Capacity Coupling

One particular difficulty which may be referred to is that of the capacity coupling existing between the primary and the secondary windings. Experience showed that this factor was becoming troublesome when several

WHAT ARE THE LIMITS OF H.F. AMPLIFICATION?—*(Contd.)*

stages of high frequency were used, and various devices had to be resorted to in overcoming it. These difficulties, however, are not insurmountable, and in fact have been satisfactorily overcome. We may, therefore, take it that, if it is desirable, high-frequency amplification can be utilised to even greater extent than it is to-day.

This view is supported by reports of the results obtained by other investigators. A high-frequency amplifier, for example, developing a total magnification of one million at the extremely high-frequency of 6,000 kilocycles (about 50 metres) has been achieved in a satisfactory manner by the Marconi Co., and examples such as this tend to show that the command of the modern radio-engineer over high-frequency currents is very effective.

A Question

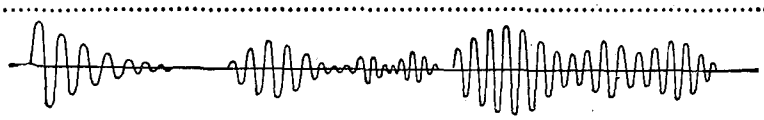
As was stated at the beginning of the article, the question is how far it is desirable to carry the amplification at high frequency, and to what extent low-frequency amplification is as good. It is proposed to review some of the factors affecting one's decision in matters such as this.

In the old days when transmission of wireless signals was carried out entirely by means of spark or other damped wave system, the rectification obtained on the detector obeyed, approximately, a square law, so that if the signal strength was doubled the rectified current was increased four times. On this point of view, therefore, an amplification of ten prior to the rectifier is equivalent to an amplification of one hundred after the rectifier—*i.e.*, at low frequency.

Rectification

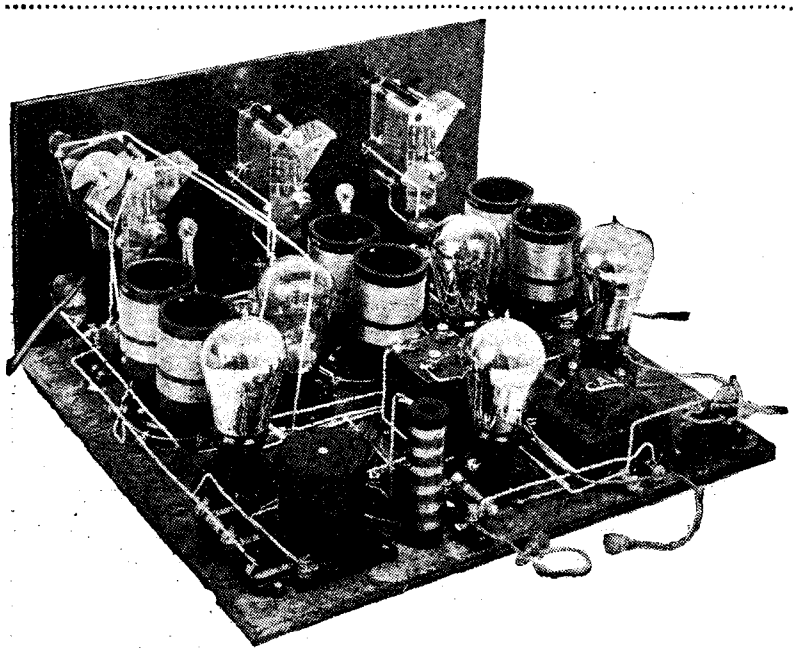
With telephony, however, we do not obtain a true square law rectification, because although the modulated carrier wave partakes of the nature of a damped wave, it may not be completely modulated. Particularly if reaction is used in the receiver, as is nearly always the case, we have in effect a more or less steady high-frequency current with modulation superimposed on top, and the more reaction we employ the less complete does the modulation become. Fig. 1 will illustrate this point and show the difference between the three types of wave.

Fig. 1 (*a*) shows a spark train, Fig. 1 (*b*) shows a completely modulated telephony transmission which will be seen to resemble a spark train in character. For both of these the rectifier would obey a square law. Fig. 1 (*c*), however, shows an incompletely modulated wave, such as would be produced by only having a partial modulation at the transmission end, or the addition of reaction at the receiving end or both. The actual modulation of Fig. 1 (*c*) is the same as that for Fig. 1 (*b*), but in the case of Fig. 1 (*b*) the modulation is complete.



(a) *(b)* *(c)*

Fig 1.—Illustrating (*a*) a spark train, (*b*) complete modulation and (*c*) incomplete modulation.



The modern type of receiver employing H.F. amplification has rendered the reception of distant stations an easy matter.

Practically all the telephony which is received is similar in form to Fig. 1 (*c*). In other words, it is not completely modulated, the actual extent of the modulation depending as much on the receiver as the transmitter. The point about this, however, is that for a wave such as this the rectifier gives a much more uniform response than it does to a damped wave.

Square Law Principle

Let us consider a simple rectifier as shown in Fig. 2. It will be clear that this rectifier obeys a square law. If we have a large input we obtain a much greater response from the rectifier than we do for a small input. With such a system therefore it pays to amplify the currents somewhat before applying them to the detector. Suppose, however, we have a constant oscillating current applied to the detector. The effect of this will be to produce a steady rectified current. If now we produce increases or decreases in the strength of this constant wave—*i.e.*, if we modulate it in some manner, then all that will happen is that the steady rectified current will increase or decrease, and these variations will be nearly proportionate to the modulations. In other words, we shall

WHAT ARE THE LIMITS OF H.F. AMPLIFICATION?—(*Contd.*)

obtain a linear rectification, and not a square law as in the previous case.

In such circumstances the advantage of high-frequency amplification before the detector is not so marked. In actual practice we do not obtain a strictly linear rectification on telephony reception, but we do obtain something which is approaching it, and consequently this argument is valid. In the case of the reception of actual continuous-wave signals where a heterodyne is utilised, then the rectification obtained is definitely linear, and exhaustive tests have shown that a properly designed low-frequency receiver will give exactly equivalent results to a high-frequency receiver. With ordinary telephony reception we have an intermediate position, the effect of high-frequency amplification being definitely beneficial, but not to the same extent as with a damped wave.

Atmospherics

A point which arises at this stage is the question of atmospheric interference. There appears to have been an increase in the intensity of atmospheric disturbances during the past season. As this coincides with the introduction of more efficient high-frequency apparatus, it is natural to suppose that there is some connection between these two factors. Moreover, the theory receives a certain amount of support from the fact that the atmospheric disturbances set up damped waves in the aerial system.

At first sight, therefore, it would appear that as far as atmospherics were concerned, the more high-frequency amplification we use the greater would be the effect produced on the detector valve, since the detector obeys the square law for such disturbances. The telephony, on the other hand, being only partially modulated, would not obtain the same benefit from the high-frequency amplification, and one would expect that the more high-frequency amplification used the greater the relative strengths of the atmospherics to the signals.

Experiments

Further investigations, however, show that this argument is fallacious, because any atmospheric disturbances will be superposed on the telephony signals, and the whole will form one composite wave. Consequently, the rectification effect produced will be the same for both the atmospheric and the signal. Some definite tests have recently been carried out in order to ascertain whether there was any difference in the atmospheric disturbances produced.

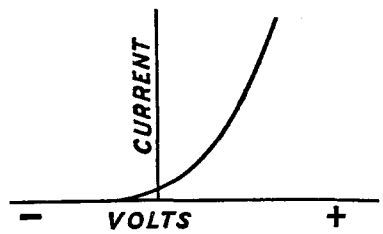


Fig. 2.—An explanatory curve for a simple rectifier.

For these experiments two receivers were connected up; one having two stages of high-frequency amplification and a note magnifier, while the other utilised a single-valve receiver with reaction and two stages of note magnification. No reaction was used in the high-frequency receiver, and with this combination it was found possible to tune into a distant station, and adjust it to give the same signal strength on both receivers. Then by a simple change-over it was possible to determine whether the atmospheric disturbances were more severe in one case than in the other.

Identical Results

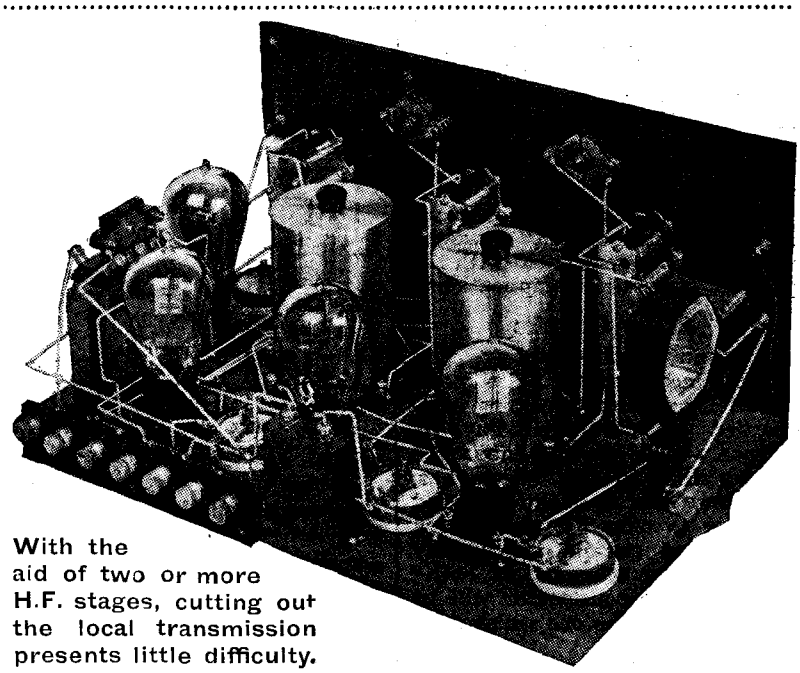
Repeated tests failed to reveal any marked difference. Actual scientific measurements were not taken, the principal object being to determine whether signals were more intelligible—*i.e.*, whether the music or speech received was more pleasant to listen to in one case than in the other, and this did not prove to be the case, the two receivers giving practically identical results. We may dispose of the idea that high-frequency amplification is causing trouble in this direction.

More Expensive

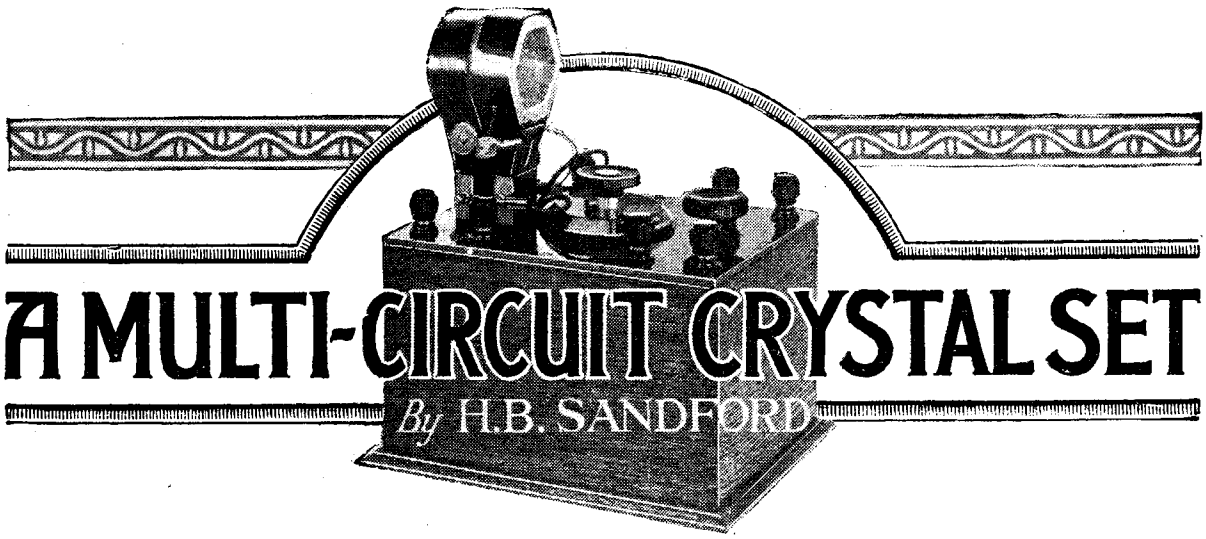
We return, therefore, to the consideration of just how much high-frequency amplification is desirable. It will be admitted that certain high-frequency amplification is definitely to be desired owing to the ease of handling which results from its use. It is then possible to obtain good and selective results without the use of critical reaction or wave-traps. At the same time there is no doubt that high-frequency amplification is more expensive than low-frequency, and it is really this factor which ultimately sets a limit to the number of stages of high-frequency amplification used in a receiver.

There are several reasons which determine that there shall be at

(*Concluded on page* 763.)



With the aid of two or more H.F. stages, cutting out the local transmission presents little difficulty.



A MULTI-CIRCUIT CRYSTAL SET

By H.B. SANDFORD

This simple and efficient little receiver is so constructed that many different circuits may be tried out with the minimum of trouble. In this way the best arrangement to suit any particular circumstances can be found in a very short time.

ABOVE all things crystal receivers shonld be simple. At the same time they should preferably be selective. To combine the advantages of selectivity with simplicity, and at the same time ensure efficiency, is, however, not necessarily an easy matter. A multi-circuit receiver usually provides a means whereby almost everyone can be assured of obtaining the circuit most suitable to their needs. But as soon as we mention "multi-circuit," however, we are at once confronted with the problem of possible complications.

Many Circuits

A multi-circuit receiver that actually incorporates simplicity and selectivity without becoming complicated is worth building by anyone. The receiver about to be described in this article has, therefore, been specially designed in order to offer the choice of a selection of circuits which may be simple, or selective, or both; so that every constructor will be able to choose the one which suits his purpose best.

Components

The components which are required to build this set are given in a list elsewhere in the article, and the makes of the actual parts used are indicated. Other suitable components of good make may, of course, be substituted if desired.

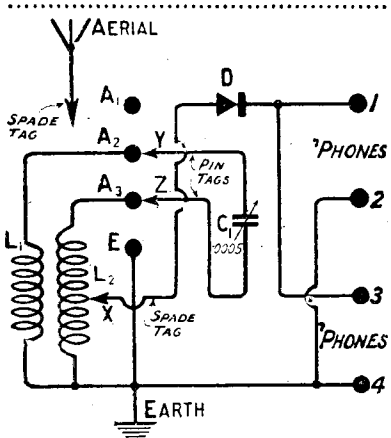


Fig. 1. — The theoretical circuit diagram. Various arrangements can be tried.

Construction

There is no need to say much about the actual construction of the receiver. It should be quite easy to follow from the drawings, which show the front and back of the panel. All the components are actually mounted on the panel itself in order to simplify the wiring. When the panel has been drilled, all the components may be assembled, care being taken to space the two coil mounts exactly as shown. All that remains now is to wire the set.

The type of coil sockets used were chosen in order to provide a simple means of making connections from the under side of the panel. Some alterations, however, have to be made to the coil mounts for this purpose. Remove the base from each mount, and secure the holder to the panel by means of two 4B.A. terminals as shown in Fig. 3. The terminals will be found to fit exactly, since the original screws which secured the base are also 4B.A. The terminals must make contact with the pin and socket of the holder in each case.

The Theoretical Circuit

The theoretical circuit shows the general arrangement of this

COMPONENTS REQUIRED

Ebonite panel 8 in. by 6 in. by $\frac{3}{16}$ in. (Camco.)
Cabinet to suit panel. (Camco.)
Micro crystal detector. (Wilkins and Wright, Ltd.)
.0005 variable condenser, Popular Type. (Bowyer-Lowe Co., Ltd.)
Two-coil mounts. (Peto-Scott, Co., Ltd.)
Eight Terminals. (Belling and Lee, Ltd.)
One Spade terminal and two pin terminals.
Glazite wire.
Dial Indicator. (A. F. Bulgin and Co.)

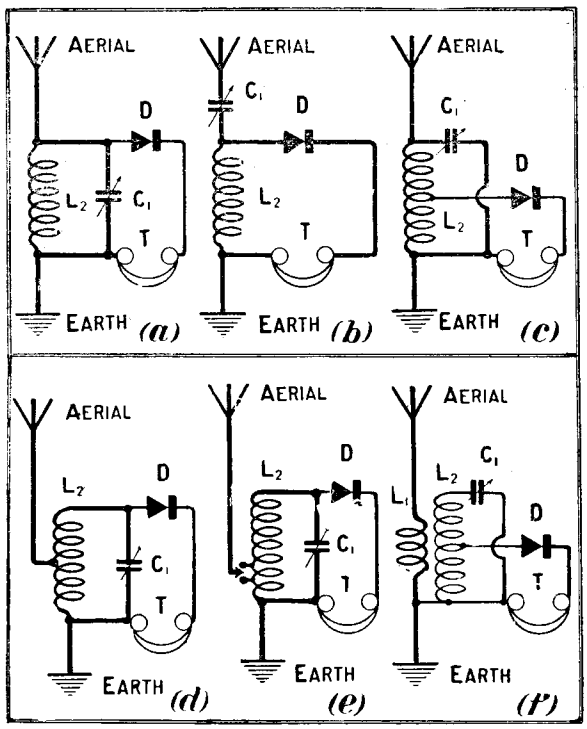


Fig. 2.—Six well-tried circuits can be used with this simple set.

receiver. The detector spade terminal is indicated by X, while Y and Z indicate the variable condenser pin terminals. It will be seen that the telephone terminals are so arranged that one or two pairs of 'phones may be used in parallel as desired. All the circuit arrangements are obtained by connecting the flex leads and the aerial to different terminals.

Ordinary, centre-tapped, or "X" coils are used according to which circuit is employed.

Circuit Arrangements

Six different circuit arrangements are obtainable, and are shown in Fig. 2.

Circuit (*a*) represents the simplest form of crystal circuit. It will be seen that direct coupling with parallel tuning condenser is employed, so that the circuit is not particularly selective, but is, nevertheless, quite suitable for reception from a powerful nearby station. The connections required are as follows :—

Aerial to terminal A_3.
Earth to terminal E.
Detector tap X to terminal A_3.
Condenser tap Y to A_3 terminal of L_2.
Condenser tap Z to E terminal of L_2.

A No. 35 or No. 40 coil should be plugged into the L_2 coil mount for the lower broadcasting band, and a No. 150 or No. 200 coil for Daventry.

Circuit (*b*). — This circuit is very similar to the preceding one, but the tuning condenser is in series instead of parallel. To obtain this circuit make the following connections :—

Aerial to terminal A_1.
Condenser tap Y to terminal A_1.
Detector tap X to terminal A_3.
Condenser tap Z to A_3 terminal of L_2.
Earth to terminal E.

The same coil mount is used for this circuit as for circuit (*a*), but a No. 60 or No. 75 coil will be required for the lower range, and a No. 200 or No. 250 coil for Daventry.

Circuit (*c*).—In this circuit the effect of the damping of the crystal on the tuning circuit is reduced by tapping the crystal on to the centre point of the tuning coil. Connections are as follows :—

Aerial to terminal A_3.
Earth to terminal E.
Condenser tap Y to A_3 terminal of L_2.
Condenser tap Z to E terminal of L_2.

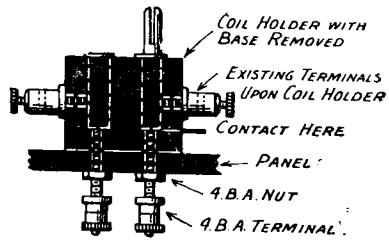


Fig. 3.—Details of the coil holders.

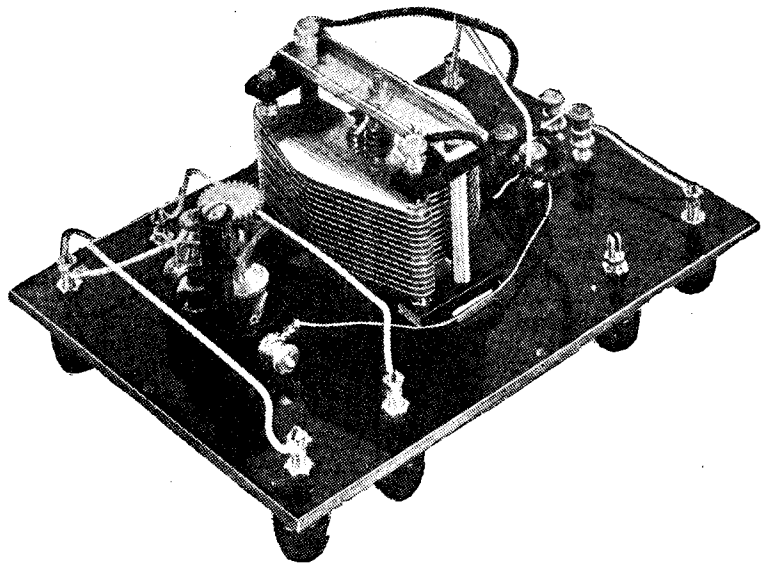
Detector tap X to centre tap terminal of plug-in coil.

The sizes of coils required will be the same as those for circuit (*a*), but must be of the centre-tapped type. Use the L_2 coil mount.

Circuit (*d*).—In this case the aerial instead of the detector tap is taken to the centre point of the tuning coil. To obtain this circuit make connections as follows :—

Aerial to centre tap of plug-in coil.
Detector tap to terminal A_3.
Condenser tap Y to A_3 terminal of L_2.

A MULTI-CIRCUIT CRYSTAL SET—*Continued.*



The crystal detector employed utilises a geared adjustment and a dust-proof cover.

A MULTI-CIRCUIT CRYSTAL SET—*(Concluded)*

Condenser tap Z to E terminal of L_2.

Earth to terminal E.

The range of coils required with this circuit is usually one size larger than that specified for circuit (*a*). The L_2 coil mount is again used.

Circuit (*e*).—In this arrangement selectivity is obtained by auto-coupling the aerial to the tuning coil.

Earth to terminal E.

Condenser tap Z to E terminal of L_2.

Circuit (*f*).—For the last circuit an inductively coupled arrangement is employed. A centre-tapped coil is used in the L_2 position, and an ordinary coil in the L_1 position. The coil sizes for L_2 are similar to those for circuit (*e*), and for L_1

Earth to terminal E.

Detector tap X to terminal on centre-tapped plug-in coil.

Operation and Results

When completed this set was given a thorough test about 10 miles east of 2LO, on a moderately sized outdoor aerial. Both the

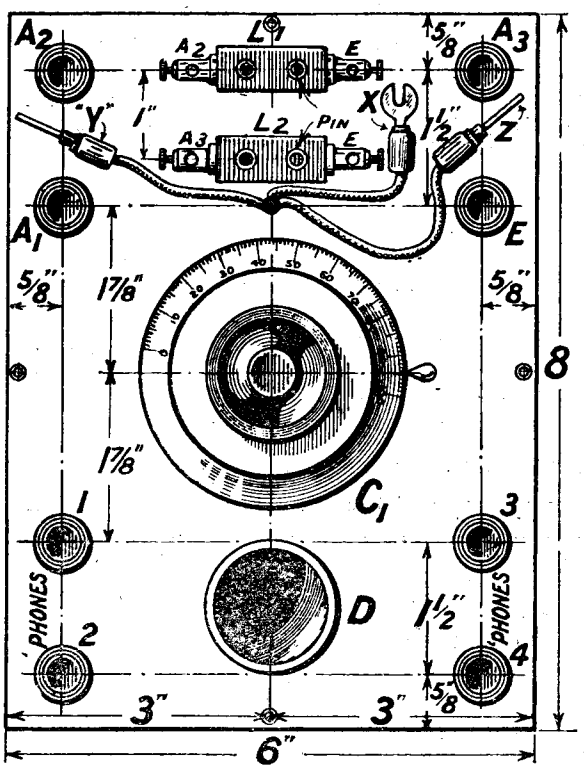
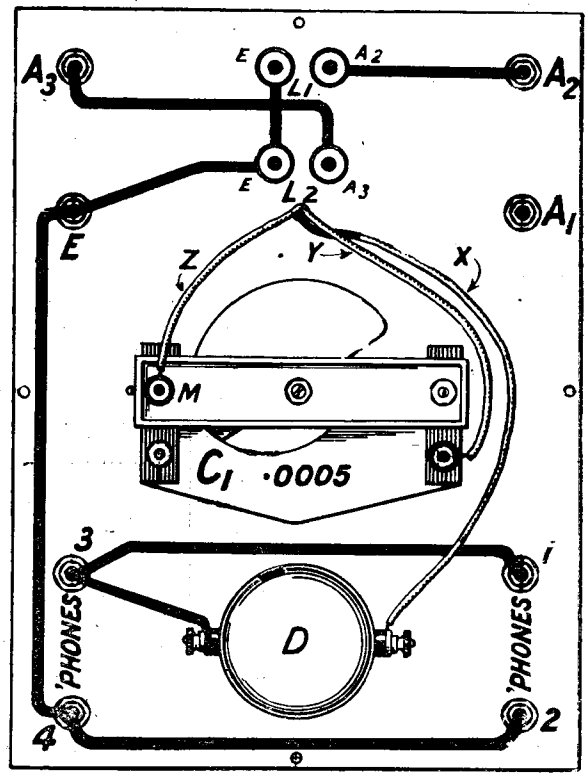


Fig. 4.—The receiver is as easily constructed as an ordinary crystal set employing a single circuit.

Fig. 5.—The practical wiring diagram may be seen below. All the wiring-up can be completed in less than two hours.



X coils will be required, and their sizes will be a No. 60 and 250 for the B.B.C. band and 5XX and the same coil mount is employed. The following connections must be made:—

Aerial to either of the terminals on the X coil.

Detector tap X to terminal A_3.

Condenser tap Y to A_3 terminal of L_2.

a No. 25 for the lower band and a No. 75 or No. 100 for Daventry. The size of L_1 will, however, vary with different local conditions, and is best found by trial. The connections for this circuit are as follows:—

Aerial to terminal A_2.

Condenser tap X to terminal A_3.

Condenser tap Z to E terminal of L_2.

London station and Daventry were received at good strength on the circuit *a*. The other circuits were then tried one after the other, when a marked improvement in selectivity was noticed. Some circuits gave better results than others, and there seems no doubt that at least one circuit should be found suitable for all sets of conditions.

WIRING INSTRUCTIONS

Join socket of holder for L1 to A2.

Join pin of holder for L1 to pin of holder for L2; pin of holder for L2 to E: E to 'phone terminal 4: 'phone terminal 4 to 'phone terminal 2.

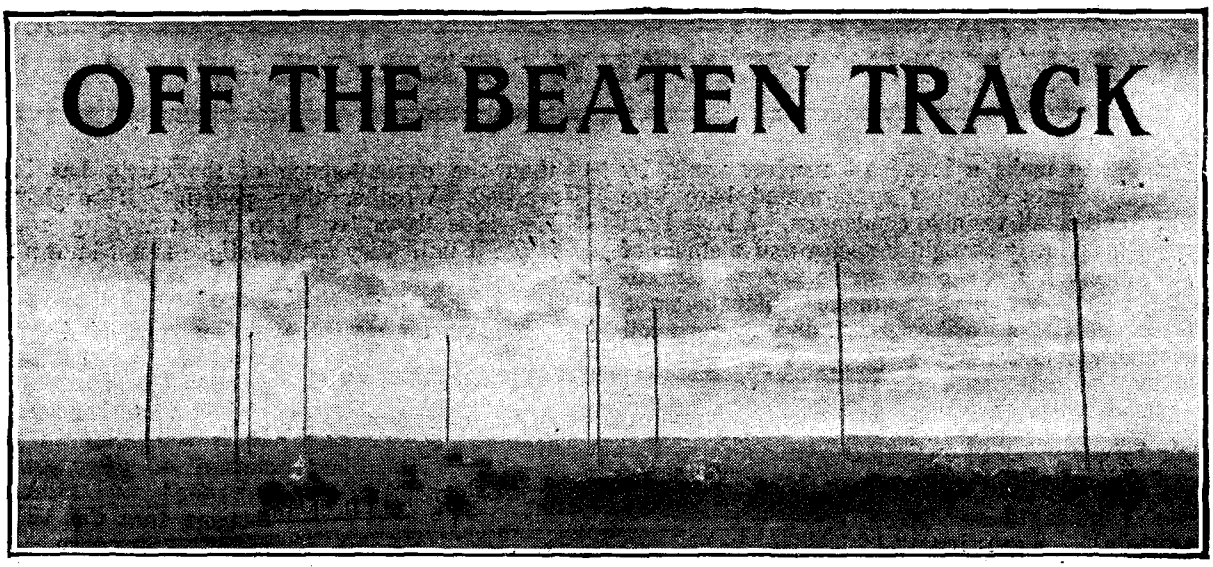
Join A3 to socket of holder for L2.

Join 'phone terminal 1 to 'phone terminal 3: 'phone terminal 3 to one side of D.

Join flex wire with spade tag on end to other side of D

Join flex lead with pin tag on end to moving plates of C1, and also similar lead to fixed plates of C1.

OFF THE BEATEN TRACK



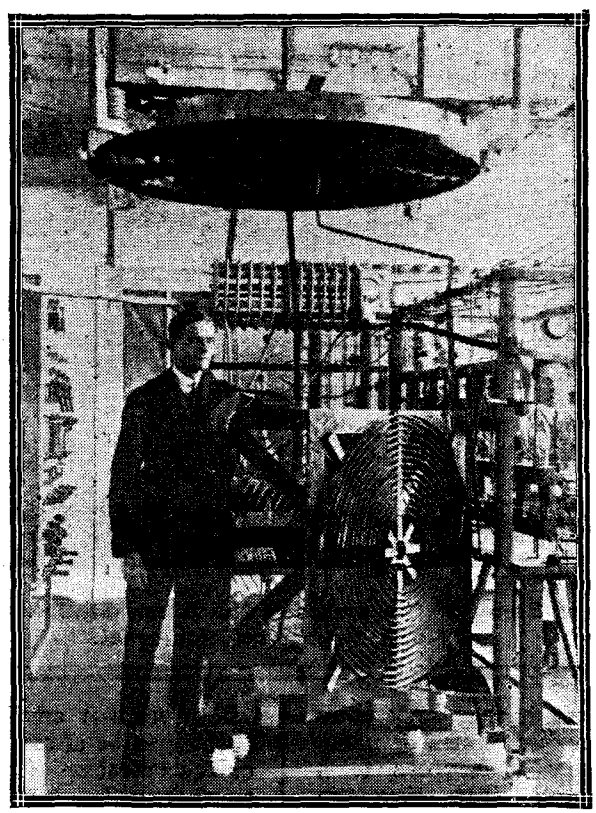
I FIND it more and more difficult each month to decide exactly what constitutes the "beaten track," since so many of the stations that used to "stay where they were put" have now acquired a disturbing habit of turning up in all sorts of unexpected places. We see newspapers blossoming out with such headlines as "The Lure of the Short Waves," and giving novices the entirely wrong impression that these short waves are fraught with all sorts of marvellous possibilities. So much so, in fact, that I have already had an enquiry from one gentleman who wants to know whether he can use his short-wave receiver for the purpose of communicating with his aunt in New Zealand!

The Track Widens!

I suppose the whole fact of the matter is that "the beaten track" is widening month by month, until ultimately it will include all wavelengths from 20 to 20,000 metres. Meanwhile, I will confine my attention to the shorter and longer waves, as usual.

Low-Power Tests

The low-power tests organised by the T. & R. section of the Radio Society of Great Britain were very interesting during the short week over which they extended, but participants were rather unfortunate on account of the poor conditions that prevailed during that week. Several British amateurs succeeded in working American stations while using their 5 watts—the maximum power allowed—and 5NN established contact with no less than fifteen United States amateurs. Generally speaking, however, the results obtained were not up to the standard of winter work on low-power. Now that the tests have finished, however, conditions have very greatly improved, and several stations are "getting across" more or less regularly with very low power indeed. This is only natural.



Part of the television transmitting equipment at the Berlin radio laboratories at Malmaison.

A Good Chance

One of the chief difficulties besetting the low-power enthusiast has always been that one naturally tends to pick out a strong signal to listen to in preference to one that causes excessive ear strain. If, however, all the strong signals are forcibly removed for a week, there will be a good chance for the weaker ones!

"Double-Purpose" Sets

It is very interesting to see just how low it is

OFF THE BEATEN TRACK—*(Concluded)*

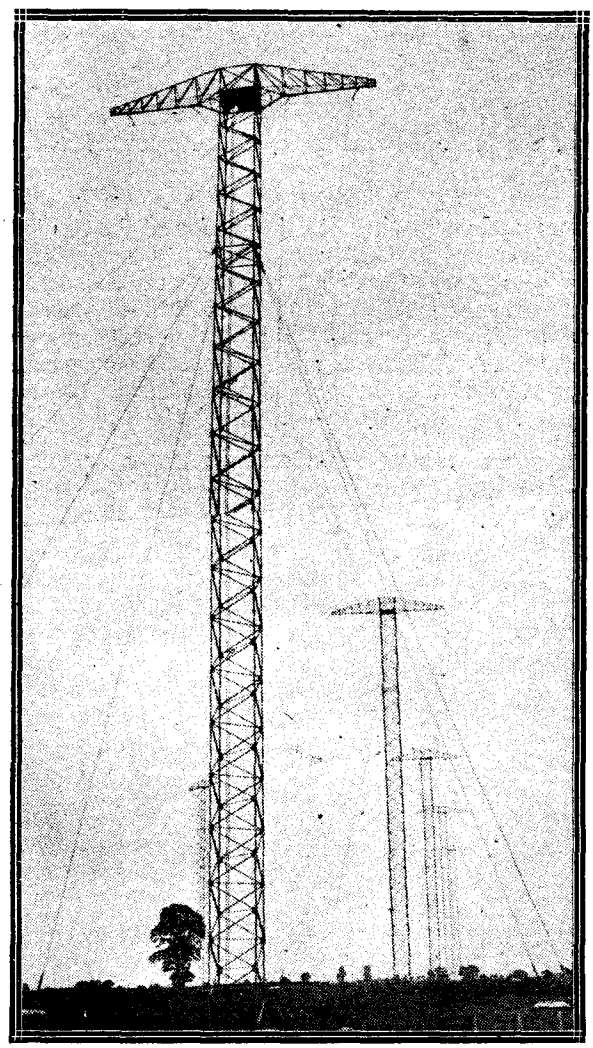
possible to make a broadcast receiver work, by the expedients of using space-wound bare wire coils, and small variable condensers. I have been using a perfectly straight detector and 2 stages of L.F. recently, and the set seems to work exceedingly well down as low as 18 metres. For this wave I plug in a 4-turn coil as A.T.I. and a 6-turn coil as reaction, and tap the aerial, in series with a neutralising condenser, on to the centre-point of the A.T.I. The first night after I had done this I managed to log several American amateurs between 18 metres and 24 metres.

Twenty Metres

There are times, however, when one wonders what the use of the 20-metre wave-band can possibly be. I have listened for the best part of an hour, and heard nothing but a few Commercial stations coming through very weakly, and the harmonics of some stations working on 40-50 metres. This is, naturally, somewhat discouraging, especially if one happens to pick one of these nights for the first test of a new short-wave receiver.

Ultra Short Waves

I am still wondering what becomes of the 5 metre waves after they have once passed the "skipped distance." No doubt it is rather fallacious to compare them with longer waves, but when one reflects that, in certain circumstances, 20 metre waves are audible up to, say, five miles, then inaudible up to 2,000 miles, after which they apparently increase in strength up to 6,000 miles or more. The general theory as to what happens to 5 metre waves appears to be that they are audible up to 50 or 60 miles (or, sometimes, as far as 100 miles) and then cannot be heard again until some very great distance, perhaps more than the circumference of the earth, has been reached. Whether they penetrate through the Heaviside layer or keep on travelling round inside it until they die of fatigue is not known!



Some of the masts of the Beam Station at North Petherton, Somerset.

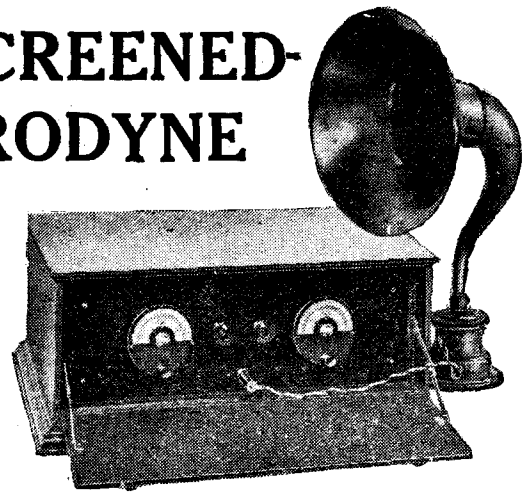
Still More!

I have always been rather amused by the shortest wave band granted for the use of United States amateurs. It is something in the nature of 73-77 centimetres! I should imagine that the wavemeter necessary to ensure that one is keeping within one's licensed band is rather a weird affair!

Straight v. Super

There are still many who prefer the superheterodyne to any other type of receiver for short-wave work, although those who have never used anything but a detector and one L.F. always say that there is nothing to beat it. A few days ago I was lucky enough to have the opportunity of testing out a friend's short-wave "super." I was struck chiefly by the absence of "mush" and background: really there was no more than one usually hears with a two-valve receiver, but the signals, of course, were enormously strong. The ease of operation, too, was really surprising when all had been carefully adjusted. I advise all short-wave enthusiasts who can to make up a superhet. I am quite confident that once they have done so they will never use anything else. There is really nothing to be afraid of, either in the construction or the operation of a super-heterodyne, so that, apart from the question of expense (which need not be great if one constructs as much of the apparatus as possible oneself) there is no excuse for *not* giving the superheterodyne a trial, at least.

OPERATING THE SCREENED-COIL SUPERHETERODYNE

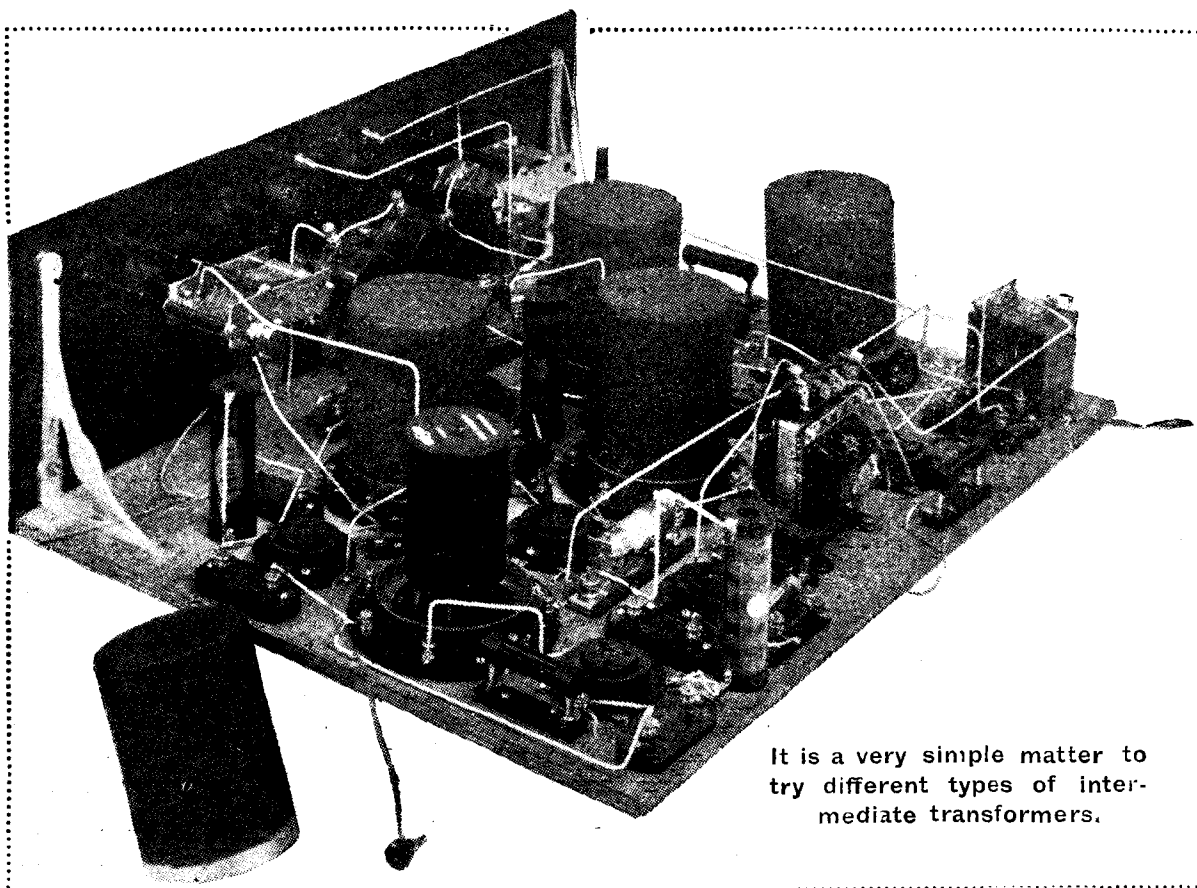


By G. P. KENDALL, B.Sc.

Winding the Oscillator Coils——Choosing the Valves——Trying Different Intermediate Transformers——L.F. Instability

WITH regard to the great majority of what are called "straight" receivers, it is possible for the designer to say to his readers: "Do exactly this, that, and the other, and the receiver will then give the best results of which it is capable." In the case of almost any superheterodyne, however, except, perhaps, the very simplest, it is not possible to say with absolute definiteness and confidence that if such and such adjustments are made then the receiver will definitely be set to its most sensitive condition.

There are, as a rule, little variations in behaviour between instruments made up from the same design, and, therefore, each one really calls for special treatment and a little experimenting and testing on the part of its owner to determine the best way to treat it to get the best results. In this characteristic, I believe, lies a great deal of the fascination of the superheterodyne receiver, which it exercises simply because it calls for somewhat greater experience and skill on the part of the user in operating and making adjustments to get the best results.



It is a very simple matter to try different types of intermediate transformers.

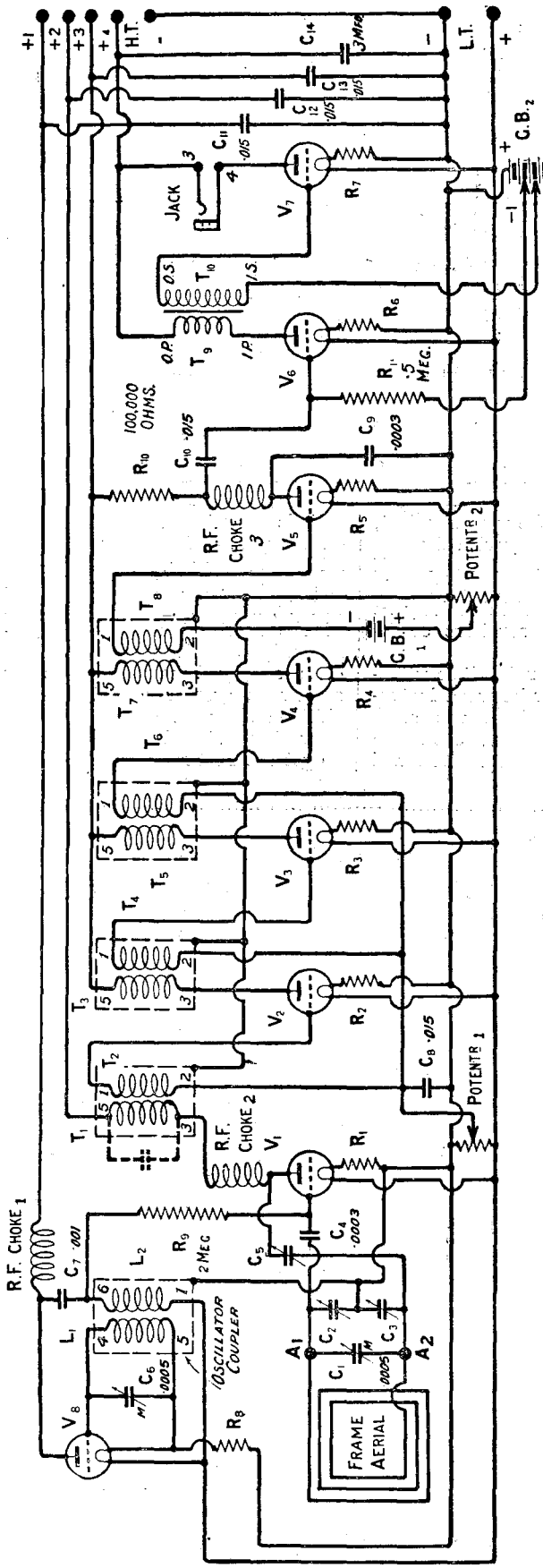


Fig. 1.—The connections of the oscillator coils are given here, and the necessary instructions for winding them are included in the text.

OPERATING THE SCREENED-COIL SUPERHETERODYNE— *(Continued)*

An Example

For example, the conditions under which the oscillator valve functions have a considerable bearing upon the results given by the set, and although it is possible to give figures for the sizes of the coils, H.T. voltage, etc., which will give satisfactory average results, a little experimenting here will often improve matters noticeably, according to the individual valve in use.

The Oscillator Coils

The starting point for the coils is a standard screened coil former, and upon this the windings are placed as follows: At the lower end (*i.e.*, nearest to the base) wind on 40 turns of No. 36 d.s.c. wire in a single layer, connecting the beginning to Pin No. 6 and the finish to Pin No. 1. Leave a space of about $\frac{1}{8}$ in., and then start another winding of the same wire in the same direction, connecting the beginning to Pin. No. 5. Wind on 80 turns, and take the finishing end to Pin No. 4, thus completing the coupler for the first tests.

Oscillator Adjustments

The figures which I have given are average ones to suit the modern types of dull-emitter valves which oscillate fairly freely, and to get the best results with other types a little experimenting with the size of the reaction winding (the smaller one) will be needed. The object is to hit upon such a number of turns that the valve oscillates strongly at all dial settings, and does not "squeal" at the *lower* settings. The procedure, therefore, with a valve of the type which does not oscillate particularly easily is to wind on 60 turns for the reaction coil, note whether the valve squeals at the lower readings, and if it does, strip off turns from the *commencing* end until the squeal just stops when the valve is working with 70–80 volts H.T.

The Ideal

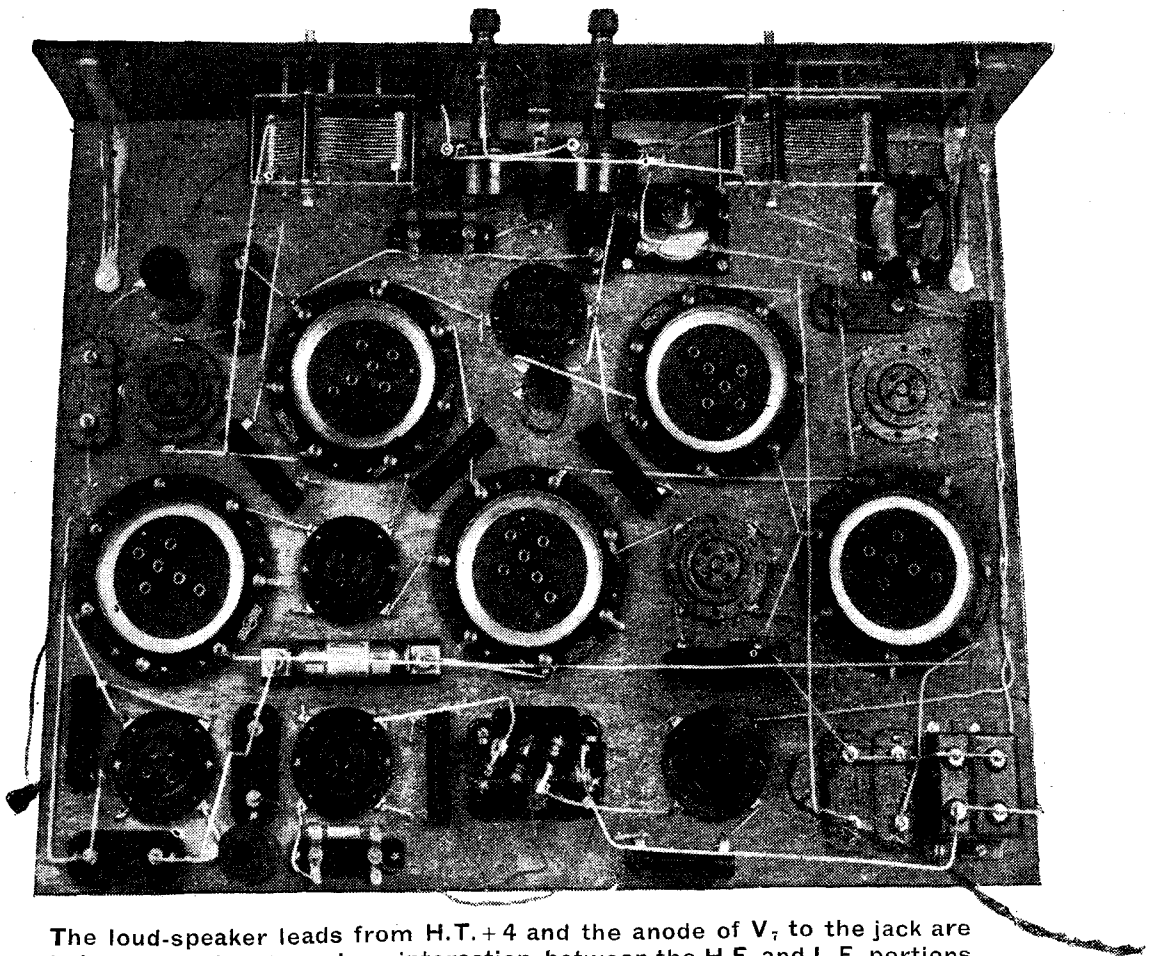
It will be observed, then, that *just short* of the squealing point is usually the best for the oscillator valve, and it is worth while trying different turns on the reaction winding until it can be produced readily by varying the H.T. voltage. Thus, if 90 volts makes the valve squeal, and it stops when the anode voltage is brought down to 80, it can be assumed that the correct conditions have been achieved, and the valve will be oscillating as strongly as is desirable.

The First Detector

Most super-heterodynes are somewhat particular as to the valves used in certain positions, and the present instrument is no exception. It is worth while to try each of your available valves in the first detector socket for a beginning, and you will probably find that one particular type gives distinctly superior results.

If you intend to buy a valve for this position,

OPERATING THE SCREENED-COIL SUPERHETERODYNE—*(Concluded)*



The loud-speaker leads from H.T.+4 and the anode of V_7 to the jack are twisted together to reduce interaction between the H.F. and L.F. portions of the receiver.

it will be a useful guide to know that those which I have found most suitable here were all of the high-impedance, high-amplification factor type, those tried successfully including the D.F.A.1, D.E.8.H.F., S.S.6, and S.T.61.

Intermediate Amplifiers

In the intermediate amplifier sockets similar valves to those just mentioned were found very suitable, but quite a scratch collection of general-purpose valves also gave very fair results, so that those who feel that the expense of a set of special valves is not justified need not fear that the set will work too badly in consequence. Much depends here on a choice of such a value of H.T. voltage as will give a smooth control of reaction on the long-wave side, as controlled by the potentiometer.

Second Detector and L.F. Valves

For the second detector another of the high-impedance, high-amplification factor types may be used, and some care should be devoted to the adjustment of negative grid bias on this valve to secure the best rectification.

For the two L.F. sockets there is naturally a wide choice of valves available, and any of the so-called power valves of medium size may be used in the first socket, and another, or a larger size, such as one of the special low-impedance type, in the last socket.

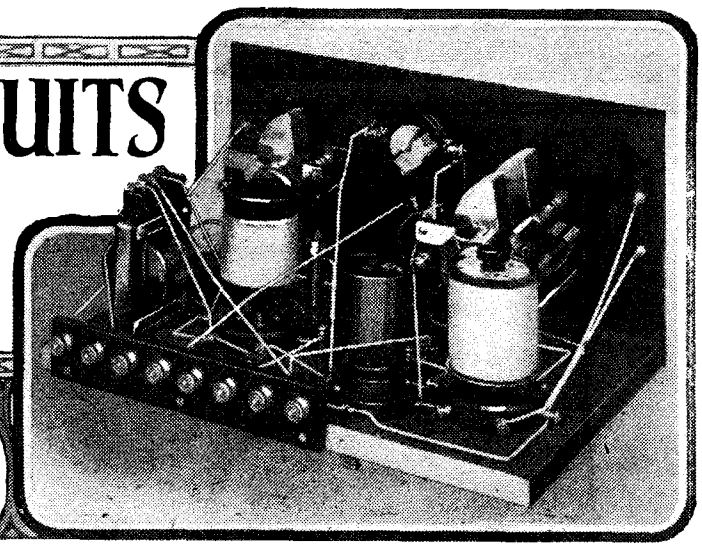
Trying Transformers

An interesting feature of this super is that it is very easy to test different sets of intermediate transformers very quickly and easily. All that is required is to obtain some spare bases for screened coils, which can be obtained very cheaply, and mount upon them the transformers to be tested. The complete set of units can then be plugged in and compared with another in a matter of seconds.

L.F. Instability

One of the problems of all superheterodynes concerns the exclusion of H.F. currents from the note-magnifying circuits, and careful precautions were taken in the present design to achieve this end. It may be as well, however, to try a few experiments with the value of the condenser C_9, since the object here is to find the *smallest* size which will achieve the desired results. If the condenser is too big, the quality of reproduction will suffer, while if it is too small, the set will be unstable and prone to emit squawking noises when the long-wave potentiometer is adjusted.

REFLEX CIRCUITS WORTH TRYING



An article of interest to all reflex enthusiasts. It places before the reader much practical and helpful information resulting from months of intensive research

IN a recent issue of MODERN WIRELESS I described an H.F. circuit that I had found particularly efficient. This circuit, which was of the centre tap grid coil neutralised type, differed from the conventional circuits of this description in respect of the lead from the centre tap, which instead of being connected straight to L.T.— had an H.F. choke placed in series.

Simple Reflexing

The circuit of a single stage is shown in skeleton form in Fig. 1*a*. An examination of this circuit will show that it is particularly suited to reflexing, since the L.F. impulses can be fed in between the centre tap of L_2 and the L.T. lead. This gives all the advantages of the shunt feed method of reflexing without any of its demerits, and Fig. 1*b* shows how reflexing would be applied. Certain advantages that are at once apparent are that the L.F. impulses are fed into the grid circuit at the nodal point (as regards H.F. currents) of the grid circuit. This means that capacitative coupling between H.F. circuits due to the windings of the L.F. transformers is practically eliminated where multi-reflex circuits are employed.

Certain snags did crop up and these will be dealt with in order in the course of the article.

Lest any experimenters reading this article feel tempted to turn over at this point and dismiss these circuits as impracticable owing to complicated construction and difficulty in making preliminary adjustments before the receiver becomes tractable, let me say at once that no difficulty need be experienced providing that simple precautions are taken.

The only factor that makes it difficult to lay down hard-and-fast rules is the fact that different L.F. transformers behave in a different manner in circuits of this description.

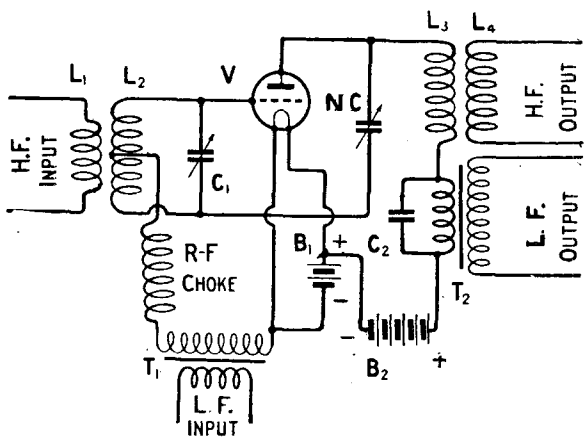


Fig. 1b.—Showing how the Fig. 1a circuit can be adapted for reflexing.

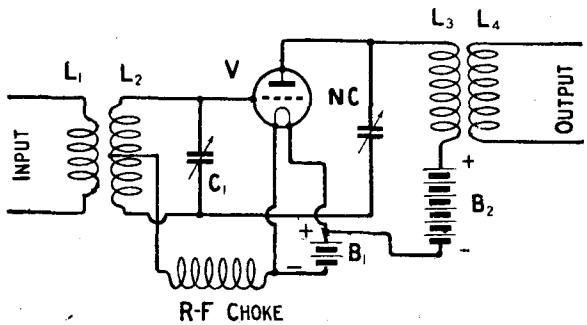


Fig. 1a.—A simple circuit which the writer has found to lend itself admirably to reflexing.

Reinartz Reaction

Of the various methods of applying reaction what is probably the simplest is the Reinartz method. In Figs. 2*a* and 2*b* the same circuit is shown with different methods of reaction control. These can of course be used with any of the circuits that follow. Fig. 2*a* shows a simplified method of obtaining Reinartz reaction where H.F. transformer coupling is used, since it makes use of the primary

REFLEX CIRCUITS WORTH TRYING—*(Continued)*

(L_3) of the H.F. transformer for reaction as well. The usual method is too well known to need reproducing here. At *2b* is shown the scheme known as throttle control in which a reaction coil L_5 is coupled tightly to the grid coil L_4 of the detector valve, a choke being placed in series with it. A variable condenser C_4 provides a delightfully smooth and accurate control of reaction.

Alternatively a swinging reaction coil may be used in which case the condenser C_4 will be omitted and the R.F. choke also, reaction being obtained in the usual manner by varying the coupling of the reaction coil to the grid coil.

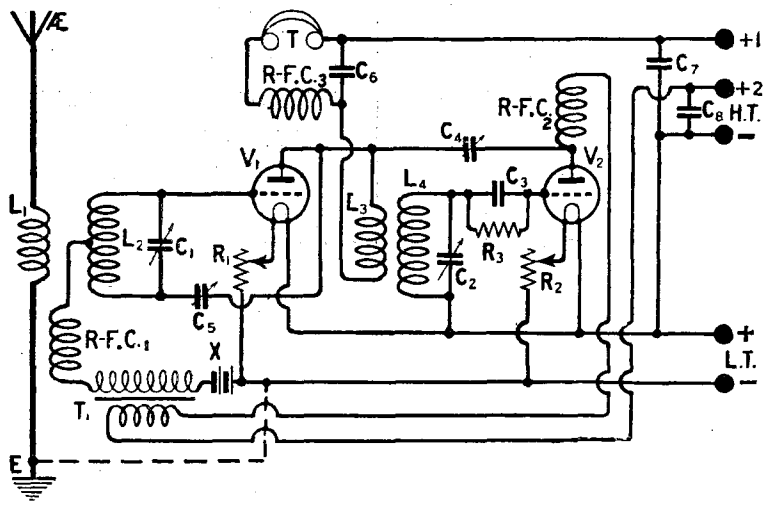


Fig. 2a.—An arrangement in which the reaction effect is produced with the aid of the variable capacity C_4.

Values

In both the foregoing circuits suitable values will be as follows :— L_1 about 35 coil, L_2 equivalent to a No. 50, L_3 and L_4 about a No. 50, C_1 and C_2 ·0005 each, C_5 is a neutralising condenser, C_3 and R_3 are the usual grid condenser and leak, C_4 for reaction may be ·0003, while filament resistances will be chosen to suit the valves and batteries in use.

Two points that should be borne in mind are that the value of H.T. used with the first valve (which acts in the role of dual amplifier) must be high enough or else partial rectification will result in the amplifying valve and, secondly, whenever possible employ a small grid battery to apply a negative bias to the grid of this valve. Such a battery is shown at X in Figs. *2a* and *2b*.

It is also advisable to use H.T. shunting condensers as shown at C_7 and C_8 of not less than 2 mfd. each, and especially does this apply to the multi-reflex circuits about to be shown.

The Prince Circuit

Before I leave the two valve circuit I should like to show a modified Prince reflex circuit, and this is given in Fig. 3. A different scheme of H.F. coupling is shown here, this being one that I first used about eighteen months ago and have found of great use on many occasions since then. It is in effect a shunt-fed tuned-anode and is particularly suited to the Prince circuit. Since reaction cannot be obtained from the detector valve with this circuit it will be necessary to make use of the neutralising condenser as a reaction control. The radio-frequency choke shown between the centre of L_2 and the coupling battery B will not be needed in all cases, much depending on the lay-out as to whether it should be included or no.

A suitable value for the coupling condenser C_4 is ·0003, but this value is by no means critical, and any fixed condenser that happens to be handy may be used.

Where reception is being carried out on the phones the radio frequency choke coil shown in one of the phone leads in three of the circuits will be found of use in reducing hand capacity effects when tuning. If a loudspeaker is used its inclusion will probably not be found necessary.

Loudspeaking

Any of the foregoing circuits will give good loudspeaker signals up to 5 to 10 miles from a local main station, depending of course on local conditions. With a frame aerial loudspeaking may be obtained up to three miles and in some cases further. On the headphones with an outdoor aerial distant stations may be received

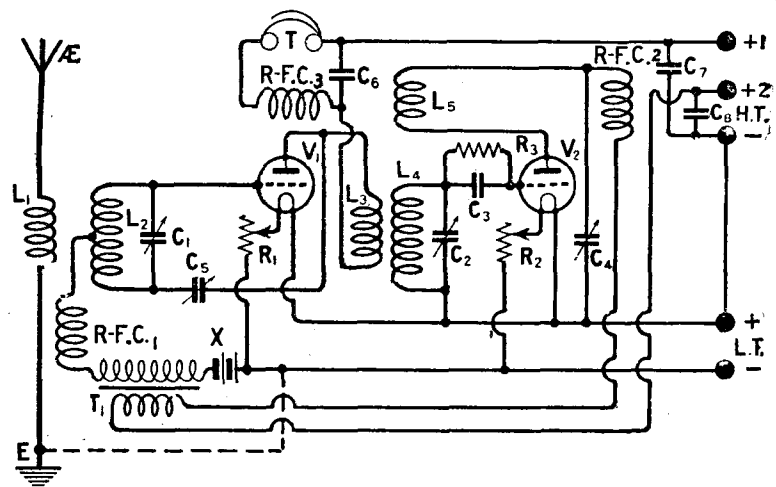


Fig. 2b.—In this circuit reaction is obtained by means of the coil L_5 and the control condenser C_4.

REFLEX CIRCUITS WORTH TRYING—*(Continued)*

and little difference in selectivity will be noticed when compared against a straight circuit.

I now come to circuits where two stages of H.F. are employed and both are reflexed at L.F.

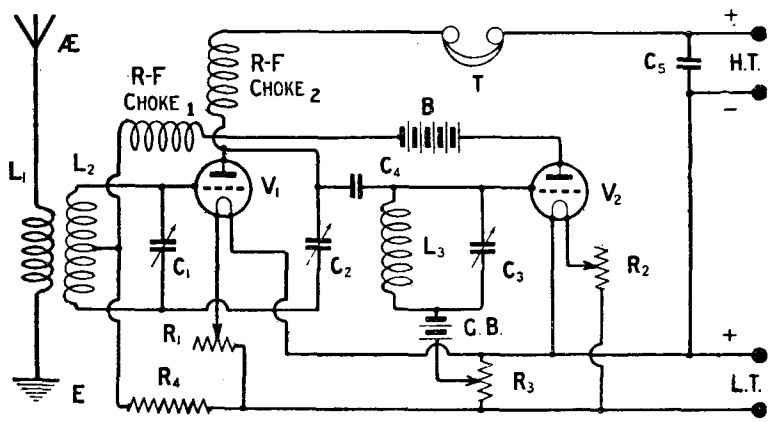


Fig. 3.—A modified Prince reflex circuit. The radio choke 1 will not be necessary in all cases.

The first point to consider here is, shall a straight reflex system be used or the inverse reflex? An important consideration that comes in here is that of rectification occuring in the H.F. valves. Mr. John Scott-Taggart has shown that in reflex circuits choke rectification may occur, especially on strong signals, owing to the presence of the L.F. transformer secondary in the grid circuit of an H.F. valve.

If however the inverse system is used as shown in Fig. 4 this trouble will not occur and the selectivity of the receiver will be retained practically unimpaired, for any rectification that occurs in the first valve will not be amplified subsequently.

H.F. Chokes

It will be noticed in Fig. 4 that H.F. chokes have not been included between the centre taps of the grid coils and the L.F. transformers. It was found in the course of experiment that these could be dispensed with and this was probably due to the secondary windings of the transformers giving all the choking effect that was required. Possibly with transformers with a rather high self capacity it would be necessary to use them, however. This is, of course, a matter that needs to be decided by the individual experimenter.

L.F. Oscillation

With a circuit identical with that shown in Fig. 4 (except that reaction was included) it was found that even at the best of times a certain tendency to oscillate at L.F. was present unless resistances as shown at R_1 and R_2 were connected across the windings of the L.F. transformers. The best values varied with the transformers and sometimes had to be as low as 100,000 ohms for R_1 but seldom less than 1·5 megohm for R_2. It is advisable to work with as high a value of resistance as possible, since a low value may cause a marked decrease in signal strength.

A Successful Circuit

A very successful circuit is shown in Fig. 5, in which the first stage of L.F. was resistance capacity and the second transformer-coupled. Although the circuit may seem a little complicated at first sight, it actually consists merely of two stages of H.F. followed by a detector employing anode bend rectification, resistance capacity re-

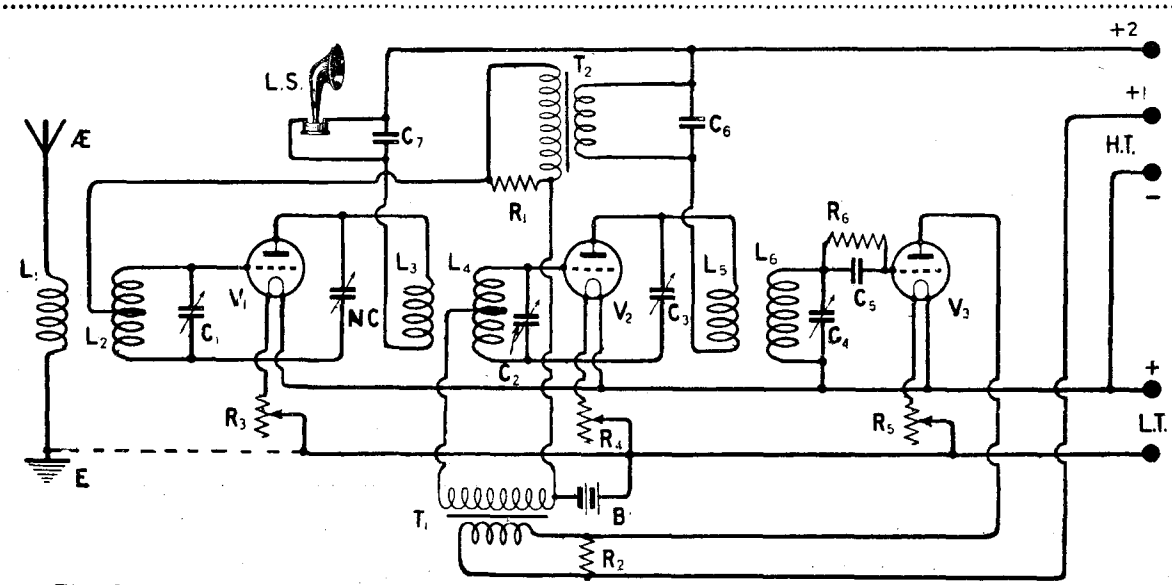


Fig. 4.—In this circuit the resistances R_1 and R_2 were used to eliminate a tendency towards L.F. oscillation.

REFLEX CIRCUITS WORTH TRYING—*(Concluded)*

flexed to the second H.F., and then transformer reflexed back to the first H.F. valve. Negative grid bias is used with both the H.F. valves, an H.T. voltage of not less than 80 volts being employed. This was with dull emitter power valves of the 5 volt ¼ ampere type. Different valves require different values of H.T. and grid bias for maximum efficiency.

With this circuit it was found possible to make the detector oscillate without the set going into low-frequency oscillation and since both stages of H.F. are neutralised it is safe to oscillate the detector without causing interference to other listeners.

Hand Effects

It is preferable that as much work as possible be done on the loudspeaker since wearing the 'phones causes capacity coupling to be introduced between the various stages when the hands are brought near the panel. This makes the set somewhat tricky to handle on very weak signals, and also for some so far unexplained reason the tendency to give a slight L.F. growl when on the verge of oscillation makes itself felt, or rather heard, although this was found to be absent otherwise.

The addition of an extra stage of L.F. was found to help cure this, and though the tendency in general to oscillate at L.F. became more noticeable, shunting the secondaries of the L.F. transformers with high resistances cut this out, and the set could be handled with the 'phones on with all three stages of L.F. in circuit.

With only 2 L.F., however, signals were of excellent strength, taking into consideration the extremely bad aerial I am forced to work with, and on the local station it was impossible to tune in fully for two reasons. Firstly it was far too loud, secondly the signals were so strong as to send the set into violent oscillation at low frequency so that nothing but a prolonged howl was to be heard.

Quality was found to be of a high order while the background was surprisingly silent. Different valves were tried in the experimental receiver that was made up for the purpose of the experiments here described and were found to function satisfactorily.

A number of different L.F. transformers were tried out, and of these only one was in any way unsuitable, all the others being easily got to work in the set.

Improving Reproduction

Where extraordinary good quality of reproduction is required the detector and first L.F. may make use of the Prince circuit, the only disadvantage to this being that reaction must be obtained by upsetting the neutralising of the H.F. stages. This also has a certain effect on the transformer-coupled L.F. stage and slightly increases the likelihood of L.F. oscillation occurring.

The keen experimenter will see that these circuits are all capable of being rearranged, different forms of L.F. and H.F. coupling being employed, and a considerable amount of experiment can be carried out on these lines.

C. P. A.

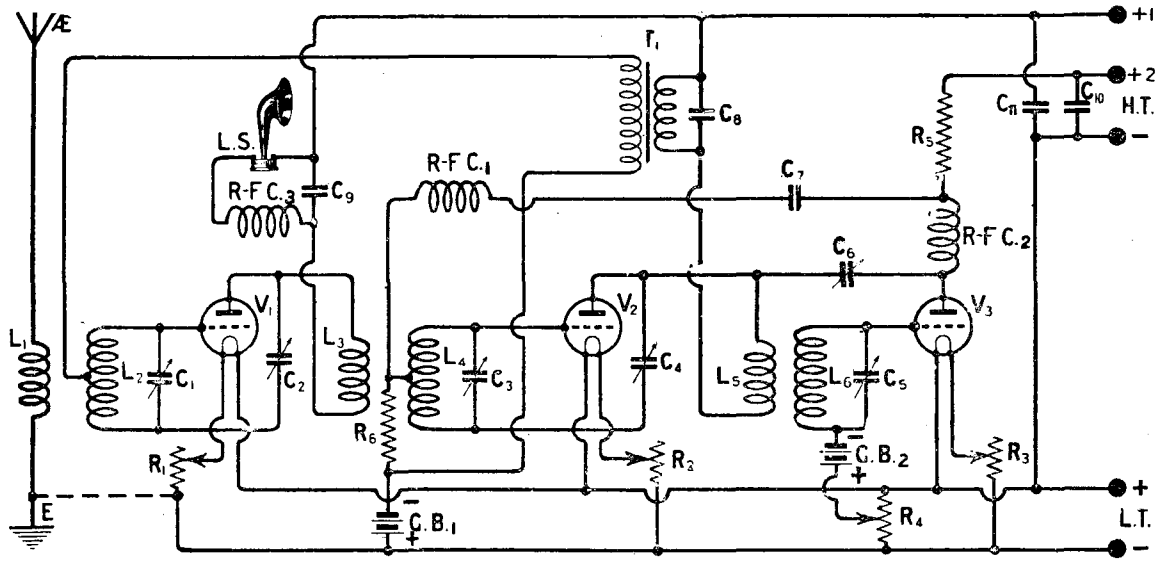
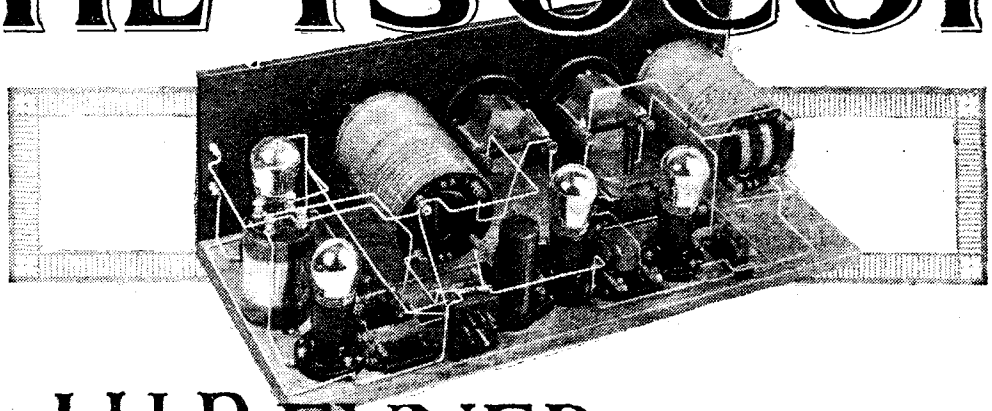


Fig. 5.—A successful arrangement incorporating a combination of transformer and resistance-capacity coupling on the low-frequency side.

THE "ISOCOIL"



By J. H. REYNER, B.Sc. (Hons), A.M.I.E.E.

This receiver has been specially designed in response to readers' requests for a neutralised four-valve set to cover a waveband of 200–4,000 metres with the same coils. It is easy to operate, will receive distant stations, and in addition gives pure reproduction, in short it is a modern receiver of the highest efficiency.

WHEN wireless first started there was a craze for building receivers which would cover a considerable wavelength range of about 300 metres up to 4,000 or 5,000 metres. In those days indeed such wide ranges were necessary, because the number of stations from which interesting transmissions were radiated was comparatively few. A good deal of the transmissions were in morse, and much of the interest lay in tapping different sources operating on different wavelength ranges.

The switching idea remained when broadcasting started for some time, and there was an era of switching of all sorts, not only to change the wavelength band, but to cut out or bring in one or more valves to the receiver. Gradually it became appreciated that switching was, in general, detrimental to the efficiency of the receiver, and little by little the switches began to drop out of the various designs.

Other Stations

This tendency was assisted by the fact that broadcasting became concentrated in a smaller band of wavelengths which could easily be covered by one set of coils. In America this condition of affairs has remained, which makes the task of the set designer very much easier. In this country, on the other hand, we have the Daventry station, and for many reasons this transmission is of particular service to the average listener. But this is not

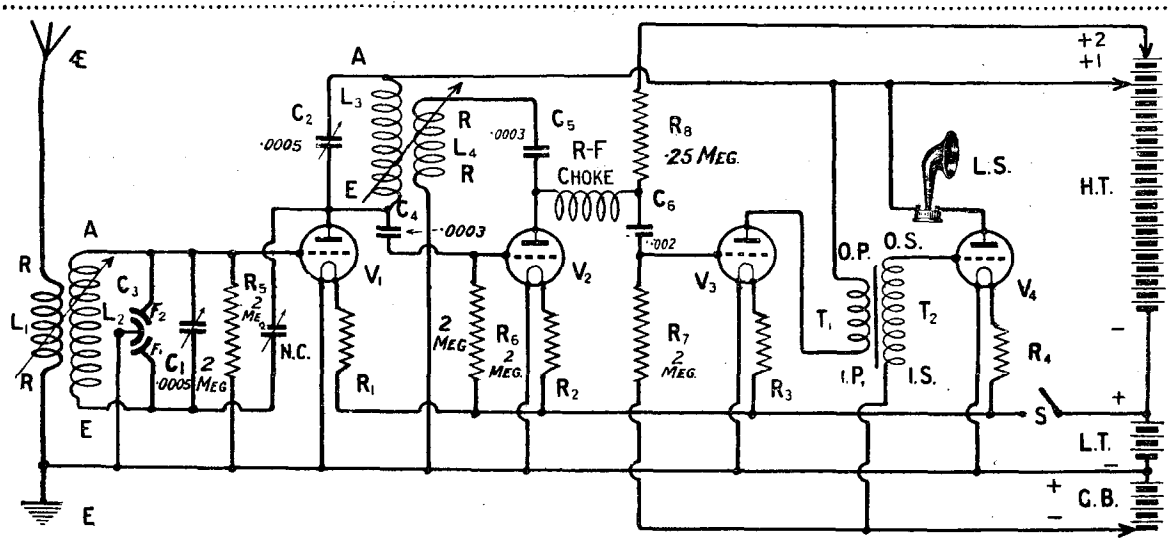


Fig. 1.—The theoretical circuit of the "Isocoil." Note that a centre-tap effect is obtained by means of the balancing condenser C_3.

A SET FOR ALL BROADCAST WAVELENGTHS

the end of the story. There are quite a number of very interesting stations radiating programmes on wavelengths quite outside our normal broadcasting band, and there is some justification for wanting a receiver which will enable these stations to be obtained.

Now this demand for an extended wavelength range makes the work of the designer considerably more difficult. It is possible to design high-frequency circuits having transformers which will give a uniform and good amplification over a certain more or less limited band of wavelength. When this wavelength band has to be extended the design of the transformers has to be altered. In some cases the type of circuit employed is not so suitable on the higher wavelengths.

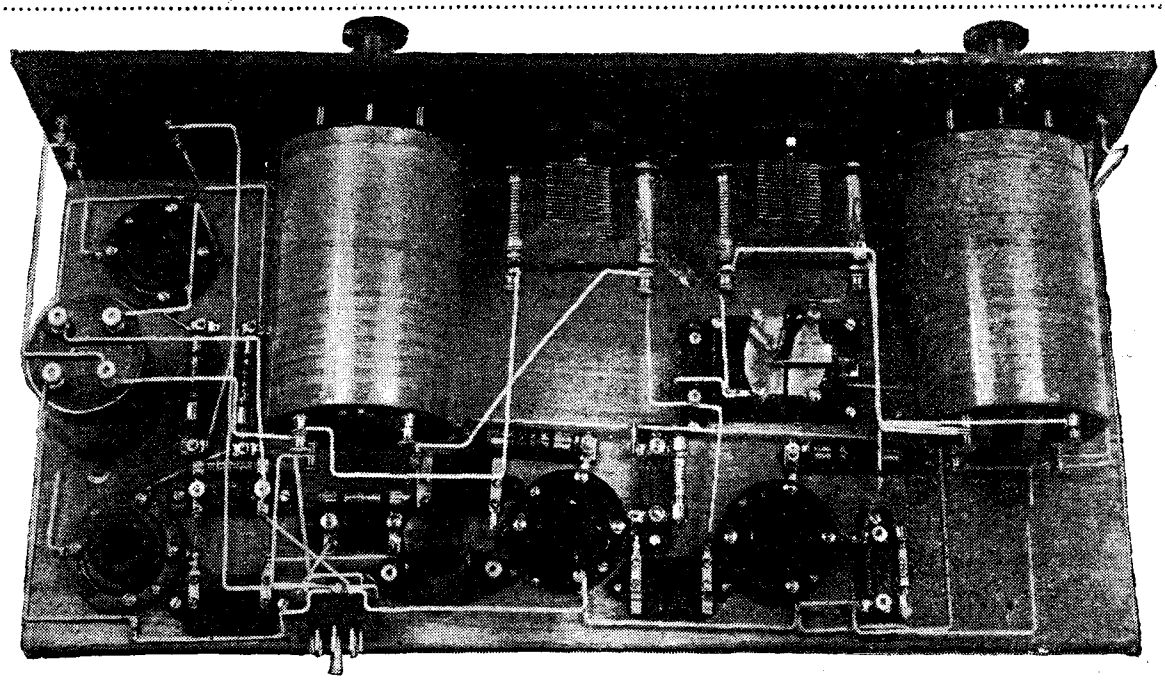
One H.F. Stage

The present receiver is an attempt to apply the knowledge gained recently and the methods which have proved their merits to the problem of the extensive wavelength band. In order to facilitate the reception of foreign programmes it was decided to incorporate one stage of high-frequency amplification. This with a reaction coupling provided on the second valve enables the receiver to be handled very easily, and, since the first stage is neutralised, without danger of interference to the neighbours.

The Tuned Anode

If a wide range is to be covered a transformer-coupled receiver is almost out of the question unless two or more sets of transformers are utilised which are switched in and out at will. The problems arising out of such a procedure would be very numerous, and it was decided to endeavour to utilise a simpler method. Recourse was made therefore to our old friend the tuned anode. With a circuit of this nature it is only necessary to have a single coil instead of a transformer. If we can find a convenient method of tapping this coil so that we may use it for a variety of wavelength ranges, then we are on the way to solving the problem.

After looking round the various components available it was decided to employ an R.I. Retroactive tuner for the purpose in question. This consists of a single-layer coil wound in sections on a large diameter paxolin former with a swinging coil fitted at the far end in order to produce coupling effect. The various sections are all connected to a switch, which is so arranged as to minimise the effect of dead ends, instead of taking a straightforward tapping on the coil in which there would be a considerable dead-end effect when only a small portion was in circuit, the switch is arranged to short-circuit the section immediately next to the tapping point, and this acts as a screen, so preventing the unused portion of the coil from influencing the portion in circuit to any considerable extent.



The neutralising condenser can be seen in this photograph near the edge of the balancing condenser. It is adjusted by means of a small screwdriver.

Efficient Reaction

The effectiveness of the arrangement is shown by the fact that, when the unit is employed as a single valve detector set, one comparatively small reaction coil provides sufficient coupling to act as a reaction over the whole of the range from about 200 metres up to 3,000 or 4,000 metres. If any serious loss were introduced into the circuit by dead-end effects on the short wave a smooth oscillation would not result, but no trouble of this nature is experienced.

This unit has been used by several set designers, and many readers must also have had oppor-

THE "ISOCOIL" — *(Continued)*

tunity of trying it out from time to time. It was decided therefore to use two s[illegible]ers in order to provide a tu[illegible]e arrangement, the first one [illegible]g in the aerial circuit, and the second one in the anode circuit of the high-frequency valve. As was previously mentioned, it was decided to neutralise the high-frequency valve. Now with a coil such as this, which is tapped with a single switch in order to obtain the different wavelength ranges, it is rather difficult to obtain the neutralising necessary, which usually demands a centre tapping on the coil.

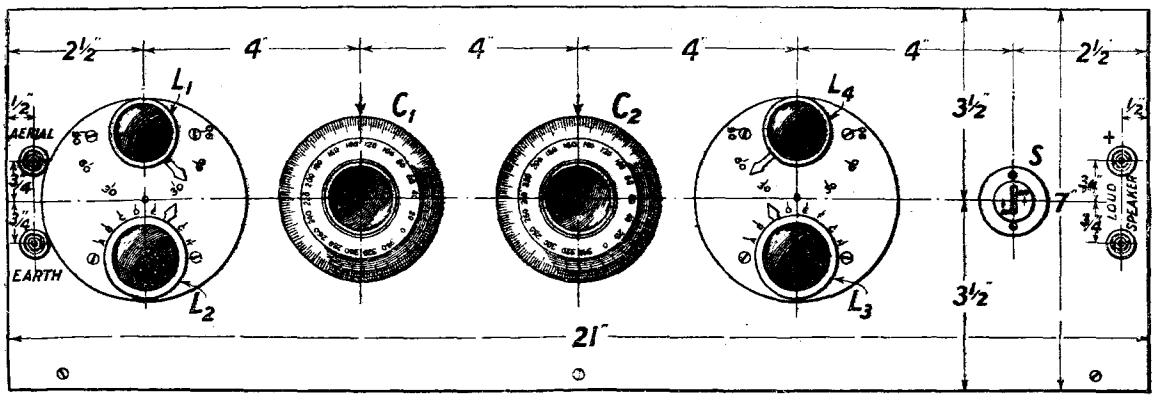


Fig. 2.—The panel drilling diagram. Blueprint No. 187a (free). It will be noted that all the main components are mounted upon the centre line of the panel.

An Alternative

An alternative way out of the difficulty is to use the dual condenser, or to place a small balancing condenser across the coil, and so obtain an electrical centre-tapping in this manner. This latter method has been adopted in the case in question, the first grid coil having a small balancing condenser connected across it, the filament connections being taken to the centre of this coil. One end of the coil then goes to the grid and the other end goes through the neutralising condenser to the anode.

Incidentally the neutralising condenser has been made a very small and attractive type which is operated by a screwdriver, so that once the neutralising point has been found it does not have to be altered again. With the type of circuit adopted neutralising adjustment remains stable over the whole of the wavelength range from 200 to 4,000 metres, so that this adjustment can be made once and for all when the set is first completed.

High Amplification

Some thought was expended concerning the possibility of using a tapped tuned-anode arrangement in order to minimise the damping on the tuned circuit imposed by the previous valve. After some consideration, however, it was decided, in the interest of simplicity, not to do this, particularly as it was proposed to utilise for the circuit one of the new high-impedance valves such as the Benjamin or Cosmos Blue Spot (which may be obtained in either the 6-volt or the 2-volt class), which have a very high impedance of the order of 60,000 or 70,000 ohms and an amplification factor of the order of 35. This means that with correct design the amplification over the whole stage will be of the order to 25 to 30, which is tolerably good for a high-frequency stage considering the wide wavelength range which has to be covered.

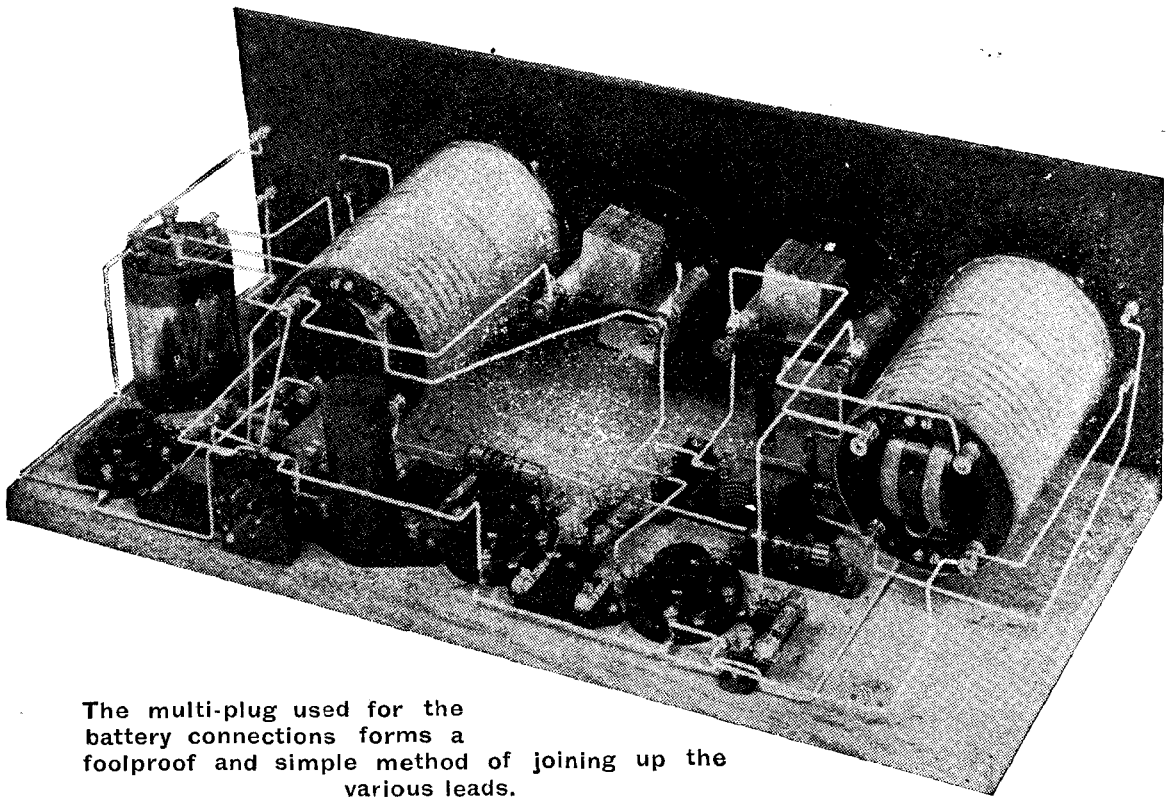
The L.F. Side

In order to obtain good quality

COMPONENTS REQUIRED

One Panel 21 in. by 7 in. by ¼ in. (British Ebonite Co.)
Two Retroactive Tuners. (Radio Instruments Ltd.)
Two ·0005 variable Condensers. (Newey.)
Four Valve Holders. (Wearite.)
Four Dumetohm Resistance Clips. (Dubilier.)
Three 2 megohm Leak. (Dubilier.)
One ·25 megohm Leak. (Dubilier.)
Four Amperites (to suit the particular valve in use) (see the description of the recommended valves later in this article). (Rothermel Radio Corporation of Great Britain)
One Multi Plug. (Wright and Weare, Ltd.)
One Neutralising Condenser. (Bremer-Tully Micro-mike.)
One High-Frequency Choke. (Lissen, Ltd.)
Two ·0003 Fixed Condensers. (Dubilier.)
One ·002 Fixed Condenser. (Dubilier.)
One Balancing Condenser. (Peto-Scott, Ltd.)
One On-Off Switch. Frost Toggle. (Rothermel Radio Corporation of Great Britain, Ltd.)
Four Terminals.
Quantity of Glazite Wire.
Packet R.P. Panel Transfers.
Cabinet with baseboard 8½in. deep.
L.F. Transformer. Concert Grand. (Eureka.)

LOCAL OR 5XX WITH SAME COILS



The multi-plug used for the battery connections forms a foolproof and simple method of joining up the various leads.

reception combined with efficient rectification, and, further, in order to permit of the use of a high-impedance detector valve which minimises the damping introduced by the detector circuit on the preceding tuned circuit, a resistance-coupled stage has been arranged for the first of the note magnifiers, this being followed by a conventional transformer-coupled stage. The resistance coupling makes use of the new type of high-resistance unit, made up in this case from individual resistances and condensers, and designed to be used with a similar valve to that used in the first stage.

Valves

Thus the valves required for the satisfactory operation of this receiver are two extra-high-impedance valves for the high-frequency and detector, and two low-impedance power valves for the first and second note-magnifiers. Those

WIRING INSTRUCTIONS.

Join aerial terminal to left-hand terminal of L1.

Join earth terminal to other side of L1 and thence to one side of R5, F– of V1, F– of V2, L.T.– and G.B.+, F– of V3 and F– of V4. Join F – of V1 also to moving plates of C3. Join G.B.+ also to left-hand terminal of L4.

Join terminal A of L2 to one side of C1 and thence to F2 of C3. Join terminal A of L2 also to G of V1 and remaining side of R5.

Join P of V1 to one side of C4 and also to one side of N.C., and thence to one side of C2 and terminal E of L3.

Join terminal A of L3 to remaining side of C2 and also to H.T.+1. Join terminal A of L3 also to O.P. of transformer T1 T2, and thence to loud-speaker + terminal.

Join remaining side of C4 to G of V2 and one side of R6.

Join other side of R6 to one side of R1 and to one side of R2, and from latter point to one side of R3, one side of R4, and one side of switch S.

Join other side of S to H.T.– and L.T.+.

Join P of V2 to one side of R.F. Choke and to one side of C5.

Join other side of R.F. Choke to one side of R8 and to one side of C6.

Join other side of R8 to H.T.+2.

Join remaining side of C5 to remaining side of L4.

Join remaining side of C6 to G of V3 and one side of R7.

Join other side of R7 to G.B.– and also to I.S. of T1 T2.

Join P of V3 to I.P. of T1 T2.

Join O.S. of T1 T2 to G of V4.

Join P of V4 to remaining loud-speaker terminal.

Join terminal E of L2 to remaining side of C1 and thence to F1 of C3 and remaining side of N.C.

Join remaining sides of R1, R2, R3 and R4 to F+ of V1, V2, V3 and V4 respectively.

THE "ISOCOIL" — *(Continued)*

readers who desire may of course use a super-power valve for the last valve in order to avoid any possibility of blasting on the local station. Definite recommendations as regards valves will be made later in the article.

Battery Connection

The only other point which requires comment is the method leading out the battery connections to the set. For this purpose a very ingenious component known as a multi-plug is utilised. On the receiver itself is a system of seven pins arranged round the circumference of a circle, and to these pins the several receiver connections are taken. The connections from the various batteries are taken to a plug which is provided with seven sockets designed to fit over the pins on the other portion of the component. An extra pin is provided registering with another hole on the plug in such a position that it is impossible to insert or connect up the plug in an incorrect manner. Since the battery leads, which are live, are connected to the sockets, no danger of shorting arises, and altogether it is one of the most convenient arrangements of making battery connections which I have seen for some time. It is particularly advantageous in that all live leads are completely covered, and there is thus no possibility of shorting the leads or accidentally burning out the valves.

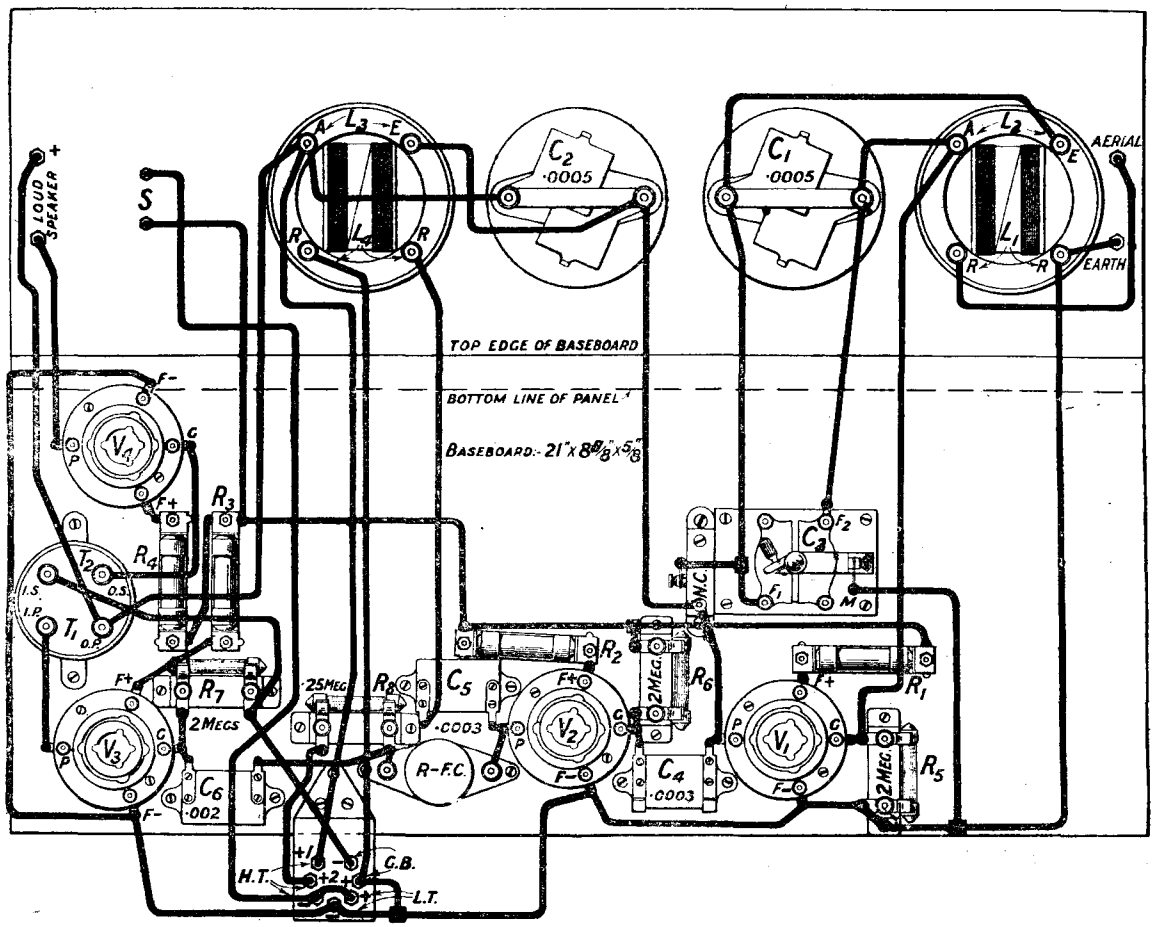


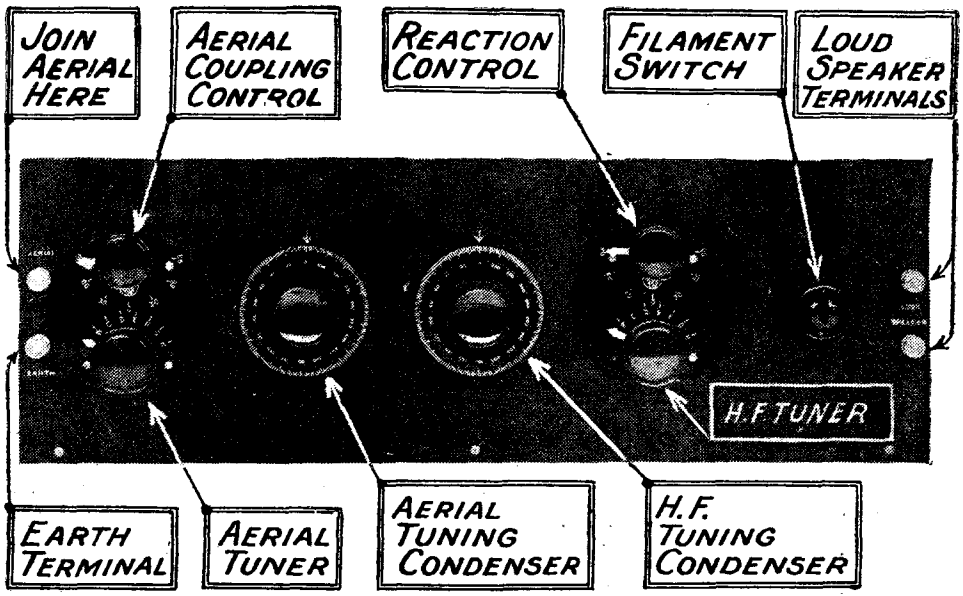
Fig. 3.—This wiring diagram is obtainable as a full-sized Blueprint free of charge. Ask for Blueprint No. 187b.

Marking Out

First of all mark out the panel in accordance with the panel drilling diagram supplied. The R.I. tuners are held in position by four screws, extra holes being required to permit the spindles of the switch and reaction control to be brought through to the front of the panel. The condensers and on-off switch will readily be mounted, as also will be the two pairs of terminals, one at each end of the panel.

It is advisable at this stage to mount the panel temporarily in position on the front of the baseboard, and lay out the components in the positions shown on the back-of-panel diagram. There is ample space except in the region of the resistance-coupled note-magnifier, where a little care has to be taken in order to space the components correctly. If the layout shown is followed, however, no difficulty will be experienced.

THE "ISOCOIL" — *(Continued)*



By means of the two tuners employed a wavelength range of from 200—4000 metres may be obtained.

The components may then be screwed into position on the base-board and the wiring up commenced. It will be found to simplify matters if the majority of the filament and low-frequency wiring is carried out with the front panel removed.

Completing the Wiring

The panel may then be fixed into position and the remainder of the wiring carried out, which will be found to be a comparatively easy matter. It is essential to wire the connections between the high-frequency valve and the two tuned circuits exactly in the manner shown. There is the small coupling between the two circuits, partly capacitative and partly magnetic. With the wiring as shown the two couplings tend to oppose each other, and the effect therefore is only slight.

Testing

When the receiver has been completely wired up it may be placed on test, and little difficulty will be experienced in its operation. It is first of all necessary to place the range switches on the two tuners to the same point. The coupling coil on the first tuner, which will be seen to be acting an aerial coupling coil, should be placed at about 45 degrees; either direction of coupling may be used, as the results are not appreciably affected by the direction of coupling. The coupling on the second tuner is utilised for reaction, a form of parallel feed reaction having been incorporated, as will be seen. This has been done because if the reaction coil were inserted in series with the very high resistance in the anode circuit little effect would result. Moreover the connections adopted have the advantage of keeping the high frequency to its own quarters and preventing H.F. currents from leaking through to the L.F. side of the receiver.

Neutralising

It is advisable to tune in to the local station, the approximate setting of which can be obtained from the test report which is given later in this article. This should be done with the reaction coupling on the right-hand tuner at zero. Tune in the stations, and then remove the Amperite controlling the first (high-frequency) valve. The neutralising condenser may then be adjusted until a silent point is obtained in the usual manner.

Care should be taken that when carrying out this operation the circuits are as nearly as possible in tune, and it is advisable to retune the circuit after the Amperite has been removed, as it is sometimes difficult to gauge the exact point on the local station when all four valves are going.

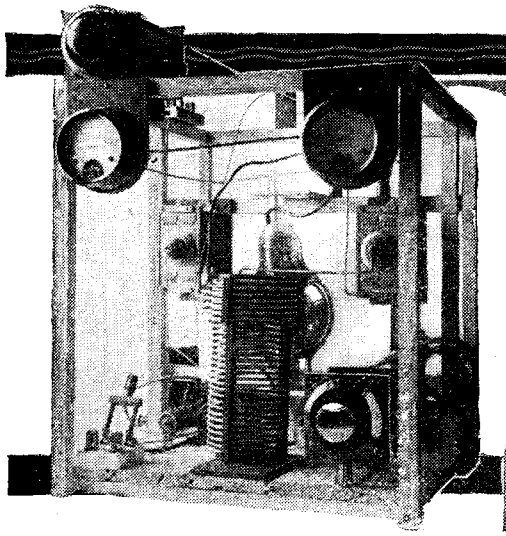
Searching

Having found this neutralised position, the neutralising condenser may then be left set, and will not

(*Concluded on page* 745.)

STATIONS RECEIVED ON LOUD-SPEAKER.

Station.	*Wavelength.*	*Aerial.*	*Tuned Anode.*
Antwerp	265.5	C 160	C 140
Newcastle	312.5	C 210	C 190
		D 150	D 130
London	361.4	E 140	E 110
Manchester	384.6	E 150	E 120
Bremen	400	E 165	E 135
Birmingham ..	491.8	E 200	E 180
		F 140	F 120
Ships	600	F 190	F 170
Lausanne	850	G 180	G 160
Daventry	1600	H 230	H 200
Radio-Paris	1780	H 255	H 240



A CRYSTAL-CONTROLLED 45-METRE TRANSMITTER

By J. H. D. Ridley, (G-5 NN)

The accurate control of the wavelength of a broadcast or Morse transmitter is becoming increasingly important. This in particular applies to short-wave transmission. Mr. Ridley's description of his crystal-controlled transmitter will therefore be found of great interest by those enthusiasts who are eager to keep abreast with modern developments.

THE practical applications of the piezo-electric qualities of certain quartz crystals have for some considerable period occupied the time and interests of both professional and amateur wireless engineers.

Although a certain amount of research has been carried out in this country on this particular type of crystal, far more appears to have been done in America, where its application to wireless was brought into prominence, first, as a resonator and, secondly, as an oscillator. No doubt readers will remember the crystal-controlled sets of NKF, the American Naval Research Station situated at Bellevue, where both 40.9 and 20.8 metre transmitters are stabilised in this manner. Also it is well to remember that KDKA on 68 metres is controlled by a quartz crystal.

The Principle

Let us for a moment consider how the particular qualities of this crystal enable it to control the output of a transmitter.

If the crystal is placed between two metal plates and a slight but constant mechanical pressure applied, an electrical charge will be produced on the two plates. By this it will be noted that a mechanical effect is giving rise to an electrical effect. Therefore, if we reverse the operation and apply to the crystal, through the medium of the plates, an alternating potential of a certain frequency we shall find that the crystal will be set into mechanical vibration, inasmuch as it will tend to expand and contract to a certain degree either side of its normal breadth, and, as its mass cannot alter but only change its shape very slightly, it naturally varies its thickness in a manner proportional to the variation of the first dimension. This effect is illustrated in Fig. 1.

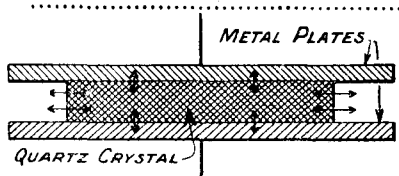


Fig. 1.—The arrows indicate how the crystal expands and contracts.

Frequency and Vibration

Now as these two effects, the mechanical and electrical, are dependent one on the other, it will be seen that an alternating voltage is being set up between the plates, the frequency of which corresponds to the natural period of the crystal. If an electrical impulse is given to the crystal it will set up an alternating voltage which will gradually fall in amplitude over a period of time governed by the density and elasticity of the particular specimen of quartz, but if these impulses are continued at a given frequency we can maintain the crystal in a state of continuous mechanical vibration

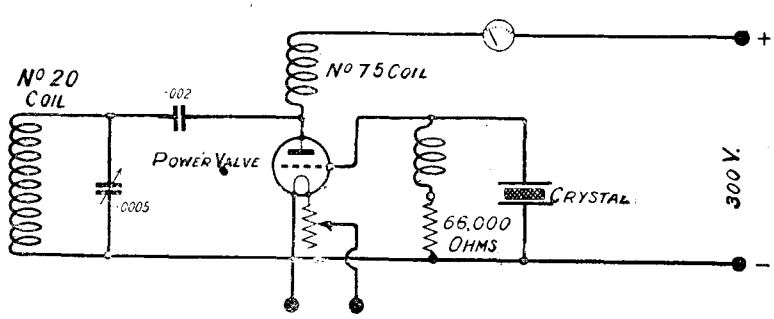


Fig. 2.—A circuit used for finding the fundamental frequency of a crystal.

A CRYSTAL-CONTROLLED TRANSMITTER—*(Continued)*

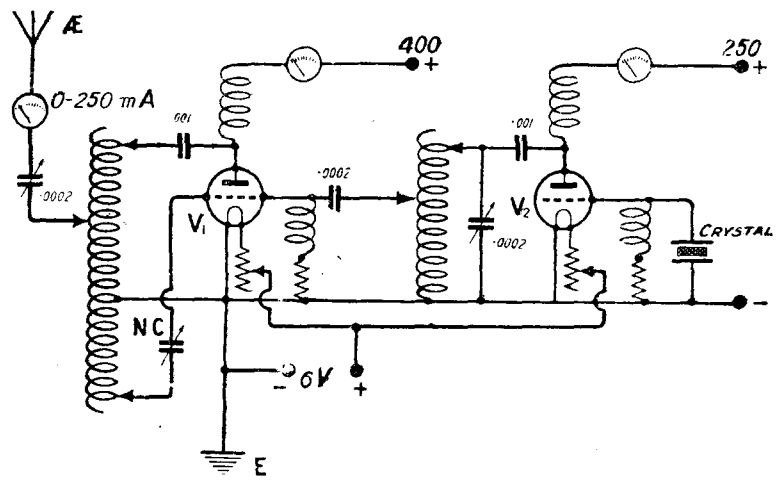
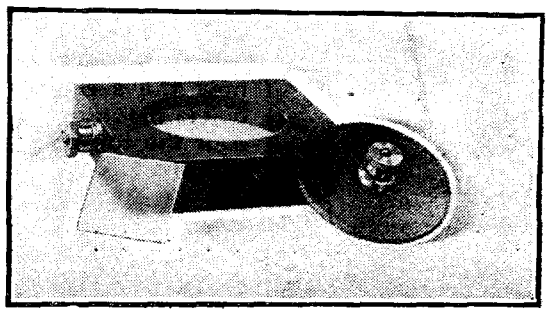


Fig. 3.—A low-power crystal-controlled circuit used by the author.

which is so rapid that it corresponds to radio frequency. Just as a musical instrument string when struck will only vibrate at its natural frequency, which is dependent on its length, thickness and elasticity, so will a quartz crystal only oscillate at one particular frequency (or harmonics thereof). The properties which govern this frequency have already been mentioned.



The neat type of crystal mount used at 5NN.

Conditions

If, therefore, a quartz crystal is obtained which has been correctly cut with proper regard to its geometrical and optical axes and ground so that both faces are absolutely parallel, and connected in a circuit as shown in Fig. 2, it will be found that the circuit will oscillate fiercely at the fundamental frequency of the crystal. The anode tuning condenser should be rotated very slowly as the resonant point of the crystal is so sharply defined that it is quite easy to pass over it if the condenser is rotated too quickly. This circuit was used to select the crystal for the transmitter at 5NN a large power-valve being used with 300 volts on the anode. At this voltage the plate current was approximately 25 milliamps, which fell to 10 m.a. when the crystal was oscillating. The inductance consists of a Burndept Short Wave Coil, No. 20.

It is interesting to note that when in place of the usual 300 volts H.T. shown in Fig. 2, 220 volts A.C. from the mains was applied, the resultant note produced was a very pleasing half-wave rectified note with clear high-pitched pulses. When the mains were full-wave rectified and applied to the oscillator valve without any pretence at smoothing, the result was almost pure D.C. Surely some of our Continental friends will appreciate crystal control.

Mechanical Stresses

It must be remembered that the potential produced by the mechanical vibration of a quartz crystal is very small indeed, and, similarly by reversing the effects, the vibration at a given potential is also minute. However, if the applied potential be heavy the crystal vibrations will build up to such an amplitude that the crystal will crack or break and by so doing render itself useless.

Alternatives

In view of the comparative weakness of oscillation of the crystal it is necessary to amplify it considerably before it is strong enough to control a valve dissipating two or three hundred watts. To get a three or four stage radio-frequency amplifier working successfully on 45 metres is no mean feat, but to get a crystal with that fundamental frequency is harder still. Therefore, one has to make use of one of two alternatives, namely (1) to obtain a crystal with a fundamental frequency that will produce a harmonic between 44 and

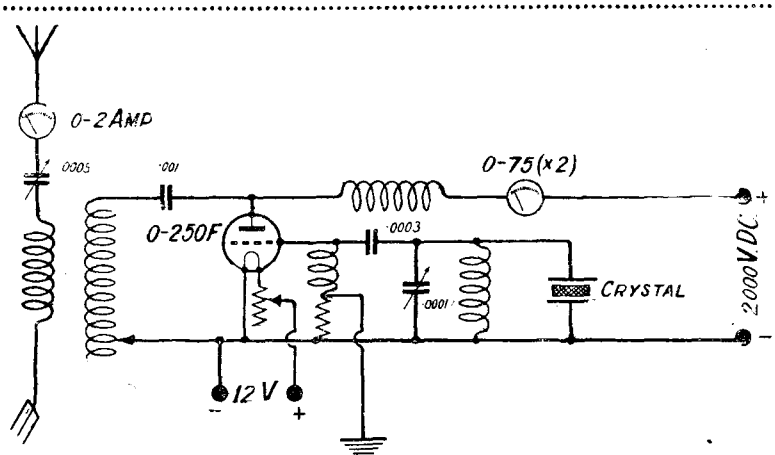
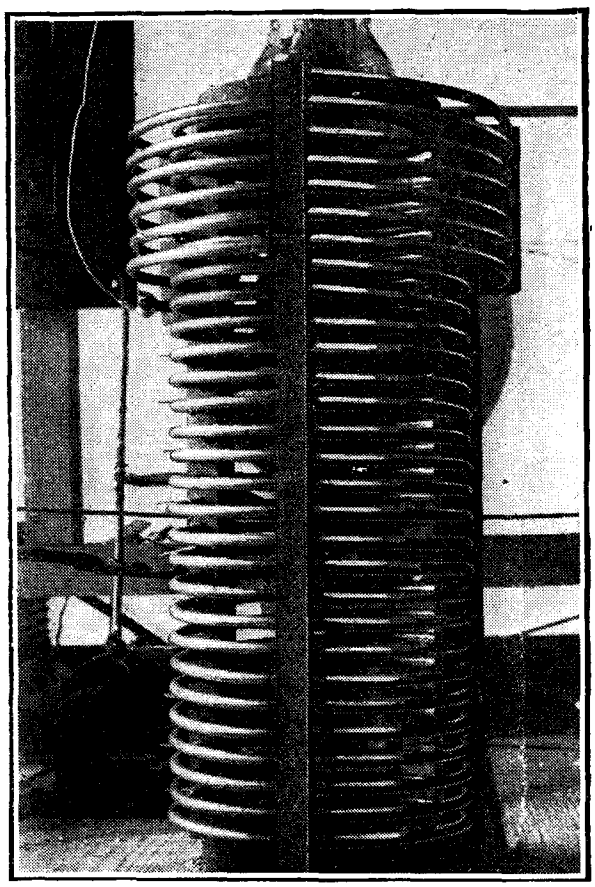


Fig. 4.—It is possible in such circuits as the above to work on a harmonic of the fundamental wavelength of the controlling crystal.

A CRYSTAL-CONTROLLED TRANSMITTER—(*Continued*)

46 metres, amplifying the fundamental and then doubling or trebling the frequency as the case may be, and passing it on to the final amplifier, or (2) connecting a crystal with a high-wave fundamental directly across the grid coil of the oscillator valve and tuning the set to the harmonic required. This is the method that has been adopted at 5NN with marked success and is, the writer believes, the only transmitter that is controlled by a crystal in this particular manner. It is only possible to do this with a comparatively thick crystal, as the applied potential would be too great for a quartz oscillator with a fundamental of that wave.



This photograph of the main inductance shows how the aerial coil is mounted over the top of the anode coil.

Practical Details

The actual crystal in use at 5NN has a fundamental of 133.5 metres, which produces the third harmonic at 44.5 metres (and incidentally a host of other parasitic harmonics above and below this wave for some unknown reason, all of which, however, are far too weak to worry about). The note is absolutely pure and clear and free from any keying click or thump, and has the peculiar bell-like quality which seems to be common to all crystal controlled sets. After working the set for a lengthy period the crystal warms up to, roughly, 100°F., which temperature it maintains. Apparently this heating up has no effect upon the crystal, for it has never yet refused to function and has been in operation for quite a considerable period. Incidentally, it may be stated that great assistance was afforded by Mr. Hinderlich of Lechmere Road, N., who placed at the writer's disposal a number of crystals to test and select from.

The First Set

Regarding the construction and other details of the transmitter, the following data will no doubt prove of interest.

The first set built was of quite low power and was really constructed to test the properties of the crystals and find out what effects were produced when this method of control was used on a master oscillator. The circuit is shown in Fig. 3 and is constructed for use on the fundamental of the quartz—namely, 133.5 metres. This set gave very satisfactory results, and was only abandoned when it was found that to operate it on 44 metres with a crystal of that frequency was far too difficult when other methods gave exactly the same results with far greater ease in manipulation.

The Main Transmitter

The second set, which is the main set at 5NN, embodies the principle suggested in alternative (2) and is shown theoretically in Fig. 4. Actually, the set is built up in a framework of white wood measuring 18in. high by 16in. wide and 16in. deep. The anode and grid inductances are built in the approved "low loss" style in order to reduce self-capacity.

The Anode Inductance

For the anode inductance three ebonite strips 8in. by 5/16in. by ½in. were taken and carefully rubbed down to remove the shiny surface which is imparted in the manufacturing process and which often accounts for poor results when not removed. Each strip was then carefully marked out and drilled with a No. 25 drill to take 12 gauge wire spaced one diameter. The wire was then threaded through these strips in inductance form, and the supports were then mounted equidistantly, and at either end on a ⅜in. section of 2¾in. external diameter ebonite tube, so as to make the whole inductance absolutely rigid. This inductance has in all twenty-seven turns, of which eighteen are actually in use for 44.5 metres. Incidentally, the inductance is tagged at every turn to facilitate tapping. Over the top

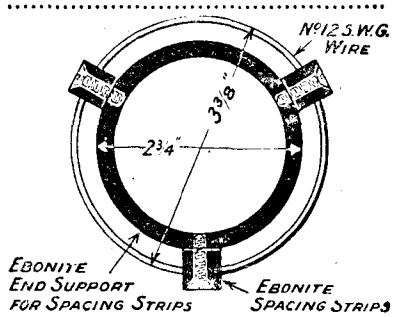
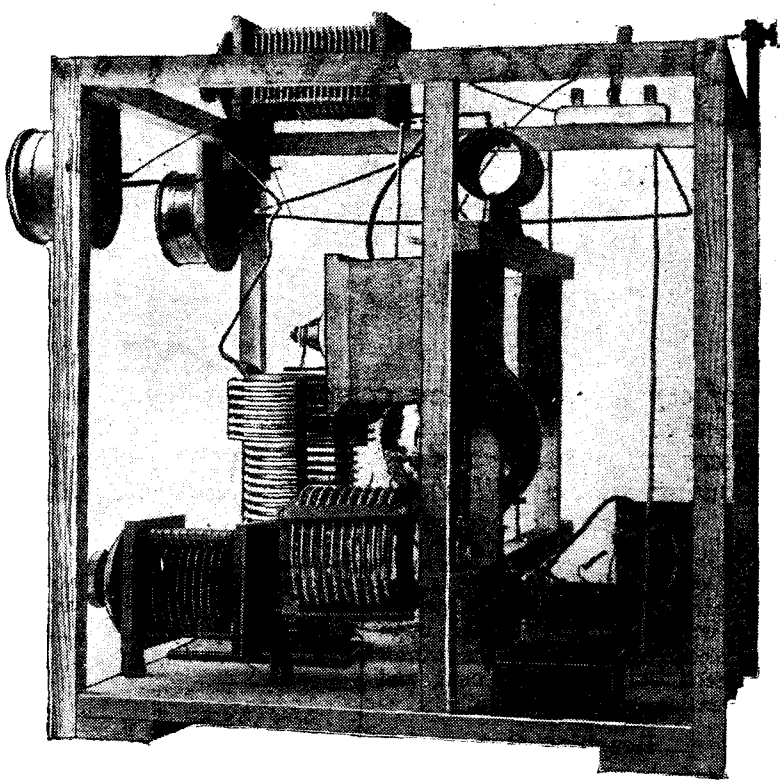


Fig. 5.—The strips on which the anode coil is wound are supported by pieces of ebonite tube.

A CRYSTAL-CONTROLLED TRANSMITTER—(Concluded)



A general view of the transmitter from which the method of mounting the grid tuning condenser and H.F. choke on ebonite pillars may be gathered.

end of this coil is wound the aerial coil, which is merely six turns of 12 gauge wire wound on three ebonite strips and sprung over the three strips supporting the anode inductance. Reference to Fig. 6 will indicate the manner of construction.

The Grid Coil

The grid inductance is built in a similar manner to the anode coil, except for the fact that there are only ten turns wound on and only six in use. The actual diameter between wire centres in both anode and grid coils is 3⅜in. In case this point is not quite clear it is shown in Fig. 5. The grid choke is wound on a 2in. tube and consists of fifty-four turns of 32 gauge D.S.C. wire. The anode choke is also wound on a similarly sized tube but consists of 135 turns of 36 gauge D.S.C. wire. The valve in use is a Mullard 0.250F, and is supplied with filtered and full wave rectified A.C. at 2,000 volts from two U.1 rectifying valves. Normal input to the oscillator is 190 watts.

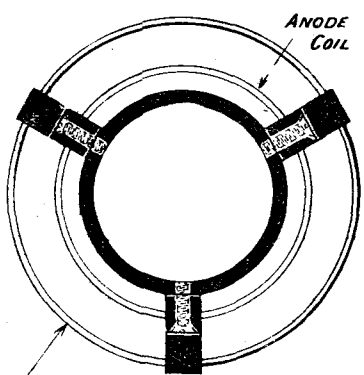


Fig. 6.—The turns of the aerial coil are mounted over the supports for the anode coil.

The Crystal Holder

The crystal holder is constructed from a block of ⅝in. ebonite and is 3 in. square, with a recess 2 in. in diameter and ¼ in. deep cut out in the centre. A brass plate of just under 2 in. diameter is placed at the bottom and a connection brought out to a terminal in the side. The crystal is placed on this plate and upon the crystal the other plate, which has its connection taken from a terminal fixed to the centre. (See Fig. 7.) Both these plates are carefully ground with grinding powder and finished off with rouge, until the contact faces are dead smooth and true. It may be stated in passing that it is absolutely essential that these plates should be as accurately ground as possible, as much of the success in getting the crystal to oscillate depends upon their condition. If the plates have been carefully ground they should be capable of lifting each other up by merely resting one on the other.

The block of ebonite is mounted on a pad of sorbo-rubber to minimise mechanical shock, as any vibration tends to throw the crystal off oscillation.

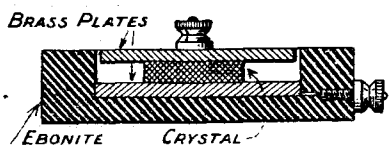
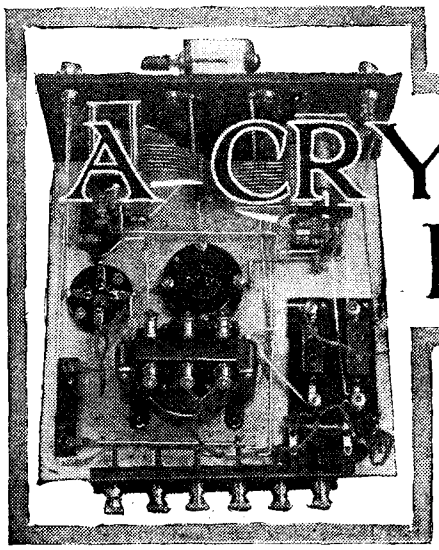


Fig. 7.—This sectional view of the crystal mount clearly shows its construction.

As a point of interest, the whole transmitter at 5NN can be moved as far as the supply leads will permit while it is actually oscillating without causing any variation of note. Several minor adjustments are necessary before the crystal will work at its maximum efficiency, but as these adjustments vary for the different stations, it is impossible to lay down any definite rules here.

Results

In conclusion, it may be stated that the building of the set has been well worth while, for never has such a perfect and stable note been obtained by any other method, many of which, incidentally, have been tried. Results are all that could be wished for. Brazilian and American stations were worked within 15 minutes of finishing the set, and every station remarked on the steadiness of the note, whilst one Canadian station suggested that 5NN must be crystal controlled.



A CRYSTAL USER BUYS A VALVE

By H. F. WALTERS.

To a very large number of crystal users there comes a time when it is desired to reach out to distant stations or to obtain more satisfactory volume from the local station. There are several ways of connecting up a valve for this purpose, and the following article will show you which is your best course to adopt.

FOR some years Ferris had been an ardent crystal user, but residing, as he does, about 40 miles from London, there came a time when he decided that the signal strength and range available from his receiver were not sufficient.

Ferris, I may say, has retired and owns a little cottage in the country with a little land on which he works, while he relies upon wireless, especially in the winter months, for his amusement and recreation in the evenings.

Reaching Out

Ferris, however, is now beginning to get tired of listening only to 2LO, the local station, and Daventry, which, of course, merely gives him the same programmes at slightly different strength, so he decided that he would add a valve to his crystal set, not only to enable him to get stronger signals from the nearest programmes but also, perhaps, to enable him to pick up other transmissions.

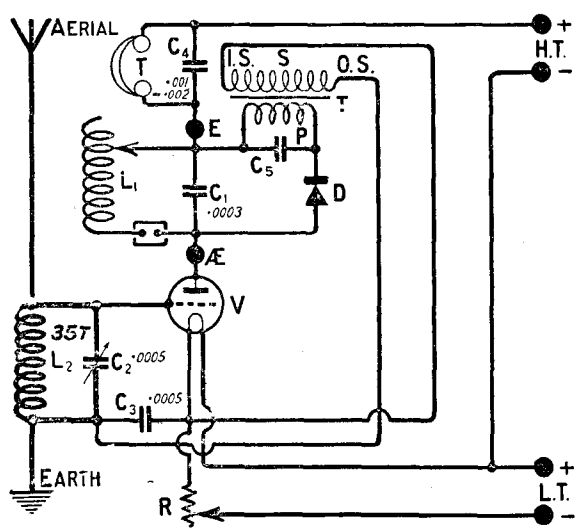


Fig. 2.—A valve may be added to the crystal set of Fig. 1 to form a reflex circuit, the valve performing the dual function of high and low-frequency amplifier.

I went down to stay with him last week-end and he asked my opinion as to what I considered the most efficient means of utilising the valve he was going to add. A consideration affecting the change he was contemplating was that of cost. His means are limited and he is not in a position to spend more than a couple of pounds at a time on his hobby.

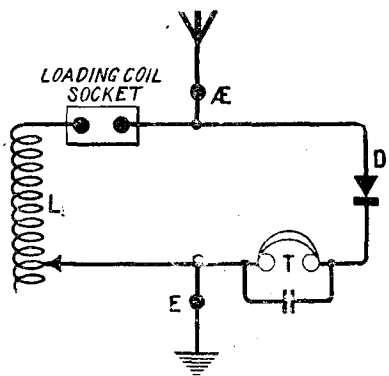


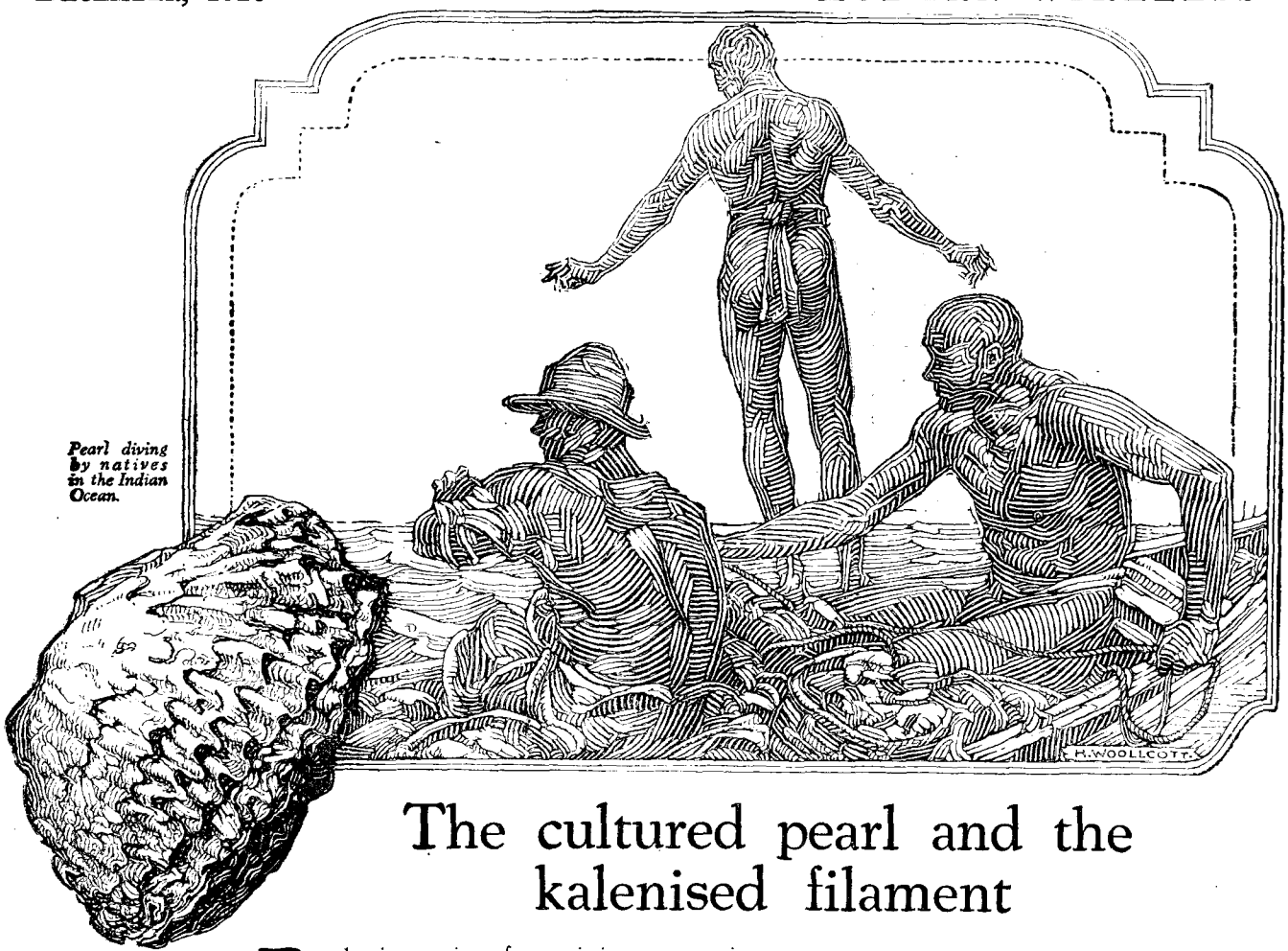
Fig. 1.—A simple crystal circuit employing a slider coil and a loading coil socket for Daventry.

The crystal set he was using consisted of a single-slider coil mounted on a little base with the crystal detector, provision being made for a loading coil to be inserted for the reception of the high-power station. The circuit is shown in Fig. 1.

Different Methods

A valve can be added to this set in three ways. Either it can be made a high-frequency amplifier, a low-frequency amplifier, or else it can be used in a reflex function, so as to give both these effects.

The reflex arrangement, of course, will give the greatest efficiency



Pearl diving by natives in the Indian Ocean.

The cultured pearl and the kalenised filament

By the ingenuity of man it is now possible to hoodwink our friend the Oyster and persuade it to produce pearls to order. This is the simple method employed in the East. An irritant is introduced into the shell. Almost immediately the creature begins to cover it with layers of a nacreous substance. Ultimately a pearl is the result.

Split a cultured pearl in half and you will find that the core and the surrounding layers are one homogeneous mass. It is quite impossible to separate either the layers or the core.

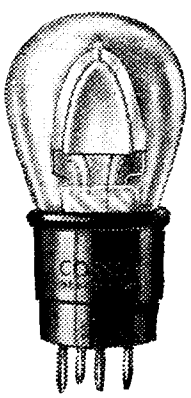
Thus from the bed of the sea comes an interesting parallel for every valve user.

The new Cossor Kalenised Filament is just as much a homogeneous mass as is the cultured pearl. In a similar manner it is formed layer upon layer. And just as the nacreous layers in the pearl cannot be separated from their centre, so the kalenised layers in the Cossor Filament cannot become detached in use from their metal core.

This new Cossor Kalenised filament is one of the outstanding contributions to Radio this season. At last there is available a complete range of 2-volt valves which function practically without heat. Yet the electron emission is terrific—many hundreds of times greater than the emission of the ordinary bright emitter. Because this kalenised filament never becomes hot it can never crystallise. It always retains its pliability. Even after 2,000 hours use it is as supple as the day the valve was made.

Remember, too, that the process of kalenisation actually builds up layer upon layer until the cross section of the filament is exceptionally large. That fact—combined with its low specific resistance, which permits a considerable increase in length—shows why the new Cossor Dull Emitter has entirely recast popular ideas as to what a 2-volt valve can do.

No longer is it necessary to use 4-volt valves to obtain big volume—the new Cossor Point One will give better results—greater sensitivity—improved tone—and all the volume your Loud Speaker can handle—with the miserly consumption of one-tenth of an ampere *and your accumulator will last twice as long as it would when using 4-volt valves,* with the consequent reduction in costs. Incidentally, too, a 2-volt accumulator costs only half the price of a 4-volt one. Finally, do not forget the exclusive method of Co-axial Mounting which ensures a shock-proof filament support, and guarantees absolute uniformity between all valves of the same class.



In three types

Red Band
For H.F. use
1·8 volts ·1 amp. **14/-**

Black Band
The Detector
1·8 volts ·1 amp. **14/-**

Stentor Two
Power Valve
1·8 volts ·15 amp. **18/6**

Cossor Point One

A CRYSTAL USER BUYS A VALVE—*(Continued)*

from the added valve, but, unfortunately, in this case it was ruled out by the question of cost.

It may be of interest to others, however, who are more fortunately situated in this respect, to see just how the conversion would be carried out.

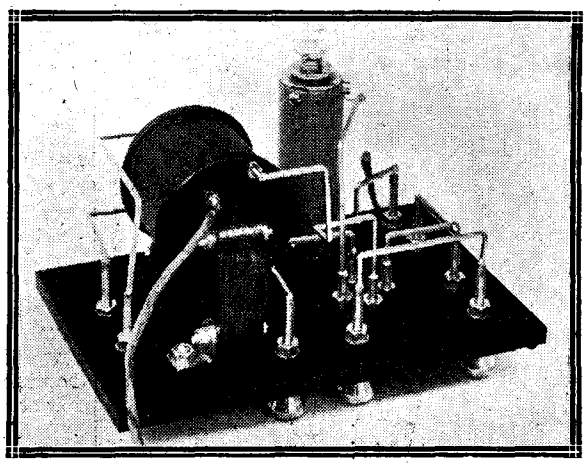
Reflexing

A theoretical circuit of the completed alteration is shown in Fig. 2. Whatever the conversion decided upon, it will be realised, of course, that the L.T. and H.T. batteries, valve, valve-holder and filament resistance will be required in each case.

The reflex arrangement shown is the simplest and probably the cheapest, and the additional apparatus required will be the tuning coil and condenser, L_2 and C_2 respectively, three fixed condensers, C_1, C_3 and C_4, and a low-frequency intervalve transformer. The fixed condenser C_1 is required in order to load up the tuning coil L_1 to cover the necessary wave-band. When originally used with the aerial as a simple crystal set, the capacity placed across the coil by the aerial and earth would probably be in the region of ·0003, and this will be a suitable value for the condenser C_1. Condensers C_3 and C_4 are merely by-pass condensers, a suitable value for C_3 being ·0005, and C_4 ·001 or ·002. The primary of the low-frequency transformer is connected to the telephone terminals of the set, while the secondary is connected as shown, between the bottom of the tuned circuit L_2, C_2 and the low-tension negative.

An Important Point

It is important that the crystal set be connected as shown with the aerial terminal going to the anode, and the earth terminal through the 'phones going to high-tension positive. Since tuned-anode high-frequency amplification is used, there is an inherent tendency to oscillation, and this may be considerably increased if the wrong connections are employed.



The low-frequency amplifier shown theoretically in Fig. 5 may be built up in the compact form shown above.

L.F. Buzzing

In the case of high-frequency oscillation occurring, not only does it make the set difficult to control, but it may also give rise to low-frequency oscillation or buzzing. At the same time, the aerial tuning arrangements employed are of the very simplest description, and thus will not give any appreciable degree of selectivity. For the benefit of those who have had sufficient experience in wireless experimental work a more advanced circuit is shown in Fig. 3. In this case the amplifying valve is neutralised so as to enable self-oscillation to be eliminated, while a far more selective means of coupling the aerial is employed, so that sharp tuning shall result.

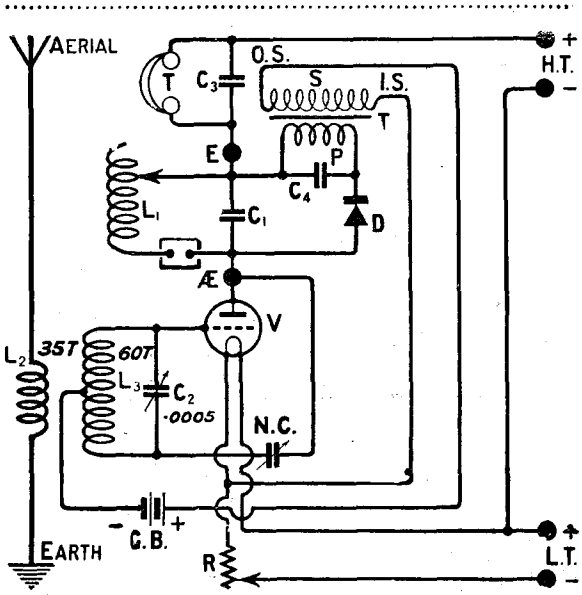


Fig. 3.—This neutralised reflex circuit gives very satisfactory results. C_1 and C_3 have the same values as their equivalents in the previous circuit.

Grid Bias

Further to aid in the obtaining of maximum efficiency and amplification from the valve, a grid-bias battery is included, by means of which a negative potential is applied to the grid of the valve so that maximum volume and purity may result, together with economy in H.T. current. It will be seen that the centre-tapped grid coil method of neutralisation is employed, and although an extra component, in the form of a neutralising condenser shown at N.C., is required, the by-pass condenser, which in the previous circuit is shown connected across the secondary of the low-frequency transformer, is no longer needed. The value of the grid bias required will, of course, depend on the valve employed and the voltage put on the anode, but a rough idea can be arrived at by taking 10 per cent. of the high-tension voltage as a maximum allowable bias.

Loose Coupling

It will be seen that loose coupling is employed for the aerial, and the coil for this purpose can easily be wound by the experimenter himself. On a 3-inch former a suitable number of turns for L_2 will be 20 to 25, while L_3 may be 60 turns tapped at the centre. The windings should be spaced about $\frac{3}{8}$ of an inch from each other, and the adjacent ends of the two windings will go to the aerial and grid.

A CRYSTAL USER BUYS A VALVE—*(Continued)*

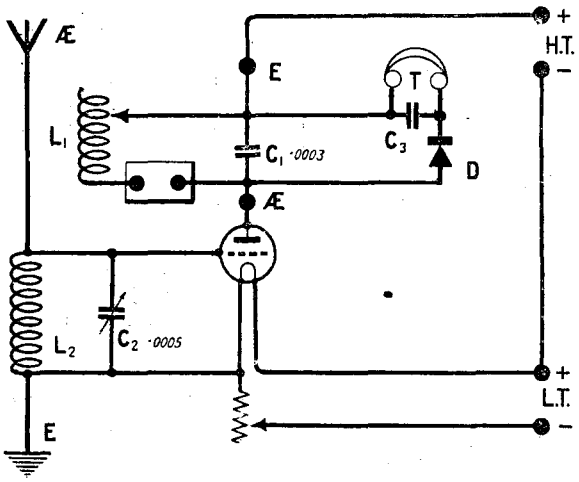


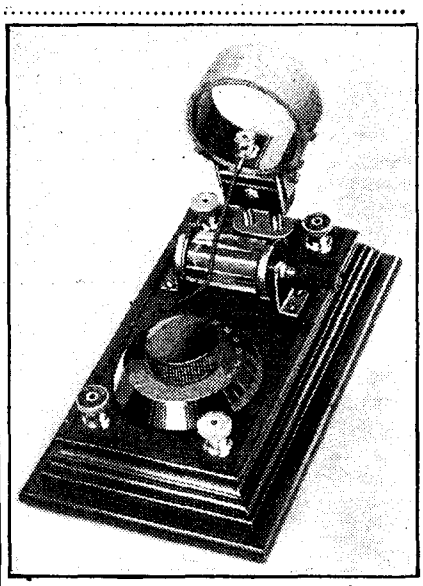
Fig. 4.—An inexpensive method of adding a valve to the crystal set is seen in this diagram, where tuned anode H.F. amplification is employed.

Neutralising

Since the aerial is connected direct to the grid in the Fig. 2 circuit, it is somewhat problematical whether it will be possible to get the set to oscillate, owing to the heavy damping imposed. The reception of stations other than the local one is, therefore, rather doubtful. With the Fig. 3 circuit, in which the valve is loosely coupled to the aerial, it will probably be found that unless correctly neutralised, the set will oscillate rather readily. Under these circumstances the neutralising condenser may, of course, be used as a reaction control, and it will be possible to pick up a number of stations besides the near-by one.

Adding an H.F. Valve

Since Ferris could not afford the conversion to a reflex set, I next suggested his adding a valve purely as an H.F. amplifier, so that he could receive other stations, while at the same time a certain increase in strength from the local transmissions would be obtained. The additional apparatus required in this case, beyond the batteries, etc., is merely a tuning coil, a variable condenser and a small fixed condenser, C_1, for the purpose previously stated. The Fig. 4 circuit is again the simplest arrangement that could be used, though the coupling method and neutralising circuit shown in Fig. 3 can be employed. In this case the centre tap from the grid coil will be connected to low tension through a high resistance of the order of 100,000 ohms, or else through a high-frequency choke.



A crystal receiver has far greater potentialities when aided by a valve amplifier.

The next suggestion I put forward was that the valve should be added as a low-frequency amplifier, in which case the only additional piece of apparatus required was the low-frequency transformer. The addition is shown in Fig. 5, but it was found, on going into the question of cost, that a really good low-frequency transformer would cost more than the extra coil and condenser required for the H.F. unit, while I explained to Ferris that the additional single stage of amplification would hardly increase his range to any appreciable extent.

A Straight Detector

The next suggestion made, which was the one finally adopted, was that the crystal set should be scrapped entirely and the valve used as a reaction detector. Under these circumstances, of course, greater signal strength might be obtained from the local station, while it would be possible to tune in distant stations from all over the Continent on the telephones. The circuit that was decided on was our old friend the Reinartz, the coil employed being a home-made one.

Though slightly more complicated and expensive than the plain H.F. circuit, owing to the fact that two variable condensers are required, the capabilities of the circuit certainly made the extra expense worth while.

The Coil

The coil was wound on a 3-inch former, using gauge 22 d.c.c. wire, and it consisted of 80 turns. The first 60 turns were tuned by a ·0005 condenser and connected across the grid and filament of the valve, while tappings were taken at every four turns of the remaining 20 turns of the coil, the aerial lead being connected

(*Continued on page 765.*)

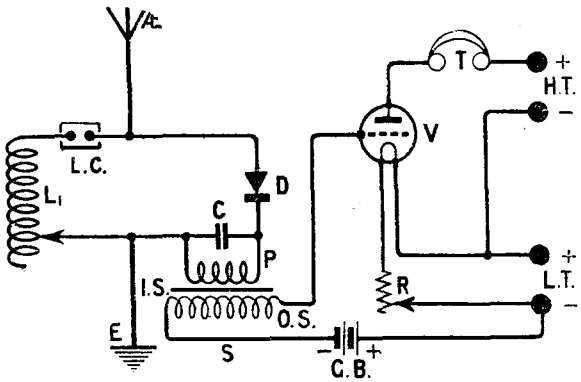


Fig. 5.—A low-frequency amplifier increases signal strength considerably, but range is almost unaffected. There is the advantage, however, that the tuning operation is not changed at all.

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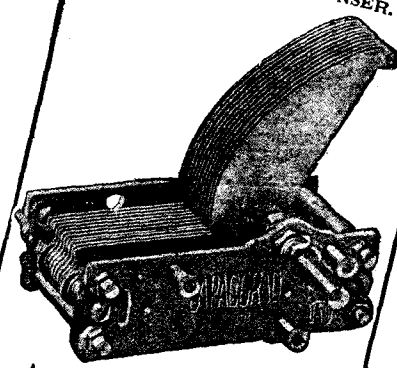

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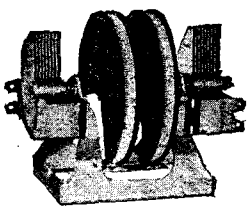

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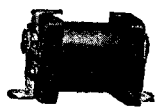

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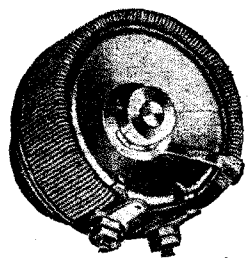

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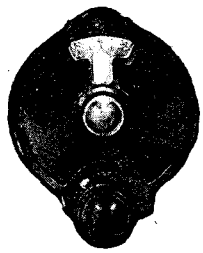

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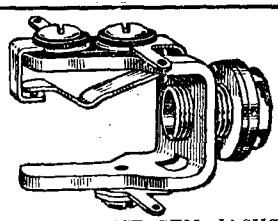

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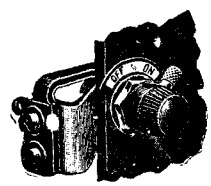

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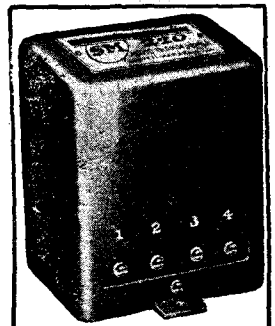

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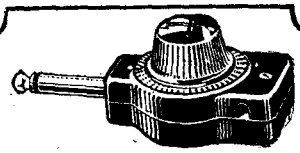

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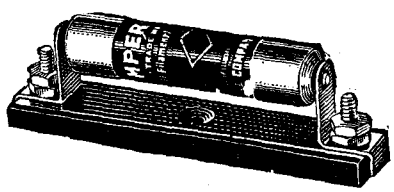

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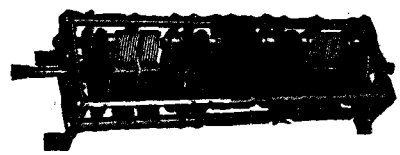

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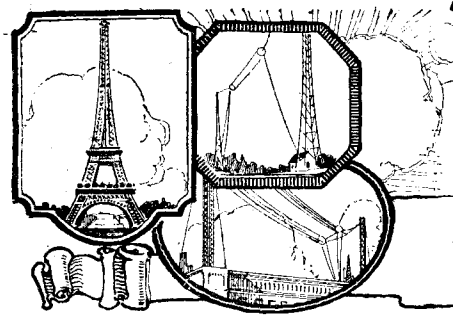


Regular Programmes from Continental Broadcast Stations

Edited by CAPTAIN L. F. PLUGGE, B.Sc., F.R.Ae.S., F.R.Met.S.

Times reduced to Greenwich Mean Time. *Corrected up to November 12th, 1926.*

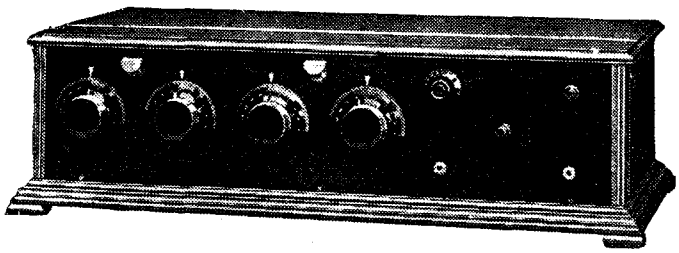
G. M. T.	Name of Station.	Call Sign and Wavelength.	Closing Time or Approx. Duration.
	WEEKDAYS.		
a.m.			
6.30	Eiffel Tower ..	FL 2650 m.	10 mins.
7.55	Amsterdam ..	PCFF 2125 m.	10 mins.
7.56	Eiffel Tower ..	FL 2650 m.	5 mins. Sp.
8.10	Eiffel Tower ..	FL 2650 m.	15 mins.
8.10	Ecole Supérieure	FPTT 447.8 m.	15 mins.
9.25	Eiffel Tower ..	FL 2650 m.	5 mins. Sp.
9.45	Lyngby ..	—— 2400 m.	10 mins.
10.0	Danzig	—— 272.7 m.	10 mins.
10.25	De Bilt.. ..	KNMI 1100 m.	5 mins.
10.30	Danzig	—— 272.7 m.	1 hour.
10.45	Lyngby ..	—— 2400 m.	10 mins.
11.0	Eiffel Tower ..	FL 2650 m.	11.30.
11.40	Hilversum ..	HDO 1050 m.	10 mins.
11.57	Nauen	POZ 3100 m.	8 mins. Sp.
p.m.			
12.30	Eiffel Tower ..	FL 2650 m.	10 mins.
12.30	Radio-Paris ..	CFR 1750 m.	2 p.m.
12.35	De Bilt ..	KNMI 1100 m.	5 mins.
1.0	Danzig	—— 272.7 m.	10 mins.
2.0	Zurich	—— 500 m.	5 p.m.
2.30	Union-Radio ..	EAJ7 375 m.	3.30 p.m.
3.0	Eiffel Tower ..	FL 2650 m.	3.30 p.m.
3.0	Königswuster-hausen	AFT 1300 m.	5.30 p.m.
3.30	Milan	IMI 315.8 m.	5.0 p.m.
3.30	Breslau ..	—— 322.6 m.	4.0 p.m.
3.30	Gleiwitz ..	—— 250 m.	4.0 p.m.
3.40	Kiev	—— 211.3 m.	5 p.m.
4.0	Voxhaus ..	566 m. and 483.9 m.	6.30 p.m.
4.0	Stettin	—— 252.1 m.	6.30 p.m.
4.10	Amsterdam ..	——PCFF 2125 m.	10 mins.
4.30	Radio-Paris ..	CFR 1750 m.	5.40 p.m.
4.40	Hilversum ..	HDO 1050 m.	5.40 p.m.
4.45	Eiffel Tower ..	FL 2650 m.	15 mins.
5.0	Gleiwitz ..	—— 250 m.	7 p.m.
5.0	Breslau ..	—— 322.6 m.	7 p.m.
5.0	Salamanca ..	EAJ22 204.1m	6 p.m.
5.0	San Sebastian ..	EAJ8 272.7 m.	7 p.m.
5.0	Muenster ..	ms 241.9	6.30 p.m.
5.0	Belgrade ..	—— 225.6 m.	6 p.m. (Sat. only).
5.15	Stuttgart ..	—— 379.7 m.	6.30 p.m.
5.15	Eiffel Tower ..	FL 2650 m.	10 mins.
5.30	Rome	IRO 422.6 m.	7 p.m.
5.30	Frankfurt ..	—— 428.6 m.	6.30 p.m.
5.30	Leipzig	—— 357.1 m.	6.30 p.m.
5.30	Cassel	—— 272.7 m.	6.30 p.m.
5.30	Dresden ..	—— 294.1 m.	6.30 p.m.
6.0	Helsingfors ..	—— 240 m.	8 p.m.
6.0	Kbely	—— 1110 m.	7.30 p.m.
6.0	Leningrad ..	—— 940 m.	9 p.m.
6.0	Hamburg ..	ha 394.7 m.	7.30 p.m.
6.0	Radio-Barcelona	EAJ1 280.4 m.	7 p.m.
6.0	Brunn	—— 441.2 m.	8.0 p.m.
6.0	Eiffel Tower ..	FL 2650 m.	7 p.m.

G. M. T.	Name of Station.	Call Sign and Wavelength.	Closing Time or Approx. Duration.
p.m.			
6.0	Moscow ..	RDW 1450 m.	8 p.m.
6.0	Bremen ..	—— 400 m.	7.30 p.m.
6.0	Hannover ..	—— 297 m.	7.30 p.m.
6.0	Kiel	—— 254.2 m.	7.30 p.m.
6.30	Zurich	—— 500 m,	9 p.m.
6.40	Hilversum ..	HDO 1050 m.	10 p.m.
6.40	Lyngby ..	—— 2400 m.	10 mins.
7.0	Union-Radio ..	EAJ7 375 m.	8 p.m.
7.0	Konisberg ..	—— 241.9 m.	8 p.m.
7.0	Radio-Cadiz ..	EAJ3 400 m.	9 p.m.
7.0	Voxhaus ..	b 566 m. and 483.9 m.	11 p.m.
7.0	Munich	—— 535.7 m.	10 p.m.
7.0	Stockholm ..	SASA454.5 m.	10 to 11 p.m.
7.0	Osio	—— 370.4 m.	9 or 11 p.m.
7.0	Muenster ..	ms 241.9	10.0 p.m.
7.0	Stettin	—— 252.1 m.	11 p.m.
7.0	Nurenberg ..	—— 329.7	10 p.m.
7.0	Zagreb	—— 275.2 m.	8.40 p.m.
7.0	Berne	—— 411 m.	9.30 p.m.
7.0	Leipzig	—— 357.1	2 to 3 hours.
7.0	Konigswuster-hausen	AFT 1300 m.	11 p.m.
7.0	Stuttgart ..	—— 379.7 m.	11 p.m.
7.0	Goteborg ..	SASB 416.7 m.	10 p.m.
7.0	Malmo	SASC 260.9 m.	10 p.m.
7.0	Sundsvall ..	SASD 545.6 m.	10 p.m.
7.0	Boden ..	SASE 1200 m.	10 p.m.
7.0	Lausanne ..	HB2 850 m.	8.30 p.m.
7.0	Copenhagen ..	—— 337 m.	9.30 or 11.
7.0	Radio-Wien ..	—— 577 m.	9.30 p.m.
7.0	Prague	—— 348.9 m.	9.0 p.m.
7.0	Eiffel Tower ..	FL 2650 m.	9 p.m.
7.0	Bratislava ..	—— 300 m.	9 p.m.
7.0	Bilbao	EAJ9 434.8 m.	9.30 p.m.
7.0	Radio-Cartagena	EAJ16 297 m.	9 p.m.
7.0	Dresden ..	—— 294.1 m.	10 p.m.
7.0	Gratz	—— 365.8	9.30 p.m.
7.15	Lyons	—— 291.3 m.	10 mins.
7.15	Frankfurt ..	—— 428.6 m.	10 p.m.
7.15	Geneva	—— 760 m.	9 p.m.
7.15	Breslau ..	—— 322.6 m.	9 or 10 p.m.
7.15	Cassel	—— 272.7 m.	10 p.m.
7.15	Gleiwitz.. ..	—— 250 m.	10 p.m.
7.30	Hamburg ..	ha 394.7 m.	10 p.m.
7.30	Warsaw.. ..	—— 400 m.	9 p.m.
7.30	Dublin	2RN 319.1 m.	10.30 p.m.
7.30	Hannover ..	—— 297 m.	10 p.m.
7.30	Kiel	—— 254.2 m.	10 p.m.
7.30	Bremen	—— 400 m.	10 p.m.
7.55	Eiffel Tower ..	FL 2650 m.	5 mins. Sp.
8.0	Königsberg ..	—— 303 m.	10 p.m.
8.0	Radio-Bruxelles	SBR 508.5 m.	10.10 p.m.
8.0	Ecole Supérieure	FPTT 447.8m.	11 p.m.
8.0	Rome	IRO 422.6 m.	11 p.m.
8.0	Seville	EAJ5 344.8 m.	10 p.m.
8.0	Lyons	—— 291.3 m.	10 p.m. (except Mon.)

G. M. T.	Name of Station.	Call Sign and Wavelength.	Closing Time or Approx. Duration.
	WEEKDAYS (Contd.)		
p.m.			
8.0	Antwerp ..	—— 285.5 m.	10 p.m.
8.12	Milan	IMI 315.8 m.	11 p.m.
8.30	Mont de Marsan	—— 400 m.	10 p.m.
8.30	Radio-Toulouse	—— 245 m.	11 p.m.
8.30	Budapest ..	—— 555.6 m.	11 p.m.
8.30	Radio-Paris ..	CFR 1750 m.	10 or 11 p.m.
8.45	Montpellier ..	—— 252.1 m.	10 p.m.
9.0	Radio-Béziers ..	——95 m.	1 hour.
9.0	Radio-Viscaya	EAJ11 434.8m.	10.30 p.m.
9.0	Radio-Barcelona	EAJ1 280.4 m.	2 to 3 hrs.
9.0	San-Sebastian ..	EAJ8 272.7 m.	11 p.m.
9.0	Radio-Catalana	EAJ13 500 m.	Midnight.
9.0	Salamanca ..	EAJ22 204.1m	11 p.m.
9.0	Strasbourg ..	——222.2 m.	11 p.m.
9.15	Petit Parisien ..	——340.9	10.30 p.m.
10.0	Union-Radio ..	EAJ7 375 m.	12.30 a.m.
10.20	Eiffel Tower ..	FL 2650 m.	5 mins.
10.44	Eiffel Tower ..	FL 2650 m.	3 mins. Sp.
11.57	Nauen	POZ 3100 m.	8 mins. Sp.
	SUNDAYS		
a.m.			
7.56	Eiffel Tower ..	FL 2650 m.	5 mins. Sp.
9.25	Eiffel Tower ..	FL 2650 m.	5 mins. Sp.
10.0	Hilversum ..	HDO 1050 m.	11 a.m.
11.30	Königswuster-hausen	AFT 1300 m.	12.30 p.m.
11.30	Union-Radio ..	EAJ7 375 m.	12.30 p.m.
11.57	Nauen	POZ 3100 m.	8 mins. Sp.
12.14	Eiffel Tower ..	FL 2650 m.	10 mins.
12.45	Radio-Paris ..	CFR 1750 m.	1.45 p.m.
2.0	Seville	EAJ5 344.8 m.	4 p.m.
2.10	Hilversum ..	HDO 1050 m.	4 p.m.
2.30	Union-Radio ..	EAJ7 375 m.	3.30 p.m.
2.30	Zurich	——500 m.	5 p.m.
4.0	Muenster ..	ms 241.9 m.	7.30 p.m.
4.30	Milan	IMI 315.8 m.	6 p.m.
4.40	Bloemendaal ..	——566 m.	2 hrs.
5.30	Leningrad ..	——940 m.	7 p.m.
6.0	Brunn	—— 441.2 m.	9 p.m.
6.0	Leipzig	——357.1	11 p.m.
6.0	Radio-Castilla ..	EAJ4 275.2 m.	8 p.m.
6.0	Radio-Barcelona	EAJ1 280.4 m.	8.50 p.m.
6.0	Dresden ..	—— 294.1 m.	11 p.m.
6.0	Eiffel Tower ..	FL 2650 m.	7.55 p.m.
6.15	Goteborg ..	SASB 416.7 m.	9.15 p.m.
6.15	Stockholm ..	SASA 454.5 m.	9.15 p.m.
6.15	Sundsvall ..	SASD 545.6 m.	9.15 p.m.
6.15	Boden	SASE 1200 m.	9.15 p.m.
6.15	Malmo	SASC 260.9 m.	9.15 p.m.
7.0	Munich	—— 535.7 m.	10.30 p.m.
7.0	Berne	—— 411 m.	9.30 p.m.
7.0	Prague	—— 348.9 m.	8.30 p.m.
7.0	Radio-Wien ..	—— 577 m.	9.30 p.m.
7.0	Lausanne ..	HB2 850 m.	8 p.m.
p.m.			
7.0	Stuttgart ..	—— 379.7 m.	10 p.m.
7.0	Zurich	—— 500 m.	9 p.m.
7.0	Hamburg ..	ha 394.7 m.	8 p.m.
7.0	Breslau	—— 322.6 m.	8 p.m.
7.0	Helsingfors ..	—— 500 m.	9.30 p.m.
7.0	Warsaw	—— 400 m.	10 p.m.
7.0	Radio-Cadiz ..	EAJ3 400 m.	9 p.m.
7.0	Barcelona ..	EAJ1 280.4 m	9 p.m.
7.0	Nurenberg ..	—— 329.7 m.	10.30 p.m.
7.0	Gratz	—— 365.8 m.	9.30 p.m.
7.0	Bremen ..	—— 400 m.	8 p.m.
7.0	Hannover ..	—— 297 m.	8 p.m.
7.0	Kiel	—— 254.2 m.	8 p.m.
7.30	Bilbao	EAJ9 434.8m.	9.30 p.m.
7.30	Stettin	—— 251.2 m.	11 p.m.
7.30	Voxhaus ..	b 566 m. and 483.9 m.	11 p.m.
7.40	Hilversum ..	HDO 1050 m.	10.40 p.m.
8.0	Kiel	—— 254.2 m.	11 p.m.
8.0	Bremen ..	—— 400 m.	11 p.m.
8.0	Hanover ..	—— 297 m.	11 p.m.
8.0	Milan	IMI 315.8 m.	11 p.m.
8.0	Oslo	—— 370.4 m.	11 p.m.
8.0	Radio-Cartagena	EAJ16 297 m.	10 p.m.
8.0	Hamburg ..	ha 3947 m.	10 p.m.
8.0	Budapest ..	—— 555.6 m.	11 p.m.
8.0	Eiffel Tower ..	FL 2650 m.	10 mins.
8.0	Konigswuster-hausen	AFT 1300 m.	11 p.m.
8.0	Muenster ..	—— 241.9	10 p.m.
8.0	Rome	IRO 422.6 m.	9.30 p.m.
8.10	Radio-Agen ..	—— 297 m.	15 mins.
8.10	Konigsberg ..	—— 303 m.	10 p.m.
8.15	Copenhagen ..	—— 337 m.	11.30 p.m.
8.15	Geneva	—— 760 m.	1 hour.
8.15	Radio-Bruxelles	SBR 508.5 m.	10 p.m.
8.15	Antwerp ..	—— 265.5 m.	10 p.m.
8.15	Eiffel Tower ..	FL 2650 m.	9 p.m.
8.25	Gleiwitz ..	—— 250 m.	11 p.m.
8.25	Breslau ..	—— 322.6 m.	11 p.m.
8.30	Marseilles ..	PTT 309.3 m.	9.30 p.m.
8.30	Ecole Supérieure	FPTT 447.8 m.	11 p.m.
8.30	Radio-Toulouse	—— 389.6 m.	11 p.m.
8.30	Frankfurt ..	—— 428.6	11 p.m.
8.30	Radio-Paris ..	CFR 1750 m.	10.45 p.m.
8.30	Dublin	2RN 319.1 m.	10.30 p.m.
8.30	Cassel	—— 272.7 m.	11 p.m.
9.0	Radio-Viscaya	AEJ11 434.8m.	11.30 p.m.
9.0	San Sebastian ..	EAJ8 272.7m.	11 p.m.
9.0	Salamanca ..	—— 204.1 m.	11 p.m.
9.15	Petit Parisien ..	—— 340.9 m.	10.30 p.m.
9.30	Radio-Catalana	EAJ13 500 m.	Midnight.
10.0	Union-Radio ..	EAJ7 375 m.	12.30 a.m.
10.44	Eiffel Tower ..	FL 2650 m.	3 mins. Sp.
11.57	Nauen	POZ 3100 m.	8 mins. Sp.

BEST IN ALL EUROPE

THE "ALL-BRITISH SIX"



Details of the amazing results obtainable on this receiver appear in the current issue of the "Wireless Constructor." This is the set which was entered by Mr. H. E. Hassall in the Multi-Valve section of the International Amateur Competition held in conjunction with the New York Radio Exhibition. The set was awarded third prize in that section and thus gained the highest award for any European entry.

AN EXCLUSIVE ARRANGEMENT BETWEEN MR. HASSALL AND OURSELVES ENABLES US TO OFFER YOU THE FINISHED INSTRUMENT BEARING A CERTIFICATE OF HIS APPROVAL.

Realising the enormous demand there will be for the "All British Six" and that the assembly and wiring of this particular circuit call for scrupulous care in order to ensure the best results, Mr. H. E. Hassall has requested us to make up this receiver. We have submitted a sample to him and he informs us that this instrument gives even better results than those obtained on the original model which he entered for the International Exhibition in New York. There is thus a fine opportunity for you to obtain immediately an instrument which we definitely state is second to none in the whole of Europe.

Each of these sets will be submitted to the designer for his approval before being released for sale and in order to safeguard buyers of this set a certificate autographed by Mr. Hassall will be given with each instrument sold by us.

The set is available in two types:

ORIGINAL MODEL, as illustrated above, complete with Copex "O.C." type coils for B.B.C. wave lengths

ORIGINAL MODEL
£33 : 15 : 0

MONO-MODEL.

This instrument is identical to the one illustrated above, except that it incorporates special single control mechanism which, whilst allowing the four dual condensers to be adjusted separately, also makes it possible for them to be rotated in unison by means of a single control fitted to the left hand side of the cabinet. With this improvement incorporated, it will be found that the dials will read dead in line from top to bottom of the scale.

MONO-MODEL
£37 : 5 : 0

N.B. Marconi Royalties amounting to £3 15s. must be added to both the above prices.

THE "SOLODYNE"

During the short time that this set has been on the market, it has achieved amazing popularity. In a large measure this is due to the ease with which many stations—both British and Foreign—may be brought in at full Loud Speaker strength, by simply rotating the one dial.

Supplied in a beautiful fall-front cabinet, made from selected mahogany and French polished. Including the necessary coils and transformers for B.B.C. wavelengths, but exclusive of valves, batteries, etc.

FINISHED INSTRUMENT £24 : 5 : 0
Marconi Royalty £3 2 6.

Every finished instrument bears the signature of Capt. W. R. TINGEY, M.I.R.E.

(late of Radio Press Research Laboratories), who is now in charge of our Test Department.

PETO-SCOTT CO., LTD.,

Head Office (Mail Order): 77, City Road, E.C.1.

COPEX

"O-C" TYPE COILS

—with the patented feature

ARE ESSENTIAL TO THE SUCCESS OF

THE "ALL-BRITISH SIX."

The chief advantages gained by the use of Copex O.C. type Coils:—

(1) Oscillation is rendered *perfectly* under control.

(2) Higher amplification is obtained.

(3) The Coils and Transformers are guaranteed to be matched within one metre.

The Coils used in Mr. Hassall's prizewinning set are priced as follows:—

One Set of 4 Split Secondary H.F. transformers, "O.C." type, 250-550 metres **£2 2 0**

Four Copex Copper Shrouds, and interchangeable 6-pin bases (Patent No. 259459) **£3 0 0**

CONVERT YOUR "ELSTREE SIX" TO USE THESE COILS.

Many owners of the "Exstree Six" will wish to alter their set to the use of Copex screened coils. The conversion is a comparatively simple matter, provided a diagram showing the necessary alterations to the wiring is first obtained.

To all purchasers of the above set of Coils and Screens, we will present free of charge a diagram giving the necessary conversion details.

FOR HOME ASSEMBLY,

If you wish to build the All-British Six Receiver, you cannot do better than take advantage of the Pilot Panel Service. We can supply the necessary parts, and with each complete set of parts we will supply full sized wiring and lay-out diagrams signed by Mr. H. E. Hassall.

These diagrams are absolutely free of charge to all purchasers of the complete kit of parts. Remember that the Pilot Service absolutely guarantees you good results.

"PILOT" Kit of Components for the All British Six Receiver **£20 3 6**

"Pilot" Panel of Polished Ebonite drilled **15 6**

Polished Mahogany Cabinet **£3 3 0**

N.B.—If a complete set of parts is purchased Marconi Royalties at the rate of 12/6 per valve holder are payable.

Full details of nearly twenty of the most popular sets available either as finished instruments or in parts for Home Assembly are contained in the Pilot Manual. Profusely illustrated. Send for a copy to-day. Post Free 6d.

THE PILOT MANUAL

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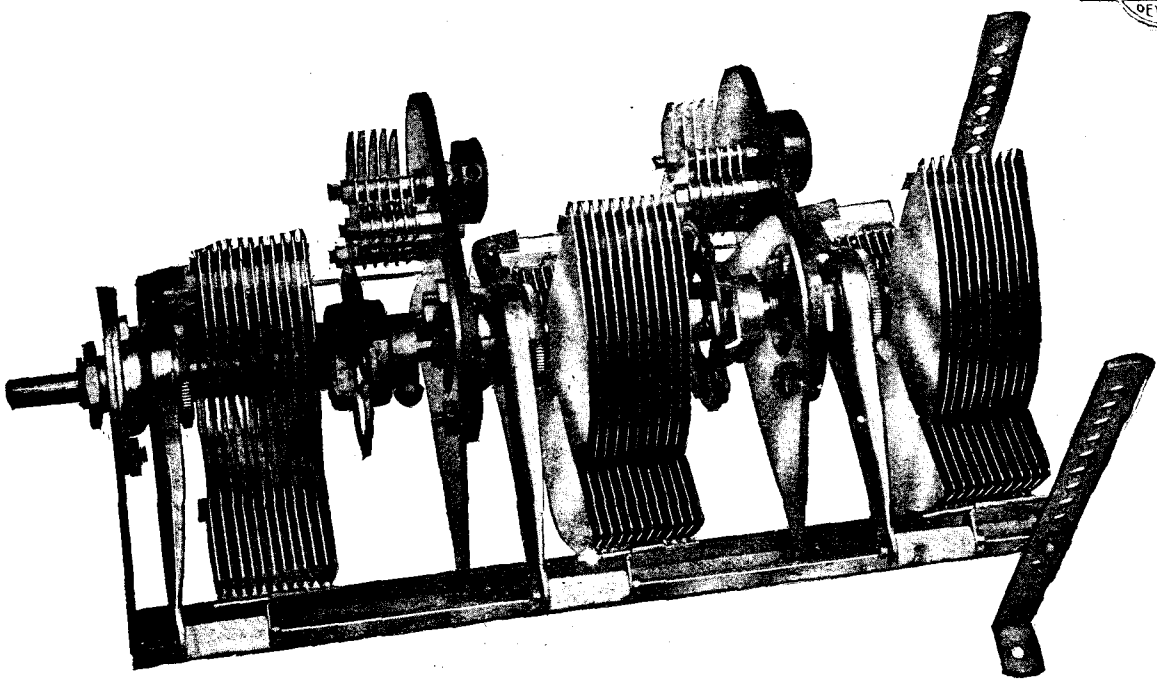
HITCH YOUR AERIAL TO A "STAR"!

Perfect Gang Control

RADIO IGRANIC DEVICES



Igranic Gang Condensers

SUCCESSFULLY overcome the difficulties of tuning two or three circuits with a single control.

Small compensating condensers are connected in parallel with the sections tuning the H.F. stages so that each circuit can be exactly equalised without altering the relative settings of the main condensers.

Two important advantages of the Igranic equalising method are that the square law tuning is preserved and the tuning range of each section is not decreased.

The Igranic method is the most simple and practical solution of the difficulties of gang control.

Each section is made up of .0005 mfd. Igranic-Pacent Square Law Condensers. The whole construction is particularly rigid so that there is no fear of the framework becoming distorted and causing the plates to touch. As a further precaution, and to ensure smooth turning movement, flexible couplings are provided between each section. The whole movement is particularly smooth.

The equalising condensers are mounted in easily accessible positions and their adjustment is particularly simple.

Prices:

Igranic Twin Gang Condenser	£2 10 0
Igranic Triple Gang Condenser	£3 15 0

RADIO IGRANIC DEVICES

FOR THE "PURAMUSIC" RECEIVER.

- .0005 mfd. Condensers.
- Tapped Primary H.F. Transformers.
- Po entiometers.
- "Micro" Neutralising Condensers.
- Twin Gang Condensers.
- "Nonmic" Valve Holders.
- Baseboard Rheostats.
- 1 megohm Variable Resistances (Tone Control).
- Fixed Condensers.
- Grid Leaks.
- "Springmore" Wander Plugs.
- Indigraph Terminals.
- Jacks and Plugs, etc., etc.

Send for Igranic Catalogue No. J. 168.

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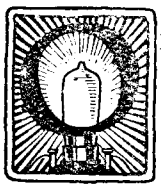
SEARCHING MADE EASY

A Wavemeter for Every Need



ONE of the most useful accessories in a wireless amateur's equipment is a wavemeter. The number of stations working at the present moment is so large that it is a matter of extreme difficulty to identify any particular station. If one tunes in to a station coming in at a good strength, then the identification is often only possible by waiting until the announcement is given, and even so after some time of waiting in this manner, the particular identification required may be missed.

If one is possessed of a wavemeter, however, it is possible to find the wavelength of a station, which at any rate narrows down the choice to much smaller limits and renders the identification very much more simple.

A Simple Method

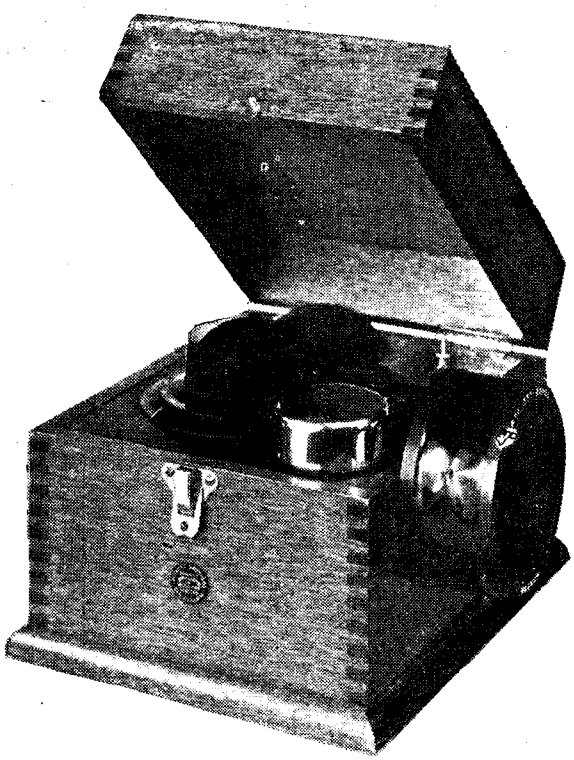
Again, it is often desired to tune in to some particular station, and this may be a matter of some difficulty unless a careful log of the receiver settings has been compiled. What can be simpler than adjusting a wavemeter to a given reading, and tuning in to the buzzer signals as if to the tuning note of the local station? Then on switching off the buzzer the station required will be found with considerably greater ease.

A Valuable Instrument

With the object of bringing such a valuable instrument within reach of everyone, Mr. J. H. Reyner, B.Sc. (Hons.), A.M.I.E.E., has designed a simple instrument which can be made up with a minimum of trouble. There are two essential requirements in a wavemeter. In the first place it must be reasonably accurate and sharply tuned. In the second case it should be provided, if possible, with a calibration. The latter condition is the more difficult one to comply with, for although a simple wavemeter can fairly easily be constructed, the question of obtaining a very accurate calibration is one of greater difficulty.

A Special Circuit

After some months of careful experiment, however, Mr. Reyner has evolved a special type of circuit. This circuit has many advantages. In the first place it gives exceptionally sharp tuning so that the wavemeter can be read to a considerable degree of accuracy. In the second case the effect of the buzzer upon the tuned circuit is reduced to a minimum so that external influences affect the calibration as little as possible.



The "Razor Sharp" Wavemeter.

In the third case special coils have been designed, and arrangements have been made with the manufacturers to supply both coils and condenser accurately matched to a standard.

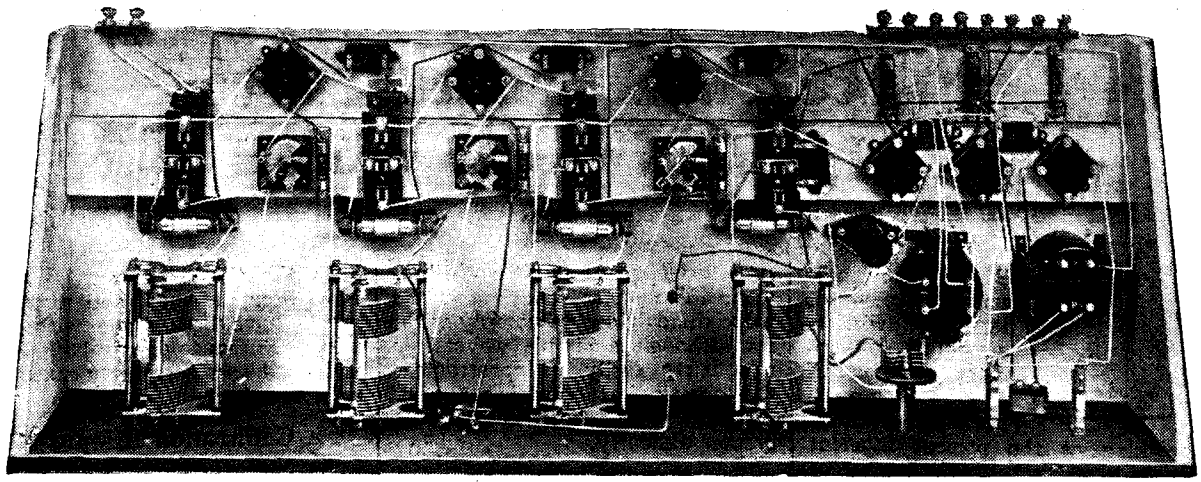
Calibration Simple

Anyone, therefore, who builds this wavemeter from the directions given obtains an instrument which is a reasonable duplicate of the original. Its calibration curve will then be almost identical with that for the initial instrument, and calibration charts have been definitely provided with the envelope.

All that is necessary is to obtain the envelope and build up the instrument exactly in accordance with the directions. The actual constructional work is very simple, and only occupies a few hours. When this has been done the instrument is adjusted in accordance with the directions given, and it can then be taken as conforming, within a small percentage, to the calibration chart provided.

This is a very marked advance in wavemeter design, and removes at once one of the principal difficulties in the construction of the wavemeter. In view of the large number of advantages which can be obtained from the possession of a wavemeter, and the fact that the instrument is very cheap to produce, we think that this new envelope (the "Razor Sharp" Wavemeter, Envelope No. 14) will recommend itself at once to our readers. The price is 1s. 6d. or 1s. 9d. post free.

Don't forget to avail yourself of our Free Blueprint Service. See page 763.



VALVES AND HOW TO USE THEM IN THE "ELSTREE SIX"

By C. P. ALLINSON, A.M.I.R.E.

THE extraordinary success of the "Elstree Six" Receiver has induced a large number of people to build this set who have had little or no experience of valve reception. As a direct result of this there seems to be a certain amount of uncertainty on the part of a number of the constructors of this receiver as to the valves to use and the best conditions under which to work them.

Not Critical

I would first of all like to emphasise very strongly that this set is not critical as regards the valves to be used in it. As is only to be expected, certain valves in certain positions will give better results than others, but this, of course, applies to any other receiver just as well. This proviso as to valves applies only to the types employed and not to the make. As long as the correct type of valve is used in the different positions any valve of known quality and repute can be used with satisfaction.

There is, to-day, a large number of valves on the market, and it is obviously outside the scope of this article to deal with them all. It is, however, intended to consider the general outstanding types and their suitability for use in the "Elstree Six" receiver.

The Circuit

Let us turn our attention to the set. We find that we have three valves amplifying at high frequency, followed by a detector, and two stages of low-frequency amplification. The three high-frequency valves should, of course, all be of the same type, and if the maximum amplification and selectivity are to be obtained from this side of the receiver, the valves used should be of the high-impedance type. It is not sufficient, however, to make sure that the valve used has a high impedance; it is also necessary that it should have a high amplification ratio. It is, for instance, possible to obtain valves with an impedance in the neighbourhood of 25,000 to 30,000 ohms, and so suitable on that count for use in this portion of the receiver as regards their impedance, which, however, have an amplification ratio of only 8 or 9. We must, therefore, turn to those special classes of valves which are produced both with a high impedance and a high amplification ratio.

Special Classes

These may be found under two headings. The first is that covering valves specially designed for high-frequency amplification, while the other applies to those which have been produced for resistance-capacity and choke-capacity amplification on the low-frequency side.

Among the high-frequency valves will be found valves with an impedance as low as 17,000 ohms, yet possessing an amplification ratio of 15, while others with an impedance of 60,000 ohms have only an amplification ratio of 16 or 17.

It will readily be understood that it is difficult to lay down any hard and fast rule as to the actual limits of the impedance of the valves to be used. It has, however, been my personal experience that valves having an impedance in the neighbourhood of 20,000 to 30,000 ohms associated with an amplification-ratio in the neighbourhood of 15 to 20 will give the most satisfactory performance as high-frequency amplifiers in the "Elstree Six."

Suitable Ranges

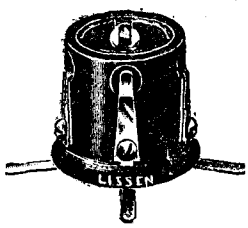
As regards the rating of the valves employed, this is entirely a matter for the personal preference of the experimenter. Suitable valves can be obtained in the 2-volt range. Among those that I have personally tried may be mentioned such valves as the Cossor Point One, Cosmos and Benjamin Short Path (Green-spot), the Mullard P.M.1.H.F. S.T. 21, and others. In the 4-volt range there is a very limited choice; such valves as the S.T. 41, P.M. 3, the Ediswan G.P. 4, etc., are the nearest approach to what is wanted.

The user of 6 volt valves has a wider scope, and among those which I have tried out myself and found satisfactory may be mentioned the S.T. 61, Burndept H. 512, the

LEAVING GRID LEAKS ON OUR FACTORY ROOF TO TEST THEM

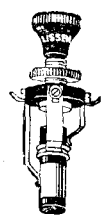
A case of **LISSEN FIXED GRID LEAKS** was left on the roof of the **LISSEN** factory during the summer of 1925—they were soaked by rain, they were baked by the sun—then they were handed over to the **LISSEN** research department, and carefully tested—in every grid leak the resistance was found unchanged and true to the marked value.

All capacities, previously 1/8, **NOW 1/-** each.



DOUBLE PURPOSE VALVE HOLDER

Can also be used for panel mounting by bending the springs straight—low loss, low capacity, meaning better, clearer signals. **LISSEN VALVE HOLDER**, previously 1/8, **NOW 1/-** each



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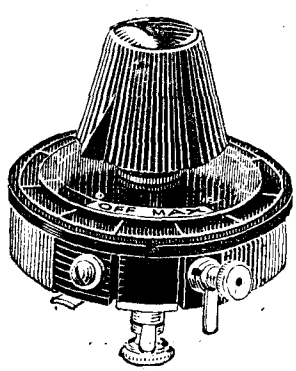
REAL RADIO SWITCHES

There is a LISSEN switch for every radio switching need. Your dealer has them all, or if any difficulty send direct.

LISSEN 2-way switch, previously 2/9, **NOW 1/6.**
Series-parallel switch, previously 3/9, **NOW 2/6.**
Double Pole Double Throw, previously 4/-, **NOW 2/6.**
Key Switch, previously 2/6, **NOW 1/6**

WON'T WARP, TWIST, BEND OR BREAK



No chance of this with a LISSEN wire-wound rheostat or potentiometer—no shorted turns—no development of faults in use—no chance of arcing, noise or flickering. And every contact brush of every LISSEN wire-wound rheostat and potentiometer moves with firm and positive action along the wire, yet never harshly. **PREVIOUSLY HIGH-PRICED**, but now largely reduced because of our new direct-to-dealer policy which cuts out wholesale profits.

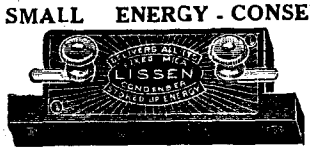
NOW 2/6.

LISSEN 7-ohms wire rheostat (patented), previously 4/-, **LISSEN** 35 ohms wire rheostat (patented), previously 4/-, **NOW 2/6**

LISSEN Dual wire rheostat, patented, previously 6/-, NOW 4/6
LISSEN POTENTIOMETER, 400 ohms, previously 4/6, NOW 2/6

EVERY ONE LISSEN ONE-HOLE FIXING, TOO. Insist on seeing a LISSEN before you buy any other.

SMALL ENERGY-CONSERVING CONDENSERS



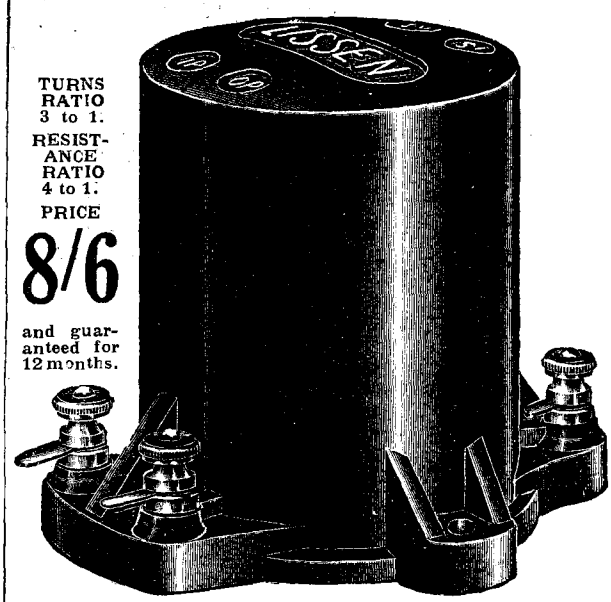
Fit LISSEN.—These small condensers deliver all their stored-up energy. The following capacities are made in mica (LISSEN also make the Mansbridge type in higher capacities). Leaky condensers waste energy—fit LISSEN and save it. Capacities :—

.0001 to .001, 1/- each (much reduced).
.002 to .006, 1/6 " " "

Note the new case which enables the condenser to be fitted upright or used flat. At present the new case is available only in certain capacities, but is quickly becoming a **LISSEN** standard.

STARTLING THE TRADE WITH A NEW LISSEN TRANSFORMER

TURNS RATIO 3 to 1.
RESISTANCE RATIO 4 to 1.
PRICE **8/6**
and guaranteed for 12 months.



Powerful amplifiers now within the reach of all!

TRADE buyers who came to us during the first few days of the Olympia Exhibition scarcely believed it when we told them the price of this new LISSEN part. After taking away samples, however, many of them came back to order and to urge for quick delivery—those who did not come back ordered direct to factory—ORDERED AFTER PROVING PERFORMANCE.

Private users who have also tested have told us they have found the results equal to expensive transformers they were previously using.

We knew all this would be the case, BECAUSE THIS NEW LISSEN TRANSFORMER WAS MADE PURPOSELY TO EQUAL THE PERFORMANCE OF EXPENSIVE TRANSFORMERS AND SO GOOD IS IT THAT WE HAVE UNHESITATINGLY WITHDRAWN IN ITS FAVOUR ALL OUR OWN HIGH-PRICED MODELS, which have been on the market and largely sold for nearly four years past. Pure, powerful, economical, amplification is now at last within the reach of all.

By ourselves distributing direct to the retail trade we have cut out all wholesale profits. This new policy, coupled with our ambitious production programme, has been a big factor in enabling us to sell the new LISSEN TRANSFORMER at its remarkably low price. Nobody should now pay highly to get a high grade transformer. Compare this new LISSEN against any for tone, purity and power. IT AMPLIFIES EVERY NOTE—EVERY HARMONIC—EVERY OVERTONE.

You can get it at your dealer's, or direct from factory if any difficulty. If you are not satisfied with it after seven days' test, take it back to your dealer's or send it back to us. You will find it suits every set and every valve you will want to use.

Include no postage if you send direct, but please send dealer's name and address.

IMPORTANT TO THE TRADE.

Retailers who have not already been notified of our new direct-from-factory-to-dealer distributing policy should in their own interests communicate with us without delay. All orders must now be sent to us at Richmond and not to usual factor.

LISSEN, LTD., Lissenium Works, 20-24, Friars Lane, RICHMOND, Surrey
Managing Director: THOMAS N. COLE.

L114.

Barretors - and Fixed Resistors are already obsolete.

APART from the high initial cost of these, it is ridiculous that you should be compelled to buy a new Resistor, at an average cost of 2/6, every time you change your Valve.

Further, the 100 per cent. efficient Fixed Resistor does not exist, and frequently you are heating your Filaments much beyond the necessary stage for correct emission, thereby shortening the life of your Valves.

The MICROSTAT Variable Fixed Resistor

is set to the correct resistance in a few moments, after which it functions like an ordinary Fixed Resistor, but—should you change your Valve, a slight turn either way of the V.F.R. concerned and your Resistor is reset to suit that particular Valve

After this they "stay put," and are operated by the pull-push switch like the ordinary Fixed Resistor, or by the "Microstat" Master Rheostat, which gives even wider range of control.

Best of all, the cost of the Microstat V.F.R. is **3/-** and this is

Adjustable for any Valve and lasts for ever

Made and guaranteed by the Manufacturers of the World Famous "Microstat,"

LIFFORD ENGINEERING CO.,

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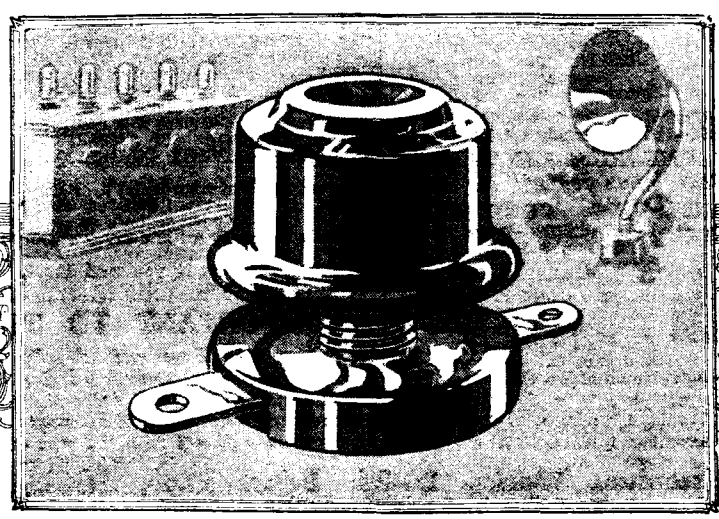

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Woodwright

FURTHER HINTS ON THE "ELSTREE SIX"—(Contd.)

Cleartron C.T. 25B, Marconi and Osram D.E. 8, H.F. and the D.E. 5 B., the Mullard P.M. 5 and P.M. 5A, the Six Sixty S.S. 6, etc. Some of these valves do not actually fall within the impedance limits of 20,000 to 30,000 ohms previously mentioned, but nevertheless have given perfectly good results as H.F. amplifiers in the "Elstree Six." There are other makes of valve, of course, which are equally suitable for use in this set, and figures as to impedance and amplification factor can always be obtained from the makers as an indication of their suitability.

The Detector Valve

With regard to the detector valve in the "Elstree Six," it has been found from the point of view of quality that purer reproduction and a more natural tone will be obtained if a low-impedance valve is used in this position. In the operating notes which accompanied the first article on this receiver, it was stated that a D.E.5B was used as detector, but experiments have proved that although this gave greater signal strength, purer tone was to be obtained by the use of the other type of valve, as stated in a later article. A suitable impedance for this valve is in the neighbourhood of 6,000 to 12,000 ohms, and there is a very large selection of valves of this type which may be used for the above purpose.

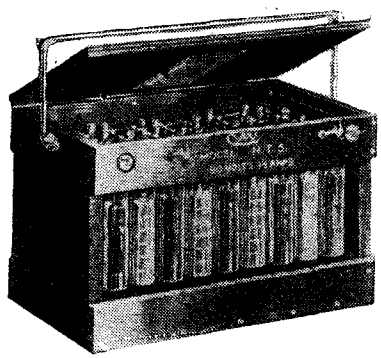
Among those that I have actually tried out myself are such valves as the S.T. 62, D.E. 5, the B. 4, the Cleartron C.T. 25 (this actually has an impedance of only 4,000 ohms), the Cossor Stentor 2, Edison P.V. 4, Mullard P.M. 6, etc.

Grid Bias

The important point to bear in mind in this connection, however, is that a different type of valve will require a different value of grid bias in order to obtain efficient rectification. Since lower bend rectification is employed it will be as well for those at all in doubt as to the value to be employed to consult the makers' curve for this purpose.

Anode Voltage

The correct value of plate voltage to employ on the detector valve in the "Elstree Six" is between 40 and 60 volts, and it will be seen that characteristic curves taken with this plate potential will show a decided bend at the bottom left-hand end of the curve. This occurs at a certain negative grid voltage, and this is the value to employ for use with the particular valve. To take an example, the bend with a D.E. 5B valve when 60 volts are used on the anode, occurs at about – 3 volts, and this is the correct value to employ with this valve. When, however, low-impedance valves, such as a D.E. 5, are employed, it will be found that the 60 volt curve does not come to its bend much before –9 or –10 volts, and in some cases even higher than that. To take another example, the B.T.H. B4 valve which has an impedance of 6,000 ohms, begins to bend between – 4 and – 8 volts on the grid, and the negative bias required will probably lie between these values.



In multi-valve receivers such as the "Elstree Six" when two very low impedance valves are used in the L.F. stages H.T. accumulators form a very convenient and steady source of supply.

I know that there has been a certain amount of misunderstanding on this point, and I would, therefore, like to emphasise again the fact that every different type of valve requires a particular value of grid bias if efficient rectification is to be obtained, and if makers' curves are not available when a particular valve is being tried out, it is a good plan to go on increasing the negative bias used in conjunction with this valve until the signal strength suddenly falls off considerably. At this point the negative bias should be somewhat decreased and the final adjustment made by means of the potentiometer. It will be found that at a certain setting on the slider most efficient reception is to be obtained

Different Settings

Another point that may be noted with regard to the setting of the grid bias for the detector valve is that the local station may require a slightly different setting than a weak and distant transmission. This will especially be the case where the set is used fairly close to a broadcasting station, and it will be found that a larger negative potential is required for strong signals than for the weak ones. At the same time the setting of the potentiometer has a certain influence on the smoothness of the reaction control. If the grid of the detector valve is too negative, it will be found that backlash is present in the reaction control. In these circumstances, the slider of the potentiometer should be moved over to the positive end a few degrees at a time until smooth reaction is obtained.

The L.F. Side

As regards the low-frequency side, there is a very wide field from which to choose a valve. The first stage can be a general purpose valve in many cases, while for the second stage it is advisable to use a small power valve. In cases, however, where it is desired to use this set for demonstrations or providing music in a large hall, it is advisable to use a special valve in the last stage, in order that maximum volume and distortionless amplification may be obtained. In many cases it may be desirable to use one of the small power valves for the first stage, especially if the receiver is located close to one of the broadcasting stations, since when listening to the local transmissions the amount of power to be handled by the first stage of low-frequency amplification may be quite considerable. A suitable impedance for the first low-frequency amplifier may be between 6,000 and 12,000 ohms, the lower impedance valve being desirable where a large degree of volume is to be handled.

Second Stage

For the second stage, when very powerful signals are to be dealt with, a valve such as the S.T. 63, D.E. 5A, or even in extreme cases the L.S. 5A type may be required.

FURTHER HINTS ON THE "ELSTREE SIX"—(Concluded)

L.F. Grid Bias

It will be noticed that two negative grid-bias terminals are provided on the set. When both the amplifying valves are of the same type, these two terminals may be strapped together and a common negative bias applied to their grids. With valves of the general purpose type, a suitable value for this would be in the neighbourhood of – 6 volts, while if a small power type of valve is employed, 9 volts will be needed. When, however, the two valves employed are of different types, separate tappings will be required for the grid bias battery. In the case of a general purpose valve followed by a small power valve – 6 volts may be required on the first terminal, while the second terminal may be – 9. Where, however, a valve of the super power type with a very low impedance is used in the last stage, a negative grid bias between 18 and 24 volts may be required, this depending, of course, on the value of high tension employed. So that there may be no confusion as to the grid bias terminals, it may be stated that looking at the set on the front, the three right-hand terminals on the terminal strip are respectively reading from left to right, grid bias positive, grid bias negative 1 and grid bias negative 2.

Reducing H.T. Current

In all cases it should be the aim of the experimenter to use as high a negative potential as practicable on each valve, not only from the point of view of pure reproduction, but with the aim of reducing the high tension current consumption which may be a heavy item in a large multi-valve set.

Fixed Resistors

Another question with regard to the use of different types of valves which may be mentioned here is that regarding the fixed resistances used with them. No doubt most amateurs will be familiar with this point, but it seems advisable to refer to the fact that different types of valves will require different values of resistances for their correct function. This is a particularly important point where types of valves are mixed in the set. For instance, 4 volt valves may be used for the high-frequency and detector, while for the low-frequency valves the 5 – 6 volt types may be employed. In this case care should be taken to see that the values of the resistances are correct for use with the particular valves employed and the battery which is being used, otherwise the valves may be damaged.

REPORTS FROM READERS WHO HAVE BUILT THE "ELSTREE SIX"

"—more than pleased"

SIR,—Since my visit to your Laboratories I have constructed the "Elstree Six." It has been working now for some weeks and I am more than pleased with the results obtained.

I commend this set to anyone seeking an efficient receiver. It is, without doubt, a marked advance on anything you have previously given us, and in my humble judgment it is the first radio instrument embodying satisfactory high-frequency amplification.

I predict for the "Elstree Six" a great future, and I believe it will be many a long day before it has to take second place.—Yours truly,

G. W. ASBERY.

Bushey Heath, Herts.

"—does all you claim"

SIR,—Having recently built the "Elstree Six," I feel I must write and express my appreciation of same. It certainly does all you claim, and tuning of distant stations is simplicity itself.

My aerial and earth system is not at all good, owing to shielding by walls, but I have no trouble in tuning in almost any Continental station either long or short wave.

I am only about three miles from the London station, but I can easily receive Bournemouth without the slightest sound of London.

I have demonstrated this set to a number of my friends, and all were delighted with the ease of control and selectivity.

I have been building wireless sets of all descriptions since before the advent of broadcasting, and have at last found a really useful set for long-distance work.

Wishing the "Elstree Six" the success it deserves.—Yours truly,

GEO. E. SMITH.

Hampstead.

"Excellent Results"

SIR,—*Re* the "Elstree Six," the set is indeed remarkable, and I can assure you I am more than pleased with the excellent results I have obtained since I completed it a month ago.

Situated in a district which is not too favourable for good reception, and also handicapped by reason of having my aerial surrounded by trees, the results I have had surpass easily those of my previously built receivers.—Yours truly,

EDWARD N. BROOKE.

Lightcliffe.

"Ideal Set"

SIR,—*Re* the "Elstree Six," I am writing to say that it is an ideal set. I have received nearly all the British and foreign stations which you state within one degree of your settings. I have received about 67 stations altogether and I am hoping to receive more this season.—Yours truly,

A. CURRAN, Junr.

Oldham.

A "Mewflex" Success

SIR,—I have just completed and partially calibrated a "Mewflex" receiver. I congratulate your staff upon arriving at such an ingenious and efficient circuit.

My list includes all German, French and Spanish stations under 500m., all British stations except Cardiff and, of course, Dublin.

This set and others emanating from Elstree should be made even better known than they are. Sunday evening searching shews how really bad oscillating is; and if the strength of the "howls" is a criterion of their distance, there's some heavy handed fans near me.—Yours truly, I. H. PATEMAN.

Harrow, Middx.

Opesti~ Nipitia~Secomba

These strange words were broadcast into space the other week when Mars came within the chatting distance of 42 million miles. The chat, however, was all on our side, and several theories exist as to why our advances met with no response.

One enthusiast writes: "Assuming that Mars enjoys the blessing of Radio, we take too much for granted that their instruments are as efficient as our own. In the transmitting set used down here by us, ORMOND Condensers were employed, and the fact that ORMOND Condensers are not, up to the present, available in Mars would amply account for their failure to establish contact."

We agree. In fact, we are convinced that the ORMOND Condenser, with its slow motion friction drive, ball bearings and easy mounting, has a ready market awaiting it in that distant sphere.

Illustrated above is our artist's idea of Mars and the Martians. Others, doubtless, have different conceptions. But however much at variance opinions on this point may be, no two opinions exist as far as ORMOND Condensers are concerned. In this all are unanimous in acclaiming ORMOND as consistently the best.

ORMOND S.L.F. CONDENSER

With 4-in. Bakelite Knob.

·0005 microfarad	..	20/-
·00035 ,,	..	19/6
·00025 ,,	..	19/-

With Dual Indicator Dial.

·0005 microfarad	..	21/6
·00035 ,,	..	21/-
·00025 ,,	..	20/6

Ratio 55-1.

ENGINEERING "ORMOND" COMPANY LTD.
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MORE "SOLODYNE" APPRECIATIONS

Two Offers To Demonstrate

"Super-Sensitive."

SIR,—I have very great pleasure in telling you that I have completed the Elstree "Solodyne" five-valve set, details of which were published in the September issue of your magazine, MODERN WIRELESS.

I had no difficulty after completing the set in tuning in British and Continental stations at loud-speaker strength by rotating the one dial.

These stations were tuned in with wonderful clarity and volume in a few minutes.

The set is super-sensitive and selective—ridiculously easy to control—stations coming in which are separated by only a few degrees without any heterodyning.

I have had the set on view at my Radio Stores, and it has created widespread interest.

I thank Elstree and MODERN WIRELESS for such a wonderful design.—Yours truly

REX W. LEONARD.

Bristol.

"Wonderful Circuit."

SIR,—As an enthusiastic amateur I wish to commend you on your wonderful "Solodyne" circuit.

For some years past I have been using American parts and circuits to get the degree of selectivity necessary for distance work while the local station is broadcasting.

I recognised in your circuit drawing the possibilities of this set and built it. It surpasses all my expectations; stations come in much too loud on the loud-speaker by just turning the tuning dial. A friend (with no wireless knowledge at all) last night tuned in 19 stations on the loud-speaker. In fact, headphones are never used.

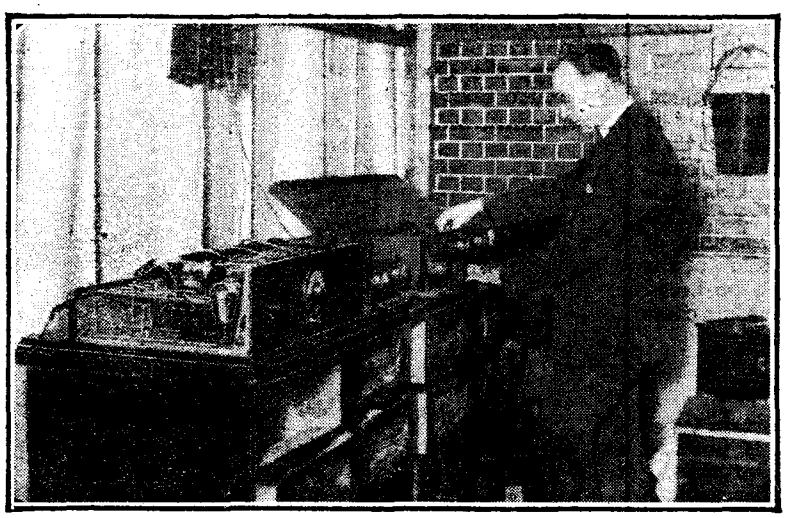
If any one should care for a demonstration I should only be too pleased to give it, as it is not until one sees how ridiculously simple it is to work that the real charm is apparent.

Thanking you for this wonderful circuit.—Yours truly,

R. S. BARLEY.

Cricklewood.

THE "SOLODYNE" AT TOTTENHAM.



At the recent radio show held at Tottenham by the Wireless League an Elstree "Solodyne" was used for demonstrating to visitors the reception of distant stations. The set can be seen on the left in the above photograph.

"Delighted."

SIR,—I have just recently finished building the Elstree "Solodyne," and must say it is beyond realisation to get the results that I obtained with the set. Within half an hour I obtained 15 stations on L.S., as B.B.C. stations were S.B. at the time. I conclude these were all Continental, some programmes were really good. To give a full detailed account would take too much time, and as I only have one free evening per week I have very little time to log them, and then results were obtained whilst set was roughly balanced. I am truly surprised and delighted with the set. I have to thank you heartily for your wonderful service to myself and the public.—Yours truly,

A. V. SKILTON.

Wimbledon.

"Sixty Stations."

SIR,—I am writing to tell you of the results which I have obtained on two Radio Press star sets. The first, a five valve "Solodyne," was constructed for a friend, who is highly delighted with it, and during preliminary tests I tuned in 60 stations on the loud-speaker with it at various times. My friend's aerial is somewhat screened, and so far he has only logged 30 stations on the L.S., but cannot say too much for the simplicity and excellence of the design.

The "Mewflex" which I constructed is giving every satisfaction, and for three valves is a wonderful "distance getter."—Yours truly, MAURICE CATHIE.

Leigh-on-Sea.

"Uncanny."

SIR,—I have now constructed two "Solodyne" sets and can only confirm what has been said in the October MODERN WIRELESS. It is absolutely "uncanny" how stations come in.

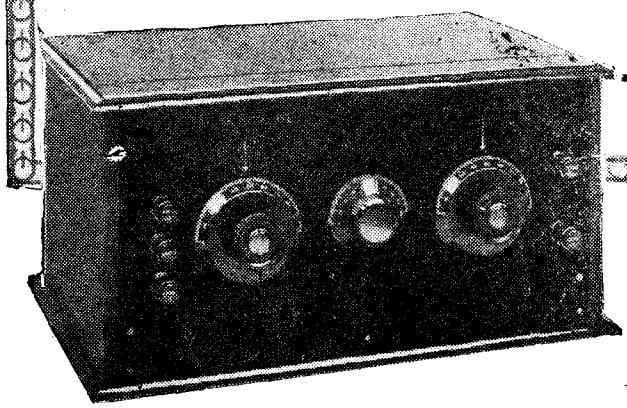
To anyone who is interested I should be pleased to demonstrate the set if they will write me first.—Yours truly,

E. W. PEARSON.

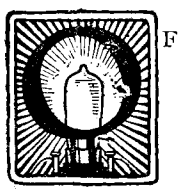
Oakland Estate, Welwyn, Herts

AN "ALL-PURPOSE THREE"

By STANLEY G. RATTEE, M.I.R.E.



A set employing a popular circuit which, in addition to being easily operated, possesses the advantage of being non-radiating.



OF the many receivers which fall within the small set class, probably the most popular is that which employs three valves, serving in their respective positions as H.F. amplifier, detector, and note-magnifier. The reason for this popularity is largely due to the fact that such a set may be looked upon as a compromise between a local station loud-speaker instrument and one which will, with a certain amount of simplicity in operation, allow of the more distant stations to be heard in the telephones, and in some cases also on the loud-speaker.

Number of Valves

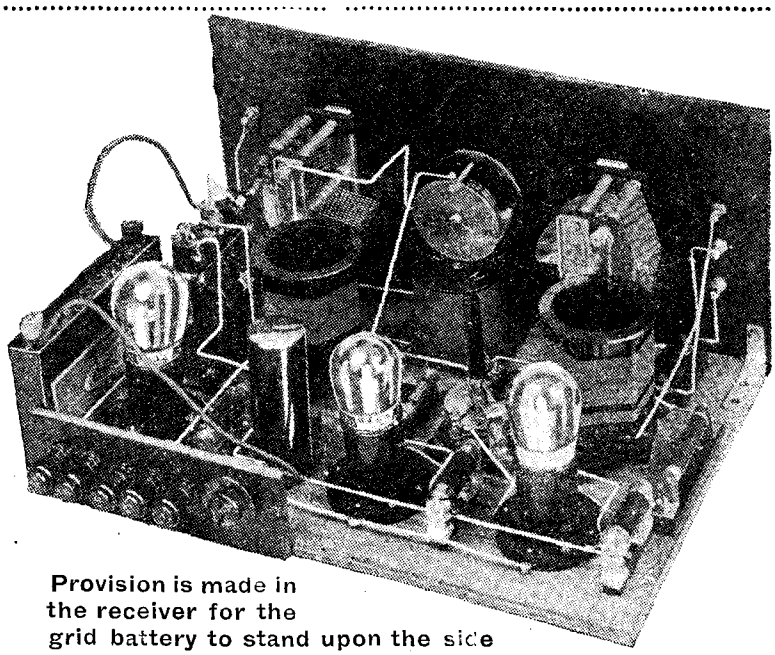
It is true that with certain types of single-valve sets it is possible to tune in other stations, but usually the operation is a rather tedious one, while the set itself is adjusted so near to the oscillation point that in many cases distortion results. For all ordinary purposes where distance work is concerned the conventional single-valve set should be regarded as not quite good enough when used in the hands of the average listener, and should therefore be left to those listeners who have more operating experience or should be left alone until some circuit is devised which will be a considerable improvement upon those at present existing, even as good as many of them undoubtedly are.

Distance work which is likely to be attendant with consistent success is best attempted with a receiver employing at least one-stage of high-frequency amplification, when it will be found that the reaction adjustments are rarely as critical as those of a single valve set, while generally the selectivity is greater.

Simple Operation

The inclusion of the high-frequency stage renders the reception of, say, the Continental stations far easier than would be the case were the set made up with even a detector and two note-magnifiers, for instance, and since the H.F. valve is of the neutralised type the question of instability need not be discussed.

It is true that two tuning controls are used, and this may, in the opinion of many small valve set users, sound a little complicated, but if one bears in mind the usual difficulties experienced with a critical reaction adjustment, the alleged complication brought about by the extra dial largely outweighs the argument. Further, in the majority of modern day receivers the two tuning condenser dials read approximately the same, thus reducing to some extent the difficulties of bringing the two circuits into tune.



Provision is made in the receiver for the grid battery to stand upon the side of the baseboard.

The Circuit Arrangement

The circuit of the receiver is shown in theoretical form in Fig. 1, wherein it will be seen that included in the aerial circuit is a fixed condenser of .0003 capacity, terminal arrangements being provided whereby the

WORLD'S CHAMPIONSHIP WINNER RECOMMENDS S.T. VALVES.

Messrs. S.T., Ltd., have received a letter (open to inspection at our Offices) from Mr. R. W. Emerson, the British Amateur who won, in the face of world-wide competition, the championship at the International Exhibition at Amsterdam. This letter is of extreme interest to MODERN WIRELESS readers because it bears eloquent testimony to S.T. valves and offers readers the opportunity of hearing these valves for themselves. You cannot do better than follow the advice of the World's leading amateur and use S.T.'s in your Elstree Six, Solodyne, or other set.

USE S.T. VALVES FOR S.T. CIRCUITS!

The following valves are recommended by John Scott-Taggart, F.Inst.P., A.M.I.E.E., recently Technical Director of the Elstree Laboratories, under whose management all the following sets have been designed. Five out of these seven star sets are covered by his patents. Who could be a better judge of the valves to use in these sets?

	2 volt.	4 volt.	6 volt.
ELSTREE SIX.			
3 H.F. ...	S.T. 21	S.T. 41	S.T. 61
Detector ...	S.T. 22	S.T. 42	S.T. 62
1st L.F. ...	S.T. 23	S.T. 42	S.T. 62
2nd L.F. ...	S.T. 23	S.T. 42 or S.T. 43	S.T. 62 or S.T. 63
MEWFLEX THREE.			
H.F. ...	S.T. 21	S.T. 41	S.T. 61
Dual ...	S.T. 23	S.T. 42 or S.T. 43	S.T. 62 or S.T. 63
Detector ...	S.T. 22	S.T. 41	S.T. 61
NIGHT HAWK.			
2 H.F. ...	S.T. 21	S.T. 41	S.T. 61
Detector ...	S.T. 22	S.T. 41	S.T. 61
1st L.F. ...	S.T. 23	S.T. 42	S.T. 62
2nd L.F. ...	S.T. 23	S.T. 42 or S.T. 43	S.T. 62 or S.T. 63
DISTAFLEX.			
Both valves	S.T. 23	S.T. 42 or S.T. 43	S.T. 62 or S.T. 63

	2 volt.	4 volt.	6 volt.
SOLODYNE FIVE.			
2 H.F. ...	S.T. 21	S.T. 41	S.T. 61
Detector ...	S.T. 22	S.T. 41	S.T. 61
1st L.F. ...	S.T. 23	S.T. 42	S.T. 62
2nd L.F. ...	S.T. 23	S.T. 42 or S.T. 43	S.T. 62 or S.T. 63
ELSTREFLEX TWO.			
Dual valve	S.T. 23	S.T. 42 or S.T. 43	S.T. 62 or S.T. 63
L.F. valve	S.T. 23		
MONODIAL.			
H.F. ...	S.T. 21	S.T. 41	S.T. 61
Detector ...	S.T. 22	S.T. 41	S.T. 61
1st L.F. ...	S.T. 23	S.T. 42	S.T. 62
2nd L.F. ...	S.T. 23	S.T. 42 or S.T. 43	S.T. 62 or S.T. 63
SPAN SPACE-THREE.			
H.F. valve	S.T. 21	S.T. 41	S.T. 61
Detector ...	S.T. 22	S.T. 41	S.T. 61
L.F. ...	S.T. 23	S.T. 42	S.T. 62

NOTE.—All S.T. valves are designed to operate direct off 2 volt, 4 volt, or 6 volt accumulators according to whether the type number begins with a 2, 4 or 6. S.T. valves may be worked with rheostats from their appropriate batteries, but an S.T. 21 for example should not be worked off a 6-volt battery. Where it is absolutely necessary to use a higher voltage battery, fixed resistors should be used.

Although S.T. valves may be worked directly off the accumulator fixed resistors of the following values will increase their lives. For:—

S.T. 21 and S.T. 22 with a 2-volt battery use 2-ohm resistors.
S.T. 23 with a 2-volt battery use 1 ohm resistors.
S.T. 41 and S.T. 42 with a 4-volt battery use 2 ohm resistors.
S.T. 43 with a 4-volt battery use 1 ohm resistors.
S.T. 61 and S.T. 62 with a 6-volt battery use 4-ohm resistors.
S.T. 63 with a 6-volt battery use 1.5 ohm resistors.

The experimenter will find that in many cases even higher resistances may be used with advantage, as the valves will work excellently at voltages much below the rated value.

If you cannot buy an S.T. valve from your local retailer write direct to us or call. All orders will be sent by post insured by us against breakage. C.O.D. orders executed on receipt of postcard.

Mr. R. W. Emerson.

Extract from Mr. Emerson's Letter.

You will, no doubt, be interested to hear the results I have obtained with the new S.T. valves, which I immediately obtained on seeing the announcements.

First of all I tried them in the actual Elstree Six with which I won the International Gold Medal at Amsterdam.

Using S.T. 61, S.T. 62, S.T. 63, in this order, I obtained with the set results considerably better than those given by other makes I had been using, and that is saying a great deal.

I have since tried them in several other sets I have built, including the Solodyne, with equal success, and I am frankly delighted with the results, and as the current consumption is so small also they are extremely economical.

They give really high amplification and are exceptionally pure in reproduction.

My Elstree Six has created so much interest that I am having to give demonstrations to friends, etc., and I shall be happy to let anyone hear it working with S T valves if an appointment is made.

(Signed)
R. WALDO EMERSON.
3, St. Anne's Terrace, St. John's Wood, London, N.W.8.

S. T. LIMITED, 2, Melbourne Place, Aldwych, London, W.C.2.

(Next to Australia House.)

Scott-Taggart makes them

THE S.T. valves described in these pages have been manufactured in England by, and to the specification of, John Scott-Taggart, M.C., F.Inst.P., A.M.I.E.E., whose name is probably more familiar than that of any other expert on the valve.

Before entering the valve manufacturing industry, Mr. Scott-Taggart was the head of the group of wireless periodicals which included *Modern Wireless*, *Wireless*, and *The Wireless Constructor*. In addition, he was the founder and head of the Elstree radio research and test laboratories, where part of the work consisted in the critical testing of valves, sets and components of the leading manufacturers in this country. Before these activities, Mr. Scott-Taggart was in charge of the manufacture of valves made for the British Government.

JOHN SCOTT-TAGGART, F.Inst.P., A.M.I.E.E.

Mr. Scott-Taggart is the author of the leading text-books on the valve, his *Thermionic Tubes in Radio Telegraphy and Telephony* being the standard and most comprehensive work on this subject. In addition, his books, *Elementary Textbook on Wireless Vacuum Tubes*, *Practical Wireless Valve Circuits*, *More Practical Valve Circuits*, *Wireless Valves Simply Explained*, *Radio Valves and How to Use Them* have helped in no small measure the present generation of valve users. More than half a million of his books have been sold, excluding foreign translations, indicating to some extent the confidence of the wireless public in his work, his judgment, and his knowledge and experience.

More than fifty patents, all concerned with valves, stand in his name, some proof of the inventive genius of one whose whole technical life has been concerned entirely with this branch of radio.

Having already firmly established the design and processes of manufacture, Mr. Scott-Taggart (whose initials S.T. give the valves their name) determined, in spite of the laborious work involved, to see that each and every valve sent out by S.T. Ltd. should be tested by electrical measurements and on actual signals under his own supervision. Each valve box has a space on it where Mr. Scott-Taggart personally initials a test certificate for the valve inside. The firm of S.T. Ltd. and its Managing Director feel that valves should not be regarded as a kind of lamp or as so much merchandise. They feel that the manufacture and testing of valves require the undiluted attention of those who have devoted their lives to this industry and have no subsidiary interests.

However casually one may regard a valve, the fact remains that no two makers' valves are the same. Outwardly and in actual operation the S.T. valve is robust, highly efficient and foolproof. A child can buy one and fit it in the family set. But inside that glass bulb all the ingenuity of modern science, the precision of specially designed machinery and painstaking care in testing have contributed to make a valve which stands out head and shoulders above others.

In the early stages, the designer of the S.T. valve refused to proceed unless he was entirely unhampered and able to use any invention he desired. As a result, S.T. Ltd. are operating under all the leading patents which have contributed to the advancement of the valve. Nothing has been sacrificed in design through inability to use some invention essential to achieve the best results.

Reasons why you'll prefer S.T. Valves

(1) *The Name behind them*

They bear the imprint of John Scott-Taggart and all that this name has come to mean in the valve world.

(2) *Possess the right Dynamic curves*

They are designed and tested on the basis of Dynamic characteristic curves. The common method is to have regard only to the static or ordinary curve. The ordinary curve, while valuable for some purposes, ignores working conditions, since it is taken with a fixed anode voltage. Every valve in a wireless receiver has, however, a constantly fluctuating anode voltage which, when the grid is made more positive, becomes less than the H.T. voltage, while when the grid is more negative, the anode voltage rises to a value higher than that of the H.T. battery. This is due to the variation in current through the impedance always in the anode circuit of the valve. This impedance may, for example, be an H.F. or L.F. transformer, a choke, a resistance or a loudspeaker.

This phenomenon is generally overlooked by both manufacturers and many valve users. Every type of S.T. valve, however, is designed to give the right Dynamic curve which represents the conditions with the impedance in circuit. The valve, moreover, is *tested* dynamically, *i.e.*, under operating conditions.

(3) *It is their curves that count*

All the operating merits of a valve, whatever the type may be, are reflected in the characteristic curves of the valve—provided, of course, that the right curves are taken. The effect of electron emission, the shape, sizes and spacing of electrodes, for example, all produce an effect on efficiency which is noticeable in the characteristic curves of the valve. That is why S.T. Ltd. lay so much store by the curves of their valves. Anyone can claim perfection and this or that merit, but in the end the curves show defects or merits. The Dynamic curve of a valve cannot lie. It's the curve that counts!

(4) *Like the Pyramids, they last*

However well a valve may work and however good a curve it may have, this is no consolation if the valve only lasts a few days or a few weeks. This brings us to what many people regard as the most important factor—the life of the valve. About 50 per cent. of the valves sold use thoria in their filaments and often the power of emitting electrons seriously falls off. The valve remains alight, but the emission falls below the safe limit and signals become—to many—unaccountably weak, and distortion also arises. The S.T. valve has a *torodium* filament and has a very long and useful life. If you buy your valves on the basis of the length of service they give, you will always choose S.T.'s, for they are built like the Pyramids—to last.

(5) *The Torodium filament*

The secret of the long life of the S.T. valve lies first in the filament and secondly in the vacuum. The filament is made of torodium, a recently invented alloy of precious metals which gives off, when heated, a copious stream of electrons. This power of emitting a generous supply of electrons remains throughout the life of the valve, and, moreover, breakages through the brittleness of the filament are unknown, as even after being used for a long period it retains a strength and pliability comparable to that of a steel cable. The life is also largely attributable to the fact that the torodium filament

operates at so very low a temperature that it gives no visible glow.

(6) *Extremely high vacuum due to the Barguet process*

The vacuum in a valve is a feature which greatly influences not merely the initial operation of the valve, but also its life. After a time, there is a tendency for gases absorbed or "occluded" by the metal electrodes in the valve to leak out into the space in the bulb and partially spoil the vacuum. It has been proved beyond question that the slightest traces of oxygen, water vapour and other gases greatly affect the electron emission and the life of the filament. In the case of S.T. valves, the electrodes are heated to a very high temperature to drive out every particle of gas. These gases are then withdrawn from the bulb by the Barguet process of evacuation, which produces the highest vacuum known to science. This high vacuum is retained, and is a potent factor in giving the S.T. valve a long and efficient useful life.

(7) *Economical, as they take very little current*

Economy in upkeep is a vital factor in the choice of a valve. Hence the great popularity of dull-emitter valves. Many so-called dull-emitters are, however, very extravagant in current consumption in comparison with the S.T. valves, which only take 0.1 ampere in most cases and 0.15 ampere in the case of one of the power valves. Work out how much this saves you in the cost of accumulator charging and the fatigue of carrying accumulators to be charged. The smallest increase above these figures means greater cost and trouble.

(8) *Not critical to work*

One of the most delightful features of the S.T. valve is the fact that it is not critical to work. You can, in fact, be careless. For example, the torodium filament will work efficiently with or without a rheostat or resistor. Many valves are very critical on filament voltage, but the 6 volt S.T., for example, will work off any voltage between about 4.5 and 6 volts. Some valves only work at their best when the accumulator is absolutely fully charged, and signals "go off" after a time. The S.T. valve, however, will continue at work until the accumulator runs down.

(9) *Non-microphonic and robust*

The S.T. valve is non-microphonic. You can tap it with impunity. It is very strongly made. Built like a chronometer for accuracy and uniformity, it is yet robust. Each electrode is supported in several places to give strength.

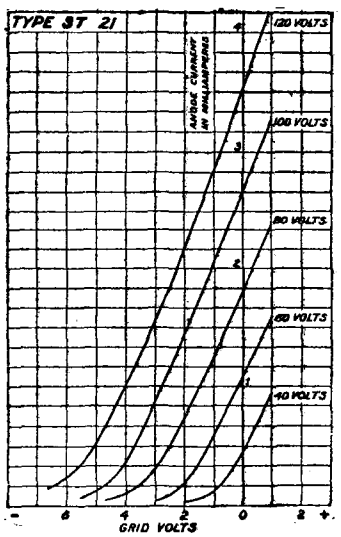
(10) *Every valve certified O.K. by John Scott-Taggart*

Every valve is tested under Mr. Scott-Taggart's supervision and every carton is personally initialled by him to certify the satisfactory characteristic of the valve. The valves are uniform and every one is a "picked" valve. Any valve not coming up to the required standard is destroyed.

Specifications and Characteristic Curves

(The curves given are static curves to serve as some comparison with other valves. Dynamic curves are obtainable on application)

VALVES FOR 2-VOLT BATTERIES



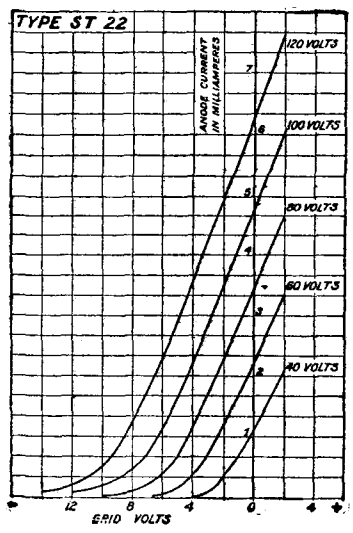
S.T. 21

H.F.

Filament 1.8 volts.
" 0.1 amp.
Anode 40–120 volts.
Impedance 26,000 ohms.
Amplification 16.

An excellent valve for H.F. amplification and resistance capacity coupling. It is also to be recommended as a detector valve.

Price 14/-



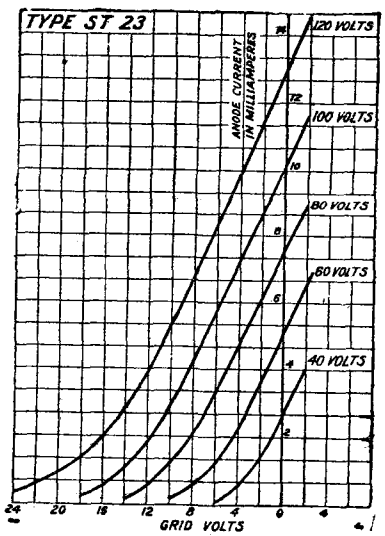
S.T. 22

L.F. and Det.

Filament 1.8 volts.
" 0.1 amp.
Anode 40–120 volts.
Impedance 16,000 ohms.
Amplification 10.

This valve is for the first stage of a low frequency amplifier and will give undistorted reproduction. It may also be used for H.F. amplification, especially in neutrodyne circuits, and for detection.

Price 14/-



S.T. 23

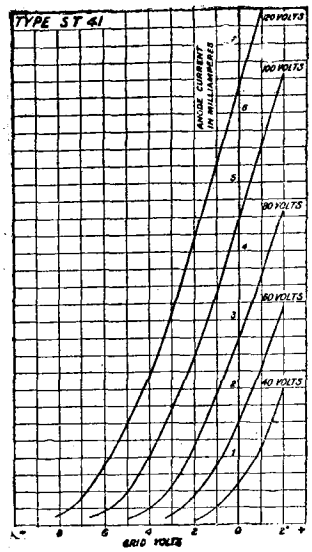
POWER

Filament 1.8 volts.
" 0.15 amp.
Anode 80–120 volts.
Impedance 6,000 ohms.
Amplification 6.

A magnificent 2 volt power valve giving superb reproduction when used as the last valve of a set when a loudspeaker is employed. Note its low impedance and the high amplification factor for such a valve.

Price 18/6

VALVES FOR 4-VOLT BATTERIES.



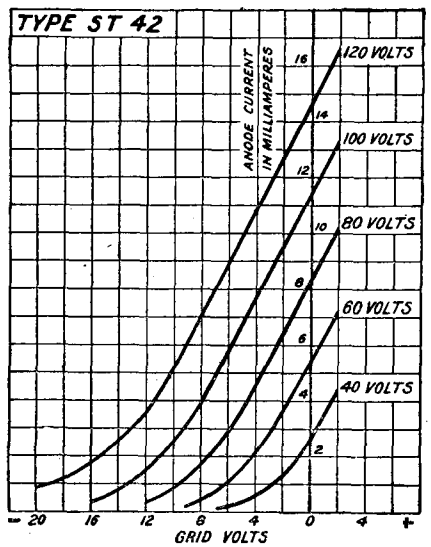
S.T. 41

H.F. and Det,

Filament 3.7 volts.
" 0.1 amp.
Anode 40-120 volts.
Impedance 16,000 ohms.
Amplification 13.

This is an efficient H.F. valve more particularly designed for neutrodyne circuits. It brings in the distant stations with ease. This valve may be used as the first L.F. and as the detector valve. It is the valve for resistance capacity coupling.

Price 14/-



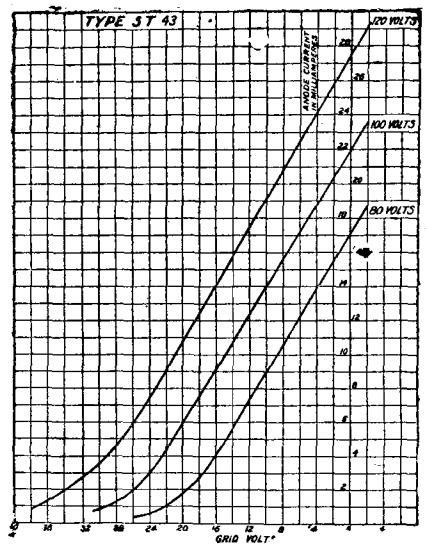
S.T. 42

POWER

Filament 3.8 volts.
" 0.1 amp.
Anode 40-120 volts.
Impedance 6,000 ohms.
Amplification 6.

An excellent power amplifier recommended for first and also the second stage of L.F. although the S.T. 43 is the ideal loudspeaker valve in the 4 volt class.

Price 18/6



S.T. 43

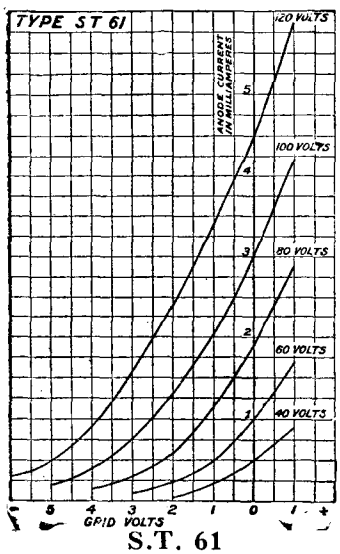
SUPER POWER

Filament 3.8 volts.
" .25 amp.
Anode 120 volts.
Impedance 4,000 ohms.
Amplification 3.33

This valve is the only standard 4-volt valve in the super power class, hitherto confined to 6 volt valves. It is "the valve with the golden voice" and is capable of great volume and exceptional purity of tone.

Price 22/6

VALVES FOR 6-VOLT BATTERIES.



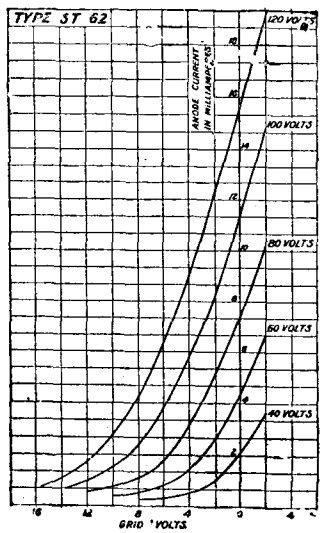
S.T. 61

H.F.

Filament 5.6 volts.
" 0.1 amp.
Anode 50-120 volts.
Impedance 20,000 ohms.
Amplification 20.

This efficient H.F. valve is particularly to be recommended for all neutrodyne types of circuit, while it may also be used for resistance capacity coupling. It makes an excellent detector.

Price 18/6



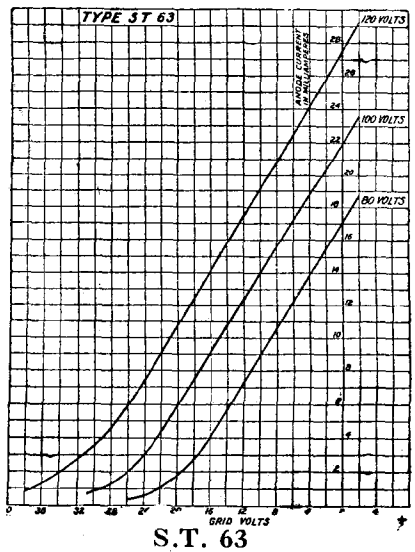
S.T. 62

POWER

Filament 5.6 volts.
" 0.1 amp.
Anode 80-120 volts.
Impedance 6,000 ohms.
Amplification 8.3

This power valve is the best of its class and makes a good first and second L.F. valve. It is intended especially as a good all-round power valve.

Price 18/6



S.T. 63

SUPER POWER

Filament 5.6 volts.
" .25 amp.
Anode 120 volts.
Impedance 4,000 ohms.
Amplification 3.33.

This is "the valve with the golden voice." It is an entirely new class of valve having very long dead-straight dynamic curve giving exquisitely pure loudspeaker reproduction.

Price 22/6

GENERAL NOTES.—S.T. valves operate at the lowest temperature of any valve made. Do not assume that because you cannot see the filament alight that the valve is not working. Any of the valves will work directly off an accumulator or with a rheostat or fixed resistor. Under no circumstances should a valve be worked with a *rheostat* off a battery of higher than the rated voltage, e.g., do not work an S.T. 23 off a 6 volt accumulator through a rheostat. No responsibility can be taken for valves spoilt by over-running—so liable to occur in such cases. Where it is desired to work, say, a 2 volt valve from a 6 volt battery (an undesirable practice) a fixed resistor should be used and suitable valves (and the resistors themselves, if desired) will be supplied on application. A rheostat or fixed resistor may always be used with, say, a 2 volt valve when working off a 2 volt accumulator, but neither is essential. The life of the valve will be increased if the filament current is kept as low as is consistent with good results.

The valves used for L.F. amplification should always be operated with a grid bias battery which should be variable, and give not less than a maximum of 9 volts. The S.T. 43 and S.T. 63 valves require a grid bias battery giving up to 18 volts.

Note that both the S.T. 41 and S.T. 61 valves, though marked H.F., may be used as general purpose valves. The marking of the valves H.F. and L.F. is adhered to, although this arbitrary labelling is really inaccurate, as the valves can often be used for different purposes. We shall always be happy to give individual customers advice on the choice of valves. A high-tension battery of 120 volts will be found the most useful.

Advt. of S.T. Ltd., 2, Melbourne Place, W.C. 2.

AN "ALL-PURPOSE THREE"—*(Continued)*

condenser may be included in the circuit or not, as desired.

The purpose of this condenser is to increase the selectivity of the set upon the lower wavelengths of the broadcast band, and it is recommended that both aerial terminals be tried for the best results, as these will depend to some extent upon individual aerials; generally, however, using the condensers for the reception of the higher wavelengths will have no appreciable effect upon selectivity with a possible loss in signal strength. On wavelengths below, say, 400 metres, however, the inclusion of the condenser in the circuit will usually be found most useful.

Details of the Coils

The two coils L1 and L2 are wound upon a common former, a spacing of about ¼ in. being allowed between the top end of L1 and the bottom end of L2. The first of these coils forms the aerial coil L1, and consists of 20 turns of No. 34 d.s.c. with the top end connected to pin No. 2, and the bottom end to pin No. 5. The second coil L2 is wound with the same gauge wire, in the same direction as L1 and consists of 90 complete turns, tapped at 45 turns.

The two ends of this coil are connected to pins No. 4 and 1, the top end of the coil being connected to pin No. 4; the tapping from the 45th turn is connected to pin No. 3.

The third coil, L3, consists of 90 turns of the same gauge wire as the other two and is identical in every respect with L2, even the connections to the pins being the same.

These coils may, if desired, be obtained ready wound from the firm named in the list of components, though winding them oneself does not present much difficulty.

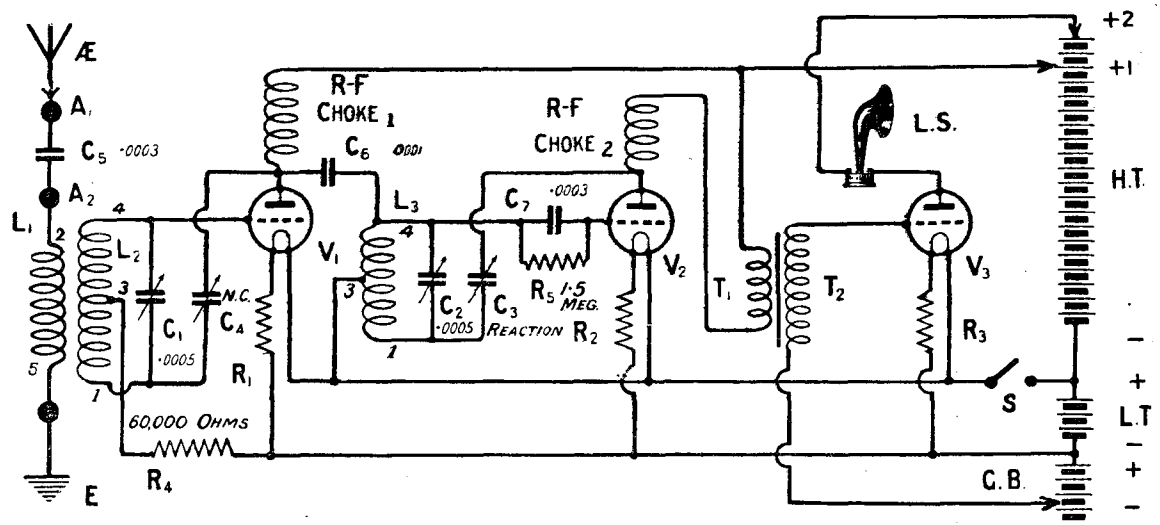


Fig. 1.—The theoretical circuit diagram. In the set the lead from terminal 3 on the coil L_3 is for convenience in wiring taken to the battery side of the switch S.

COMPONENTS REQUIRED

Ebonite panel, 14 in. by 7 in. by $\frac{3}{16}$ in. ("Ebonart.")
Cabinet to suit, with baseboard 9 in. deep. ("Camco.")
Two ·0005 "Popular" condensers. (Bowyer-Lowe Co., Ltd.)
Panel mounting "Midget" condenser. (Beard and Fitch, Ltd.)
Two H.F. chokes. (Beard and Fitch, Ltd., and Lissen, Ltd.)
One L.F. transformer. (Igranic Electric, Ltd.)
Two six-pin coil bases and coils, as described. (Collinson Precision Screw Co., Ltd.)
Three "Lotus" valve holders. (Garnett, Whiteley and Co., Ltd.)
Board mounting neutralising condenser. (Peto-Scott Co., Ltd.)
Three "Temprytes" of a valve suitable to the valve chosen. (Sydney S. Bird.)
One 60,000 ohm resistance with base. (L. McMichael, Ltd.)
One ·0003 condenser with clips. (Dubilier Condenser Co., Ltd.)
One ·0001 condenser. (Dubilier Condenser Co., Ltd.)
One 1·5 megohms leak. (Dubilier Condenser Co., Ltd.)
One ·0003 fixed condenser. ("Efesca.")
Two panel brackets.
Ebonite terminal strip, 6 in. by 2 in. by ¼ in.
One "On-off" Toggle switch. (Rothermel Radio Corp. of Gt. Britain, Ltd.)
Ten terminals: "Aerial 1," "Aerial 2," "Earth," "Output +," "Output –," "H.T.+1," "H.T.+2," "H.T.–," "L.T.+," "L.T.–."
Two wander plugs, one red, one black.
Short length rubber covered flexible wire.
"Glazite" connecting wire.

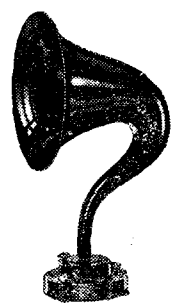
Now Grannie *can* listen!

"THAT Wireless" Grannie used to say, "was no good—she never *could* hear what 'the man was saying!" That was before the **Brown** Crystal Amplifier came. Now she sits and listens to the Loud Speaker working from the little Crystal Set. For hours and hours! Now she appreciates the boon broadcasting can be. Mostly everyone, now, can work a Loud Speaker from a Crystal Set without the use of a single valve. If you live within fifteen miles of a B.B.C. Station (or eighty miles from Daventry) the **Brown** Crystal Amplifier will enable you to obtain pure, faithful Loud Speaker reproduction from your Crystal Receiver. No Valves. No accumulators. Just the Crystal Amplifier connected to your Set and the Loud Speaker. The only accessory needed is a 4½ volt dry battery. What more ideal way of enjoying the broadcast? You get the results of your friend the valve-user without any of the worry, trouble and expense his accumulators cost him.

Brown
—for faithful Radio interpretation.

See your Dealer about the Crystal Amplifier to-day. Get him to demonstrate it on one of the nine **Brown** Loud Speakers. You'll be sure to want one for yourself.

The H.Q.
20 inches high
2000 or 4000 ohms.
£6 0 0



The H1.
120 ohms. £5 5 0
2000 ohms. £5 8 0
4000 ohms. £5 10 0

S. G. BROWN, LTD., Western Avenue, North Acton, W.3.

Retail Showrooms: 19, Mortimer Street, W.1; 15, Moorfields, Liverpool; 67, High Street, Southampton. Wholesale Depots: 2, Lansdown Place West, Bath; 120, Wellington St., Glasgow; 5-7, Godwin Street, Bradford; Cross House, Westgate Road, Newcastle; Howard S. Cooke & Co., 59, Caroline Street, Birmingham. Robert Garmany, Union Chambers, 1, Union Street, Belfast, N. Ireland.

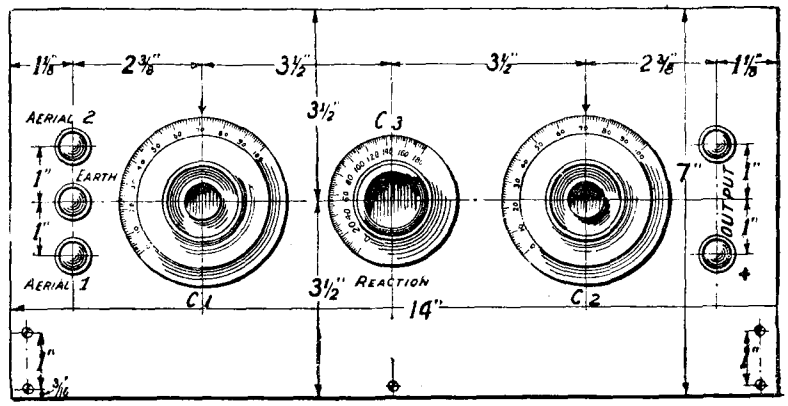
A SET FOR GENERAL USE

Components and Materials

Before starting upon any endeavour to build a receiver as illustrated, it is suggested that the materials and components given elsewhere be collected together. Following upon the names of these components, their trade mark or manufacture is given, and though of course other suitable makes will be found among the advertisement pages, the actual values where stated should be strictly adhered to.

Arranging the Components

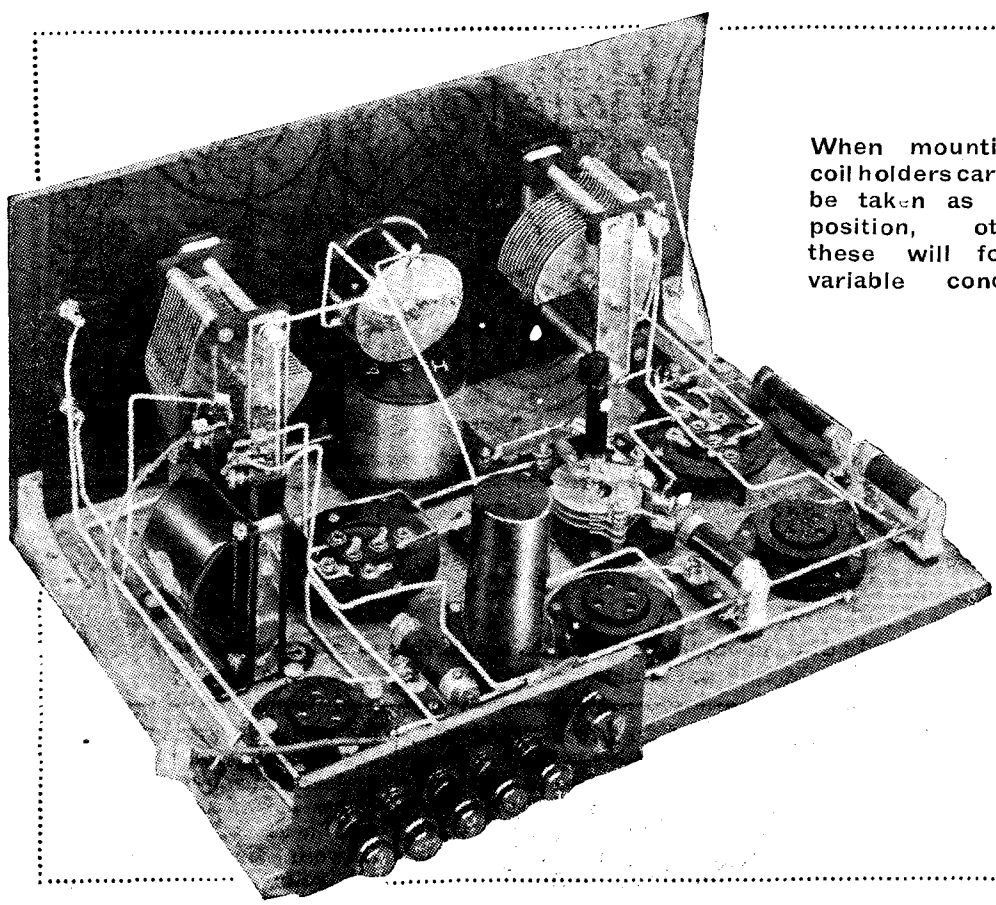
In view of the fact that the coils used do not employ screens, it is essential that the layout illustrated should be copied with care, otherwise there may be some difficulty in either obtaining selectivity or stability over the whole tuning range of the condensers. Another point worthy of remembering is that when mounting the components upon the baseboard care must be taken to ensure that sufficient room is allowed to enable the valves to vibrate clear of the various components. The best way of making sure of this fact is to insert the valves in the holders and to then ascertain the best positions by moving them about upon the baseboard.



Two aerial terminals allow of the use of a small series condenser in the aerial circuit if desired. Blueprint No. 185a.

Valves to Use

Valves of the 2, 4, and 6 volt types may be used with equal success, and the best results have been obtained with valves of the special types. General purpose types may of course be used if desired, but special high impedance valves are to be preferred for use in the H.F. stage, and valves of the power type in the detector and low-frequency stages.



When mounting the coil holders care should be taken as regards position, otherwise these will foul the variable condensers.

AN "ALL-PURPOSE THREE"—(Continued)

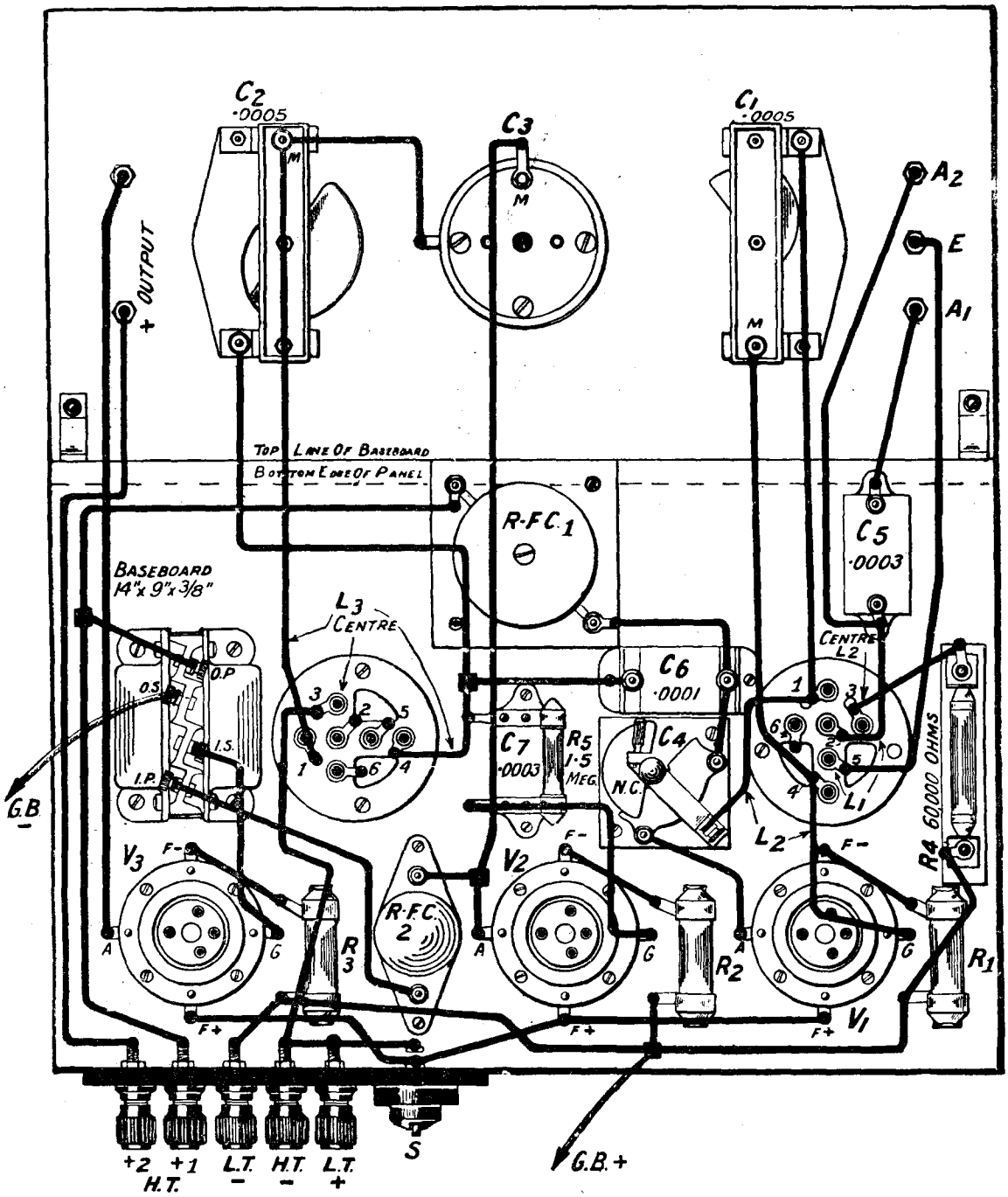
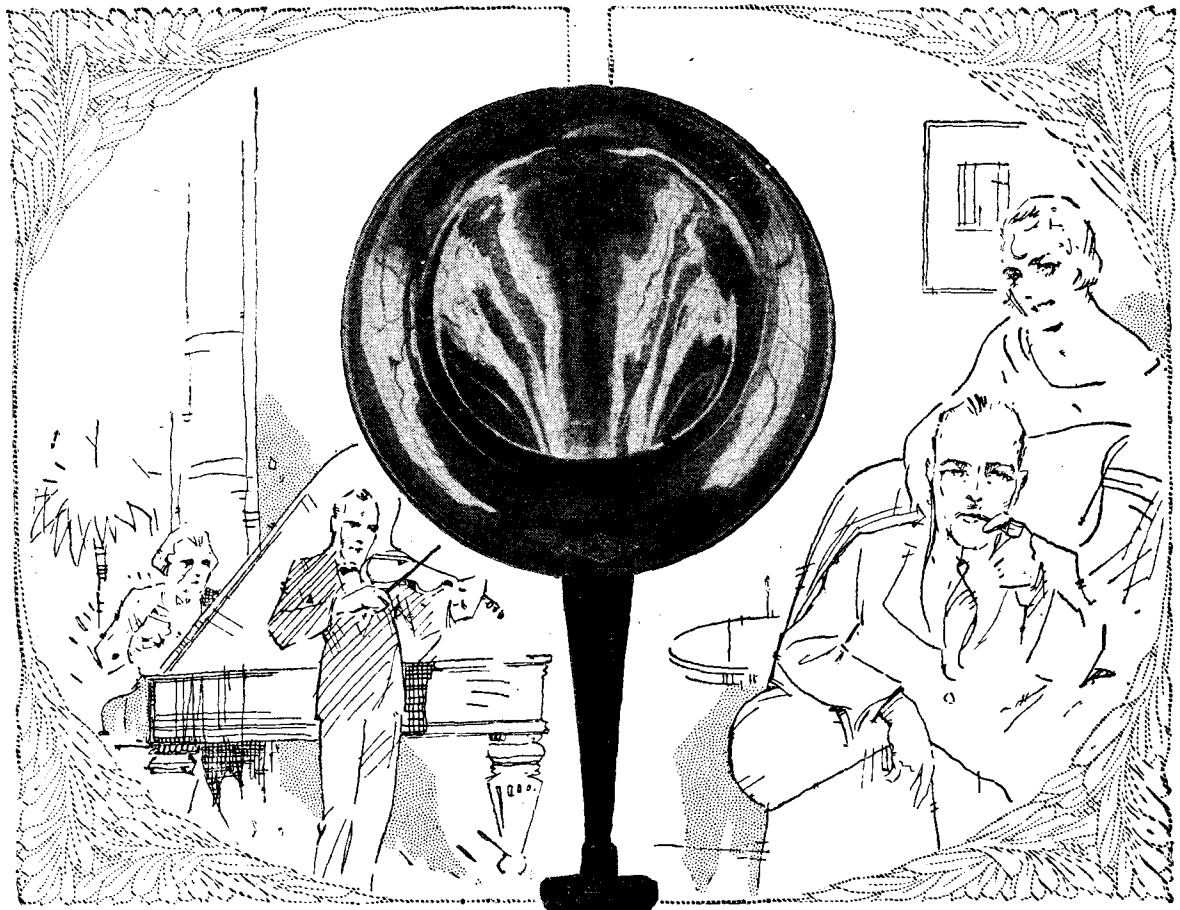


Fig. 3.—The grid of V_3 is connected to I.S., since this was found to be more satisfactory in this particular case. Blueprint No. 185b (free.)

The value of the H.T. voltage applied to the H.T.+1 terminal may be in the nature of 60–80 volts, while that applied to H.T.+2 may be 120 volts.

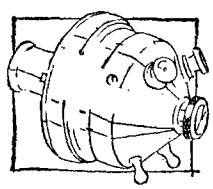
Readers are warned that every care should be exercised in adjusting the value of the grid volts and with, say, a power valve in the last stage with 120 volts applied to its anode, the grid battery should be connected in circuit using as a start 4½ volts. The local station should then be tuned in to its loudest volume, and the value of the grid volts increased until signals either become weaker or distorted whereupon the voltage above 4½ volts should be noted, and, after halving the difference between this and the original 4½ volts, the figure, plus the



GOLDEN HARMONY

CLEAR at a whisper—clear at the heavy volume of a brass band . . . the T.M.C. "Concert Grand" brings a wealth of mellowness, and faithfully reproduces the sounds originated in the broadcasting studio.

The instrument is unequalled for its freedom from "throaty" noises, because the copper used in the construction of the horn is in a natural, unstressed state and its frequency of vibration is out of range of that of any note which the loud speaker may be called upon to reproduce. It gives that full richness which only copper can give.



The magnetic system—a vitally important part of every loud speaker—is the result of much study and experimental work. Your dealer will supply you. **Price - £5 : 10 : 0**

THE "GRAMO-SPEAKER."

The "Gramo-speaker" is a little brother to the "Concert Grand." In a moment it will turn your Gramophone into a splendid loud speaker, or it can be fitted to home made or purchased horns of ordinary design. It makes a most useful extra loud speaker at a nominal price, for your nursery or for entertaining your domestic staff. It is not an adapted "Earpiece" with the diaphragm held in place by a screw-on cap, ready to loosen through its own vibration. It is a real loud speaker unit with an adjustable magnetic system (loud speaker size) fitted with permanent magnets of cobalt steel and a diaphragm firmly clamped between ground metal surfaces. For performance, finish and price it is the best of its kind. Ask your dealer to show it to you. Its price is only **13/6.**

OTHER T.M.C. RADIO SPECIALITIES.

LOUD SPEAKERS.

"Standard" £4 5 0
"Junior" ... £1 10 0
"Minor" ... 17 6

CRYSTAL SETS.

From 9s. to £2 7s. 6d.

OTHER T.M.C. RADIO SPECIALITIES.

HEADPHONES.

No. 3. (Lightweight) in cardboard box 17/6
No. 2a. Heavier Model 15/-
Plush lined cases, 2/6 extra.

LOW-CAPACITY KEYS.

No. 1. 12 point, 3 position 7/-
No. 2. 6 ,, 2 ,, 6/-
No. 3. 24 ,, 3 ,, 15/3

Prices do not apply to Irish Free State.

TMC

Ask for the new T.M.C. Catalogue.

Telephone Manufacturing Co. Ltd.

HOLLINGSWORTH WORKS, WEST DULWICH, S.E. 21

'Phones: Sydenham 2460-1. *Telegrams: "Bubastis, Dullcrox, London."*

AN "ALL PURPOSE THREE"—(*Concluded*)

4½ volts should be approximately correct.

Neutralising the Set

After the wiring of the receiver has been checked and found to be correct, turn the "on-off" switch to the "off" position and connect the L.T. grid and H.T. batteries. Connect the phones, insert the valves, connect the aerial and earth (the aerial to either terminal for the time being) and light the valve to a suitable degree of brilliancy.

Commencing with the condensers all set to a zero reading, slowly turn C_1 and C_2 one or two degrees at a time until the local station is tuned in to its loudest volume, whereupon turn out the H.F. valve by removing its "Tempryte" and adjust the neutralising condenser so that no signs of the local station are heard, irrespective of any amount of re-tuning performed with C_1 and C_2. Re-light the H.F. valve and re-tune to the local station, when it will be found that satisfactory results are obtained.

Operating the Set

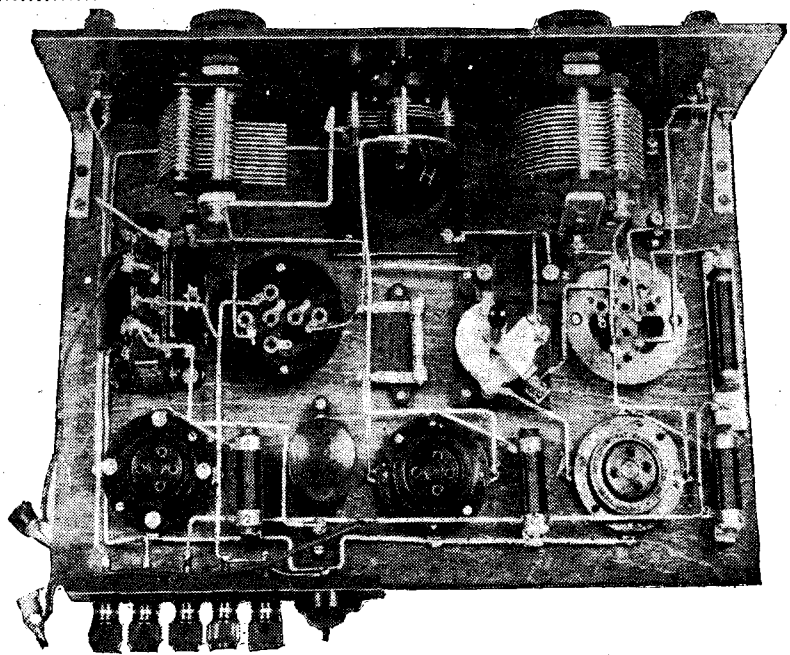
By slowly turning the condensers C_1 and C_2 together the signals from the local station will quickly disappear, and the turning of the condensers should be continued at such relative speeds that the two circuits L_2C_1 and L_3C_2 are always in tune (as evidenced by a slight breathing sound in the phones) until a distant station is picked up. Upon the station being properly tuned in the aerial should be connected to the other terminal and the C_1 condenser again adjusted for the best results, noting whether or not there is any improvement in including or excluding the .0003 series condenser.

Results Obtained

The stations marked with an asterisk were received at moderate loud-speaker strength, while the remainder were at comfortable telephone strength.

Birmingham.*	Radio Barcelona.*
Hamburg.*	Munster.
Newcastle.	Leipzig.
Frankfurt.	Radio Milan.
Bournemouth.*	Radio-Toulouse.*
Radio Belgique.*	San Sebastian.

The district in which these stations were received is not by any means a good one on account of the proximity of the Crystal Palace to the receiving aerial, nevertheless the stations given were picked up without difficulty, in addition to London.



Although three valves are used the wiring is both simple and easily arranged.

WIRING INSTRUCTIONS.

Join one side of R—F.C.1 to OP of transformer; OP of transformer to H.T.+1.

Join A1 to one side of C5.

Join moving plates of C1 to contact 4 of L2, contact 4 of L2 to G of V1.

Join fixed plates of C2 to one side of C6 and one side of C7 and R5; same side of C7 and R5 to contact 4 of L3.

Join output + to H.T.+2.

Join other output terminal to A of V3.

Join one side of S to L.T.+; L.T.+ to H.T.–; H.T.– to contact 3 of L3.

Join F+ of V3 to remaining side of S; same side of S to F+ of V2; F+ of V2 to F+ of V1.

Join L.T.– to one side of R3; same side of R3 to one side of R2 and connect flex lead for G.B + to this point; same side of R2 to one side of R1; same side of R1 to one side of R4.

Join F—of V3 to remaining side of R3.

Join F—of V2 to remaining side of R2.

Join F—of V1 to remaining side of R1.

Join remaining side of R4 to contact 3 of L2.

Join remaining side of R.–F.C. 1 to remaining side of C6; same side of C6 to fixed plates of C4; fixed plates of C4 to A of V1.

Join G of V2 to remaining side of C7 and R5.

Join one side of R.–F.C.2 to I.P of transformer.

Join G of V3 to I.S. of transformer.

Join flex lead for G.B. – to O.S. of transformer.

Join E to contact 5 of L1.

Join A2 to remaining side of C5; same side of C5 to contact 2 of L1.

Join fixed plates of C1 to contact 1 of L2; contact 1 of L2 to moving plates of C4.

Join moving plates of C3 to remaining side of R.–F.C.2 and A of V2.

Join fixed plates of C3 to moving plates of C2; moving plates of C2 to contact 1 of L3.

RADIO PRESS LECTURE TOUR COMMENCES

"SOLODYNE" DEMONSTRATION AT BIRMINGHAM

THE first of the series of Provincial lectures which is being arranged in order to demonstrate in concrete form the results of recent research work at Elstree took place at Birmingham on Tuesday, November 9th. The lecture was organised in co-operation with Radio Press, Ltd., by the Bournville Radio Society.

As most readers will know, Messrs. Cadbury Bros., Ltd., have a large factory at Bournville, near Birmingham, which together with a large area of surrounding ground laid out for residential and recreation purposes has been developed as a form of model village. The Bournville works employ over 10,000 and boasts a flourishing radio society.

This society, therefore, arranged the lecture as one of their ordinary meetings, and by the courtesy of Messrs. Cadbury Bros. invitations were extended to any residents in Birmingham or the neighbouring districts who might care to attend.

Efficient Arrangements

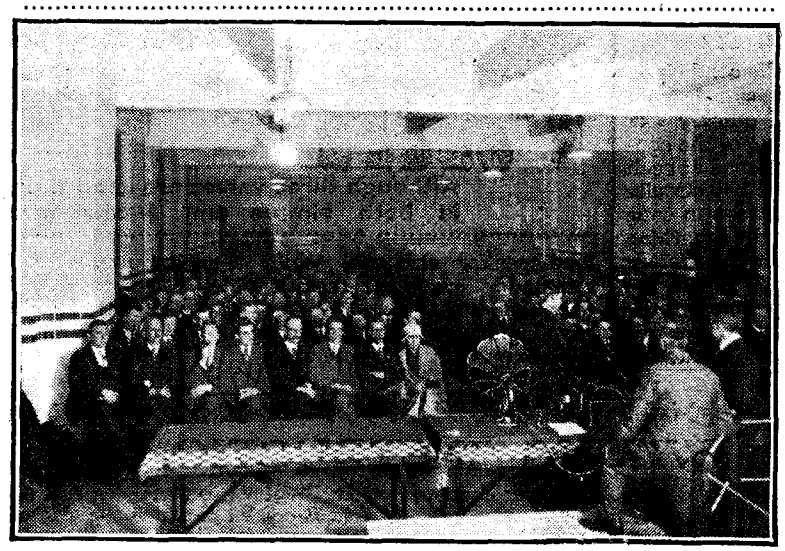
Owing to the efficient arrangements made by the Bournville Radio Society, and also in no small measure to the courtesy of the B.B.C. in including some reference to the lecture in the local announcements from the Birmingham station, a very good attendance was obtained, over 400 people being present on the evening of the lecture.

The lecture was actually delivered by Mr. J. H. Reyner, who first of all expressed his pleasure at being able to come into personal contact with so many interested readers. He then proceeded to outline briefly the developments which have been made in the science of receiver design during the past year or eighteen months.

A Typical Set

For this purpose a five valve set was taken as typical, since the design of a receiver such as this introduces all the principal problems which are encountered in general practice. It was pointed out that the design of simpler receivers was merely a matter of omitting one or more valves, in which case certain of the problems became less important than others.

Having briefly discussed the necessity for rectification in a receiver, the desirability of amplifying the low-frequency currents produced to obtain loud-speaker reception was reviewed, and it was shown that in order to obtain satisfactory results under a variety of conditions, two stages of low-frequency amplification was a useful number. With suitable arrangements, including, if necessary, a volume control, two such stages could be made to give good loud-speaker reproduction on widely differing signal strengths.



This photograph was taken during the demonstration at Bournville. Mr. Reyner may be seen (standing) in the extreme right-hand corner, facing the audience.

The Correct Valve

Mr. Reyner pointed out that the development of efficient low-frequency amplifying apparatus had really been achieved some considerable time ago, and that we were in a good position as far as the low-frequency chain was concerned. He emphasised the importance of choosing the correct valve in order to obtain the best results from the point of view of quality. Attention had been directed recently more particularly to the use of special valves for the last stage of a note magnifier, and the importance of a good valve in this position was demonstrated.

The "Solodyne"

The Elstree "Solodyne" had been connected up, and various demonstrations throughout the

THE "SOLODYNE" AT BOURNVILLE—*(Concluded)*

evening were given on this receiver. The first of these consisted in replacing the existing last valve, which was of the super-power type having a very low impedance, with a valve of a much higher impedance. The change of the quality even when the grid-bias had been suitably readjusted was very marked.

H.F. Amplification

The lecturer then proceeded to explain the necessity for using a certain amount of high-frequency amplification in order first of all to bring weak signals to a suitable strength so enabling the rectifier to operate efficiently, and, secondly, in order to obtain a good measure of selectivity.

It was in this position of the receiver that the principal development had occurred during the past year, and the development had been in the direction of increasing the control which one obtained over the high-frequency amplification. A comparatively short time ago the amplification which was obtained from a high-frequency valve was almost negligible, and one often obtained cases where louder signals were heard if the alleged high-frequency amplifying valve was removed.

A Simple Example

The actual amplification obtainable in an average modern receiver was demonstrated by a simple change of connections which had the effect of removing the first two (high-frequency) valves in the "Solodyne" receiver previously referred to. The increase in volume obtained by the two high-frequency stages was considerable, and amply demonstrated the effectiveness of the high-frequency amplification.

Complete Control

The next point mentioned was the desirability of complete control over the high-frequency stages.

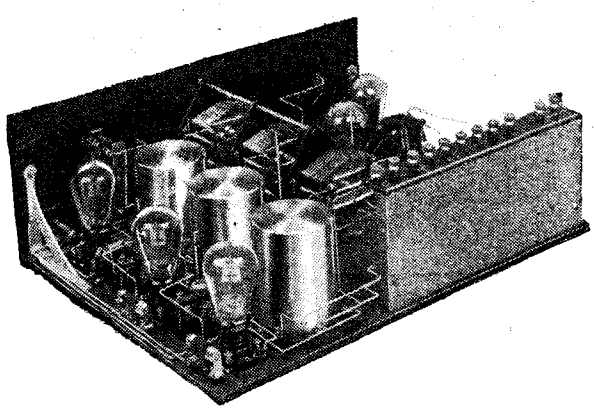
It was shown that stray couplings through the valves were overcome by some form of neutralised circuit. There remained, however, the couplings existing between the circuits themselves.

This led to a brief consideration of the use of screening in receivers, and it was shown that the only true solution lay in the complete screening of the individual stages.

Effect of Screening

As an interesting example of the completeness of the control which is obtained an interesting demonstration was given.

The receiver was first of all tuned to the local station operating four miles away. The middle transformer (that handing on the energy from the first high-frequency valve to the second) was then completely removed, and no signals whatever were obtained. Yet on replacing the transformer signals once more came back at sufficient volume to fill the large hall in which the lecture was given.



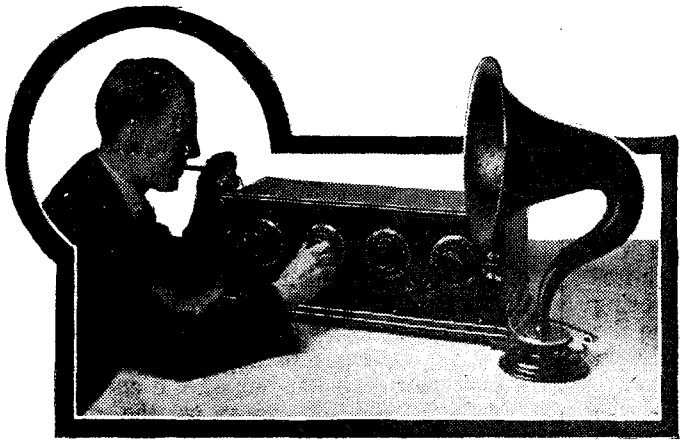
The Elstree "Solodyne" was described in the September issue. The main feature of the receiver is the perfect control of two high-frequency stages—three tuned circuits—by means of a single dial. Such are the capabilities of the set that over fifty stations were received on the loud speaker during the Elstree tests.

Gang Control

Some final reference was then made to the problems of "gang" control enabling several tuned circuits to be controlled with one multiple condenser, after which a brief demonstration was given of the manner in which this problem had been satisfactorily overcome. The dial was slowly rotated from one end of the scale to the other, and one after another the different stations came in. The demonstration was then discontinued for a time while Mr. Reyner invited questions, and a considerable number of the audience took advantage of this opportunity, very keen interest being displayed in the whole of the proceedings.

Every assistance was rendered throughout the lecture by Mr. Wilkes, the President of the Bournville Radio Society, and by Mr. Goodwin, the Secretary, and various other members of the committee, who all contributed to making the evening a success.

SOME NOTES ON LOW-FREQUENCY AMPLIFICATION



By E. R. WILLIAMS

In this article our contributor deals with the three popular types of L.F. magnification. It will be found very interesting reading by those who wish to obtain the best possible results from this portion of the receiver.

AUDIO-FREQUENCY amplification is one of the most essential functions of a wireless receiving set, particularly if sufficient volume of sound is required for working a loud-speaker. One might use six or more high-frequency valves followed by a detector, and fail to get the same volume from the local station as could be obtained from a valve detector, followed by a single low-frequency amplifier. The high-frequency amplifier would naturally be more sensitive to weak signals, but it would be unable to build up the same degree of volume from a comparatively strong signal.

H.F. Amplification

Those who live near a broadcasting station and choose to confine their attention to this station, will derive little benefit as far as volume is concerned from the high-frequency amplifier. In such cases the more usual set comprises a detector followed by a stage or more of L.F. amplification Another point in favour of this type of amplification is its simplicity; there are no circuits to tune; the valves do not have to be neutralised, and straggling leads have little effect on the performance of the set.

Purity of Tone

There are, however, a few fundamental points which the constructor must grasp, if he wishes to obtain purity of tone rather than a blaring noise from his loud-speaker. In nine cases out of ten, the fact that one set gives purer reproduction than another is due to some part of the low-frequency amplifier working more efficiently in one case than in the other. In this article, it is proposed to discuss the various types of L.F. amplifiers, their relative efficiencies, and the conditions under which they will best perform.

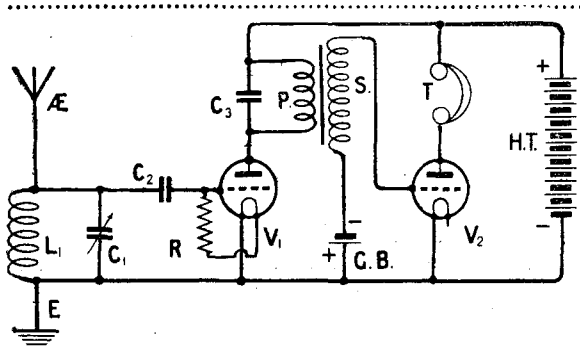


Fig. 1.—The elementary diagram of a simple transformer-coupled amplifier following a detector valve. The L.T. battery is omitted to simplify matters.

Transformer Coupling

Figure 1 shows a diagram of a detector valve followed by one stage of transformer coupled amplification. The radio frequency oscillations are imposed on the grid of the detector valve V_1: here they are rectified and amplified. There are some who do not fully appreciate the fact that a detector valve has to amplify and rectify at the same time; so that its characteristics must be suitable for both performances.

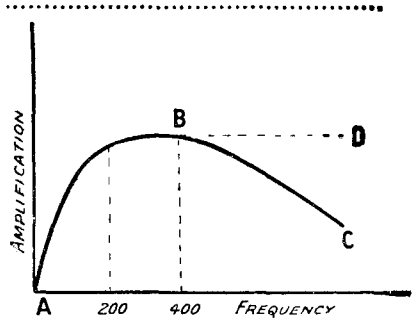


Fig. 2. — Illustrating the effect on the higher frequencies of a shunting capacity across the secondary. The curve is, of course, exaggerated.

The wave formation of the oscillations in the plate circuit of V_1 is fairly complex, as the high-frequency component of the current is imposed on the low-frequency or rectified component. A small condenser is placed across the primary of the L.F. transformer, in order to by-pass the high-frequency oscillations.

Energy Transference

The L.F. pulsations set up a P.D. across the primary P. of the low-frequency transformer: it is necessary to obtain as large a value as possible for this P.D., in order

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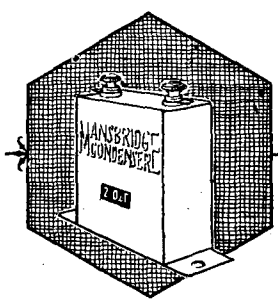

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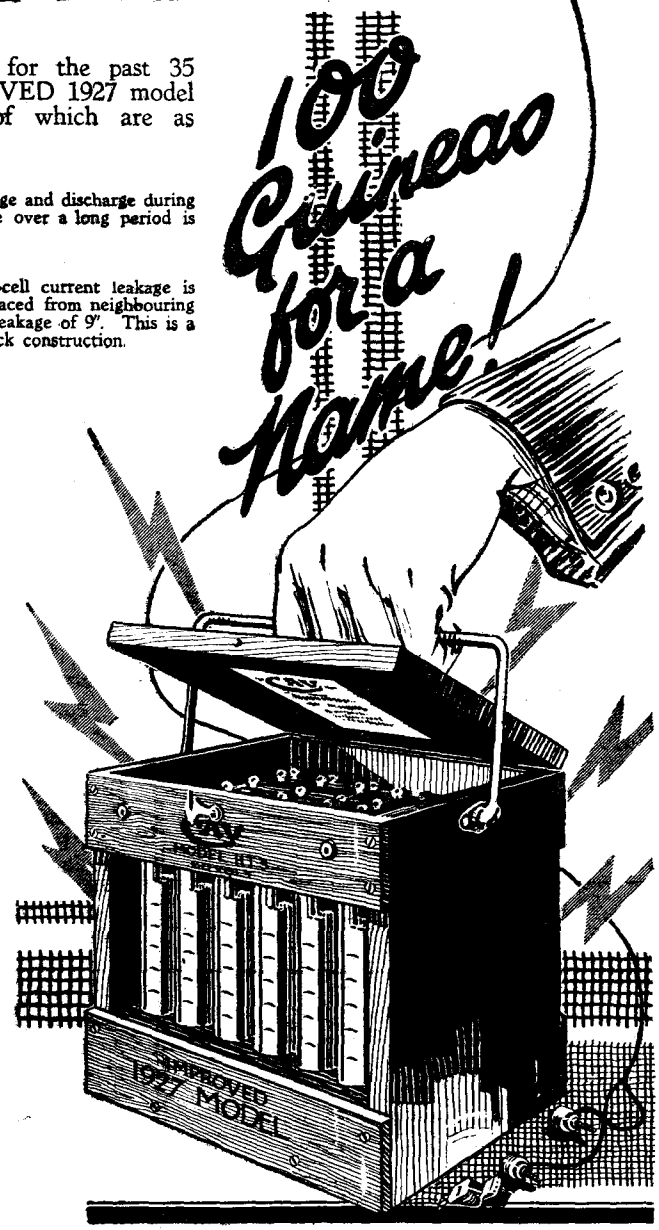

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SOME NOTES ON L.F. AMPLIFICATION—*(Contd.)*

to cause the greatest voltage change on the grid of V_2. The primary should offer a very high impedance to the L.F. pulsations if the P.D. across it is to be a maximum.

Unfortunately, the impedance of the primary depends on the frequency of the oscillation passing through it: the lower the frequency the less is the impedance and consequently the smaller is the P.D. across the primary. This is a very difficult state of affairs, as it means that in broadcast reception high notes may be amplified more than low notes.

Uniform Amplification

Thus in designing an L.F. transformer to give a reasonably uniform amplification over a wide band of frequencies, it is necessary for the primary impedance at a frequency of 200 cycles to be very high; we are assuming that the preceding valve has an impedance of about 20,000 ohms, which is the average value for a general purpose valve. When it is considered that the middle C of a piano has a frequency of only 256, the importance of a high impedance at a low frequency in the primary of the transformer is evident. It would be much better to increase the primary winding so that the amplification did not start falling off until the frequency dropped to 100 cycles, but this would necessitate a very extensive and bulky winding which in the case of a transformer would be unpractical.

Secondary Turns

By increasing the number of turns on the secondary winding, we can step up the voltage from the primary and thus increase the overall amplification of the preceding valve. If there are three times as many turns on the secondary as there are on the primary, the theoretical amplification will be increased threefold. However, there is a limit to the amplification obtained in this way; we have seen that the primary winding must have a large inductance at low-frequencies; this means a large number of turns. If the step-up ratio between primary and secondary is to be five, then there must be five times as many turns on the secondary as on the primary. This would lead to very bulky windings with a large amount of self capacity across and between them. The transformer would act to a great extent as a condenser, and would cause the higher frequencies to pass through without being amplified. The curve giving the magnification at different frequencies would be similar to that shown in Fig. 2, where the magnification, having risen to a maximum at 200 cycles, commences to fall at 400 cycles, and follows the curve A B C instead of A B D. Thus it is evident that the total number of turns in the whole transformer is limited owing to the effects of self-capacity, and, as the primary must have a sufficient number, the ratio between the turns on the secondary and on the primary, and therefore the amplification in the transformer, is also limited.

Ratios

In practice well designed transformers, having a step-up ratio of 3 or 4 to 1, will give fairly uniform amplification down to a frequency of 200 cycles, if used with a suitable valve. But for more even amplification on the lower frequencies, this ratio would have to be reduced. A 1 to 1 ratio would allow the inductance of the primary to be made over 100 henries. In this way, very even amplification could be obtained down to a frequency as low as 100 cycles: however, there would be no voltage amplification in the transformer, although the losses in the primary would be cut down to a minimum.

A more efficient and less expensive method of obtaining the advantages of a 1 to 1 transformer is to use an L.F. choke; this is similar in construction to a transformer except that there is no secondary winding. The diagram of a two valve set employing one stage of L.F. choke amplification is shown in Fig. 3.

The fluctuations of P.D. across the choke are conveyed to the grid of the valve V_2 through the condenser C_4. The grid leak R_1, which should have a value of about 0.5 megohms, keeps the mean potential of the grid constant by preventing the accumulation of charges on the grid, due to the isolation effect caused by the condenser C_4.

Valve Impedance

At the beginning of this article, reference was made to the imped-

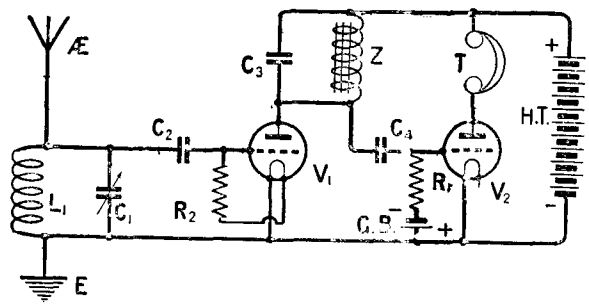
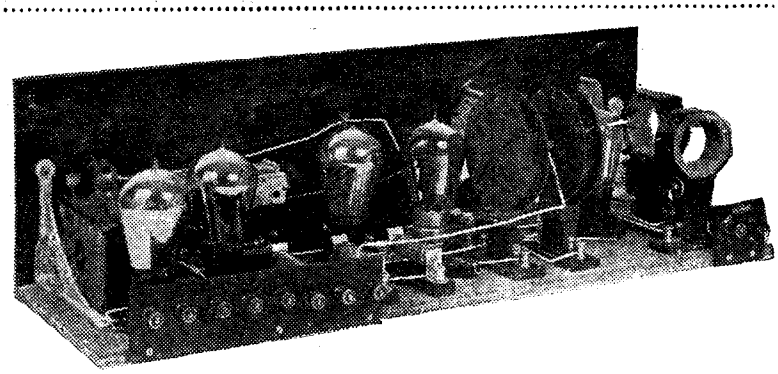


Fig. 3.—In this circuit the choke Z should have a high impedance and the condenser C_3 should be kept small.



With a well-designed set employing resistance coupling very pure results are obtainable.

SOME NOTES ON L.F. AMPLIFICATION—*(Contd.)*

ance of the valve. If a low impedance valve is used, the impedance of the primary winding in its plate circuit need not be very high, and consequently the step-up ratio of the transformer can be increased.

However, as a general rule, the lower the impedance of the valve, the lower is its amplification ratio. It will, therefore, be best for the detector valve to have a high impedance, which will suit its rectifying qualities, and give it a high amplification ratio ; but a low ratio transformer or a choke must be used in its plate circuit. The first L.F. valve will preferably have a lower impedance, so that it can handle a higher grid voltage ; but to compensate for the lower amplification obtained from the valve, a higher ratio transformer can be used in its plate circuit.

Overloading

The last valve in the amplifier should be capable of handling a large amount of power, and should therefore have a very low impedance. No gain of signal strength will be obtained by using a high amplification valve in this stage, unless the signals are very weak. If the signals are strong, such a valve will be overloaded, and loss of strength, coupled with distortion, will result.

In order to obtain efficient results from an L.F. amplifier, it is essential that the right amount of grid bias is employed. This negative bias will depend on the valve in use, and the amount of high tension on its plate. The makers usually supply printed information on the correct working potentials of each valve sent out ; so that if their advice is followed these difficulties will be avoided.

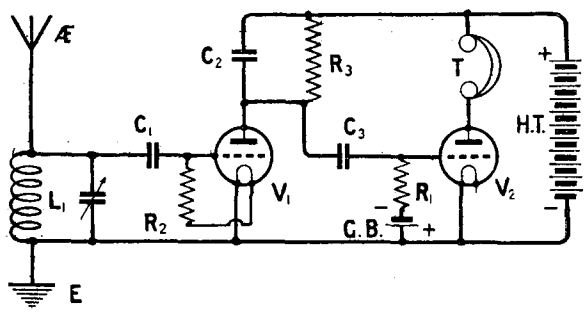


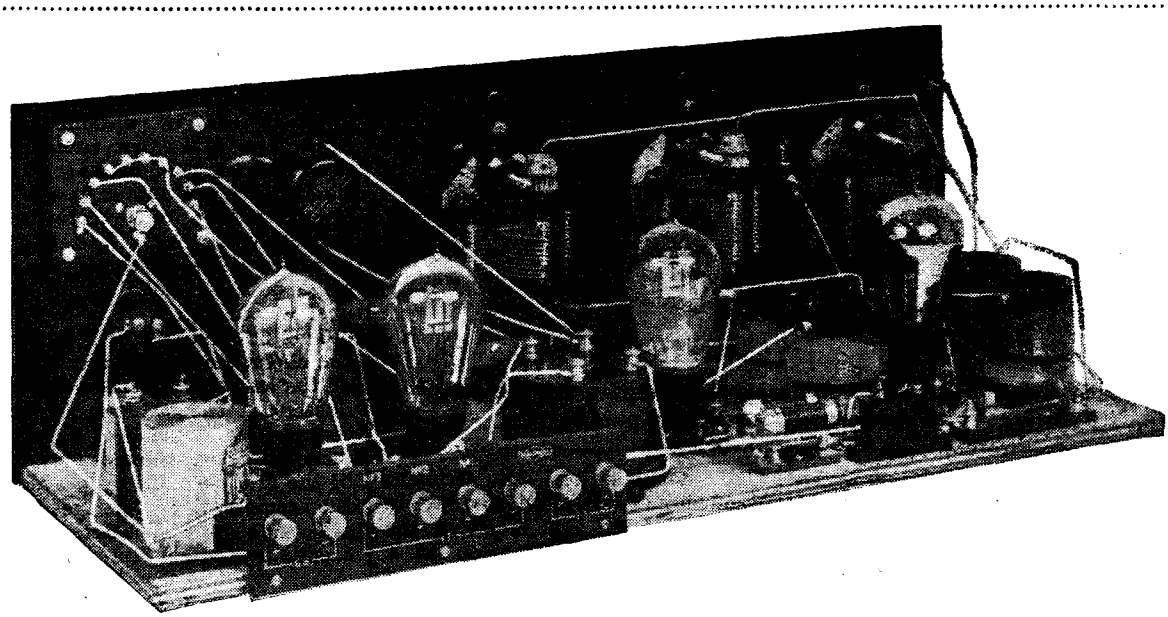
Fig. 4.—Resistance amplification, although giving very pure results, does not with ordinary valves give the same magnification as transformer coupling.

Resistance Coupling

There is one form of inter-valve coupling which has lately become very popular, namely, the resistance-capacity coupling. If a non-inductive high resistance of the order of 100,000 ohms is substituted for the choke in Fig. 3., any change of plate potential in the valve V_1 will set up a P.D. across the resistance R_3 (Fig. 4), and this P.D. will be communicated to the grid of the valve V_2 through the condenser C_3. This coupling appears to be entirely similar to the choke coupling previously described ; however, there is one outstanding difference which characterises this method. A non-inductive resistance has no resonant frequency, so that the amplification obtained with this type of coupling is independent of the frequency : this means that the low notes will be amplified equally with the high notes.

Amplification Obtained

Until comparatively recently, however, resistance coupling has been unpopular with the wireless amateur on account of the relatively low amplification obtained. When bright emitting valves were uni-



A choke-coupled amplifier has many of the advantages of resistance coupling provided high-impedance chokes are used together with suitable valves. The amplification obtained, however, is in practice, frequently, slightly higher.

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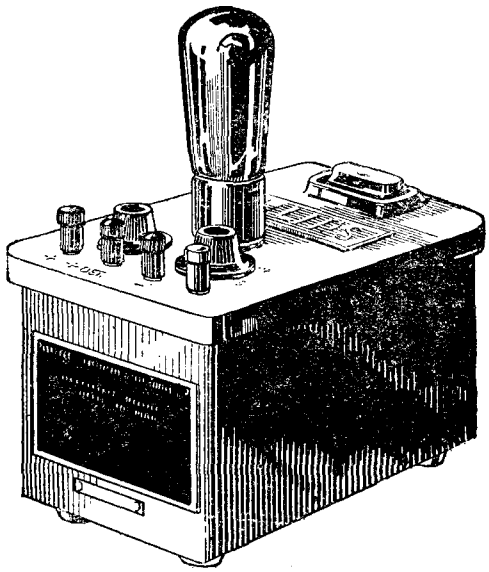

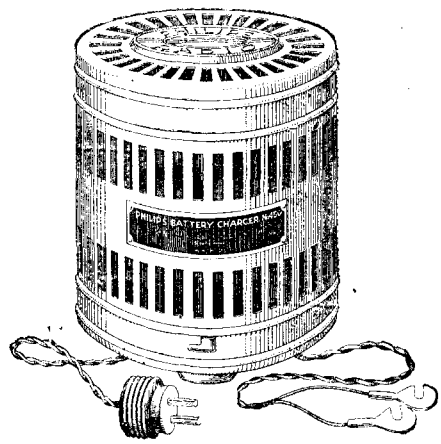

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SOME NOTES ON L.F. AMPLIFICATION—(*Concluded*)

versally employed, and it was considered that two resistance coupled amplifiers gave the equivalent strength of a single transformer coupled stage, it is not surprising that the transformer was the most popular. However, the advent of the high amplification valve has placed the resistance-coupled amplifier in such a position that it is now a serious rival of the transformer or choke coupled amplifier, although this fact is not so generally realised.

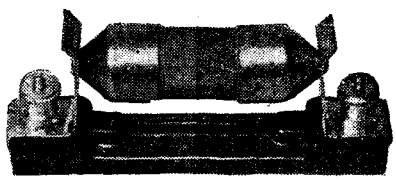
However, resistance coupling still has its limitations; in the first place, the current from the H.T. battery has to pass through the resistance, which may have any value from 50,000 ohms to half a megohm; if we allow the plate current to have a value of half a milliamp, the voltage drop through the resistance will be anything from 25 to 250 volts.

Values to Use

In practice, resistances of half a megohm are only used with valves which have an internal impedance of the highest value, and in consequence a low plate current, so that the voltage drop is correspondingly reduced. We have already found that a very high impedance valve is unsuitable in conjunction with a transformer or choke on account of the fact that the amplification falls off very rapidly at low frequencies.

Even Amplification

There are a group of valves especially made for resistance-coupled amplifiers; such valves as the D.E. 5B, and Mullard D.F.A.4,



In a resistance amplifier care should be taken to use anode resistances of good make.

S.T.61, etc., which have amplification ratios of approximately 20, come into this class. If anode resistances of 150,000 ohms are used in conjunction with them, a very satisfactory degree of amplification will be obtained. The Cosmos S.P.18 blue spot has an amplification factor of 35, and an impedance of 70,000 ohms; if an anode resistance of 400,000 or 500,000 ohms is used in conjunction with this valve, the amplification will be equal to that given by some transformers, with the added advantage that all frequencies will be magnified equally.

Unfortunately, a high impedance valve is incapable of handling a large amount of power, so that for the second and subsequent stages a different type of valve having a lower impedance will be necessary.

The problem of high-tension voltage does not present very much difficulty, because the power valve in the last stage will require 120 volts, and this voltage can be applied with advantage to the preceding valves *via* the anode resistances.

Conclusion

From the facts outlined in this article, resistance capacity-coupling can be relied upon to give a uniform amplification over the whole band of frequencies; and, provided that the right valves and resistances are employed, the total amplification when using two or three stages can be nearly as high as a good transformer amplifier employing the same number of valves.

READERS' RESULTS WITH "MODERN WIRELESS" STAR SETS

"Delighted"

SIR,—With reference to the Elstree "Solodyne," I have built this set and have endeavoured to duplicate the original in every detail, and up to the present have been able to receive at good strength and purity 12 to 14 stations, but have hopes of being able to receive all 50.

I need hardly say I am delighted with the "Solodyne" so far as I have got at present.—Yours truly,

GEO. F. PERCIVAL.

Putney.

"Wonderful Set"

SIR,—Since the advent of wireless I have built sets of all descriptions and sizes mostly of Radio Press design, and I have also heard most of the commercial sets, including American, and I conscientiously say that none of them comes within 50 per cent. of the "Elstree Six."

The selectivity, volume, and *especially the quality* of the "E.6" are absolutely perfect, and the simplicity of tuning in all B.B.C. stations and most Continental stations is wonderful—a child can handle it well.

I shall be only too pleased to demonstrate it to anyone in the district of Leeds.

Thanking you for the production of such a wonderful set, and wishing you every success in the future.—Yours truly,

F. REEVE.

192, *Burley Road, Leeds.*

"26 Stations in 10 Minutes"

SIR,—The results with the "Solodyne" are easily what they are stated to be. I absolutely know nothing about wireless and built my set purely by the blueprint. I had only a little trouble in tuning the triple condenser.

It may interest you to know that I picked up 26 stations the other night in less than ten minutes, and I am confident if I could get rid of the noises from the trams I could get well over 70 stations on the two sets of coils.—Yours truly,

W. C. FARROW.

Peterborough.

Choose your programme—
these Eureka Ortho-cyclics will find the Station

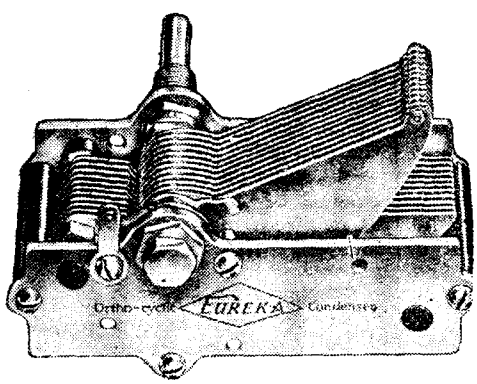
AT last here is a variable Condenser which makes station hunting a pleasure. The Eureka Ortho-cyclic utilises new principles of tuning. The old idea of crowded wavelengths jostling each other at one end of the dial has gone for ever. In the Eureka one degree on its 100° dial covers one Geneva wavelength of 10 kilocycles separation, irrespective of its position. The first fifteen degrees on the dial covers fifteen wavelengths precisely—no more and no less. Whereas this same movement with an ordinary Condenser would cover no less than 51 possible wavelengths. And the second fifteen degrees on the Eureka Ortho-cyclic still covers only fifteen wavelengths—and so on right through the dial one degree equals one wavelength. As evenly, in fact, as the rungs of a ladder.

This is the kind of tuning you have always longed for. Now you can get razor sharp selectivity at small cost. The new Geneva wavelength plan makes ortho-cyclic principles of tuning essential. The ether is being divided into wavelengths of 10 kilo-cycles separation. That is to say, using a Eureka Ortho-cyclic Condenser there can never be more than one station to any degree on the dial. It will be impossible with a sensitive Set equipped with Eureka Ortho-cyclics to hear two stations at the same time.

See this all-metal, low loss, Condenser at your Dealer's to-day—you will be amazed at its low price for such a beautifully constructed instrument.

Six exclusive Eureka features:

1. Compact design permits a panel depth of only 2 inches.
2. Ball bearings throughout ensure velvet-smooth action.
3. One-hole or three-hole mounting as desired.
4. Electrical losses so low as to be negligible.
5. Earthed rotor ensures stable reception.
6. Permanent contact guarantees continuous silent performance.



Prices:

·0005 mfd. - 15/6
·0003 mfd. - 14/6

Slow Motion Dial.
Engraved 0 to 100, right to left, for kilo-cycles, and 0 to 100, left to right, for wave-lengths. Beautifully constructed in metal throughout to fit all condensers, including the Eureka Ortho-cyclic, with ¼-inch shafts. Easily fixed to set. Price **4/6**

EUREKA ORTHO-CYCLIC CONDENSER

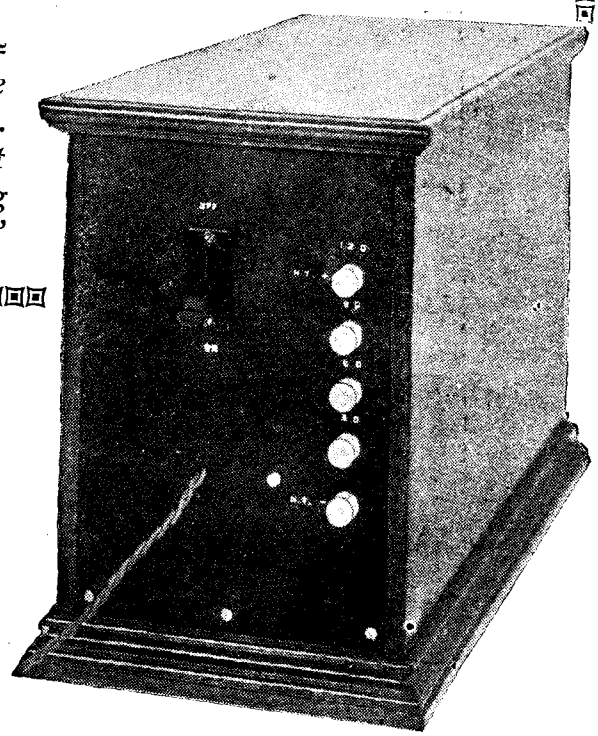
Gilbert Ad. 6333.

Advt. Portable Utilities Co., Ltd., Fisher St., W.C.1

A SIMPLE H.T. UNIT FOR THE A.C. MAINS

By THE STAFF OF THE ELSTREE LABORATORIES

This H.T. Battery Eliminator is designed to work from the ordinary house lighting mains. Various values of H.T. voltage can be obtained from the output terminals, and an efficient smoothing system eliminates any chance of "hum."



A SHORT time ago a simple unit was described whereby high-tension accumulators could be charged from the alternating current mains. For this purpose a simple rectifying valve was utilised, the filaments being supplied by means of a small step-down transformer connected across the mains. The valve then will rectify the supply and pass it on to the particular accumulators to be charged.

Utilising A.C. Mains

Such a unit can be made in quite a simple manner since it is only necessary to rectify the current and not to smooth it in any way. Where it is desired to utilise the A.C. mains for supplying the high-tension voltage direct, it is necessary not only to rectify the current, but to incorporate a system which will smooth out the fluctuations of current and present a more or less steady current for the anode circuit of the valve.

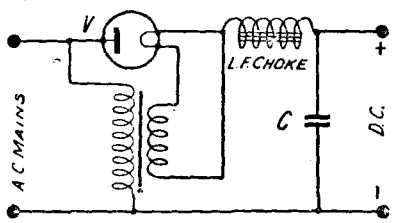


Fig. 1.—Showing how the alternating current may be rectified by means of a two-electrode valve.

The present unit is the result of some little experiment in order to provide a simple and yet efficient unit for a purpose such as this. There are several problems which have to be overcome, some of which are obvious, and others are only encountered when actually experimenting with apparatus. Briefly we may divide our problems in two broad classes. The first of these is the problem of rectifying the current, and the second is that of smoothing it.

Rectification

Of the two the first problem is the simpler. It is simply necessary to obtain a valve having an emission such that it can supply the maximum current required without any danger of overloading. There are several such valves on the market, and at the present instance one of the D.U. series manufactured by the Mullard Radio Valve Co. has been used for the purpose. These valves are provided with a large filament, whereby an ample emission is obtained. An anode surrounds the filament, the normal grid electrode being omitted. There are two types of valve, the D.U.5 and the D.U.10, the one being designed to operate at 2.5 volts on the filament with a current of .8 of an ampere, the other taking 4 volts on the filament with a current of 1 ampere.

Of the two, the D.U.10 naturally gives the greater emission, and since it was desired to obtain a large output from the D.C. side which would require a heavy current pulse from the rectifier, it was decided to use this valve in the unit under consideration.

A Simple Circuit

Now a simple circuit incorporating a rectifying valve such as this is shown in Fig. 1. It will be seen that the valve is simply inserted in series with the mains so that a uni-directional current can flow, the current in the reverse direction being suppressed by the rectifying valve. The filament of the valve is lit by means of a transformer also connected across the mains. There are three disadvantages attached to a simple arrangement such as this.

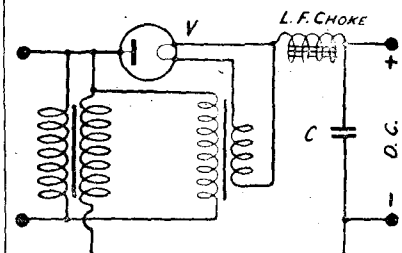


Fig 2.—Improved results may be obtained by joining an additional transformer in circuit as shown.

The first of these is that one half of the wave is suppressed

For Dull Emitter Valves

NOW that the Dull Emitter Valve has finally ousted the extravagant bright emitter from the market it has been necessary to evolve a new type of Accumulator suitable for two and three-valve Sets. The present day demand is for an accumulator small in size, light in weight, low in price, which will hold its charge for weeks and even several months without attention. The ordinary Accumulator was good enough for bright emitter valves consuming ·75 ampere each. Its plates never had a chance to become sulphated. No sooner was the accumulator charged up than the Set began to drain away its energy. After a week or so a further charge was necessary. But to put an ordinary accumulator to serve a 2-valve Set equipped with Dull Emitters is a waste of money. The plates are almost certain to sulphate if the accumulator is not given a regular charge—whether it is exhausted or not.

The unusual construction of the new Oldham O.V.D. (patent applied for) makes it the ideal Accumulator for small Receiving Sets. Its low initial price, coupled with the few pence only required for recharging, will enable every user to lower his maintenance costs immediately.

Where else can you find these seven features?

Type O.V.D.

2 volts—for use with Dull Emitter Valves. Fitted with the new Laminode Plate. Dimensions 6 ins. by 3 ins. by 2½ ins. 10 amp. hours.

5/6

Charged ready for use Add acid only

Other Oldham Accumulators

Your Dealer can show you a wide range of other Oldham Accumulators — all made under the Special Activation Process. Ask to see particularly the Oldham H.T. Accumulator, which is made under expanding bookcase principles. With its handsome lid and base, it is the finest H.T. Accumulator on the market. Price 10d. per volt. Catalogues free—write to-day.

1 Charged ready for use

Every O.V.D. is charged ready for immediate use at the factory. It is only necessary to add acid and wait half an hour or so for the cell to be ready for use. No tedious and annoying delay while the cell is put on charge.

2 Laminated buckle-proof plates

The plates are laminated for extra strength and to permit the free circulation of the electrolyte. Standard plates are used which cannot shed their active material. No separators are required.

3 No leaking away of charge when not in use

In the ordinary accumulator the positive and negative plates are closely interleaved together. Some local action therefore is inevitable when the accumulator is standing idle. In the O.V.D. the plates are welded together in sets of three with a generous space between the positive and the negative groups. This eliminates interaction and enables the plates to hold their charge even for months without attention.

4 Large coloured terminals

Even the external appearance of the O.V.D. is distinctive and workmanlike. Note its generous coloured moulded terminals, indicating correct polarity at a glance. A man's size terminal which will grip any wire quickly and securely.

5 Quick charging and slow discharging

Never before has it been possible to combine these two requirements in an accumulator. The usual way to ensure a slow discharge has been to use a thick plate. But thick plates need a prolonged charge. Compare a thick plate, if you like, to a thick mass of absorbent material plunged into a liquid. It will take a long time for moisture to penetrate to its inmost recesses. But cut the material into strips and they absorb moisture at once. This, in non-technical language, is the principle of the Laminode Plate. It is the equivalent of a thick plate, but the electrolyte can flow through it immediately and get to work upon its several surfaces without hindrance. Any O.V.D. Accumulator can be recharged within 8 hours—speedy charging won't harm its plates.

6 Stout glass cell

The glass cell used in the O.V.D. offers further evidence—if such were needed—of the care and forethought put into its manufacture. Crystal clear and robust, it has ample mud space at the bottom to trap all the sludge.

7 Plates made under the Special Activation Process

The secret of the popularity of Oldham Accumulators among wireless enthusiasts lies in the efficiency of the plates made under the Special Activation Process. This process, because it produces a plate active right through, not merely on its surfaces only, gives that smooth unfluctuating current flow that is so essential for good broadcast reproduction. And at the same time it ensures a length of service which is truly remarkable.

Special Activation Process Batteries

OLDHAM

Oldham & Son, Ltd., Denton, Manchester

Also 6, Eccleston Place, London, S.W.1 *Phone: Sloane 2701.*

A SIMPLE H.T. BATTERY ELIMINATOR—*(Continued)*

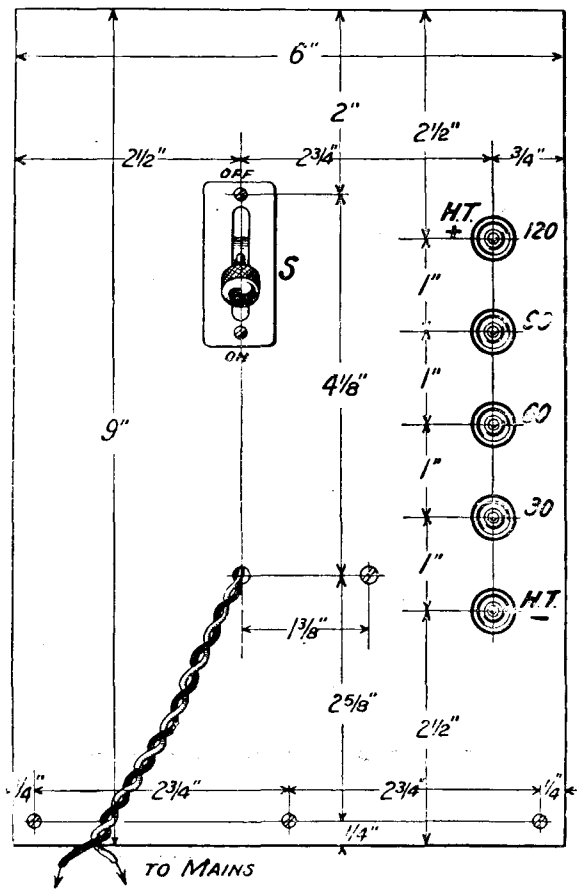


Fig. 4.—The panel drilling diagram. Various H.T. values can be obtained by means of the terminals marked.

altogether, and therefore more efficient smoothing apparatus is required. The rectified current is produced on the output side of the arrangement, and consists of a pulse of current, then a blank interval corresponding to the reverse half of the alternating current, succeeded by another pulse. We have to smooth this out into a more or less steady voltage, having a value somewhere in between the maximum value of the voltage pulse and the zero line.

Two-Wave Rectification

It is possible to minimise the effect of the fluctuations by using another valve so connected as to make use of the other half of the wave instead of suppressing it. This is known as double-wave rectification, and demands the use of a special centre-tapped transformer and another rectifying valve. As a result of experiments, however, it was found possible to obtain good and sufficient results without undue expense by the use of single-wave rectification only, and as this only necessitates the purchase of one rectifying valve this system has been adopted in the present instance.

Earthed Mains

The other disadvantage associated with the Fig. 1 circuit arises from the fact that one terminal of the mains is often earthed. Since the receiver is also connected to earth, this earth being usually connected to one side of the L.T. battery which is in direct contact with the H.T. negative, it follows that trouble may quite easily arise from this source. Thirdly, the voltage output obtainable from a unit connected up as in Fig. 1 is directly dependent upon the voltage of the mains, and the final D.C. voltage obtained at the end of the smoothing unit is very considerably lower than that on the input side.

The reasons for this voltage drop are outside the scope of this article, but they can be considered at some future time. The disadvantages just mentioned, however, can be overcome by using the circuit shown in Fig. 2. Here the voltage from the mains is stepped up by means of a transformer to any required value, so that whatever the voltage on the mains, we can obtain, by suitable design, a definite output from the rectifier unit. At the same time, since the D.C. side of the unit is definitely isolated by means of a transformer from the mains themselves, any trouble due to the earthing of the receiver is satisfactorily overcome.

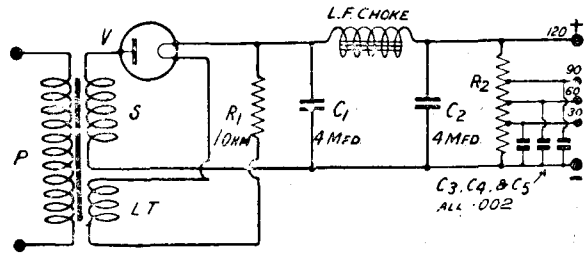


Fig. 3.—The theoretical circuit of the unit. To simplify matters the "on-off" switch is omitted.

COMPONENTS REQUIRED

One ebonite panel 9 by 6 by ¼ (any suitable make).
One cabinet with baseboard 13¾ in. deep.
One special transformer (Radio Instruments, Ltd.).
Two 4 mfd. 600 volt type Mansbridge condensers (T.C.C.)
Three .002 mica condensers (T.C.C.)
One L.F. choke (Formo Co.).
One 20,000 ohm resistance tapped in four equal sections to carry 20 milliamps. (Varley Magnet Co.).
One 2 pole 2 way switch (Utility.)
One valve holder (Benjamin).
One D.U.10 valve.
One fixed resistor, 1 ohm to carry 1 ampere.
One length of lighting flex with suitable plug for attaching to the lighting circuit.
Five terminals.
Quantity of Glazite wire.
One packet of Radio Press panel transfers.

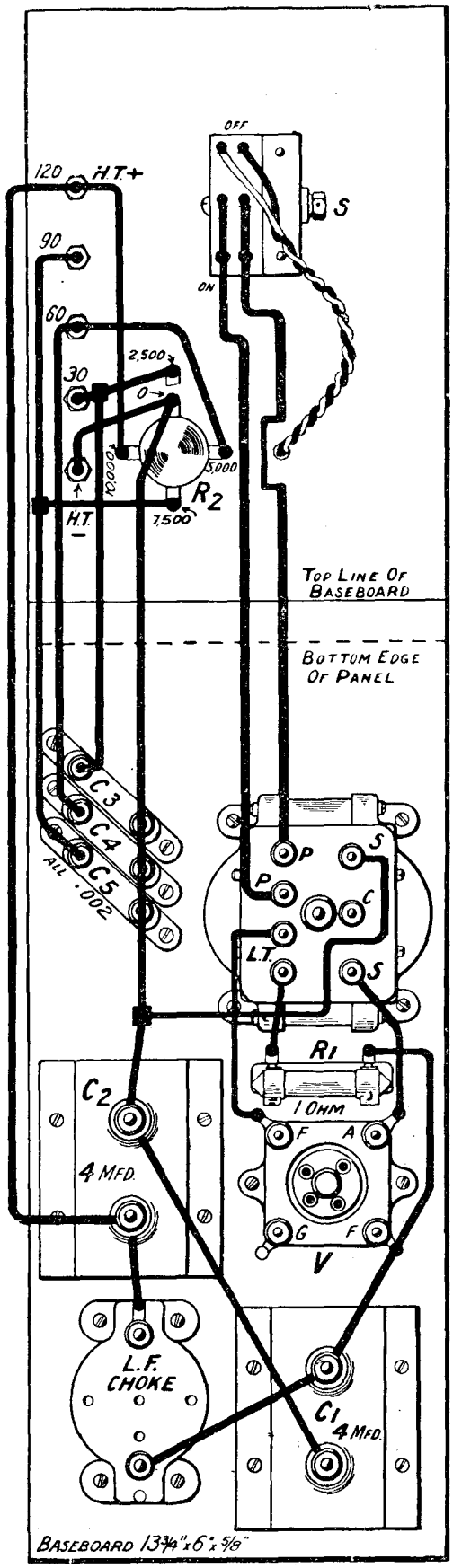


Fig. 5.—For the purpose of smoothing, two large condensers and an iron-cored choke are connected in the output circuit of the unit.

A SIMPLE H.T. UNIT FOR THE A.C. MAINS — *(Cont.)*

A Special Transformer

For this unit, therefore, a special transformer has been made up by Messrs. Radio Instruments. It is provided with three windings. First there is a primary winding, designed to suit the voltage of the mains in question. Secondly, there is a low-tension winding from which 4 to 5 volts may be obtained for the filament of rectifier valve. Finally there is a high-tension winding, in this case of 300 volts, for application to the rectifying valve. In order to render the transformer of universal use, it has been arranged with a centre-tap on the high-tension winding, so that it is possible to obtain 150 volts plus or minus with respect to this centre-tapping in cases where it is desired to use double-wave rectification.

Principles

This value may seem a little on the high side, but the matter is one relating to the load taken from the unit. In order to smooth the variation of voltage, we connect a system of chokes and condensers across the D.C. output of the unit, the final circuit being as shown in Fig. 3. Now the operation of the unit briefly is this. The alternating current pulse through the rectifying valve charges up the condensers, and these condensers then discharge through the receiver. Now the voltage which the condensers will actually take up depends upon the relative rates of charge and discharge. The condenser voltage must adjust itself so the amount of charging current received in the form of pulses through the rectifying valve is exactly equal to the amount of energy drawn away in a steady current through the valves of the receiver.

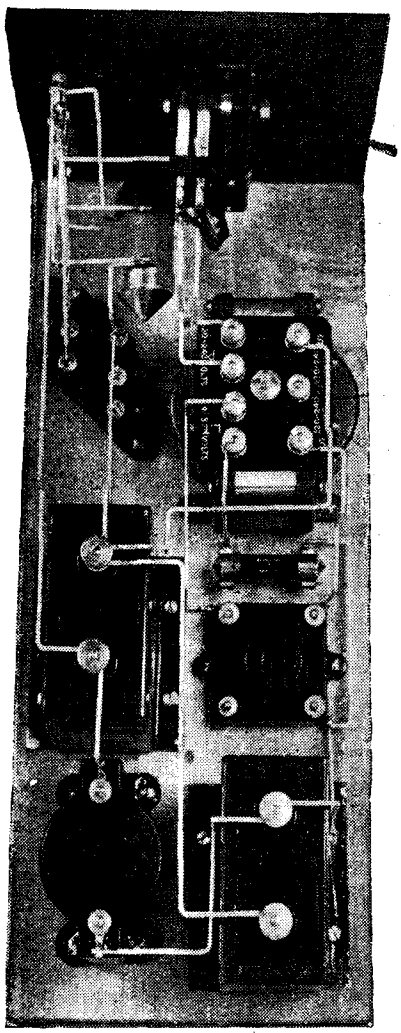
Effect of Load

This brings us to another difficulty in the design of these units. When the supply of direct current from the unit is very small the voltage at which the smoothing condensers settle down is high. As soon as any load is placed on the unit, however, the voltage very rapidly falls to a much lower value. Now a condition of affairs such as this is not at all satisfactory. For example, if we design our unit to give 120 volts in use, then when we switch the set off the voltage may rise quite unpleasantly high, and there may even be a possibility of danger from shock.

Permanent Load

In order to overcome this difficulty, therefore, it is necessary with a simple circuit such as this to incorporate a definite permanent load which will prevent the voltage on the unit rising rapidly when the receiver is switched off. It is found that after a certain point is reached the variation of voltage as the load is altered is only comparatively small. It is necessary therefore to connect a resistance across the output side which is permanently in circuit, and which is sufficient in value to demand this critical current from the unit permanently. In the case in point this resistance has been made of 10,000 ohms resistance, and with a load of this order, the full voltage developed is of the order of 160 volts, *i.e.*, just a little more than half the value of the voltage on the transformer.

A SIMPLE H.T. UNIT FOR THE A.C. MAINS—*(Continued)*



The resistance seen near the switch is tapped to permit different values of H.T. to be applied to the anodes of the receiving valves.

This is because single-wave rectification is being used. With double-wave rectification the value of the D.C. voltage, even on load, is much nearer the R.M.S. value of the voltage on the transformer secondary, and for this reason it is possible to obtain satisfactory results with only 150 volts on each valve, so that the same transformer with a centre tapping on the high-tension winding would be suitable.

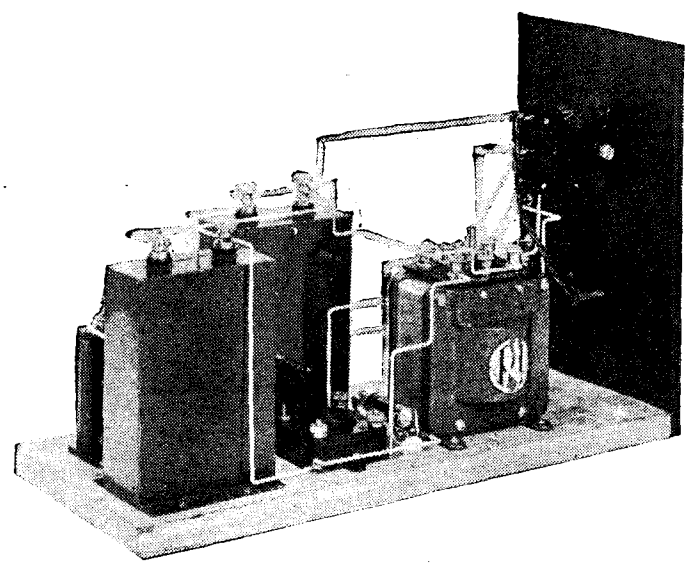
This, however, is incidental, the point being that on no load, but with the resistance in circuit, the D.C. voltage output is of the order of 160 volts. With a full 20 milliamp load, the voltage drops to something of the order of 120 volts, which is quite a reasonable regulation from no load to full load. This check resistance has been made in the present instance to serve another purpose, that of obtaining suitable tappings from the mains voltage. It is often desired to use a voltage of 30 volts or 60 volts for the detector valve, and although in some cases as much as 120 volts can be used on high-frequency valves, it is often preferable to cut it down to something of the order of 90. Three tappings have been taken therefore on the resistance, these tappings being suitably condensed, as may be seen from the diagram.

Flexibility

These briefly are the difficulties which have to be overcome in the design of a suitable H.T. unit. It was decided to make the unit as flexible as possible, and for this reason the various tappings have been provided, and a special transformer has been utilised. This means that the desired results can be obtained irrespective of the voltage of the supply, since Messrs. Radio Instruments are supplying these transformers in various grades, the voltages on the L.T. and H.T. terminals of the transformer being the same in each case, but the primaries being designed to cover different voltages of supply. When ordering the transformer, therefore, it is essential to specify the voltage of the supply, and the frequency. These figures can easily be obtained from the local supply authorities.

Condensers

One final word may be given concerning the condensers before the actual constructional details are considered. It was pointed out last month that the use of ordinary 300 volt type Mansbridge condensers was not satisfactory, when the R.M.S. value of the voltage with which they had to deal was greater than 150. In this case we are dealing with an R.M.S. value of 300, so that these condensers are particularly unsuitable and might easily break down in practice. For this purpose special condensers tested on 600 volts direct current are utilised in order that there shall be no danger of breakdown.

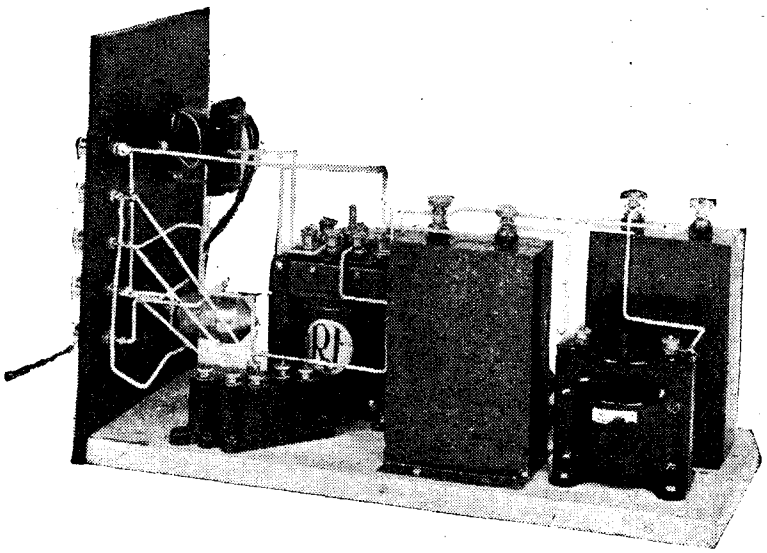


The special transformer used incorporates a centre-tap, which enables double-wave rectification to be obtained should it be desired.

The Choke

The choke coil is not a special component, as it was desired to reduce the cost of the unit as far as possible. After some experiment, therefore, it was found that a standard choke as used for low-frequency amplification could be

A SIMPLE H.T. BATTERY ELIMINATOR—(*Concluded*)



The small mica condensers joined across the H.T. tappings serve to by-pass the H.F. component in the anode circuit of the receiver.

used satisfactorily, provided it was of sufficiently high inductance, and the particular unit shown is both adequate for the purpose, and cheap in price.

An ebonite panel has been utilised in order to carry the On-off switch for the filament control of the valves and the 5 H.T. terminals. The remainder of the apparatus, however, has been mounted behind the panel, a hinged lid type of cabinet being provided in order that the whole apparatus may be totally enclosed, and thus adequately be protected.

Drilling

The first operation is the drilling of the panel to carry the small number of components mounted thereon, and this may easily be done by reference to the panel drilling diagram provided.

The next procedure is the mounting of the transformer, valve holder, choke condensers and fixed resistor on the baseboard in the positions shown. Ample space is provided and no difficulty should be experienced in this connection. The instrument is now ready for wiring up and this may be carried out in a straightforward manner.

Wiring Up

First of all push the free end of the lighting flex through the hole at the bottom of the panel provided for its use. At a distance of about 6 inches from the end make a large knot which will prevent the flex from being pulled through by any external force. The two ends of this flex may be bared and soldered to the two top points of the double-pole switch. Then take two leads from the two centre contacts of the switch as shown to the input terminals of the transformer. Then connect the L.T. terminals, marked 4 to 5 volts, through the fixed resistor on to the two filament terminals of the valve holder.

A Point to Note

A lead is then taken from one terminal of the high-tension winding of the transformer to the anode pin of the valve holder. It will be noted that the grid terminal is not used, since there is no grid in the rectifying valve. The other terminal of the high-tension winding is taken direct to the negative of the H.T. terminals. A lead is taken from the one side of the filament of the rectifying valve through the choke, and on to the 120 volt H.T. terminal. The 4 mfd. condensers are connected across these two leads, one on each side of the choke as shown, while finally the tapped resistance is connected across the H.T. terminals. The several tapping points are then connected to the respective tappings, the small mica condensers being connected across these points as indicated.

This completes the unit, which is now ready for use. It is only necessary to insert the valve in the holder, connect the plug into the lighting socket and throw the switch into the "On" position. The terminals will then carry D.C. potentials of the values of 30, 60, 90, or 120 respectively within the limits of variation with load which was previously discussed.

WIRING INSTRUCTIONS

Join 7,500 top of R2 to HT+90 and one side of C5.

Join HT— to 0 top of R2: 0 top of R2 to one side of C3: same side of C3 to one side of C4; same side of C4 to remaining side of C5; same side of C5 to one S terminal of transformer, and one side of C2; same side of C2 to one side of C1.

Join 2,500 top of R2 to HT + 30; HT + 30 to remaining side of C3.

Join 5,000 top of R2 to HT + 60: HT + 60 to remaining side of C4.

Join 10,000 top of R2 to HT + 120: HT + 120 to remaining side of C2; same side of C2 to one side of LF choke.

Join other side of LF choke to remaining side of C1; same side of C1 to one F terminal of V; same F terminal of V to one side of R1.

Join other side of R1 to one LT terminal of transformer.

Join other LT terminal of transformer to remaining F terminal of V1.

Join A of V to remaining S terminal of transformer.

Join one P terminal of transformer to one bottom contact of S, and to opposite centre contact.

Join other P terminal of transformer to remaining bottom contact of S and to opposite centre contact.

Join flex leads to remaining two contacts of S and take through hole in panel.

DISTANCE WITH A SMALL SET

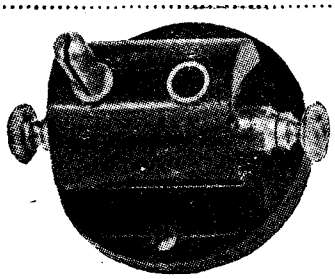
By STANLEY G. RATTEE, M.I.R.E.

Below will be found some useful hints and tips for the single-valve user, together with details of how he may improve his set without in any way disturbing the wiring of his present receiver

THOSE readers who use single-valve sets of the conventional type will have already experienced the difficulty in tuning the distant stations on account of the fact that before the set can be adjusted to its most sensitive condition, the arrangement bursts into self-oscillation.

The type of receiver where this is most met with is fitted with a swinging reaction coil, coupled to the grid coil, control of reaction being given by the variation of coupling between the two coils.

In this arrangement it is found that any alteration of the reaction coupling upsets tuning to such an extent that a resetting of the grid tuning condenser becomes necessary; similarly alteration of the grid-tuning condenser must also be followed by a readjustment of the reaction coupling to maintain the set in a sensitive condition.



The "aperiodic" aerial coil can be mounted in the set parallel to the existing fixed coil.

What is Proposed

Since single-valve sets of this type are perhaps the most commonly used at present, it is proposed to give in the present article some useful tips as to how the set may be improved by making a few external connections, at the same time retaining the set in its original form, with its original wiring.

In the arrangements to be described, though the coupling between the grid and reaction coils may be variable, if desired, it will be found best to adjust the coupling to some optimum value and make all reaction adjustments by means of the variable condenser as explained later.

Selectivity Requirements

In order that distance work may be carried out with some freedom from interference, particularly from the local station, it will be appreciated that some attention must be given to the aerial circuit.

In most of the receivers of the type under discussion direct aerial coupling is employed and, by the single addition of another coil, the receiver may be converted to one possessing an inductively-coupled aerial circuit.

All that is necessary is that a fixed coil-holder be added to the panel of the set so that the two coils are parallel and the coil-holders are at a distance of about one inch apart.

A connection should be taken from one side of the coil-holder to the earth terminal of the receiver, while the other side of the coil-holder should be connected to the aerial direct. Since the connections are common to all the arrangements discussed, they may be made

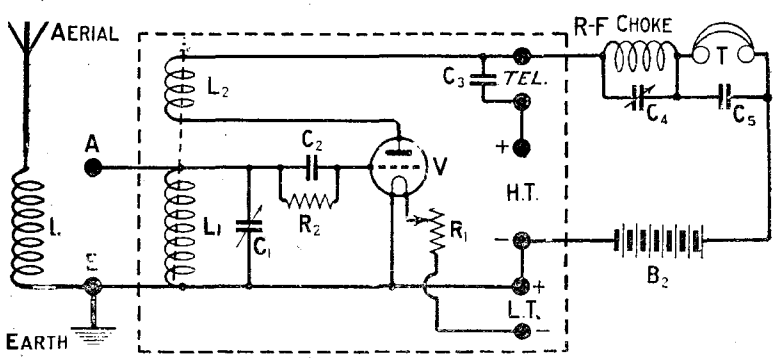
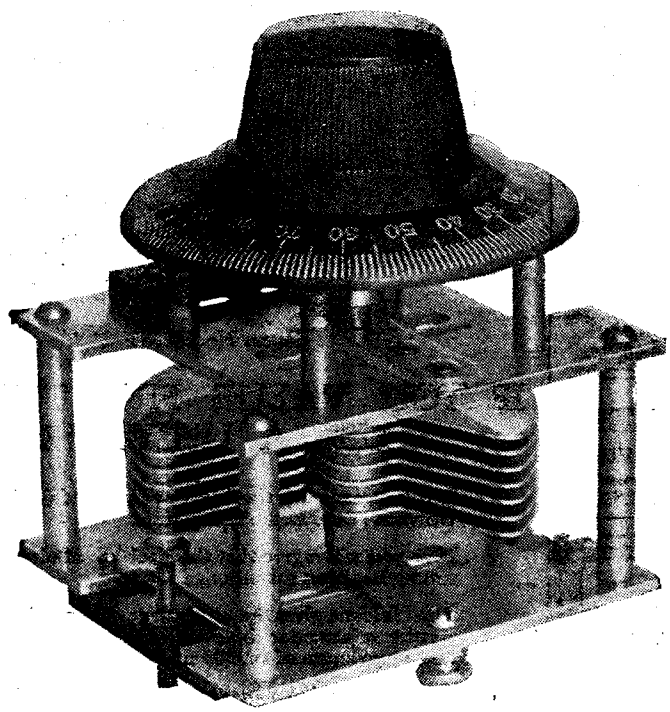


Fig. 1.—Selectivity may be improved by adopting the method of aerial coupling in which the coil L is "aperiodic."

DISTANCE WITH A SMALL SET—*Concluded*

permanent and will not be referred to again; the original aerial terminal of the set will not be used in any circumstance and may therefore be left free so far as external connections are concerned.

tive of H.T. battery to the H.T. negative terminal of the set, and the L.T. connections in the usual way. The H.T. positive terminal of the set, together with the unused 'phone terminal, both remain free.



The reaction control condenser may have a value of ·0003 in the circuit described by the author.

Connections Required

Within the dotted lines of Fig. 1 will be seen the circuit of a conventional single-valve set, while outside the portion shown dotted will be seen the various additions which go to make the receiving of distant stations an easier proposition.

The aerial coil referred to in the last paragraph is shown at L, while from that 'phone terminal, which is connected to the reaction coil socket, a connection is made to one side of a radio-frequency choke, the other side of which is connected to one of the telephone tags. Across the radio choke is connected a ·0003 variable condenser.

The remaining connections to complete the circuit are: 'phones to the H.T. battery positive, negative of H.T. battery to the H.T. negative terminal of the set, and the L.T. connections in the usual way. The H.T. positive terminal of the set, together with the unused 'phone terminal, both remain free.

Working the Set

For reception upon the broadcast band a No. 25 or 35 coil should be used for L, with a No. 60 for L_1 and a No. 35 or 50 for L_2. The radio-choke may be either one of the specially made commercial products or a No. 300 plug-in coil.

To operate the set with these connections, first adjust C_1 so that the moving vanes are completely engaged with the fixed, slack off the reaction coupling as far as possible, set C_4 to a half-scale reading and then light the valve, using about 45 volts for the H.T.; now slowly tighten the coupling between the reaction and grid coils until the set just oscillates, whereupon immediately decrease the reading of the C_4 condenser, when oscillation will cease.

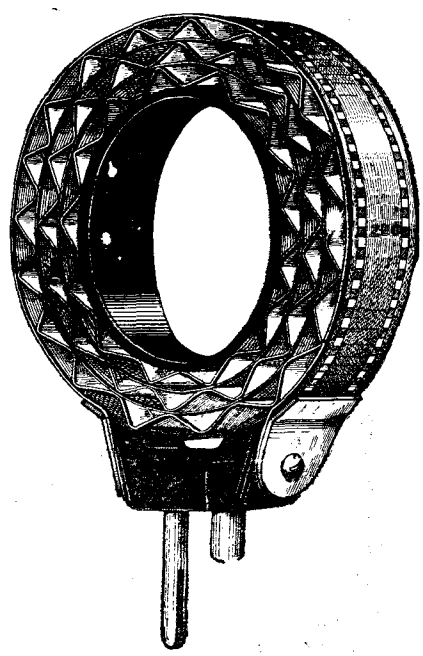
Having set the coupling between the two coils, leave all remaining reaction adjustments to a variation of the C_4 condenser, taking care that the set is not allowed to create interference through mishandling on your part. To assist in this matter it should be remembered that any *reduction* in the reading of C_1 should be preceded by a decrease in the reading of C_4.

Adjustment of H.T. Voltage

It will probably be found when using 45 volts H.T. that the receiver will pass into self-oscillation with a "click" or "pop," and since this pop is most undesirable for distance work, every endeavour should be made on the part of the operator to remove it.

To this end the value of the H.T. voltage should be reduced, say 3 volts at a time until the click is almost imperceptible.

By using various values, and at the same time adjusting the filament current, a combination of both will be quickly reached where the set almost passes into self-oscillation without the operator being aware of it.



A plug-in coil of suitable size can be used as a radio choke.

ALTERNATING CURRENT MEASURING INSTRUMENTS

By the Staff of the Elstree Laboratories

The differences between the various classes of instruments employed for D.C. and A.C. measurements are not always realised. In this article the uses of the more common types are described in an interesting and easily understandable manner.

IN last month's issue some details were given of the properties of alternating current, and it was shown therein that the maximum value of the voltage or current was nearly 50 per cent. greater than the rated value. The particular effect of this on the condensers in a smoothing unit designed to work off the A.C. mains was brought out, and it was shown that in many cases the condensers employed require an extra insulation.

Now this difference between the peak value, as it is called, and the mean or R.M.S. value comes into alternating current calculations in other ways. It is proposed in this article to discuss some of the methods which are actually adopted in practice for the measurement of alternating current and voltages, and also of rectified current such as may be used in charging units.

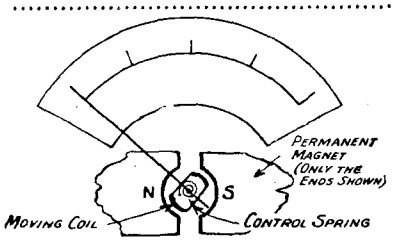


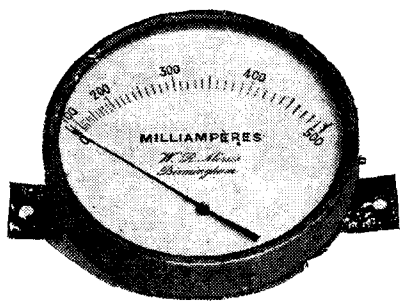
Fig. 1.—In a moving-coil instrument a simple coil rotates in a strong magnetic field. Such meters can be made very accurate.

Types

There are three principal types of measuring instruments utilised for the determination of the voltage or current in any circuit. They are (*a*) The Moving-Coil Type; (*b*) The Moving-Iron Type; and (*c*) The Hot-Wire Type.

Moving-Coil Instruments

The moving-coil pattern is similar in principle to a small



For A.C. work hot wire instruments are commonly employed.

motor. A motor comprises in essentials a magnetic field produced either by a permanent magnet or an electro-magnet, in which is situated a coil or a wire or a series of coils wound in a suitable formation. When current is passed through the coils there is a torque or twisting action which causes the armature or moving portion to rotate.

The moving-coil instrument utilises a simple coil only which is so placed as to be free to rotate in a strong magnetic field produced by a permanent magnet. It cannot rotate indefinitely, however, but is restrained by a spring, so that the torque or twisting force produced by the current passing through the coil has to overcome the resistance of the spring. The stronger the current the more will it succeed in doing so, and the greater will be the deflection or rotation of the coil, and the larger will be the scale reading produced by the pointer attached thereto.

A Precision Meter

Now moving-coil instruments can be made very sensitive. They will respond to very small currents or voltages, and what is more they can be designed to absorb very small currents in giving the particular indication required. The advantage of this is obvious, for if we are measuring the voltage of a high-tension battery with a voltmeter that takes 20 milliamps to operate it, we are putting a heavy drain on the battery which may conceivably run it down more than the actual use on a receiver. For direct current work, therefore, the moving-coil instrument remains pre-eminent where an instrument of precision is required.

For alternating current work, on the other hand, the moving coil instrument cannot be used. It is well known that the direction of the magnetic field produced by a coil depends upon the direction of the current passing through it. Since the whole operation of a moving coil instrument is the result of the interaction between the fixed magnetic field and that produced by the coil carrying the current, it follows that the direction of motion of the pointer will be dependent upon the direction of the current flowing through the instrument.

A Serious Obstacle

This is in many cases a valuable property, but where we are dealing

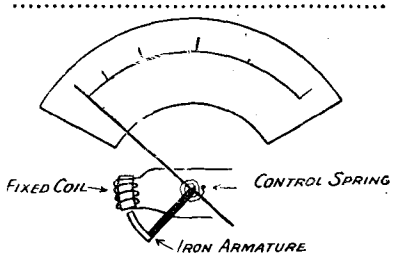


Fig. 2.—Moving iron instruments are cheaper to manufacture than the moving coil type, bnt are not quite so sensitive.

with alternating currents it is a serious obstacle. An alternating current, as we have seen, flows first in one direction and then in the other. These pulses of current follow each other with regularity and with considerable rapidity, even the lowest frequencies used for power work being of the order of 25 complete cycles per second.

ALTERNATING CURRENT MEASURING INSTRUMENTS—*(Continued)*

That is to say, the current rises to a maximum, passes through zero to a maximum in the opposite direction, and then falls to zero again 25 times in every second. Moreover, the pulses of current in one direction are identical with those in the other.

The effect on the moving coil in a measuring instrument, therefore, is that a momentary impulse in one

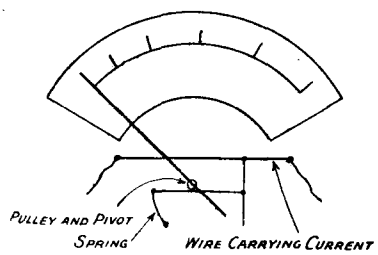


Fig. 3.—The principle of the hot-wire meter depends upon the expansion of a short length of wire.

direction is succeeded by an equal and opposite impulse in the opposite direction. If the needle were able to follow the variations, then it would fluctuate on either side of the zero point. In the majority of cases, however, it is not able to respond in the time available (only one-fiftieth of a second or less to each impulse) and consequently it gives no indication whatever. Thus an instrument of the ordinary moving-coil type is quite useless for measuring alternating currents.

Oscillographs

Instruments are designed for special work which are specifically arranged to be able to follow variations of current. Such instruments are provided with a very light moving system, often consisting of a single turn of very thin wire. They do not carry a pointer, since even the lightest of pointers would have far too much inertia to enable it to vibrate at the high rate necessary. They are provided in such cases with a small and very light mirror by means of which a beam of light may be reflected.

If the coil carrying the mirror is deflected in either direction by the current, the beam of light will also be deflected, and thus an indication can be obtained of the current passing through the instrument. Devices such as these are known as oscillographs. They are utilised to examine the actual variations in current which take place in a circuit. The indication given by the reflection of the spot of light from the mirror on the moving coil may either be arranged to act on a photographic plate or a strip of sensitised paper (in which case the whole instrument naturally has to be enclosed in a light-proof cabinet), or by suitable arrangements the spot of light can be thrown on to a ground glass screen.

Laboratory Equipment

Instruments such as these, however, are not utilised for ordinary every-day measurements, but have their place in laboratory equipment for the examination of special problems apart from the ordinary measurements which have to be made in the daily routine. For all such ordinary work, unless the elaborate precautions just outlined are taken, the ordinary moving-coil instrument is unable to respond to the rapid fluctuations of alternating current, and therefore gives no indication whatever if utilised on an alternating current circuit.

Moving-Iron Type

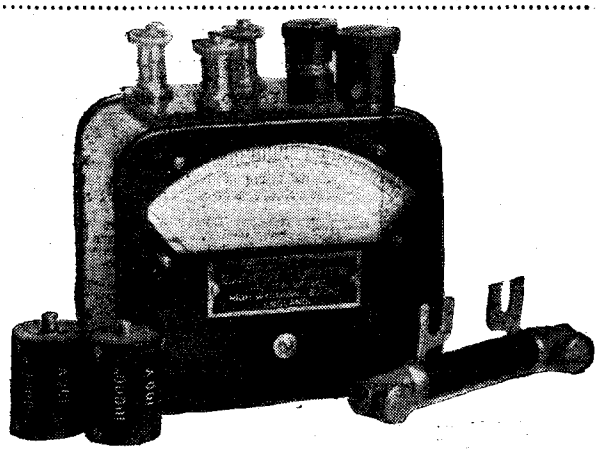
Hence we must use some property which depends upon the strength of the current, but not upon its direction. This brings us to the second class of instrument known as the moving-iron type. These meters depend for their action upon the magnetic force exerted by a coil on a simple piece of iron.

The magnitude of such a pull is dependent on the strength of the current, but the iron will be attracted irrespective of the actual direction of the current flowing through the coil. If therefore we arrange for our instrument to act upon a principle such as this it will still give an indication if an alternating current is passed through it, and it can therefore be used to measure such current.

Root-Mean-Square

As was shown last month, the average value of an alternating current or voltage chosen for comparison is the Root-Mean-Square, which is the square root of the average of the current or voltage squared at any instant. If therefore the moving-iron instrument is to be satisfactory, the reading it gives should be proportional to the square of the current flowing through it, and this is actually the case.

If we double the current we produce four times the effect. Such an instrument, therefore, would register the average value of the magnetic effect experienced from moment to moment, and since the magnetic effect in each case depends upon the square of the current, the total response of the meter is proportional to the mean of the current squared. The R.M.S. value, as we have seen, is the square root of this figure, so that a moving-iron instrument will give us a definite comparison between the R.M.S. or rated values of current or voltages as required.



For D.C. work one of the most useful instruments is a multi-range meter designed to measure both current and voltage. These instruments are, however, not suitable for A.C. measurements.

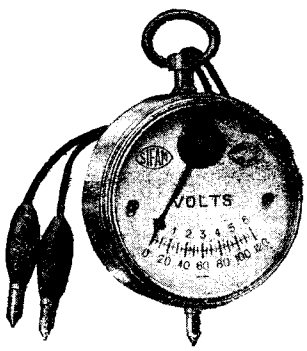
Non-Uniform Scale

Since the instrument depends on square law, however, it will be obvious that it cannot have a uniform scale, such as is the case with a moving-coil instrument. The scale will tend to open out towards the top end. This, however, is a difficulty associated with all alternating current instruments which must obey a non-linear law in order that

ALTERNATING CURRENT MEASURING INSTRUMENTS—(*Concluded*)

they shall not be affected by the variation in direction of the current.

A simple moving-iron type of instrument consists of a coil of wire at the end of which is a small rod of iron, which is carried on the end of an arm pivoted in some suitable manner. When a current passes round the coil the iron rod is sucked into the coil, the attraction increasing with the current. A pointer is attached to the moving mechanism so that an indication of the relative strengths of the current is thus obtained.



Small pocket meters are useful for approximate L.T. or H.T. battery measurements.

Current Demands

Moving-iron instruments are generally less delicate than moving-coil instruments as far as actual construction is concerned, so that they are somewhat cheaper to manufacture. On the other hand, they are not so sensitive as the moving-coil type, so that first of all it is not possible to read such small currents or voltages, and secondly the current taken by a moving-iron instrument is considerably greater than that taken by a moving-coil meter to give a corresponding indication.

Hot-Wire Type

The third class of instrument is the hot-wire type. It will be remembered that the R.M.S. rating for current in an alternating current was so chosen that a D.C. current and an A.C. current of the same amperage should produce the same heating effect in a given circuit. The heating effect of a current is dependent only on the strength (or strictly speaking upon the square of the strength), but not upon the direction. This therefore gives us another method of measuring alternating current, and this type of instrument is used to a considerable extent.

In its simplest form the hot-wire ammeter consists of a fairly long thin wire of phosphor bronze, through which the current to be measured is passed. The passage of the current causes the wire to heat up, and in so doing to expand. Thus the wire, instead of being tightly stretched, sags in the middle when the current passes. By an ingenious arrangement, shown in Fig. 3, this sag is magnified and caused to produce a definite pull on a small cord or chain which passes round a pulley wheel acting on a pivot. The rotation of this pulley wheel is magnified by a long pointer which travels over the scale and gives an indication of the current.

Disadvantages

For power work the hot-wire type of ammeter is not as common as the moving-iron type. It suffers from the same disadvantages, namely, it has an uneven scale, and, moreover, this scale cannot be made more uniform, as is the case with a moving-iron instrument. It has the further disadvantage that it is somewhat sluggish in action, and is also subject to zero errors. This means that the pointer does not return to the correct zero point after it has given a reading, so that when the next reading is taken, it merely starts from the second place and introduces an error into the indication.

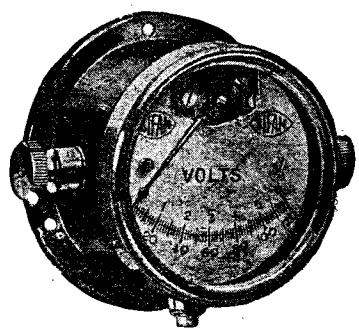
For wireless work where very high-frequency currents have to be measured, however, it is almost the only type of instrument which is of any service.

Pulsating Currents

We have seen, therefore, the types of instruments which are most commonly employed for the measurement of alternating quantities. We still have to consider, however, the question of a suitable instrument to use when dealing with pulsating or rectified currents. The type of instrument here depends entirely upon the service to which the pulsating current is to be put. If, for example, we are going to light a lamp with a rectified current, then we require an alternating current instrument, such as a moving-iron or a hot-wire type which will give us the Root-Mean-Square value of the fluctuating current. An instrument such as this, as we have seen, will give us the equivalent direct current which would produce the same heating effect as the particular pulsating current in question.

A Point to Note

If, on the other hand, we wish to use this pulsating current for battery charging, as is more usual, then we require a moving-coil instrument, or some other instrument which gives a reading directly proportional to the current. For instance, in a case such as this what we wish to know is the average value of the current. At one instant we put a pulse of current through the battery, and at the next instant we have no current at all. Now the effect on the battery as far as charging is concerned is the same as if we passed a steady current the whole time, and this equivalent current is the true average value of the current and not the R.M.S. value.



For measurements of H.T. voltage a good moving-coil instrument is more desirable from the point of view of current consumption than a cheap moving-iron voltmeter.

As we have seen, the R.M.S. value is 1·1 times the true average or the mean value of the current, so that we should get a different indication on a moving-coil instrument than a moving-iron instrument. Some readers may possibly have observed this to be the case, and have been puzzled thereby, but viewed in this light the explanation is quite simple, since one meter reads the R.M.S. and the other reads the true mean value of the current flowing. Which of these we require is simply a matter to which the use of the rectified current is being put.

STABILISING WITHOUT A CENTRE TAP

By C. P. ALLINSON, A.M.I.R.E.

There must be a very large number of readers who have sets employing H.F. transformers and ordinary plug-in coils without centre-taps. This article will therefore fill a long felt want since it shows how old circuits may be modernised by a simple method of neutralisation involving but little outlay.

IN a recent issue of MODERN WIRELESS I described a series of experiments which had been carried out on the subject of neutralised high-frequency amplifying circuits. For these tests a centre-tapped grid coil circuit was used, in which one end of the grid coil is connected to the grid of the amplifying valve, and the other end through a neutralising condenser to the anode, while the centre tap on the coil is taken to L.T. negative. It was found that when the grid was left free, that is, the filament return was omitted, a higher degree of amplification was obtained, and this effect was ultimately retained by the use of a high-frequency choke connected in series with the filament return lead.

A Disadvantage

The necessity for a centre tap in neutralising circuits of this description, as well as those in which a centre-tapped anode coil is employed, is a disadvantage in that it does not allow ordinary plug-in coils or high-frequency transformers of the old type to be employed. It was decided, therefore, to see if it were not possible to evolve a neutralising circuit which, while giving satisfactory stability up to two or three stages of H.F., would, nevertheless, enable the centre tap to be dispensed with, so that all those experimenters who still have large quantities of plug-in coils or plug-in H.F. transformers of the old pattern could employ these in modern neutralised circuits. There is a very large number of experimenters in this category who do not feel that the expense of buying special coils for neutralised circuits is justified.

Experiments

Experiments were carried out, both with the centre-tapped grid coil and the centre-tapped anode coil method of neutralisation, and in view of the fact that I have done a good deal of work on the former method, this was the first one to be examined with a view to the evolution of a new circuit. Incidentally, certain conclusions drawn from the action of this circuit led to the discovery of a method of an equivalent to the centre-tapped anode coil method of neutralisation which would function satisfactorily.

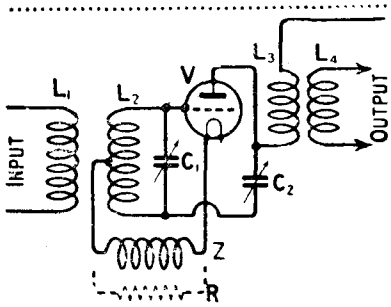


Fig. 1.—The basic centre-tapped grid coil circuit.

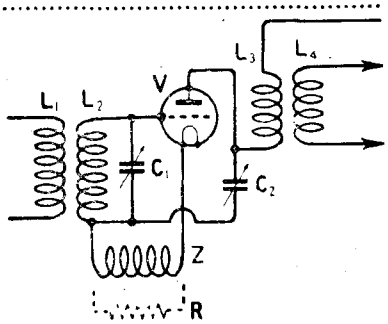


Fig 2.—In this circuit the filament return is taken to the bottom of L_2.

The Basic Circuit

The basic centre-tapped grid coil circuit is shown in theoretical form in Fig. 1. An inductance L_1 is coupled to the grid coil L_2, which is tuned by a condenser C_1. The neutralising condenser is shown at C_2, while the anode coil L_3 is coupled to the output coil L_4, as shown. In the filament return which is connected to the centre point of L_2 is shown a high-frequency choke Z which may alternatively be replaced by a high resistance R, for which a suitable value is 100,000 to 250,000 ohms. Now, when a choke is being used as shown, it is obvious that there is no return path for any high-frequency current, the sole function of the choke appearing to be the stabilisation of the grid. If it were not for this choke, there is no doubt that in a number of cases, a high negative potential would build up on the free grid, thus entirely stopping the functioning of the valve.

It therefore occurred to me that it could not matter at what point on the coil L_2 the lead to the high-frequency choke Z were taken. The most logical position for this connection would, of course, be at the bottom of the coil, and Fig. 2 shows the first of the circuits that was tried. We now get a circuit that is equivalent to the one shown in Fig. 1, the only difference being that the centre tap on the coil L_2 has been eliminated. When this circuit was tried out, it was found that a neutralising effect was obtained in the usual manner.

STABILISING WITHOUT A CENTRE-TAP—(*Continued*)

That is, when the valve was turned out it was possible to obtain a minimum or zero signal position on the neutralising condenser C_2. This was found to hold whether a choke Z or resistance R were connected at the position shown, the particular value for the resistance actually employed in these experiments being 250,000 ohms.

Three Stages

This method having been found successful experimentally, it was next decided to make up a receiver embodying this circuit and this was therefore done without delay. The full theoretical diagram is shown in Fig. 3, and it will be seen that three stages of high-frequency were employed. It may seem somewhat of a jump from a single experimental stage of high-frequency to go to three stages, but I may mention that it was only lack of time that prevented my constructing a four stage H.F. amplifier at once. It is obvious that if a three or four stage amplifier can be made to work successfully, no difficulty should be experienced at all with one or two stages, while any difficulties that may crop up in the practical application of theoretical principles will probably be far more pronounced and therefore more easy to trace in a multi-stage receiver of this description.

Reaction

It will be seen from the circuit that reaction is used in the detector valve circuit and this was found to be required in order to get the full range and sensitivity from the receiver. The three high-frequency circuits are identical, the inductances L_1, L_3 and L_5 being the same, while L_2, L_4 and L_6 were also

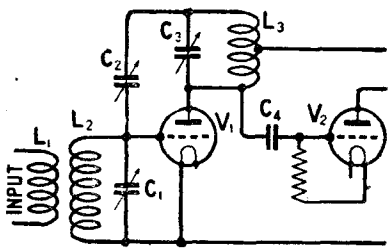


Fig. 4.—A conventional neutralised tuned-anode employing a centre-tapped coil.

similar. The resistances R_5, R_6 and R_7 were 250,000 ohms each, and were all connected direct to L.T. negative. The valves used were of the high-impedance high-amplification type and it was found possible with this arrangement to use a voltage as high as 80 or 90 volts without any instability on the high-frequency side resulting. If the coupling between the anode and grid coils was tightened, it was found that a slight drop in anode voltage had to be made in order to secure complete stability, but with looser coupling by the use of smaller coils in the anode circuit, it was found possible to push the voltage up to 120 volts without self-oscillation occurring in any way.

Neutralisation

Neutralisation was carried out in each stage in the normal manner, provided that the anode coil was connected in the right direction. Using this arrangement it was found possible with only one stage of low frequency to receive a number of distant Continental transmissions at good strength on the loud-speaker. Selectivity was of a satisfactory order, it being found possible to receive Bournemouth without interference from London at two miles from this station. None of the coils used was screened in any way, although they were placed with their fields vertically, so as to reduce any direct pick-up to a minimum.

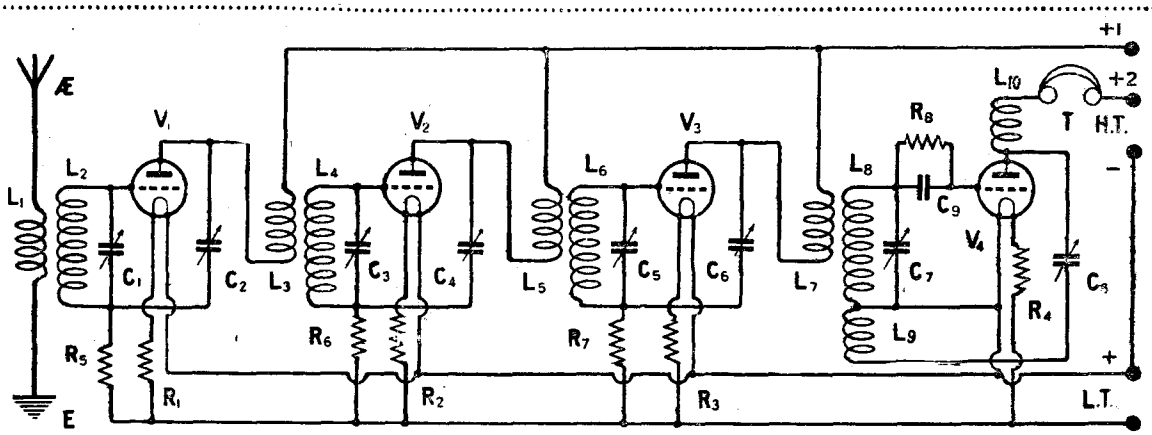


Fig. 3.—The theoretical circuit of the receiver embodying the Fig. 2 method was as shown above. Reaction was controlled by means of the condenser C_8.

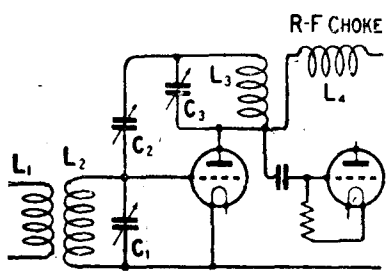


Fig. 5.—How the need for the centre-tap shown in Fig. 4 was rendered unnecessary by using a radio-choke as shown.

Tuned Anodes

Attention was next directed to the tuned anode circuit which is shown in Fig. 4. It will be observed that the H.T. supply is connected to the centre point of the inductance L_3, namely, the *nodal* point of the coil. In the case of the centre-tapped grid coil method of neutralisation, as we have just seen, there was no need for this point on the coil to be held at earth potential by a direct connection

STABILISING WITHOUT A CENTRE-TAP—(Concluded)

to low tension. It therefore seemed a feasible scheme that the H.T. might be fed to the anode of the valve through a choke connected direct to the anode, and by this means the centre tap on the coil would be eliminated.

The circuit is shown in Fig. 5 and will no doubt be clear without further explanation. On this arrangement being tried out it was

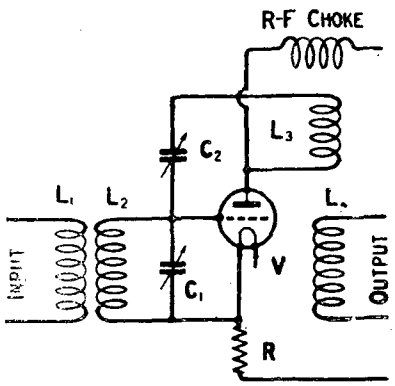


Fig. 6.—Showing how an H.F. transformer can be utilised.

found that neutralisation could be obtained by the balancing method with the valve turned out. It was found, however, that a somewhat smaller capacity for neutralising was required than with the conventional arrangement. An experimental receiver was next made up, using two stages of tuned anode employing this neutralising arrangement, followed by a further stage of H.F. This was transformer coupled in order that Reinartz reaction might be employed, and this arrangement was found to be perfectly stable at all frequencies.

H.F. Transformers

This then is the scheme that would need to be employed where H.F. transformers of the old-barrel type are employed, on account of the tight coupling existing between the anode and grid coils. Further, it will be remembered that these transformers generally are used with the primary tuned, so that this scheme would be necessary in order that a neutralised circuit may be employed.

The values of the components used do not differ in any way from those normally employed, and no special precautions need to be taken in the construction of sets employing this principle outside those which are always necessary in the construction and lay-out of H.F. amplifiers. In cases where severe interference is experienced owing to direct pick-up, the use of screened coils will, of course, be a decided advantage.

Plug-in Coils

The important feature, however, of the circuit shown lies in the fact that ordinary plug-in coils may be used with the scheme. As a guide to the experimenter, I show in Fig. 7 the correct way of connecting a standard connection plug-in coil with the various arrangements described. I say standard connection because a number of makers have adopted the convention of connecting their coils to the plug and socket of the holder so that in all cases the polarity of the field will be the same. This can easily be tested in a single-valve receiver by exchanging one reaction coil of one make for another. If the connections of the reaction coils do not have to be altered in order to get the set to oscillate the direction of the windings is the same in each case.

Polarity

This provides a simple test, but if the experimenter wishes to be certain as to the polarity of his coils a simple test unit may be made up as shown in the sketch in Fig. 8. This will be seen to consist of a coil-holder, a filament

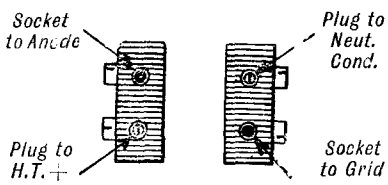


Fig. 7.—The author's method of connecting up plug-in coils for one of the arrangements described.

resistance and a small magnetic compass. The compass is raised above the baseboard on a small block of wood so as to allow of its being placed in the centre of the field of the coil. A battery is then connected in series with the coil and a resistance, this being used to prevent a too heavy flow of current taking place. It should then be noted which pole of the compass needle is attracted towards the coil. Care should be taken, of course, when comparisons are made at intervals that the battery

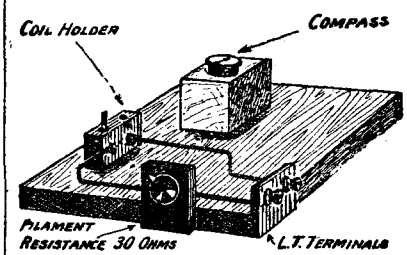


Fig. 8.—A simple way in which the polarity of coils may be tested.

is connected the same way round in each case.

Reversing Connections

Using then coils all of similar polarity, the connections shown in Fig. 7 will be correct when plug-in coils are used in a receiver employing the circuit embodied in Fig. 2. If, however, it is found that any of the coils have a polarity reversed to the other ones being used, it will, of course, be necessary to reverse the connections going to the coilholder in which this particular inductance is inserted.

In the case where a receiver is made up, using the principles outlined above, employing plug-in barrel type H.F. transformers, it may be necessary to experiment with the connections to the primary in order to make sure that proper neutralisation is occurring, although in general it will be found that the connections advised by the maker will be found to be correct.

It is rather important that magnetic coupling between coils in a multi-stage H.F. amplifier be either totally eliminated by the use of screened or binocular coils or by placing the coils as far apart as possible. Better still, since the methods of neutralising described are particularly suited to plug-in coils, the zero coupling position should be found so that the interaction is at a minimum. If this is not done the neutralising becomes affected; either it is difficult to carry out, or else it may be found that the set is over-stable owing to negative reaction effects.

require to be altered again. Searching for distant stations is then a very simple matter. By means of the reaction on the second valve the receiver may be brought to any required condition of sensitiveness, and with the aid of the test report no trouble will be found in obtaining a large number of alternative programmes.

One particular advantage of the receiver lies in the possibility of dodging atmospherics. It is very often found that when atmospherics are heavy on the lower broadcast band, they are comparatively light on the 1,000 to 2,000 metre band. Thus, if one's normal programmes are being disturbed by atmospheric conditions, it is possible to run up to Hilversum or Koenigswusterhausen or Daventry if this is giving a suitable programme, and so obtain satisfactory reception.

Suitable Valves

The following list of valves will be found of assistance. It is on the high frequency and detector stages that the difference between various valves is most marked, and, in this class only, the first valves are preferable to those coming later. On the low-frequency side there is little to choose between the various types of valves and readers may make their own choice in the matter.

Some recommended valves are as follows:—

6-Volt	
H.F. & Detect.	L.F.
SP 55/B.	SP. 55/R.
P.M.5.A.	P.M.6.
D.E.5.B.	D.E.5.
S.T.61.	S.T.63.

2-Volt.	
H.F. & Detect.	L.F.
SP. 18/B.	SP. 18/R.
P.M.1. H.F.	P.M.2.
Cossor .1 H.F.	Cossor Stentor 2.
S.T.21.	S.T.23.

Other valves having similar characteristics may be used.

FURTHER "ELSTREE SIX" APPRECIATIONS

The opinions of successful constructors.

"Every Success"

SIR,—*Re* the "Elstree Six," I have much pleasure in informing you that I have now had this set in operation for about two months, and find that it gives me every satisfaction. I constructed it entirely without outside help, even to the cabinet, which says much for the clarity of your instructions, seeing that I am entirely without technical knowledge.

I get quite a number of stations, most of which are unidentified, but I may mention Dublin, Hamburg, Stuttgart, Breslau, nearly all the B.B.C. stations, including Bournemouth and Manchester, without any trace of the 2LO. I have no doubt that in the hands of a skilled operator much more might be obtained, but I can make no such claims and have only used the set in a kind of haphazard manner. Should you know of anyone in my district wishing to hear it I shall be glad to let them have every facility for an opportunity, either to work it for themselves or whatever sort of demonstration I can give them.—Yours truly,

C. LOUIS.

Belgrave Road, E. 11.

"Huge Success"

SIR,—I have pleasure in stating that the "Elstree Six" which I constructed in strict accordance with Radio Press blue print and recommended components (a most important factor) has turned out a huge success. The purity and strength on a good loud-speaker cannot be equalled on any other set which I have heard. The ease with which this set can be handled is a joy and pleasure. The majority of B.B.C. stations are indeed simple to tune in with excellent volume, and the principal foreign stations respond equally as well. Daventry and many high-power foreign stations give enormous volume on five valves. The "Elstree Six," in my opinion, is everything one could desire. I have made up and tested circuits of every description during the last six years recommended by wireless experts, and am firmly of the belief that there will be many bald heads at the Elstree Laboratories before the "Elstree Six" can be improved upon.—Yours truly,

Pembroke. H. F. JACKSON.

"Remarkable Volume"

SIR,—I would say that I was much interested in and gratified by the impressions I gained at the demonstration of the "Elstree Six" which I had the pleasure of hearing when visiting your laboratories.

Undoubtedly the chief weakness with the majority of powerful receiving sets has been the methods employed for H.F. amplification, and it was a great pleasure to be allowed to operate your set at Elstree, and to experience the ease of control, the excellent quality of the transmissions received, and to hear the remarkable volume at which even the relay stations could be heard.

I have made up one of these sets and find that at the situation of my transmitting station, 2ZP, I am able to obtain even more gratifying results than is the case at Elstree, and you will be interested to hear that I have obtained not only a very large number of British and foreign stations, but that I have been able to receive Manchester and Cardiff at good strength, with satisfactory quality and without interference from London.

I feel that an expression of thanks is due to your organisation and to your Elstree staff for the work they have done in originating this circuit. —Yours truly,

G. FREDERICK FORWOOD.

Limpsfield.

The wavelength of 2LO is now controlled by means of a new and very accurate wavemeter. The above photograph was taken during a Press inspection of the instrument. Capt. Eckersley, the Chief Engineer of the B.B.C., may be seen fourth from the left.

"Claims Fully Justified"

SIR,—I thought you would be interested to know how my "Elstree Six" is working. I have had this set in operation for three weeks, so I am not writing in the first glow of enthusiasm. All your claims are fully justified—all my condensers read absolutely alike and it is no exaggeration to say that if I place the four condensers on any degree I am bound to get a station—all tuned in on the loud-speaker. I use only five valves—there is too much volume on six. I have demonstrated this set to many of my wireless friends, and they are all amazed at the volume, purity and the ease with which I tune in different stations—the small reaction condenser I never touch, being left at zero always—the performance is more wonderful owing to the fact that my aerial is only 25 feet long but 50 feet high.

Wishing you every success which you well deserve.—Yours truly,

H. LLOYD.

Bangor.

"THERE IS NOTHING NEW . . . ."

(*Concluded from page 652.*)

away to almost inaudibility, only to come back again.

In Eastern Waters

Probably the most interesting part of the world where to observe fading is the Pacific Ocean, for there the "see-saw" effect is most marked.

At a point about Hong Kong, for instance, it is no unusual thing for a ship to be in communication at night with a Japanese station, when suddenly signals will fade away and in their stead will be heard a transmission from Singapore or Penang. After some little while these latter signals will begin to fade when back will come the original Japanese station.

On one occasion the station at Hong Kong was able to hear and even to exchange signals with Thursday Island, Australia, during one of these fading and freak periods, a distance of some several thousand miles in the tropics, and though the feat was an exceptional one, stations such as Choshi, Singapore, Penang, Rangoon and so on would fade in and out of range practically every evening of the week.

Conclusion

Strange though it may seem, the effect of fading seems to be observable only during hours of darkness, or at any rate to be most pronounced during that period. Such a condition would seem to prevail throughout the world with the addition that in some parts twilight and daybreak are also times when freakish effects can be observed.

In regard to broadcasting quite interesting experiences can be had when listening to many of the mid-continental stations; Radio Belgique for instance, when using the old wavelength, was frequently a subject to fading. Radio Barcelona also offers a chance for experiment, while most of the American short-wave stations will also be found quite accommodating in this direction, WIR in particular.

S. G. R.

THE "PURAMUSIC" RECEIVER.

(*See page 627.*)

THE EFFECTS OF CAPACITY IN H.F. CIRCUITS

By L. I. LESLIE

Who gives some very interesting details of the results of experiments on the effects of capacity-coupling existing between H.F. transformer windings.

WITH present-day neutralised circuits we are sometimes too ready to assume that any H.F. receiver is bound to be stable provided that some sort of neutralising condensers are employed. Those who attempted to use several H.F. stages in a receiver during the early days of broadcasting will no doubt remember the formidable difficulties that existed in the design of these receivers. The layout and wiring had to be very carefully planned out. Each component was made with the object of reducing undesirable capacity effects to a minimum. Even then the designer was defeated in his task of controlling superfluous oscillation unless he introduced damping into the tuned circuits. In most cases the effect of damping in an H.F. circuit is to cause a loss of signal strength and a general falling off in efficiency.

Damping

H.F. amplification is in the most favourable circumstances low in value compared with that obtainable in an L.F. stage, so that if damping has to be introduced into every tuned circuit to prevent oscillation, the overall effect of the amplifier will be very small indeed. The advent of the neutrodyne principle of neutralised H.F. stages has brought the H.F. amplifier well to the fore, and it is now possible to employ almost any number of H.F. stages in a receiver. At the same time the full effect of the amplification from each stage can be obtained. But it must be remembered that a neutrodyne condenser is only designed for neutralising the small capacity between the plate and the grid of a valve. Capacities existing between the plate circuit and grid circuit of valves sometimes cannot be neutralised.

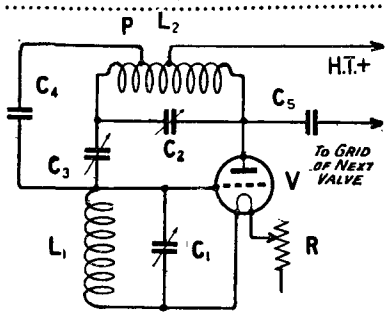


Fig. 1. The effect of stray capacity in this explanatory circuit is illustrated by the condenser C_4.

The Neutrodyne Principle

The circuit of a valve acting as an H.F. amplifier is shown in Fig. 1. L_1 C_1 represents the grid and L_2 C_2 the anode circuit. C_3 is a neutralising condenser having a capacity approximately equal to that between plate and grid of the valve. The anode coil L_2 is tapped in the centre, and this tapping is taken to the positive H.T. The anode coil is now split in two halves with a condenser at each end. The other end of each condenser is connected to the grid. The feed back of energy from the anode coil L_2 to the grid takes place through C_3, and through the valve, but their effects are in opposite phase, therefore if C_3 is adjusted so that it is capable of passing the same energy as will feed through the valve, a balance is obtained and there will be no feed back of energy from L_2 to the grid. This is a straightforward explanation of the neutrodyne principle.

Stray Capacity

Supposing a lead from the grid circuit passes over the anode coil L_2, if P is the nearest point on this coil to the lead, there will be a capacity from P to the grid circuit. It is evident that this capacity cannot be neutralised by adjusting C_3 unless P happens to be at one end of the coil. If there are a number of these stray capacity effects in an H.F. amplifier it will tend to become unstable even when the valve capacities are neutralised. Therefore it can be seen that a neutrodyne circuit must receive the same amount of care in wiring as any other H.F. amplifier.

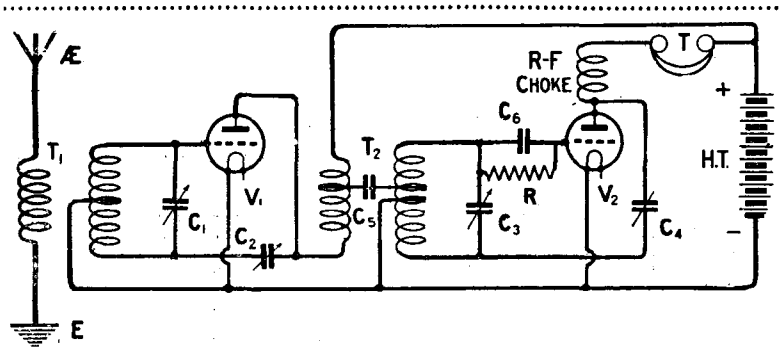


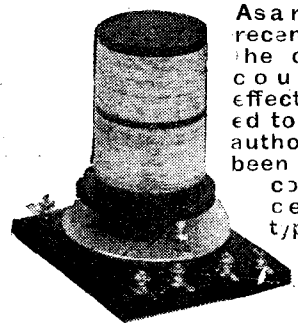
Fig. 2.—The capacity between the primary and secondary windings of T_2 is represented by C_5. This capacity in some cases renders the set very unstable.

H.F. Transformers

H.F. transformers are now in general use as a means of coupling the plate circuit of one valve to the grid circuit of the next. The reason for their popularity lies in the fact that they are very selective and can be made as efficient as any other form of intervalve coupling. There seems to be some doubt in wireless circles as to whether to employ a

THE EFFECTS OF CAPACITY IN H.F. CIRCUITS
(Continued)

tight or a loose coupling between the primary and the secondary of these transformers. The maximum energy is transferred from primary to secondary when the coupling is tight, but the selectivity suffers owing to the increased capacity between the two windings. This is explained by the fact that as this capacity increases it tends to cause a direct coupling between the two windings of the transformer, so that they become the equivalent of a single winding.



As a result of recent tests the capacity coupling effect referred to by the author has been overcome in certain types of transformers.

This is not the only harmful effect of coupling capacity. Recent experience has shown that it causes instability in an H.F. amplifier and will sometimes prevent satisfactory neutralisation of the valves in use.

Split-Secondary Circuits.

Fig. 2 is a diagram of a two-valve circuit utilising one high-frequency valve followed by a detector. T_1 and T_2 are two split-secondary transformers. C_2 and C_4 are the two neutralising condensers. C represents the capacity between the primary and secondary windings of the transformer T_2. This circuit can be redrawn in a much simpler form as shown in Fig. 3. For the sake of simplicity no batteries are shown and the transformer T_2 is represented by a single inductance L_2. This is quite justifiable as the primary and secondary of T_2 are always connected through the high-tension battery. C_5 represents the capacity between the two windings of the transformer. On reference to Fig. 3 it will be seen that the combination of C_2, L_2 and C_1 constitutes a Hartley reaction circuit. The valve V_1 will oscillate if C_2 is large enough. On further examination it is evident that C_5, L_3 and C_3 also form a Hartley reaction circuit. Both of these circuits act on the same valve V_1, so that if C_5, which is the capacity between primary and secondary of the intervalve transformer is large enough in value, V_1 will oscillate.

This is a very interesting result as it definitely proves that the larger the capacity existing between the windings of an H.F. transformer the greater is the tendency for the preceding valve to oscillate. This result is fully borne out in practice.

Experiments

Certain H.F. amplifiers have been tested in the Elstree Laboratories which have been very difficult to neutralise. Those having split secondary windings as in the circuit of Fig. 2 invariably give more trouble in this respect than those with a split primary winding.

An example of the latter type is shown in Fig. 4. It will be seen that the neutralising condenser C_2 is connected in series with the untuned primary winding of the transformer. If the coupling between the primary and secondary is very tight, the primary will become a tuned circuit, and C_2L_2 will then form a Hartley reaction circuit, in consequence of which the valve V_1 will be more liable to oscillate. However, provided that the coupling is not over tight, the valve V_1 will be less liable to oscillate than it would be in the circuit shown in Fig. 2.

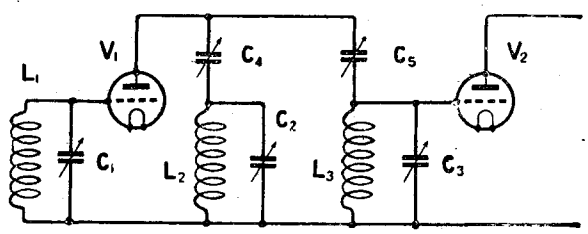
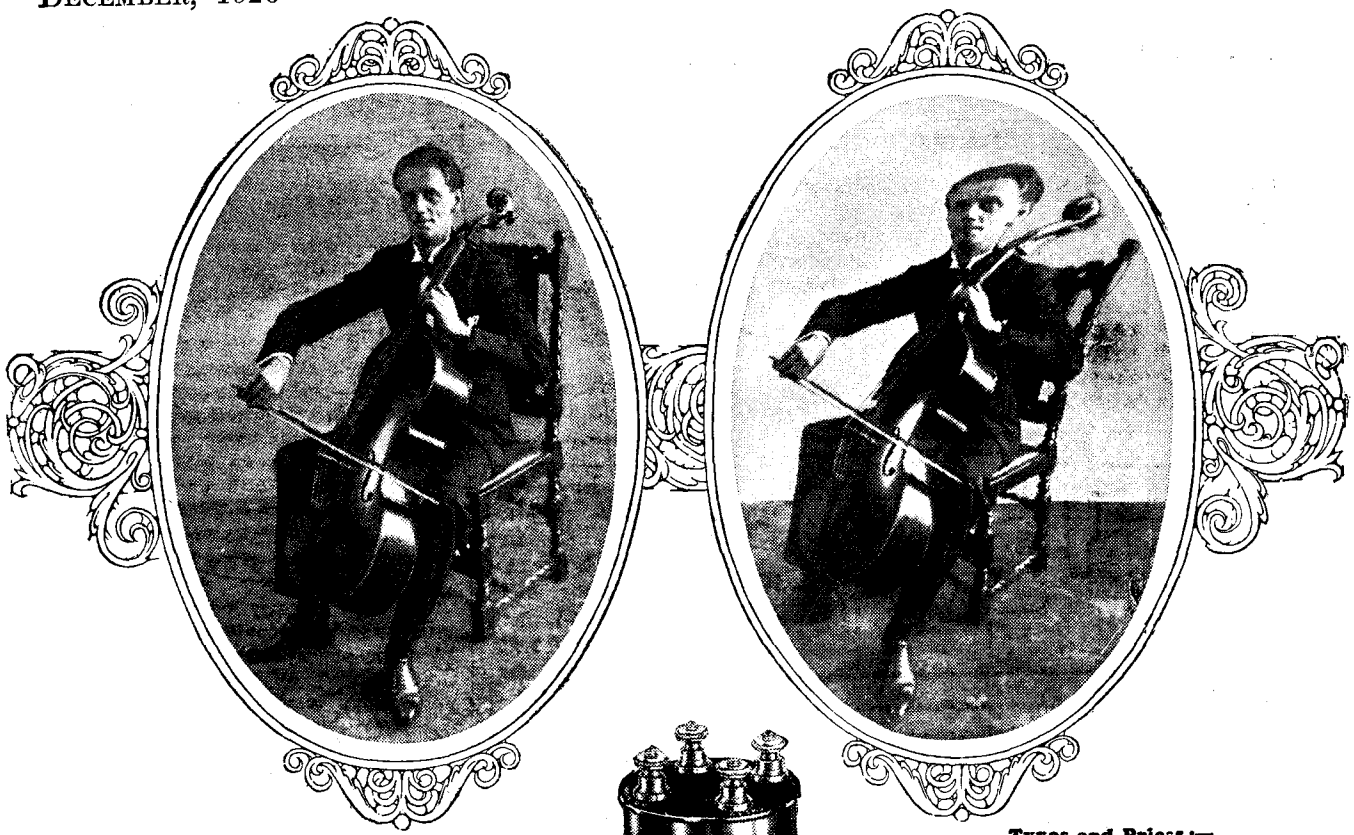
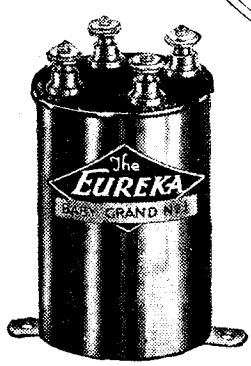


Fig. 3.—A simplified explanatory diagram of Fig. 2 illustrating the effect of capacity coupling.

An Important Point

It is now quite evident that for increased stability in valve circuits the capacity between the primary





Types and Prices:—

Eureka Concert Grand
A superb L.F. Transformer hermetically enclosed in a coppered steel case proof against atmospheric influences. Fully guaranteed. No. 1 25/-. No. 2 21/-.

Eureka Reflex
For reflex work a special Eureka is available. Gives an exceptional volume of mellow clear tone. Fully guaranteed. 15/-.

Eureka Baby Grand
For those who cannot afford the necessarily higher price of the larger Concert Grand we have introduced the Baby Grand. Fully up to the same high standards of workmanship. Fully guaranteed. No. 1 15/-. No. 2 15/-.

Eureka L.F. Choke Unit
The Eureka Choke Unit, incorporating grid leak and condenser, is the finest instrument of its type. Fully guaranteed. 25/-.

The wise concert-goer chooses his seat with care ——

MAYBE it has been your misfortune to occupy a seat at a concert close to the drums. During the whole evening your impression of the music has been overshadowed by this irritating boom-boom-boom. The piping notes of the flute and the delicate tones of the oboe have been inaudible. To catch the melody your ears have had to fight through this resonant background.

Perfect reproduction of broadcast music is more often than not a question of balance. If an L.F. transformer is used which amplifies the low notes at the expense of the high ones, distortion is inevitable. You will hear the drums and the 'cellos and lose the flutes and the oboes. In other words, your seat will be too near one side of the orchestra. The regular concert-goer sits a reasonable distance from the orchestra—by experience he has learned that distance lends enchantment to the ear! The Eureka L.F. Transformer has been designed to give listeners a truthful rendering of orchestral music. It does not—indeed it cannot—amplify some tones at the expense of others.

By reason of its exclusive method of winding and its non-laminated core it is scientifically corrected against distortion. Just like the anastigmat lens in a camera, for instance, which is corrected to avoid giving a distorted image. Any lens will give some kind of a picture and any L.F. transformer will give some degree of amplification. But it may not be true to nature. The Eureka Transformer has now been before the public for three years. Its popularity amongst those who appreciate radio components of high quality has consistently and deservedly increased. Tens of thousands of listeners are to-day enjoying by its aid, a quality of radio music which can only be compared to the actual broadcast transmission in the studio by the artistes themselves.

Re-creates the EUREKA Living Artiste

Advertisement of Portable Utilities Co., Ltd., 8 Fisher Street, London, W.C. 1.

Gilbert Ad. 6323.

THE EFFECTS OF CAPACITY IN H.F. CIRCUITS
(Concluded)

and secondary of the H.F. transformer must be low in value. Considerable difficulties arise in designing a transformer which will have a maximum inductive coupling with a very small capacity coupling. As a rule some compromise has to be effected, and signal strength is sacrificed for the sake of stability.

Recent tests on the coupling capacity of transformers carried out at the Elstree Laboratories show that designers have not come to any definite agreement as to the maximum allowable capacity. Most of the types of transformers tested had been used in sets constructed at the Elstree Laboratories and published in the Radio Press journals. So that the reports of these tests were extremely interesting in view of the different degrees of stability possessed by many of the receivers.

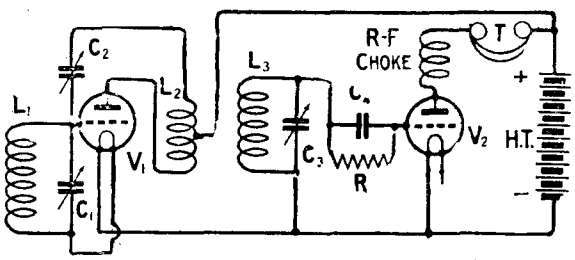


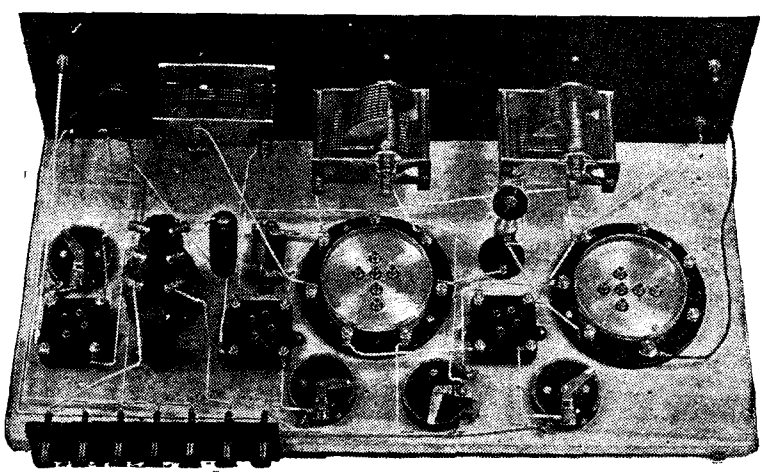
Fig. 4.—In a split primary transformer if the coupling between the windings is very close the primary becomes tuned.

Measured Capacities

The minimum coupling capacity in any transformer tested was 7·8 mmf, whilst the maximum was as high as 28·4 mmf. Both these transformers had split primary windings and a six-pin base. The capacity between a Dimic 1A and a standard No. 50 plug-in coil was found to be as low as 8·52 mmf; readers will remember that this combination was used successfully in the "Elstree Six." It was found that two plug-in coils tightly coupled together had a coupling capacity varying from 12 to 15 mmf, and the number of turns or layers on the coils had little effect.

One Method

One method of obtaining high inductive and low-capacity coupling in a transformer is to wind both the primary and secondary with a fine gauge of wire and space every turn, and on test this method has proved to be very efficient. Similar results can be obtained by winding the primary with a fine wire, and the secondary with a heavier gauge wire. The primary is placed in the middle of the secondary, so that the capacity coupling is equivalent to that obtained with two coils wound with fine wire.



In a receiver employing two or more H.F. stages the disposition of certain leads is of considerable importance.

THE "ELSTREE SIX"
READERS' RESULTS

SIR,—I may say that I am most delighted with the "Elstree Six," and, of course, it is far and away ahead of anything I have ever come across. I live about 4 miles from Manchester B.B.C. Station—as the crow flies—and I have never yet had a set which would successfully cut out Manchester and get 2LO. Several people have told me that they can do it with various sets, but I have never *heard* it done until I built the "Elstree Six."

At the present time I have lent this set to a Canadian friend of mine who is over here for some months and is actually living within 1½ miles of the B.B.C. Manchester Station, and, although he is in a very bad position, with trams passing the house, etc., he tells me that he can still cut out Manchester and receive London, and fresh stations come in with practically every movement of the dial, so, although I cannot give you the actual number received on the receiver, I may say that I should think that the set is fully up to the claims made in MODERN WIRELESS.

From all this you will gather that I am absolutely satisfied and could not wish for a better receiver. My friend who is using the set now has a first-rate Super-Het in Canada and he tells me that he considers the quality of reception with the "Elstree Six" is better and that the Super-Het is no better—if as good—as regards selectivity and sensitivity.—Yours truly,

G. T. M. BEVAN.

Northendon.

"Really Amazing."

SIR,—I have had my "Elstree Six" working for two months. The results are really amazing and it is quite a treat to be able to separate one station from another without any background whatever.

I have a four-valve set which I considered good, but always had that little background of Manchester when I tuned in 2LO.

With two ranges of coils, I have heard quite fifty stations on the loud-speaker with the "Elstree Six," and I have only a chance to listen in about 10 p.m. —Yours truly,

J. ROBBINS.

Salop.

NEWS FROM ADVERTISEMENTS

All our readers will have a particularly active interest in the advertisements appearing in this issue with the object of choosing apparatus not only to satisfy their own cherished requirements but also to purchase Christmas gifts for their friends.

IT will be noticed in the advertisement of Messrs. Bowyer-Lowe and Co., Ltd., that this company's products are guaranteed for a period of twelve months.

* * *

The fact that Cyldon condensers were used in the winning receivers in the set competitions at New York and Amsterdam is featured in the advertisement of Messrs. Sydney S. Bird and Sons.

* * *

An interesting and wide range of Radio components is included in the announcement of Messrs. The Rothermel Radio Corporation of Great Britain, Ltd.

* * *

Prominence is given by Messrs. Igranic Electric Co., Ltd., to their range of Gang condensers. Readers will recollect that this type of condenser is used in the "Puramusic," the "Monodial" and the "Solodyne" receiver.

A new type of fixed resistor is being advertised by Messrs. The Lifford Engineering Co. This is sold under the brand name of "The Microstat." It will be observed from this company's advertisement that this accessory is adjustable for any type of valve.

* * *

Messrs. British Electrical Sales Organisation, Ltd., are making a special Christmas appeal in connection with the "Beco" loudspeaker produced by them.

* * *

Messrs. The Automatic Coil Winding Co., Ltd., are offering "seven days' trial" of the Slektun Coil.

* * *

Messrs. Rexo Engineering Co. are announcing a special line in connecting wire. This product is of particular interest to readers who encounter difficulty with the soldering iron.

Ribbed low loss coil formers are shown in an announcement by Messrs. Redfern's Rubber Works, Ltd.

* * *

A new screened coil, to Radio Press specification, is announced by Messrs. J. R. Wireless, Ltd.

* * *

The Unimic coil is being featured in an announcement issued by Messrs. L. McMichael, Ltd.

* * *

"One hundred guineas for a name" is the attractive subject of Messrs. C. A. Vandervell and Co., Ltd.'s advertisement.

* * *

The new magnetic microphone bar amplifier is displayed by Messrs. Economic Electric, Ltd.

* * *

A complete kit for the "Monodial"—the successful "Wireless" receiver—is announced by Messrs. Will Day, Ltd.

* * *

In the series of advertisements issued by Messrs. S.T., Ltd., readers will find full details of the range of radio receiving valves being marketed by this company. It will also be seen that suitable valves are recommended for certain Radio Press Star receivers.

"Elstree Six" Results

"A Great Advance."

SIR,—The "Elstree Six" which I have just assembled is in my opinion a great advance on any set I have heard or assembled, and fully comes up to the accounts which you have published in your various periodicals. I have not had time to test it on all B.B.C. stations, and only a few foreign stations have been tried for; but so far as I have gone, no set that I have come across can compare with it. I live about 80 miles from 5XX and the volume on five valves is too great for a fair sized room unless you de-tune. No one who can use a soldering iron need hesitate to assemble the "Elstree Six," provided he follows the blue print and uses the parts as advised in MODERN WIRELESS. I can only say that I consider your several publications have placed a wonderful "possibility" in the hands of anyone who cares to take advantage of it, which I have done to the full, commencing with the first description of S.T. 100.—Yours truly,

CYRIL E. GREENALL.

Grantham.

"Marvellous Results."

SIR,—I have completed the "Elstree Six," and although I have not yet been able to try it under the *best* conditions, owing to a neighbouring tree practically touching my aerial, I feel I must tell you what truly marvellous results are obtained even under these very adverse circumstances.

The selectivity is wonderful and the tone on 2LO is as clear as any set I have heard (on the five valves).

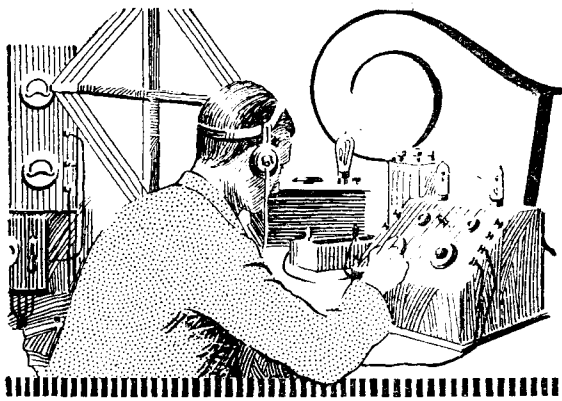
I have already picked up over twenty stations at full loud-speaker strength, and several others at good strength on the loud-speaker. Milan has come in at wonderful strength but with rather bad fading.

I have built several MODERN WIRELESS sets at various times, but must say this: the "Elstree Six" has given me the most pleasant surprise.

Wishing you every success and congratulations to the staff of MODERN WIRELESS.—Yours truly,

C. G. OSTLER.

Strood.



Tested by Ourselves

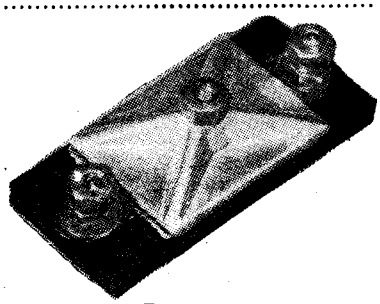
Fixed Condensers

MESSRS. The Penton Engineering Co., have sent us for test three of their Penton fixed condensers. The construction of these condensers is rather novel. The base of the component is stamped from bakelised fibre, four holes being provided for fixing. The elements of the condenser are arranged as usual by a number of foils insulated with mica, the whole being held firmly in position with a stamped metal frame through which passes a screw holding the condenser tightly together. Two terminals are supplied for connecting up.

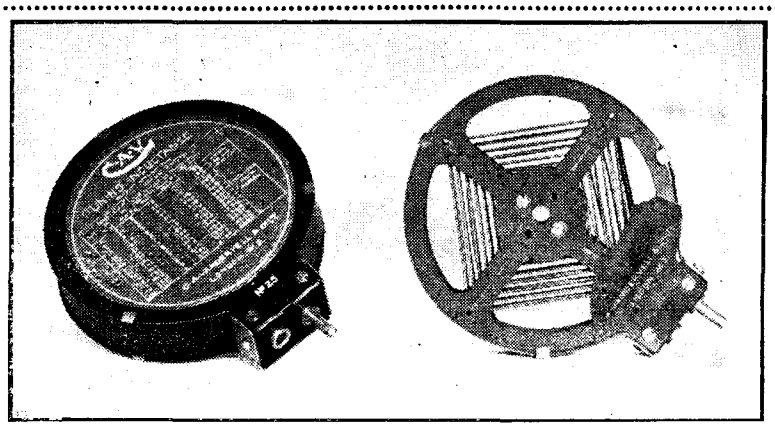
The use of fibre as a mounting does not appear to detract from the value of the condenser, and on test the insulation was found to be of a high order. The capacities of the condensers were found to be within reasonable limits of the values stated, and since the price is moderate these condensers will, no doubt, commend themselves to our readers.

High-frequency resistance tests showed that the coils were of a high order of efficiency, and this conclusion was borne out by practical trial in actual receivers. The whole coil is completely enclosed in a case of presspahn or similar material, which protects the windings from damage, and the constants of the various coils are marked on this outside covering, which serves as a very useful reference table.

We can recommend these coils to our readers.



The Penton fixed condenser.



C.A.V. plug-in coils are wound with bare wire on a species of X former.

C.A.V. Coils

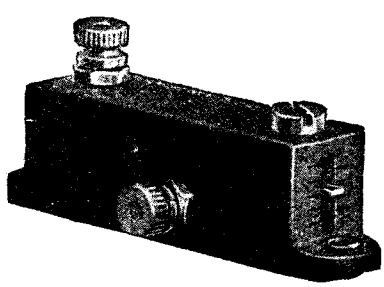
WE have received from Messrs. C. A. Vandervell and Co. a set of C.A.V. plug-in coils for test. These coils are wound on a species of X former with bare copper wire, the former being suitably slotted so that the windings are air spaced. This type of construction goes a good way towards the elimination of dielectric losses, and the result, as reflected in the efficiency of the coil, is certainly satisfactory.

Bremer Tully Mikro-Mikes

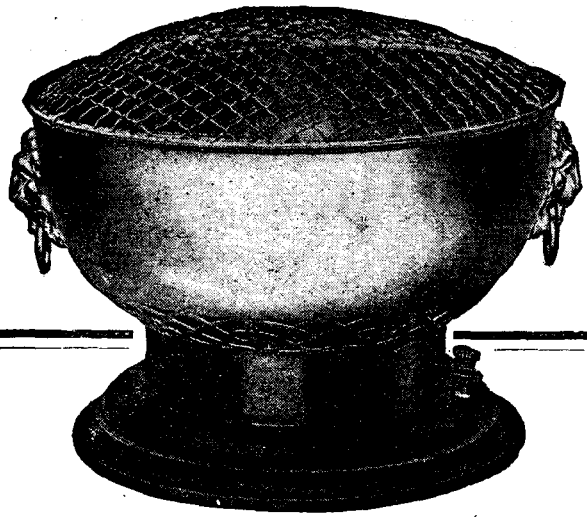
WE have received for test from Messrs. R. A. Rothermel one of their Mikro-Mike condensers. As the name suggests, these are micro-capacity condensers for balancing neutrodyne circuits.

The condenser is enclosed in a narrow oblong moulded box fitted with two terminals, one on top, and one at the side of the unit. Adjustment is made by means of a screw which as it is rotated moves or withdraws a small vane to and from another metal plate. The unit may be secured to the baseboard through two metal-eyeletted holes fitted into lugs at each end of the condenser. The use of the metal eyelets prevents the moulding breaking away, which sometimes occurs when too much pressure is applied to this type of moulding.

Tested in a split-primary type of neutrodyne receiver, the condenser was found to function very satisfactorily, the balancing being easily accomplished, and the adjustment being very firm. The nominal capacity of the condenser



The Bremer Tully Mikro-Mike neutralising condenser.



An Ideal Xmas Present

Whether for yourself—or for a friend or relation—the "Beco" Rose Bowl Hornless Loud Speaker makes an ideal present. Of really beautiful appearance, it combines a useful and attractive flower bowl with a perfect loudspeaker. Music, song and speech are rendered faithfully, with a pure, clear tone—and if required—sufficient volume for dancing. Moreover, whether the bowl is empty—or filled with water and flowers, the splendid tone is just the same. Obtainable in three varieties as follows :

Nickel Plate, -	£5 5 0
Oxydised Silver,	£5 17 6
Antique Brass,	£5 17 6

"BECO"

Hornless Loud Speakers
make listening a pleasure

Other "Beco" Models available from 52/6.

Ask your dealer to demonstrate.

If your dealer cannot supply, write to Dept. M.W.

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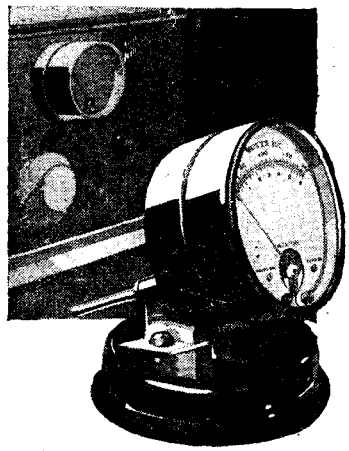
623, Australia House, Strand, London, W.C. 2.
Telephone: City 7665. Telegrams: "Becospeker, Estrand, London."



Refinement

It is the small defect that often mars your radio reproduction. Not enough pressure on the anode, or perhaps too heavy a grid bias will completely spoil an evening's programme. Check these little inaccuracies with a reliable High Resistance measuring instrument—in other words check them with a Weston Voltmeter.

Weston Model 506 Pin Jack Voltmeter is designed specially to measure accurately both filament and plate voltage. It is another of the wide range of Weston products which are recognised as standard throughout the world, and it reveals the same excellence of design and workmanship for which the name Weston has been famous since 1888.

Either this Model, or for those who prefer it, the Weston Panel mounting Voltmeter will do much to ensure that perfection of reproduction which is only possible when a careful adjustment is made of the filament and anode voltage.

Refinement in such details leads to refinement in results, and economy in operation — which in turn means extra life to your Valves and Batteries.

WESTON Pin Jack Voltmeter

Price complete with testing cables

£2 : 10 : 0

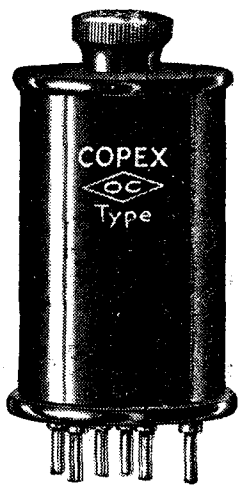
WESTON
STANDARD THE WORLD OVER
Pioneers since 1888

Weston Electrical Instrument Co. Ltd.
15, Gt. Saffron Hill,
London. E.C. 1

TESTED BY OURSELVES—*(Contd.)*

is from 2 to 30 micro-micro-farads, and on test this was found to be the case.

We can recommend this component for use in a set such as the type indicated, and specially in cases where very little baseboard room is available.



The Peto-Scott 'O.C.' coil is designed to reduce capacity coupling between the primary and secondary windings.

"O.C." Transformer

WE have received from Messrs. Peto-Scott, Ltd., an improved type of high-frequency transformer suitable for use with the standard six-pin base. It may be used either in the standard screening unit, or on a six-pin base without the screens.

One of the difficulties with certain types of balanced neutralised circuits is that the neutralising point is inclined to be very critical. In certain cases it is possible to obtain circuits which will proceed to oscillate in another mode of oscillation before they have been correctly neutralised, so that the circuits cannot be adequately stabilised.

A large percentage of this effect is due to capacity coupling existing between the primary and secondary of the transformer, and in order to overcome this Messrs. Peto-Scott have adopted a special form of construction which minimises the capacity coupling, while still retaining a high degree of magnetic coupling.

On test we certainly found that the circuit remained stable over a wider band of the neutralising condenser, and that certain circuits which could not be stabilised at all under normal circumstances were quite under control when this new type of transformer was utilised.

When tested on the "Solodyne" and the "Mewflex" receivers the stabilising was found to be considerably simplified and the overall amplification was somewhat increased.

The tuning properties of the circuits remain unimpaired and the coils are interchangeable with the normal types of H.F. transformer.

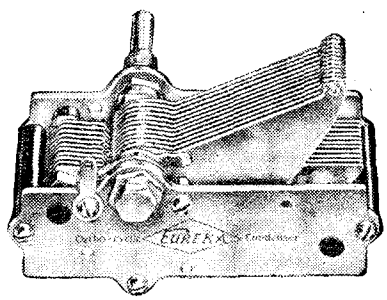
We can recommend this interesting unit to our readers.

"Eureka" S.L.F. Condenser

MESSRS. Portable Utilities Co., Ltd., are the manufacturers of a variable condenser of straight-line frequency type, a sample of which we have received for testing purposes.

This component is one of the most compact instruments of this kind we have yet seen. It is of the grounded rotor type, and in addition to a well-fitting journal for the main bearing, the spindle is provided with a ball race. The far end of the spindle has a large single steel ball bearing, arrangements being provided by means of which this may be adjusted. The stator plates are insulated from the end plates by spacers which appear to be of ebonite, while connections are made to the rotor by means of a braided copper pigtail.

Constructed almost entirely of aluminium, this condenser is extremely light in weight, while either three-point suspension or one-hole fixing may be used as required.



The straight-line-frequency condenser of Messrs. Portable Utilities Co., Ltd.

Rated at ·0005 the actual capacity of this condenser was found to

TESTED BY OURSELVES
(Continued)

be ·00052 while its minimum value was ·000021.

This instrument certainly bears out the maker's claims for a low-loss instrument, while its construction and finish are exceedingly good.

L.T. Accumulator

WE have received from Messrs. C. A. Vandervell and Co. a glass accumulator for low-tension supply, in which the several

The C.A.V. accumulator is enclosed in a stout glass container.

cells are enclosed in glass jars instead of celluloid containers. It is claimed that this construction eliminates any tendency to frothing, reduces surface leakage, and in general gives a more robust construction.

The actual unit comprises three such cells having a capacity of 40 ampere hours actual, mounted in a wooden carrying crate, the individual cells being separated by rubber buffers. A particular feature of the construction of the cells themselves is that no separators are used in the make-up, the plates being kept apart by glass fins moulded on to the side of the containing jar itself. This not only gives a very low internal resistance but considerably minimises the

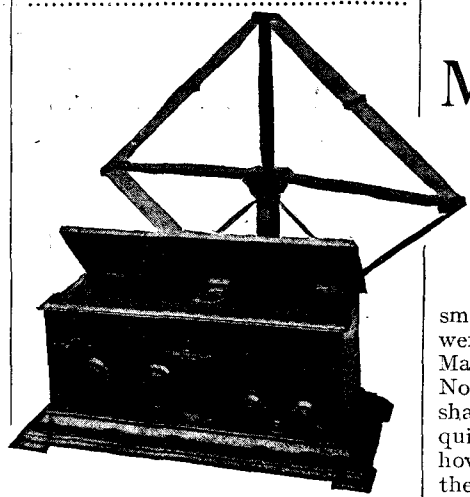
TESTED BY OURSELVES—(Concluded)

risk of internal short and tendency to sulphation. It is claimed therefore that the cell can be roughly treated, and considerably mishandled without serious detriment.

The battery was charged and allowed to stand for six weeks. It was then used intermittently for about 2 hours per week, taking 2 to 3 amperes discharge. The treatment was continued for several weeks, after which a steady discharge of 4 amperes was taken from the battery until it was discharged, the voltage of each cell reading 1.8.

The battery was then allowed to stand in this discharged condition for over a month, but during the whole of this period no sign of sulphation was visible. The battery was subsequently charged up and discharged again when it gave its full capacity.

It will be obvious that this treatment is very nearly the last word in misuse, yet the battery stood up extremely well, and is still giving excellent service. It is naturally a little heavier than the ordinary type of accumulator, but it would appear that this disadvantage is more than offset by the increased robustness which is obtained by this construction.



The Liberty superheterodyne receiver is manufactured by Messrs. Radi-Arc Electrical Co., Ltd.

We can confidently recommend this battery to our readers.

Supersonic Units

MESSRS. Radi-Arc Electrical Co., Ltd., have sent us one of their "Liberty" supersonic kits for test and report.

With the kit wired up, using ·06 valves for the first six valves and power valves for the last two, excellent loud-speaker reception on a number of stations was obtained in daylight on a small frame aerial. Among these were Birmingham, Bournemouth, Manchester, London, Cardiff and Nottingham. Although tuning was sharp, Cardiff was not obtained quite clear of London. Manchester, however, was entirely free, while the signal strength obtained under daylight conditions was in every way up to normal.

The results obtained indicate that the supersonic kits produced by Messrs. The Radi-Arc Electrical Co., Ltd., give satisfactory results, and can be recommended.

IN PASSING

(*Concluded from page 635*).

Our repast being over, the Professor informed us that he would without delay unfold the surprise which he had in store. He whispered to a waiter who, opening the door, ushered in young Edward Bugsnip and another lad of the village bearing between them a vast packing case. From this they produced under Professor Goop's directions two large wireless sets, a receiver and a transmitter.

The Surprise

"My friends," remarked the Professor, beaming on the members of the club, "we have heard a great deal lately about attempts to communicate with Mars. This problem I am glad to say, I have now solved and I propose to-night to let you hear a message from our fellow wanderer in space. Curiously enough the Martians speak English though their voices are somewhat hoarse and rasping. Now if you will kindly listen for a little time I am sure we shall hear something."

We sat round all agog with expectation. For quite a while nothing at all happened, then suddenly a queer harsh voice which sounded as if its owner was suffering from atmospherics in the vocal chords called: "Hullo! Hullo! Is that Jupiter?" "No, no," cried the Professor into his microphone. "This is the Earth."

"Sorry you have been trrrroubled; ring off, please," grated the voice, and not another sound could we get for an hour or so, when in response to the Professor's frantic appeals for Mars the voice ground out "Number engaged." Most unfortunate, was it not?

THE LISTENER-IN.

WHAT ARE THE LIMITS OF H.F. AMPLIFICATION?

(Concluded from page 655)

least three tuned circuits in a receiver which is to incorporate selectivity with good quality of reproduction. A high degree of selectivity cannot otherwise be obtained without cutting off some of the sidebands. This problem has been discussed in detail in previous articles, and the general requirements in this direction are now fairly well known.

It is the tuning circuits themselves which are principally responsible for the cost of high-frequency amplification, but with a good modern design it is possible to obtain excellent results under all average conditions with only three tuned circuits. Special selectivity demands the addition of a further tuned stage which may either be in the form of another tuned circuit or a wave-trap to eliminate the local station.

Four Tuned Circuits

As in many cases this special selectivity is desirable, the use of three stages of high-frequency amplification, incorporating four tuned circuits, has become fairly common, but the high cost of such an arrangement puts such receivers out of reach of many enthusiasts.

Future developments will, no doubt, be in the direction of increasing the efficiency of the high-frequency side of the receiver, so that we can obtain very much increased selectivity, possibly together with greater over-all amplification, with only three tuned circuits.

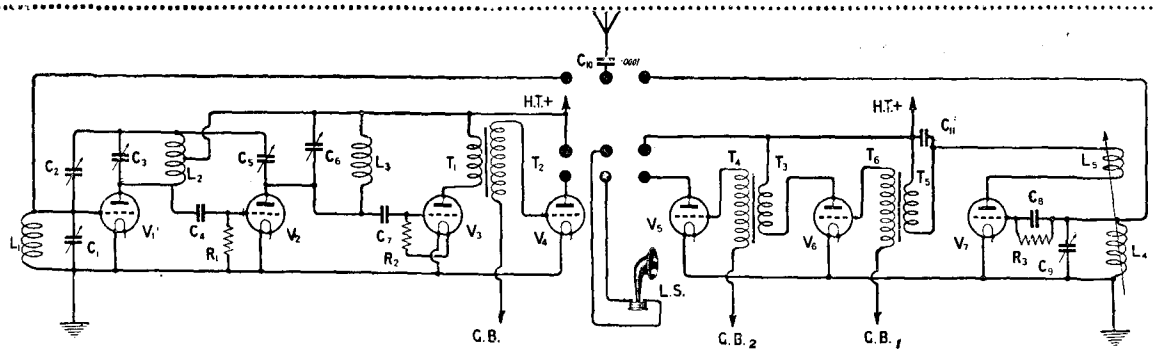
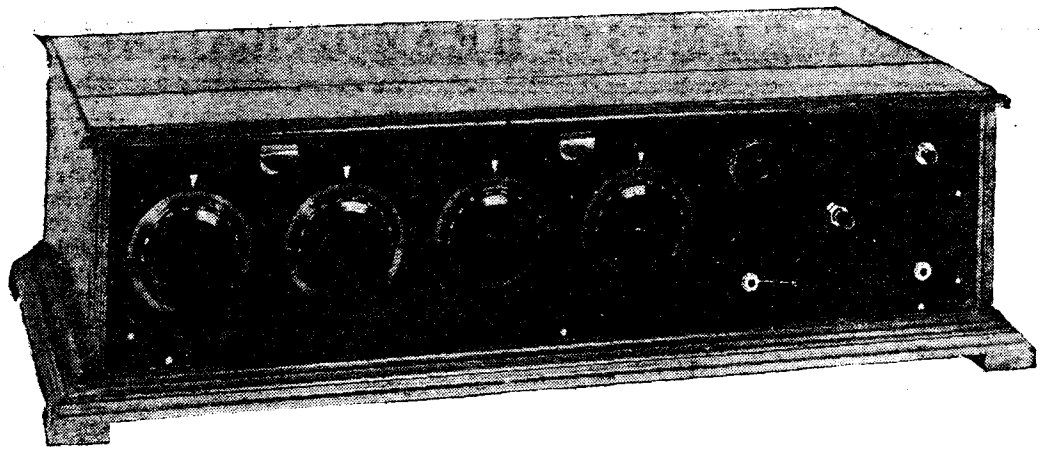


Fig. 3.—How two separate receiving circuits were connected up in order to carry out certain experiments. That on the left incorporates two H.F. stages and that on the right a detector and two L.F. valves.



THE "ALL-BRITISH SIX"

European Championship Set described in the issue now on sale

THE "ALL-BRITISH SIX" was entered for competition in the Multi-Valve Class of the International Amateur Set Building Contest at the Radio World's Fair in New York, and was awarded the Third Prize in this Open Competition.

A receiver, to compete successfully in America, needs selectivity of a very high order. Around New York, for example, there are over 65 Broadcasting Stations in operation.

The "All-British Six" uses the circuit of the famous "Elstree Six," modified to allow of the use of screened H.F. Transformers. This modification was made necessary by the extreme selectivity required.

Mr. H. E. Hassall, one of our readers, who constructed and entered the "All-British Six" for the New York Competition, describes in his own words the design and construction of the Set. Full details are given and the usual blueprints may be obtained, so that readers may make up similar sets, and realise from their own experience the high performance of which the "All-British Six" is capable.

BUY YOUR COPY TO-DAY

BESIDE THE FULL DESCRIPTION OF THE "ALL-BRITISH SIX," THIS ISSUE ALSO INCLUDES:

Music Via the Ether
By JACK HYLTON.

Making Use of Your Supply Mains
By J. H. REYNER, B.Sc. (Hons.), A.M.I.E.E.

Choice of Programmes Made Easy
By STANLEY G. RATTEE, M.I.R.E.

Getting the Best from the "Spanspace Three"
By G. P. KENDALL, B.Sc.

A "Throttle - Controlled" Single-Valve Set
By L. H. THOMAS.

Improving Your Short-Wave Set
By A. V. D. HORT, B.A.

How Wireless Components Are Made
By CAPT. JACK FROST, M.I.R.E.

Watch Your Batteries!
By A. S. CLARK.

Do We Need Reaction?
By D. J. S. HARTT, B.Sc.

The Wireless Constructor

SIXPENCE MONTHLY

December Issue now on Sale

From all Newsagents, Bookstalls and Booksellers, or direct from the Publishers, Radio Press, Ltd., Bush House, Strand, London, W.C.2. Subscription Rates, **8/6** per annum United Kingdom, **7/6** per annum Canada and Newfoundland, and Other Countries **8/6** per annum. *Lesser periods pro rata.*

A CRYSTAL USER BUYS A VALVE—

(Concluded from page 682.)

at about the 8th turn, and the lead from the reaction condenser being connected at about the 16th turn. Since these connections were made with clips it was, of course, possible to alter them if required. The less the number of turns between the aerial lead and the earth connection on the coil, the greater, of course, the selectivity of the set, though as would be expected, a slight drop in signal strength was experienced. It was found, however, that quite tight coupling could be used without any trouble being experienced from lost selectivity.

Ferris has now had the set for a month and to say that he is delighted with it is putting it mildly. Not only does he find that variations in signal strength do not affect him so much as they used to with the crystal receiver, but the actual transmission from the local station is ever so much louder and clearer, not only enabling news items to be followed more easily, but giving him far more enjoyment from the musical part of the programmes.

Although he has had but little experience in the handling of wireless receivers, he has already got the hang of this one extraordinarily well, and I heard from him a few days ago saying that he had already received a number of distant stations.

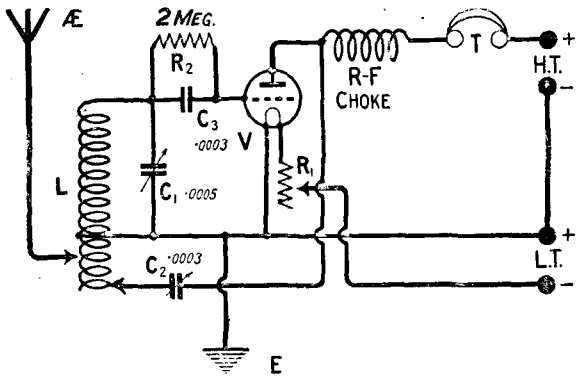


Fig. 6.—A valve used as a detector with reaction has much to commend it. This diagram shows a popular form of Reinartz circuit.

In the next issue of MODERN WIRELESS we hope to publish a complete list of dial settings for the "Elstree Six" and "Solodyne" receivers, giving the new readings for the British and Continental stations. These could not be included in the December number owing to the fact that the wavelength changes only came into force a short time before this issue closed for press.

The "PURAMUSIC"

(*Continued from page 633.*)

neutralising condenser which is mounted on the panel may be used as a reaction control for finding other transmissions by over-neutralising, *i.e.*, increasing its value well beyond the neutralisation position.

Now tune across the station and watch the milliammeter as you do so. If you are close to the local station so that the transmission comes in strongly, it will be found that as the station is tuned in the plate current will drop and drop till it reaches a small value at which the sound heard in the loud-speaker is extremely weak and distorted. It is therefore necessary to increase the negative bias on the grid of the detector valve till the L.F. high-tension current once more rises to normal.

Final Adjustment

All these adjustments should, of course, be made with the tone control resistance at its highest value. If, however, you find that you cannot quite bring the plate current back to normal when the station is fully tuned in, on account of its great strength, then the value of the volume control resistance should slowly be decreased till the desired condition is arrived at.

A Peculiarity

I would like to point out that a property of this circuit is that it will not work when overloaded. If the applied signal has too great a swing it will not just come through with slight distortion as frequently happens in conventional circuits, but it would become badly distorted; for the straight line part of the L.F. valve characteristic which is being worked on has definite limits at both top and bottom. This is a peculiarity of the circuit, and the only thing to do is to increase the value of H.T. on the detector and L.F. valves and increase the value of the grid battery $G.B_1$ and the coupling battery B_3, or else decrease the signal strength by means of R_7. It will be found that the total volume will remain constant up to a given point, but the distortion will gradually get less till a certain point is reached at which all distortion goes and the signal then gets weaker.

Distant Transmissions

Once the correct adjustment has been found for the local station

THE "PURAMUSIC"
(Concluded)

it should be noted, for unless the receiver is used at a fair distance from this station the setting for distant transmissions (should it be desired to listen to them) will be different, it will in fact be the same as the first adjustment made before the local was tuned in, *i.e.*, the setting at which a movement either way of the potentiometer slider produced a slight scraping sound.

After the correct setting for the local transmission has been arrived at the loud-speaker plug should be transferred to the second jack and the grid bias adjusted till the best quality is obtained. At the same time the milliammeter needle should be watched and it should remain fairly steady, though a slight downward kick may be noted on very strong or high notes.

Not Critical

As regards the correct valves to use in this set I have found that the receiver is by no means critical. High impedance, high-amplification valves such as the S.T. 61, Mullard D.F.A.4 and equivalent types are to be recommended for the H.F., though general purpose valves have been used with satisfactory results; for the detector a valve having a fairly low impedance, for instance the S.T. 62, D.E.5 or similar valves (in the neighbourhood of 7,000 or 8,000 ohms) is to be preferred, while the last two valves may both be small power valves of the quarter-ampere type.

If a valve of the resistance capacity type is used for the first L.F. (this being choke-coupled to the next valve) greater amplification is obtainable from the L.F. side, but the adjustment becomes rather more critical. It has the advantage, however, that about a 9 volt battery is then sufficient for B_3, at the same time its higher impedance relative to the choke results in the output being higher pitched.

If the receiver is to be used very close to a broadcasting station then a special valve in the last stage is to be advised; valves such as the D.E. 5A and Mullard D.P. 425 or 625, the S.T. 43 or 63, Cosmos S.P. 55R, or Burndept L.L. 525 will be found suitable.

With valves of this description it will be found advisable to use up to 18 or 20 volts negative bias.

INDEX TO ADVERTISERS