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A TWO-VALVE SET. By E. J. Marriott.
A TWO-VALVE POWER AMPLIFIER. By C. P. Allinson.
A SINGLE-VALVE SHORT WAVE SET. By D. J. S. Hartt, B.Sc.
A CRYSTAL RECEIVER. By A. Johnson-Randall.
A NOVEL METHOD OF SMOOTHING D.C. RIPPLES. By Major James Robinson, D.Sc., Ph.D., F.Inst.P.
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November, 1925

NOW that the winter is upon us the wireless enthusiast is commencing operations in earnest. Reception conditions are improving noticeably week by week, and in view of the developments which have been made during the past summer, we may look forward to a very interesting winter of experimenting.

Tendencies this Winter

Major Robinson outlined the tendencies in radio design in our September issue. There can be little doubt that this winter is going to be a selectivity winter. Super heterodynies will be experimented with to a considerable extent, but more straightforward types of circuits will not be neglected. The problem of short-wave reception must not be lost sight of, and, as is outlined in this issue, there is some very interesting matter to be received at these high frequencies. We wish our readers all success this winter, and they can rest assured that we shall keep them well posted with the latest details.

Features in This Issue

We have this month an attractive list of sets. Mr. Harris describes "The Special Five," which is to a large extent the outcome of his recent experiences in America. The circuit is remarkably selective, but goes one better than the average American set in that the low-frequency side is markedly superior, a very good quality of reproduction being maintained.

A somewhat different set is the Anode Input Reflex Set by Mr. Reyner. This set has been designed for those who want a simple loud-speaker set with a minimum of adjustment. There is only one tuning control and a very smooth reaction adjustment. It is primarily a set for the local station, but has given satisfactory reception on quite a number of the more distant stations.

For the benefit of those who prefer to use plug-in coils throughout their receiver, Mr. Marriott has designed a Two-valve Neutrodyne receiver. This set employs two plug-in coils for the neutrodyne stage, the coupling between the two being variable to obtain the maximum flexibility.

For the Short-Wave Enthusiast

A simple short-wave receiver is described by Mr. Hartt, and this, in conjunction with an article by Mr. Hort on "What to Listen for on Short Waves," will be of particular interest to those who have not yet explored this region of the ether. For the coast dweller or those who experience interference, Mr. Johnson Randall has designed a two-circuit crystal set. This circuit employs a tuned aerial loosely coupled to a tuned low-loss secondary and is capable of giving very selective results. The tuning of the set is not unduly complicated, and this set will no doubt prove of use to those who are troubled by jamming.

A Power Amplifier

Many people think that a power amplifier is a difficult and costly piece of apparatus to construct. This, however, is not the case, and a particularly successful two-valve power amplifier has been designed and described by Mr. Allinson. This instrument gives excellent strength and quality. In fact, used with a crystal set within ten or twelve miles of the local station, the results are quite uncomfortably loud.

Articles

There is the usual quota of interesting articles. Major Robinson gives details of a novel arrangement for obtaining high-tension supply from D.C. mains without the use of the usual chokes and condensers for smoothing purposes. Capt. Crowther gives some useful advice on the choice of a valve for a particular purpose.

Those readers who have experienced difficulty in obtaining smooth control of reaction will find some interesting remarks in an article on Reaction Control Circuits, wherein the conditions for smooth reaction are laid down and a large number of suitable forms of circuit are given.

Other articles of interest follow, including several novel features.

Finally, we would particularly refer our readers to an article by Mr. Kendall, on the subject of the so-called "Aperiodic Aerial." Mr. Kendall shows that the aerial circuit in such cases is really tuned, but that the resonance curve is so broad that one coil serves to cover a wide band of frequencies.

123
If I were asked what qualities the average experimenter desired most of all in his receivers, I should have no hesitation in answering selectivity and range. After the first novelty of receiving any wireless at all has worn off, the desire to reach out into space in search of distant stations grows apace; but however sensitive the set may be, if it is not selective, the local station will make itself heard over a wide leading place, and our detector circuits are at least as good as anybody else's. Improvements in selectivity and sensitivity, as I have pointed out in previous articles, are largely dependent upon the development of the high frequency amplifying side of our apparatus, and since returning from the United States, I have devoted a good deal of thought and experiment to this question.

Good Quality
Third in the list of desirable characteristics I would place quality. Increasing attention is being paid to this desirable feature of receiving sets, particularly as the broadcast programmes themselves are particularly well transmitted in this country. In audio-frequency amplifiers, and in loudspeakers to work with them, Great Britain unquestionably has the tuning range, completely swamping the distant stations.

Sensitivity
The receiver described this month will, I hope, appeal to those home constructors who are in search of the desirable characteristics referred to above. It is by far the most selective receiver I have yet designed; its sensitivity is of a very high order (at Wimble don I have received Birmingham at medium loud-speaker strength, without any aerial, but just the earth lead alone); it is economical to run, using a total filament current of 1½ amperes, with the valves for which it is mainly intended, and considerably less if the -06 type of valve is used; the quality of reproduction and silence of background are both remarkable, and finally, although it is large, the wiring and general construction are both very simple.

Special H.F. Transformers
The theoretical circuit which is given in Fig. 1 has several points of interest to the home builder.
high frequency transformers used are of a design manufactured by Messrs. Peto Scott Co., Ltd., modified according to some suggestions I made to the firm. They are interchangeable, so that widely different wavelength ranges can be covered, and embody several of the points mentioned in my last month's article on "High Frequency Transformer Design."

The tuning of this set is so exceedingly sharp that at first the reader may have difficulty in picking up stations. To simplify pick-up I have designed a special aerial tuning coil arrangement which, as a matter of fact, can be very simply adapted to other receivers.

Aerial Coupling Arrangements

From some points of view it would have been preferable to use a single layer solenoid coil in the first grid circuit, but in view of the many interesting combinations possible with plug-in coils of efficient design (by the way, plug-in coils vary widely in efficiency), and as, moreover, we want to be able to cover very wide bands of wavelengths when listening to broadcasting in Europe, I have thought it advisable to introduce the arrangement to be described.

Two Coil Socket

It consists of two board-mounting sockets for plug-in coils, placed side by side, and slightly separated. The type of board-mounting socket in which the connections are made by screwed terminals has been chosen for reasons which will be obvious on examining the receiver. On one side, the two sockets are bridged by a wire, and on the other side the left-hand terminal is left free, while the right bridging link on the other side of the two sockets. If now the flexible lead is connected to terminal No. 2, and a suitable coil plugged in to the right-hand socket, we have direct coupling of the aerial to the grid circuit. This gives fairly flat tuning, and is useful when picking up a distant station, to enable you to tune in the high frequency stages. When the other tuning has been adjusted for the best results, the flexible lead can be removed from terminal 2, and the plug-in coil changed for, say, a Lissen X coil, while the flexible lead is connected to one of the tappings on the X coil. In passing I should mention that it is essential to follow the exact arrangements shown in my drawing, as far as the position of the pin and the socket are concerned, for unless this is done, the tapping on the X coil will not come in the right position.

Increasing Selectivity

This arrangement will give higher selectivity, but should it not prove sufficiently high, the flexible lead should be removed from the X coil tapping and inserted in terminal I, the X coil being left in the right-hand socket. Now in the left-hand socket plug a small coil, such as a 25 or 35, whereby you will obtain semi-aperiodic aerial tuning, with still higher selectivity. The selectivity will increase with the reduction in size of the coil in the left-hand socket.

A closer view of one of the new high-frequency transformers used in this receiver.
The tuning position of the first condenser will remain almost the same with any change in coil in the left-hand socket, provided that the left-hand coil is not too large. Gambrell coils also serve admirably for this form of coupling.

In examining the theoretical diagram it will be noted that there are but three filament resistances. I am all in favour of simplification of wireless receiver control; and as it is highly desirable to use the same type of valve in the first two sockets, I have arranged for one filament resistance to control these two valves. The detector valve has its own filament resistance, and one filament resistance is used to control the two note-magnifying valves.

Suitable Valves

My favourite valve for this type of receiver is the kind using about ½ ampere, sometimes referred to as a small power valve. Valves of this type are made by a number of manufacturers. The first note magnifier valve should preferably be of the type designed for resistance capacity amplification. If ½ ampere valves such as the D.E.5 are used in sockets 1, 2, 3 and 5, and if for the first L.F. stage a valve D.E.5 B. or equivalent is used, the total filament current will be only 1½ amperes.

If it is essential to use the 0.6 ampere type of valve, then the first note magnifier valve should be of the kind used for resistance capacity amplification, such as the D.E.3 B. or other makers' equivalent. As a matter of fact the set will work quite well with any good valve, but if you wish to use bright emitters throughout, use separate filament resistances for each valve, as it is not desirable to pass the current for two bright emitters through one filament resistance.

Notice, too, that in this receiver filament resistances are all in the positive L.T. Leads. In conformity with modern tendencies in design, all terminals are placed behind the instrument, and I have used but one jack to enable telephones to be plugged-in after the detector valve. In case some readers may wonder why I have not included three jacks to enable telephones to be plugged-in after the detector, the first note magnifier or the second note magnifier, I should explain that many months’ experience with a receiver made up in this way has shown me that ability to plug-in after the first note magnifying valve is not required in practice, and that one invariably uses the loud-speaker when all five valves are in operation. My general rule is, when using the telephones, to plug-in after the detector and loud-speaker on the final valve.

Grid Bias Terminals

There are just two further points in the design to which I would like to refer before passing to con-
November, 1925

MODERN WIRELESS

constructional details. One is that I have not used a common positive terminal, for the two grid bias arrangements. I have found in practice that quite frequently one uses separate grid bias batteries for the two last valves and indeed theoretically there are reasons for one doing so. It is always finnicky to place two different wires on the one terminal, and I think it will be found generally desirable to use four terminals instead of three, when grid bias is applied to two separate valves. Even if one grid bias battery is used, there is no difficulty, since both positive terminals are linked inside the instrument, so that either one can be the common terminal.

Separate Tuning Condensers

The final point refers to the question of the tuning controls. In many of my designs I have used a double condenser, requiring matched transformers. Some manufacturers of high frequency transformers have been very successful in their matching, as have some makers of variable condensers. But in many cases trouble has arisen through bad matching. We have by no means reached finality in high frequency transformer design, in view of which I have designed the present receiver, so that once it is made all kinds of high frequency transformers can be experimented with. For this reason separate condensers are used for each of the high frequency stages. There is then no possibility of trouble in regard to matching, and a wider flexibility is obtained.

Constructional Work

The wiring of the instrument is very simple, and is probably easier than that of any receiver I have previously described. The following components are needed:

One Panel, measuring 36 in. by 9 in. by ½ in. (this should be of first-class guaranteed ebonite of any of the reputable makes).

One Cabinet to suit (this is the same cabinet as used in the Anglo-American Six).

One Baseboard for same (this is usually supplied with the cabinet).

Two Board - mounting Coil Sockets, with side terminals (Peto Scott Co., Ltd.).

Three Square Law Variable Condensers, each of .0001 μF capacity (Bowyer-Lowe Co., Ltd.).

Three Filament Resistances to suit valves. For the ½ ampere type of valve these can all be 5 ohms (Polar).

One Double circuit Jack with Plug (G.R.C. or equivalent make).
One On and Off Switch (R. A. Rothermel Ltd.).
Two Neutralising Condensers (Polar Micrometer).
Five Board-mounting Valve Sockets (Antipong—Bowyer-Lowe Co., Ltd.).
Two Special High Frequency Transformers with tapped primaries (Peto Scott Co., Ltd.) (these are supplied with the board-mounting sockets).

One Ordinary Board-mounting Valve Socket (this is used as a simple means of connecting the high tension leads to the transformers. It is not used to hold a valve).
One Grid Leak and Condenser combination .0003 µF and 2 megohms (L. McMichael, Ltd.).
One L.F. Transformer (any good make will do. I have used the new pattern G.R.C., with considerable satisfaction here).
One 100,000 ohms Wire Wound Anode Resistance (Mullard Radio Valve Co., Ltd.)
One Fixed Condenser .0003 µF (Dubilier).
One Fixed Condenser .01 µF (Dubilier).
One Grid Leak with mounting, 1/2 megohm (L. McMichael, Ltd.).
Two Terminal Strips (one carrying aerial and earth terminals and the other the remaining terminals as shown (Magnum), (Burne Jones & Co., Ltd.).
Glazite Wire, for wiring up (about 20 feet will be ample)
Radio Press Panel Transfers.

Valves and Batteries
Notes on valves have been given at the beginning of the article. If dry batteries are used for high tension supply, it is suggested that one 60-volt unit with tappings be used for the first three valves, and a second battery up to 120-volts for the last two valves. If two such batteries are used, the negatives should be joined together and a wire taken to the H.T. negative terminal. High tension accumulators will give better results, in which case one high tension accumulator up to 120-volts can be used. In any case, whether high tension accumulators or dry batteries are used, a 1 µF or 2 µF condenser should be shunted across each tapping. I have not included these in the instrument as I consider fixed condensers as part of the high tension battery equipment.

The wiring is so straightforward that it needs no explanation other than that given in the drawings. Notice that three of the sockets of the valve holder used as distributor of the H.T. for the high frequency transformers are joined together. Flexible leads for the transformers are made to terminate with valve legs or other suitable plugs, and will then slip easily into the sockets. This facilitates change of transformers, when desired.

Operating Notes
The operation of this receiver will be learned very rapidly. The best way to start is to plug-in, say, a 60 or 75 coil (a 60 is advised, as this matches in inductance the high frequency transformers used). Disconnect aerial and earth and set all three condensers approximately at the same figure, say 20 degrees. If one of these condensers is swung backwards and forwards, it will be found that the set is oscillating. The two neutralising condensers should then be adjusted very carefully until the swinging of any of the condensers will not cause oscillation on the set. You will soon find how to do this.

Once this position has been found, the condenser can be locked by the ring provided, and the aerial and earth connected with one of the connections indicated in the beginning of the article. Stations will then be picked up with the greatest ease by rotating the three dials.

Since the above instrument was built, Messrs. Peto-Scott have brought out the special H.F. transformers can readily be seen in this view. When the set was first constructed different neutralising condensers were used. They have since been changed to Polar micrometers to avoid short-circuiting, and to give a higher capacity range.

Fig. 4.—Illustrating the aerial coupling arrangements.

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Fig. 4.—Illustrating the aerial coupling arrangements.
A Problem

"What is worrying me," I remarked, "is whether switches are permissible and if so, which switches?"

"Eh?" said the Professor, looking up quite startled from his work. "My dear Listener, that sibilant sentence sounds like a spluttering soda siphon."

"Same to you and many of them," quoth I, at which the good man smiled, realising with some surprise that he himself was suffering similarly.

"No, this is terrible; this shushing business grows on one, and if I do not bring myself up short I shall run the compositor out of s's before he has got through more than the first paragraph. If that happened I suppose he would use f's, pretending that they were old fashioned long s's and then we should

find the whole thing filled with fuch fentencef of "Fhould we ufe fwitchef?" or "Fwitchef are dif- 

fictinctly liable to become an obfef- 
fion." That of course would never 

whilst I fling ink over my left shoulder.

do, for probably you, reader, 

would get the habit, and instead of 

shushing you would go fuffing 

about all over the place.

Suppose One Lisped

Possibly if you happened to have 
a lisp you would find things still 
worse, for you might be called upon 

nethethary." Thtill I det hire. . . 

Excufe me . . . Oh well, hang it, 

forgive me—that's a word you 
can't mess about anyhow. One 
moment please whilst I fling ink 
from my fountain pen over my 
left shoulder, turn the table 
round three times, and do the other 
things which ward off evil in-

fluences. What I am trying to 
say, if only I can manage to get it 
said without slipping into f's or 
th's, is that I want to tell you all 
about Professor Goop's opinion 
of switches and in doing so I will 
endeavour neither to shush nor to fuff nor to thuth more than I can help.

Switches

I think that at this point we 
had better have a fresh paragraph 
so that we may get a really fair 
start. It took the Professor and 
myself quite a little while to get

Fig. 1.—The thorough use of switches as suggested by Professor Goop.
Indispensable to the bobbed and shingled.

A variety of purposes. Without them, properly applied, the young idea could never be taught to shoot as it should; without switches, shunting upon railway lines would become an impossibility and much unemployment would be caused; without switches the bobbed and the shingled would be unable to grow at a moment's notice long tresses should occasion demand it.

Switching and Pulling

The switch then is not to be condemned in any sweeping fashion. In the wireless set the thorough use of switches shown in Fig. 1 enables the proud owner practically to turn his set inside out at a moment's notice should he wish to do so. Perhaps I am a little rash in saying this as a moment's notice, for in the case of the thoroughly switched set it is best to give at least half an hour's grace to allow the operator to disentangle the various switches and to arrive at the correct combination. Anyway this is much quicker than pulling the set to pieces and re-soldering all the connections necessary. As a matter of fact, though, thorough switching and pulling the set to pieces are almost synonymous terms since, if the switches run from S1 to S16, as they do in the diagram, there are about forty points to come unstuck, and if I know anything about wireless sets one of them always will. Unfortunately I have no room to show you more than the high frequency side of the circuit in question. If only the pages of MODERN WIRELESS were slightly wider I would draw you the low frequency department as well and we could have another dozen or so here quite comfortably.

Variety

You see the beauty of a circuit of this kind. The operator can earth his aerial in a flick, use a single or double circuit tuner, throw the A.T.C. into series or parallel, earth the secondary or not, connect the grid of the first valve to the potentiometer or to low tension negative, use tuned plate or resistance capacity coupling with his high frequency valves at will, connect the grid-leak of his rectifier to low tension positive or low tension negative, connect the ditto of the second high frequency valve to the potentiometer or low tension minus, cut out both potentiometers when they are not required, connect the telephones or loud-speaker and switch off both high and low tension batteries. In a word his set is thoroughly flexible, so flexible in fact that it will usually be caught bending. If he remembers to disconnect the aerial from earth the odds are a shade over 10 to 1 that he will omit to switch on his high tension battery. Should he do this it is Bush House to a husband that he will omit to switch on the accumulator and will run round in circles grinning like a dog and wondering why and how all the filaments of his valves have burned out unbeknownst since the last time he used the set.

Something to Play With

Still, he will have heaps to play with and that is what the average wireless enthusiast really wants. If you gave him a one-knob set he would be utterly miserable. The whole thing would be so dull. Most of us like the possibility of trouble. This is to be seen from our very earliest days. Give a baby (and do not forget that you and I were once things like that) a feeding bottle whose mouthpiece thing can be worked off if he tries hard enough and the child is perfectly happy. He goes on trying until it comes off and he is drenched from top to toe in a flood of warm milk. He then yelling to attract attention and positively wriggles with joy as he watches his fond mamma's efforts to clean up the mess.

Uninteresting

Present the same child with a perfect safety feeding bottle and see what happens. He makes one or two strenuous efforts to bring off the old jest, and then finding that there is nothing doing, he goes black in the face and does not laugh again until the doctor turns up. As fully fledged wireless men to-day we are precisely the same. Though being compelled to disembody the set with screwdriver, pliers and experienced selection of other tools is no more pleasant than being wet to the skin with a bottle full of milk, we still regard the set which does not make the process necessary at frequent intervals as something flat and totally uninteresting.

Examinations

An Athenian sage, who has probably bored more schoolboys than any other man alive or dead, once wrote that life without examinations would be a wearisome thing. As regards this sentiment I find that my young hopefuls are in complete disagreement with the philosopher when the end of the term approaches. They maintain that life without examinations would be a happy and a glorious thing. But there speaks the voice of the inexperienced youth. The wireless man knows full well that unless he were called upon to make frequent examinations of his set he would soon chuck wireless altogether and take to knitting or spooling as a hobby.

Shushing

Here I feel that I must quote Professor Goop's famous maxim, though I can take no responsibility for the way in which he puts his opinion. "Do not be surprised," he said "if upon fitting many switches swishing, swashing and swishing noises are heard in the receivers." There is, of course, a great deal of truth in this remark, though I hasten to point out that any of the noises which he mentions—I forbear from repeating them, for you know them quite well—can usually be brought to an end by the manipulation of Sr5 or Sr6 in the diagram, to say nothing of Sr1. A similar result
November, 1925

We All Do It

Do not imagine from what I have said that Professor Gooch (as regards switching of coils) would change the coils out of their sockets and push in others to replace them. He will do almost anything else that you may suggest with the utmost cheerfulness, but when the question of changing coils crops up he goes on strike at once. Many of my friends have never heard Daventry or Radio-Paris simply because they cannot bring themselves to mount the necessary inductances, though all are lying ready to hand upon the wireless table.

The Single Switch

What I find happens to me as regards switches is this. Exercising the greatest self restraint, I proceed to construct a switchless set. Then some fellow writes an article showing how easy it is to slightly improve one or other of the circuits. To try out the new idea I fit up a neat little switch so that I can change over from the old circuit to the new and vice versa in a second and so compare the two properly. That switch remains a permanent part of the receiver. The following week comes another new improvement and another switch. At the end of about six months the panel is positively bristling with switches, and though I know that their presence is responsible for many evil things I cannot bring myself to do away with them. This goes on until there comes a time when wishing to fit yet one more switch I cannot find room for it anywhere. At this point I cover my head with ashes and cry aloud that I will sin no more. I pull the set to pieces and make a new one purified from all taint of switching. If you want to continue the story you have only to go back to the beginning of this paragraph. Recently the Professor and I came to the conclusion that no set should contain more than a single switch and we have pacified our consciences by designing the Gooch-Listener Single Switch Unit, which can be attached to any wireless set. I must admit that it is rather a bulky affair, looking rather like the control arrangement of a power station, still it is a unit and it enables you to do practically all the things that you can with the circuit in Fig. 1. As the Professor said, there is no doubt about its singleness, and you can always tell your friends perfectly truthfully that you have no switches in your wireless set, the Gooch-Listener Single Switch Unit being quite outside it.

The Listener-In.

Radio Press, Ltd., Opens an American House

A NEW era of Radio Press achievement has dawned with the inauguration of our new American House. Through these offices our readers will be kept in close touch with American ideas, developments being quickly reported by a competent expert, who, moreover, will view such progress through English eyes.

Mr. A. H. Morse, A.M.I.E.E., M.I.R.E., who has been appointed as manager of the new company, has been actively concerned with the technical aspects of radio communication for some years.

Varied Career

In 1897, Mr. Morse started in the Post Office Telegraph Service, which he left in 1900 to serve in the South African war. He subsequently supervised the erection of one of the first telegraph lines in West Africa.

From 1906-7 he served as consulting engineer to the De Forest Wireless Corporation, of which he later became Superintendent.

From 1909 to 1911 he was Superintendent of Construction and Maintenance to the United Wireless Telegraph Company, and in 1912 joined the Marconi Company in this country.

Three years later he was appointed adviser to the Indo-European Telegraph Co., but returned to Canada in 1919, when he became Managing Director of the Marconi Company in that country, an appointment which he held till 1923 when he resigned in order to enter business on his own account.

Radio Press, Ltd., will thus be admirably served and our readers will receive the latest information from the new offices, situate in the Bush Building, 42nd Street, New York, an excellent position in one of New York's most famous thoroughfares.
Appointment of H. J. Barton-Chapple
Wh.Sch., B.Sc. (Hons.), A.C.G.I., D.I.C., A.M.I.E.E.,
to the Staff of Radio Press, Ltd.

It is with great pleasure that we introduce to our many readers Mr. H. J. Barton-Chapple, who recently joined the senior technical staff of Radio Press, Ltd., as the outcome of our development policy in connection with the Research Laboratories at Elstree.

Qualifications
He is possessed of high qualifications, as a result of a particularly successful career. Before entering the City and Guilds (Engineering) College, Mr. Barton-Chapple secured a Whitworth Scholarship, which stands preeminent amongst open competitive scholarships in the United Kingdom, owing to the high standard of the examination and the rigid conditions for competing.

On entering College in 1919 he passed straight into the second year, and at the final examination of the third year secured the Associateship of the City and Guilds of London Institute (A.C.G.I.), heading the list of successful candidates and as a result securing the Siemens Memorial Medal. He also obtained the Henrici Medal for Mathematics, being the student of greatest merit in this subject. In the same year Mr. Barton-Chapple graduated at the University of London, obtaining the B.Sc. degree in Electrical Engineering with first-class honours.

This was followed by a fourth year Post-Graduate Course in Radio Telephony and Telegraphy under Professor Mallett, on the successful completion of which he was awarded the Diploma of Membership of the Imperial College of Science and Technology (D.I.C.).

Further Experience
On leaving College in 1922 Mr. Barton-Chapple was appointed Lecturer in Electrical Engineering (specialising in High-Frequency and Thermionic Valve work) at the Bradford Technical College. Since that time he has conducted classes in Electrical and Radio Engineering, being entirely responsible for the courses in the latter subject, and his efforts have met with particular success.

His duties brought him into immediate contact with every type of student. Thereby much experience was gained in elucidating problems in such a manner that students were able to secure a clear conception of the normally intricate points.

Practical Research
Mr. Barton-Chapple has had considerable opportunity for research work, and several articles on the results of such investigations have appeared from time to time in the technical Press.

While at Bradford Technical College he was elected an Associate Member of the Institution of Electrical Engineers (A.M.I.E.E.), a qualification which, as our readers know, is of a distinctly valuable character.

Our readers therefore may look forward to some very helpful articles from Mr. Barton-Chapple’s pen, many of which will be the outcome of research work at our new laboratories which are now in full swing.

NEXT MONTH—A SPECIAL
CHRISTMAS DOUBLE NUMBER
Among the special features will be practical details, by MAJOR JAMES ROBINSON, of the construction of sets to operate direct from the D.C. mains. Other items will be:
Practical Experiments in Selectivity. By Percy W. Harris, M.I.R.E.
And numerous designs for sets by leading Radio Press Writers.

On Sale Dec. 1st. Make sure of your copy. Price 1s. 6d.
Some interesting details of the new station to augment the long distance CW traffic from and to ships, formerly handled by Devizes

In August, 1920, the British Post Office opened a Wireless Station at Devizes, in Wiltshire, for maintaining communication with ships beyond the normal working range of the existing coast station system, which is not greater than about 150 miles. This station was equipped with a continuous wave transmitter and receiver working on two wavelengths of 2,100 and 2,400 metres to ships fitted with long range continuous wave receivers and 1½ kw. continuous wave transmitters to give a system having a maximum working range of from 1,500 to 2,000 miles.

Rapid Increase of Traffic

At the time of opening, only about 40 ships were so equipped, but by the beginning of 1923 this number had increased to 120, and as the facilities became known, the land station was rapidly outgrown. In order to cope with the increasing traffic, two possible courses were open. The first, to erect a new land station with transmitter and receiver some distance from Devizes, and the second, to build a new receiving station to house two or more receivers, and to install a second transmitter at Devizes. The second method was finally adopted, as being the more economical and workable, particularly from the point of view of future extension. Accordingly, work was commenced on the new receiving station near Burnham-on-Sea in Somerset, the station being completed and opened for traffic on February 2 of this year. The wave lengths of 2,100 metres and 2,400 metres were retained for the new service. The continuous wave transmitters with which the ships are equipped are capable of transmitting over a wave range of from 1,900 metres to 2,900 metres, so that more receivers can be added at Burnham as traffic requirements continue to grow. The site for the receiving station was chosen and laid out with a view to providing for such extension.

Remote Control of Transmitter

With the adoption of separate receiving and transmitting stations arose a necessity for some system of remote control whereby the operator at Burnham could listen to signals from ships, and could immediately reply by keying a transmitting set at Devizes. It was also desirable on grounds of economy that the same operator should be able to start and stop the transmitting set when he commenced or finished his outgoing traffic. The apparatus employed for this purpose is explained later.

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The general appearance of the station can be seen from the photograph at the head of this article. The building itself is a single-storied brick structure, and contains a power room, battery room, two store-rooms, instrument room, land line room, office for the officer in charge, and retiring room.
A view of one of the masts at Burnham showing the leeds in from the loops.

for the staff. The instrument room is at the back of the building and overlooks the open site on three sides, thus allowing free access for leads from the aerials. Between the instrument room and the land line room is a communication hatch, through which messages received and written by the wireless operator can be passed for retransmission by another operator over land lines to London, or through which messages received from London by land line can be passed to the wireless operator for transmission via Devizes to ships. The scheme is illustrated in Fig. 2.

Instrument Room

The receivers and other apparatus controlled by the operators are placed on benches which run round three sides of the instrument room, and are so arranged that the tuning, direction finding and filament controls of the receiver, the switch by which the transmitter at Devizes is started up and shut down, and the hand key which operates this transmitter are all within easy reach of the operator's chair.

A few feet away is the telegraph sounder by which land line signals from the engineer at Devizes are made audible. Power boards are fitted at intervals round the wall, and from these current at 52 volts for radio high tension circuits, 26 volts and 78 volts for land line circuits and 4 volts for radio low tension circuits is taken through fuses. These boards are also fitted with terminal connections to the radio and telegraph earths. A low tension switchboard for connecting to the three low tension batteries for charge or discharge is also fitted in this room.

The receiving equipment originally supplied by the Marconi Co. at Devizes is in use at Burnham. Directional reception is employed to minimise interference from the East, the majority of the reception being from West and South-West.

Facilities are provided whereby traffic may be received from ships at high speed and relayed direct to the Central Telegraph Office in London, where it is recorded telegraphically.

Power Supply

No power supply is available in the immediate vicinity of the station and an independent power supply is installed, comprising two similar engine generator sets, one of which can be seen in the foreground of the photograph of the power room. The prime movers are single cylinder petrol-paraffin four-stroke engines, driving 3 kW generators for charging the main 50-volt lighting batteries. The land line and H.T. voltages are also provided from small accumulators. They are of 8 amp-hour capacity and are the small cells seen in the foreground of the battery room. Part of the 50 volt lighting battery which consists of 27 cells of 700 amp-hour capacity can also be seen in this photograph. The battery room also contains six other cells forming the three 4-volt low tension batteries for lighting the filaments of the receivers. These cells are of the same capacity as those of the lighting battery and are connected in series with the main battery for charging.

An automatic switchboard is provided, which keeps the voltage on the mains constant between 52 and 55 volts. This is effected by means of an automatic switch, which cuts in or out certain cells at the end of the battery, so varying the total voltage within the limits specified.

Control Arrangements

It was stated earlier that the transmitters at Devizes were remote controlled from the receiving point at Burnham. This remote control apparatus at the receiving station consists essentially of a hand

A closer view of an automatic switchboard similar to that used at Burnham. The switch is operated by a motor at the back of the panel.
Ca/Awn/under

-11

Hon Polarised Relay

Morse key

ham is in the " Off " position, the hand key can be used for "speaking" to Devizes, but will not operate the transmitter.

On placing the switch to "start," however, the non-polarised relay operates and starts up the transmitter. Operating the key at Burnham then causes the transmitter to function.

Safety Arrangements

An interlocking relay is incorporated at Devizes, which is a safety device preventing the operator from keying, and so taking a heavy current from the generators before they have had time to run up to full speed.

The control gear can be isolated or operated independently at the Devizes end if necessary.

The Devizes station is thus completely remote controlled by the

Fig. 1.—A diagram of the remote control arrangements at Devizes.

key and a switch key. The former is used for sending Morse signals to the engineer or for transmission through the sets to ships, and is arranged to work on both 26 and 78 volts.

The non-polarised relay operates independently of the direction of

The lighting, the receivers and the land lines are run off accumulators all housed in one room. The main lighting batteries are in the foreground and the H.T. and land line batteries on the right.

arranged to reverse the connections between the battery and the line. The switch key is used for starting and stopping the transmitting sets, and in the "stop" position connects a 26 volt battery through the hand key to the line, while in the "start" position it changes over to a 78 volt battery.

Fig. 1 indicates the arrangement of the apparatus at the Devizes end of the control circuit. The operation of the polarised relay depends on the direction of the current passing through it. The reversals of current caused by the operation of the hand key at Burnham thus cause this relay to operate, and it is the current, but will not work on the 26 volt battery.

Thus, when the switch at Burnham is in the "Off" position, the hand key can be used for "speaking" to Devizes, but will not operate the transmitter.

On placing the switch to "start," however, the non-polarised relay operates and starts up the transmitter. Operating the key at Burnham then causes the transmitter to function.

Fig. 2.—The station at Burnham controls the transmitters at Devizes by remote control and is also in telegraphic communication with London.
MOST readers will remember that by last winter short-wave developments had reached such a stage that many enthusiastic amateurs were induced to make up receivers with the idea of receiving that popular station KDKA, of East Pittsburgh, Pennsylvania, then working on about 4410 kc. (68 metres). Those who did so no doubt experienced a certain amount of difficulty at first, and found that the conditions were not so straightforward as on the broadcast band. Later we saw further developments in short-wave reception and transmission, with the result that there is now a fair amount of activity down to about 200 metres and lower.

Larger Frequency Band

Thus we see that at the present time the enthusiastic amateur has to contend with a band of wavelengths of from twenty to about two hundred metres, if he wants to embrace the whole of the activities on the short waves. The main essentials for such a set are: First, a simple circuit which can be made to oscillate over the whole of the tuning range and which is at the same time easy to control as far as oscillation is concerned; that is to say, the oscillation control must be such as will allow one to bring the set into or out of oscillation easily without any backlash. No elaborate circuit is necessary, and that shown in Fig. 1 is probably the most satisfactory of the more simple circuits.

Design of Receivers

Further important factors to bear in mind in designing a wide wavelength-range short-wave receiver are the selection of components, particularly the variable condenser used for tuning valve and valve holder, and the design of the coils to be used; in addition to these factors we must consider the question of casual capacities and endeavour to eliminate them as much as possible. Some further information on this subject will be found in my articles in Wireless Weekly, Vol. 6, Nos. 20 and 23, in which I discussed a number of characteristic cases.

It is, of course, an easy matter to make up a short-wave receiver from a given design, but it is somewhat more difficult to calibrate it.

There are, however, one or two methods of calibration on these high frequencies which the average amateur can use with success without much additional or more complicated apparatus. I refer here to the method of calibrating by harmonics and the Lecher wire method. This latter method is particularly suitable for calibrations on, say, 20,000 to 12,000 kc. (15-25 metres). I have described such a method of calibration in an article in Wireless Weekly, Vol. 7, No. 3, and have given some details on the "harmonics" method in Wireless Weekly, Vol. 7, No. 5.

Choice of Circuit

Now with regard to the present receiver, you will see from the circuit diagram that a simple oscillator circuit, using the form of reaction sometimes attributed to Reinartz, is used. A small aperiodic aerial coil is coupled to one end of the reaction coil. The local earth lead is made a tapping point upon the coil with the aid of a Burndt spring clip, or some similar device, so that the number of turns in the grid circuit and the number in the reaction coil can be adjusted. Reaction is con-
Fig.—The coils $L_1$ and $L_2$ are wound as one continuous coil. Note that the moving vanes of the variable condensers are represented by arrows.

clucked by the condenser $C_3$, otherwise the circuit is quite conventional.

Readers who have experimented even on 60 or 70 metres will be aware of the fact that as we go higher in frequency, the degree of sharpness of tuning increases, so that it is essential, if we are going to use the receiver up to 15,000 kc., to have some form of fine adjustment of the movement of the moving vanes of the condenser. There are several ways in which this can be achieved; we may have a long extension handle rigidly secured to the condenser dial and in this way secure a reasonably fine movement and freedom from body or hand capacity effects.

Geared Dials

With the introduction of geared dials, however, we have another solution to the problem. There are now on the market several excellent forms of this type of dial. On the reaction condenser such a refinement is not absolutely necessary, but it would further simplify the handling of the receiver.

Reducing Stray Capacities

With the idea of reducing some of those casual capacities which affect the tuning range, I have made provision for the use of a V.24 type of valve. With care the ordinary type of 4-pin valves will be found suitable for use up to 15,000 kc., but low capacity valves of the type I have mentioned are more satisfactory and even necessary when we wish to go higher in frequency.

Choosing Components

I recommend intending constructors who have had only limited experience to adhere strictly to the specifications for the components given in the following list; others who have had some experience of work on the high frequencies have a wide selection of components, if care and discrimination are used. The components embodied in the actual set seen in the photographs are:

- One .0005 µF square law variable condenser (Igranic).
- One .0003 µF square law variable condenser (Collinson).
- One National Velvet vernier dial (R. A. Rothermel, Ltd.).
- One ebbonite panel, 12 in. by 7 in. by $\frac{1}{4}$ in. (Paragon).
- One ebbonite strip, 12 in. by 1 in. by $\frac{1}{4}$ in. (Paragon).
- One ebbonite strip, 5 in. by 2 $\frac{1}{4}$ in. by $\frac{1}{4}$ in. (Paragon).
- One No. 1 terminal strip (Burne-Jones and Co., Ltd.). (Only six of the terminals are actually used.)
- One high-frequency choke (Lissen, Ltd.).
- One bright emitter filament resistance (L. McMichael, Ltd.).
- One .0003 µF fixed condenser and gridleak mounting (Dorwood).
- One 2-megohm gridleak (Dubilier).
- One set of clips for V.24 type valve.
- Two large terminals, three valve sockets, 4 B.A. screws and nuts, wood screws, Burndent spring clip, square wire, six suitable brass brackets, and Radio Press panel transfers.
- No. 20 enamel covered wire (about $\frac{1}{2}$ lb.).
- No. 18 D.C.C.

A general view of the receiver with the 3C turn coil in position. The geared dial on the left has the appearance of an ordinary dial.
Two low-loss formers, 3½ in. diam. and 4 in. long, with glass discs, and brass angle brackets (Collinson Precision Screw Co.).

One 10-turn bare wire coil of No. 12 bare copper wire, and 4 in. diam. with valves pins soldered on ends (Scientific Appliances, Ltd.).

One piece thin ebonite tube, 2½ in. diam. and 1½ in. long (Burne-Jones and Co., Ltd.).

Making the Receiver

With the exception of one or two small points, the construction of the receiver will be found to present no great difficulty. You may have a little difficulty in marking out and drilling the holes for fixing the tuning condenser and the geared dial. There are three holes for the securing screws of the condenser; one for the condenser spindle and four for the geared dial. The hole for the condenser spindle should be drilled ½ in. or more in diameter (the reason for this will be apparent later). It will be necessary, too, if you are using the particular dial I have specified to cut off ½ in. from the condenser spindle and to remove the stop on the spindle; the latter operation can easily be done by merely unscrewing the set screw. The shortening of the spindle should be done with care, using a good hacksaw blade, otherwise the condenser is likely to be damaged. If you are averse to a procedure of this sort, I would advise you to use some other type of vernier dial which can be fixed without shortening the spindle.

Other Geared Dials

Such makes as the Burndept, Jewett Micro-Dial, and E-Z-Too Vernier Dial will be found suitable for this purpose.

Fixing the Geared Dial

Having drilled the holes for securing the condenser, take the geared dial to pieces by first of all removing the knob by loosening the set screw and then removing the dial portion by unscrewing the three small brass screws which secure it to the circular metal part which contains the gearing mechanism. Then fix the condenser temporarily in its correct position on the panel, and place this circular metal part just referred to on to the shortened condenser spindle, securing it with the set screw provided. A large ½ in. hole in the panel is necessary to allow for this. Having secured the gearing mechanism in its correct position on the condenser spindle, use this as a template to drill the four holes for the securing screws which are used to fix it to the panel. 0 B.A. screws are perhaps best for fixing the gearing mechanism to the panel. The dial is then put on with the aid of the three small brass screws and the knob finally secured in position, care being taken that it does not scrape against the dial.

Points to observe in Wiring

The wiring is best carried out with some rigid wire, all connections being carefully soldered and special attention paid to the spacing of the various wires, particularly those in the grid circuit of the valve. These should be kept well spaced from all neighbouring wires and those in the plate circuit. I do not think that great attention need be paid to the length of the wires, since the more
important factor seems to be their adequate spacing.

**Design of Coils**

It is quite possible to cover the range of 15,000 to 1,500 kc. with the aid of only two coils. This is a matter however, give you the design for two such coils, and also indicate the turn numbers and dimensions for an intermediate coil.

**Coil Sizes and Turn Numbers.**

The 10-turn coil is fairly springy but can be used down to 20 metres, of great convenience, but whether we are working efficiently on any frequency in this range, when using only two coils, is a doubtful point, for we may not possibly be preserving a reasonable inductance to capacity ratio on every frequency. I will, in care is taken not to allow it to vibrate. If any difficulty is experienced owing to this vibration I would advise you to obtain two strips of ebonite and clamp the turns of the coil between them at the top. The second coil consists of 30 turns of No. 20 gauge enamelled wire, wound with double spacing on a standard Collinson low-loss former, 31⁄4 in. in diameter and 4 in. long, with the usual glass disc in the centre. The ends of the coil are soldered to the brass angle brackets provided with the coil, and a short length of wire is soldered to the 15th turn to act as a tapping point. This coil is mounted by securing the lower end of the angle bracket under the large terminals.

**Intermediate Coil**

For the intermediate coil I suggest one of 20 turns, with a centre tap. This is wound and mounted in the same way as the 30-turn coil.

The "aperiodic" aerial coil consists of 10 turns of No. 18 D.C.C. wire on the length of 23⁄4 in. diameter tube. Two connecting rods are put on the ends of this coil to enable the aerial and the earth connections to be made. The coil is mounted with the aid of a valve-pin and socket.

Various sizes of this coil can be tried for different parts of the desired tuning range and I suggest 2-turn and 5-turn coils in addition to the 10-turn coil.

**Operation and Adjustment**

For the preliminary test adjust the filament temperature and H.T. voltage to such a value that oscillation takes place over the entire tuning range. Try this out with all of the coils, with the local earth tap on the centre tapping. The set should go into and out of oscillation without any backlash. The correct adjustment of the H.T. voltage and the filament temperature will ensure that this is so. Finally, the aerial and the earth may be connected up and searching for signals commenced. The 10-turn coil tunes to about 5,660 kc. (about 53 metres), while the 30-turn coil tunes from above this figure to about 1,500 kc. (200 metres). This is with the local earth tap on the centre tapping in each case.

With the 10-turn coil and the tapping point taken so that there are four turns in the grid circuit, I have been able to tune up to 10,000 kc. (15 metres). A description of what to listen for on these high frequencies is given in another article in this issue.

In conclusion, I may say that the construction of a receiver such as this should provide you with a fascinating contrast to the usual broadcast reception and give a good insight into the peculiarities of short waves.
How to Run Your Receiver Direct from D.C. Mains

By MAJOR JAMES ROBINSON, D.Sc., Ph.D., F.Inst.P.
Director of Research

The voltage from D.C. mains is unsuitable for H.T. supply, unless special precautions are taken, owing to small variations which give rise to a hum. This article describes a novel method of overcoming this defect.

A device which will enable listeners to use their valve receivers and amplifiers direct off the electric supply mains, and thus to abolish the troubles of accumulator charging and of replacing high-tension batteries, will be welcome. After all, accumulators and high-tension batteries are merely for the purpose of providing voltage and current for the amplifier, and if in any house a supply of voltage is already there, it is highly desirable to make use of it, if a practicable scheme can be evolved.

In this country, for some reason or other, very little use appears to have been made of the electric mains for the direct supply of voltage and current to amplifiers, although a considerable use is being made of such mains in some other countries. The problem is comparatively straightforward. This is particularly so in the case of direct current supplies, which are usually of 200 to 240 volts, although certain supplies are of the order of 100 volts.

In the case of alternating currents, a certain amount of trouble exists owing to the different frequencies of the various supplies, the frequency varying from 25 to 60. These troubles, however, are not serious, and could be overcome without serious trouble in attempting to apply the voltage of the mains direct to amplifiers.

D.C. Mains

In the case of D.C. mains, the straightforward plan would thus appear to be to bring down the voltage to what is required by means of a resistance, and thus to apply the voltage as required to the amplifier. However, the problem is not quite so simple, because there is another trouble, which is that the so-called direct current supply is not quite constant enough. Usually there is a variation of voltage of the order of about half a volt, although in some cases the variation may be even more than this.

This variation takes place at a considerable frequency, which is very often not uniform, so that we have to arrange to eliminate this ripple, and to obtain an absolutely smooth supply of voltage. As the actual voltage induced in an aerial from wireless waves is very small, of the order of a few millivolts only, whereas the variation of voltage on the direct current mains may be 500 millivolts or more, it is quite obvious that it will be impossible to receive wireless signals unless something is done to eliminate the variation of voltage due to these D.C. mains.

Use of Chokes and Condensers

The usual method suggested for eliminating the ripple of D.C. mains is to employ large inductances which are called "chokes" and large condensers. A method for using chokes and condensers for eliminating the ripple is described in MODERN WIRELESS for October.

There is, however, another method which may be employed, utilising a thermionic valve to eliminate the ripple, and by means of such a valve a constant voltage may be obtained. The principle underlying the method will be understood from Figs. 1 and 2. A two-electrode valve is all that is required, although it is possible to use an ordinary three electrode valve by joining the grid and anode together.

Saturation Current

In Fig. 1, the characteristic of a two-electrode valve is shown, the current being plotted for different voltages. Volts are plotted along OX...
and the current is plotted along OY, the voltage being applied between the filament and the anode. This curve is well known, the general characteristics being that when the voltage on the anode is negative no current flows, and as this negative voltage is diminished the current begins to flow, until there is no potential between the anode and filament, when a small amount of current flows to the anode. When the anode is made positive, the current increases up to a maximum value, and on reaching this point, no matter how much the voltage is increased, the anode current never increases. This maximum current is called the "Saturation Current." In Fig. 1, the maximum current is obtained when the voltage on the anode is given by OH, the current then being given by HT.

This principle is, of course, very old, being the principle of the Fleming valve. It is immediately obvious, however, that if we apply a variable voltage to such a valve with the mean value at a point such as A, and allow the voltage to vary between C and D, the anode current is absolutely constant, being of the value of CE or DF the whole time. We must now examine how this principle can be applied actually to the direct current mains in order to keep the variable voltage, and thus variable current, away from the amplifier.

In Fig. 2 a method of connecting the valve in series with the direct current mains is shown. The filament of the valve is supplied in this case by a separate battery M. The filament is joined to the negative pole of the electric supply. The anode of the valve is joined to a resistance R, the other end of which resistance is joined to the positive pole of the supply. We thus have the valve joined in series with the resistance and both together put across the main terminals.

All we have to do now is to adjust conditions so that the voltage across the valve is of such a value that the current through the valve is absolutely constant, irrespective of any slight fluctuations of voltage. We must so arrange the resistance R and the magnitude of the current through the valve, so that the potential at which the valve is working is well to the right of the point H in Fig. 1. It is advisable to arrange that it is some considerable distance to the right of H, e.g., at A.

Adjustment of Valve

The points which require attention in order to obtain this condition are the resistance R and the emission from the filament which is controlled from the filament battery M. Very little calculation is required in order to find the actual conditions, that is, the emission and the actual resistance R which are required. The current through the resistance is equal to the voltage across it divided by the value of the resistance in ohms. This is a statement of the well-known Ohm's law.

It is usually possible to obtain a valve which will produce the saturation current for a voltage of 60 to 80 volts. If we allow such a valve to have about 100 volts across it, we have left available for the resistance R also 100 volts, assuming the voltage of the mains to be 200 volts. Suppose that the saturation current is one-tenth of an ampere, then this current will also flow through the resistance. The voltage across the resistance R is then to be 100 volts, and as the current is one-tenth of an ampere, the resistance of R, by Ohm's law, must be 1,000 ohms.

In these circumstances we have the voltage from the mains, of 200 volts, divided into two parts, that across the resistance R and that across the valve V. As the current which passes through the valve is constant, if the valve is working at the saturation point as described, the current through the resistance R is constant, and thus the potential across R is also constant. All the voltage variations of the mains, therefore, are absorbed by the valve V. If the main voltage rises to 207 volts, the valve cannot pass any more current owing to the saturation effect, so that the voltage developed across the resistance still remains the same, that is, 100 volts.

Effect of Altering the Resistance

Consider for a moment the effect of altering the value of the resistance R by some large amount. Suppose that the resistance of R is reduced to 100 ohms. As the current is l/10th of an ampere, the voltage across R is 10 volts, and thus the voltage across the valve becomes 190 volts without changing the current through the valve.

On the other hand, suppose that we make the resistance of R much greater, say, 4,000 ohms. It will be obvious that the current in the valve must now change, for the following reason. Let us assume that it does not change, but remains constant at the value of l/10th of an ampere. By Ohm's law we have a resistance of 4,000 ohms which has a current of l/10th of an ampere flowing through it, and thus we require a total voltage of 400 volts, which is impossible, as we have only 200 volts altogether.

Thus it is obvious that if we increase the resistance of R above 1,000 ohms, the current will remain at l/10th of an ampere until the distribution of the
voltage between the resistance and the valve is of such a nature that the voltage across the valve is equal to the value OH in Fig. 2. This voltage for most ordinary valves is of the order of 60 to 80 volts. As soon as the conditions are such that the voltage allowed for the valve becomes less than OH, then the current through the valve will diminish. At this stage, of course, the valve is not in the condition that we require for smoothing purposes.

Practical Manipulation

We have discussed some theoretical reasons for the distribution of voltage between the resistance and the valve, and have shown how it is possible to obtain the correct relations. In practice the method to be employed is as follows: In series with the valve and the resistance it is advisable to use a milliammeter. This is shown as MA in Fig. 2.

Also in series with the resistance and amplifier a small battery should be employed for test purposes, which is shown as N in Fig. 2.

The object of this battery is to produce artificial variations of the voltage on the mains. Conditions should finally be obtained so that no matter what the voltage of this battery, within limits, or which way round it is connected, the current through the milliammeter is constant. The resistance R should be varied, and also the emission from the filament should be varied by means of the battery M and its filament rheostat.

Elimination of Filament Battery

So far we have supplied the current for the filament of the valve V by a separate accumulator M. But as we have already plenty of electrical power, it is advisable to use this electrical supply to heat the filament of the smoothing valve V. The way to do this is shown in Fig. 3, where the filament is joined in series with another resistance R. This resistance should be so adjusted as to give the correct filament current for the valve V.

A suitable resistance for this purpose is an electric lamp, which should be chosen of the correct wattage to give the correct current to the filament. In addition, a small variable resistance should be used with this electric lamp in order to allow of the finer variations of the filament current and thus of the emission.

Temperature Lag

By using the electric supply to heat the filament of the smoothing valve V we introduce the possibility that we may not obtain the maximum amount of smoothing, because the variations of voltage on the mains are now introduced to the filament of the smoothing valve and thus we get the temperature of the filament of this valve altering in harmony with the voltage variations on the mains. Changing the filament current, and thus the emission, is equivalent to changing the saturation current. This is shown in Fig. 4, where we get curves 1 and 2 corresponding to the smaller and larger filament currents.

In actual practice, however, this effect is not serious, if appreciable, at all. The variations of electric voltage are followed only very slowly by change of temperature of the filament. Temperature effects are by no means instantaneous, and time is required to change the temperature of the filament when the voltage is altered. Owing to this lag of temperature effects, the difference between the saturation currents 1 and 2 is usually extremely small. This is particularly so, because the frequency of the variation of voltage is usually comparatively high, being anything from 60 to 1,000 cycles per second.

A Suitable Single Valve Circuit

There is no doubt, therefore, that a valve used in this manner cuts down the variations of voltage obtained on the direct current mains to a very large extent, actually to about 1 per cent. of the original variation. The final clearing up of this variation can be obtained by using a condenser of a few uF across the resistance R as shown in Fig. 5. We thus have at the points A and B, a source of potential or voltage of the order of 100 to 120 volts, which is absolutely constant, and we can now make use of this source of supply for our amplifiers and receivers for both the anode supply and the filament supply.

We shall consider in this article only the case of a single valve receiver. In Fig. 6 a scheme is shown whereby the anode supply is fed from the mains by means of this smoothing valve. In this case it is necessary to use a special battery to heat the filament of the receiving valve D. The smoothing
arrangement, including the smoothing valve V is shown to the left of the figure, including the series resistance R for the anode of the smoothing valve, and the series resistance R₁ for the filament of the smoothing valve.

Our source of supply for anode voltage is now the two terminals A and B. A is obviously the terminal to join to the anode of the receiving valve. The point B should be connected to the filament of the receiving valve. A very simple form of receiving circuit is shown, with a direct coupled aerial. Reaction is used in this circuit, as shown at L₁ and L₂.

**Aerial and Earth Both Insulated**

The first point of interest is that the aerial must be insulated from the receiver, and this is done by using a series condenser, F, which is shown as a variable condenser. The aerial must not be connected direct to earth as if this is done it will result in earthing the receiving circuit DHG and thus in earthing the mains at some particular point corresponding to B. This must be avoided at all costs for there is usually an earth already in the mains which will most certainly be at some other point, so that the aerial must be earthed through a condenser G which should have a value of the order of µF.

Again the telephones are at a somewhat high potential, and these should also be well insulated, or else a telephone transformer should be used. The high tension voltage may be varied if desired by arranging a tapping point on the resistance R.

In this case, where we only supply the anode current of the receiving valve from the smoothing circuit, a comparatively small current is required, so that there is no necessity to use a large smoothing valve V. A valve which will give an emission current of 20 milliamperes is quite sufficient, and quite a number of receiving valves will do this.

**Filament of Receiving Valve**

In Fig. 7 a diagram is shown for the case where both the filament supply of the receiving valve V and the anode supply are provided by the smoothing circuit. The filament of the valve D is now joined in series with the resistance R, the anode supply being obtained from the positive end of the resistance R as before. A variable tapping might be used at A. It is, however, very often convenient to use a lamp in place of the resistance R₂, and in this case it will not be easy to provide a variable tapping point at A.

The magnitude of the filament current in the valve D is controlled by the emission of the valve V. This controls the current through the rectifying valve V as is required, and for convenience and economy it is recommended that a 60 milliampere valve be used as the receiving valve D. In this case we need not provide for too great an emission current in the valve V.

An emission of about 65 milliamperes is required and, therefore, it is necessary for us to use a valve V which is capable of giving a saturation current of more than this value. A number of valves are available which will do this. The LS 5 valve is capable of giving 70 or 80 milliamperes. Two B₄ valves in parallel will also provide sufficient emission. In these cases, of course, we are using three electrode valves, whereas two electrode valves are all that is required. With three electrode valves it is necessary to connect the grid and anode together.

**Cost of Running**

As regards the question of cost of running such a circuit this should not be too high, particularly if we use a valve as rectifier which has a dull emitter filament. If we use a bright emitter such as the LS 5, the filament current is three-quarters of an ampere, which requires a power of 150 to 160 watts. This means that in six hours we have used 1 unit of electric power, so that the cost will be of the order of 1d. per hour. It is possible to have cheaper running by using other valves. It should be possible for valve manufacturers to design a valve which can operate on very little filament current and yet give the required emission.

**Special Forms of Valve**

One method of doing this is to have a valve designed which has a very long filament, as the emission from a filament is proportional to its length.

In this way it should be possible to obtain an emission of 60 milliamperes for a filament current of about 200 milliamperes. In the circumstances the running of such a smoothing circuit should be very economical.

Examples have been shown for single valve receivers, but the method may be applied equally to multivalue sets, and further details will be given in a future issue.
MODERN WIRELESS

November, 1925

The photo above shows the main aerial tuning inductance in process of construction. It is wound with heavy cable made up of a large number of strands of fine wire to reduce the high frequency resistance. The photo on the right shows the large glass panel carrying the lead-in insulator for the aerial. The actual strain on the lead-in is taken by the three balanced insulators outside.

When using stranded wire cable the ends of the wires have to be connected to the rest of the circuit by soldering round the edge of a large diameter copper tube. This photo shows this operation, which takes a considerable time, actually in progress.
Some of the Latest Photographs

Coupled circuit valve transmitters will be employed, and this photograph shows some of the large oil-filled condensers for the closed circuits. Note the heavy insulators required to withstand the high voltage.

The station building itself is of imposing appearance, as can be seen from the above photograph. The 420 ft. masts can clearly be seen, while some idea of the size of the aerial is obtained from the left-hand photo which shows one of the huge spreaders.
AN ANODE-INPUT REFLEX SET

By J.H. REYNER,
B.Sc.(Hons.) A.C.G.I., D.I.C.
Staff Editor

A simple set for the nearer stations.

The set which is described in this article was designed primarily with the object of providing a simple set having a minimum number of adjustments which would be capable of giving loud-speaker results on the local station up to a distance of 30 to 40 miles, and telephone reception, with possible loud-speaker results, on some of the more distant stations. As will be seen this result was more than achieved.

Simplicity of Operation

The reflex principle was employed because in a set of this character, where extreme efficiency is not desired, one of the valves can quite satisfactorily be used at both high and low frequency. One of the disadvantages of the reflex principle, however, lies in the fact that it does not lend itself very well to long distance reception. A second disadvantage lies in the fact that in the usual form of reflex arrangement several adjustments are required in the process of tuning in.

These disadvantages have been overcome to a large extent in the present set. There is only one tuning control, and associated with it a reaction control which is particularly smooth in operation. The only other adjustments which are required in the set are the three filament rheostats, which remain adjusted once they have been set approximately to the correct position.

Single Tuning Control

The idea of utilising only one tuning control resulted from the necessity for keeping the set as simple as possible. Now in the ordinary reflex circuit it is necessary to tune the grid circuit, and also to tune the anode circuit of the reflex valve. The detector, which may be either crystal or valve, is then placed across the tuned circuit in

The Original Circuit

The essence of the circuit as originally tried is shown in Fig. 1. Here the tuned circuit is connected across the anode and filament of the valve V, and coupled to this circuit is a small coil L2, which is applied across the grid and filament. The high-tension supply to the valves is obtained through the high-frequency choke L3, and the condenser, C2, is inserted in the anode circuit of the valve to prevent the high tension from short circuiting through L1.

The currents set up in the aerial induce voltages in L2 which are applied across the grid and filament of the valve and are amplified in the ordinary way. These currents then flow through the circuit C2-L2 back to the filament, and if the coils are in the correct direction this will produce a reaction effect which will ultimately cause the valve to oscillate. The reaction can be
controlled by varying the value of the condenser $C_2$. The voltage developed across the tuned circuit $L_1C_1$ is then applied across the grid and filament of the detector valve $V_1$ in the anode circuit of which is an intervalve transformer. The secondary of this intervalve transformer is connected in the grid circuit of $V_1$, so reintroducing low-frequency variations into this valve so that the valve amplifies the current both at high-frequency and low-frequency.

**Final Form of Circuit**

This simple form of circuit has been shown in order to enable the reader to appreciate the real functioning of the final form of circuit adopted. It was found for several reasons that this circuit did not give the results that were expected of it, and several minor modifications were made before the circuit was finally made up into the form of a set. The final form of circuit is shown in Fig. 2.

Furthermore, better results were obtained by making the tapping at the grid end of the coil as shown, in accordance with the usual Reinartz practice.

Finally, instead of controlling the reaction effect by varying the value of the condenser $C_2$, the condenser $C_3$ caused slight variations in the tuning of the circuit which were not very desirable. By making $C_3$ fixed, however, and varying the shunt capacity across $T_2$, an equally good reaction effect was obtained without the slightest effect on the tuning of the main oscillating circuit.

It will be seen that a third (low-frequency) valve has been added in this circuit in order to obtain loud-speaker results. We may now consider the design of the set.

**Components Required**

The components required are as follows (the names of the makers of the various components have been given in brackets after each item, although similar components by other manufacturers may equally well be used):

- 1 Ebonite Panel, 6 in. by 8 in. by 3 in. (Paragon).
- 1 Mahogany Cabinet, 9¾ in. deep take panel with baseboard 9 in. deep. The back of the case must be cut away to allow for the two terminal panels.

The modifications are as follows. The condenser $C_1$ instead of being connected simply across the coil $L_1$, is connected across both $L_1$ and $C_1$, which are wound both on the same former. This was found to give very much better signals, particularly in the reception of distant stations. Secondly, in order to increase the selectivity the aerial was not connected across the whole coil but across a portion only.

![Fig. 2 - The circuit ultimately adopted, which gave much superior results. An extra L.F. valve has also been added.](image-url)

**Fig. 3 - The lay-out of the panel may be seen from this figure. A full-size Blue Print, No. 135a, may be obtained, price 1s. 6d. post free.**

The condenser across the secondary of the intervalve transformer $T_2T_3$, was made variable. It was found that the varying of the condenser
1 Low-Loss Coil Former (6 in. long, 3 in. diameter (Collinson Precision Screw Co., Ltd.).
3 Filament Rheostats, dual type (L. McMichael, Ltd.).
3 Anti-vibration Valve Holders (Burne-Jones & Co., Ltd.).
1 300x1 μF Fixed Condenser (L. McMichael, Ltd.).
1 1000x2 μF Fixed Condenser (L. McMichael, Ltd.).
1 Grid Leak, 2 megohms (L. McMichael, Ltd.).
2 Angle Brackets (Burne-Jones & Co., Ltd.).
1 Terminal Panel, 7 in. by 2 in. with 7 terminals (Burne-Jones & Co., Ltd.).
1 Terminal Panel, 3½ in. by 2 in. with 4 terminals or plug sockets.
1 Z Toon vernier condenser dial.
1 Packet Radio Press panel transfers.
1 Jack, single open type.
1 Intervalve Transformer (Radio Instruments, Ltd.).
1 L.F. Intervalve Transformer (L. McMichael, Ltd.).

These latter items are important, as the set is of the reflex variety. The transformers employed were an R.I. transformer for the reflex stage and a McMichael for the second stage. Other makes of transformer may be employed, but in some cases there is more tendency to oscillation in the reflex valve than in others. This point, however, is dealt with in some detail later.

Lay-Out
The lay-out of the components may be seen from Fig. 3 and Fig. 4, which illustrate the front and back of panel arrangements. The coil should be wound with 90 turns of No. 22 wire, tappings being taken at the 5th, 10th and 20th turns. The tapping at the 20th turn is taken to the earth terminal, the remaining tappings being connected to the aerial terminals. As has been remarked, the selectivity of the set is obtained by only tapping the aerial across a very small portion of the coil. Plug sockets have been used, therefore, to enable the best tapping to be found under varying conditions.

The actual lay-out of the components on the baseboard should be adhered to as closely as possible, in order that any tendency to oscillation may be under control. It will be noticed that the two transformers have been placed reasonably far apart to minimise any tendency to low-frequency howling. The front of panel lay-out, of course, can if desired be altered, providing the tuning and reaction condensers are maintained approximately in the position shown. The position of the three rheostats on the right of the set is not important.

The vernier dial is almost essential. The particular dial employed is designed to take a ½ in. spindle, but a small strip of metal was inserted to adapt it to the 3/16 in. spindle. Dials to fit 3/16 in. spindles may now be purchased.

Wiring Up
Having laid out the components upon the baseboard as indicated in Fig. 4, and fixed the condensers and rheostats and the telephone jack to the panel, the process of wiring may be commenced. It will be noticed that the various connections have been made as direct as possible. With the particular arrangement of components, the wiring is fairly well spaced and care should be taken to see that this spacing of the wiring is followed in making up the receiver. If this is not done there may be some difficulty when the set is finally tested out. Beyond this precaution there is little else that calls for any comment.

Operation of Set
The operation of the set, when completed, is particularly simple. The reaction condenser should be placed in the zero position (i.e., "All out"). Having inserted the valves in their sockets and adjusted the filament currents to suitable value, the local station is tuned in by suitable adjustment of the tuning condenser. It will then be found that an increase in the capacity of the reaction condenser will cause the set gradually to come up to the oscillation point until a limit is reached, when it quietly commences to oscillate.

For the local station the reaction condenser is not as a rule required.
The condenser may be set in the zero position and the tuning control turned round until the station is heard. Having tuned the station in, an increase of strength may be obtained, if required, by bringing the set up to the point of oscillation. The frequency of the oscillation increases so the reaction condenser has also to be increased. This means that as the tuning capacity is decreased so the reaction condenser has to be increased. Once this peculiarity has been mastered, it is possible to

**Valves**

The liability of the set to oscillate depends upon the type of valves employed, although, with the details given, the set will be well under control with the majority of valves. The last valve should, of course,
For the reflex valve any general purpose valve may be employed, such as a D.E.3 or a D.E.R, or one of the corresponding bright emitter type.

The detector H.T. (H.T1) should be comparatively small, about 30 to 36 volts, as otherwise the detector valve tends to oscillate. The H.T. for the other valves (H.T2) should be as large as is permissible with the valves in use.

Tendency to Oscillate

The oscillation in this circuit is controlled, as has been seen, by a capacity across the secondary of the reflex transformer. It may, however, be found that with the particular transformer and particular valves employed, the circuit still oscillates even at the minimum of the reaction condenser. In such a case the trouble may be remedied very simply by moving the earth tapping down a few turns, i.e., making the tapping at the 18th or 19th turn instead of the 20th. It is simpler to try different valve combinations first, however, as with the majority of valves reaction control comes well in the middle of the condenser.

Conversely, if the reaction is insufficient at the high frequencies (low wavelengths), the earth tapping should be moved upwards a few turns.

With suitable adjustment the reaction control is smooth and free from backlash. It also remains near the oscillation point over a reasonable range.

Variations of H.T. voltage and filament current should be tried till this ease of control is obtained.

The lay-out of the components is compact, while the wiring is adequately spaced.

With some valves an increase of C2 is beneficial, and values up to 0.007 µF may sometimes be employed with advantage. If C2 is too large, low-frequency buzzing takes place.

If different transformers from those specified are employed, the effect of the changing over the connections to the terminals should be tried, as it will usually be found that one connection gives rather better signal strength than the reverse.

Test Report

As has been stated, the set was primarily designed to operate upon the local station, and to give simple control with good selectivity. Actually, however, the receiver has been tested in various parts of London, and no difficulty was experienced in tuning in several other stations on the loud-speaker, as will be seen from the accompanying test report.

Valves in use: All D.E.3 type.


Aerial on smallest tap (10 turns).

Dial Station Remarks

33 Unidentified Dance music.
34 Aberdeen Radio Toulouse
36 Birmingham French station
48 Glasgow
51 German station London in background.
52 Newcastle Interference from London.
55 Bournemouth

All the above on the loud-speaker.

Note.—The dial used is a frequency dial, so that the higher wavelengths (lower frequencies) tune in at the lower readings.

The finished set has an attractive appearance.

November, 1925

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Aerial on smallest tap (10 turns).

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IMPORTANT NOTICE.

Owing to the numerous applications from our readers for Back Numbers of our publications, we have decided to make no extra charge on any of our periodicals for issues published within six months. The charges for back issues more than six months old will be as in the past.
Opinions of Famous Amateurs

THIS advertisement is written not by us, but by some of the most prominent amateurs in Great Britain who have conducted independent tests of the GECOPHONE Low-Loss Slow-Motion Variable Condenser.

Extract from report from Mr. J. C. READ, Vice-President of the Hounslow and District Wireless Society.

"When the condenser was placed in circuit there was a marked increase in signal strength and the receiver much more sensitive. The hand-capacity effect is almost entirely eliminated and working on 30 metres it could be regarded as negligible. The micrometer adjustment is of a very convenient ratio, i.e., a large wavelength band can be covered quite conveniently and the most minute adjustments can be easily made. There is absolutely no backlash."

(Signed) J. C. Read.

Extract from report from Mr. H. LITTLEWOOD.

"On the broadcasting band of wavelengths tuning is greatly improved, and stations are now received with the greatest of ease which, in the case of the ordinary condenser, were most difficult to tune in. Hand-capacity, the principal fault of many condensers, is entirely absent: "When used as closed circuit condenser in a short wavelength receiver the results were astounding. Tuning was simply child's play. You have undoubtedly set a new standard in variable condensers which, in my opinion, will take a great deal of betting."

(Signed) H. Littlewood

Extract from report from Mr. S. MACDONALD ASH.

"I consider it to be a masterpiece of design and workmanship and have already realized its great advantage in long-distance reception. The beautiful slow adjustments, which are perfectly smooth and without the slightest backlash, far surpasses that of any variable condenser I have yet tested. I shall have no hesitation in recommending this condenser on every possible occasion."

(Signed) S. Macdonald Ash.
experts in radio acoustics since 1908

The Table-Talker
designed with expert knowledge of acoustics


The ultimate excellence of the Brandes instrument does not lie solely in the hands of the master craftsman. True, his care and ingenuity must be exercised during construction, but the basic principles are laid down for him by technical experts in the Brandes laboratories. There the secrets of acoustics are thoroughly investigated and finally built into our plans. The electrical impulse is captured by your set. Transformed to audible sound by a Brandes loudspeaker that transmitted sound is perfectly reproduced.

The new goose-neck design is the result of research in radio acoustics, which definitely establish its value in relation to the diaphragm fitted. One feature remaining unchanged is the patent material used in the construction of the horn which eliminates any suggestion of harshness. It is now possible to control volume and selectivity with the small lever located at the rear of the base and to tune-in to a finer degree. Elegantly shaped, it still has that tasteful neutral brown finish and felt-ruffled base. Height 18 ins., bell 10 ins.

Ask your Dealer for the Table-Talker.

Audio Transformer Ratio: 1 to 5
17/6

Matched Tone Headphones
20/6

The Brandola
90/6

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WITH so many different types and makes of valves on the market at the present time it is sometimes very difficult to make a decision as to what kind to use in any particular receiver or amplifier. It is proposed, in this article, to give some idea of the fundamental valve characteristics and constants required for the performance of different functions, and so to assist one in making a decision as to what valve to buy.

Valve Constants
Most manufacturers now supply data for each of their different types of valves, from which one is able to judge their capabilities and their limitations, having regard to the set in which they are to be used. The following are the more important constants of a valve which should be considered:

- Filament current and voltage.
- Voltage amplification ratio.
- Impedance.
- Grid bias required under working conditions.
- Maximum or total emission.

The Filament
Let us consider these various points in turn. If economy in filament battery power is of no importance, then probably the only advantage in choosing a dull emitter valve is that it has a considerably longer life than that of the bright emitter. In other respects there is nothing to be gained. As economy in accumulators, however, is generally of very great importance it is usual for the choice to fall to the dull emitter, especially in cases where the number of valves exceeds two or three.

With regard to dull emitters, it is as well to remember that there are two distinct types of filament on the market, namely, the coated filament and the thoriated tungsten filament. If a valve with a coated filament is obtained great care must be taken not to over-run it, as this is easily done if the filament voltage is increased by more than about ten or twenty per cent. above its specified value. The thoriated tungsten filament is not nearly so susceptible to excessive voltage and is not easily burnt out.

What is Voltage Amplification Ratio?
We now come to the voltage amplification ratio, which is the theoretical voltage amplification of a valve. For instance, if this ratio for any particular valve is 10, then by applying an alternating current potential of 0.1 of a volt between the grid and the filament, it should be possible to obtain an alternating potential of 1 volt across the anode circuit. In practice, however, this actual "step-up" in voltage cannot be obtained owing to the high impedance of the valve itself, which cannot be neglected in comparison with the practical values of external impedance in the anode circuit. For example, if the external impedance in the anode circuit is only equal to the impedance of the valve itself, then the actual voltage amplification is only half the theoretical value.

The higher the external impedance in the anode circuit compared with that of the valve itself, the nearer will the amplification factor under working conditions approach that of the theoretical amplification ratio. In practice, for voltage amplification it is usual to make the external impedance of the anode circuit if possible at least 3 to 4 times that of the valve itself.

In cases where a load is taken from the anode circuit to operate a loudspeaker, for instance, the conditions are somewhat different, and these will be discussed below.

Valve Impedance
We have also to consider the internal impedance of the valve. This is not simply the resistance of the valve as obtained by dividing the value of the high-tension voltage applied to the anode by the anode current. It is obtained by finding the change in anode current produced by a small
change in the anode potential and dividing the change of anode volts by the change in anode current. For example, if a valve, at zero grid potential, gives 10 milliamps anode current at 90 volts, and 12 milliamps at 70 volts, then the impedance of the valve at zero grid volts, and a mean anode voltage of 100 is equal to

\[ \text{Impedance} = \frac{90 - 70}{12 - 10} = \frac{20}{2} = 10,000 \text{ ohms}. \]

The impedance and amplification ratio of a valve depend on the size and spacing of the electrodes. A valve with a high amplification ratio usually has a high impedance and a valve designed for a low impedance has a comparatively low amplification ratio.

**Classification of Valves**

Let us now consider the effect of these various characteristics in different types of circuits. Receiving and amplifying valves can at present be divided into the following types according to their uses:

(a) High-frequency amplifiers and detectors.
(b) Low-frequency amplifiers.
(c) Power or loud speaker valves.
(d) General purpose valves.

We will consider these requirements in turn.

**High-frequency Amplification and Rectification**

As the voltages and power dealt with in high-frequency amplification and rectification are very small the maximum emission required from the valve is comparatively small and need not exceed 5 to 10 milliamps. The chief requirements of a detector valve is a high voltage-amplification factor. Although this means a high impedance, it is not of serious consequence. The valve should be designed for a comparatively low anode voltage, and should be such that the characteristic is fairly symmetrical about the zero grid volts line. The requirements are thus an impedance of 30,000 to 60,000 ohms with an amplification factor of 10 or more.

For high frequency work the external impedance in the anode circuit is usually very high, particularly if tuned circuits are employed. This has led to the use of valves having a high impedance and consequently a high amplification factor.

**Low-frequency Amplification**

For low-frequency work the external impedance is usually fairly low, so that a low-impedance valve is preferable. For power amplifier work, using transformer coupling, the valve should be designed so that the mid point of the working straight part of the anode current-grid voltage characteristic is obtained with about -5 volts on the grid. This allows of a fairly large sweep in the grid potential without the liability of the grid becoming positive. To obtain these conditions without the necessity of excessive high-tension voltage, the valve should have an amplification ratio of, say, between 5 and 10 with an impedance of from 10,000 to 25,000 ohms.

**Resistance Amplifiers**

The valve required for use in a resistance amplifier depends on the value of the anode resistances. If these are of the order of 50,000 to 100,000 ohms the impedance of the valves can be as much as 30,000 to 50,000 ohms. This allows a valve of a high amplification ratio to be used. The high tension supply in all cases should be sufficient to enable the valve to be operated with a negative grid bias of one or more volts, depending on the amplitude of the signal.

With resistance amplifiers it must be remembered that the high-tension voltage must always be considerably greater than that normally required with transformer coupled amplifiers, owing to the voltage drop across the resistance itself. In a resistance amplifier in which a valve is used with an impedance equal to half that of the anode resistance, the voltage required on the amplifier will be three times that normally used with the valve in a transformer coupled amplifier.

**Power or Loud-Speaker Valves**

Up to the present we have been dealing with valves whose chief function has been voltage amplification. Practically no power has been required from the anode circuit. As the power taken by a loud speaker may be considerable, it is essential to select a special valve for this purpose. The power that can be obtained from a valve naturally depends on the high tension voltage, but as this is limited in most cases to about 200 volts at a maximum, the valve used should be capable of supplying the power required at this voltage and of course supplying it without distortion.

To obtain power under these conditions it is essential that the impedance of the valve should be very low. The amplification ratio is of secondary importance but this of course should be as high as possible for any given impedance. For instance, a valve with an impedance of 5,000 ohms and an amplification factor of 3 is capable of giving much more volume of sound without distortion than a valve having an amplification ratio of, say, 15 and an impedance of 25,000 ohms.

In addition to a low impedance, a loud-speaker valve must have a very considerable emission, which should not be less than 20 milliamps. It should also be designed for operation at a negative grid bias of at least 10 volts.

**A General Purpose Valve**

For general purpose work, a valve with an amplification ratio of 10, an impedance of 30,000 ohms and a total emission of 10 milliamps is required. For low-frequency work the anode voltage should be about 700 volts with a grid bias of from -3 to -5. For high-frequency amplification and rectification an anode voltage of about 30 to 40 would probably be sufficient. Such a valve is not suitable, however, for operating a loud-speaker of any size.
Building up a whisper of sound

FROM quite a small thing up and up you can build it—the sustained volume crystal clear all the time. Words coming through without a slur in the syllables.

You can tell an amplifier built with LISSEN parts—purity is the striking thing about it. The LISSEN T1 Transformer should be used immediately behind the detector valve. The impedance of this transformer is obtained by means of the exceptional coil used, and not by means of a heavy iron core, which always tends to distort. For prominent amplification, use a LISSEN T1 for the first stage. Follow the LISSEN T1 Transformer by one or more LISSEN L.F. CHOKEs, and you will have an amplifier which will give you reproduction of outstanding purity; rich, true tone, which makes listening a pleasure.

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Obtainable from all leading Wireless Dealers, Electrical Contractors, and Stores.
In many cases the amateur who sees the words "power amplifier" promptly imagines a large instrument, difficult to construct and complicated to wire, and, in many cases an important point to him, costly to build.

The instrument described in the following article need not, however, cost a great deal more than an ordinary two-stage L.F. amplifier to make, while it has been so designed and laid out as to enable it to be constructed and wired up without difficulty even by the comparative beginner. At the same time certain refinements have been included, so that the greatest purity of tone may be obtained under varying conditions.

**Neat Appearance**

As will be seen from the photograph, the unit presents a neat and businesslike appearance; while its perfectly symmetrical lay-out, as viewed from the front of the panel, renders it pleasing to the eye. Further, the use of a polished ebonite panel gives it a certain distinction. Only four terminals appear on the panel, two of which are connected to the telephone terminals of the receiver, the other two being connected to the loud-speaker. All the other terminals to which the batteries are connected are carried on a terminal strip at the back of the instrument.

**Jack Switching**

The plug-and-jack method of switching is employed to connect the loud-speaker in the plate circuit of either of the two valves; while the jacks, being of the filament type, automatically switch on the requisite valve or valves. The loud-speaker is not connected directly into the plate circuit, a filter circuit being employed so as to protect the loud-speaker windings from any possibility of ill effects owing to heavy plate currents that may be flowing. A valuable feature is the inclusion of jacks in both the high-tension leads in order that a milliammeter may be placed in circuit so as to check up the actual plate current flowing and also any distortion that may be occurring.

As is probably known to most readers, if distortion is occurring owing to incorrect high-tension voltage or incorrect grid bias, this is shown on a milliammeter included in the plate circuit by slight variations of the current. The more violent the "kicking" of the needle the worse the distortion.

In order to handle very large signals with the maximum purity obtainable it is, of course, necessary to use a power valve. The valves employed should be of the DE3, B6, or DFA type, with which a maximum plate voltage of about 120 volts should be used.

Separate H.T. tappings are provided for each valve, as also separate grid bias, so that each valve may be adjusted independently to work under the best conditions.

**Shunt Condensers Across Transformers**

A further refinement is the provision of means by which condensers may be connected across the primaries of either or both the L.F. transformers used, and resistances across the secondaries. The condenser across the loud-speaker...
is also of the clip-in type, so that different values may be tried out here. Where a fixed condenser is provided across the output terminals of the receiver with which this amplifier is to be used, the fixed condenser $C_1$ across the primary of the first inter-valve transformer may not be required; while the condenser $C_2$ indicated across the primary of the second transformer will only seldom be needed.

Optional Resistances
The values for the resistances to be connected across the secondaries of the transformers, where they are needed, should be determined by experiment; but in very few cases will they need to be lower than half a megohm. Their function is to apply a small load to the secondary so as to reduce any resonance effects which may cause certain frequencies to be amplified more than others. In the instrument used by the author they were not really found necessary, though a 2-megohm leak resistance would be in the region of 7 milliamps. at the outside.

Small Anode Current
It is generally believed that a power amplifier takes a very heavy current from the high-tension battery, but provided that the maximum allowable negative grid bias is used, this need not be more than 3 or 4 milliamps. per valve. The total current thus taken by the amplifier would be in the ratio (The Marconiphone Co., Ltd.).

One ebonite panel, 20 in. by 8 in. (Paragon).
One cabinet, with loose baseboard for same (W. H. Agar).
One Ideal L.F. transformer, 2.7 to 1

The complete circuit diagram of the power amplifier described. When used with a crystal set, the L.T. negative should be earthed.

The appearance of the set is neat and distinctive.
The Ruler of Radio

Your set may be a good one, but it is only as good as the valves permit. The valve is the ruler of radio with absolutely autocratic powers. Every note of music, every inflection of voice, all the charm of radio is made or marred by the valves you use.

How important then it is to choose Marconi Valves—the valves that are persistently perfect in performance, scientifically—not freakishly—designed and sturdily manufactured for long and lasting service. Your friend who uses them and your dealer who sells them, will confirm the merits of Marconi Valves.

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—from the first Bright Emitter Valve to the Super-sensitive Wuncell Dull Emitter

NOTHING can stem the pitiless tide of progress. The four-horse coach of two decades ago has now been superseded by the 40 h.p. car. And the bright emitter valve of two years ago is now being rapidly superseded by that most economical of all Dull Emitters—the Wuncell.

Wireless enthusiasts are everywhere realising that economy in valves means much more than actual current consumption. It means long life. Obviously a valve with an ultra-low current consumption and a short life—due to its fragile nature—cannot truthfully be called an economical valve.

The Wuncell puts life first and current consumption second. In spite of this, its wattage is still less than one-sixth of any bright emitter valve. That is to say, any six-volt accumulator which might, for example, have given 20 hours at a charge with bright emitters would give 120 hours using Wuncells.

The abnormally long life of the Wuncell Valve is due to its special filament, manufactured under a patent process known only to Cossor. Instead of being whittled down, as in most dull emitters, it is actually built up layer upon layer until it is as stout as that used in any standard bright emitter, and when in use it merely glows at a temperature not exceeding the embers of a dying match.

Its prolific output of electrons—harnessed to the well-known Cossor principles of construction—ensures a sensitivity which has no counterpart in any make of valve. For the first time since the Dull Emitter appeared on the market, users are saying that here at last is a perfect match in performance for the best bright emitter valve ever made.
Two dual filament resistances (Burndept Wireless, Ltd.)
Two Antiphonic valve holders (Burndept Wireless, Ltd.)
Two double circuit double filament control jacks, long type (General Radio Co., Ltd.)
Two double circuit jacks, short type (General Radio Co., Ltd.)
Two plugs (General Radio Co., Ltd.)
One milliammeter, 0 to 20 milliamps. (Burndept Wireless Ltd.)
Three fixed condenser mountings, clip-in type (L. McMichael, Ltd.)
Two grid leak mountings (L. McMichael, Ltd.)
One Super-Success Audio choke (Beard and Fitch).
One set of 125 µF fixed condensers (T.C.C.).
Two 2 µF fixed condensers (T.C.C.).
One terminal strip, 6 in by 2 in, by 1/4 in. (Paragon).

The positions of all holes should be centre punched so that the drill may not wander. Next fix the panel transfers where required, and then mount the components on the panel itself. The panel may now be mounted on to the baseboard, after which the components which go on the baseboard are fixed into position. The lay-out of this baseboard may be obtained from the wiring diagram shown in Fig. 2. Next drill the terminal strip, fix the panel transfers to it, put the terminals on and fix to the baseboard where shown.

**Wiring of Jacks**

The wiring may now be commenced. First of all wire up the low tension filament supply circuit, taking particular care to get the connections to the filament contact from the jacks correct. The holes are numbered in the wiring diagram to correspond with the numbers shown in the theoretical circuit diagram, while the enlarged view of the jacks in Fig. 3 has the tags numbered to correspond with both of these. There should, therefore, be no difficulty in completing this.

In case there should be any doubt, however, as to the connections for the jacks, the following points should be noted:

- **Jack No. 1** — Contact 1 to Anode V, and OP of the Second Transformer.
- Contact 2 to IP of Second Transformer.
- Contact 3 to meter jack 1, other side of this going to HT +.
- Contact 4 to contact 6 jack 1, and to R4.
- Contact 5 to R1.

The single hole in the centre of the panel below the milliammeter is a 1/4 in. hole to allow of the milliammeter plug being inserted there when not required to be inserted in the anode circuit of either of the valves. In order that a sound connection may be made to the jacks with the flex leads, all round telephone tags have been soldered on the ends of the flex. The single leads from the filter circuits are fastened to the baseboard at one point by means of a screw and a washer, so as to take the strain of any pull that might accidentally be placed on them, and so eliminate any risk of the soldered joints being injured.

**Testing Out**

Having completed the instrument, it should next be carefully tested out. To do this, first of all
connect the low-tension battery to its terminals, and insert two valves, one in each valve-holder. See that the filament resistances are in the "off" position and insert the loudspeaker plug into jack No. 1. Turn on the filament resistance and see that the valve lights correctly. Now turn on the second filament resistance, and in this case the second valve should not light. On transferring the plug from jack No. 1 to jack No. 2, both valves should light. If this is in order, O.K., and separate leads taken to each of the high-tension terminals, giving the correct voltages. These will depend, of course, on the valves being used and the amount of volume requiring to be handled.

Milliammeter Connections
Next find out the correct connections for the milliammeter by plugging it into one of the meter jacks with the valve alight, and a small value of high tension plugged in. If the needle swings is which. If the meter is not mounted, it should be noted that the holes for the flex and plug will not be needed.

Connections to Receiver
Having ascertained that the connections of the instrument are correct, connect it to the receiver with which it is to be used. It should be noted that the top of the two input terminals should be connected to that terminal on the receiver which goes either direct

![Fig. 2](image-url)
Sir, you've been looking for me!

RIGHT along you've wished for a better fixed condenser, and now, at last, such an instrument is available. The Efficient Watmel is my name—a better fixed condenser, superior in all the points that make for highest efficiency. Witness my Test Report, it speaks for itself. Next time you're at your dealer's, ask to see me. Close examination will decide you that I'm the fixed condenser you've been looking for.

Watmel Test Report
1. High Insulation—7,000 volts.
2. Complete Condenser up to 1,000 volts.
3. Capacity checked.
4. Insulation up to 500 volts after Fixed Assembly.
5. Final Capacity Test.

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<td>£2.25</td>
<td>0.002 to 0.003</td>
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<tr>
<td>£2.75</td>
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<tr>
<td>£3.25</td>
<td>0.005 to 0.006</td>
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The success frame aerial is an ingeniously designed frame aerial. Constructed of thoroughly seasoned wood — stained black. It is collapsible, which obviously offers a distinct advantage to flat dwellers. The particular construction permits collapse without damaging the wires. When in use the wire is held taut, a specially prepared braided covered insulated wire is used. All metal fittings are heavily nickelled. The Success Frame Aerial presents a very desirable piece of apparatus for all Super Heterodyne owners. WAVEBAND COVERED with a 300-500 M.F. Stated capacity, 300 to 500 METRES.

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"It works!" Think what that means, you often-disappointed home constructors! How many times have you built sets with parts from a dozen different sources and found it impossible to get anything like good results? But make a set from the FADA 169-A components and you'll have a five-valve Neutrodyne that works to perfection. It works because every part has been designed by FADA for this particular circuit—because every part fits, mechanically and electrically.

You never saw a set as easy to construct as this. Every component is provided, ready to assemble. A 75-page instruction book describes every operation down to the smallest detail, in correct order. A short evening's work with a few simple tools, and you have a set that looks as good, and works as well, as the most expensive outfit money could buy.

All the wonderful FADA properties are evident in this set you can build yourself. Selectivity that cuts out ZLO in London and brings in other British or Continental stations at once. Simplicity that reduces tuning merely to turning the dials to specified positions. Marvellous clarity and loud-speaker volume!

Over 10,000 amateurs have built sets from these FADA components. You can do the same and get the same perfect results.

The complete outfit of components (less case and valves) costs £14. If your local dealer does not stock, write:

FADA Radio Ltd.
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Manufactured under Hazeltine Patents granted in Great Britain.
local broadcast station, using only one of the valves at first. Tune the station in as loudly as possible and insert the milliammeter in its jack, and note how much current is passing, and whether the milliammeter needle kicks or swings at all. If 80 volts are being used on volts. A larger anode voltage will, of course, call for greater negative bias, and vice versa.

It is always preferable to adjust the grid bias to the maximum allowable without producing distortion, in order to effect economy in high-tension current.

The apparatus is well spaced, giving ample room for wiring.

Adjustment of Grid Bias

If the receiver is very close to a broadcasting station, and the volume is at all large, it may be necessary to raise the anode voltage in order to eliminate kicks on the needle, in which case the grid bias will, of course, have to be increased accordingly. If signals are loud with only one stage of the power amplifier in use, the second stage will make signals absolutely unbearable. The receiver should, therefore, first be detuned before switching in the second valve. The anode and grid voltages of this should then be adjusted by using the milliammeter as a check, by plugging it into the other jack. If 120 volts are being used on the plate of this valve, then the correct grid bias will be in the region of 9 volts. A larger anode voltage will, of course, call for greater negative bias, and vice versa.

Foreign Stations

In the late afternoon, when 2LO was not on, a number of foreign stations were received on the loudspeaker with the greatest of ease. Among these were Vox-Haus (Berlin), San Sebastian (Spain), Hamburg (Germany), and one or two of the B.B.C. stations, which were not identified. No difficulty was experienced in tuning the stations in directly on the loud-speaker, and quality was all that could be desired.

Test Report

Separate tests were made with this instrument, in one case using two DE5 valves, and in the other using a couple of small power valves of different denominations, B6 and B7, which were handy. The amplifier was connected up to a single-valve reaction receiver.

The broadcasting from 2LO was first of all received, using one stage of L.F. amplification only, and with this signals were as loud as could possibly be required even in a large sized room. After the necessary adjustment had been made, the reproduction was noticeable for its excellent quality. On switching on the second valve,
Is Self-Capacity a Bogey?


One hears a good deal about self-capacity of coils and the general impression is that self-capacity is to be avoided at all costs. In this article Mr. Barton-Chapple shows just where self-capacity can cause trouble and how ill effects may be avoided.

Before commencing to discuss the effects of self-capacity, it is desirable to obtain a clear idea of what self-capacity really is. In order to produce a current through a coil of wire it is necessary to apply a voltage across the ends of the coil. In a similar manner if a coil is carrying current there must be a voltage developed across the coil.

Thus in a coil inserted in a wireless circuit the wireless currents which are set up in the coil will produce voltages across the coil (these voltages being applied to the detector or amplifier which is in use). Now considering this in a little more detail it will be clear that every portion of the coil must have a small voltage across it, produced by the current; that is to say, there must be a small voltage between each individual turn of the coil.

A Small Condenser

We have here all the elements of a condenser. We have two conductors at a different voltage, separated by an insulator; that is, the insulation of the wire itself. There is thus a capacity between the two parts of the coil.

The effects of all these small capacities between the various internal portions of the coil all add together to produce an effect which is the same as if a small capacity were connected across the terminals of the coil itself. It is this somewhat imaginary capacity which we term the "self-capacity" of the coil. Actually, of course, as we have just seen, the capacity is really made up of a somewhat complex system of little inter-turn capacities. But the effect on the coil when used in a wireless circuit is found to be exactly the same as that of connecting a parallel capacity across the coil, and for this reason it is usually regarded from this point of view. The point is illustrated in Fig. 1.

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Value of Self-Capacity

Let us now consider some of the effects produced by this self-capacity. We are interested technically in three aspects of the question. First of all there is the effect of the capacity upon the tuning of the circuit, and this introduces the second question; that is to say, the actual value of the self-capacity and its dependence upon the type of coil and the nature of the windings. The third question is that of the losses which are introduced into the circuit by this additional capacity.

Now the value of the self-capacity is normally very small. The author recently measured the self-capacities of a large range of coils suitable for broadcast reception made by both amateurs and commercial firms, and found that the values varied from 4 μF for a single layer coil to as much as 35 μF for multilayer coils. The higher values were no doubt due to poor mounting, for the coil windings were particularly good, and an improvement could be effected by remounting on a reliable coil mount of best quality material.

With large multilayer home-made coils even larger capacities were obtained, the extreme being found in a coil of just over three henries inductance, which reached a figure of over 700 μF.

The various methods of avoiding self-capacity have been discussed on various occasions, and it is not proposed to dwell upon these in this article. The main principle to be followed in winding coils is to ensure that the turns at the beginning and end of the coil shall be kept well apart. Care should also be taken to avoid adjacent turns being too close to each other, and this has given rise to the practice of winding well spaced types of coil. The question we have to discuss at the moment, however, is not how to reduce the self-capacity, but what is the effect of the self-capacity on the circuit and whether it is as serious as is generally supposed.
HE Dubilier Condenser Co. (1925) Ltd. manufactures the largest condensers in the world, using the best dielectric in the world (i.e., Mica) in the largest Condenser factory in the World.

Our factory at Acton is illustrated above, together with the largest Condenser in the world, which was manufactured entirely by us at our works.

The fact that we produced the first practicable mica condenser is evidence of our ability as experimenters and pioneers, while the further fact that we are to-day, after twelve years of development, the largest manufacturers of wireless condensers in the world is evidence of the outstanding quality of our products.

The Dubilier Condenser Co. (1925) Ltd., manufactures—Fixed Mica Condensers, Variable Air Condensers, Anode Resistances, Grid Leaks, the Dubrescon Valve Protector, the Ducon Aerial Adaptor, the Minicap Switch, and the Mansbridge Variometer. The Company are also sole concessionaires for the Mansbridge Condenser.

Whenever any of these products are required it is always wisest to—

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THE initials “B.T.H.” on any piece of radio apparatus, as everyone knows, stand for perfect workmanship and design. This fact is exemplified in the three B.T.H. Variable Condensers illustrated, which are unsurpassed in mechanical and electrical efficiency.

The STANDARD TYPE is a very robust instrument, and the moving vanes are so rigidly set that they remain parallel to the fixed vanes throughout the whole movement. Constancy of calibration is therefore maintained. It is perfectly silent in operation.

The STANDARD WITH VERNIER, whilst retaining a perfectly rigid construction, provides a very delicate adjustment. Maintenance of calibrated capacities and silence in operation are important features. A definite stop prevents complete rotation. The vernier vane is actuated by a small knob mounted on the main dial.

The SQUARE-LAW TYPE has all the good features of the Standard with the addition that the wave-length variation is approximately proportional to the scale readings. It will therefore be found that the stations are spaced out, thus giving a greater degree of selectivity.

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<th>TYPE</th>
<th>.00 25 m.f.</th>
<th>.000 5 m.f.</th>
<th>.001 m.f.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>13 6</td>
<td>15 6</td>
<td>1 1 0</td>
</tr>
<tr>
<td>Standard with Vernier</td>
<td>17 0</td>
<td>19 6</td>
<td>1 6 0</td>
</tr>
<tr>
<td>Square Law</td>
<td>13 6</td>
<td>15 6</td>
<td>1 1 0</td>
</tr>
</tbody>
</table>

B.T.H. VARIABLE
CONDENSERS

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Effect on Tuning

Let us now consider the effect of the self-capacity on the tuning of a particular coil. There are two particular cases to be considered. In the first case we have circuits of the type shown in Fig. 2. Here the signal voltage is introduced into the coil itself. This may come from an aerial circuit or by coupling from a previous circuit in a valve amplifier or some similar arrangement.

The coil is tuned by connecting a variable condenser across the two ends, and it will be seen that the only effect of the self-capacity in this case is to increase the value of the tuning condenser. The result of this will be that the maximum value will be slightly higher, although this increase will be almost inappreciable, and the minimum value will also be increased by the same amount.

Restriction of Tuning Range

Now at the minimum value of the condenser the capacity of the variable condenser itself is very small, so that the self-capacity of the coil becomes appreciable, and it is quite possible for the resultant capacity across the coil to be two or more times as great as the minimum value of the condenser. The effect of this, therefore, is to reduce the tuning range of the coil to some extent.

With normal circuits working on broadcast frequencies, this does not cause any appreciable trouble, with a well-wound coil. With a poorly wound coil, however, tuned with a small condenser, this restriction of tuning range may be very serious, and may cause considerable trouble in actual practice.

For this reason it is customary to use well-spaced windings and to avoid any solid dielectric in the make-up of the coil. This form of construction is also useful from the other points of view, such as the reduction of losses in the circuit, as will be seen later.

Rejector Effect

The second type of circuit in which a coil may be employed is that shown in Fig. 3. In such a case the voltage induced in the circuit is not in the coil itself, but in series with it. In this case the coil acts as a parallel tuned circuit, and it is well known that such a circuit has the properties of a rejector. It has a very high resistance at the frequency to which it is tuned, and it can be shown that the resistance is also quite appreciable even at frequencies some distance away from the natural frequency of the coil.

If, therefore, we have a coil having an appreciable self-capacity in circuit in this manner, it is quite possible that the actual resistance of the complete circuit may be increased to several times the normal value.

This particular form of trouble is prevalent in cases where loading coils are used when the circuit is of the type shown. We see, therefore, that the self-capacity of the coil is more harmful in a case like this than in the previous case where the energy is introduced into the coil itself. The case in Fig. 3 is fortunately less commonly used than the type shown in Fig. 2, but this type of circuit has to be used on occasion, and it is desirable to employ a coil having a low self-capacity in such a case.

Losses in the Circuit

We now come to consider the third aspect of the question; that is to say, the problem of the losses set up in the circuit. Now it can be shown that whenever there is any solid insulation for a condenser, there are losses set up by the presence of the insulation in the electric field of the condenser.

In the case of a coil we have just seen that the insulation in between the "plates" of the condenser is really the actual insulation of the wire of the coil itself. This insulation, in many cases, is cotton or silk, and this does not constitute an ideal insulator at high frequencies. The losses in such a dielectric are very often heavy, and this makes the condenser connected across the coil a very poor one. That is to say, the current flowing through this self-capacity will give rise to very appreciable losses which are to be avoided as far as possible.

Special Forms of Construction

This has led to the development of special forms of winding for low-loss coils. In such coils the insulation on the wire is made of as good a quality as possible. Cotton-covered wire is avoided wherever practicable, and either silk, or even better, enamelled wire is used. If the coil is wound with a spaced winding then no insulation need be used on the wire at all. This method, unfortunately, has the disadvantage that the wire of the coil is liable to oxidise on the outside, which increases its resistance, so that a thin coating of enamel is desirable to avoid this oxidation.

Losses the Principal Trouble

We see, therefore, that the most serious effect of self-capacity is the loss which is set up in the circuit, due to the imperfect insulation between the turns from a point of view of high frequency currents. The insulation may be perfectly good as far as actual conductivity is concerned, but it may nevertheless be very poor for high frequency work. With adequate precautions, however, this loss may be reduced to a negligible quantity, and that is one reason for the great prevalence of the low-loss coil at the present moment.

Multi-layer coils have to be used in certain circumstances, in which case the precautions necessary to avoid loss are more complicated, but with suitable care a reasonably low loss can still be obtained.
IS THE AERIAL CIRCUIT EVER APERIODIC?

by G.P. Kendall, B.Sc.

An account of some extremely interesting investigations upon a popular method of aerial coupling.

Some little time ago a tuning arrangement of the general form illustrated in Fig. 1 began to achieve a considerable degree of popularity, and the name "aperiodic aerial circuit" was given to it. The main features of this arrangement are that we have actually aperiodic in its functioning. It has further been maintained that the only tuned circuit in this arrangement is the secondary circuit $L_1C_1$, which, of course, provides the only adjustment in the circuit, and that it possesses the sharpness of tuning of a given circuit. This desirable end is achieved, moreover, without sacrifice of signal strength, when the correct number of turns has been found for the aerial winding.

Need for Adjustment

The arrangement has certainly proved its merits in actual practice, but certain curious variations in its behaviour on different aerials have led to a certain amount of disappointment in some cases. Many experimenters have noticed that although someone may recommend, say, ten turns as the correct number for the aerial winding, yet on their particular aerial nothing less than fifteen gives anything like the signal strength which could be obtained with an ordinary direct-coupled arrangement. It has been concluded by almost everyone who has tried the arrangement upon more than one aerial that some adjustment of coupling turns is needed to suit a particular aerial if the very best results are to be obtained, although an average number can be applied which will give fair results upon the great majority of aerials.

Fig. 1.—This graph shows the relation between turns in the aerial winding (plotted horizontally) and signal strength (S) measured across the secondary.

It has been argued that with this arrangement the aerial functions as an aperiodic collector of energy, the circuit comprising the aerial, most of the good points of a loose-coupled tuner of the conventional type containing separately tuned primary and secondary circuits, with the advantage that only one tuning control is necessary.

An Advantage

The principal property of this arrangement which has been found so attractive is the fact that its selectivity under proper conditions is very considerably higher than that of an ordinary direct coupled arrangement, so that it serves a very useful purpose in cases where it is desired to improve the sharpness of tuning of a given circuit. This desirable end is achieved, moreover, without sacrifice of signal strength, when the correct number of turns has been found for the aerial winding.

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that selectivity is extremely high, and signal strength rather poor, and that as the number of turns is increased selectivity gradually falls off, while signal strength rises up to a certain point, remains more or less constant over a wide range of turn numbers, and then gradually falls off again as the aerial turns are increased above a certain point: it is necessary to reduce the aerial turns as far as possible to obtain a high degree of selectivity without undue sacrifice of signal strength. These points, and a number of other somewhat obscure ones, connected with the functioning of this so-called aperiodic aerial arrangement, have led to a good deal of investigation being carried out upon its properties, notably by Mr. A. D. Cowper, M.Sc., most of whose results have been published in Wireless Weekly. Much interesting and useful information has been derived from this work, but the point regarding the actual functioning of the aerial circuit, that is to say, whether it is really aperiodic or semi-aperiodic, or whether it is tuned by virtue of the tight coupling between the primary and the secondary, in the way in which we are accustomed to consider takes place in a high frequency transformer whose secondary is tuned, has not received very much attention.

Interesting Tests
In an endeavour to obtain some light upon this point I have recently carried out a series of quantitative experiments, the results of which I think may be of some interest to the readers of Modern Wireless.

All these experiments consisted in the measurement of signal strength given by different arrangements of tapping points, series condensers and resistances, and it is therefore desirable to explain the method of measurement employed.

The Method
The procedure was to tune the arrangement to the frequency of the local station's carrier wave, this station being situated at a distance of about eight miles from the receiving point, and to measure the signal strength resulting across the receiving point by means of a very elementary form of the Moullin voltmeter, and an example will make this method clearer than a lengthy description. If the reader will examine Fig. 1 he will see that this illustration shows a curve giving the relation between two variable factors, and inset a sketch of the circuit concerned. This circuit is the typical "aperiodic aerial" arrangement, with a variable tapping upon the aerial winding, while the bracket at the right, across the secondary, indicates that the voltage across this circuit was used as a means of estimating the signal strength S.

What was actually done was to place the aerial tapping "T" upon different numbers of turns on the aerial winding, and measure the signal strength produced across the secondary in each case, it being understood that the secondary was re-tuned to resonance each time the aerial tapping was moved. The result is shown in the graph, the number of turns in the aerial circuit being plotted horizontally, and the signal strength vertically.

Starting with 16 turns in the aerial circuit, a signal strength of 3.2 was obtained, from which value signal strength rose steadily as the number of turns in the aerial circuit was increased until the eighteenth turn was reached, beyond which point signal strength began to fall off again.

The Coil
The coil which was used for this experiment, and for all the others which we are considering, was a " Three-step " inductance, of which an illustration appears at the head of this article. It comprised 6o turns of No. 22 d.c.c. wire, and the aerial winding was wound directly in the top of the secondary, being inserted turn by turn in the slots in the former.

The form taken by the curve illustrated in Fig. 2 is a thoroughly typical one for this circuit arrangement, and this will no doubt be familiar to readers who have studied

![Fig. 2](image_url)

**Fig. 2.** The auto-coupled type of circuit gives a curve which conforms closely to that of a circuit with a separate aerial winding (see Fig. 1).

![Fig. 3](image_url)

**Fig. 3.** These three graphs show the effect of adding series condensers in the aerial circuit.

...
falls off more rapidly beyond the optimum point.

The actual position of the peak also varies with the capacity of the aerial, a large aerial showing a peak further back towards the left. In general, however, the length of the relatively flat portion of the curve is sufficiently great to cover quite a considerable band of frequencies, so that in one sense it is perhaps justifiable to describe it as an "aperiodic aerial" arrangement.

At the outset of these experiments it was desired to ascertain whether there was any fundamental difference in the behaviour of the simple form of the aperiodic aerial arrangement, and the scheme known as auto-coupling. (This is a method in which the earth connection is made to the lower end of the tuning coil, and the aerial to a point some ten or fifteen turns up the coil.) It might be expected that the results would be very similar to those of the "aperiodic aerial" arrangement in its conventional form, and accordingly a curve was plotted for the same coil as before, varying the position of a direct aerial tap.

Series Condensers

The result is shown in Fig. 3. The form of the curve so closely resembles that of Fig. 2 that it was assumed that further investigations might be confined to the separate winding arrangement.

Effect of Resistance

The next experiment was designed to show the effect of greater or less amounts of resistance in the aerial circuit, and for this purpose the usual circuit was set up and curves plotted showing the relationship between turns in the aerial circuit and signal strength, with varying amounts of resistance inserted in the aerial lead. The three curves, 2, b and c, in Fig. 5, show the result, curve a being the result of the insertion of approximately 30 ohms in the aerial circuit, b 20 ohms, and c 10 ohms. The dotted curve is inserted for reference, this being the form obtained when no resistance is added. It will be seen that the effect of adding resistance is to increase the sharpness of the peak and to remove the peak to the left, i.e., towards the smaller numbers of turns in the aerial circuit. In effect, the results obtained are thus merely the imitation of a high resistance aerial, which will be remembered as having the effect of increasing the sharpness of the peak.

Neither of these observations seems to accord very well with the conception of an aperiodic aerial circuit, and it was therefore decided to seek some more decisive method of testing the point.

Further Tests

Now, one of the main arguments in favour of the aperiodic theory is to be found in the fact that the number of turns included in the aerial circuit for the best signal strength across the secondary is far below the number which would be required to tune the aerial circuit in itself to the received frequency. As a matter of fact, signal strength falls off seriously long before such a number of turns is included in the aerial circuit as would tune that circuit to the received frequency. It therefore seemed that it would be profitable to enquire into the shape of the curve up to and beyond the point at which the aerial circuit is actually tuned, since the greater number of published curves show only that portion of the range illustrated in the various diagrams which have appeared in the preceding part of this article.
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Mr. Cowper has recently published in Wireless Weekly an article upon this subject, in which he showed the relation between signal strength and the number of turns included in the aerial circuit, over a much wider range than had previously been done, the curve being of the general form shown in Fig. 5.

The Tuning Point
This is naturally an extremely suggestive result, and it becomes even more so when it is remembered that the curious minimum point immediately following upon the peak corresponds to such a number of turns in the aerial circuit that that circuit was tuned to the received frequency.

![Graph showing the relationship between signal strength and number of turns in the aerial circuit](image)

**Fig. 6.—The author's last experiment was to vary the number of turns in a separate aerial loading coil (T₂ plotted horizontally). The numbers 6, 12, and 18 indicate the number of turns in the coupling winding.**

Coupling Effects
In the method adopted by Mr. Cowper in carrying out his investigations, all the turns included in the aerial circuit were fairly closely coupled to the secondary winding, and it was decided to endeavour to determine the shape of the curve when it could be decided that the effect was more that of tuning the circuit, and not to such a great extent one of variation in the coupling between primary and secondary, since it was thought that when all the turns included in the aerial circuit were coupled closely to the secondary winding, it is possible that the effect may be one more of variation of coupling than of actual tuning.

The Last Test
The procedure therefore adopted was to include a fixed number of turns in the coupling winding, say, 15, and then to insert in the aerial lead a tapped loading coil whose turns might be varied at will, and which was not coupled in any way to the other winding. In this way the aerial circuit could be tuned to the received wavelength without increasing the coupling between the two circuits. Several curves were next plotted to show the relationship between the number of turns in the loading coil and the signal strength obtained in the secondary circuit, and three of these are shown in Fig. 6.

Each of these curves is marked with the number of turns included in the coupling winding, while horizontally can be read the number of turns in the separate loading coil, the signal strength being recorded vertically. Now, these curves will at once recall to mind the "double humped" resonance curve obtained with the ordinary tuned primary and secondary arrangement, when the coupling between the two coils is too tight, and this resemblance is very suggestive as to the true mode of functioning of the so-called aperiodic aerial circuit.

Conclusions
The curves show that the arrangement conforms to the behaviour of a very tightly coupled primary and secondary, in the sense that when the coupling is tightened, that is to say when the number of coupling turns is increased the two humps are pushed further apart and the "dip" or notch between them becomes deeper, and, further, that the two side humps are flattened out. A test arrangement is simply a primary circuit so closely coupled to the secondary circuit that two very much flattened humps are produced instead of a sharply peaked resonance curve, and that we commonly work upon one of these humps, usually the one appropriate to the smaller number of turns in the aerial circuit rather than the larger.

It would follow from this that the curve shown in Fig. 1 and in Fig. 3 are each one of these flattened humps. Such a hump appears to be wide enough upon its relatively flat portion to accommodate quite a considerable band of frequencies.

Weakening the Coupling
It is worthy of note that if the coupling between the aerial and the secondary winding is weakened notably, perhaps with the idea of getting selectivity, the flatness of the humps disappears, the two humps approach each other, and we revert to practically the ordinary separately tuned primary and secondary scheme. When this is done it is no longer possible to cover a wide band of frequencies with a fixed number of turns in the aerial circuit, and the term "aperiodic aerial circuit" is less appropriate even than before.
Perhaps one of the biggest difficulties of those listeners living within crystal range of a broadcasting station near the coast is to eliminate the annoying background of Morse so prevalent in these areas.

Any attempt to increase selectivity, so difficult in crystal receivers on account of the damping effect of the crystal itself, is a step in the right direction; and although receivers of this type may be a little more complicated than those of the direct-coupled types, the final results are well worth the slight extra care needed in the construction.

In the last issue of Modern Wireless I described a simple three-valve receiver of a type specially suited to coastal dwellers, and it is with the object of assisting the crystal enthusiast that I have designed the little set described in this article.

The Circuit

The circuit is shown in Fig. 1, and consists mainly of two tuned circuits—the aerial circuit and a closed secondary circuit. It will be noticed that the aerial circuit is in two portions indicated by the two inductances $L_1$ and $L_2$. $L_1$ consists simply of a plug-in coil of the usual commercial pattern placed in relation to the secondary inductance $L_3$ in a position of minimum coupling, that is the axes through the centres of the two coils are at right-angles.

Loose Coupling

The aerial circuit is loosely coupled to the inductance $L_3$ by means of a very small coil $L_4$, consisting of two to three turns wound directly over one end of $L_3$. Since the aerial load exercises a damping effect upon the aerial tuned circuit, no appreciable advantage is gained by attempting to eliminate all possible sources of loss in the aerial circuit inductances. These are tuned by a 0.0005 µF variable condenser which may be placed in series or parallel with the aid of the conventional three terminal arrangement.

Low-Loss Secondary

The secondary circuit inductance is of the low-loss type, and is tuned by a variable condenser of 0.0005 µF. To lessen the effect of the crystal damping upon this closed circuit, one side of the crystal detector has been connected to a flexible lead and spring clip (1) which may be attached to tapping points along the inductance.

The general utility of the receiver has been increased by the simple expedient of attaching a flexible lead terminating in a spring clip (2) to one side of the telephones in addition to that already mentioned. By joining clip 1 to $A_3$ note the few turns of D.C.C. wire forming the coupling between the aerial and the secondary.
November, 1925

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(Fig. 1 and Fig. 3) and clip 2 to \(E_2\), it will be seen that the set now becomes direct-coupled and can be used for any wavelength by the use of the appropriate plug-in coil.

So much for the design, and now for the construction. The components you will require are as follows:

1. Cabinet and baseboard, 14 in. by 7 in. (Camco.)
2. Insulating panel, 14 in. by 7 in. by 3/16 in. (Radion.)
3. 0005 \(\mu\)F variable condensers, square-law pattern. (Collinson Precision Screw Co., Ltd.)
5. Low-loss coil former, 7 in. by 3/4 in. (Peto-Scott Co., Ltd.)
6. Coil plug for baseboard mounting. (Burne-Jones & Co., Ltd.)
7. Terminals.
8. Brass angle brackets. (Burne-Jones & Co., Ltd.)

Approx. 1 lb. of No. 20 S.W.G. enamelled wire and a very small quantity of No. 22 S.W.G. d.c.c. wire, the number of turns being adjusted on test in actual reception. Next mount the former and coil plug upon the baseboard, and wire up, following out the connections shown in Fig. 3. You will notice that short lengths of square wire are soldered to enable the crystal tap to be used. One of the end rings of the former is drilled to take two small terminals, to which the ends of the coil \(L_2\) are secured. This small coil may consist, to commence with, of three or four turns of No. 22 S.W.G. d.c.c. wire, the number of turns being adjusted on test in actual reception.

The construction of the receiver itself is extremely simple, and the first thing to do is to drill the panel to the dimensions given in Fig. 2. The two variable condensers are upon the centre line of the panel, but the crystal detector is mounted \(\frac{1}{2}\) in. above left of the vertical one. This was necessary in order to retain symmetry.

The components are not mounted upon the baseboard to any specified dimensions, their position having been determined by trial, and the constructor would do well to follow the lay-out as closely as possible.

Having drilled the panel and mounted the two variable condensers crystal detector and terminals, commence winding the low-loss coil. This is wound with 82 turns of No. 20 gauge enamelled wire, and an ebonite ring is placed in the middle to stiffen up the square wire are soldered to enable the crystal tap to be used. One of the end rings of the former is drilled to take two small terminals, to which the ends of the coil \(L_2\) are secured. This small coil may consist, to commence with, of three or four turns of No. 22 S.W.G. d.c.c. wire, the number of turns being adjusted on test in actual reception. Next mount the former and coil plug upon the baseboard, and wire up, following out the connections shown in Fig. 3. You will notice that short lengths of square wire are soldered at three points marked \(A_1, E_1\), and clip 2.

To operate the set connect the aerial to the terminal marked “Aerial,” and the earth to “Earth,” joining \(A_1\) and “Earth” together with a short piece of wire, and connect the telephones to the two terminals marked. Attach clip 1 to \(A_1\), and clip 2 to \(E_1\), inserting a No. 35 or 40 coil in the socket \(L_4\). Rotate the condenser dial \(C_1\) until you hear your local station, if necessary adjusting the crystal detector at intervals. Tune in the station until signals are loudest, and find the best spot on the crystal.

Then attach clip 1 to one of the tappings upon the low-loss coil and clip 2 to the short length of wire as shown in Fig. 3. Rotate the condenser \(C_2\) until signals are heard, and then re-tune slightly on \(C_1\).

Selectivity

You are now in a position to conduct some interesting experiments in selectivity. Attach the spring clip (clip 1) to the tapping points along the inductance \(L_3\), and note the effect. re-tuning after each
Fig. 3.—The wiring diagram is easily followed and has been arranged to give maximum flexibility.

alteration. Try decreasing the number of turns in the coil \( L_2 \), removing one turn at the time until the best selectivity is obtained. You will probably find that it is possible to use one turn only with good effect.

For Belfast, Aberdeen, and stations above, say, 420 metres a No. 50 coil should be tried for \( L_1 \), but for Newcastle, Bournemouth and Cardiff a No. 35 or 40 will usually be adequate. To receive Daventry attach clip 1 to \( A_2 \), and clip 2 to \( E_2 \), and insert a No. 150 coil or its equivalent in the socket \( L_1 \). On the shorter wavelengths, it is interesting to note the effect of placing the condenser \( C_1 \) in series, first removing the piece of wire joining \( A_2 \) to "Earth" and then connecting the aerial to \( A_2 \). A coil one size larger than that used with the parallel arrangement will probably be necessary.

Test Report

The set was tested upon an aerial 35 feet high and 100 feet in length, at a distance of 15 miles from 2LO. For the reception of this station a No. 40 (Lissen) or a Gambrell B1 gave good results. The number of turns in the coil \( L_2 \) varied from five downwards, and finally two turns were found adequate. Increasing the number of turns to four flattened the tuning very considerably and for maximum selectivity close up to the local station one turn or, at the most, two should be ample. The effect of varying the position of the coil \( L_1 \) was tried and any variation from the position shown in the wiring diagram resulted in a loss in selectivity, thus proving that the position of minimum coupling had been adopted in the first instance.

The final position of clip 1 was on the centre tap on the coil, but in other cases better results may be obtained with one of the other tapping points. Using the direct coupled arrangement, i.e., with clip 1 on \( A_2 \) and clip 2 on \( E_2 \), and using a No. 150 coil or a Gambrell \( E_1 \) in socket \( L_1 \), Daventry was obtained at excellent strength. The low-loss coil was tested for wavelength range with a wavemeter reading from 200-500 metres, the readings on the closed circuit condenser \( C_2 \) being 45 degrees and 146 degrees respectively for these two wavelengths. It will, therefore, be seen that the coil described covers the broadcast waveband with a large margin.
The M◎ Tuned Supersonic Transformer
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<thead>
<tr>
<th>Size</th>
<th>with Vernier</th>
<th>without Vernier</th>
</tr>
</thead>
<tbody>
<tr>
<td>.00025</td>
<td>6/-</td>
<td>6/-</td>
</tr>
<tr>
<td>.0003</td>
<td>9/-</td>
<td>7/-</td>
</tr>
<tr>
<td>.0005</td>
<td>9/-</td>
<td>8/-</td>
</tr>
<tr>
<td>.001</td>
<td>10/-</td>
<td>9/-</td>
</tr>
</tbody>
</table>

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What to Listen for on Short Waves

By A.V. D. Hort, B.A.

There is an increasing amount of activity at frequencies above the broadcast band. This article gives some idea of what may be received in this region of the ether.

One-Valve Receiver

<table>
<thead>
<tr>
<th>Time G.M.T.</th>
<th>Station heard.</th>
<th>Signals heard, etc.</th>
<th>&quot;R&quot; strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>2330</td>
<td>German</td>
<td>Unidentified German Am\u00f6\u00f6\u00f6ter</td>
<td>4</td>
</tr>
<tr>
<td>2342</td>
<td>U.S.A.</td>
<td>Weak telephony</td>
<td>7</td>
</tr>
<tr>
<td>2343</td>
<td>KDKA, East Pittsburg</td>
<td>Music and speech, clear though faint</td>
<td>-</td>
</tr>
<tr>
<td>2350</td>
<td>Czechoslovakian Am\u00f6\u00f6\u00f6ter</td>
<td>3BWJ U CS 1KJ.</td>
<td>6</td>
</tr>
<tr>
<td>2355</td>
<td>U.S.A.</td>
<td>AGS de WIZ</td>
<td>7</td>
</tr>
<tr>
<td>2357</td>
<td>Amateur</td>
<td>CQ foreign U 2CXL</td>
<td>4</td>
</tr>
<tr>
<td>0000</td>
<td>&quot;</td>
<td>1\u00f6\u00f6\u00f6\u00f6ter U (unidentified)</td>
<td>3</td>
</tr>
<tr>
<td>0002</td>
<td>&quot;</td>
<td>CQ U 1KA</td>
<td>6</td>
</tr>
<tr>
<td>0003</td>
<td>&quot;</td>
<td>5\u00f6\u00f6\u00f6\u00f6ter U 8ALY</td>
<td>5</td>
</tr>
<tr>
<td>0007</td>
<td>U.S.A.</td>
<td>4FL U 3LR</td>
<td>6</td>
</tr>
<tr>
<td>0010</td>
<td>Amateur</td>
<td>ABC de WIR (harmonic)</td>
<td>4</td>
</tr>
<tr>
<td>0015</td>
<td>&quot;</td>
<td>CQ U 1SI</td>
<td>5</td>
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<tr>
<td>0020</td>
<td>&quot;</td>
<td>ABC de W\u00f6O</td>
<td>8</td>
</tr>
<tr>
<td>0030</td>
<td>&quot;</td>
<td>2030 2LO</td>
<td>9</td>
</tr>
<tr>
<td>0035</td>
<td>&quot;</td>
<td>2035 2LO</td>
<td>8</td>
</tr>
<tr>
<td>0040</td>
<td>&quot;</td>
<td>2037 French amateur</td>
<td>6</td>
</tr>
<tr>
<td>0045</td>
<td>&quot;</td>
<td>2039 British</td>
<td>3</td>
</tr>
<tr>
<td>0050</td>
<td>&quot;</td>
<td>2043 Italian</td>
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<td>0055</td>
<td>&quot;</td>
<td>2043 2LO</td>
<td>6</td>
</tr>
<tr>
<td>0100</td>
<td>&quot;</td>
<td>2045 Norwegian amateur</td>
<td>4</td>
</tr>
<tr>
<td>0110</td>
<td>&quot;</td>
<td>2047 Italian amateur</td>
<td>7</td>
</tr>
<tr>
<td>0115</td>
<td>&quot;</td>
<td>2050 2LO</td>
<td>5</td>
</tr>
</tbody>
</table>

October 7.

- "Harmonic"—very strong
- "Lower harmonic"
- "8BP de F8CA"
- "Test de G 5HX"
- "NRL de I 1AU"
- "Harmonic"
- "de LAAX"
- "CQ de I 1C0"
- "Harmonic"

Pittsburgh, in Pennsylvania, which operates at about 5,000 k.c. (60 metres). The frequency employed varies from time to time. This station can be heard any night, with the exception of Sundays, between the hours of 11:15 p.m. and midnight G.M.T., and there is rarely any difficulty in picking up the transmission. The period quoted is devoted to the "dinner-hour programme," which usually consists of musical items. The regular evening programme does not ordinarily begin till 1:30 a.m. by our time. The transmission may vary considerably in strength from night to night, and sometimes fading is very pronounced, together with a curious form of distortion, commonly described as "distance distortion." But the occasions are very rare when the transmission is altogether inaudible, and now that the winter
months are approaching reception conditions are almost noticeably improving each night. Comfortable headphone strength of these programmes is easily obtainable with a receiver consisting of a detector and one stage of low frequency amplification.

Telephony Transmissions

Another American telephony transmission is that sent out by WGY, the Schenectady station of the General Electric Co. The programmes from this station, which itself transmits at a frequency within the ordinary broadcast band, are relayed on 3,000 k.c. (100 metres) by 2NX, the General Electric Co.'s short-wave station. Normally this transmission does not begin till about 2.30 a.m. G.M.T.; good signal strength is usually obtainable.

Telephony transmissions by amateur transmitters are, of course, somewhat irregular, but on most nights a certain number of stations may be picked up, many Continental stations being frequently heard at good strength.

Knowledge of Morse Code

To obtain the greatest interest from reception on the short waves it is really necessary to have at any rate an elementary knowledge of the Morse code. Familiarity with the code makes possible the identification of the many hundreds of stations to be heard working any night, and indeed at almost any time in the twenty-four hours. It is not by any means essential to sit up till the small hours of the morning in order to pick up stations at long distances, though, of course, the man who is out to set up new records in reception or transmission finds the early morning the best time for his purpose.

Half an Hour's Reception

In order to give some idea of what may be heard any night, two tables are given here, which may be taken to be a fair sample of the possibilities of reception on short waves. The transmissions recorded in these tables were heard on the evenings of October 6th and 7th, dates which were selected quite at random, and the list shown represents about half an hour's reception in each case. The dial of the main tuning condenser was turned on each occasion once only from maximum to minimum during the period of listening, and each station heard was recorded as it was picked up. The coils in use at the time covered a frequency range of from about 3,500 k.c. to slightly above 7,500 k.c. (85 to 40 metres). The group of U.S. amateurs heard almost nightly on October 6th were all working on the 6,000 to 7,500 k.c. band; many others were also heard at varying strengths, but the time available was too short to record accurately more than a few. It will be noticed that the tables include stations spread over a considerable area, six European countries being represented, as well as three of the American districts.

Good Signal Strength

The column headed "R" strength, indicating the comparative strength of signals on the "R" scale (from R1—"audible but unreadable"—to R5—"very strong indeed"), is given mainly in order to show that to hear most transmissions there is no necessity to possess extreme acuteness of hearing. It is also worthy of note that there is usually a considerable amount to be heard on the short waves even without sitting up very late.

Those who wish to calibrate their short-wave receivers or wavemeters will find that many stations send their wavelength immediately after their call sign, when signing off at the end of a Message. As a general check on the wavelengths on which reception is being carried out this information is extremely useful. Accurate calibration checks may also be obtained from the signals sent out by certain commercial and experimental stations, notably by NKF, the United States Naval Experimental station, at Bellevue, Anacostia, D.C. Details of certain test transmissions carried out by NKF are to be found in Wireless Weekly, Vol. 6, No. 23.

Atmospheric Disturbances

During broadcasting hours listeners in the vicinity of a broadcasting station will usually find that they can receive the programme at quite good strength on one of the harmonics at these high frequencies. The writer has even found this of some service in special circumstances. One of the peculiarities of short-wave reception is that sometimes when atmospheric disturbances are sufficiently pronounced to interfere with pleasant reception at the broadcast frequencies, this interference is much less marked, even hardly noticeable, at the higher frequencies. When this is the case it may be found worth while to sacrifice a certain amount of signal strength and receive the programme on a harmonic without the annoying crackles caused by atmospherics. It must not be supposed that this remedy is infallible, but on several occasions the writer has used the method with success; when thunderstorms are in the vicinity of the receiver, it is, of course, very unlikely that the experiment will prove to be worth while.

H.T. Supply on Aeroplanes

The necessary high-tension voltage for aircraft wireless equipment is usually obtained from a small generator similar to the one shown above. In this particular case the angle of the small propeller can be varied relatively to the slip stream of the aeroplane propeller, so varying the speed of the generator and thus the voltage produced.
It’s easy with a Fulstop Super Condenser—you can pick out stations which hitherto you had never been able to get. The Fulstop guarantees to abolish all hand capacity effects and the consequent increased audibility is very marked. The Fulstop patent clockwork multigear gives the use of two ratios of movement: a 2 to 1 and 125 to 1, and enables the most minute adjustment to be made with ease. The Fulstop is a no-loss condenser, perfectly square law and has brass vanes.

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<th>25/6</th>
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<td>.00022</td>
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<td>.0003</td>
<td>28/6</td>
</tr>
<tr>
<td>.001</td>
<td>.0001</td>
<td>30/6</td>
</tr>
</tbody>
</table>

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STANDARD FULSTOP
(No gear.)

GUARANTEED TO ABOLISH HAND CAPACITY.

<table>
<thead>
<tr>
<th>PRICE</th>
<th>.00022</th>
<th>.0003</th>
<th>.001</th>
</tr>
</thead>
<tbody>
<tr>
<td>.0002</td>
<td>9/6</td>
<td>8/3</td>
<td></td>
</tr>
<tr>
<td>.0003</td>
<td>10/3</td>
<td>8/9</td>
<td></td>
</tr>
<tr>
<td>.0005</td>
<td>11/3</td>
<td>9/6</td>
<td></td>
</tr>
<tr>
<td>.001</td>
<td>13/6</td>
<td>11/6</td>
<td></td>
</tr>
</tbody>
</table>

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MODERN WIRELESS

THE final choice of the type of circuit to be used by the constructor of a wireless receiver must be determined by his individual requirements. If, for instance, the loudest signals possible with two valves are desired from the local station, then the circuit used must include as much low-frequency amplification as possible; whereas, when distant reception is aimed at, high-frequency amplification is indicated.

Increased Range

A high-frequency amplifying valve preceding the detector, when correctly operated, allows considerable ranges to be covered without recourse to that edgelike reaction adjustment, and consequently without so much distortion. In the receiver to be described, the first valve is arranged as an H.F amplifier, and the second as a detector.

The neutralised capacity method of stabilising the H.F. valve is incorporated, but here the arrangement is perhaps slightly different to that to which we have become accustomed.

Neutralising Coils

Instead of the now commonly used H.F. transformer type of neutrodyne unit, two plug-in coils are used, and to allow a certain degree of flexibility they are mounted in a variable two-coil holder.

A variable grid-leak is also incorporated, and in some cases this will be found useful on distant receptions.

Short Wiring

A perusal of the photograph of the back of the panel will show that all the wiring has been kept as short as possible, consistent with efficient spacing; and the anode and neutrodyne coils (L₂ and L₄) are mounted at an angle of 90 degrees to the aerial and reaction coils (L₁ and L₃) in order that a minimum of coupling shall exist between them.

It will also be seen that the internal connections from the terminals to the aerial tuning condenser (C₃) and coil (L₃) differ slightly from those usually made. It is possible with this modified arrangement to place C₃ either in series or parallel with L₃, and further to use the aperiodic aerial arrangement, when desired, without having to connect the aerial lead directly on to the coil in the cabinet.

The correct methods of connecting up aerial and earth for the Radio Press journals, those makes actually used are indicated. Other good quality makes, however, will serve equally as well:

Panel 16 in. by 8 in. (Radion).
Cabinet (All Concert de Luxe, with opening in back for terminal strip) (Camco).
One variable condenser, square law type, 0.0005 µF (R.I.).
One variable condenser, square law type, 0.00025 µF (R.I.).
Two fixed condensers 0.0003 µF (Watmel).
One variable grid leak (Watmel).
One back of panel coil holder (Quality) (Goswell Engineering Co., Ltd.).
One 2-coil holder (Magnum) (Burne-Jones & Co., Ltd.).

Components Required

A complete list of the components used to build this receiver will be seen below, and as is usual in three possible arrangements will be made perfectly clear from the diagrams given in Fig. 2.

Two Clearer Tone valve holders (Benjamin Electric, Ltd.).
One Neutrodyne condenser (L. McMichael, Ltd.).
One Terminal panel No. 1 Magnum (Burne-Jones & Co., Ltd.).
One Telephone jack (General Radio Company, Ltd.).
A Neutralised Receiver for Plug-in Coils

One Telephone plug (General Radio Company, Ltd.).
Two Filament rheostats (General Radio Company, Ltd.).
One spring clip.
Three Lacquered brass terminals.
Flexible wire and square section tinned copper wire.
Screws, etc.
One Packet of Radio Press panel transfers.

Panel Layout
A diagram of the panel, with all the measurements necessary for marking out and drilling it, is given in Fig. 3. It will be seen that this is a perfectly straightforward and simple operation.

Modification to Coil Holder
The valve holders and variable coil holder may now be fixed in their correct positions. With regard to the latter, it should be noted that the type used will not normally fit into the cabinet behind the other components on the panel, and so the control arm has been bent to a more upright position, thus overcoming the difficulty.

In the position in which this coil-holder is fixed, the variable condenser (Cz) limits the possible variation of coupling between coils plugged in the holder to about 20 degrees. This variation is however, quite sufficient for the purpose of the receiver.

Wiring Up
Wiring up must now be proceeded with, and, so far as possible, the actual paths taken by the wiring as shown in the photographs should be carefully followed.

Be very sure to connect up the aerial, anode, and neutrodyne coils exactly as shown in the wiring diagram, otherwise it may be found impossible to neutralise V₁ in order to prevent oscillation.

The flexible reaction leads must, of course be joined up, and the correct way round for these will only be discovered by actual test later on. Care should also be taken to connect the positive phone terminal to H.T. +

Neutralizing the H.F. Valve
Before testing out the receiver the H.F. valve V₁ must be neutralised.
Connect up both the H.T. and L.T. batteries, short the reaction coil socket, and plug in the phones. The H.T. and L.T. for each valve must be adjusted according to the makers' instructions, Do not apply too high a potential to the anodes, especially that of V₁, otherwise neutralising will be a difficult matter. Aerial and earth leads must not yet be connected but the two lower terminals A₁ and Earth should be joined together with a piece of wire, and the necessary coils must of course be plugged in. The following sizes will generally be found correct:
Aerial - 75 X, Anode - 75, Neutrodyne - 60. For 5 XX the coils are 250 X, 250 and 200 respectively. The neutrodyne coil is on the left-hand side, and the tuned anode coil on the right-hand side, looking from the front of the set.
Now light up the valves to their correct brilliancy, set the condenser C₁ to a fairly low value,
All wiring on the receiver is kept as short as possible. Note that the handle of the neutrodyne two-coil holder is bent at right angles.

say 20 degrees, and let L1 and L2 be tightly coupled.

Testing for Oscillation

Now on swinging the condenser C3 throughout its entire range, it will be found that oscillation occurs over a certain number of scale degrees, a definite click in the phones indicating both the commencing and finishing of the oscillatory state. Touching the grid connection of V1 with a wet finger will always confirm whether the set is oscillating or not. If it is, a loud plonk will be heard both on making and breaking the finger contact, otherwise only a click will be heard on making contact.

The number of scale degrees over which oscillation occurs will be found to diminish as the neutrodyne condenser C3 is adjusted towards maximum, until a point

Fig. 3.—The layout of the front of the panel may be seen from this diagram. Ask for Blue-Print No. 131a, price 1/6 post free.
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Wireless Accessories will prove the most popular gifts of all. Here is a list to choose from.

HUNT'S Patent "Saveit" Fuse Saves Your Valves!
Two shillings spent on a Hunt's Patent Safety Fuse Wander Plug saves you the price of several valves. Accidents will happen and one that might mean a burnt-out valve costs only 6d. to replace the flash-light bulb in the plug. May be used with either bright or dull emitter valves. Price 2/-. postage 2d. extra.

Keen research workers demand Hunt's variable Grid-Leaks. They are invaluable for pure reproduction and delicate long-distance tuning. Under Panel, Single Hole fixing model, Fig. No. 1104 "NEWLEAK," 5/- each, as illustrated. Standard Model, 1/5 megohms, other calibrations to order. 5/- each, postage 3d. extra. Anticapacity handle, 5½ in. long, Fig. No. 1110, 6d. each.

HUNT'S "Three Dee" Spade Terminals.
Here is the finishing touch to every well constructed set. No lead can last so long or so neatly as it does when fitted with a "spade" terminal. (Pro. Pat.) Adjusted in a second, no trouble, permanent. Red or black body, nickel-plated spades. Price 3d. each, postage extra.

HUNT'S "Clutch" Tape Does Not Perish!
Fig. 455. H.A.H. "Clutch" Brand of Insulating Tape is invaluable for all electrical work. Keeps for one year in stock under good conditions and does not soil the hands. Supplied in an airtight tin box. Price 6d. and 9d. per tin, postage extra.

HUNT'S "Easitune" Kills Hand Capacity.
Fig. 910. Hunt's "Easitune" (Pro. Pat.) Anti-capacity Vernier Tuning Handle fine tunes any condenser without dismantling the set in any way. One touch at the spring catch and the handle grips tightly any condenser knob. The handle is perfectly insulated and the tuner's hand is 5½ ins. away from the condenser knob. Price 2/-. postage 3d. extra.

HUNT'S High-Grade Instruments.
We stock nearly 50 different types of high-grade measuring instruments for all purposes—totaling in all nearly 200 calibrations. Any special reading or calibration can be supplied to exact requirements on request. Below are a few of the most popular types.

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<tr>
<th>Instrument</th>
<th>Type</th>
<th>Calibrations</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>Fig. 152</td>
<td>Double reading voltmeter, 0-7 v., 0-100 v.</td>
<td>each</td>
<td>12/6</td>
</tr>
<tr>
<td>Fig. 150</td>
<td>Pocket type voltmeter, 0-7 v., 0-15 v. or 0-25 v.</td>
<td>each</td>
<td>7/6</td>
</tr>
<tr>
<td>Fig. 151</td>
<td>Pocket type ammeter, 0-2½ a. or 0-25 a.</td>
<td>each</td>
<td>7/6</td>
</tr>
<tr>
<td>Fig. 133</td>
<td>Pocket type volt and ammeter, all readings</td>
<td>each</td>
<td>10/5</td>
</tr>
<tr>
<td>Fig. 160</td>
<td>Panel type voltmeter, 0-7 v., 0-15 v. or 0-25 v.</td>
<td>each</td>
<td>9/-</td>
</tr>
<tr>
<td>Fig. 161</td>
<td>Panel type ammeter, 0-2½ a. or 0-25 a.</td>
<td>each</td>
<td>9/-</td>
</tr>
</tbody>
</table>

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Complete Set of Parts, including panel, drilled and engraved, £3 8s. 9d.
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George Wickes simply wouldn't believe I built it myself—

I was always such a duffer at making things. Even when a boy I was the despair of old Croggins—the master who took the woodworking classes.

No wonder George Wickes was surprised when he saw my 4-Valve Set the other evening. "But you did not build this yourself?" he gasped. "Yes," was my reply, "every bit of it except the cabinet." "Well, I am surprised," he said, "and to think that as a kid you were so utterly hopeless with tools and always bottom of the Science Class. Tell me where you picked up all this expert wireless knowledge." "Oh, it's quite easy," and then I told him all about the Pilot System.

I told him how we had practically decided to buy a 2-Valve Set until one day a fellow at the office related his experiences with a Pilot Set he had made himself with absolutely no skill or electrical knowledge. Fired by a spirit of emulation I sent for the particulars of these Pilot Sets and found that I could get all the parts for a fine looking 4-Valve Set for less than the money I should be called upon to pay for the ready-built 2-Valve Set. The only question was "Could I build the Set?" Well, the long and the short of it was that I decided to make the plunge and I sent for the parts.

They duly arrived, neatly packed, and I made a start. It was an easy job fitting them together—even a duffer like myself could not very well insert the components in the wrong holes in the panel—the diagrams were so clear. The soldering was a bit of a problem and I must have got through at least half a stick of solder and made quite a few bad joints before I discovered that a red-hot iron won't work! However, all good things have to come to an end some time and eventually the soldering part of the job was finished.

I unscrewed the panel from the cabinet and proudly showed George the results of my handiwork.

"And now let me hear it," he suggested. After a round of the B.B.C. Stations, with one or two Continental ones thrown in for extra measure, poor old George could only express his bewilderment. "It is far better," he said, "than the three-valve Set I paid £30 for three months ago. I can only get London and Bournemouth, and you can get practically every Station you want on yours." So George is a red-hot prospect for a Pilot Set, and I'm going round in a week or two's time to see what progress he is making with his new five-valver.

* The Pilot Chart of 32 pages, fully illustrated, will be sent (post free 3d.) on application to Head Office.
The wiring may readily be followed from this diagram. Readers preferring a blueprint, however, may obtain one (No. 134b), price 1/6 post free.

The Distant Stations
A small reaction coil may be plugged in, in place of the shorting plug if desired, and, if the connections are the correct way round, will be found to increase signal strength as its coupling with $L_1$ is tightened.

Although very good results are obtainable with this set, it is not advised that a beginner constructs it, but those who have had some experience with neutrodyne circuits will find it of great interest. The size of the neutrodyne coil was not found to be extremely critical, one size smaller than the anode coil usually being suitable.

Test Report
The receiver was tested on a moderately small aerial, about 3.5 miles west of 2LO, and signals from that station were, of course, very loud indeed in the telephones. Bournemouth and Birmingham were heard at good strength, the former with a slight background from London, although not sufficiently strong to spoil the reception.

Several amateur transmitters were heard at a strength sufficient to work a loud speaker.

Of Continental stations the following were received with comparative ease:
- Radio Toulouse, Madrid, Munster, Hamburg, and two or three other French and German stations which were not identified.
- On the longer waves, Daventry came in only slightly weaker than 2LO, and Radio Paris was heard at fair telephone strength, as was also Eiffel Tower.
Reaction Control Circuits

by J. H. REYNER, B.Sc. (Hons.), A.C.G.I., D.I.C., Staff Editor.

That fine control of reaction which makes all the difference is partly a matter of the circuit employed, but also very largely one of adjustment. This article gives some useful advice on the subject.

Almost every simple valve circuit employs reaction in some form or another in order to increase the amplification obtainable from the valve in use, and so to increase the reception from the long-distance stations.

It is proposed in this article to discuss a variety of different methods of producing reaction and to indicate how the best results may be obtained. Before actually discussing the circuits themselves, however, a brief consideration of the principle which underlies successful reaction adjustment will be of considerable advantage.

Consider any tuned circuit connected across the grid and filament of a valve. The voltages developed across this circuit will cause amplified currents to flow in the anode circuit of the valve, and in a reaction circuit these currents are arranged in some manner to produce voltages in the grid circuit in such a direction as to increase the voltages already existing. As the amount of this energy fed back is increased so the voltage on the grid circuit gradually increases until a point is reached at which the set commences to oscillate.

Smooth Control Essential

Now when the oscillating condition of affairs commences there is a change in the character of the events. Under normal conditions the currents in the grid circuit of the valve are limited by the resistance losses in the circuit. As the reaction is increased so a certain proportion of this energy loss is made up, but there still remains a damping effect which limits the current. When the oscillation point is reached, however, the energy fed back by the valve is equal to the energy loss; if there is no resultant loss of energy, then the effective resistance of the circuit must be zero, and there is nothing to prevent the current from increasing indefinitely. Under certain conditions it may actually increase until a point is reached where the valve commences to saturate. That is to say the set will suddenly commence to oscillate very violently, giving a sharp "plonk," which is very undesirable.

Backlash in Reaction Circuits

Another effect which is very often noted in a poorly designed or badly adjusted circuit is that of backlash. If the reaction is gradually increased until the set commences to oscillate, then the reaction setting must be reduced an appreciable amount before the set ceases to oscillate. This means to say, of course, that if the reaction has been gradually coaxed up to the oscillation point, then if the set suddenly oscillates, it is impossible to come just off the oscillation point, for when the set does stop oscillating, it is no longer near the critical reaction point.

These several effects can be explained by referring the characteristic curve of the valve.
Consider Fig. 1. Assume that the valve is working at the point A. For small variations of voltage the anode current will vary between B and C of the particular characteristic shown. At this point the effective slope of the characteristic is as indicated by the full line.

Assume now, however, that the circuit commences to oscillate. The current in the oscillating circuit, and thus the voltage on the grid, will increase and the valve will now, perhaps, be oscillating between the points D and E. It will be seen that the effective slope of the characteristic between these two points, as shown by the dotted line, is steeper than it was in the previous case. Consequently the amount of reaction which is required to maintain oscillation will be less, since the critical value of the feedback required depends upon the amplification factor of the valve.

**Tendency to Oscillate greater when Set is Oscillating**

Thus, if the reaction coupling is reduced the valve will continue to oscillate below the point at which it commenced to oscillate. When it ultimately stops oscillating the current in the circuit will drop again, and the grid voltage will fluctuate between B and C. As we have seen, the effective slope of the characteristic over this range is less and therefore more reaction will be required. There is thus a backlash effect such as we have just described, the reaction adjustment at the point where the valve stops oscillating being appreciably less than that required to make it oscillate again.

Consider, however, the arrangement shown in Fig. 2. If the valve is working a little farther up the characteristic, then for small variations of voltage the slope will be as shown by the full line. If the voltage variations are increased so that the valve is working between the points D and E on the characteristic, then the effective slope will be as shown by the dotted line.

**A Limiting Effect**

It will be seen that in this case the slope of the dotted line is less than the slope of the full line. This means to say that once the valve starts oscillating the strength of the current will tend to increase. As soon as it does so, however, the effective amplification factor of the valve will begin to decrease, so that the current will very shortly be limited. The sudden rapid increase of current, therefore, which causes the undesirable “plonking” will be obviated if the valve is working in a manner such as this, and the set will gradually slide into oscillation. Backlash will also be avoided by this means, because at the point where the set finally stops oscillating, as the reaction adjustment is slacked off, it is quite ready to commence oscillating again, and if the reaction adjustment is increased the smallest amount, the set will once again commence to oscillate.

**Adjustment of Working Point**

It will thus be seen that the working point of the characteristic has a considerable effect upon the smoothness of the reaction obtained. If the working point is properly adjusted the reaction control will cause the set to slide smoothly into oscillation without any “plonking” or any backlash. The adjustment of the working point of the characteristic can be carried out by means of a potentiometer control, which is the most satisfactory method. It may also be adjusted to a large extent by variations in the filament current and H.T. voltage of the valve.
The Choice of Experts

Were one doubtful as to the merits of the Igranic Low-Loss Square Law Variable Condenser one has but to note the type of circuits for which this instrument is specified by well-known experts on receiver construction to be assured that here at last is available a laboratory instrument, and at a reasonable price.

In the September issue of Modern Wireless three Igranic Low-Loss Variable Condensers were specified for "The Harmony Four," an instrument for which the author claims surprising volume, purity, and very sharp tuning. In the same issue appear also particulars of "The America Three," by yet another author, in which Igranic Low-Loss Variable Condensers are also given pride of place. This circuit, as its name implies, being designed for the reception of American stations.

In Wireless Constructor of the same month Igranic Low-Loss Variable Condensers are recommended by yet another author for a Low-Loss Reinerz Circuit, a selective single-valve receiver. These three examples serve to show the favour in which this highly efficient Igranic Radio Device is held when longer range and greater selectivity are required.

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- Valve Holders, etc., etc. Also the Igranic Supersonic Heterodyne Receiver Outfit.

Write for List Z801.

STOP PRESS!

For the "Coastal Three" described in the October issue of Modern Wireless Igranic Square Law Condensers were again specified.
If the circuit includes a condenser and leak in the grid circuit, an adjustment of the value of the grid leak will also have a beneficial effect.

Some circuits are better than others in respect of the smoothness of operation, but in many cases it will be found that a circuit will give disappointing results because of the wrong adjustment of the working point on the characteristic. With these few remarks, which are just intended to throw some light upon a point which is not always appreciated, we will pass on to the consideration of some actual reaction control circuits.

**Magnetic Reaction**

Fig. 3 shows the ordinary simple electro-magnetic reaction circuit. (In the majority of the figures which follow, the aerial and earth connections and the several batteries have been omitted, because they are not relevant to the matter under discussion.) In this simple case smooth reaction can be obtained if considerable care is taken, but the circuit suffers from the disadvantage that the movement of the two coils L1 and L2 relative to each other causes a variation of the tune of the grid circuit, which is undesirable.

A circuit which has come into considerable prominence is that employing a capacity control over the feed-back. The circuit shown in Fig. 4 is usually known as the Reinartz circuit. This circuit is not a capacity reaction circuit, but the high-frequency current in the anode circuit passes through the condenser C2 and through the inductance L3, back to the filament. The choke coil L3 prevents the high-frequency currents from passing round through the high-tension battery. The condenser C2 acts as a by-pass for the high-frequency current, and the larger the value of this condenser the easier will be the path for the high-frequency current, and consequently the greater the reaction effect. This circuit, however, only exercises a control over a comparatively small range, and it is, therefore, advisable to make L2 variable in order that the best adjustment may readily be obtained.

**Capacity Reaction**

Fig. 6 is a proper capacity reaction circuit. Here there is a variometer L1 in the grid circuit tuned with a condenser, and there is also a tuned circuit L2C2 in the anode circuit. The voltages developed across the coil L2 produce voltages across the capacity between anode and grid shown in the Fig. dotted as Cm. Under certain conditions this voltage is sufficient in value and in the right direction to produce oscillation, and it is found that with any valve having a fairly high capacity condenser. In this case there is a fixed coupling between the grid coil L1 and the reaction coil L2, and a choke coil L3 has been inserted in series with the lead from the high-tension battery. This choke coil, of course, tends to prevent the high-frequency currents from flowing through the anode circuit, and is, therefore, shunted by a small condenser C2. This condenser acts as a by-pass for the high-frequency current, and the larger the value of this condenser the easier will be the path for the high-frequency current, and consequently the greater the reaction effect. This circuit, however, only exercises a control over a comparatively small range, and it is, therefore, advisable to make L2 variable in order that the best adjustment may readily be obtained.

**Another Form of Capacity Control**

The circuit shown in Fig. 5 is another form of electro-magnetic reaction controlled by means of a condenser. In this circuit the magnetic reaction between L2 and L3 opposes the capacity reaction. In this case there is a fixed coupling between the grid coil L1 and the reaction coil L2, and a choke coil L3 has been inserted in series with the lead from the high-tension battery. This choke coil, of course, tends to prevent the high-frequency currents from flowing through the anode circuit, and is, therefore, shunted by a small condenser C2. This condenser acts as a by-pass for the high-frequency current, and the larger the value of this condenser the easier will be the path for the high-frequency current, and consequently the greater the reaction effect. This circuit, however, only exercises a control over a comparatively small range, and it is, therefore, advisable to make L2 variable in order that the best adjustment may readily be obtained.

Fig. 7.-In this circuit the magnetic reaction between L2 and L3 opposes the capacity reaction.

Fig. 8.-The Ultraudion circuit. Reaction is controlled by varying the grid leak R.

Fig. 6.—A true capacity reaction circuit, feed-back being obtained through the valve capacity Cc. The Condenser C, may usually be omitted.

Fig. 7.—In this circuit the magnetic reaction between L2 and L3 opposes the capacity reaction.
between the electrodes, oscillation will be set up when the two circuits are approximately in tune. The oscillation in this case is controlled by detuning one or other of the circuits, and by this means a comparatively critical control of reaction may be obtained. Quite satisfactory reaction control may be obtained even if \( C \) is omitted, particularly if \( L \) has a high self-capacity. Fixed coils and variable condensers may be used if desired.

**Fig. 9.—Another direct-coupled reaction circuit. Reaction in this case is controlled by \( C \).**

The circuit shown in Fig. 7 is another form of capacity reaction circuit. In this case, due to the presence of the coil \( L \) in the anode circuit, there will be a certain reaction effect through the inter-electrode capacity of the valve as in the previous case. The coil \( L \), however, is coupled to the coil \( L_1 \) in the grid circuit in such a direction as to oppose oscillation, and by this means the electrostatic feed-back may be neutralized by an equal and opposite electro-magnetic reaction, so keeping the circuit just off the oscillation point.

**Direct Coupled Circuits**

A third class of circuit is that in which the anode and grid circuits are tapped across different portions of the same oscillating circuit. One of the most satisfactory of these is the Ultradian circuit. This circuit is shown in Fig. 8, and will readily oscillate under normal conditions. It will be seen that the anode is connected to one end of the oscillating circuit and the grid to the other end through a condenser, and there is also a grid leak \( R \) between the grid and the filament. Reaction is controlled in this case by varying the value of this grid leak resistance, which introduces damping across the grid circuit and so ultimately stops the oscillation. Provided a reliable form of grid leak is available, this circuit will give very satisfactory results.

The circuit shown in Fig. 9 is a form of the well-known Hartley circuit. In this case the filament is tapped to a point about the centre of the oscillating circuit, and the grid and the anode to the extreme ends of the oscillating coil. The reaction is controlled by the variable condenser \( C \), which controls the amount of high-frequency current which is allowed to pass from the anode through the coil back to the filament. The control in this case is somewhat similar to that of the Reinartz circuit.

A modification of this circuit is shown in Fig. 10, in which the condenser in the anode circuit is fixed. The grid end of the coil, however, is not connected direct to the grid, but is connected through a choke coil \( L \), which is shunted by a condenser \( C \). The coil \( L \), of course, tends to prevent the high-frequency current from reaching the grid, and the condenser \( C \) by-passes these currents and permits oscillation. The filament tap need not be at the centre of the coil \( L \), and will very often be found to be more satisfactory somewhat nearer the grid end of the coil, as shown in Fig. 10.

**Absorption Circuits**

A type of circuit which has also been used with particularly satisfactory results is the absorption circuit. This circuit was originally known as the Cockaday circuit and various modifications of it have been made from time to time. The essence of the principle is shown in Fig. 11, which will be seen to be a simple electro-magnetically coupled oscillating circuit. This circuit is normally permitted to oscillate, but is controlled by the absorption circuit \( L_1C_1 \), which is coupled to the oscillating circuit \( L_2C_2 \). When it comes into tune with \( L_1C_1 \) the circuit stops oscillating.

**Fig. 11.—A type of absorption circuit. When \( L_1C_1 \) comes into tune with \( L_2C_2 \) the circuit stops oscillating.**

---

**November, 1925**
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Sir—I have constructed the "Harmony Four" as described by Mr. Percy W. Harris, in the Septemb'r, 1925, issue of MODERN WIRELESS.

The ease, strength and purity with which distant stations can be tuned in is truly remarkable—B.B.C. and Continental stations being received at excellent loud-speaker strength.

I have had experience with various sets described in MODERN WIRELESS, but for purity and volume on distant stations the "Harmony Four" is easily the finest circuit I have tried, and must be at least as good as the wonderful American circuits we hear so much about.

The first evening the set was constructed, Thursday, October 1st, the School of Posts and Telegraphs, Paris, was tuned in on the loud-speaker without the slightest trace of L.F., four miles distant, and for strength was comparable—with-the-the strength of L.O., four miles distant, and for sound it was tuned in the B.B.C. and Continental stations without having to rely on "S.B."—Yours truly,

A. W. KELLY.

No Equal

Sir—I have just completed the "Harmony Four" described by Mr. Percy Harris, in the September MODERN WIRELESS.

The set was originally constructed from components I already had, but since the photo was taken I have substituted a .005 variable condenser, as recommended, in place of the .001. I must congratulate you on designing a really efficient method of H.F. amplification. I am sure this circuit will meet with approval from all amateurs who desire to select their evening's programme from the various British and Continental stations without having to rely on "S.B."—Yours truly,

Percy W. Harris.

"S.B."—Yours truly,

A. W. KELLY.

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SIR.—I have just completed the "Harmony Four" as described by Mr. A. W. Kelly, with its additional L.F. stage.

I have made up some 40 or 50 sets all told, but so far I have not discovered its equal.

The three controls are not difficult to handle, and the fact that there is no reaction coil makes it a real pleasure to use.

I used it on Sunday night between 6.30 and 8, and logged some ten Continental stations, all at full loud-speaker strength, and the great majority perfectly clear and free from the distortion which usually accompanies reaction in its usual form.

I also obtained good full loud-speaker results from Rome and Madrid on Monday.

I find a slight difficulty in cutting out L.O. from Manchester and Cardiff, and also Bournemouth in a lesser degree, but altogether it is a topping circuit and, as Mr. Harris says, "not difficult to handle."—Yours truly,

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The general characteristics are given in the list below. It will be noticed that the classification adopted is novel, and is a serious attempt to overcome the chaos which exists in the valve world to-day.

The valves are classed as H. (high frequency), L. (low frequency) or H.L. (general purpose), followed by the filament voltage and the filament current. Thus H.310 is a 3-volt valve taking -10 amp. filament current, and intended for use as a high-frequency amplifier.

The internal impedances and amplification factors given below are average values.

The value of \( V_g \) (grid bias) quoted in each case is the value at approximately the middle point of the straight part of the characteristic to the negative side of the zero line.

The value given is thus a fair indication of a suitable grid bias to employ in use.

As has been stated, the valves are very satisfactory in use, and we have no hesitation in recommending them to our readers.

<table>
<thead>
<tr>
<th>Valve Type</th>
<th>H.310</th>
<th>H.312</th>
<th>H.310</th>
<th>H.310</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filament voltage</td>
<td>1.5 to 3 volts</td>
<td>2.8 to 3 volts</td>
<td>2.8 to 3 volts</td>
<td>2.8 to 3 volts</td>
</tr>
<tr>
<td>Current</td>
<td>-10 amp.</td>
<td>-10 amp.</td>
<td>-10 amp.</td>
<td>-10 amp.</td>
</tr>
<tr>
<td>Anode voltage</td>
<td>40 to 120</td>
<td>40 to 150</td>
<td>40 to 150</td>
<td>40 to 150</td>
</tr>
<tr>
<td>Anode current at ( V_a = 80 ), ( V_g = -7 )</td>
<td>3.85 milliamps</td>
<td>3.85 milliamps</td>
<td>3.85 milliamps</td>
<td>3.85 milliamps</td>
</tr>
<tr>
<td>Amplification factor</td>
<td>4.6</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
</tr>
<tr>
<td>Internal impedance</td>
<td>60,000 ohms</td>
<td>60,000 ohms</td>
<td>60,000 ohms</td>
<td>60,000 ohms</td>
</tr>
</tbody>
</table>

For the complete report, our readers are referred to the complete report.
The L 240 is a 2 volt emitter valve for LF work.
The L 240 is a 2 volt dull emitter valve for LF work.
The HL 565 type is a general purpose bright emitter.
The L 525 type is a 5 volt power valve.
A 5 volt HF valve, the HL 213 type.
A good general purpose valve is the HL 213 type.
The L 550 type is a good dull emitting power valve.
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November, 1925

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Anti.

Super 'Phones, 12/6 pair.

Sterling, English Ericsson, $8.11; Extra Large B.B.C., 10.8; 36v., 7/-; Switch, 7/-; B.B.C., 28/11; 6.50; 15/-; Gravity Detector, 6/6 2/6.


Type 610, fixed, 3/-, 3/8, Variable 1/3.

Panel -2 -way, 3/-; 3 -way, Sockets, 1/-.

250, 5/3; 300, 6/-.

Shaped Plug, 2 10/-.

4/6.

4.5, 5/6, 6/- dozen.

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Mandridge Vario

Fixed 2 -way Anti Cap on HEADPHONES, " KAY RAY " DETECTORS.

Sets stocked.

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Fixed Condensers, .001, .002 to .006, each, 2/-

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Rheostat, 5/6; D.E., 6/6.

H.R. Valera - 600, 1.35; 70, 80, 104, 16/6.

- H.F. Transformers, Anode, 8/-.

7/ -

Coil Holders, 2 -way, 2d.

Transformers, 6d, 4,-1, 2.7-

L.F.T., 21/;

Electric Coil Holders, 2 -way, keen Knob, 8/8.

Loud Speaker, 14/8.

1.35; 70, 80, 104, 16/6.

Transformers, 6d, 4,-1, 2.7-

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1.35; 70, 80, 104, 16/6.
MODERN WIRE-LESS

B 508.
Built up with copper foil and test ruby mica dielectric. High insulation and capacity adjusted to within 5 per cent. Stocked in capacities from 0.0002 to 0.03 mfd. 2/- to 3/6 each.

B 505.

B 558.
Strongly constructed on the same principle as variable condensers for panel mounting. Enclosed in dust-proof non-inflammable Celastoid covers, and fitted with dial, knob, two terminals and three feet for fixing to table or board if required. Price 12/- each.

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B 506.
Mounted on ebonite base (3 ins. x 2 ins.) with glass tube to protect crystal from dust. The catch-wheel is of silver wire. A feature of this crystal holder is that it can be easily taken to pieces and put up again. Price 4/- each.

B 530.
Single, double and triple. Suitable engraved for use with valves or for plug-in type high-frequency transformers. 5/6, 8/- and 13/6 each.

THE SILVERTOWN COMPANY

MAKERS:
THE SILVERTOWN COMPANY

SILVERTOWN VERNIOMETER.
(Patent applied for.)
The Silvertown Verniometer is a most ingenious device for applying slow motion to variable condensers, variometers, etc., consisting of an ebonite dial and knob (0-100°) fitted with worm wheel, bracket and worm spindle, micrometer barrel and pointer, complete with fixing screws. Gear ratio 20:1. Fitted with instantaneous release. Backlash entirely eliminated. Hand capacity reduced to a minimum. Suitable for the following makes of condensers: Silvertown, Burndept, Sterling, Ormond ordinary and Ormond Low Loss. Made type of condensers for which they are required when ordering. Price 6/- each.

THE SILVERTOWN COMPANY

CRYSTAL HOLDERS.
B 506.

B 505.

B 530.

WIRELESS ACCESSORIES
Quality guaranteed by over 50 years' electrical manufacturing experience.

SILVERTOWN VERNIOMETER.
(Patent applied for.)
The Silvertown Verniometer is a most ingenious device for applying slow motion to variable condensers, variometers, etc., consisting of an ebonite dial and knob (0-100°) fitted with worm wheel, bracket and worm spindle, micrometer barrel and pointer, complete with fixing screws. Gear ratio 20:1. Fitted with instantaneous release. Backlash entirely eliminated. Hand capacity reduced to a minimum. Suitable for the following makes of condensers: Silvertown, Burndept, Sterling, Ormond ordinary and Ormond Low Loss. Made type of condensers for which they are required when ordering. Price 6/- each.

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B 530.

MOUNTED VALVE SOCKETS
SINGLE VALVE TYPE.
B 530.
Single, double and triple. Suitable engraved for use with valves or for plug-in type high-frequency transformers. 5/6, 8/- and 13/6 each.

THE SILVERTOWN COMPANY
Letters from Our Readers.

A Hartley-Reinartz Circuit

Sir,—As a result of reading the article in Modern Wireless for August on the Hartley-Reinartz circuit, by A. D. Cowper, M.Sc., I decided to make it. The set far exceeds my expectations, as on the night of September 7 I logged no fewer than four amateurs on telephony—2XO, 2VL, 2KG, 6DA—and about a dozen on telegraphy, the call signs of which I could not read. Telegraphy not being my strong point, signal strength varying between R.4 and R.6, all these on an indoor aerial with a gas-pipe earth; using one stage of L.F. 2LO romps in at L.S. strength. Yours truly, P. R. Lovell, Paddington, W. 2.

The Autumn Double Number

Sir,—As an old reader, I hasten to congratulate you on the Autumn Number of Modern Wireless. The tendency nowadays is for a new radio journal to appear with the resplendence of a comet, only to evaporate, shortly into, the ethereal. Without fear of contradiction, I feel I am voicing the opinion of all your readers when I say that your latest effort is easily the most brilliant. Not only is it brilliant and easily understood by anyone with but an elementary knowledge of wireless, but it is indeed a pleasure to be able to read through your magazine without constantly being harrowed by examples of bad grammar—a fault which is, unfortunately, much in evidence in several journals which appear during the course of a month. Allow me also to congratulate you on having acquired the services of Dr. Robinson. Truly the Air Force’s loss is indeed our gain. His intensely interesting article on Forthcoming Developments in Radio justly deserved the prominence you saw fit to give it, and I, in common with your other readers, will look forward with pleasure to many absorbing expositions from his masterly pen.

With so many shining lights I do hope Mr. Percy Harris will not be lost to us. In him one feels that one has a friend indeed, at least so think five delighted families who listen in nightly through the medium of different sets which it has been my pleasure to construct solely from his splendid articles.—Yours truly, C. Taylor Brading, Croydon.

Advertisements

Sir,—As a constant reader of your publications I would like to express my high appreciation of the articles therein. On the other hand, the matter of many of the advertisements (as in all wireless journals) warrants a certain criticism. For example, reference to last month’s Modern Wireless shows that of nine advertisements of low frequency transformers, five only state the ratio of turns; one, curiously enough, gives the total number of turns but not the ratio; the remaining three manufacturers ask you to buy a proverbial pig in a poke and give no information whatsoever.

In the same way four manufacturers of loud-speakers do not deign to state the resistance of their instruments. Meanwhile, in the important matter of matching valves, transformers and such-like, the unfortunate constructor must take a lucky dip blindfold. Surely manufacturers are not afraid of giving themselves away if, for example, they disclose data as to the impedance of their transformer primaries?

Many other cases occur to one, such as gauge of wire and H.F. resistance of tuning coils, but I must not trespass further on your time or space. Surely it is time that our manufacturers learnt that the average wireless enthusiast tries to take an intelligent interest in the apparatus he uses.—Yours truly, R. E. Tarrant, London, E.C.T.

Have you Bought your BIRTHDAY NUMBER = of THE WIRELESS CONSTRUCTOR?

Now on Sale. Price 6d.
M O D E R N W I R E L E S S

THERE can be little doubt that short waves are going to be experimented with to a considerable extent this winter. For those who have not yet experimented with these high frequencies, some articles by Mr. G. P. Kendall in Wireless Weekly, starting in Vol. 7, No. 4, will be of particular interest.

In commencing this series on "Practical Short-wave Reception," Mr. Kendall describes the principles governing the choice of a circuit, and follows this by a discussion on "How to Lay Out a Short-Wave Receiver," and further articles giving practical details of the whole subject.

Dr. Robinson in Vol. 7, No. 3, also gives some interesting facts concerning the radiation from short wave aerials, and shows how at these frequencies the length of the aerial becomes comparable with the wavelength, giving rise to various peculiar effects. For example, certain types of aerials do not radiate at all in a horizontal direction, but only up into the atmosphere at an angle.

Selectivity is a problem which has been exercising the minds of all amateurs for some time. In order to enable amateurs to start their experiments this winter on the right lines, and in possession of the maximum of helpful information, a series of articles has been written by Mr. J. H. Reyner, commencing in Vol. 7, No. 4, of Wireless Weekly on the whole question of Selectivity and Tuning in general. These articles discuss first of all the number of circuits which are necessary to obtain adequate selectivity without distortion, and follow up by giving some practical details as to the resistances of coils of various shapes and forms.

A Notable Occasion

The issue of the Wireless Constructor for November is the birthday number of this popular journal, and to mark the occasion a special issue has been provided. In view of the extensive use of crystal receivers, Major James Robinson speculates as to whether valves will ever die out. Although there are several interesting alternatives, the valve is indispensable in several cases, and Major James Robinson comes to the conclusion that the valve has really come to stay.

The Ultraudion circuit is one which is capable of giving very great selectivity and at the same time very sensitive results. Mr. Harris describes an interesting two-valve receiver made up on this principle.

Other articles of interest to the enthusiastic experimenter will complete what is a particularly attractive number of a journal which has already proved its merits in catering for the public needs.

"Wireless"

The new Radio Press weekly, Wireless, has quickly established itself in the homes of the non-technical public. "Did Marconi Invent Wireless?" is the title of a striking article by Mr. A. H. Morse, while articles by Major James Robinson, William Le Queux, Captain Round and other well-known scientists are constantly appearing.

THE SPECIAL FIVE

Designed by Mr. P. W. Harris, M.I.R.E.

And described in this issue.

This Kit has been included under our well-known "PILOT" PANEL SERVICE. (Full details of which appear in our full-page announcement in this issue). Prices are as follows:

**Type A.**

**Type B.**

**K E I T O F C O M P O N E N T S** (including coils and H.F. Transformers 300-400 kc.)

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NOTE: Where a complete kit of components, together with a drilled and engraved panel, is purchased, Marconi Royalties are payable at 50.

WRITE FOR DETAILED PRICE LISTS FOR ABOVE SET or for any of the other sets described in this issue.

THE NEW P.S. LOW-LOSS H.F. TRANSFORMER

15/- 15/-

An entirely new type of H.F. Coupling; involving a complete departure from former standards in H.F. Transformer design. The primary of this transformer is spiral and its exclusive design and shape make it the last word in low loss and efficiency. The secondary is air wound on a threaded shellformer and each coil is made to an exact standard, resulting in the condenser that results being approximately the same in each successive stage of H.F. Tuning. The main feature of this transformer, however, is that capacity coupling has been reduced to an absolute minimum, resulting in a degree of selectivity previously unattained. This transformer is the result of months of complete personal work and we wish to warn the public that none are genuine unless they bear our name. Available in two wavelengths through the Broadcast Band and Beyond respectively. Other ranges will be available almost immediately.

REFUSE ALL Imitations

PETO SCOTT CO., LTD.,

Head Offices: 77, CITY ROAD, E.C.1.

Branches: Plymouth: 4, Rank or England Place.

P.S. 315.
Give a good set its best chance

It's unfair to choke it with poorly designed coils. H.F. Currents demand area; ATLAS LOW-LOSS COILS are wound with twin-wire and offer a double surface path. Everything that is known of low-loss coil design is incorporated, and whether it's a question of distance, selectivity, volume, or all combined, there's no serious rival to Clarke's 'ATLAS' LOW-LOSS COILS.

**Price 4/3 to 17/6**

**CLARKE'S ATLAS SPECIAL DAVENTRY COIL, No. 175.** Price 7/9 each

H. CLARKE & CO. (Mcr.), LTD., Radio Engineers, "ATLAS" WORKS, Old Trafford, MANCHESTER

THE PANEL DE LUXE

SUCCESS in Wireless is ever dependent upon trifles. One man will succeed where another will fail. No component can exercise such influence for good or ill as the panel. Start with a Radion Panel and you will be sure that your foundation is correct. Radion is recognised throughout the wireless industry as the highest grade ebonite panel it is possible to make—and its superb surface will add considerably to the appearance of any Receiver.

Radion is available in 27 different sizes in black and mahogany. Radion can also be supplied in any special size. Black 1d. per square inch, mahogany 1½d. per square inch.

RADION

American Hard Rubber Company (Britain) Ltd.

Head Office: 13A Fore Street, London, E.C. 2
Deps: 120 Wellington Street, Glasgow.
118 Snow Hill, Birmingham.

Whl Agents: 8 Corporation Street, Belfast

Build Yourself or Buy Completed a Radion Proved Set

Hundreds of unsolicited testimonials confirm its fine performance on distant or local stations. It is replete with refinements which ensure best results under all conditions.

Constructors' Sets—Instructions, diagrams, and details complete to the last screw

Kit of Components $d. Per Thousand Mahogany & Drilled. Cabinet.

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If components and panel purchased at one time Mexico Royalty of 1½d. per value payable.

Send stamp for list of all sets and units, including Regenerative, Valve-Crystal, Reflex and Super-Het. Kits. Full catalogue of components also, 3d. stamps.

Completed Sets—Style of Cabinet is the same, but panel arranged for greatest simplicity of operation. Fittings nickel, terminals at back, one switch turns on and off. Radion Receivers are suitable for all stations whatever their wave-length. Hundreds of testimonials confirm their efficiency.

Send stamp for list of all sets and units, including Regenerative, Valve-Crystal, Reflex and Super-Het. Kits. Full catalogue of components also, 3d. stamps.

`The Wonderful No. 61... A 2-VALVE LOUD-SPEAKER SET` £4 15 0

or complete with Loud-Speaker, D.E. Valves, Batteries, Aerial, etc. £9 15 0.

RADIAX LTD. 40, Radio House, Percy St., LONDON, W.1.

3 minutes from Tottenham Court Road and Goodge Street Tube Stations.

Phone: Museum 499.
EARLY in the last century the immortal Mr. Jorrocks put forward a scheme for a revision of the calendar which was to include the entire omission of summer. This season of the year he described as a time when life was not worth living, since he could not indulge in his favourite pastime of hunting. Were Jorrocks with us to-day he would no doubt find many ardent supporters among the ranks of wireless enthusiasts, who have little use for the hot season with its long days and short nights. They welcome the coming of autumn as eagerly as do the hunting man, the shooter and the footballer, for when the summer is past we can look confidently in every way in reception conditions. But there are, of course, enthusiasts who still struggle after long-distance reception throughout the summer, and, indeed, the very fact that conditions are adverse lends an added interest to the work; and a point not to be forgotten is that if a receiving set is built during the lighter months and gives satisfactory results, then one may feel quite sure that it is really up to the mark, and that it will do great things when the best part of the wireless year draws on.

Causes of Poor Reception

The fact that long-distance reception in summer time is not so good as that obtainable in autumn, winter and early spring is due to a variety of causes. The larger part of the broadcast transmissions takes place in daylight, the ground is often parched and dry for long periods on end, and electrical disturbances which give rise to atmospherics are of much more frequent occurrence than they are during the colder months. The passage from summer to autumn conditions is often quite a rapid one. Last year, for example, there was a sudden very marked change for the better during the last week in August, which was noted by experimenters in many parts of the country. There were slight setbacks on particular days and nights afterwards, but on the whole the improvement continued steadily until the end of the following month, when it became very rapid indeed. By the middle of October it was possible to tune in without any great difficulty on an efficient set American broadcasting stations operating on the 600 to 1000 kc. band (500 to 300 metres), which since the previous April were heard feebly that identification was often impossible. With the coming of autumn the wireless man has the feeling that his set is becoming much more "lively," to borrow a term from the motorist. During broadcasting hours a small movement of the tuning condensers may bring in quite a number of stations at points where but a short time previously nothing was to be heard. One is no longer confined to one or two British stations.
Ideal Entertainment by the Ediswan Troupe

P.V. 6. Hallo! Fancy meeting you! I am surprised!
A.R.D.E.: I'm more surprised at your surprise. You should know better by now. We Ediswans always find each other in the end.
P.V. 6: That's true, my dear: but we seem to have found each other remarkably quickly in this case. Mr. Owner has only had this set a fortnight, and already you're here, and Miss "Other Valve" has gone!
A.R.D.E.: Good for you—and for him!

P.V. 6: I did my best. But she was very trying. However, I'm always chivalrous—it's in the family. We seem to do more for other valves than for ourselves.

A.R.D.E.: They need it. We—we always work well together.
P.V. 6: Of course, my dear. But then, we know each other so well, and are so sure of each other's abilities that—well, it ISN'T WORK. It's pleasure!
A.R.D.E.: That's true... and now, I hear F.L.—the Eiffel Tower. Let's get MR. OWNER some pleasure... Ready?
P.V. 6: Ever—till the end of my life.
A.R.D.E.: Which is, naturally, a long way off!

EDISWAN VALVES

ALWAYS GIVE A GOOD PERFORMANCE.

AT ALL WIRELESS DEALERS


In replying to advertisers, use Order Form enclosed.
CERTAINTY in Radio is one of the great advantages that the new A.J.S. Instruments confer upon you. You can always be certain that reception will be perfect—that is one of the reasons why Sir Oliver Lodge chose A.J.S., for use in his own home. Write for particulars today.

A. J. S. CHOKE UNITS.
A carefully designed Choke when used with the correct valve will give equal volume to any transformer with very greatly improved tone quality over the whole range of audible frequencies. A. J. S. Choke Units, besides giving the utmost amplification with natural reproduction, eliminate or greatly reduce atmospherics and electrical disturbances.

Every A.J.S. Receiver carries with it 12 MONTHS' WRITTEN GUARANTEE & 12 MONTHS' FREE INSURANCE. Write for free particulars and illustrated literature.

A. J. STEVENS & Co. (1914), Ltd.
Radio Call Sign: 5 R.I.
Telegrams: "Reception, Wolverhampton."
LONDON OFFICES & SHOWROOMS: 139/141 CHARING CROSS ROAD, LONDON, W.C.2
with perhaps a sprinkling of Continental transmissions; one's travels upon the magic carpet of wireless may now be almost world-wide. I suppose that every wireless man hankers after long-distance reception, and it is natural that he should, for there is no thrill which can quite equal that experienced when some far-away station is picked up for the first time and tuned in so that music and intelligible speech can be heard. The improved conditions to be expected during the coming months will increase the range of any set, but the man who wishes to do real long-distance work will see to it that he takes full advantage of them by bringing his receiving equipment to the highest possible state of efficiency.

Interference
Where interference is experienced from power cables, tramways, electric railways, and so on, or when improved selectivity is desired, the use of a counterpoise may be found to give better results than any kind of earth connection. A type of counterpoise that has often improved long-distance reception consists of two lengths of wire or copper tape, spaced not less than 8 feet apart, stretched immediately under the aerial itself. Two insulators in series are used at both ends, and the lead-in from the counterpoise is brought into the house through an insulating tube similar to that used for the aerial lead-in. The wires of the counterpoise should be slung not less than 6 feet above earthed objects, and it should be remembered that if this device is used the effective height of the aerial is represented by the distance between it and the wires of the counterpoise. It is frequently found that the use of such a counterpoise produces an increase in both range and signal strength of the receiving set. Usually, too, selectivity is much improved. The only way to determine whether any particular kind of earth connection or counterpoise will give better results than another is to try out each in turn, for just as one man's meat is another man's poison, so an arrangement which will give first-rate results in one case may be quite unsatisfactory in another. So much depends upon the locality in which the station is situated, the nature of the ground, the nature of the building and other factors.

Batteries
As regards the receiving set itself it is important that the valves and the batteries should be in thoroughly good condition. Valves (particularly the high-tension ones) which have been a great deal of service, are apt to lose some of their sensitivity and may be far too insensitive for good long-distance work. Crackling noises, so often mistaken for atmospherics, which become particularly noticeable when the set worked anywhere near the oscillating point, may quite possibly come from an old high-tension battery. When the set is brought into a sensitive condition for the reception of some far-away transmission, noises due to the high-tension battery are amplified to a considerable extent, and if they are bad may be sufficient to drown what would otherwise be an audible signal. Even if the battery is quiet, its voltage may be much lower than you imagine. For successful long-distance work, then, see that your battery is quiet and of full voltage.

Condenser Efficiency
For long-distance work it undoubtedly pays to have a set of really efficient inductances. It has been shown by Mr. Kendall, by Mr. Sylvan Harris and others that we have probably exaggerated in the past the proportion of losses in the receiving set that are due to condenser inefficiency; the badly designed and badly made inductance coil is a far worse culprit. It is therefore well worth the while of any amateur who contemplates reaching out with his set to purchase or to make up for himself a set of coils that can be relied upon as thoroughly efficient. At the same time, my own experience, for what it is worth, is that poor variable condensers do increase not a little the difficulty of the task of tuning in weak and distant signals even upon the broadcast frequencies. Two years ago I was using a receiving set provided with cheap metal-ended condensers of a design that one would nowadays condemn at sight. With these I was never

MODERN WIRELESS

The large and handsomely decorated studio at the Rome station, from which many British listeners are entertained throughout the year.
Modern Wireless

November, 1925

able to receive, except on particularly favourable nights, transmissions from such stations as WGY, WBZ and WHAZ. Subsequently I rebuilt the condenser and provided watch-spring connections for their spindles, with the result that tuning-in was greatly facilitated on good nights, whilst even on poor ones it was often possible to tune-in several Transatlantic broadcasting stations.

Wavemeter

Searching for weak signals, particularly if the receiving set contains several tuned circuits, may be a difficult matter unless a wavemeter of some kind is available. The word wavemeter, of course, is a misnomer, since the instrument is really a frequency meter, but the term has become generally accepted. Those who care to make the outlay necessary for purchasing an accurately calibrated wavemeter (there are several good types on the market) will find it an exceptionally useful instrument, since with its help the set can be tuned readily to any desired wavelength, or, at any rate, to its near neighbourhood, which means that only very small movements of the tuning controls are necessary whilst searching is in progress. For all ordinary purposes a good buzzer wavemeter will 'give readings of sufficient precision. Since the only battery required is a small dry cell to operate the buzzer, this kind of wavemeter can be made up entirely self-contained in quite a small case.

An Important Point

The main point to remember when using a buzzer wavemeter is that it should be placed at some distance from the aerial tuning inductance of the receiving set. If the distance between the two is small, so that the coupling between them is comparatively tight, it may be found that the note of the buzzer is heard with almost equal loudness over a number of divisions of the condenser scale. Close tuning and accurate readings are obtained only when the distance between the two is such that the note of the buzzer is just comfortably audible in the telephone receivers or the loudspeaker when tuning is made as sharp as it can be.

How to Calibrate One Wavemeter from Another

Opinions are rather divided among wireless folk at the present time over the question of high-frequency amplification for long-distance work. There are many who swear by it, whilst others will have none of it. Only the expert, however, can get the fullest amplification by reaction, and for the ordinary man high-frequency amplifying valves are a great help. Certainly for work upon the very short waves the high-frequency amplifier is out of place, since no present system appears to be able to deal satisfactorily with the enormously high frequencies involved; nor is high-frequency amplification necessary here, since shortwave signals, such as those of KDKA, even from great distances, come through with surprising strength upon a single valve set, provided that both it and its collector system are efficient and that the receiving station is not situated in a blind spot. Upon the 600 to 1000 kc. band (500 to 300 metres) rate of the foreign stations are working whilst our own are not. One of the best times for Continental reception used to be on Sunday between the afternoon and the evening transmissions of our own stations. At the present moment, however, it is difficult to do any successful work at this time, in London at any rate, owing to the interference experienced from oscillating receiving sets. In the country matters are not so bad as a rule, though the effects of radiation may be troublesome at times. In long-distance work the maxim "live and let live" should be observed, for if receiving sets are allowed to oscillate the situation soon becomes ridiculous, no one being able to hear anything. Luckily many of the Continental stations may be found at work on any night of the week after the closing down of our own. Reception conditions are often very good indeed at these late hours, and as many of the oscillators have retired to bed, much less interference may be expected.

Weather Conditions

Weather and atmospheric conditions have a great deal to do with long-distance reception. Speaking generally, the best results may be looked for on a dull overcast night when rain either threatens or is actually falling. Often, too, one obtains wonderful results upon a thoroughly dirty night which anyone who is not a wireless enthusiast might well anathematise.
A.C.A.V. VALVE HOLDERS
Of unique design, the A.C.A.V. Valve Holders are unequalled for their achievement of Anti-Capacity and Anti-Vibration results. For adapting to existing valve sockets, it is fitted with split pins, whilst it can also be supplied for screw fixing.

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<th>Cat. No.</th>
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Some Unusual Faults
by John Underdown.

Two years ago a walk along the front at any little seaside town on the Kent coast, between Dover and Deal, disclosed scarcely more aerials than could be counted on the fingers of one hand. To-day many houses and bungalows sport an aerial, showing how greatly increased is the popularity of the Broadcasting Service. The number of listeners is being continually augmented, and many who have previously only associated the word “valve” with such everyday things as bicycles will become the proud possessors of valve receiving sets and may be confronted at any time by faults which to the uninitiated seem inexplicable. It is proposed, in the course of this short article, to deal with a few somewhat puzzling occurrences in order that the remedies, which are by no means always obvious, shall be available should such difficulties be experienced.

A Valve Fault
Recently a friend who was using a general purpose type of three-valve set employing the circuit of Fig. 1, wrote to me stating that he was experiencing difficulty. The symptoms were that the set, which had previously given every satisfaction, had ceased to function when the high-frequency valve was burning at normal brilliancy, although when this valve was switched off on its filament resistance $R_1$ or only just glowing, the programme from the local station (2LO), distant 20 miles, gave fair telephone volume for the loud-speaker was obtained. The effect of changing the three valves round in all three sockets had been tried, but only when the original H.F. valve was placed in the first socket and extinguished, or almost so, would the set work.

Filament and Grid Touching
Through previously having experienced similar difficulties, the trouble was at once apparent from these particulars, and the remedy, that of replacing the high-frequency valve, given. This at once allowed the set to function in the normal manner.

The explanation of this puzzling phenomenon was that the filament of the H.F. valve had sagged badly so as to be in close proximity to the grid, and when alight at normal brilliancy expanded sufficiently to touch completely. This to all intents and purposes was equivalent to short-circuiting the aerial circuit so that no signal voltages were applied across the grid and filament of the first valve. When cold, or the filament only just glowing, no “short” was present and the set functioned, since signal voltages were applied to the detector valve through the internal grid to plate capacity of the first valve.

Low-Frequency Circuits
A valve fault of this type, namely, the filament shorting to the grid, only gives rise to the symptoms previously mentioned when in an H.F. stage and hence in other positions is not easily detected since it will appear to light correctly, although causing a complete cessation of signals should it be used as a detector or as a more amplifier. If, therefore, a set becomes “dead,” although all the valves appear to be glowing at normal brilliancy, attention should be paid to these accessories as well as to the more obvious points such as seeing that H.T. and loud-speaker leads are intact. By gradually turning down the filament resistances in turn it is possible, with many bright emitters, to see whether the filaments are abnormally curved, since their shape may be clearly seen when only just glowing, although sagging is not discernable at normal brilliancy. With dull emitters, generally, it is often impossible to locate such defective filaments by inspection, and if a spare valve is available it should replace each valve in the receiver in turn, when provided one only is responsible, the offender will be easily discovered. Perhaps a better test is to try them individually in a single valve set should one be obtainable, since the very remote possibility of more than one developing the same trouble is thus guarded against.

Trouble Due to Microphonic Valves
A further somewhat unusual trouble, due to the microphonic effects in certain $06$ ampere type...
MODERN WIRELESS

valves, has recently come to my notice, the user of the set in question residing in a remote part of Cornwall and employing the well-known "4-Valve Family Receiver" designed by Mr. Percy W. Harris, mainly for loud-speaker work from 5XX. In this case, in the telephones excellent reception was obtained from the high-powered-station on three valves, and apparently the quality was still good on four, although so loud that it was difficult to judge with any degree of certainty. When, however, the loud-speaker was substituted for telephones a buzzing noise was heard, which grew rapidly in intensity until it completely drowned all signals. Upon switching over to phones on four valves, the trouble seemed to have ceased.

Mechanical Vibrations

A letter elicited the fact that the loud-speaker was standing very close to the set and, in fact, on the same table on which this was placed. .06 ampere valves were employed for all stages, and these were placed in ordinary type valve-holders. From this information it was deduced that the buzzing was due to microphonic effects in the valves, and on advising that the loud-speaker be shifted into another part of the room, the trouble ceased and signals from the loud-speaker were of excellent quality.

The explanation was that actually the physical vibrations set up by signals from the loud-speaker had set the electrodes of the valves vibrating at an audible frequency, and this effect being cumulative, it finally drowned all signals. Such cases as this are not very common, but where a loud-speaker is employed close to the set, and buzzing starts, gradually growing until signals are drowned, it is always well to switch over to phones and notice whether the effect is still present. If absent it may be taken definitely that the trouble is due to vibrations from the loud-speaker affecting the valve filaments, and this instrument should be shifted to a remote part of the room, when the buzzing will generally cease.

A Tropadyne Fault

Now that Supersonic heterodyne receivers are becoming so popular, every genuine experimenter wishes to try a receiver of this type, but often the number of valves employed makes the cost of such a set prohibitive, so that any means which will reduce the number required, without sacrificing efficiency, will make special appeal. The "Tropadyne" arrangement, of which the combined first detector and oscillator portion of the circuit is shown in Fig. 2, is one that has many staunch adherents. In certain designs of American origin the oscillator coils L2 and L3, in the diagram are wound on one former, being separated by only a small distance such as \( \frac{1}{2} \) in.

Testing the arrangement

Recent experiments with the oscillator coils L2 and L3, wound with 24-gauge double cotton-covered wire, on a 34 in. former, elicited a certain amount of information which may be interesting to certain experimenters and is given here-with. L2 consisted of 51 turns with the nodal tapping point taken from the 26th turn. L3, the reaction coil, was of 40 turns spaced at \( \frac{1}{3} \) in. from L2, and wound on in the same direction. The oscillator and first detector part of the set was connected to a normal receiver employing two high-frequency stages, a detector and one low-frequency amplifier. The coil L3 in the diagram was actually the aerial coil of the set, whilst L2 was the reaction coil, the connections to which were altered so as to make it the primary of the

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input filter transformer. When the correct connections for the reaction coil L3 had been found, the set functioned excellently, giving 2L0 on the loud-speaker at good volume, with employing an ordinary No. 50 plug-in coil for the frame aerial L1, fair loud-speaker strength without any trace of 2L0. Newcastle and Bournemouth, as well as certain Continental stations, also came in well, but Birmingham was extremely disappointing in strength, although on the outside aerial, reaction coil L3. Increasing the high tension on the oscillator valve improved results somewhat, but the station was still not up to expected strength. Increasing the size of L3, by five turns again increased volume from 5IT, but on going back to the lower wavelength stations, such as Cardiff, the set gave a continuous squeal. By cutting the former between the two coils and arranging that L3 could be moved, thus tightening or loosening the coupling as desired, the difficulty was finally overcome.

A Puzzling Combination of Faults

When only one fault is present in a receiver the behaviour of the set is often such that a ready diagnosis can be given. Occasionally, however, several faults are present at once, giving rise to very conflicting symptoms, which in most cases call for a thorough instrument test to locate successfully their causes. An interesting combination of faults, giving rise to some rather peculiar phenomena, occurred with a set employing the circuit shown in Fig. 3. It will be observed that the circuit is a perfectly straightforward one, consisting of a direct coupled detector valve with reaction, followed by one transformer and one

Fig. 2. — The Tropodyne arrangement employed with some receivers.

at a distance of 12 miles from the London station.

Variable Reaction Coupling

Employed on a 4-ft. frame Manchester was successfully obtained at this station is one of the best of the distant ones received in this district. From these results it was deduced that such poor reception from the Birmingham station was due to a too small

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choke coupled stage of note magnification.

Test on an Aerial

When completed the receiver was placed on the aerial for a test, a No. 35 coil being inserted in the aerial socket and a No. 50 for reaction. An ordinary "R" type valve was used as the detector, followed by a DE5B in the second socket and B4 in the last. The H.T. supply to the detector valve was 60 volts, whilst 120 were used on the last two valves, with 1½ volts grid bias for the first and 6 for the second.

Long Wave Morse Signals

Tuning in the normal manner in order to test on the London station, the distance to which was roughly fifteen miles, no traces of this station could be found, and only weak Morse was received. This appeared to be a jumble of long wave C.W. stations, to whose wavelengths the set should not have tuned. Occasionally faint strains of music could be heard, and with difficulty it was ascertained from an announcement that the station was 5XX. The very weak telephony received from this station was much distorted, although the values of grid bias for both valves were directly to L.T. negative, signal strength improved somewhat, but the distortion was more pronounced. No reaction could be obtained, even on reversing the leads to the reaction coil L. Tuning on C4 seemed to have no appreciable effect.

The Aerial Coil Suspected

From previous observations it was well known that the effect of removing the aerial coil from a receiver often results in a number of long wave Morse stations being heard. The aerial coil L1 was therefore removed and tested for con-
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Mr. PERCY W. HARRIS
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With the set removed from the cabinet but connected to the aerial in the normal manner and tuned to the local station tests were then carried out with a pair of telephones by connecting these first across the IP and OP terminals of the L.F. transformer. Signals at a satisfactory strength for a detector valve at the distance from the local station were obtained with the telephones in this position and purity was excellent. Next the second valve was lit and telephones connected across the choke coil to the points marked 1 and 2 in Fig. 3. Signals were again heard at good strength and purity, the normal step-up from valve to valve being obtained. This exonerated the detector part of the circuit, the low-frequency transformer and the second valve.

The Choke Coil

From the previous results it was obvious that the fault was located either in the choke coil Z, the coupling condenser C4, the grid leak R5, or the last valve.

The telephones were therefore left connected in parallel with the choke coil Z and the loud-speaker placed between the LS terminals and the last valve lit. With the normal values of grid bias, as previously indicated, signals on the loud-speaker were now of fair strength and purity. Volume was, however, up to that which should be expected from a 3-valve receiver. It showed, however, that the choke coil Z was the offender, and testing this for circuit with a pair of telephones and a dry cell only gave very faint "clicks." Testing across the secondary winding of the first transformer, for the sake of comparison, very much louder "plonks" were obtained in the telephones, thus showing the choke coil Z to be disconnected.

The Trouble Remedied

Careful examination of the two leads from the ends of the choke coil winding to its two terminals disclosed the fact that one was loose, and the removal of the outside covering of Empire cloth showed that corrosion had taken place at the point where the stout wire from one terminal was joined to the finer wire of which the choke was wound. This was apparently due to the use of acid flux and was soon remedied. When the repair had been effected and the choke coil replaced the receiver functioned excellently.

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**"Quality" Duplex Coils**

Messrs. Goswell Engineering Co., Ltd., have sent for practical test a set of their "Quality" duplex coils. These are double-basket coils, d.c. wire, mainly self-supporting, and are mounted on the customary plug-and-socket coil-base for use in coil-holders. The sizes submitted were the Nos. 25, 35, 50, 75, 100, 150, 175, 200, 250, 300, the last two being actually made up of two double-baskets mounted closely side by side for the sake of compactness. The No. 200 was, therefore, the largest, being 5 in. in diameter by about 3 in. thick; this and the No. 175 had a reinforcement of radial rods between the outer windings. On practical trial it was not found possible to obtain self-oscillation on a small single-wire outside aerial with the Nos. 25 or 35 in the grid-circuit, direct-coupled; No. 50 with No. 75 as reaction covered the ordinary short-wave range for the main stations with a .0005 µF. tuning-condenser in parallel, and distant coil reached about 97 kc. with the same reaction-coil. The short-wave coils appeared to be of medium resistance when tested; it is obvious that the inductance-value is in each case considerably below that of most commercial coils of the same turns-rating, in general a coil two sizes larger than usual being required. The appearance is neat and workmanlike, and it would appear as if the coils would stand quite a deal of handling, being securely mounted and tied. The price is quite moderate.

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"Varic" Variometer

FROM Messrs. Lionel Robinson & Co. we have received a sample of the "Varic" air-spaced variometer, in which both rotor and stator windings are of thick wire with insulation that gives good spacing, and are practically self-supporting. The instrument is about \( \frac{3}{4} \) in. diameter overall, and is designed for "mounting" behind the panel by two small screws and short brackets. A substantial plain spindle carries a knob-and-bevel scale, which are secured by a set-screw to the spindle. The frame of the instrument is built up on light fibre rings, giving a minimum of solid dielectric. It appears to be "sturdily" made; small terminals are provided for connections at the side of the frame, whilst good noiseless connection with the rotor windings is ensured by spring bearings. The available tuning-range, on an aerial of \( .0003 \mu \text{F} \) capacity, was found to be from about 1,500 to 3,00 microamperes for \( .34 \mu \text{F} \) capacity, a certain amount of casual panel capacity being present as well. In valve-reception, without reaction, by the Moullin voltmeter method, the signal-voltage recorded on the local station compared with that given by an optimum design of plug-in coil; in crystal reception the figure observed was 34 microamperes on the small single-wire aerial as against 35 microamperes for a large standard air-spaced low-loss variometer, and on the large high aerial of greater capacity, 114 microamperes as against 117 with the standard. The crystal was tapped across the whole inductance in these tests. The performance of this carefully designed variometer was, therefore, excellent, and it showed an unusually low H.F. resistance. It can be most heartily recommended for general use where a variable inductance is required, and should give every satisfaction so long as the windings are kept quite dry.

The "Anvil" Coll-Former

FROM Messrs. Burwood Electrical Supplies Co. (1924) we have received a sample of their "Anvil" coil-former, which is specifically intended for winding, at home, coils of the duo-lateral and honeycomb variety. This consists of a \( \frac{3}{4} \) in. diameter brass ring carrying two rows of radial screwed pins, 15 in each set and spaced \( \frac{3}{4} \) in. apart, but "staggered," on which the wire is wound in the familiar zigzag manner, counting either six or nine pins at each crossing. The finished coils, it is suggested, should be made rigid by means of cold lacquer before removal from the former. Suitable wire-sizes (commencing with No. 22 gauge) and turn-numbers are given in an accompanying pamphlet. The former is a well-finished substantial instrument; it is provided with a convenient wooden handle for use when winding; and the pins were firmly held, yet readily removable from the finished coil. It should prove well adapted for its purpose. Some question might conceivably arise in connection with the use of this apparatus for the construction of duolateral coils, in regard to possible patent infringements; however, it is evident that the same instrument can be used for making a variety of low-capacity coils.

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Radio Press News

There are many amateurs who are not content with simply knowing generally how to construct a set and how the set works. Particularly in view of the developments which are taking place nowadays, many enthusiastic experimenters desire to pursue the theory of wireless somewhat more deeply than they have previously done. While there are many textbooks already on the market, these books are often either too mathematical or else deal in too great detail with certain aspects of the problem of the theory of wireless.

Filling a Need

It is to meet this need in wireless literature that the latest Radio Press book, "Modern Wireless Communication," has been produced. This work, which has been prepared by Mr. J. H. Reyner, B.Sc. (Hons.), A.C.G.I., D.I.C., of the Radio Press staff, is designed specifically to appeal to the student who has a certain technical knowledge but who wishes to proceed somewhat farther. The book is written in a non-mathematical vein, but at the same time sufficient calculations are introduced to enable the student to design his own circuits and apparatus.

A further advantage of the book is that many of the more advanced chapters have been written in such a way that they may be completely omitted on a first reading of the book, without in any way destroying the sense or the continuity of the arrangement.

Elementary Conceptions

The book falls naturally into several sections. In the first section the elementary conception of an electric current is considered and the properties of capacity, inductance and resistance are dealt with in detail. The question of alternating and oscillating currents is then considered, and the mathematics of this portion of the subject is dealt with at some length. This is important, because it conveys a very clear idea of what is actually happening in a wireless transmitter or receiver, and a clear understanding of the elementary mathematics of the various processes is of considerable utility in some of the more complex applications of wireless. Resonant circuits and tuning, including the important subject of coupled circuits, are dealt with as a corollary to this section.

Wireless Transmission

The second section of the book commences with a very lucid description of the elementary principles of radio communication, illustrating how a wireless wave is generated and propagated from point to point. This is all done from a non-mathematical point of view. The principal types of spark transmitters in use to-day are then described, and a chapter on the reception of spark signals follows, in which the general principles underlying wireless reception are laid down.

The Valve

The thermionic valve is then discussed in some detail, the characteristics and the use of a valve as an amplifier, detector and oscillator being outlined. This naturally leads to the use of continuous waves for radio communication, and after a brief description of the continuous wave system the various forms of continuous wave transmitters, valve, arc and high frequency alternator are described.

Advanced Knowledge

The third section of the book deals with miscellaneous application of the art. A considerable space is devoted to the design and operation of valve amplifiers, and the question of radio telephony is discussed. Chapters follow on the use of frame aerials and direction finding equipment generally, losses in conductors, radio-frequency measurements, elimination of interference, high speed telegraphy, aerials and masts, and finally a short and somewhat more technical consideration of the propagation of the electric wave around the surface of the earth. In order to assist the serious student in obtaining some idea of the values used in practice, a series of examples is given at the end of the book, together with the necessary answers.

On the whole we think that this book will be extremely valuable to the great majority of wireless amateurs. It is written in such a way that the mathematics are very unobtrusive and can even be omitted if desired, but they are there when they are required.

November, 1925

Mullard Double Ring Dull Filament Valves

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<table>
<thead>
<tr>
<th>Coil No.</th>
<th>Inductance Microhenries</th>
<th>Self-Capacity to/mfds.</th>
<th>Approx. Wave Length</th>
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<td>2000</td>
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<table>
<thead>
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<th>Capacity</th>
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<tr>
<td>0.033 mfld.</td>
<td>5/-</td>
</tr>
<tr>
<td>0.081 mfld.</td>
<td>7/-</td>
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THE BIG STELLA LOUD SPEAKER.

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<tr>
<td>1 megohm</td>
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